California State Water Project
2021 Watershed Sanitary Survey Update
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State Water Contractors

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ACRONYMS AND ABBREVIATIONS

AAL -	archived advisory level
ACWD	Alameda County Water District
acre feet/year	acre-feet per year
AEWSD	Arvin-Edison Water Storage District
AIPCP	Aquatic Invasive Plant Control Program
APAP	aquatic pesticide application plan
APAR	aquatic pesticide application report
AVEK	Antelope Valley East Kern Water Agency
Banks	H.O. Banks Delta Pumping Plant
BBID	Bryon-Bethany Irrigation District
BCID	Banta Carbona Irrigation District
BLM	Bureau of Land Management
BMP	Best Management Practice
BOD	biochemical oxygen demand
BSPP	Barker Slough Pumping Plant
$CaCO_3$	calcium carbonate
Central Valley Regional Board –	Central Valley Regional Water Quality Control Board
CCF	Clifton Court Forebay
CCL	Contaminant Candidate List
CCWA	Central Coast Water Authority
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
CECs	Constituent of Emerging Concern
Cfs	cubic feet per second
CFU	colony forming units
CLAWA	Crestline Lake Arrowhead Water Agency
CLI	Clean Lakes Inc.
COC	constituent of concern
CVC	Cross Valley Canal
CVP	Central Valley Project
DBP	disinfection byproduct
DBW	California Dept. of Parks and Recreation, Division of Boating and Waterways
DCC	Delta Cross Channel
D/DBP	disinfectants/disinfection byproducts
DDW	Division of Drinking Water
Delta	Sacramento-San Joaquin Delta
Devil Canyon	Devil Canyon Afterbay
DLR	detection limit for purposes of reporting
DMC	Delta-Mendota Canal
DOC	dissolved organic carbon
DOM	dissolved organic matter

DPWD	Del Puerto Water District
DSM2	Delta Simulation Model 2
DV Check 7	Del Valle Check 7
DWR	California Department of Water Resources
EAV	emergent aquatic vegetation
EBRPD	East Bay Regional Parks District
EC	electrical conductivity
E. coli	*Escherichia coli*
EIR	Environmental Impact Report
FAV -	floating aquatic vegetation
FIB	Fecal indicator bacteria
FONSI	Finding of No Significant Impact
Gianelli	William R. Gianelli Pumping-Generating Plant
HA	health advisory
HAA	haloacetic acid
HAB	harmful algal bloom
HAA5	five haloacetic acids
HBSL	health based screening level
HHBP	human health benchmark for pesticides
HORB	head of Old River barrier
HRL	health reference level
IEP	Interagency Ecological Program
IESWTR	Interim Enhanced Surface Water Treatment Rule
IRWD	Irvine Ranch Water District
ITP	Incidental Take Permit
Jensen WTP	Joseph Jensen Water Treatment Plant
KWB	Kern Water Bank
KWBA	Kern Water Bank Authority
KWBC	Kern Water Bank Canal
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
KCWA	Kern County Water Agency
Kern	Kern Water Bank Authority
MAF	million acre-feet
MBR	membrane bioreactor
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
Mgd	million gallons per day
MIB	2-methylisoborneol
Mills WTP	Henry J. Mills Water Treatment Plant

MLE	modified Ludazk-Ettinger
MRL	method reporting limit
MWJWTP	Mission San Jose WTP
MWDSC	Metropolitan Water District of Southern California
MWQI	Municipal Water Quality Investigations
N	nitrogen
Napa County	Napa County Flood Control and Water Conservation District
NBA	North Bay Aqueduct
NBR	North Bay Regional
ND	nondetectable, non-detect
NDR	Northern Drainage Region
NL	notification level
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRWQC	National Recommended Water Quality Criteria
NTU	nephelometric turbidity unit
NVRRP	North Valley Regional Recycled Program
OEHHA	Office of Environmental Health Hazard Assessment
OMR	Old and Middle Rivers
ONF	O'Neill Forebay
O&M	DWR's Division of Operations and Maintenance
P	phosphorus
Pacheco	Pacheco Pumping Plant
PAHs	polyaromatic hydrocarbons
Palmdale	Palmdale Water District
PFAS	per- and polyfluoroalkyl substances
PHG	Public Health Goal
PID	Patterson Irrigation District
POA	percent of Aqueduct
POTW	Publicly owned treatment works
PPCP	pharmaceuticals and personal care products
PPWTP	Polonio Pass Water Treatment Plant
PTOX	potentially toxic cyanobacteria
RAA	running annual average
RL	response level
RMP	Regional Monitoring Program
RPC	relative percent change
RSL	regional screening level
RWCF	regional wastewater control facility

SAV	submersed aquatic vegetation
SBA	South Bay Aqueduct
SBPP	South Bay Pumping Plant
SCU	Santa Clara Unit
SCWA	Solano County Water Agency
SCV Water	Santa Clarita Valley Water Agency
SDWA	Safe Drinking Water Act
SL	screening level
SLWD	San Luis Water District
SRA	State Recreation Area
SRIBP	Strand Ranch Integrated Banking Project
SWRCB	California State Water Resources Control Board
SVI	Sacramento Valley Index
SWC	State Water Contractors
SWP	State Water Project
SWSD	Semitropic Water Storage District
SWTR	Surface Water Treatment Rule
TDS	total dissolved solids
Terminal Tank	Santa Clara Terminal Reservoir
THM	trihalomethanes
TKN	total kjeldahl nitrogen
TMDL	total maximum daily load
T&O	taste and odor
TOC	total organic carbon
TSS	total suspended solids
UCMR	Unregulated Contaminant Monitoring Rule
USEPA	United State Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service
Valley Water	Santa Clara Valley Water District
VAMP	Vernalis Adaptive Management Plan
VOC	volatile organic compounds
WDL	Water Data Library
WDR	waste discharge requirement
WERT	Watershed Emergency Response Team
WKWD	West Kern Water District
WPCF	water pollution control facility
WRMWSD	Wheeler Ridge Maricopa Water Storage District
WQCF	Wastewater Quality Control Facility
WQMP	Water Quality Management Plan
WSID	West Stanislaus Irrigation District
WTP	water treatment plant

WWTF	wastewater treatment facility
WWTP	wastewater treatment plant
WWD	Westlands Water District
Zone 7	Zone 7 Water Agency of the Alameda County Water Conservation and Flood Control District

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EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

The State Water Project (SWP) provides drinking water to approximately two-thirds of California's population and is the nation's largest state-built water development project. The SWP extends from the mountains of Plumas County in the Feather River watershed to Lake Perris in Riverside County. **Figure ES-1** shows the major features of the SWP. Six previous SWP watershed sanitary surveys were completed in 1990, 1996, 2001, 2006, 2011 and 2016 so the contaminant sources and water quality issues have been well documented. The California State Water Project Watershed Sanitary Survey, 2021 Update (2021 Update) focuses on updating the source water quality evaluation of the SWP through 2020 as well as special topics on wildfires, aquatic vegetation in the Delta, endothall treatments, Non-project turn-ins to the California Aqueduct and the Delta Mendota Canal, and the North Valley Regional Recycled Water Program.

Figure ES-1. The State Water Project

WATER QUALITY SUMMARY

Twelve chapters of the report address water quality constituents having the capacity to cause drinking water standards to be violated or to reduce the quality of drinking water supplies conveyed through the SWP. Although there are potentially numerous constituents in drinking water sources, the key water quality challenges facing the SWP Contractors that treat water from the SWP are the formation of disinfection byproducts, due to high concentrations of organic carbon and bromide in the source water, emerging contaminants such as PFAS and pharmaceutical and personal care products (PPCPs), as well as algal blooms, taste and odor problems, and operational problems. The water quality chapters are organized as follows:

- Chapter 2 – Water Quality Background
- Chapter 3 – Organic Carbon
- Chapter 4 – Salinity
- Chapter 5 – Bromide
- Chapter 6 – Nutrients
- Chapter 7 – Taste and Odor Incidents and Algal Toxins
- Chapter 8 – Turbidity
- Chapter 9 – Pathogens and Indicator Organisms
- Chapter 10 – Arsenic and Chromium
- Chapter 11 – Constituents of Emerging Concern
- Chapter 12 – Article 19 Constituents and Alkalinity
- Chapter 13 – Potential Contaminant Sources (Special Topics)

The Department of Water Resources (DWR) Municipal Water Quality Investigations (MWQI) Program and the Division of Operations and Maintenance (O&M) conduct a comprehensive water quality monitoring program of the Delta and the SWP facilities. The long period of record at many locations allows the data to be analyzed for spatial trends, long-term trends, and seasonal trends. Most of the data has been entered into DWR's Water Data Library. This online database is a valuable tool that provides easy access to the data shortly after it has been collected.

Chapters 3 through 12 contain detailed analysis of the water quality data collected in the watersheds, the Delta, and the SWP facilities. Each of those chapters ends with a summary of the key findings from the data analysis. Those summaries are also presented in this section to provide the reader with a brief overview of water quality in the SWP. Chapter 13 presents the special topics on wildfires, aquatic vegetation in the Delta, endothall treatments, Non-project turn-ins to the California Aqueduct and the Delta Mendota Canal, and the North Valley Regional Recycled Water Program.

WATER QUALITY TRENDS

Spatial Trends

The data were analyzed to determine if water quality changes as the water flows down the Governor Edmund G. Brown California Aqueduct (California Aqueduct) and is stored in reservoirs. Factors that could potentially affect water quality include:

- North Bay Aqueduct (NBA) – The NBA is an enclosed pipeline so water quality should not change between Barker Slough and the water treatment plant intakes.

- Banks to South Bay Aqueduct (SBA) Terminal Tank – Water from Lake Del Valle enters the SBA below Del Valle Check 7 (DV Check 7). This primarily affects SBA water quality in the fall months when releases are made to the SBA.

- Banks to O'Neill Forebay – There are no inputs to the California Aqueduct in this reach.

- O'Neill Forebay and San Luis Reservoir – Water from the Delta-Mendota Canal (DMC) mixes with water from the California Aqueduct in O'Neill Forebay. Storage in San Luis Reservoir and the timing of filling and releases from the reservoir can potentially impact water quality.

- San Luis Canal Reach of the California Aqueduct – Local streams that run eastward from the Coastal Range Mountains bisect the aqueduct at various points. During storms, water from some of these streams enters the aqueduct. Additionally, non-Project inflows from Westlands Water District may enter from Check 13 to Check 21, but only in years in which Westlands' Central Valley Project allocation is 20 percent or less.

- Coastal Branch of the California Aqueduct – The Coastal Branch is 115 miles long; the first 15 miles are open aqueduct and the remainder is a pipeline. No drainage enters the open canal section.

- California Aqueduct between Check 21 and Check 41 – This reach of the aqueduct is used to convey both surface water and groundwater non-Project inflows acquired through transfers and exchanges among local agencies. The quality of the non-Project inflows can affect the quality of the water in the aqueduct.

- West Branch of the California Aqueduct – Pyramid and Castaic lakes provide almost 500,000 acre-feet of storage, which greatly reduces the fluctuations in water quality seen in the aqueduct. Natural inflow from the watersheds of the reservoirs can affect water quality during substantial storm events.

- East Branch of the California Aqueduct – Silverwood Lake has a capacity of only 74,970 acre-feet and does not moderate water quality the way the West Branch reservoirs do. Natural inflow from its watershed can affect water quality at times. Additionally, drainage into the East Branch occurs from direct drains in the Hesperia area.

This analysis included an evaluation of all of the data at each monitoring location. Each chapter provides a table indicating the data available and evaluated for each location. The data collected during comparable periods of time at all locations were analyzed to draw conclusions about spatial trends. Generally, the time periods compared for most monitoring locations was 1998 to 2020. The data were statistically analyzed using the non-parametric Mann-Whitney test which determines if the data sets being compared are statistically different. The median concentrations are representative of the entire data set. The key findings for spatial trends are:

- The median total organic carbon (TOC) concentration of 3.5 mg/L at Banks is the same as the median concentration of 3.5 mg/L at DV Check 7. Once the water enters the California Aqueduct, TOC concentrations generally do not change appreciably. Median TOC concentrations along the California Aqueduct range from 3.0 to 3.4 mg/L. Water from the DMC (measured at McCabe) has a median TOC of 3.35 mg/L, and is not statistically significantly different from Banks. Median TOC at Pacheco Pumping plant, on the west end of San Luis Reservoir, is also 3.5 mg/L. Large volumes of low TOC groundwater and surface water are allowed to be pumped into the aqueduct between Checks 21 and 41, particularly in dry years. Therefore, median TOC at Check 41 is 3.0 mg/L, statistically significantly lower than the median TOC of 3.2 mg/L at Check 21. The median TOC concentration of 2.9 mg/L at Castaic Outlet is statistically significantly different from the median concentration of 3.0 mg/L at Check 41 during the 1998 to 2020 period. This may be due to the dampening effects of storage in the lake or to inflows from the local watershed. The median concentration of 3.1 mg/L at Devil Canyon is not statistically significantly different from the median concentration of 3.0 mg/L at Check 41 during the 1998 to 2020 period that data have been collected at both locations. Since the capacity of Silverwood Lake is small in comparison to the West Branch reservoirs, the dampening effect seen in the West Branch is not seen in the East Branch.

- Electrical conductivity (EC) concentrations do not change (are not statistically significant) from Banks to DV Check 7. The median EC concentration of 410 µS/cm at Banks is similar to the median EC concentration of 405 µS/cm at DV Check 7. Changes to EC in the California Aqueduct and SWP reservoirs are complex. There is a statistically significant increase of 65 µS/cm between Banks and O'Neill Forebay Outlet due to storage in San Luis Reservoir and to mixing with water from the more saline DMC in O'Neill Forebay. Water from the DMC (measured at McCabe) has a median EC of 465 µS/cm, and is statistically significantly higher than Banks. Median EC at Pacheco Pumping plant, on the west end of San Luis Reservoir, is 504 µS/cm. The higher EC in San Luis Reservoir is likely due to a combination of evaporation in the reservoir and pumping of water into the reservoir during the fall and winter months when Delta salinity is high. However, there is not a significant change in median EC between O'Neill Forebay Outlet (475 µS/cm) and Check 21 (473 µS/cm). EC levels at Check 21 and Check 41 are generally similar when there are no pump-ins, yet EC decreases at Check 41 with higher volumes of non-Project water pumped into the Aqueduct, particularly during extended dry periods. The median EC at Castaic Lake Outlet (Castaic Outlet) is 37 µS/cm higher than at Check 41 but there is no significant change between Check 41 and Devil Canyon Afterbay (Devil Canyon).

- There is a statistically significant decrease in bromide concentrations between Banks (median of 0.20 mg/L) and DV Check 7 (median of 0.16 mg/L). It is likely that bromide concentrations decrease from Banks to DV Check 7 as water leaving Banks enters Bethany Reservoir and is mixed and diluted within Bethany Reservoir, and then additional dilution occurs if water enters Dyer Reservoir, or Dyer releases water into the SBA. With the exception of DV Check 7 and Pacheco, bromide does not change significantly between Banks and Check 21. The median bromide concentration at Pacheco is 0.24 mg/L, which was statistically significantly higher than the Banks median of 0.20 mg/L. The higher bromide concentrations in San Luis Reservoir are likely due to a combination of evaporation in the reservoir and pumping of water into the reservoir during periods when Delta bromide concentrations are high. The median bromide concentration of 0.20 mg/L at Check 41 is statistically lower from the median bromide concentration of 0.22 mg/L at Check 21. Similar to EC, bromide levels at Check 21 and Check 41 are generally similar when there are no pump-ins, yet bromide decreases at Check 41 with higher volumes of non-Project water pumped into the Aqueduct, particularly during extended dry periods. The median bromide concentration at Castaic Outlet of 0.22 mg/L is not statistically different from the median bromide concentration of 0.20 mg/L at Check 41. The median bromide concentration at Devil Canyon of 0.20 mg/L is not statistically different from the median bromide concentration of 0.20 mg/L at Check 41.

- Turbidity levels are quite variable as water moves down the aqueduct but the impact of settling in reservoirs is quite apparent in that median turbidity levels in the reservoirs are 1 to 2 NTU. Median turbidities along the SWP ranged from 2 to 8 NTU, with Banks having a median turbidity of 8 NTU, and Barker Slough had the highest median turbidity of 30 NTU.

- Higher nutrient concentrations at McCabe compared to Banks is due to the higher nutrient concentration in the San Joaquin River, which has a higher source water influence at Jones and also McCabe.

- Total phosphorus (total P) concentrations do not change as water flows from the Delta through the SBA and the California Aqueduct, except from Check 21 to Check 41 and Check 41 to Castaic Outlet. The median total P concentration of 0.08 mg/L at Check 41 is statistically lower from the median total P concentration of 0.09 mg/L at Check 21, due to the introduction of non-Project inflows between Checks 21 and 41. The median total P concentration at Castaic Outlet of 0.04 mg/L is statistically lower from the median total P concentration of 0.08 mg/L at Check 41. The median total P concentration at Devil Canyon of 0.08 mg/L is not statistically different from the median total P concentration of 0.08 mg/L at Check 41. Median total P concentrations are generally less than 0.1 mg/L throughout the system, with the exception of Barker Slough which has a median total P of 0.2 mg/L.

- Median total nitrogen (total N) concentrations are generally less than1.0 mg/L throughout the system. The median total N concentration of 0.88 mg/L at Check 13 is statistically higher from the median total N concentration of 0.80 mg/L at Banks, due to the introduction of DMC water to O'Neill Forebay. Higher nutrient concentrations at McCabe compared to Banks is due to the higher nutrient concentration in the San Joaquin River. Total N concentration increases from Check 21 to Check 41, as the median total N concentration of 1.00 mg/L at Check 41 is statistically higher than the median total N concentration of 0.81 mg/L at Check 21, due to the introduction of non-Project inflows between Checks and 21 and 41. Total N concentration decreases from Check 41 to Castaic Outlet, as the median total N concentration of 1.00 mg/L at Check 41 is statistically higher than the median total N concentration of 0.63 mg/L at Castaic Outlet. This reflects the effect of reservoir storage to moderate a range of nutrient concentrations. The median total

N concentration at Devil Canyon of 0.90 mg/L is not statistically different from the median total N concentration of 1.00 mg/L at Check 41.

Wet Year and Dry Year Trends

The data were analyzed to determine if there are water quality differences between wet years and dry years. Wet years are defined as those that are classified by DWR as wet and above normal. Dry years are defined as those that are classified as below normal, dry, and critical.

- Dry year TOC concentrations are statistically significantly higher than wet year concentrations at Hood, Vernalis, Banks, DV Check 7, McCabe, Gianelli, Check 13, and Check 21. There is no significant difference in wet and dry years at Pacheco and Devil Canyon. Dry year concentrations are statistically significantly lower than wet year concentrations at Check 41 and Castaic Outlet. Large volumes of low TOC groundwater and surface water are allowed to be pumped into the aqueduct between Checks 21 and 41, particularly in dry years, which can explain the lower TOC concentrations at Check 41 in dry years.

- EC levels during dry years are statistically significantly higher than EC levels during wet years at all locations except Barker Slough and Castaic Outlet. The higher levels during dry years are due to less dilution of agricultural drainage, urban runoff, and treated wastewater discharged to the rivers and Delta during low flow periods and to seawater intrusion in the Delta during periods of low Delta outflow. Barker Slough is influenced more by the local watershed than by differences in Delta conditions in different year types. There is little variability in Castaic due to the dampening effects of storage.

- Bromide concentrations during dry years are statistically significantly higher than bromide concentrations during wet years at all locations except Barker Slough and Pacheco. There are no statistically significant differences between year types at these two locations. The median bromide concentrations during dry years are 50 to 60 percent higher than the median concentrations during wet years. This is due to greater seawater intrusion in the Delta during periods of low Delta outflow.

- Turbidity levels are statistically significantly lower during dry years than wet years at most locations that were included in this analysis. Wet years generally increase turbidity due to erosion and watershed runoff. There was no statistically significant difference between dry and wet years for San Luis Reservoir at Pacheco and at Castaic Outlet, due to the dampening effect of the reservoirs.

- For total P and total N, the effect of dry versus wet years is more pronounced at the locations representing the inputs to the Delta, or a local watershed such as Barker Slough. At these locations (Hood, Vernalis, McCabe) the total N concentrations are generally higher in dry years, with Barker Slough and Pacheco as the exception, having higher total N in wet years compared to dry years. Total P is also higher in dry years at Hood, Vernalis, and McCabe, but higher in wet years at Pacheco, and no difference between wet and dry years at Barker Slough. Once the water enters the California Aqueduct at Banks, there is no statistically significant effect of dry versus wet years for both total P and total N as the water moves from Banks, DV Check 7, Check 13 and Check 21. Check 41 has higher total N and lower total P in dry years due to the impact from non-Project inflows which occur more frequently in dry years.

Summaries of the water quality analyses for each constituent are provided below:

ORGANIC CARBON

- The DOC fingerprints indicate that the San Joaquin River is the primary source of DOC at the south Delta pumping plants when flows on that river are high. During dry years, the Sacramento River has more influence on DOC concentrations at the pumping plants. Delta agricultural drainage is also a source of DOC at the pumping plants.

- The median TOC concentration of 1.9 mg/L is the same at Hood and West Sacramento. This is despite the fact that the high quality American River (median of 1.6 mg/L) enters the Sacramento River between these two locations. This is likely due to the fact that urban runoff and treated wastewater from the Sacramento urban area are discharged to the river between West Sacramento and Hood. The median TOC concentration of 3.3 mg/L at Vernalis is statistically significantly higher than the median concentration of 1.9 mg/L at Hood.

- TOC concentrations are much higher in the NBA than any other location in the SWP. The concentrations range from 1.3 to 43 mg/L, with a median of 4.6 mg/L. The local Barker Slough watershed is the source of this TOC.

- TOC concentrations do not change as water leaves Banks and flows through the SBA and the California Aqueduct. The concentrations at DV Check 7 range from 1.5 to 9.2 mg/L during the period of record with a median of 3.5 mg/L.

  The median TOC concentrations along the aqueduct from Check 13 to Check 41 range from 3.0 to 3.3 mg/L. Generally, San Luis Reservoir and Castaic Lake have less variability in TOC concentrations than the aqueduct due to the dampening effect of reservoir mixing. TOC concentrations at Check 21 and Check 41 are generally similar when there are no non-Project water pump-ins between the two locations. However, TOC decreases from Check 21 to Check 41 when high volumes of non-Project water are pumped into the Aqueduct between the two locations.

- Water agencies treating SWP water in conventional water treatment plants must remove TOC from their influent water based on the TOC and alkalinity concentrations of the source water. Agencies treating NBA water typically remove 35 percent of the TOC and at times, are required to remove up to 50 percent of the TOC.

- Based on the average TOC and alkalinity concentrations at DV Check 7, the water agencies treating SBA water must remove 35 percent of the TOC. When the source water alkalinity is 60 mg/L or less, and the source water TOC is greater than 4 mg/L (but less than 8 mg/L), 45 percent TOC removal must be achieved. Over the 60 months from January 2016 to December 2020, this occurred in five months (January to March 2017, April 2018 and June 2018).

- Based on the average TOC and alkalinity concentration at Check 13, the downstream water agencies treating SWP water in conventional water treatment plants must remove 25 percent of the TOC. In January and February 2017, alkalinity concentrations dropped below 60 mg/L when TOC concentrations exceeded 4.0 mg/L leading to the requirement to remove 45 percent of the TOC in the source water.

- The real-time analyzers at Hood, Vernalis, Banks, and Gianelli provide valuable information on the variability of TOC concentrations at these locations. The real-time monitoring data compare well with the grab sample data collected on the same day, with R squared values ranging from 0.7636 to 0.8995.

- Time series graphs at all of the other key locations were visually inspected to determine if there are any discernible trends. There are no apparent long term trends at most of the locations included in this analysis. There was an increasing trend from 2012 to 2015 for most sites, but that increasing trend was halted due to the wet year of 2017.

- Over the past 10 years, there were a number of locations where the maximum TOC occurred in either 2014, 2015 or 2016 as a result of consecutive years of dry water years since 2012. For example:
    - Hood maximum TOC concentration of 9.1 mg/L was measured in December 2014.
    - Vernalis maximum TOC concentration of 14.1 mg/L was measured in December 2016.
    - DV Check 7 maximum TOC concentration of 7.6 mg/L was measured in April 2016.
    - Pacheco maximum TOC concentration of 5.9 mg/L was measured in September 2015.
    - McCabe maximum TOC concentration of 7.8 mg/L was measured in March 2014.
    - Gianelli maximum TOC concentration of 8.4 mg/L was measured in March 2016.

- As shown in **Table ES-1**, dry year concentrations are statistically significantly higher than wet year concentrations at Hood, Vernalis, Banks, DV Check 7, McCabe, Gianelli, Check 13, and Check 21. There is no significant difference in wet and dry years at Pacheco and Devil Canyon. Wet year concentrations are statistically significantly higher than dry year concentrations at Check 41 and Castaic Outlet.

- There is a distinct seasonal pattern in TOC concentrations in the Sacramento River, the Delta, and the aqueducts. High concentrations (5 to 9 mg/L) occur during the wet season and low concentrations (2 to 3 mg/L) occur in the summer through fall months. Lower TOC concentrations in summer through fall is likely due to the operation of the Delta Cross Canal, which is open from June 16 to November 30, providing higher quality water from the Sacramento River. Vernalis has a slightly different pattern with both winter and summer peaks. The summer peak is attributed to agricultural drainage entering the river during low flow periods. Castaic Lake displays a different seasonal pattern. Concentrations are highest in the summer months and lowest in the winter months.

Table ES-1. Comparison of Dry Year and Wet Year TOC Concentrations

	Median TOC, mg/L				
Location	**Dry Years**	**Wet Years**	**TOC Difference (mg/L)**	**Percent Difference**	**Statistical Significance**
Hood	2.1	1.8	0.3	14%	D>W
Vernalis	3.4	3.2	0.2	6%	D>W
Banks	3.8	3.15	0.65	17%	D>W
Barker Slough	4.3	5.9	-1.6	-37%	D<W
DV Check 7	3.7	3.25	0.45	12%	D>W
McCabe	3.4	3.2	0.2	6%	D>W
Pacheco	3.5	3.5	0	0%	No
Gianelli	4.2	3.3	0.9	26%	D>W
Check 13	3.4	3.2	0.2	6%	D>W
Check 21	3.3	3.1	0.2	7%	D>W
Check 41	3.0	3.1	-0.1	-4%	D<W
Castaic Outlet	2.8	3.0	-0.2	-7%	D<W
Devil Canyon	3.0	3.2	-0.2	-7%	No

SALINITY

- The EC fingerprints indicate that the San Joaquin River, seawater intrusion, and Delta agricultural drainage are the primary sources of EC at the south Delta pumping plants. The San Joaquin River has a greater influence on EC at Jones than at Clifton Court.

- The median EC at Hood (156 µS/cm) remained low, similar to historic data. EC levels at Vernalis (median of 609 µS/cm) are statistically significantly higher than the levels in the Sacramento River.

- EC levels in the NBA are higher and more variable than at Hood but lower than the levels at Banks. Elevated EC levels during the spring months are associated with base flows from sodic soils in the upstream Barker Slough watershed.

- EC levels in the SBA are similar to Banks, with levels ranging from 111 to 894 µS/cm and a median of 406 µS/cm. EC tends to increase in the fall months.

- Because different periods of record are available at sampling locations, it is difficult to compare all of the location using the same time period. However, the majority of locations can be compared using a common data set from 1997 to 2020. These are the 1997 to 2020 EC medians; Banks at 410 µS/cm, DV Check 7 at 406 µS/cm, McCabe at 467 µS/cm, O'Neill Forebay Outlet at 476 µS/cm, Check 21 at 474 µS/cm, Check 41 at 455 µS/cm, and Devil Canyon at 456 µS/cm. The 1997 to 2020 medians show an increase in EC moving downstream. There is a statistically significant increase between Banks and McCabe, most likely due to the influence of the San Joaquin River at Jones. There is a statistically significant decrease between Check 21 and 41, most likely due to non-Project inflows of lower EC water introduced between Check 21 and Check 41.

- EC levels at Castaic Outlet are less variable than the aqueduct locations, due to the dampening effect of about 500,000 acre-feet of storage on the West Branch. The dampening effect is not seen in Silverwood Lake on the East Branch due to its limited hydraulic residence time. The median EC at Castaic Outlet is statistically significantly higher than Check 41.

- There are a number of real-time monitoring locations in the watersheds, along the California Aqueduct, and in the reservoirs. There is good correspondence between the grab sample and real-time EC data at most locations, poorer correspondence at Castaic.

- Time series graphs at each key location were visually inspected to determine if there are any discernible long-term trends. The only long-term trends observed in the data are related to hydrology, with EC increasing during dry years and decreasing during wet years at most sites. All of the dry year medians decreased from the 2016 WSS for all locations. All of the wet year medians decreased from the 2016 WSS for all locations, except Pacheco and Castaic Outlet which were essentially unchanged.

- There were a number of locations where the maximum EC concentration over the entire period of record occurred during the study period. For example:
    - Barker Slough maximum EC concentration of 826 µS/cm was measured in March 2017.
    - Pacheco maximum EC concentration of 708 µS/cm was measured in January 2016.
    - Check 41 maximum EC concentration of 722 µS/cm was measured in February 2019.
    - Castaic Outlet maximum EC concentration of 651 µS/cm was measured in February 2016.
    - Devil Canyon maximum EC concentration of 645 µS/cm was measured in January 2016.

- EC levels during wet years are statistically significantly lower than EC levels during dry years at all locations except Barker Slough and Castaic Outlet, as shown in **Table ES-2**. The higher levels during dry years are due to less dilution of agricultural drainage, urban runoff, and treated wastewater discharged to the rivers and Delta during low flow periods and to seawater intrusion in the Delta during periods of low Delta outflow. Barker Slough is influenced more by the local watershed than by differences in Delta conditions in different year types. There is little variability in Castaic due to the dampening effects of storage.

- There are distinct seasonal patterns in EC levels but they vary between locations. On the Sacramento River, EC levels are lowest in the early summer, increase in the fall and then decrease during the spring months. On the San Joaquin River, EC levels are lowest in the spring during the Vernalis flow requirements stipulated in Decision 1641, increase during the summer months due to agricultural drainage discharges, continue to climb during the fall due to seawater intrusion, and remain high until late winter or early spring when flow increases on the river. The seasonal pattern at Banks is similar to the Sacramento River with the lowest levels in July and the highest levels in December. The pattern seen at Banks is seen at most of the other locations except below San Luis Reservoir there is a bimodal seasonal pattern with a secondary peak in EC during May and June. Large amounts of water are released from the reservoir during these months, resulting in higher EC levels in the California Aqueduct.

Table ES-2. Comparison of Dry Year and Wet Year EC Levels

	Median EC (µS/cm)				
Location	**Dry Years**	**Wet Years**	**EC Difference (µS/cm)**	**Percent Difference**	**Statistical Significance**
Hood	165	142	23	14%	D>W
Vernalis	698	392	306	44%	D>W
Banks	486	293	193	40%	D>W
Barker Slough	286	292	6	2%	No
DV Check 7	486	300	186	38%	D>W
McCabe	552	314	238	43%	D>W
Pacheco	521	495	26	5%	D>W
Gianelli	549	435	114	21%	D>W
O'Neill Forebay Outlet	531	373	158	30%	D>W
Check 21	506	374	132	26%	D>W
Check 41	483	350	133	28%	D>W
Castaic Outlet	476	493	17	3%	No
Devil Canyon	491	369	122	25%	D>W

BROMIDE

- Bromide concentrations in the Sacramento River are low, often at or near the detection limit of 0.01 mg/L. Bromide concentrations in the American River were non-detectable from 1997 to 2020. Conversely, bromide concentrations are high in the San Joaquin River (median of 0.22 mg/L).

- Bromide concentrations in the NBA are higher and more variable than at Hood but substantially lower than the levels at Banks. The Barker Slough watershed is the source. The median bromide concentration at Barker Slough is 0.04 mg/L.

- The median concentration of bromide at Banks (0.20 mg/L) is not statistically significantly lower than the median of 0.22 mg/L at Vernalis.

- The median bromide concentration at Banks (0.20 mg/L) is statistically significantly higher than the median bromide concentration at DV Check 7 (0.16 mg/L).

- The median bromide concentration at Banks (median of 0.20 mg/L) is statistically lower than the median bromide concentration at Pacheco (median of 0.24 mg/L).

- Bromide concentrations in the DMC at McCabe (median of 0.19 mg/L) and at O’Neill Forebay Outlet are not statistically significantly different from Banks. Bromide does not change statistically significantly between O’Neill Forebay Outlet Check 13 and Check

21. However, Check 41 is statistically significantly lower in bromide than Check 21, due to large volumes of low bromide groundwater and surface water turned-into the Aqueduct between Check 21 and Check 41. Bromide concentrations at Check 41 are not statistically different compared to Castaic Outlet and Devil Canyon. Bromide concentrations in Castaic Lake are slightly less variable than the aqueduct locations; however, the dampening effect is not seen in Silverwood Lake.

- The real-time analyzers at Vernalis, Banks, and Gianelli provide valuable information on the variability of bromide concentrations at these locations. The real-time monitoring data compare well with the grab sample data collected on the same day, with R squared values ranging from 0.8821 to 0.9835.

- Bromide concentrations are a function of the hydrology of the system. Time series graphs at all of the other key locations were visually inspected to determine if there are any discernible trends. There are no apparent long term trends at most of the locations included in this analysis. Bromide concentrations increase during dry years and decrease during wet years. Consecutive dry years from 2012 to 2015 resulted in an increasing bromide during these years. However, an overall decrease in bromide began in the wet year of 2017, as there was more fresh water available from the Sacramento and San Joaquin Rivers, lessening seawater intrusion into the Delta.

- Bromide concentrations during dry years are statistically significantly higher than bromide concentrations during wet years at all locations except Barker Slough, as shown in **Table ES-3**. There are no statistically significant differences between year types at this location. The median bromide concentrations during dry years are 50 to 60 percent higher than the median concentrations during wet years. This is due to seawater intrusion in the Delta during periods of low Delta outflow.

- There are distinct seasonal patterns in bromide concentrations but they vary between locations. At Barker Slough, bromide concentrations increase during the spring months due to groundwater and subsurface flows from the Barker Slough watershed and then decrease throughout the summer and fall months. On the San Joaquin River, concentrations reach minimum levels in April and May due to spring pulse flow requirements under D-1641. The concentrations then increase throughout the summer, fall, and early winter months. Concentrations are low at Banks from February through July and then increase steadily throughout August, fall, and early winter months due to the discharge of agricultural drainage and seawater intrusion. Downstream of San Luis reservoir, bromide concentrations show the same pattern as Banks except there is a secondary peak in May and June due to the release of large amounts of water from San Luis Reservoir.

Table ES-3. Comparison of Dry Year and Wet Year Bromide Concentrations

	Median Bromide mg/L				
Location	**Dry Years**	**Wet Years**	**Bromide Difference (mg/L)**	**Percent Difference**	**Statistical Significance**
Vernalis	0.26	0.12	0.14	54%	D>W
Banks	0.26	0.095	0.165	63%	D>W
Barker Slough	0.04	0.04	0	0%	No
DV Check 7	0.21	0.1	0.11	52%	D>W
McCabe	0.24	0.1	0.14	58%	D>W
Pacheco	0.25	0.24	0.01	4%	No
Gianelli	0.23	0.14	0.09	39%	D>W
Check 13	0.26	0.13	0.13	50%	D>W
Check 21	0.25	0.14	0.11	44%	D>W
Check 41	0.2	0.13	0.09	41%	D>W
Castaic Outlet	0.22	0.2	0.03	14%	D>W
Devil Canyon	0.2	0.14	0.09	39%	D>W

NUTRIENTS

- Source modeling of nitrogen and phosphorus identifies agriculture, atmospheric deposition, and wastewater effluent as sources of total nitrogen in the Central Valley. Geologic sources, agriculture, and wastewater discharge are the primary sources of phosphorus (Saleh and Domagalski, 2021).

- Nutrient concentrations increase considerably in the Sacramento River between West Sacramento and Hood, despite the inflow of the high quality American River, due mainly to the discharge from the Sacramento Regional Wastewater Treatment Plant. The median concentrations of total N (0.71 mg/L) and total P (0.08 mg/L) at Hood are statistically significantly higher than the median concentrations of total N (0.29 mg/L) and total P (0.05 mg/L) at West Sacramento. Total N and total P concentrations in the San Joaquin River are considerably higher and more variable than concentrations in the Sacramento River. The median total N concentration at Vernalis of 1.8 mg/L is the highest in the SWP system. The total P median is 0.14 mg/L, almost twice the level found at Hood.

- Nutrient concentrations in the NBA are higher compared to the Sacramento River at Hood. The median total N concentration at Barker Slough is 0.79 mg/L and the median total P concentration is 0.20 mg/L. The highest concentrations occur in the winter months due to the influence of runoff from the local Barker Slough watershed.

- Total N and total P concentrations in water exported from the Delta at Banks are sufficiently high to cause algal blooms in the aqueducts and downstream reservoirs.

- Nutrient concentrations do not change as water flows from Banks through the SBA due to the short travel time. Median total N concentrations increase from 0.73 mg/L at Banks to 0.885 mg/L at O'Neill Forebay Outlet (Check 13) and the increase is statistically significant (Mann-Whitney, *p*=0.012). The increase of total N at Check 13 is likely due to the introduction of DMC water at O'Neill Forebay, as the median total N concentration of 1.02 mg/L at McCabe is statistically significant higher than the median concentration of 0.69 mg/L at Banks (Mann-Whitney, *p*=0.0000).

- Median total P concentrations at Banks and Check 13 are the same, with a median of 0.09 at both locations. There are no substantial changes in nutrient concentrations as water moves from Check 13 to Check 21. Median total N concentrations increased from 0.81 mg/L at Check 21 to 1.00 mg/L at Check 41 and the increase is statistically significant (Mann-Whitney, *p*=0.0001). There is a statistically significant decrease in total P concentrations from a median of 0.09 mg/L at Check 21 to a median of 0.08 mg/L at Check 41 (Mann-Whitney, *p*=0.000). These changes are due to introduction of turn-in water between Check 21 and Check 41, most evident in dry years when turn-in volumes are higher. Typically, there are higher nitrate concentrations in turn-in water compared to Aqueduct water, and conversely, lower P concentrations in turn-in water compared to Aqueduct water.

- Median nutrient concentrations are substantially lower at Castaic Outlet (total N is 0.62 mg/L and total P is 0.04 mg/L). Algal uptake and subsequent settling of particulate matter may be responsible for the lower nutrient concentrations in the terminal reservoirs. Median total N concentrations are statistically significantly lower at Devil Canyon compared to Check 41 (Mann-Whitney, *p*=0.007), however the total P median concentration at Check 41 of 0.080 mg/L is not statistically significant compared to the total P median concentration of 0.076 mg/L at Devil Canyon.

- Concentrations of total N over the recent 5 year reporting period remained within historical range for all locations except for Hood and Barker Slough. Total N reached a new maximum concentration of 2.44 mg/L at Hood in June 2018, as well as a new maximum concentration of 3.23 mg/L at Barker Slough in January 2016.

- Concentrations of total P over the recent 5 year reporting period remained within historical range for all locations except for Vernalis and Castaic Lake Outlet. Total P reached a new maximum concentration of 0.89 mg/L at Vernalis in December 2016, as well as a new maximum concentration of 0.26 mg/L at Castaic Lake Outlet in November 2016.

- As shown in **Tables ES-4** and **ES-5**, the effect of dry versus wet years is more pronounced at the locations representing the inputs to the Delta, or a local watershed such as Barker Slough. At these locations (Hood, Vernalis, McCabe) the total N concentrations are generally higher in dry years, with Barker Slough and Pacheco as the exception, having higher total N in wet years compared to dry years. Total P is also higher in dry years at Hood, Vernalis, and McCabe, but higher in wet years at Pacheco, and no difference between wet and dry years at Barker Slough. Once the water enters the

California Aqueduct at Banks, there is no statistically significant effect of dry versus wet years for both total P and total N as the water moves from Banks, DV Check 7, Check 13 and Check 21. Check 41 has higher total N and lower total P in dry years due to the impact from non-Project inflows which occur more frequently in dry years.

Table ES-4. Comparison of Dry Year and Wet Year Total N Concentrations

	Median Total N (mg/L)		
Location	**Dry Years**	**Wet Years**	**Statistical Significance**
Hood	0.79	0.56	D>W
Vernalis	1.85	1.25	D>W
Banks	0.84	0.76	No
Barker Slough	0.74	0.84	W>D
DV Check 7	0.81	0.78	No
McCabe	1.09	0.84	D>W
Pacheco	0.84	1.02	W>D
O'Neill Forebay Outlet	0.92	0.80	No
Check 21	0.92	0.80	No
Check 41	1.1	0.88	D>W
Castaic Outlet	0.66	0.56	D>W
Devil Canyon	0.93	0.82	No

Table ES-5. Comparison of Dry Year and Wet Year Total P Concentrations

	Median Total P (mg/L)		
Location	**Dry Years**	**Wet Years**	**Statistical Significance**
Hood	0.08	0.07	D>W
Vernalis	0.14	0.115	D>W
Banks	0.1	0.1	No
Barker Slough	0.19	0.21	No
DV Check 7	0.1	0.09	No
McCabe	0.12	0.09	D>W
Pacheco	0.09	0.10	W>D
O'Neill Forebay Outlet	0.09	0.09	No
Check 21	0.09	0.10	No
Check 41	0.08	0.1	W>D
Castaic Outlet	0.04	0.03	No
Devil Canyon	0.07	0.09	W>D

- Seasonal trends also vary throughout the system. Total N shows a stronger seasonal pattern than total P. Generally the same seasonal pattern for total N remains throughout from Banks, DV Check 7, Pacheco, McCabe, Check 13 and Check 21. Total N concentrations are high in the winter months (January to March), decline in the spring and summer, and increase during the fall months. The seasonal pattern weakens at Check 41 likely due to non-Project inflows. Generally the same seasonal pattern for total P remains throughout from Banks, DV Check 7, and Check 21. Total P is more stable at Pacheco and Check 13. Total P concentrations are slightly higher in the winter months, decline in the spring and then have a secondary peak in July or August before declining through the fall. Seasonal impacts are impacted by Vernalis Adaptive Management Plan (VAMP) flows on the San Joaquin River in April and May, as well as agriculture drainage in the summer months.

TASTE AND ODOR INCIDENTS AND ALGAL TOXINS

Taste and Odor Incidents

- With the exception of the southern reservoirs, 2-methylisoborneol (MIB) was detected less frequently over the threshold value of 8 ng/L than geosmin. This represents a change as MIB has historically been more problematic than geosmin.
- Although taste and odor compounds may be traced to an upstream source, subsequent growth in Clifton Court forebay, along the Aqueduct, and in reservoirs may also occur, so the source may not be always clear.
- Over the past ten years, a large majority of sites along the SWP had their peak MIB or peak geosmin concentration occur during the extended drought from 2012 to 2016.
- Recently, Banks experienced its highest geosmin concentration in the past ten years in July 2020, Check 13 experienced its highest geosmin concentration in the past ten years in November 2020, and Lake Del Valle (Conservation Outlet) had its highest MIB concentration in the past ten years in November 2020.
- Treatment of aquatic vegetation using endothall within Clifton Court forebay may also play a role in elevating geosmin at Banks, particularly if T&O compounds are already present at Clifton Court Inlet.
- Similarly, treatment of aquatic vegetation using endothall within O'Neill forebay may also play a role in elevating geosmin at Check 13. However, Check 13 is also impacted by water quality from the Delta Mendota Canal and if releases from San Luis Reservoir are occurring.

Algal Toxins

- DWR began cyanotoxin monitoring at various locations in the SWP since 2006. The 2013 to 2020 data shows that microcystin is found throughout the SWP above its health advisory (HA) level. Lake Perris is the only location where cylindrospermopsin has been detected. Levels at Lake Perris are rarely above the health advisory levels for children (less than six years old) and never exceed the health advisory levels for adults.

- Although cyanotoxins have been found in SWP source waters, it should be noted that the HA levels for microcystin and cylindrospermopsin apply to finished or treated drinking water. Additionally, compliance with the HA levels are not based on a single sample, but the HA is based on the concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to ten days of exposure. To date, there has been no detection of cyanobacteria in treated SWP water, based on voluntary monitoring conducted by Zone 7 Water Agency of the Alameda County Water Conservation and Flood Control District (Zone 7), Santa Clara Valley Water District (Valley Water), Central Coast Water Authority, Antelope Valley – East Kern Water Agency, and Crestline-Lake Arrowhead Water Agency.

- Based on the DWR monitoring data, the highest microcystin concentrations are found in Silverwood Lake and Pyramid Lake.

- Pyramid has consistent detections of microcystin every year, but microcystin is not detected as frequently at Castaic Lake, which is immediately downstream of Pyramid Lake.

- A large Microcystin bloom in the Central Delta was visually confirmed by the United States Geological Survey (USGS) in summer 2020. The USGS plans to expand cyanobacteria and cyanotoxin monitoring, as well as study the drivers of harmful algal blooms (HABs), and the use of fluoroprobes to detect the presence of cyanobacteria.

TURBIDITY

- Turbidity levels in the Sacramento River are related to flows, with higher turbidities associated with higher flows. The San Joaquin River shows the same pattern of rapidly increasing turbidity when flows first increase in the winter months; however during prolonged periods of high flows, turbidity drops back down. Median turbidity levels at Vernalis (17 NTU) are higher than at Hood (10 NTU).

- The turbidity levels at Barker Slough are substantially higher (median of 28 NTU) and more variable than at Hood or any other SWP monitoring location. Over the 2016 to 2020 reporting period, peak turbidity levels occurred in January. The median turbidity at Banks (8 NTU) is statistically significantly lower than in the Sacramento and San Joaquin rivers, reflecting settling in Delta channels and Clifton Court Forebay. Although the median turbidity is low, there is tremendous variability in turbidity at Banks. Turbidity decreases from a median of 8 NTU at Banks to a median of 5 NTU at O’Neill Forebay Outlet below San Luis Reservoir and then slightly increases between O’Neill Forebay Outlet and Check 41 (median value 6 NTU). The turbidity levels at DV Check 7 on the SBA are similar to those at Banks. Turbidity levels are low in the SWP reservoirs with a median of 2 NTU in Pacheco and Devil Canyon and 1 NTU at Castaic Outlet.

- There are a number of real-time instruments measuring turbidity in the SWP. Based on the 2016 to 2020 data, the real-time turbidimeters showed improved correspondence to grab sample data compared to the last (2011 to 2015) Update. For the last Update, the poorest correspondence was at Barker Slough, Check 41, Devil Canyon, and Castaic. For this Update, the poorest correspondence was at Pacheco and Castaic. It is recommended to verify the proper maintenance of these two turbidimeters.

- Turbidity levels are statistically significantly lower during dry years than wet years at most locations that were included in this analysis, as shown in **Table ES-6**. In wet years, turbidity generally increases due to erosion and watershed runoff. There was no statistically significant difference between dry and wet years for San Luis Reservoir at Pacheco and at Castaic Outlet, due to the dampening effect of the reservoirs.

- The seasonal patterns vary greatly. The Sacramento River has high turbidity during the winter months and low turbidity during the summer. The San Joaquin River shows an opposite pattern with high turbidity during the summer possibly due to agricultural inputs in the summer or algal blooms. The seasonal pattern at Banks is similar to the San Joaquin River. A 2002 DWR study concluded that summer peaks in turbidity at Banks are potentially due to the re-suspension of sediment in Clifton Court due to high winds in the Delta during the summer months. Additionally, high pumping rates in the summer create high velocities in the forebay which may re-suspend sediment and lead to higher turbidity.

- Along the aqueduct, there are peaks in the winter months and again in June or July. For all locations except for Pacheco and Devil Canyon, turbidities reach the lowest levels in the fall when flows on the rivers are lowest.

Table ES-6. Comparison of Dry Year and Wet Year Turbidity Levels

	Median Turbidity (NTU)				
Location	**Dry Years**	**Wet Years**	**Turbidity Difference (NTU)**	**Percent Difference**	**Statistical Significance**
Hood	8	12	-4	-50%	D<W
Vernalis	16	18	-2	-13%	D<W
Banks	7	10	-3	-43%	D<W
Barker Slough	24	35.5	-11.5	-48%	D<W
DV Check 7	7	8.2	-1.2	-17%	D<W
McCabe	9	14	-5	-56%	D<W
Pacheco	2	2	0	0%	No
Gianelli	3.5	5.9	-2.4	-69%	D<W
Check 13	4	7	-3	-75%	D<W
Check 21	4	8	-4	-100%	D<W
Check 41	5	9.6	-4.6	-92%	D<W
Castaic Outlet	2	1	1	50%	No
Devil Canyon	1.5	3	-1.5	-100%	D<W

PATHOGENS AND INDICATOR ORGANISMS

- The Regional Board collected monthly *Giardia* and *Cryptosporidium* samples at Hood, Vernalis, and Banks from April 2015 through March 2017 as part of the Delta Regional Monitoring Program (RMP) Pathogen Study. There were detects of both *Giardia* and *Cryptosporidium* at Hood and Vernalis, none of either at Banks. All the running annual averages (RAAs) for *Cryptosporidium* were below the trigger of 0.075 oocysts/L and the sources are placed in Bin 1 under the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). *Giardia* levels were higher than *Cryptosporidium* levels in the Sacramento River at Hood and the San Joaquin River at Vernalis, indicating that they are sources of *Giardia* to the Delta. *Giardia* was detected during all times of the year and *Cryptosporidium* was detected during the fall.

- The DWR diversion at the Banks water treatment plant (WTP) in the Delta was sampled for both indicator organisms and protozoa. Total coliform monthly median densities generally exceeded 1,000 MPN/100 mL and were among the highest in the SWP sources evaluated. Fecal coliform and *E. coli* densities were often greater than 200 MPN/100 mL, especially in the winter months. There were two detects of *Cryptosporidium* at the Banks Pumping Plant, resulting in a continued LT2ESWTR Bin 1 classification for the source. However, the coliform data suggests that the 3-log *Giardia* and 4-log virus reduction requirements may not be adequate for the Banks WTP and should be carefully considered by the State Water Resources Control Board Division of Drinking Water (DDW).

- The NBA Contractors previously completed LT2ESWTR monitoring, resulting in Bin 1 classifications. *Cryptosporidium* monitoring conducted during this study period continued to support Bin 1 classification. Total coliform monthly medians were similar to historical values, often exceeding 1,000 MPN/100 ml and were among the highest in the SWP sources evaluated. However, *E. coli* monthly medians remained stable and were below the 200 MPN/100 ml advanced treatment threshold in all months. The current 2-log *Cryptosporidium*, 3-log *Giardia*, and 4-log virus reduction requirements continue to be appropriate for the WTPs that treat NBA water.

- The SBA Contractors previously completed LT2ESWTR monitoring, resulting in Bin 1 classifications. Valley Water and Zone 7 conducted additional protozoan monitoring and the results are consistent with the previous Bin 1 classification. All of the *E. coli* monthly medians for SBA Contractor data were less than the 200 MPN/100 ml advanced treatment threshold. Peak total coliform densities occurred in the summer months while peak *E. coli* densities occurred in the winter months. The current 2-log *Cryptosporidium*, 3-log *Giardia*, and 4-log virus reduction requirements continue to be appropriate for the WTPs that treat SBA water.

- Valley Water and DWR use San Luis Reservoir to supply the Santa Teresa and San Luis WTPs, respectively. Valley Water previously completed LT2ESWTR monitoring, resulting in a Bin 1 classification at the Santa Teresa WTP. Valley Water recently conducted additional protozoan monitoring for the Santa Teresa WTP and the results were consistent with the previous Bin 1 classification. Total coliform monthly medians were similar to historic values, and *E. coli* monthly medians were lower than historic values and well below the 200 MPN/100 ml advanced treatment threshold. Peak *E. coli* densities occurred during wet weather months. The current 2-log *Cryptosporidium*, 3-log *Giardia*, and 4-log virus reduction requirements continue to be appropriate for the Santa Teresa and San Luis WTPs.

- Central Coast Water Authority (CCWA) completed LT2ESWTR Round 2 monitoring, confirming a Bin 1 classification. CCWA continued quarterly monitoring through November 2019, with an additional 11 samples collected and there were no detects of either protozoa. The coliform data continued to show generally low overall densities. Total coliform monthly medians were less than 1,000 MPN/100 mL in all but four months, and *E. coli* monthly medians were well below the 200 MPN/100 ml advanced treatment threshold. The data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses continue to be appropriate for the Polonio Pass WTP.

- Kern County Water Agency (KCWA) conducted coliform and protozoa monitoring near its turnout on the California Aqueduct. The source was previously classified as Bin 1 under the LT2ESWTR and no additional action was required. *Giardia* and *Cryptosporidium* monitoring during this study period confirmed Bin 1 classification. KCWA's total coliform densities can exceed 1,000 MPN/100 ml with peak monthly medians lower than those presented in the 2016 Update. *E. coli* densities remained stable and below the 200 MPN/100 ml advanced treatment threshold in all months. The protozoan, fecal coliform, and *E. coli* data indicate that the California Aqueduct in this reach should be provided 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses. Prior to its decommission in 2016, DWR monitoring at the Edmonston WTP showed total coliform monthly medians always less than 1,000 MPN/100 mL and fecal coliform monthly medians always less than 200 MPN/100 mL.

- Metropolitan Water District of Southern California (MWDSC) and Santa Clarita Valley Water Agency (SCV Water) previously completed LT2ESWTR monitoring for their WTPs taking water from Castaic Lake, resulting in Bin 1 classifications. MWDSC and SCV Water both conducted monthly *Giardia* and *Cryptosporidium* monitoring during the study period, with no detections of either protozoa, resulting in a continued Bin 1 classification. DWR previously completed LT2ESWTR *E. coli* monitoring for their WTPs taking water from Pyramid Lake, resulting in Bin 1 classifications, and data from this study period continues to support a Bin 1 classification. Total coliform monthly medians at MWDSC's Jensen WTP intake can exceed 1,000 MPN/100 ml during the summer months and peak densities were lower than those presented in the 2016 Update. *E. coli* remained stable and well below the 200 MPN/100 ml advanced treatment threshold. Coliform densities in Castaic Lake are lower and stable throughout the year. Coliform densities in Pyramid Lake are also lower throughout the year. The fecal coliform, *E. coli* and protozoan data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses continue to be appropriate for the treatment plants treating water from the West Branch.

- Antelope Valley East Kern Water Agency (AVEK) and Palmdale Water District previously completed LT2ESWTR monitoring, resulting in Bin 1 classifications. AVEK and Palmdale Water District both conducted *Giardia* and *Cryptosporidium* monitoring during the study period, with no detects of either *Giardia* or *Cryptosporidium*, resulting in a continued Bin 1 classification. The AVEK total coliform monthly medians were generally less than 1,000 MPN/100 ml and the fecal coliform and *E. coli* monthly medians were well below the 200 MPN/100 ml advanced treatment threshold. The Palmdale total coliform monthly medians were often above 1,000 MPN/100 ml. The *E. coli* monthly medians were always below the 200 MPN/100 ml threshold. The fecal coliform, *E. coli*, and protozoan data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses continue to be appropriate for the treatment plants treating water from the East Branch.

- MWDSC and Crestline Lake Arrowhead Water Agency (CLAWA) previously completed LT2ESWR monitoring at their WTPs, resulting in Bin 1 classifications for both agencies. MWDSC conducted monthly *Giardia* and *Cryptosporidium* monitoring during the study period, with no detects of either protozoa resulting in a continued Bin 1 classification. CLAWA also conducted *Giardia* and *Cryptosporidium* monitoring during the study period with no detects and conducted LT2ESWTR Round 2 *E. coli* monitoring which resulted in continued Bin 1 classification. MWDSC's data show that total coliform monthly medians can exceed 1,000 MPN/100 ml, especially during the summer months, and median densities are lower than those presented in the 2016 Update. *E. coli* remained stable and well below the 200 MPN/100 ml advanced treatment threshold, with peaks occurring during the winter months. CLAWA's data show that total coliform monthly medians are well below 1,000 MPN/100 ml, with peaks also occurring during the summer months. Fecal coliform and *E. coli* monthly medians were well below the 200 MPN/100 ml advanced treatment threshold, with peaks also occurring during the winter months. The *E. coli* and protozoan data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses continue to be appropriate for the treatment plants treating water from the East Branch lakes.

ARSENIC AND CHROMIUM

- The introduction of non-Project inflows to the California Aqueduct between Checks 23 and 39 can cause an increase in the concentration of total and dissolved arsenic in the SWP water. All values in the SWP during the study period are less than the MCL of 10 µg/L. Check 41 saw the greatest increases in total and dissolved arsenic during the years with greater than 300,000 acre-feet of turn-in volume, 2014 and 2015. Increases in arsenic levels were generally seen in years with greater than 150,000 acre-feet of turn-in volume, but at lower levels, such as 2016 and 2020. The turn-in water can be either groundwater or surface water. The arsenic level of the turn-in surface water is similar to that already in the Aqueduct, causing little impact. The arsenic levels of the turn-in groundwater can vary significantly, with median total arsenic values ranging from less than 2 to 12 µg/L. The highest levels were seen in the Semitropic Water Storage District (SWSD) #3 turn-ins near Check 24.

- The introduction of non-Project inflows to the California Aqueduct between Checks 23 and 39 does not appear to cause a significant increase in the concentration of total and dissolved chromium in the SWP water. All of the samples along the California Aqueduct during the study were well below the total chromium MCL of 50 ug/L. The impact of turn-in volumes on chromium levels in the Aqueduct appears to be less important than on arsenic levels, and increased chromium levels may be more related to the type of inflow. The hexavalent chromium levels of the turn-in surface water is similar to or lower than that already in the Aqueduct, causing little impact. The total and hexavalent chromium levels of the turn-in groundwater can vary significantly, with median hexavalent chromium values ranging from 0.85 to 5.9 µg/L. The highest levels were seen in the SWSD #3 turn-in near Check 24.

- Overall, the impact of the non-Project turn-in program to Aqueduct water quality varies from year to year, as the turn-in volumes and sources vary. As an example, 2016 was a year with high volumes of groundwater turned into the Aqueduct, as 2016 was the fourth year of consecutive dry years from 2013 to 2016. In comparison, 2017 and 2019 were wet years, and the source of turn-ins was flood surface water and the overall turn-in volumes were lower.

CONSTITUENTS OF EMERGING CONCERN (CECs)

- Monitoring data within the SWP shows that PFAS are detectable in the source water. The most frequently detected PFAS include: PFHxA, PFPeA, PFBS, PFHpA, PFBA, PFHxS, PFOA, and PFOS. Four of the most frequently detected PFAS have DDW NLs, while two more have an impending DDW NL. The four PFAS with DDW NLs include PFOA, PFOS, PFBS, and PFHxS (recommended NL). There were no detects in the SWP above the respective DDW NLs for PFOA, PFOS, PFBS, and PFHxS. Looking at individual SWP Contractor data, there is very little detectability of PFAS downstream in the SWP, except for PFHxA. PFHxA appears to be the most ubiquitous and long-lasting PFAS in the SWP, and DDW is preparing a NL.

- POTW effluent monitoring indicates that they are a source of PFAS in the Sacramento River, San Joaquin River, and Delta, sometimes at levels above the DDW NLs. The most frequently detected PFAS was PFHxA at 93 percent of samples positive, with all of those detect results above the MRL. It appears that PFHxA is quite ubiquitous at POTW effluents. The majority of PFHxS detects were above its DDW NL.

- Monitoring data in the SWP shows that PPCPs are infrequently detected in the source water, but do appear to have an upstream to downstream increasing trend. The most prevalent PPCPs were galaxolide, DEET, and sucralose. Bisphenol A was also detected at all sites. Galaxolide and sucralose both increased significantly downstream of POTWs. The San Joaquin River system had significantly higher levels of sucralose, while the Sacramento River system had significantly higher levels of galaxolide. Overall, the San Joaquin River at Buckley Cove had the most detections of CECs; caffeine, carbamazepine, DEET, meprobamate, sucralose, sulfamethoxazole, TCPP, and TCEP were detected in all samples.

- Monitoring data in the sources to the Delta show that unregulated pesticides are commonly detected in the source water, but are generally not present at levels of concern based on currently available human health threshold information. The Sacramento, Mokelumne, and San Joaquin Rivers are all potential sources of unregulated pesticides to the Delta, and Ulatis Creek is a slightly more significant source. The top detected pesticides of interest are; oxyfluorfen, diuron, iprodione, imazalil, and oxadiazon. Three of these, oxyfluorfen, diuron, and iprodione, are also on the United States Environmental Protection Agency (USEPA) Contaminant Candidate List (CCL) 5.

- Monitoring data in the sources to the Delta show that other chemicals of potential interest can be detected in the source water, but are not present at levels of concern based on currently available human health threshold information. Two of these, Bisphenol A and tris(2-carboxyethyl)phosphine (TCEP), are on the USEPA CCL5.

ARTICLE 19 CONSTITUENTS

- Monthly average water quality objectives for sulfate and boron were never exceeded during the past twenty years at Barker Slough, Banks, Del Valle Check 7, Pacheco and Check 13.
- In contrast, water quality objectives for chloride were exceeded in many months, with the exception of Barker Slough which had no exceedances.
- Over the past twenty years, monthly average water quality objectives for hardness were exceeded at Barker Slough three times, once at Del Valle Check 7 and never at Banks, Pacheco, and Check 13.
- Over the past twenty years, monthly average water quality objectives for total dissolved solids (TDS) were exceeded at Barker Slough twice, four times at Banks, five times at Del Valle Check 7, once at Check 13 and never at Pacheco. Except for Barker Slough, the TDS exceedances occurred in the drought years of 2014 and 2015. Water at Barker Slough is influenced by the local watershed, which contains saline soils, and therefore high TDS occurred in wet years of 2017 or spring runoff.
- The ten year average (January 2011 to December 2020) water quality objectives were exceeded for TDS, sulfate and chloride at Banks, Del Valle Check 7, Pacheco and Check 13.
- Pacheco had the highest 10-year averages for TDS, sulfate, chloride and hardness.

ALKALINITY

- Alkalinity is greatly influenced by hydrology, as low alkalinities in SWP source waters occurred in the wet years such as 2017 and 2019. The exception to this is the Barker Slough location, as the local soils in the watershed are highly mineralized and cause alkalinity to increase in wet years.

- Low alkalinities present treatment challenges for contractors treating SWP.

WILDFIRES IN SWP WATERSHEDS

Post-fire monitoring in the North Complex, Carr and Camp fire burn areas showed elevated levels (above primary and secondary drinking water maximum contaminant levels (MCLs)) for aluminum, iron, and manganese in smaller watershed tributaries in samples collected by the Central Valley Water Quality Regional Control Board and DWR. According to the Central Valley Regional Board, iron and aluminum occur naturally in soils in both watersheds. The elevated levels of iron and aluminum are indicative of soil transport from stormwater runoff, caused by the burn severity and lack of vegetation to control sediment and erosion. For the Camp Fire, levels of aluminum, iron and manganese were lower in the post-fire runoff samples collected by DWR in the Lake Oroville watershed, compared to the post-fire runoff samples collected by the Central Valley Regional Board in the Butte watershed.

Lead, antimony, and arsenic were also detected above their respective primary MCLs in post-fire monitoring of watershed tributaries in the Butte watershed following the Camp Fire, but were not above MCLs in the Lake Oroville watershed. Additionally, arsenic and lead were not detected above their respective primary MCLs in post-fire monitoring for the Carr Fire. No samples were collected for antimony in the Carr fire watershed after the fire.

Overall, the highest concentrations of metals in post-fire runoff were after the Camp Fire, compared to the Carr and North Complex fires. Post-fire monitoring showed that water quality impacts from wildfires may continue after the first post-fire winter. Quite often, there was a second peak which occurred in the second winter after the wildfire.

In addition to monitoring post-fire runoff from burn areas, DWR also collected runoff from unburned areas and compared the two samples. Generally, increases from unburned areas to burned areas were observed for total aluminum, total iron, total manganese, total nickel, dissolved nitrate +nitrite, turbidity and total suspended solids.

It is important to note that the impact to the State Water Contractors will diminish as water moves further downstream the Sacramento River. These wildfires occurred in the upper Sacramento River watershed. Sacramento River water is mixed with the American River prior to the Delta, and additionally mixed with water from the San Joaquin River and tidal waters within the Delta, prior to the export pumps.

AQUATIC VEGETATION IN THE DELTA

Invasive Aquatic Vegetation is a problem that appears to be worsening, resulting in the need for increased chemical usage in recent years (2017 to 2019) compared to 2013 to 2016. Currently, fluridone is used for submersed aquatic vegetation (SAV) control, at concentrations far below levels of concern to human health. However, fluridone has not shown to be effective in controlling SAV. Therefore, different chemicals may be used more in the future, such as diquat and endothall, and both have a drinking water MCL.

Based on the annual California Department of Parks and Recreation, Division of Boating and Waterways (DBW) reports, reductions in SAV biovolume and percent cover after treatment with fluridone have mixed results. Reductions for SAV biovolume and percent cover were worse in

2019 (compared to 2016 and 2017), as only 29 to 33 percent of sites had at least a 10 percent reduction of biovolume or percent cover. Studies by Khanna et al 2021 show that the treatments provide only a 10 percent reduction compared to treated sites, the effect of treatments do not last longer than a year, and consecutive years of treatment were not more effective than single year treatments. Studies by Rasmussen et al 2021 also confirm that SAV was not reduced in the Delta after fluridone application, likely due to the tidal environment.

New tools such as benthic mats, bubble curtains, or new herbicides are proposed to be deployed at Decker Island and Prospect Island in 2021. As of September 2021, benthic mats and bubble curtains have not been deployed, as they require approval by the Army Core of Engineers. For control of Egeria, the most effective results with a 98 percent of control were demonstrated in Indian Slough, when diquat (contact herbicide) was used as a follow-up to a fluridone (systemic herbicide) treatment.

ENDOTHALL TREATMENTS AT CLIFTON COURT

As demonstrated in 2018, the low pumping rate at Banks Pumping Plant (Banks) reduced the downstream peak of endothall, keeping endothall concentrations at or below the MCL at Banks and non-detectable at South Bay Pumping Plant (SBPP). This was in contrast to 2019, when the pumping rate was high at Banks, and the SBPP resumed pumping at the same time as Banks. As a result, endothall concentrations at the SBPP remained above the MCL of 100 µg/L for about 28 hours in 2019. For the June 2020 treatment, it was decided to keep SBPP off for 48 hours, in addition to the 24 hours hold time in CCF, and additionally, the applied endothall dosage was reduced to 1.25 mg/L. In June 2020, endothall concentrations at SBA Check 2 never reached above the MCL, although endothall was detectable below the MCL for 8 hours. In November 2020, water was held in Clifton Court Forebay (CCF) for approximately 96 hours (before Banks started pumping), and there was an additional 43 hours before SBPP started pumping. This resulted in no detectable endothall at SBA Check 2 after CCF treatment.

These studies have provided a better understanding of the fate and transport of endothall from CCF and through the SBA. For example, it has been shown that the 24 hour hold time in the CCF reduces the endothall concentration by 45 to 60 percent. However, this still results in endothall residual concentrations higher than the MCL, with applied dosages ranging from 1.25 to 2 mg/L. Longer hold times in the CCF result in lower endothall concentrations at Banks, as demonstrated in November 2020. Staggering the pump start times at Banks and SBPP also proved to be beneficial in keeping the endothall concentrations below the MCL at SBA Check 2 for both the June and November 2020 treatments, as this provided for additional time before SBPP started pumping water into the SBA. Lower pumping rates at Banks Pumping Plant results in lower endothall concentrations at Banks as shown in 2018. If pumping rates at Banks and SBPP are not staggered and are high, detectable concentrations of endothall can move through the SBA. Therefore, there are a number of factors which influence the amount of residual endothall reaching the downstream intakes:

- Application or Dosage concentration of endothall
- Pumping rates at Banks and SBPP, and ability to stagger pump start times
- Amount of contact time or “hold” time in CCF and Bethany Reservoir

- Availability of releases from Lake Del Valle and Dyer Reservoir which can be used to prolong SBPP outages, or possible use as a source to blend endothall concentrations down in the SBA.

The contractors will continue to work closely with DWR to optimize all of the conditions above, to the extent possible, in order to keep endothall concentrations below the MCL in the source water. It should be noted that endothall was never detected in any valid treated water samples collected by the water agencies.

ENDOTHALL TREATMENTS AT O'NEILL FOREBAY

The endothall studies have provided a better understanding of the fate and transport of endothall from O'Neill Forebay and downstream the California Aqueduct. Unlike the CCF treatments, there is no requirement to hold water in the O'Neill Forebay and it is more difficult to close the Check 13 radial gates since the facility is part of the San Luis Joint-Use complex. Fortunately, the shoreline areas needing treatment in O'Neill Forebay are a small percentage of the total area and volume of O'Neill Forebay. There are a few factors which influence the amount of residual endothall reaching the downstream intakes and may be controlled/adjusted:

- Application or Dosage concentration of endothall
- Percent area or volume to be treated
- Pumping rates at Dos Amigos Pumping Plant

The contractors will continue to work closely with DWR to optimize all of the conditions above, to the extent possible, in order to keep endothall concentrations below the MCL in the source water.

NON-PROJECT TURN-INS TO THE CALIFORNIA AQUEDUCT

Overall, during the reporting period, the highest volumes of non-Project turn-in water occurred in the San Joaquin Field Division, through the Cross Valley Canal (CVC) and the Kern Water Bank Canal (KWBC). Typically, higher turn-in volumes occur during dry years, when supplemental supplies are most needed. If turn-ins occur during wet years, they are likely to be surface water.

Resultant downstream water quality is reflective of the sources being turned in, volumes being turned in, and flow in the Aqueduct. The impact of the turn-in program to Aqueduct water quality varies from year to year, as the turn-in volumes vary greatly. Generally, groundwater turn-ins increase arsenic, nitrate and sulfate levels in downstream water quality (due to higher concentrations of these constituents in the turn-in water compared to the Aqueduct), and decrease salinity, bromide and chloride (due to lower concentrations of these constituents in the turn-in water compared to the Aqueduct). The results for total chromium during this reporting period have shown both increases and decreases in downstream water quality.

Over the reporting period, turn-ins occurring in 2016 had the highest water quality impact, specifically in the months of January and February 2016. Arsenic concentrations increased by 5 µg/L from Check 21 to Check 41, with a resultant arsenic concentration of 8 µg/L at Check 41. Similarly, nitrate as NO_3 increased by 14.4 mg/L in January and increased by 12.3 mg/L in February. Sulfate increased by 39 mg/L in January and 60 mg/L in February. Total chromium increased by 5 µg/L in January and by 4 µg/L in February. This impact was due to repair work in Pool 30, such that Aqueduct flow stopped downstream of Pool 30, but Arvin Edison Water Storage District (Arvin Edison) and Wheeler Ridge Maricopa Water Storage District (WRMWSD) continued to operate. POA reached as high as 48 percent in January 2016 and 46 percent in February 2016. No MCLs for any of the constituents of concern were exceeded in the Aqueduct over the 2016 to 2020 reporting period.

However, recent data from 2021 indicate that arsenic above the MCL of 10 µg/L entered the Aqueduct from SWSD 3 turn-in. Greater effort or improvements are needed by SWSD to keep turn-in levels below the arsenic MCL.

There have been a few detections of 1,2,3-TCP above its respective MCL of 0.005 µg/L in the Cross Valley Canal, turn-in 10P1X for WRMWSD, and in the Arvin Edison canal which do not comply with the DWR policy.

There have been low level detections of PFAS in the turn-ins**,** with no results above the notification levels of 5.1 ng/L for PFOA, 6.5 ng/L for PFOS and 500 ng/L for PFBS. However, monitoring results will continue to be evaluated in anticipation of upcoming PFAS regulations.

NON-PROJECT TURN-INS TO THE DELTA MENDOTA CANAL

Although the annual groundwater turn-in volume to the DMC is currently limited to 50,000 AF per year, this is a substantial potential contaminant source. Typically, higher turn-in volumes occur during dry years, when supplemental supplies are most needed. Resultant downstream water quality is reflective of the sources being turned in, volumes being turned in, and flow in the DMC. Similar to turn-ins to the California Aqueduct, the impact of the turn-in program to DMC water quality varies from year to year, as the turn-in volumes vary greatly

NORTH VALLEY REGIONAL RECYCLED WATER PROGRAM

Based on the monitoring conducted to date, there are impacts to downstream users. It should be noted that as the volume of treated wastewater increases in the future, these impacts will likely worsen.

Although one of the main purposes of monitoring conducted by the MWQI SPC and the SWC was to ascertain downstream impacts, these impacts were not always self-evident in an increase in a constituent's concentration from the downstream to upstream location along the DMC, as the wastewater input is diluted once it enters the DMC. For example, nitrate, TKN, total dissolved solids, and specific conductance were always higher in the effluent compared to upstream, but no increase in these constituents were seen when comparing the upstream to the downstream sample. However, this does not mean there is no impact from wastewater, but rather the impact is diluted.

Out of the monitored nutrients, phosphorus and orthophosphate did have a statistically significant increase from DMC-001 to DMC-002 when both WWTPs were discharging, which is likely due to high levels of phosphorus in Turlock's effluent (compared to Modesto). Increased concentrations of phosphorus could increase the growth of algae and the presence of algal toxins as water travels downstream. Although the City of Turlock conducted algal toxin monitoring at DMC-001 and McCabe, this was only for one year when both WWTPs were discharging.

There were 10 CECs which showed an increase of 20 percent or higher from the upstream to downstream in at least two separate events. Eight chemicals showed an increase of 20 percent or higher from the upstream to downstream in at least three out of five events:

- Lidocaine percent increase ranged from 38 to 500 percent
- Sucralose percent increase ranged from 35 to 120 percent
- Sulfamethoxazole percent increase ranged from 29 to 380 percent
- Carbamazepine percent increase ranged from 68 to 120 percent
- Primidone percent increase ranged from 32 to 100 percent
- Iohexal percent increase ranged from 21 to 223 percent
- Amoxicillin percent increase ranged from 45 to 305 percent
- Theophylline percent increase ranged from 26 to 30 percent.

It should be noted that the percent of wastewater in the DMC flow ranged from 1.1 to 4.4 percent across the five sampling events, so a significant increase to be detected in the downstream must indicate a very high level of these contaminants in the treated wastewater discharge. Overall, most organics were nondetectable, with the exception of low levels of dalapon in the Turlock effluent, and one low level detection of di-n-butyl phthalate in the Modesto effluent.

Water quality monitoring conducted by the City of Turlock demonstrated that downstream users are receiving higher levels of phosphorus and orthophosphate due to the treated wastewater discharge. Water quality monitoring conducted by MWQI demonstrated that downstream users are also receiving higher levels of certain pharmaceuticals. Additionally, it is likely that TDS, electrical conductivity, nitrate and TKN will increase in water received by downstream users as the volume of treated wastewater discharged to the DMC increases in the future.

RECOMMENDATIONS

Chapter 14 contains recommendations for consideration by the State Water Contractors, DDW and the DWR MWQI Program and O&M Division. These agencies will work together to determine if, and how, the recommendations will be implemented.

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CHAPTER 1 INTRODUCTION

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CHAPTER 1 INTRODUCTION

The State Water Project (SWP) provides drinking water to approximately two-thirds of California's population and is the nation's largest state-built water development project. The SWP extends from the mountains of Plumas County in the Feather River watershed to Lake Perris in Riverside County. It is linked with the Central Valley Project that extends from southern Oregon in the Sacramento River watershed to the Mendota Pool. The watershed of the SWP is vast; encompassing the 27,000-square-mile Sacramento River and 13,000-square-mile San Joaquin River watersheds and at times, the 13,000-square-mile Tulare Basin watershed. There are numerous activities in the watershed that can affect drinking water quality. In addition, the watersheds of Del Valle, San Luis, Pyramid, Castaic, Silverwood, and Perris reservoirs contribute potential contaminants to the SWP system. There are also a few locations along the Governor Edmund G. Brown California Aqueduct (California Aqueduct) where Coastal Range drainage enters the system during flood events. Groundwater and surface water from other sources are introduced to the California Aqueduct as a means of supplementing water supplies. The Barker Slough watershed influences water quality for the North Bay Aqueduct (NBA), possibly to a greater extent than any other local watershed within the SWP. With a watershed of this size and complexity, the SWP Watershed Sanitary Survey is, by necessity, more complex than sanitary surveys completed for smaller watersheds.

HISTORY OF THE SWP SANITARY SURVEY

The California SWP Watershed Sanitary Survey, 2021 Update (2021 Update) is the seventh sanitary survey of the SWP. The 1990 Sanitary Survey of the SWP was the first sanitary survey conducted in the state for the California Department of Health Services (CDHS), to comply with the Surface Water Treatment Rule requirement for a watershed sanitary survey (Brown and Caldwell, 1990). There was no guidance on how to conduct a sanitary survey so the SWP Contractors worked closely with CDHS, the California Department of Water Resources (DWR) and the consultant team to develop the scope. The 1990 Sanitary Survey focused on reviewing available water quality data and providing an inventory of contaminant sources in the Sacramento, San Joaquin, and Tulare watersheds and along the aqueducts, with minimal effort on the contaminant sources in the SWP reservoir watersheds. The SWP Sanitary Action Committee, formed to follow up on the recommendations contained in the 1990 Sanitary Survey, produced the SWP Sanitary Survey Action Plan (State Water Contractors, 1994). A number of the recommendations from the 1990 Sanitary Survey were addressed between 1990 and 1996.

The 1996 Update focused on the recommendations from the 1990 Sanitary Survey and major changes in the watersheds between 1990 and 1996 (DWR, 1996). In addition, the 1996 Update provided more details on contaminant sources in the watersheds of Del Valle, San Luis, Pyramid, Castaic, Silverwood, and Perris reservoirs; the NBA Barker Slough watershed; and the open canal section of the Coastal Branch.

The 2001 Update provided more details on contaminant sources in the watersheds of the SWP reservoirs and along the aqueducts (DWR, 2001). It also contained a detailed analysis of indicator organism and pathogen data from the SWP. A major objective of the 2001 Update was to provide the SWP Contractors with information needed to comply with the California

Department of Public Health (CDPH) Drinking Water Source Assessment Program requirements.

Rather than simply updating all of the information from the previous three sanitary surveys, the 2006 Update provided an opportunity to concentrate on the key water quality issues that challenge the SWP Contractors (Archibald Consulting et al., 2007). CDPH requested that the 2006 Update address the Jones Tract levee failure and emergency response procedures, efforts to coordinate pathogen monitoring in response to the Long Term 2 Enhanced Surface Water Treatment Rule, and a review of significant changes to the watersheds and their impacts on water quality. The SWP Contractors developed the State Water Project Action Plan (State Water Project Contractors Authority, 2007), which identified priorities and courses of action for following up on the recommendations from the 2006 Update.

Similar to the 2006 Update, the 2011 Update concentrated on the key water quality issues that challenge the SWP Contractors (Archibald Consulting et al., 2012). The SWP Contractors requested that the 2011 Update provide updated information on drinking water regulations and most of the issues addressed in the 2006 Update. CDPH requested that the 2011 Update include a discussion of the impacts of the biological opinions and drought on water quality, the impacts of non-Project inflows on water quality, subsidence along the aqueduct, and a discussion of the monitoring conducted to comply with the Long-Term 2 Enhanced Surface Water Treatment Rule. In addition, the 2011 Update presented all available water quality data at a large number of locations in the Delta and along the aqueducts, rather than concentrating on the last five years of data. This was done to assess long-term trends in the data.

The 2016 Update focused on evaluating key water quality constituents in the SWP, as well as specific topics on grazing and impacts from the 2012 to 2015 drought. Key water quality constituents were updated to include 2011 to 2015 data.

SCOPE AND OBJECTIVES OF 2021 UPDATE

The State Water Contractors and the Division of Drinking Water (DDW) formed a Watershed Sanitary Survey Subcommittee to develop the scope of work for the 2021 Update. The 2021 Update focuses on evaluating previous key water quality constituents in the SWP, and also expanded those constituents to include constituents of emerging concern, alkalinity and selected Article 19 constituents (boron, chloride, total dissolved solids, total hardness, sulfate). Specific topics selected by the Subcommittee to be discussed in the 2021 Update are wildfires, endothall treatments, aquatic vegetation in the Delta, non-Project turn-ins to the California Aqueduct, non-Project turn-ins to the Delta Mendota Canal, and the North Valley Recycling Regional Recycled Water Program.

The report time period covers from January 1, 2016 to December 31, 2020. The objectives of the 2021 Update is to:

- Satisfy the DDW requirements to update the watershed sanitary survey every five years.
- Highlight and focus on the State Water Contractors' key source water quality issues and selected potential contaminating activities to identify impacts on source water quality.

- Conduct an analysis of all of the water quality data that has been gathered on the Delta and the SWP facilities to identify spatial and long-term trends.
- Identification of appropriate management actions to protect and possibly improve source water quality. Development of recommendations for management actions that are economically feasible and within the authority of the Municipal Water Quality Investigations (MWQI) Specific Project Committee (SPC) or the Department of Water Resources (DWR) to implement is critical.

REPORT ORGANIZATION

This report is organized in the following manner:

Chapter 1 – Introduction

Chapters 2 through 12 – Water Quality in the Watersheds and the State Water Project

These chapters address concerns over water quality constituents having the capacity to cause drinking water standards to be violated or to reduce the quality of drinking water supplies conveyed through the SWP. Although there are potentially numerous constituents in drinking water sources, the key water quality challenges facing the State Water Contractors that treat water from the SWP are the formation of disinfection byproducts, due to high concentrations of organic carbon and bromide in the source water, emerging contaminants such as PFAS and pharmaceutical and personal care products (PPCPs), as well as algal blooms, taste and odor problems, and operational problems.

- Chapter 2 – Water Quality Background and Summary
- Chapter 3 – Organic Carbon
- Chapter 4 – Salinity
- Chapter 5 – Bromide
- Chapter 6 – Nutrients
- Chapter 7 – Taste and Odor Incidents and Algal Toxins
- Chapter 8 – Turbidity
- Chapter 9 – Pathogens and Indicator Organisms
- Chapter 10 – Arsenic and Chromium
- Chapter 11 – Constituents of Emerging Concern
- Chapter 12 – Article 19 Constituents and Alkalinity

Chapter 13A to 13F – Potential Contaminant Sources

Specific topics on wildfires, endothall treatments, aquatic vegetation in the Delta, non-Project turn-ins to the California Aqueduct, non-Project turn-ins to the Delta Mendota Canal, and the North Valley Recycling Regional Recycled Water Program will be discussed. Each topic will cover background/water quality concern, current pertinent information (for example acreage burned for wildfires, volumes of herbicides applied to water to address aquatic vegetation, volumes of water turned into the California Aqueduct and the Delta Mendota Canal), and any relevant water quality monitoring. Please refer to **Executive Summary** or **Chapter 13** for more information.

Chapter 14 – Recommendations

A summary of recommended actions are described in this chapter.

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CHAPTER 2 WATER QUALITY BACKGROUND AND SUMMARY

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TABLES

CHAPTER 2 WATER QUALITY BACKGROUND AND SUMMARY

Chapters 3 to 12 contains detailed descriptions of water quality conditions in the Sacramento-San Joaquin Delta (Delta) and the State Water Project (SWP). This chapter provides the background on the SWP needed to understand the water quality chapters and it provides a summary of the more detailed information that is in the following chapters. This chapter is organized to cover the following topics:

- The SWP – This section provides a brief overview of the major facilities of the SWP.
- Hydrology and SWP Operations – The hydrologic conditions in the Sacramento and San Joaquin basins and the Delta area discussed in this section. Key aspects of SWP operations that affect water quality are also described.
- Water Quality Data – The sources of water quality data and the locations that are included in the data analysis in Chapters 3 through 12 are discussed in this section.

THE STATE WATER PROJECT

The SWP extends from the mountains of Plumas County in the Feather River watershed to Lake Perris in Riverside County. **Figure 2-1** shows the major features of the SWP. Water is delivered to Plumas County Flood Control and Water Conservation District upstream of Lake Oroville. The City of Yuba City and Butte County receive SWP water from Lake Oroville. The Sacramento and San Joaquin rivers are the two major rivers providing water to the Delta, the source of water for most SWP Contractors. **Figure 2-2** shows the Delta and the key water quality monitoring locations in the Delta and the tributaries to the Delta.

Water from the north Delta is pumped into the North Bay Aqueduct (NBA) at the Barker Slough Pumping Plant, as shown in **Figure 2-3**. Barker Slough is a tidally influenced dead-end slough which is tributary to Lindsey Slough. Lindsey Slough is a tributary to Cache Slough which is a tributary to the Sacramento River. The pumping plant draws water from both the upstream Barker Slough watershed and from the Sacramento River, via Lindsey and Cache Sloughs. Other local sloughs may also contribute water to the NBA. The NBA pipeline extends 21 miles from Barker Slough to Cordelia Forebay (Cordelia) and Pumping Plant, and then 7 miles to its terminus at two 5-million gallon terminal tanks. The NBA serves as a municipal water supply source for a number of municipalities in Solano and Napa counties. The Solano County Water Agency (SCWA) and the Napa County Flood Control and Water Conservation District (Napa County) are wholesale buyers of water from the SWP. In Solano County, NBA water is delivered to the Travis Air Force Base and the cities of Benicia, Fairfield, Vacaville, and Vallejo. For Napa County, NBA water is delivered to the cities of Napa, American Canyon, and treated NBA water (from Napa) to Calistoga.

In the southern Delta, water enters SWP facilities at Clifton Court Forebay (Clifton Court), and flows across the forebay about 3 miles to the H.O. Banks Delta Pumping Plant (Banks), from which the water flows southward in the Governor Edmund G. Brown California Aqueduct (California Aqueduct). Water is diverted into the South Bay Aqueduct (SBA) at Bethany Reservoir, 1.2 miles downstream from Banks. **Figure 2-4** is a map showing the locations of the SBA facilities. The SBA consists of about 11 miles of open aqueduct followed by about 34 miles of pipeline and tunnel serving East and South Bay communities through the Zone 7 Water Agency of the Alameda County Flood Control and Water Conservation District (Zone 7 Water Agency), Alameda County Water District (ACWD), and Santa Clara Valley Water District (Valley Water). Water from the SBA can be pumped into or released from Lake Del Valle at the Del Valle Pumping Plant. Lake Del Valle has a nominal capacity of 77,110 acre-feet, with 40,000 acre-feet for water supply. The terminus of the SBA is the Santa Clara Terminal Reservoir (Terminal Tank).

Figure 2-1. The State Water Project

Figure 2-2. Delta Features and Monitoring Locations

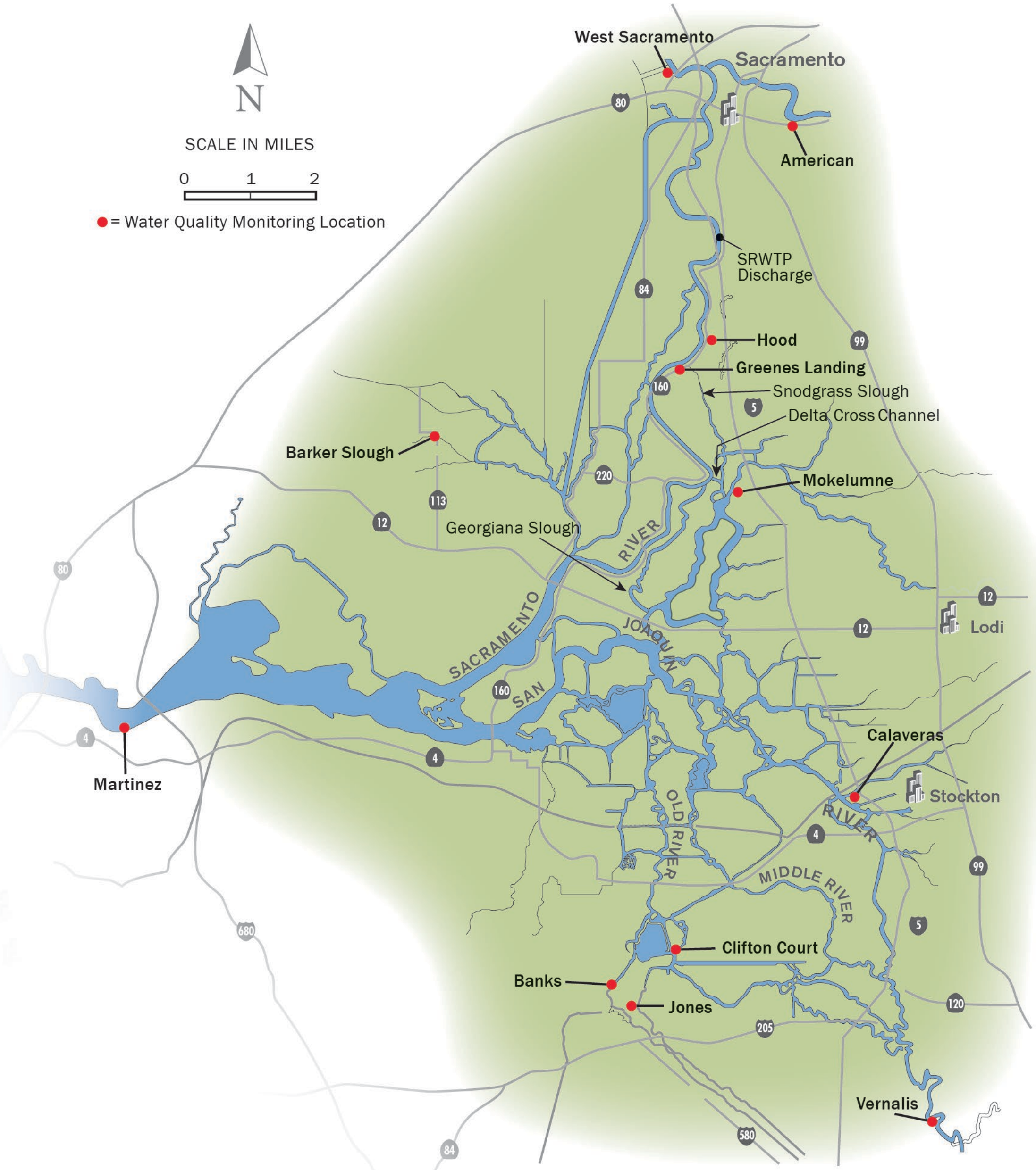


Figure 2-3. The North Bay Aqueduct

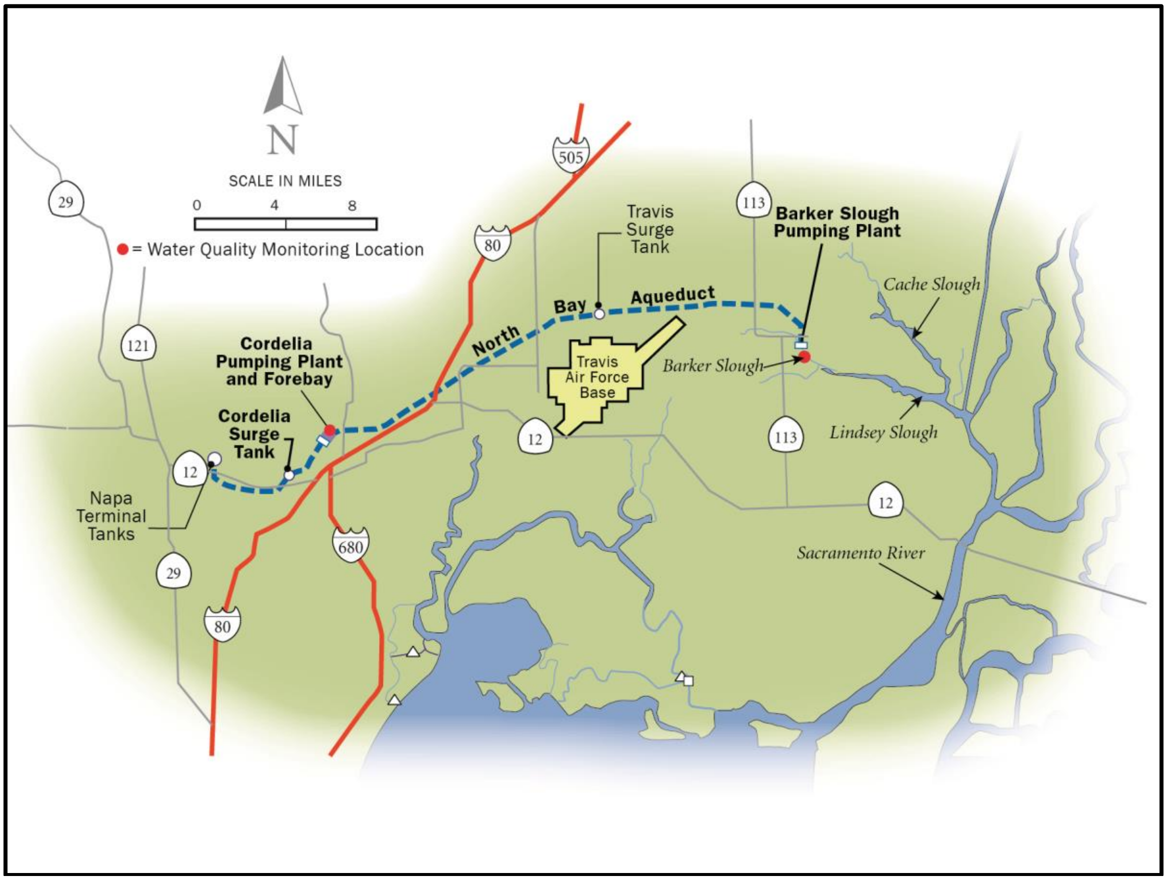
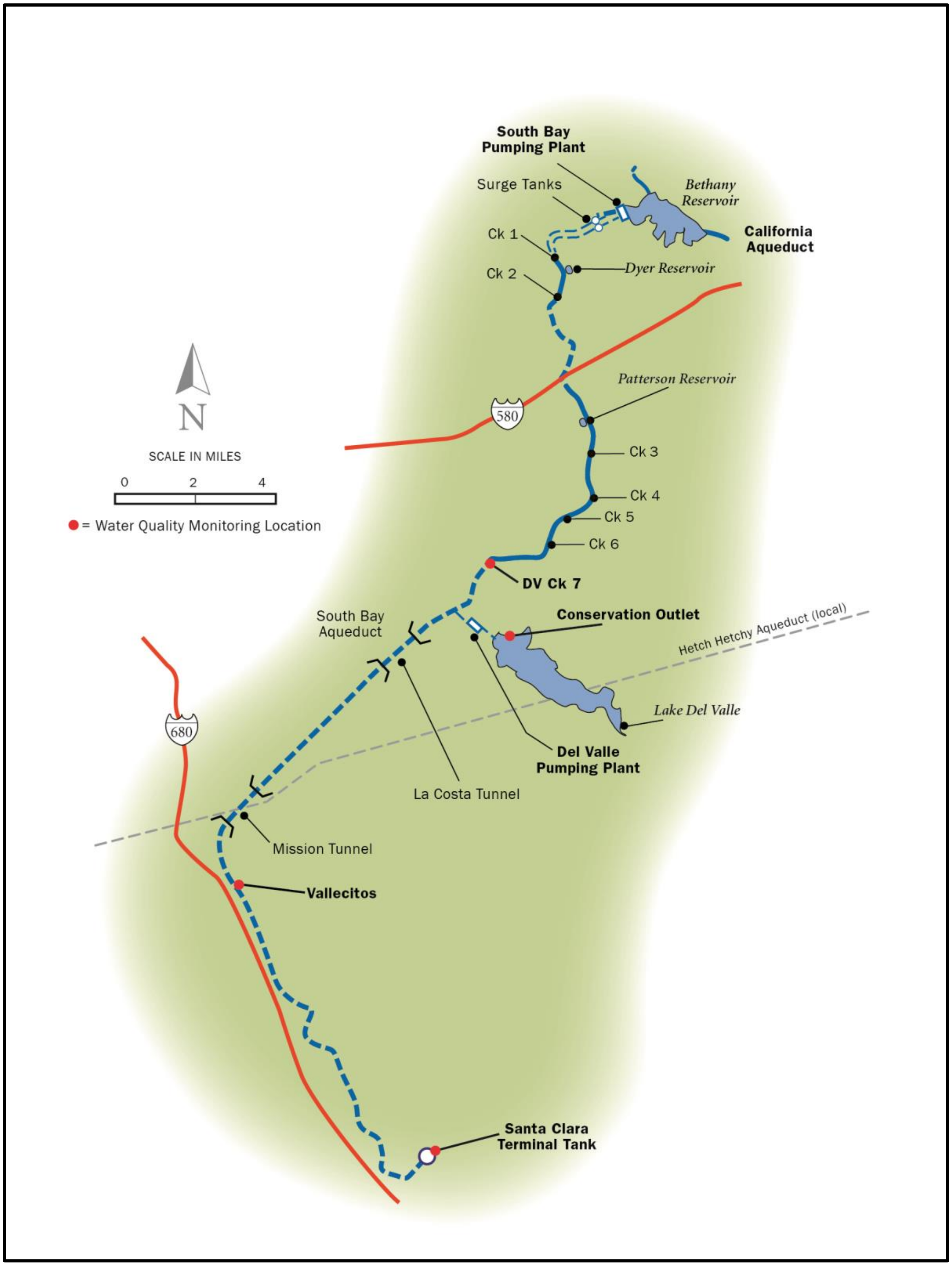


Figure 2-4. The South Bay Aqueduct



From Bethany Reservoir, water flows in the California Aqueduct about 59 miles to O'Neill Forebay, as shown in **Figure 2-5**. The forebay is the start of the San Luis Joint-Use Facilities, which serve both SWP and federal Central Valley Project (CVP) customers. CVP water is pumped into O'Neill Forebay from the Delta-Mendota Canal (DMC). The DMC conveys water from the C.W. "Bill" Jones Pumping Plant (Jones) to, and beyond, O'Neill Forebay. The O'Neill Pump-Generation Plant (O'Neill Intake), located on the northeast side of O'Neill Forebay, enables water to flow between the forebay and the DMC. San Luis Reservoir is connected to O'Neill Forebay through an intake channel located on the southwest side of the forebay. **Figure 2-6** is a location map that shows these features. Water in O'Neill Forebay can be pumped into San Luis Reservoir by the William R. Gianelli Pumping-Generating Plant (Gianelli) or released from the reservoir to the forebay to generate power. San Luis Reservoir, with a capacity of 2.03 million acre-feet, is jointly owned by the SWP and CVP, with 1.06 million acre-feet being the state's share. An intake on the west side of the reservoir provides drinking water supplies to Valley Water. Water enters Valley Water's facilities at Pacheco Pumping Plant (Pacheco), from which it is pumped by tunnel and pipeline to water treatment and ground water recharge facilities in the Santa Clara Valley.

Water released from the reservoir co-mingles in O'Neill Forebay with water delivered to the forebay by the California Aqueduct and the DMC, and exits the forebay at O'Neill Forebay Outlet, located on the southeast side of the forebay. O'Neill Forebay Outlet is the inception of the San Luis Canal reach of the California Aqueduct, as shown in **Figure 2-7**. The San Luis Canal extends about 100 miles to Check 21, near Kettleman City. The San Luis Canal reach of the aqueduct serves mostly agricultural CVP customers and conveys SWP waters to points south. Unlike the remainder of the California Aqueduct, which was constructed by the state, the San Luis Canal reach was federally constructed and was designed to allow drainage from adjacent land to enter the aqueduct. Local streams that run eastward from the Coastal Range mountains bisect the aqueduct at various points. During storms, water from some of these streams enters the aqueduct. This is generally not the case for the other reaches of the aqueduct.

The junction with the Coastal Branch of the aqueduct is located 185 miles downstream of Banks and about 12 miles south of Check 21. The Coastal Branch provides drinking water supplies to central California coastal communities through the Central Coast Water Authority (CCWA) and the San Luis Obispo County Flood Control and Water Conservation District. **Figure 2-8** is a map showing locations of these facilities. The Coastal Branch is 115 miles long; the first 15 miles are open aqueduct and the remainder is a pipeline.

Figure 2-5. California Aqueduct between Banks Pumping Plant and San Luis Reservoir

Figure 2-6. O'Neill Forebay and San Luis Reservoir

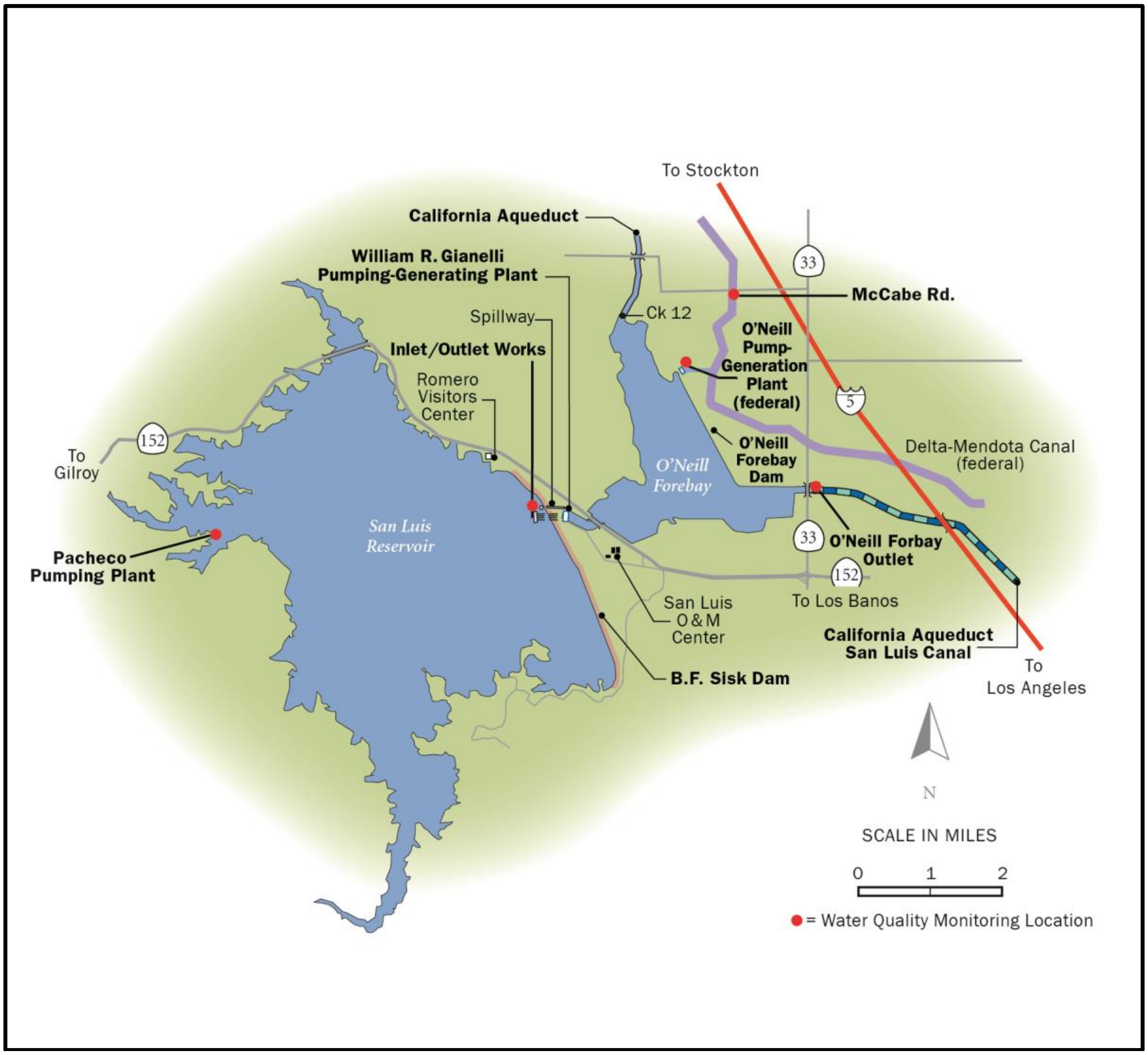
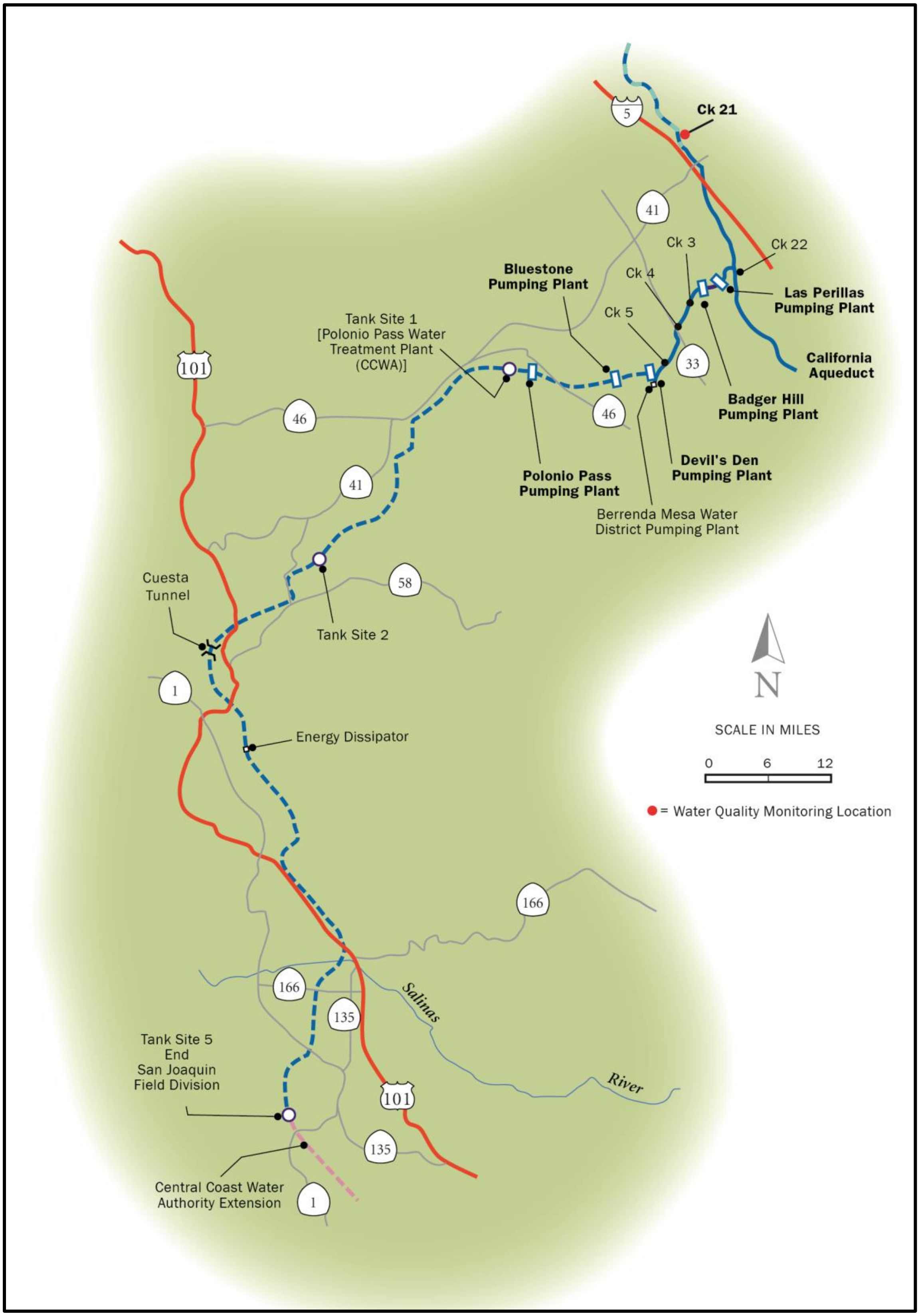


Figure 2-7. San Luis Canal Reach of the California Aqueduct

Figure 2-8. The Coastal Branch of the California Aqueduct



From the junction with the Coastal Branch, water continues southward in the California Aqueduct as shown in **Figure 2-9**, providing water to both agricultural and drinking water customers in the service area of Kern County Water Agency (KCWA). The Kern River Intertie is designed to permit Kern River water to enter the aqueduct during periods of high flow. Due to increasingly scarce California water supplies, the SWP is used to convey both surface water and groundwater acquired through transfers and exchanges among local agencies. Most of the non-Project water enters the aqueduct between Check 21 and Check 41. Edmonston Pumping Plant is at the northern foot of the Tehachapi Mountains. This facility lifts SWP water about 2000 feet by multi-stage pumps through tunnels to Check 41, located on the south side of the Tehachapi Mountains. About a mile downstream, the California Aqueduct divides into the West and East Branches. The West Branch flows 14 miles to Pyramid Lake, then another 17 miles to the outlet of Castaic Lake, the drinking water supply intake of the Metropolitan Water District of Southern California (MWDSC) and Santa Clarita Valley Water Agency (SCV Water). Pyramid Lake has a capacity of 171,200 acre-feet and Castaic Lake has a capacity of 323,700 acre-feet. **Figure 2-10** is a map showing locations of West Branch features.

From the bifurcation of the East and West Branches, water flows in the East Branch to high desert communities in the Antelope Valley served by the Antelope Valley East Kern Water Agency (AVEK) and the Palmdale Water District (Palmdale). **Figure 2-11** is a map showing East Branch features. As in the southern San Joaquin Valley, groundwater from the local area has occasionally been allowed into the aqueduct to alleviate drought emergencies. On the East Branch near Hesperia, surface water drainage from part of that city enters the aqueduct during storm events. The inlet to Silverwood Lake is located on the north side of the reservoir near Check 66. Silverwood Lake has a capacity of 74,970 acre-feet and serves as a drinking water supply for the Crestline-Lake Arrowhead Water District (CLAWA). Water is drawn from the south side of the reservoir and flows through the Devil Canyon Powerplant to the two Devil Canyon afterbays. Drinking water supplies are delivered to MWDSC and San Bernardino Valley Municipal Water District from this point, and water is also transported via the Santa Ana Pipeline to Lake Perris, which is the terminus of the East Branch. MWDSC routinely takes a small amount of water from Lake Perris.

Figure 2-9. California Aqueduct between Check 21 and Check 41

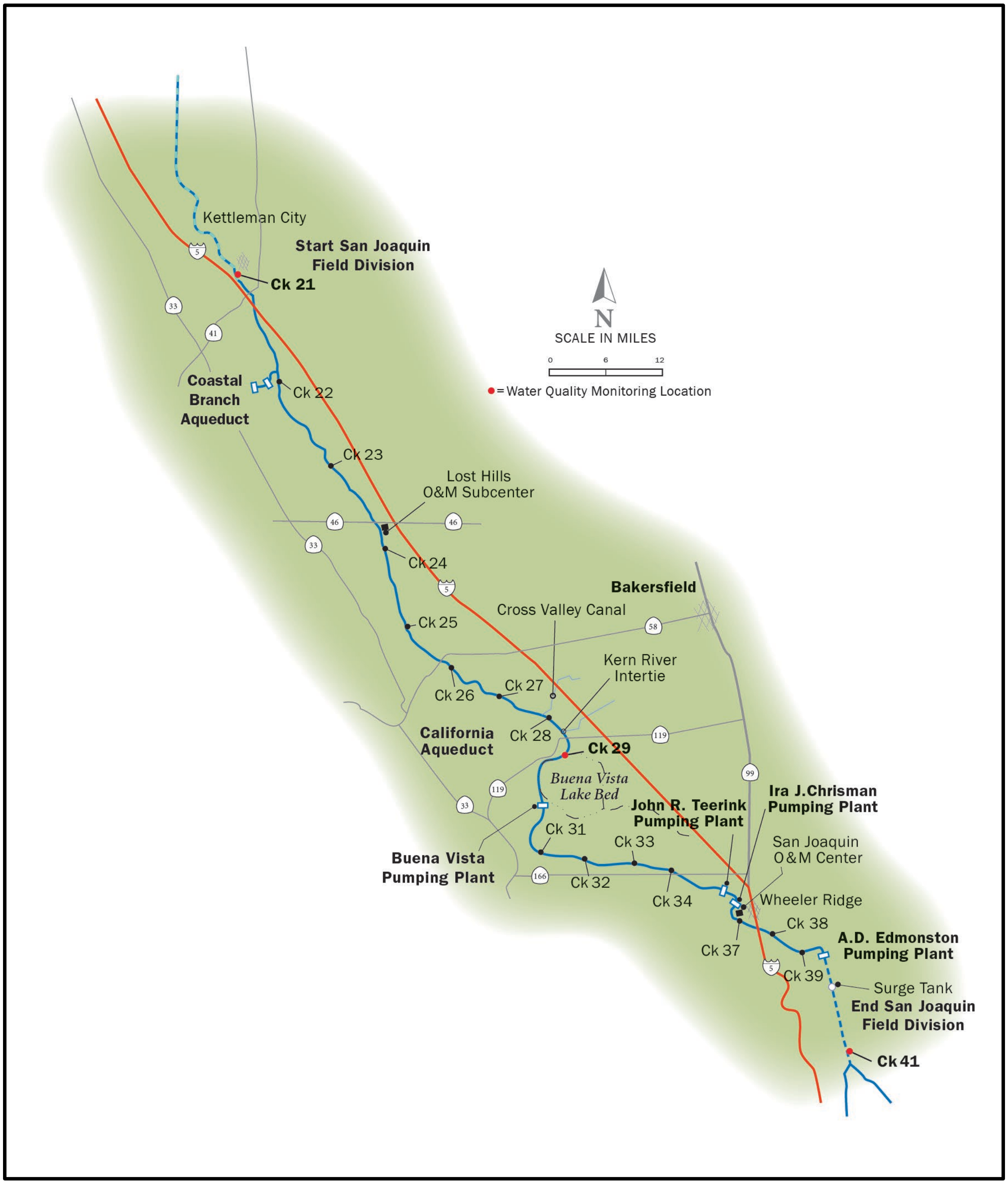
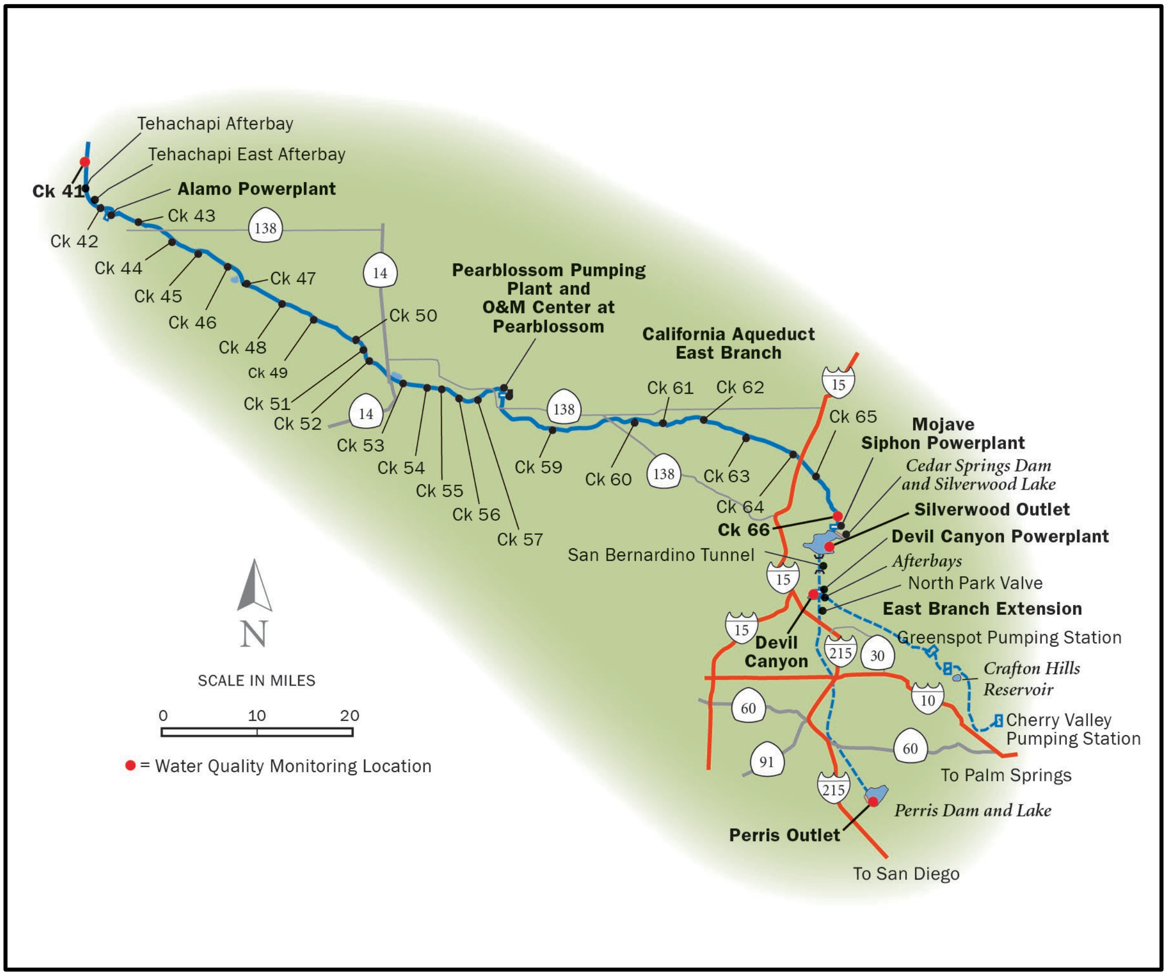


Figure 2-10. The West Branch of the California Aqueduct

Figure 2-11. The East Branch of the California Aqueduct



HYDROLOGY AND OPERATIONS

The Delta is located at the confluence of the Sacramento and San Joaquin rivers and San Francisco Bay. Water quality at the SWP export locations is greatly affected by hydrologic conditions in the Sacramento and San Joaquin basins, operations of reservoirs, and operations of the Delta Cross Channel and barriers in the South Delta. The water quality of water delivered to State Water Contractors south of the Delta is also affected by the timing of diversions and the operations of reservoirs south of the Delta. A brief overview of Delta hydrology and SWP operations is provided in this section to place the water quality discussion in proper context.

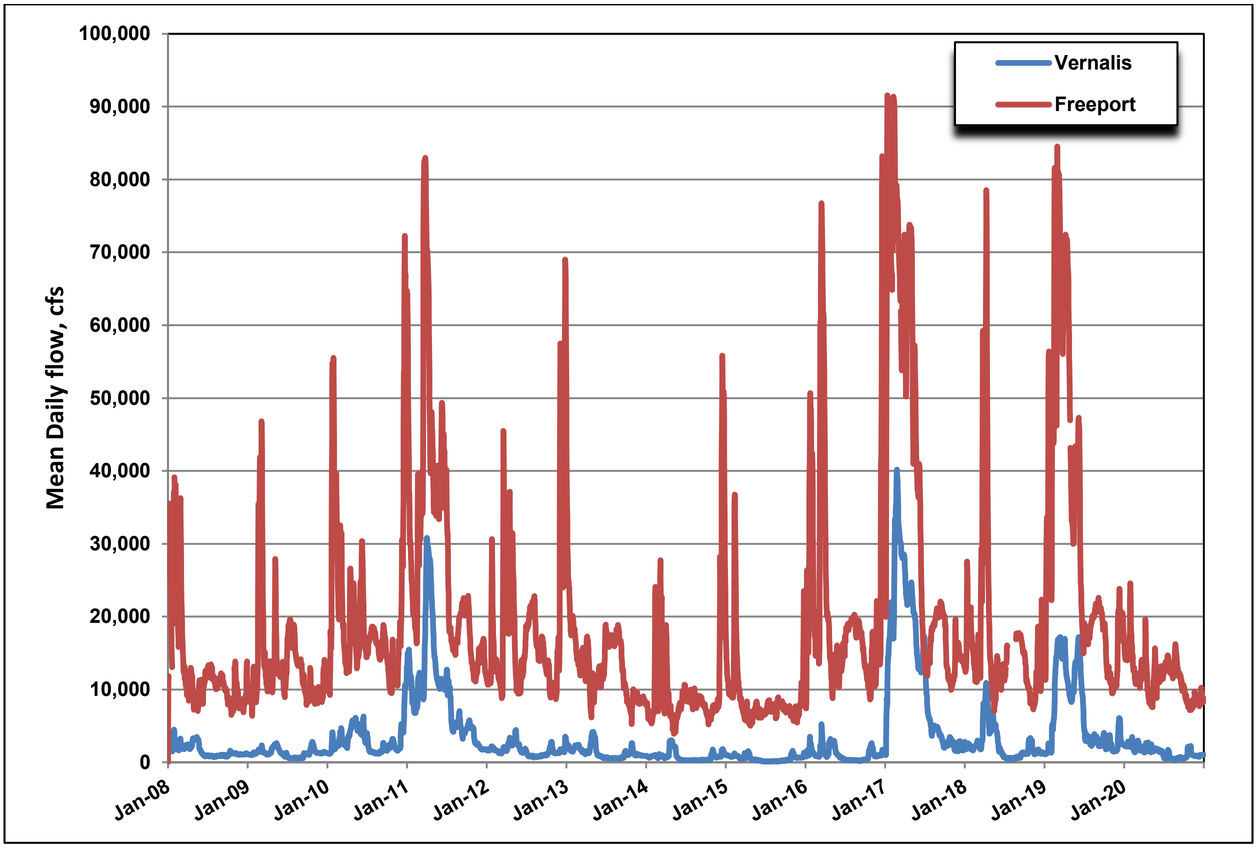
DELTA HYDROLOGY AND OPERATIONS

Delta Inflow

The two major sources of freshwater inflow to the Delta are the Sacramento and San Joaquin rivers. Additional flows come from the eastside tributaries: the Mokelumne, Calaveras, and Cosumnes rivers. The Sacramento River provides approximately 75 to 85 percent of the freshwater flow to the Delta and the San Joaquin River provides about 10 to 15 percent of the flow. Mean daily flows measured at Freeport on the Sacramento River are shown in **Figure 2-12** for the period of 2008 to 2020. During extremely wet years, Sacramento River flows can exceed 90,000 cubic feet per second (cfs) at Freeport. Freeport is downstream of the Sacramento urban area, as shown previously on **Figure 2-2**. To prevent flooding in the Sacramento urban area, high flows on the Sacramento River are diverted into the Yolo Bypass at Fremont Weir, upstream of Sacramento.

Figure 2-12 indicates that the flows in the San Joaquin River at Vernalis are substantially lower than flows in the Sacramento River. Peak flows can exceed 40,000 cfs but flows are normally much lower. San Joaquin River flows are impacted by the flow requirements stipulated in Decision 1641 (D-1641). D-1641 includes “spring flow” requirements that apply from February 1 through April 14 and May 16 through June 30, as well as higher spring “pulse” flows that apply from April 15 to May 15. These flow requirements set a minimum monthly average flow rate, based on the water year type. Flows are increased on the San Joaquin River by releasing water from reservoirs on the Merced, Stanislaus, and Tuolumne rivers. Combined exports at the Banks and Jones pumping plants are reduced to 1,500 cfs. These actions that are taken to improve salmon smolt survival also improve water quality.

Figure 2-12. Mean Daily Flow for Sacramento River at Freeport and San Joaquin River at Vernalis, 2008 to 2021



Flows on the Sacramento and San Joaquin rivers are highly managed. CVP and SWP reservoirs on the rivers and their tributaries attenuate the highly variable natural flows, capturing high volume flows during short winter and spring periods and releasing water throughout the year. The California Department of Water Resources (DWR) classifies each water year based on the amount of unimpaired runoff that would have occurred in the watershed unaltered by water diversions, storage, exports, and imports. **Table 2-1** presents the water year classifications for the Sacramento and San Joaquin basins between 1980 and 2020. This table illustrates that there are multi-year dry periods and multi-year wet periods.

The California Department of Water Resources adopts five water year types: wet, above normal, below normal, dry, and critical. The classification is based on a water year index that is derived from full natural flow measurements. For the Sacramento River region, the water year index is called the Sacramento Valley Index (SVI) (also known as the "4 River Index" and the "40-30-30 Index") and uses the sum of calculated monthly unimpaired runoff from the following gauges: Sacramento River above Bend Bridge, Feather River at Oroville, Yuba River at Smartsville, and American River below Folsom Dam. The SVI is calculated based on the following equation:

SVI = (0.4 X current April-July runoff) + (0.3 X current October-March runoff) + (0.3 X previous year's index)

The current April-July runoff is for the sum of the runoff for the four rivers in the current water year from April to July, in million acre-feet. If the previous year's index exceeds 10 MAF, then 10 MAF is applied instead. Once the SVI is calculated, the year type classification is based on the thresholds in **Table 2-2.**

Table 2-1. Water Year Classifications

Water Year	Sacramento Basin	San Joaquin Basin
1980	Above Normal	Wet
1981	Dry	Dry
1982	Wet	Wet
1983	Wet	Wet
1984	Wet	Above Normal
1985	Dry	Dry
1986	Wet	Wet
1987	Dry	Critical
1988	Critical	Critical
1989	Dry	Critical
1990	Critical	Critical
1991	Critical	Critical
1992	Critical	Critical
1993	Above Normal	Wet
1994	Critical	Critical
1995	Wet	Wet
1996	Wet	Wet
1997	Wet	Wet
1998	Wet	Wet
1999	Wet	Above Normal
2000	Above Normal	Above Normal
2001	Dry	Dry
2002	Dry	Dry
2003	Above Normal	Below Normal
2004	Below Normal	Dry
2005	Above Normal	Wet
2006	Wet	Wet
2007	Dry	Critical
2008	Critical	Critical
2009	Dry	Below Normal
2010	Below Normal	Above Normal
2011	Wet	Wet
2012	Below Normal	Dry
2013	Dry	Critical
2014	Critical	Critical
2015	Critical	Critical
2016	Below Normal	Dry
2017	Wet	Wet
2018	Below Normal	Below Normal
2019	Wet	Wet
2020	Dry	Dry

Source: http://cdec.water.ca.gov/cgi-progs/iodir/wsihist

Table 2-2. Sacramento Valley Index Year Type Classification in MAF

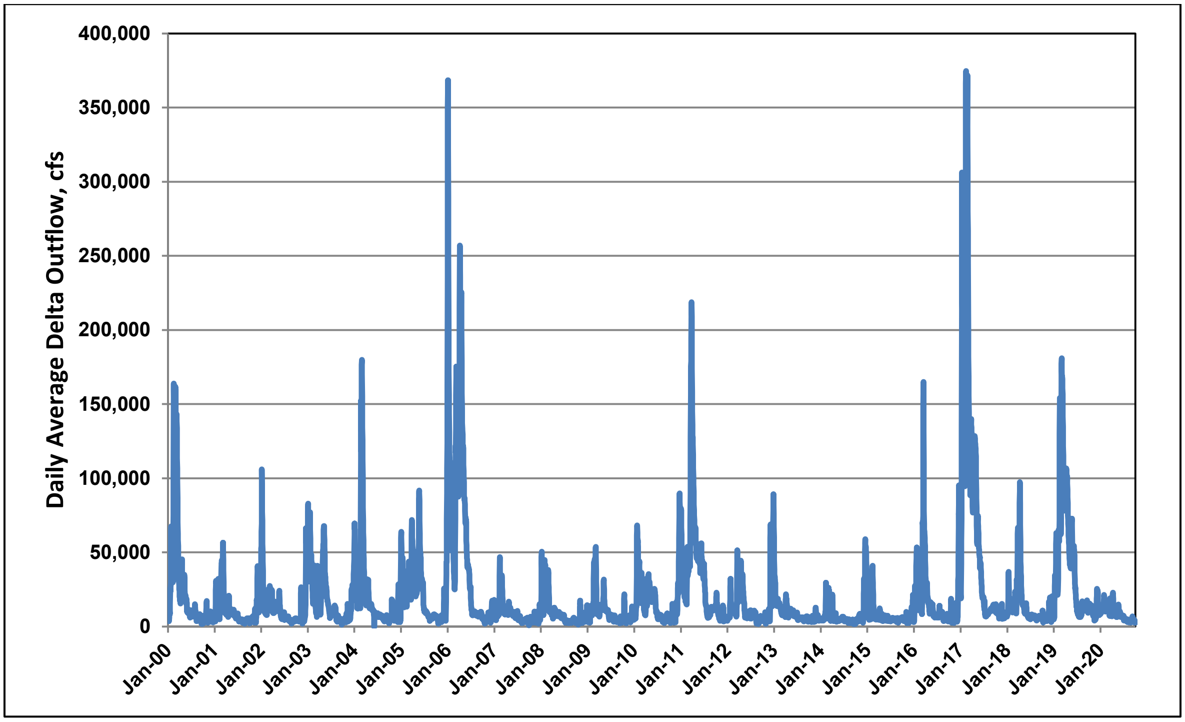
Water Year Type	**Sacramento Valley Index (MAF)**
Wet	Equal to or greater than 9.2
Above Normal	Greater than 7.8, and less than 9.2
Below Normal	Greater than 6.5, and equal to or less than 7.8
Dry	Greater than 5.4, and equal to or less than 6.5
Critical	Equal to or less than 5.4

Delta Outflow Index

Delta outflow, inflow that is not exported at the SWP and CVP pumps or diverted for use within the Delta, is the primary factor controlling salinity in the Delta. Except under conditions of high winter runoff, Delta outflow is dominated by tidal ebb and flood. Over the tidal cycle, flows move downstream toward San Francisco Bay during ebb tides and move upstream during flood tides. Freshwater flows provide a barrier against seawater intrusion. When Delta outflow is low, seawater can intrude further into the Delta, increasing salinity and bromide concentrations at the export locations. **Figure 2-13** shows the variable and seasonal nature of Delta outflow from 2000 to 2020.

Data was obtained from the DWR's Dayflow home page. Dayflow is a computer program designed to estimate daily average Delta outflow. The program uses daily river inflows, water exports, rainfall, and estimates of Delta agriculture depletions to estimate the "net" flow at the confluence of the Sacramento and San Joaquin Rivers, nominally at Chipps Island. It is a key index of the physical, chemical, biological state of the northern reach of the San Francisco Estuary. The Dayflow estimate of Delta outflow is referred to as the "net Delta outflow index" (NDOI) because it does not account for tidal flows, the fortnight lunar fill-drain cycle of the estuary, or barometric pressure changes. It is a quantity that never actually occurs in real time. Rather it is an estimate of the net difference between ebbing and flooding tidal flows at Chipps Island (~ + / - 150,000 cfs), aliased to a daily average. Depending on conditions, the actual net Delta outflow for a given day can be much higher or lower than the Dayflow estimate.

Figure 2-13. Net Delta Outflow Index



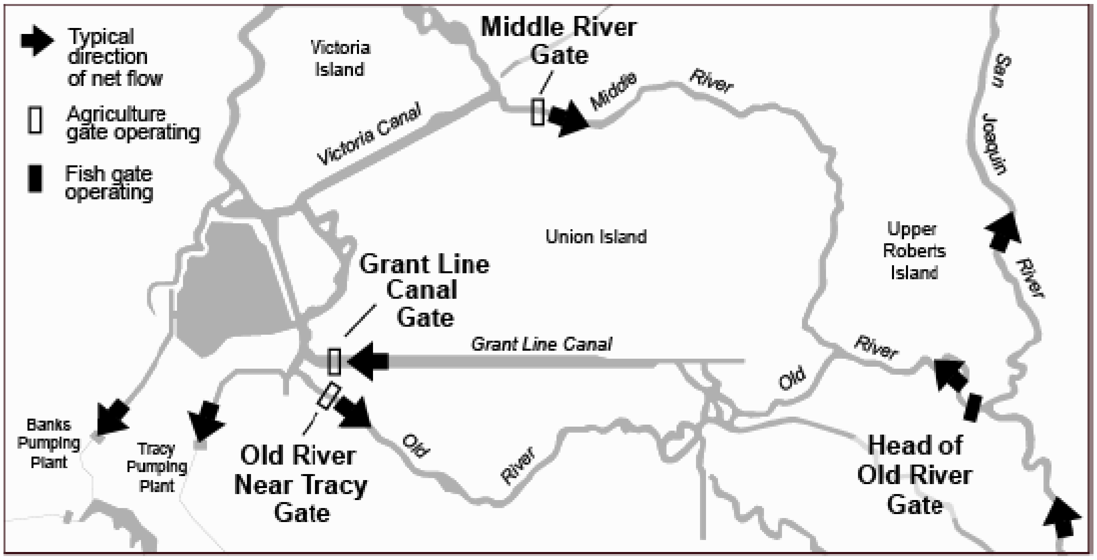
Source: http://www.water.ca.gov/dayflow/

Delta Operations

Water from the Sacramento River flows into the central Delta via Georgiana Slough and the Delta Cross Channel, which connects the Sacramento River to the Mokelumne River via Snodgrass Slough (**see Figure 2-2**). The Delta Cross Channel is operated by the U.S. Bureau of Reclamation (Reclamation). The Cross Channel operations are determined by several factors, including fish migration, Delta water quality, and flow in the Sacramento River. The Cross Channel is generally closed between January and mid-June, open between mid-June and October, and closed in November and December. Flows of Sacramento River water through the Delta Cross Channel improve central Delta water quality by increasing the flow of higher quality (lower salinity, lower organic carbon) Sacramento River water into the central and southern Delta. The relative impact of the Delta Cross Channel operations on water quality at the south Delta pumping plants is governed by pumping rates and flows on the San Joaquin River.

DWR installs temporary rock barriers in south Delta channels (Old River near Tracy, Grant Line Canal, and Middle River) to enhance water levels and improve circulation in the south Delta for agricultural diversions. These barriers are generally in place during the irrigation season of June to October. Another temporary barrier is installed in the spring (mid-April to mid-June) at the head of Old River to aid salmon migration down the San Joaquin River. This barrier is also installed in the fall, if needed, to aid salmon migrating up the San Joaquin River to spawn. **Figure 2-14** shows the locations of the temporary barriers. These barriers divert San Joaquin River water to the central Delta where it can be mixed with Sacramento and Mokelumne river water before entering the south Delta pumping plants. The degree of water quality improvement by mixing with Sacramento River water is dependent on the rate of pumping, which is controlled by the amount of reverse flow permitted on the Old and Middle rivers.

Figure 2-14. South Delta Temporary Barriers



Source: DWR 2006. Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun March.

Sources of Water at South Delta Pumping Plants

DWR uses results from the Delta Simulation Model 2 (DSM2) to identify the contributing sources of water volume, electrical conductivity (EC), and dissolved organic carbon (DOC) at each of the Delta intakes; this technique is known as fingerprinting. The fingerprinting technique has been described by DWR (DWR, 2005a). The volumetric fingerprint, which shows the relative volumes of water from various sources at Clifton Court, is shown in **Figure 2-15**. This figure shows that the Sacramento River is the predominant source of water for the SWP at Clifton Court; however, during wet and above normal years in the San Joaquin Basin and at other times when flow in the San Joaquin River is relatively high, the San Joaquin River contributes more water to the SWP. During the 2016 to 2020 period, the Sacramento River contributed an average of 53 percent of the water at Clifton Court, the San Joaquin River contributed 33 percent, agricultural drains contributed 8 percent, eastside streams (Cosumnes, Mokelumne, and Calaveras rivers) contributed 6 percent, and seawater intrusion contributed 1 percent. The volumetric fingerprint for Jones is shown in **Figure 2-16**. This figure clearly shows the greater influence of the San Joaquin River at Jones. During the 2016 to 2020 period, the Sacramento River contributed an average of 41 percent of the water at Jones, the San Joaquin River contributed an average of 47 percent, agricultural drains contributed 7 percent, eastside streams contributed 4 percent, and seawater intrusion contributed 1 percent.

Figure 2-15.Modeled Volumetric Fingerprint at Clifton Court Forebay

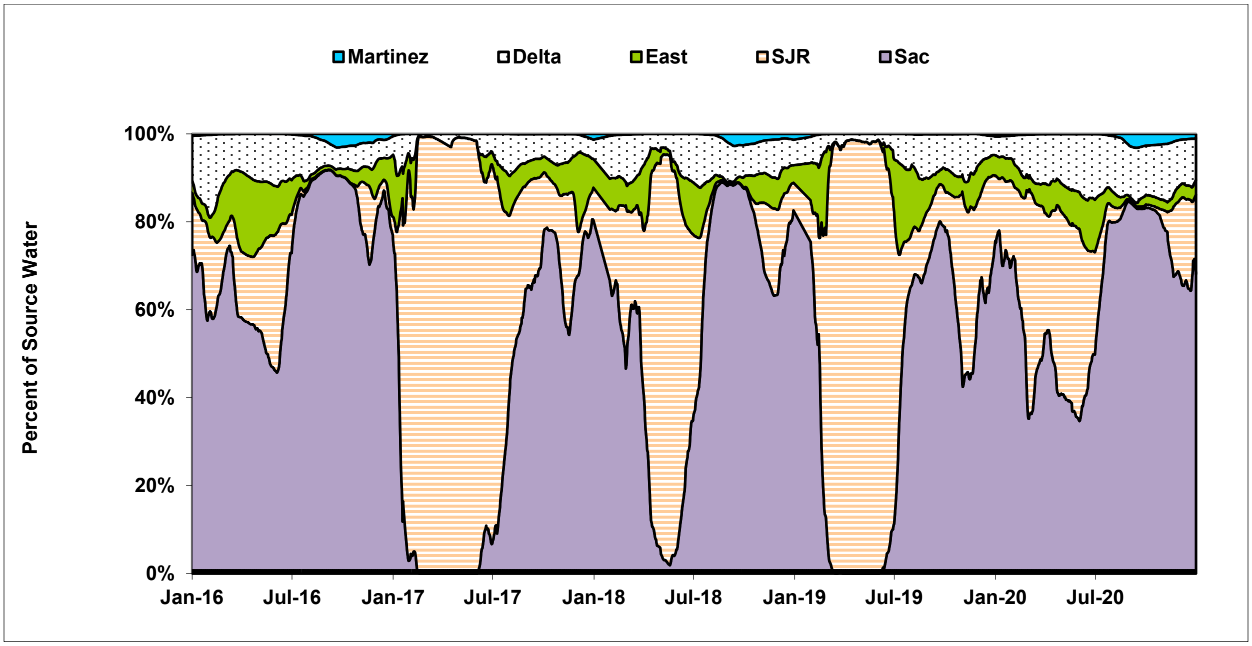
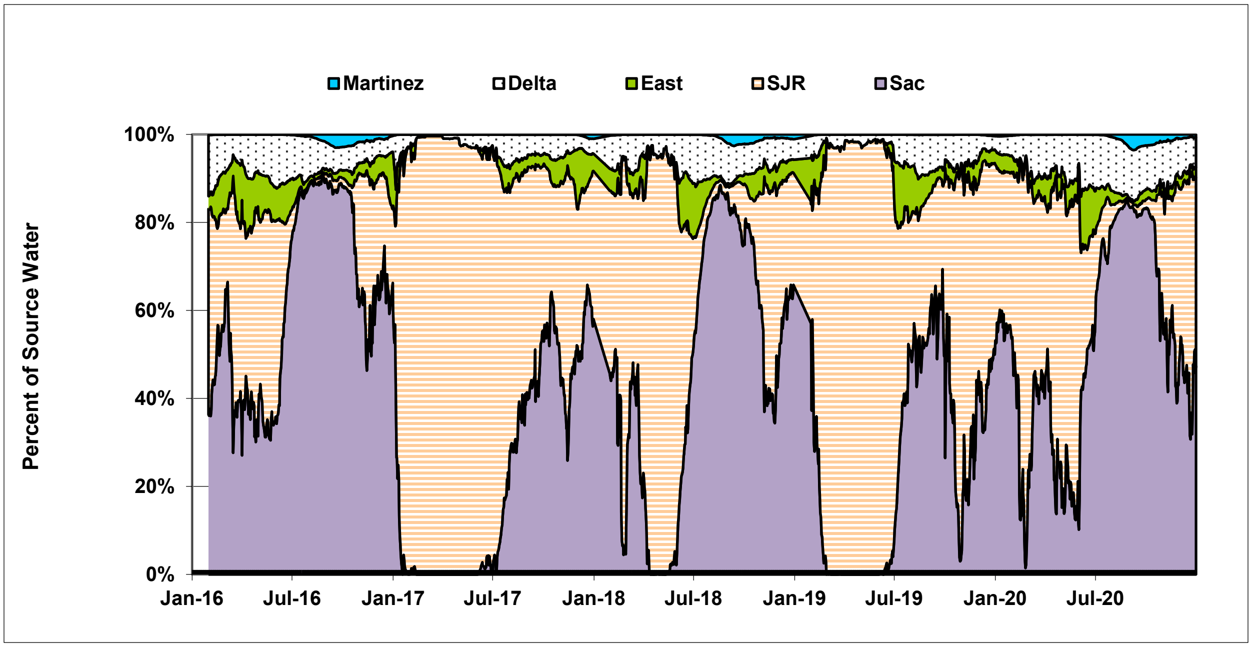


Figure 2-16. Modeled Volumetric Fingerprint at Jones



Seawater intrusion is represented on the fingerprints as "Martinez"; Martinez represents the western boundary of the Delta in the DSM2 model. Seawater intrusion is most significant during the fall months, when river flows are minimal. During the fall months of critically dry years, the Martinez water volume can sometimes be 2 to 3 percent of the total volume at both pumping plants. However, since the water at Martinez is heavily influenced by seawater intrusion, that small volume can contribute significant salinity and bromide.

STATE WATER PROJECT OPERATIONS

Information is presented in this section on pumping at the major pumping plants supplying water to the NBA, SBA, and California Aqueduct and on releases from Lake Del Valle to the SBA and San Luis Reservoir to the California Aqueduct. From 1998 to 2006, diversions at the Banks Pumping Plant were governed by the 1995 Bay-Delta Plan (D-1641). The Bay-Delta Plan established new water quality objectives for the Delta that resulted in lower diversions of water from the Delta in the spring and higher diversions in the fall, starting in 1998. Delta operations changed again in 2007 when DWR voluntarily reduced exports in the spring to reduce entrainment of delta smelt. Biological opinions issued by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) and court orders (the Wanger Decision) changed operations at the south Delta pumping plants beginning in 2008. The Bureau of Reclamation and DWR reinitiated Endangered Species Act consultation on Central Valley Project (CVP) and SWP long-term operations in 2016. After operating under the 2008 Biological Opinions for over a decade, the NMFS and the USFWS reached a no jeopardy and no adverse modification conclusion in October 2019. In short, the NMFS and the USFWS determined that the proposed operations of the CVP and SWP would not jeopardize threatened or endangered species or adversely modify their designated critical habitat. In early 2020, the State of California, after careful review, concluded that the 2019 Biological Opinion did not do enough to protect endangered fish, so the State filed litigation and is currently challenging the 2019 Biological Opinions. DWR adopted a new 10-year Incidental Take Permit for SWP on March 31. 2020 which contains elements not included in the 2019 Biological Opinions. On September 30, 2021, the Bureau of Reclamation, in coordination with the USFWS, the NMFS, and DWR requested to reinitiate consultation on the Long-Term Operation of the CVP and SWP. The goals are for Reclamation to submit a comprehensive Proposed Action by December 2022, and for NMFS and USFWS to complete a new Biological Opinion within 12 months of receipt of Reclamation's Proposed Action.

North Bay Aqueduct

Water is pumped into the NBA via the Barker Slough Pumping Plant. **Figure 2-17** presents annual pumping at the Barker Slough Pumping Plant for the 1998 to 2020 period. **Figure 2-17** shows pumped volumes ranged from about 33,000 acre-feet in 2016 to almost 60,000 acre-feet in 2007. **Figure 2-18** presents the average monthly pumping for the 2016 to 2020 period. This figure shows that pumping during the months of January to April is minimal and pumping is relatively high for the remaining months.

Figure 2-17. Annual Pumping at the Barker Slough Pumping Plant

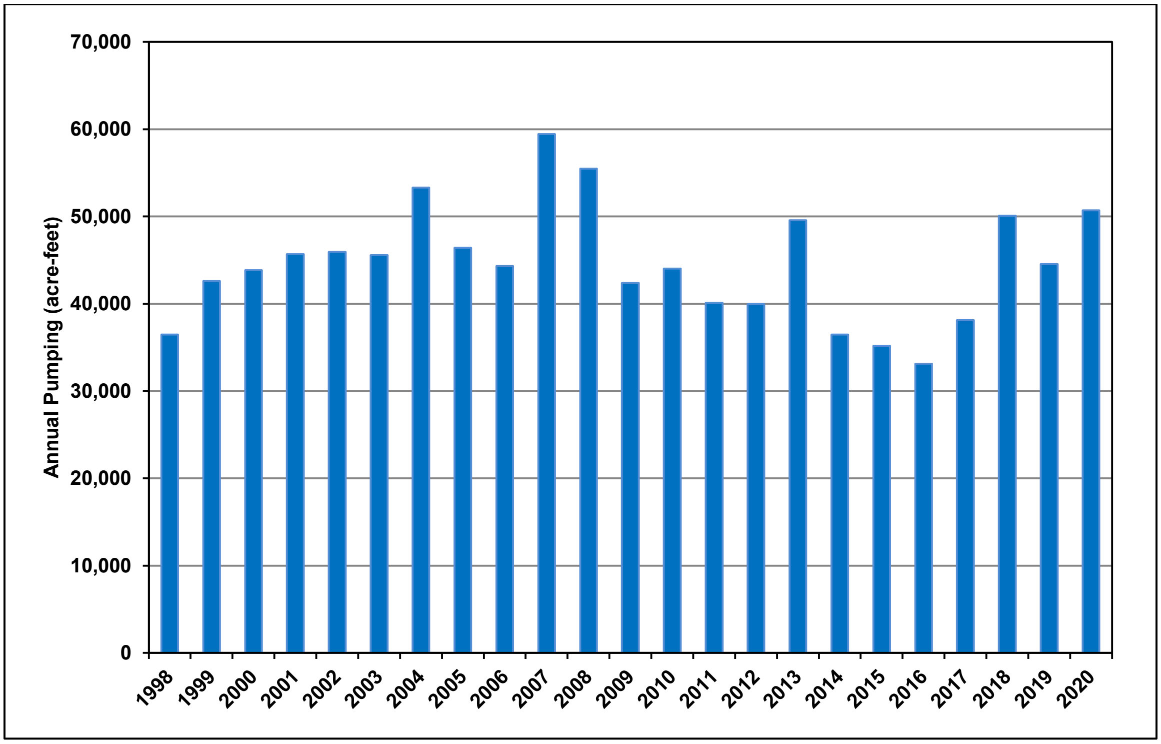
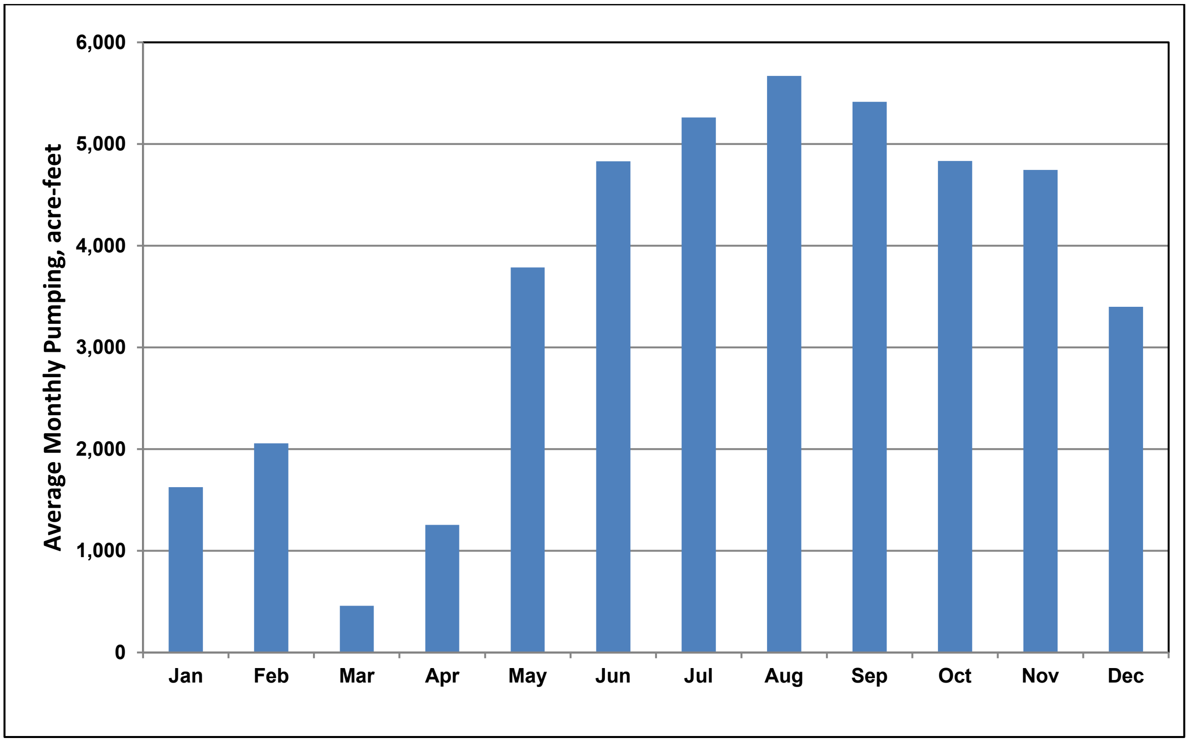


Figure 2-18. Average Monthly Pumping at the Barker Slough Pumping Plant (2016 to 2020)



Banks Pumping Plant

Water is pumped into the California Aqueduct via the Banks Pumping Plant. **Figure 2-19** presents the annual pumping at Banks for the 1998 to 2020 period. **Figure 2-19** shows pumped volumes ranged from 840,000 acre-feet in 2015 to over 4 million acre-feet in 2005. As discussed previously, pumping operations changed starting in 2007. **Figure 2-20** presents the average monthly pumping from 2016 to 2020. This figure shows that pumping is highest in the summer months and lowest in the April and May period.

South Bay Aqueduct

As discussed previously, water is pumped from Bethany Reservoir via the South Bay Pumping Plant into the SBA. **Figure 2-21** presents annual pumping at the South Bay Pumping Plant for the 1998 to 2020 period. **Figure 2-21** shows a large range in pumped volumes with less than 80,000 acre-feet pumped in 1998 to almost 160,000 acre-feet pumped in 2007. **Figure 2-22** presents the average monthly pumping from 2016 to 2020. This figure shows that the least amount of water is pumped into the SBA during the winter months and the most is pumped in during the summer months. Lake Del Valle is the other source of water for the SBA Contractors. Lake Del Valle receives natural inflows from its watershed and Delta water pumped into it at the Del Valle Pumping Plant. **Figure 2-23** presents the average monthly pumping at the South Bay Pumping Plant and average monthly releases from Lake Del Valle for the 2016 to 2020 period. During most months of the year there are minimal releases from Lake Del Valle so ACWD and Valley Water are receiving primarily water from the Delta. Water is released from Lake Del Valle primarily from September to November and can represent a large portion of the water that ACWD and Valley Water receive during these months.

Figure 2-19. Annual Pumping at the Banks Pumping Plant

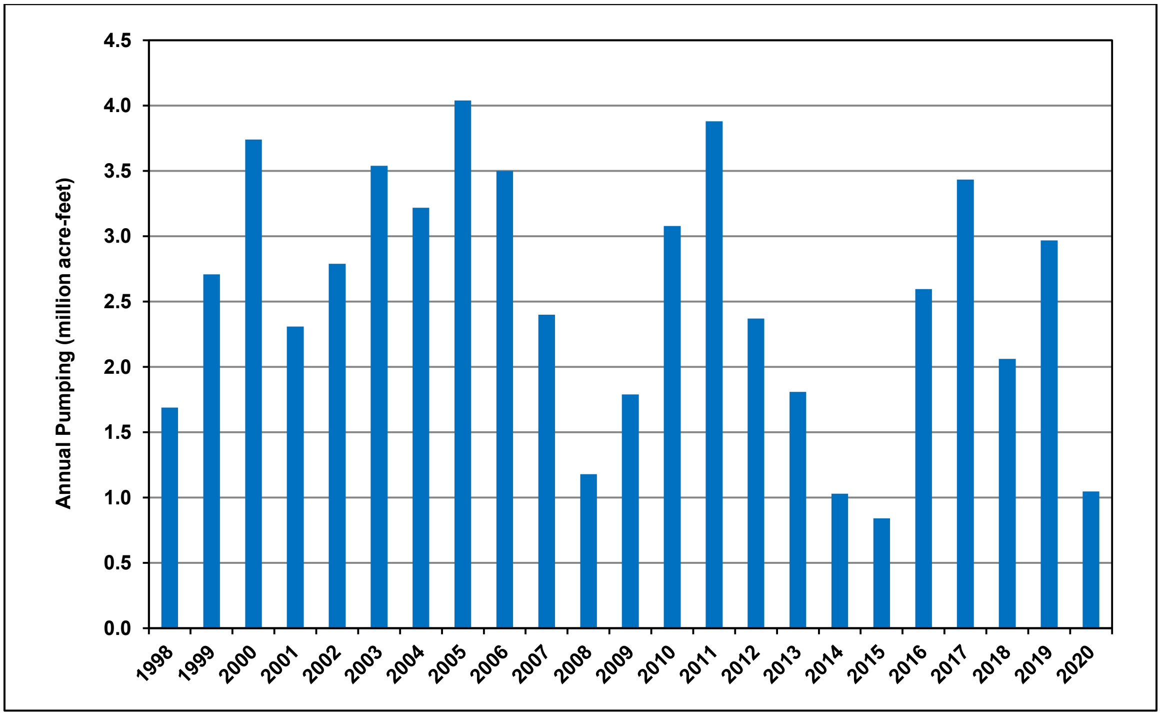


Figure 2-20. Average Monthly Pumping at the Banks Pumping Plant (2016 to 2020)

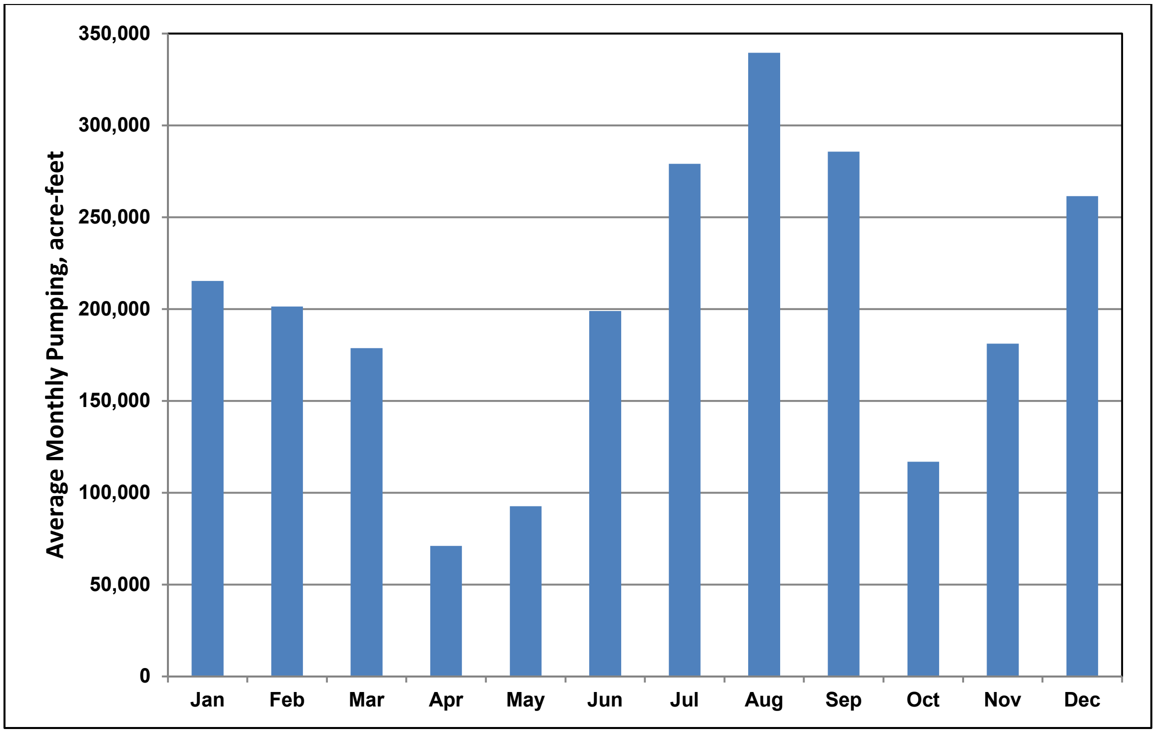


Figure 2-21. Annual Pumping at the South Bay Pumping Plant

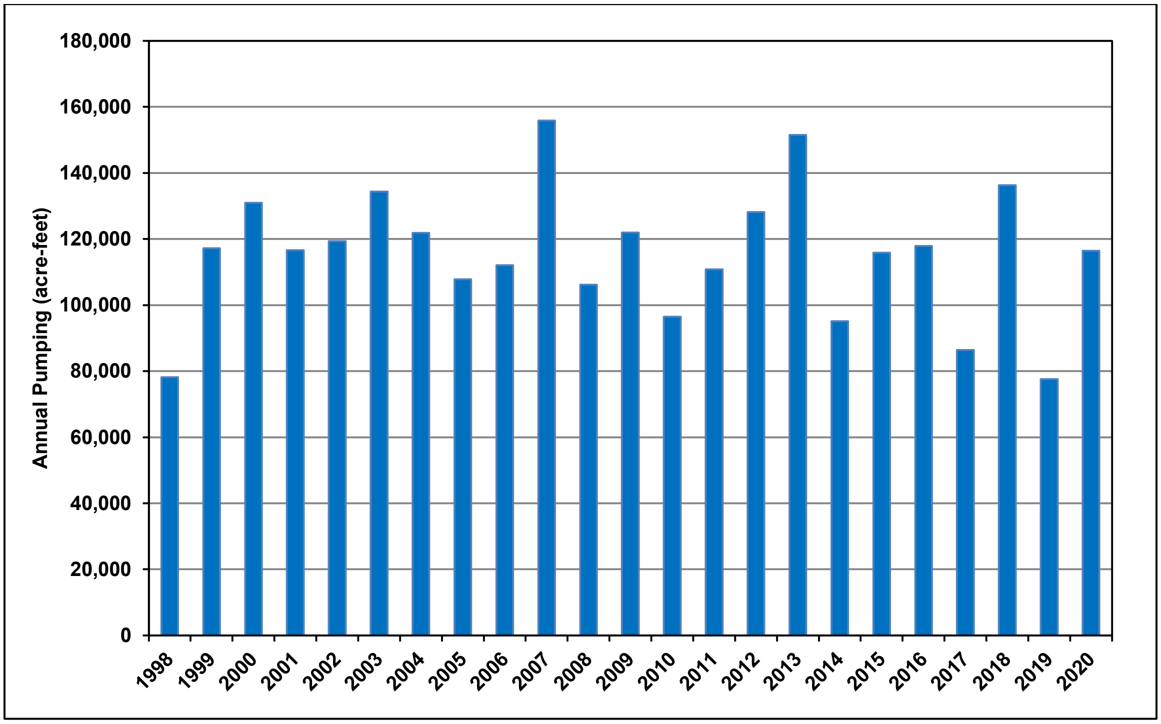


Figure 2-22. Average Monthly Pumping at the South Bay Pumping Plant (2016 to 2020)

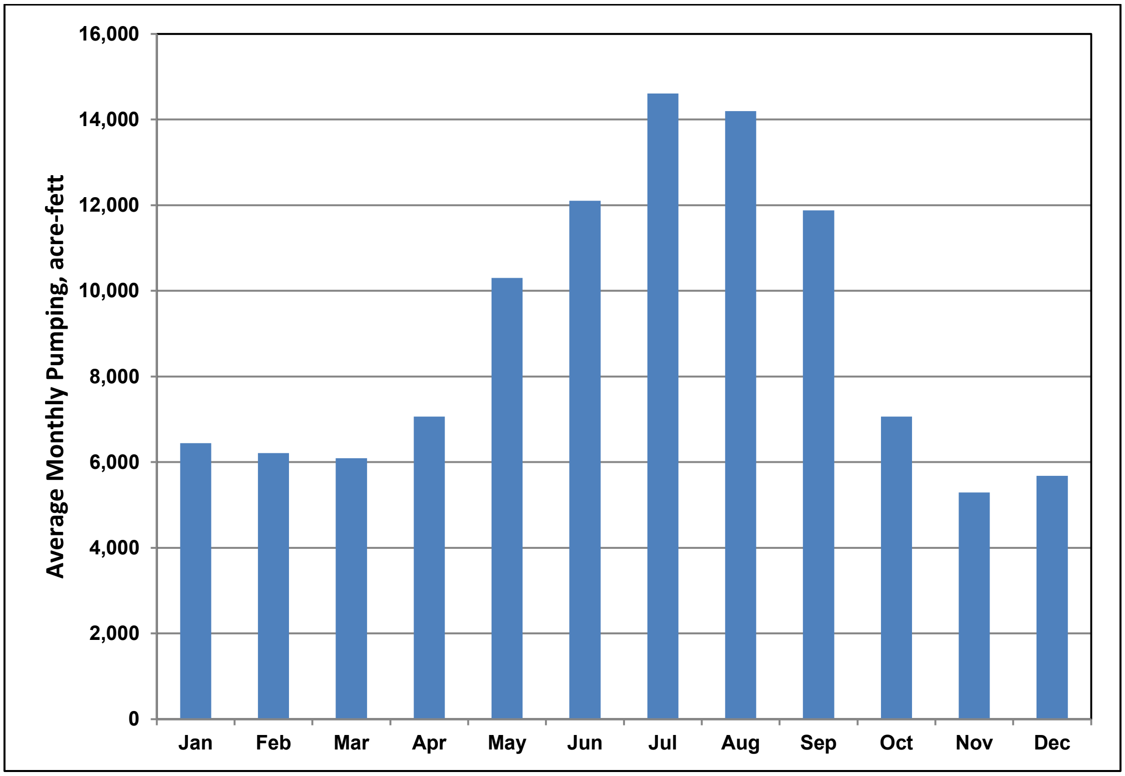
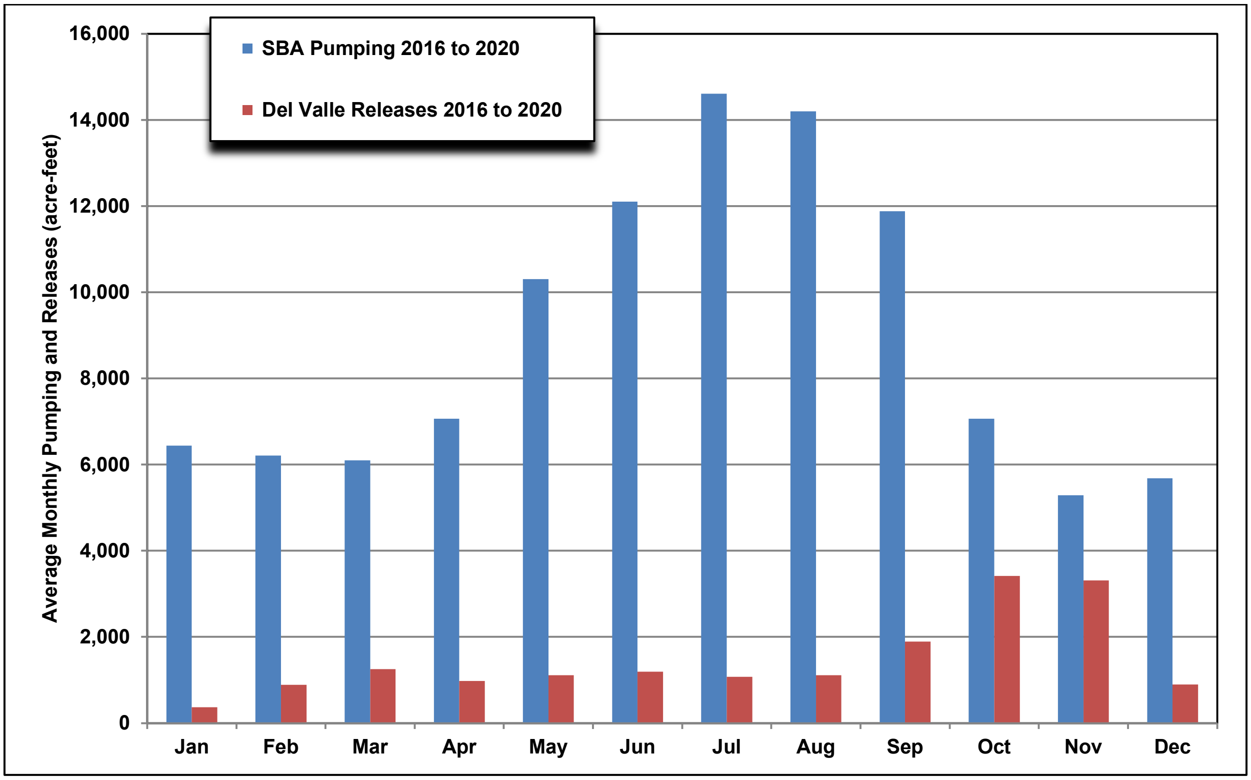


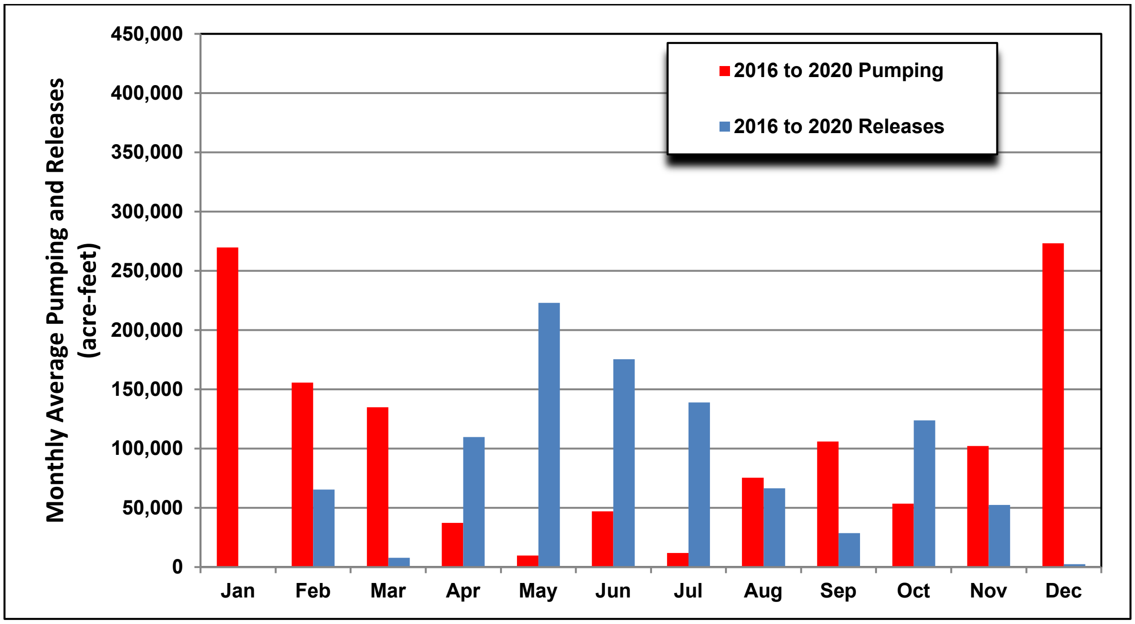
Figure 2-23. Monthly Pumping at the South Bay Pumping Plant and Releases from Lake Del Valle (2016 to 2020)



San Luis Reservoir

Water is generally pumped into San Luis Reservoir starting between the fall months and March, when supplies are available and demand for water is lowest. The stored water is released from the reservoir during the summer months when agricultural and urban demands are highest. **Figure 2-24** shows the average monthly pumping and releases from the Gianelli Pumping Plant for the 2016 to 2020 period.

Figure 2-24. Monthly Pumping at the Gianelli Pumping Plant and Releases from San Luis Reservoir (2016 to 2020)



WATER QUALITY DATA

DATA SOURCES

Sources of data include flow data from the U.S. Geological Survey (USGS) and DWR, as well as discrete (grab) sample water quality data and continuous recorder (real-time) water quality data from DWR monitoring stations in the Delta and SWP. The grab sample data were obtained from DWR's Water Data Library and the real-time data were obtained from CDEC. A number of SWP Contractors provided pathogen and indicator organism data. The pathogen data provided by the Contractors generally comes from the intakes to their water treatment plants rather than at locations in the SWP that are monitored by DWR.

MONITORING LOCATIONS

Chapters 3 through 10 contain a discussion of data collected at numerous locations in the major rivers, the Delta, and the SWP, with varying periods of record. **Figure 2-2** shows the monitoring locations in the Delta and **Figures 2-3 through 2-11** show the monitoring locations along the SWP. **Table 2-2** provides a brief explanation of the monitoring locations that are referred to in the following chapters.

Table 2-3. Water Quality Monitoring Locations, 2016 to 2020

Monitoring Location	Abbreviated Name	Description
The SWP Watershed		
Sacramento River at West Sacramento	West Sacramento	Sacramento River upstream of Sacramento urban area
American River	American	American River five miles upstream of confluence with Sacramento River
Sacramento River at Hood	Hood	Sacramento River inflow to the Delta
Sacramento River at Greenes Landing	Greenes Landing	Sacramento River inflow to the Delta two miles downstream of Hood. This station was replaced by Hood.
Mokelumne River at Wimpys	Mokelumne	Mokelumne River inflow to the Delta
Calaveras River at Brookside Road	Calaveras	Calaveras River inflow to the Delta
San Joaquin River near Vernalis	Vernalis	San Joaquin River inflow to the Delta
Clifton Court Forebay Inlet Structure	Clifton Court	Inlet to Clifton Court Forebay from Old River
Harvey O. Banks Delta Pumping Plant Headworks	Banks	Inception of California Aqueduct
North Bay Aqueduct		
Barker Slough Pumping Plant	Barker Slough	Inlet to North Bay Aqueduct (supplies Fairfield and Vacaville)
Cordelia Pumping Plant Forebay	Cordelia	North Bay Aqueduct (supplies Vallejo, Benicia, Napa, and American Canyon)
South Bay Aqueduct		
Del Valle Check 7	DV Check 7	SBA upstream of Lake Del Valle
Del Valle Conservation Outlet	Conservation Outlet	Outlet from Lake Del Valle to SBA
Vallecitos Turnout	Vallecitos	SBA downstream of Lake Del Valle
Santa Clara Terminal Reservoir	Terminal Tank	Terminus of the SBA at Valley Water intake
Delta-Mendota Canal		
Headworks at Jones Pumping Plant	Jones	Inception of the DMC
DMC at McCabe Road	McCabe	DMC upstream of O'Neill Forebay at McCabe Road bridge
DMC at O'Neill Intake	O'Neill Intake	DMC at milepost 70 near O'Neill Pump-Generation Plant
California Aqueduct and Reservoirs		
Pacheco Pumping Plant	Pacheco	San Luis Reservoir releases to Valley Water
Gianelli Pumping-Generating Plant	Gianelli	San Luis Reservoir releases to O'Neill Forebay and California Aqueduct
O'Neill Forebay Outlet	O'Neill Forebay Outlet	California Aqueduct at O'Neill Forebay outlet
Check 21	Check 21	California Aqueduct at end of San Luis Canal reach. Represents water quality in Coastal Branch Aqueduct.
Check 29	Check 29	California Aqueduct 3.5 miles downstream of Kern River Intertie
Check 41	Check 41	Inlet to Tehachapi Afterbay near bifurcation of East and West Branches
Check 66	Check 66	East Branch, near Silverwood Lake inlet
Castaic Lake Outlet Tower	Castaic Outlet	Outlet from Castaic Lake on the West Branch. Samples are collected in surface water at 1 meter depth.
Silverwood Lake at San Bernardino Tunnel	Silverwood Outlet	Outlet from Silverwood Lake via the San Bernardino Tunnel to Devil Canyon.
Devil Canyon Headworks and Afterbay	Devil Canyon	Devil Canyon Afterbay, intake for MWDSC's Mills WTP, and for San Bernardino Valley Municipal Water District.
Lake Perris	Perris Outlet	Outlet to Lake Perris and intake for MWDSC, terminus of East Branch.

- Sacramento River at Hood (Hood) – Represents the quality of water flowing into the Delta from the Sacramento River.

- San Joaquin River at Vernalis (Vernalis) – Represents the quality of water flowing into the Delta from the San Joaquin River.

- Barker Slough Pumping Plant (Barker Slough) – Represents the quality of water entering the NBA.

- Banks Pumping Plant (Banks) – Represents the quality of water entering the California Aqueduct.

- South Bay Aqueduct Del Valle Check 7 (DV Check 7) - Represents SBA water quality upstream of releases from Lake Del Valle. Since limited data are collected downstream of this location, it is used to represent the quality of water delivered to all SBA Contractors.

- Delta-Mendota Canal at McCabe Road (McCabe) – Represents the quality of water entering O’Neill Forebay from the DMC.

- Pacheco Pumping Plant (Pacheco) – Represents the quality of water delivered to Valley Water from San Luis Reservoir. This location is also used to represent the quality of water delivered to O’Neill Forebay from San Luis Reservoir since limited data are available at Gianelli.

- William R. Gianelli Pumping-Generating Plant (Gianelli) – Represents O’Neill Forebay water when pumping occurs into San Luis Reservoir, and San Luis Reservoir water when releases occur from San Luis Reservoir.

- California Aqueduct O’Neill Forebay Outlet – Represents the quality of water entering the California Aqueduct after mixing of water from the aqueduct, DMC, and San Luis Reservoir in O’Neill Forebay.

- California Aqueduct Check 21 (Check 21) – Represents the quality of water entering the Coastal Branch and delivered to Central Coast Water Authority and San Luis Obispo County Flood Control and Water Conservation District. This location is also used to evaluate the impacts of turn-ins to the aqueduct between O’Neill Forebay Outlet and Check 21.

- California Aqueduct Check 41 (Check 41) – Represents the quality of water entering the east and west branches of the aqueduct. This location is also used to evaluate the impacts of turn-ins to the aqueduct between Check 21 and Check 41.

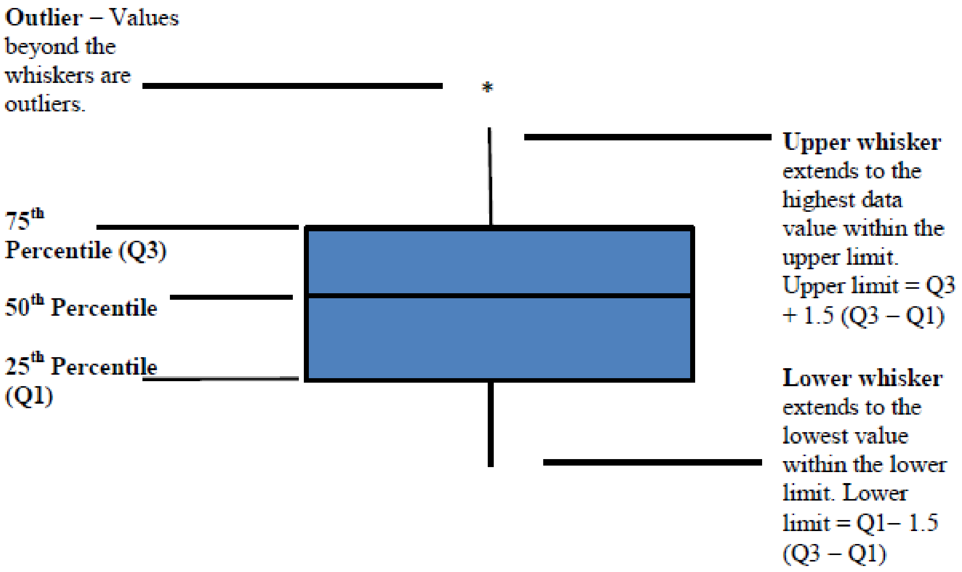
- Castaic Lake Outlet (Castaic Outlet) – This is the terminus of the west branch of the aqueduct. It represents the quality of water delivered to MWDSC and Santa Clarita Valley Water Agency (SCV Water).

- Devil Canyon Afterbay (Devil Canyon) and Silverwood Lake (Silverwood) – Represents the quality of water delivered to MWDSC, Crestline Lake Arrowhead Water Agency (CLAWA), and San Bernardino Valley Municipal Water District.

DATA EVALUATION AND STATISTICAL ANALYSIS

Time series plots are presented for each of the key locations for each constituent that is discussed in the following chapters. Non-detects were set at the detection limit and included in the graphs and the statistical analyses. Box plots are also used to show data from multiple locations on one plot and to display seasonal differences at one location. **Figure 2-25** presents an explanation of the box plots. Since environmental data are not normally distributed, the non-parametric Mann-Whitney test (also called the Wilcoxon Rank-sum test) was used for comparisons of data among locations and between wet years and dry years. In this report, the *p*-value is reported whenever a statistical comparison is made. The *p*-value is a computed probability value used in combination with a prescribed level of significance (α) to determine if a test is statistically significant. The smaller the *p*-value, the stronger is the evidence supporting statistical significance. The commonly accepted α-value of 5 percent or α=0.05 is used in this report. If the *p*-value is <0.05, the statistical test is declared significant.

Figure 2-25. Explanation of Box Plots



CHANGES IN ANALTYICAL METHODS FOR WATER SAMPLES

The DWR Bryte Laboratory changed the analytical methods used for the following analytes over the reporting period, as noted below in **Table 2-3.**

Table 2-4. Changes in Analytical Methods by DWR Bryte Lab

New Analytical Method	Previous Analytical Method	Date Change
Total Alkalinity mg/L as CaCO3 Std Method 2320 B [1]*	Total Alkalinity mg/L as CaCO3 Std Method 2320 B (Filtered) [1]*	March 2020
Dissolved Bromide mg/L EPA 300.0 [1]*	Dissolved Bromide mg/L EPA 300.0 28d Hold [1]*	August 2020
Dissolved Nitrate + Nitrite mg/L as N Std Method 4500-NO3-F [1]*	Dissolved Nitrate + Nitrite mg/L as N Std Method 4500-NO3-F (DWR Mod [1]*	November 2020
Dissolved Organic Carbon mg/L as C EPA 415.3 (D) [PS-3]*	Dissolved Organic Carbon mg/L as C EPA 415.1 (D) Ox [PS-3]*	July 2019
Total Organic Carbon mg/L as C EPA 415.3 (T) [PS-3]*	Total Organic Carbon mg/L as C EPA 415.1 (T) Ox [PS-3]*	June 2019
Total Phosphorus mg/L as P EPA 365.4 [1]*	Total Phosphorus mg/L as P EPA 365.4 DWR Modified [1]*	November 2020
Total Kjeldahl Nitrogen mg/L as N EPA 351.2 [1]*	Total Kjeldahl Nitrogen mg/L as N EPA 351.2 DWR Modified [1]*	November 2020
Specific Conductance uS/cm@25 °C Std Method 2510-B [1]*	Specific Conductance uS/cm@25 °C Std Method 2510-B (Filtered) [1]*	July 2020

REFERENCES

Literature Cited

California Department of Water Resources. 2005a. Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. 26th Annual Progress Report to the State Water Resources Control Board.

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CHAPTER 3 ORGANIC CARBON

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CHAPTER 3 ORGANIC CARBON

WATER QUALITY CONCERN

Organic matter in a waterbody consists of dissolved and particulate materials of plant, animal, and bacterial origins, in various stages of growth and decay. Total organic carbon (TOC) exists as particulate organic carbon and dissolved organic carbon (DOC) and can be divided into humic and non-humic substances. Humic substances are high molecular weight compounds largely formed as a result of bacterial and fungal action on plant material and include soluble humic and fulvic acids and insoluble humin. Non-humic substances include proteins, carbohydrates, and other lower molecular weight substances that are more available to bacterial degradation than humic substances. Strong oxidants, such as chlorine and ozone, are used to destroy pathogenic organisms in drinking water treatment plants, but these oxidants also react with organic carbon compounds (primarily humic substances) present in the water to produce disinfection byproducts (DBPs).

TOC is a precursor to many DBPs. Increased levels of TOC in source waters affect DBP concentrations by increasing the amount of precursor material available to react with the disinfectant and by increasing the amount of disinfectant required to achieve adequate disinfection. According to the U.S. Environmental Protection Agency (USEPA), DBPs have been associated with an increased risk of cancer; liver, kidney and central nervous system problems; and adverse reproductive effects (USEPA, 2001). While many DBPs have been identified, only a few are currently regulated. Concern over potential health effects of total trihalomethanes (TTHMs) and haloacetic acids (HAA5) has resulted in federal and state drinking water regulations controlling their presence in treated drinking water. The Stage 1 Disinfectants and Disinfection Byproducts (D/DBP) Rule reduced the TTHM Maximum Contaminant Level (MCL) from 0.10 mg/L to 0.080 mg/L and established an MCL for HAA5 of 0.060 mg/L. In addition, this rule established treatment requirements based on the concentrations of organic carbon and the levels of alkalinity in source waters, as shown in **Table 3-1**. Organic carbon is a concern for drinking water agencies treating State Water Project (SWP) water in conventional water treatment plants because TOC concentrations fall in the range that require action under this Rule. TOC removal compliance is based on the running annual average (RAA), calculated quarterly, of monthly removal ratios. The removal ratio is the ratio of the removal achieved divided by the removal required. The RAA of the removal ratios needs to equal or exceed 1.00.

Table 3-1. Percent TOC Removal Requirements

TOC (mg/L)	Alkalinity (mg/L as $CaCO_3$)		
	0 – 60	> 60 – 120	> 120
> 2.0 – 4.0	35.0	25.0	15.0
> 4.0 – 8.0	45.0	35.0	25.0
> 8.0	50.0	40.0	30.0

Furthermore, on January 4, 2006, the USEPA adopted the Stage 2 Disinfectants and Disinfection Byproducts (Stage 2 DBP) Rule. Under the Stage 2 DBP Rule, public water systems that deliver disinfected water are required to meet TTHM and HAA5 MCLs as an average at each compliance monitoring location, referred to as a locational running annual average (LRAA) (instead of as a system-wide average as in previous rules). The Stage 2 DBP Rule reduces DBP exposure and related potential health risks, and provides more equitable public health protection. Stage 2 DBP Rule compliance monitoring under the federal rule began in April 2012 for the largest water systems. DDW adopted Stage 2 DBP Rule Regulations in June 2012 and all water systems began compliance monitoring under the rule in October 2014.

WATER QUALITY EVALUATION

Organic carbon can be present in source waters in dissolved and particulate forms. Although the Stage 1 D/DBP rule refers only to TOC which includes both dissolved and particulate matter, DOC is also of interest to the SWP Contractors. DOC is measured in a sample that has been filtered through a 0.45 µM filter to remove particulate matter. Therefore, measured DOC concentrations should consist of dissolved organic carbon plus any particulate matter smaller than 0.45 µM in diameter. DOC is of interest because coagulation and filtration processes employed in drinking water treatment plants treating SWP water remove most particulate matter. Therefore, DOC may be a better indicator of organic carbon that remains available to form DBPs. The 2011 Update included a comparison between DOC and TOC. It was found that there is a good correlation between DOC and TOC at most locations in the SWP system. DOC is generally about 85 to 95 percent of TOC and the coefficient of determination (R2) is generally 0.9 or better. Therefore, only TOC is discussed in this update.

The organic carbon data used in this evaluation include real-time and grab sample data from the Department of Water Resources (DWR) Municipal Water Quality Investigations (MWQI) Program and grab sample data from the Division of Operations and Maintenance (O&M) SWP Water Quality Monitoring Program. In the past, organic carbon concentrations have been measured by DWR using two laboratory methods. The combustion method oxidizes organic carbon at high temperature whereas the wet oxidation method oxidizes organic carbon with chemical oxidants. The combustion method is thought to result in a more complete oxidation of organic carbon and often produces higher concentrations, particularly when the turbidity of the water is high. Ngatia and Pimental (2007) evaluated organic carbon data from five locations in the SWP and found that the two methods are comparable. Ngatia et al. (2010) conducted an analysis of data collected from the Sacramento River at Hood (Hood). Ngatia et al. (2010) found that the two methods were equivalent and that the field instruments were equivalent to the laboratory instruments at the 20 percent equivalence level. Since 2012, the Sievers TOC analyzers use UV-persulfate oxidation to analyze the real-time samples collected at Hood, Vernalis, Banks and Gianelli. Grab TOC samples analyzed by DWR's Bryte Laboratory use oxidation methods USEPA Method 415.1 and changed to USEPA Method 415.3 in July 2019.

ORGANIC CARBON FINGERPRINTS

DWR uses the fingerprinting method to identify the sources of DOC at Clifton Court Forebay (Clifton Court) and at the C.W. "Bill" Jones Pumping Plant (Jones) in the Sacramento-San Joaquin Delta (Delta) (see Chapter 2 for a description of the fingerprinting methodology). The DOC volumetric fingerprints for the January 2016 to December 2020 period are shown in **Figures 3-1 and 3-2**.

These figures show that the three primary sources of DOC at the south Delta pumping plants are the Sacramento and San Joaquin rivers and Delta agricultural drainage. During the January 2016 to December 2020 period, the Sacramento River contributed a median DOC concentration of 1.14 mg/L at Clifton Court, the San Joaquin River contributed 0.67 mg/L, and agricultural drains contributed 0.95 mg/L. The eastside streams contributed a median of 0.03 mg/L and the median contribution from seawater was 0.001 mg/L. As shown in **Figure 3-1**, during the wet years of 2017 and 2019 when flows on the San Joaquin River were high, most of the DOC at the export pumping plants comes from that river. This is because San Joaquin River water will preferentially reach the export pumping plants before Sacramento River water. However, during dry years when San Joaquin River flows are lower, more Sacramento River will be pumped to the export pumping plants to meet demand, and therefore the Sacramento River has more influence on DOC concentrations at the pumping plants. **Figure 3-2** shows the greater influence of the San Joaquin River on water quality at Jones compared to Clifton Court. During the January 2016 to December 2020 period, the San Joaquin River contributed a median DOC concentration of 1.37 mg/L at Jones, the Sacramento River contributed 0.86 mg/L, and agricultural drains contributed 0.76 mg/L. The eastside streams contributed a median of 0.02 mg/L and the median contribution from seawater was 0.001 mg/L.

The DOC fingerprints at Clifton Court were evaluated on a monthly basis, using data from 2016 to 2020, as shown in **Figure 3-3.** The operational impact of the Delta Cross Canal is evident at both Clifton Court and Jones. Delta Cross Canal (DCC) is a gate-controlled diversion channel on the east bank of the Sacramento River, about 30 miles downstream of Sacramento. The DCC facilitates the diversion of fresh water from the Sacramento River into the interior Sacramento-San Joaquin River Delta to the CVP and State Water Project (SWP). When the DCC is open, fresh water from the Sacramento River flows into the interior Delta and improves water quality at the export locations. The DCC is generally open from June 16 to November 30, and closed from December 1 to May 20. Therefore, this is why DOC is lowest at Clifton Court from June through November as shown in **Figure 3-3**.

DOC fingerprinting results also shows that agricultural drainage is high during the month of February, which contributes to higher DOC in the winter, in addition to storm events. Therefore, fingerprinting results can explain why the lowest TOC concentrations occur in the summer and fall months and also why TOC increases in the winter from storm events and Delta island agricultural drainage.

The DOC fingerprints at Jones were evaluated on a monthly basis, using data from 2016 to 2020, as shown in **Figure 3-4. Figure 3-4** shows many of the same trends as **Figure 3-3**, such as high agricultural drainage in February, and lower DOC levels from June to November which is due to the Delta Cross Canal being open during these months. **Figure 3-4** shows the much higher contribution of San Joaquin River at Jones, compared to Clifton Court.

Figure 3-1. Modeled DOC Fingerprint at Clifton Court

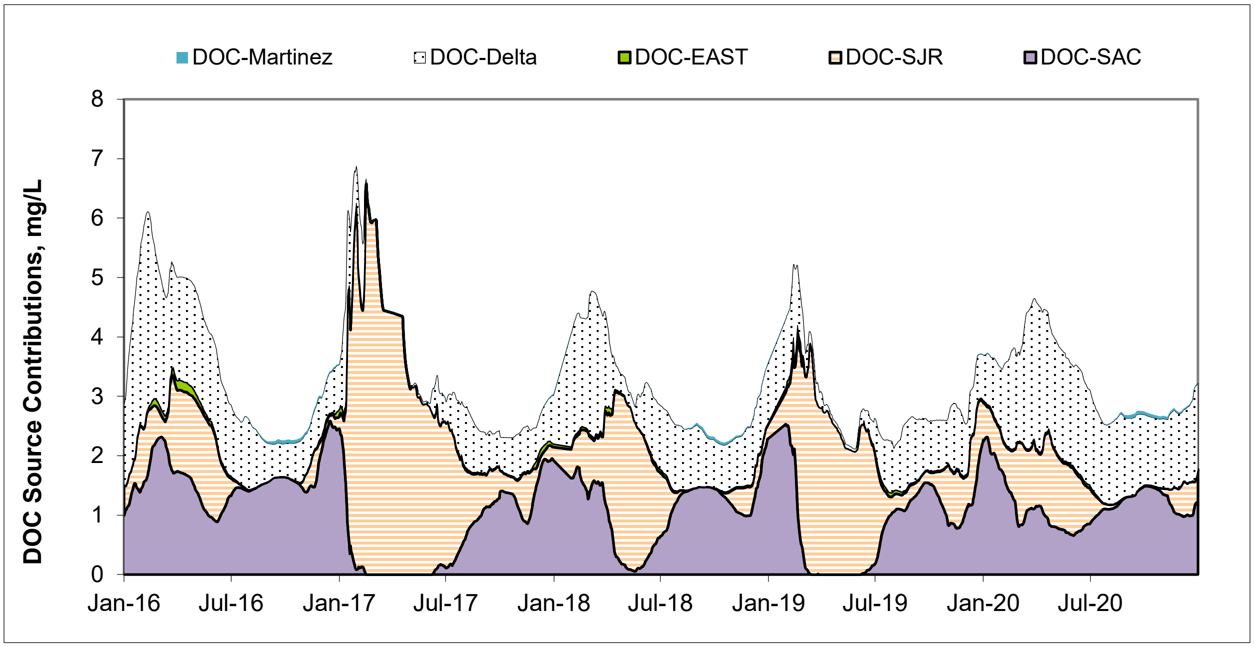


Figure 3-2. Modeled DOC Fingerprint at Jones

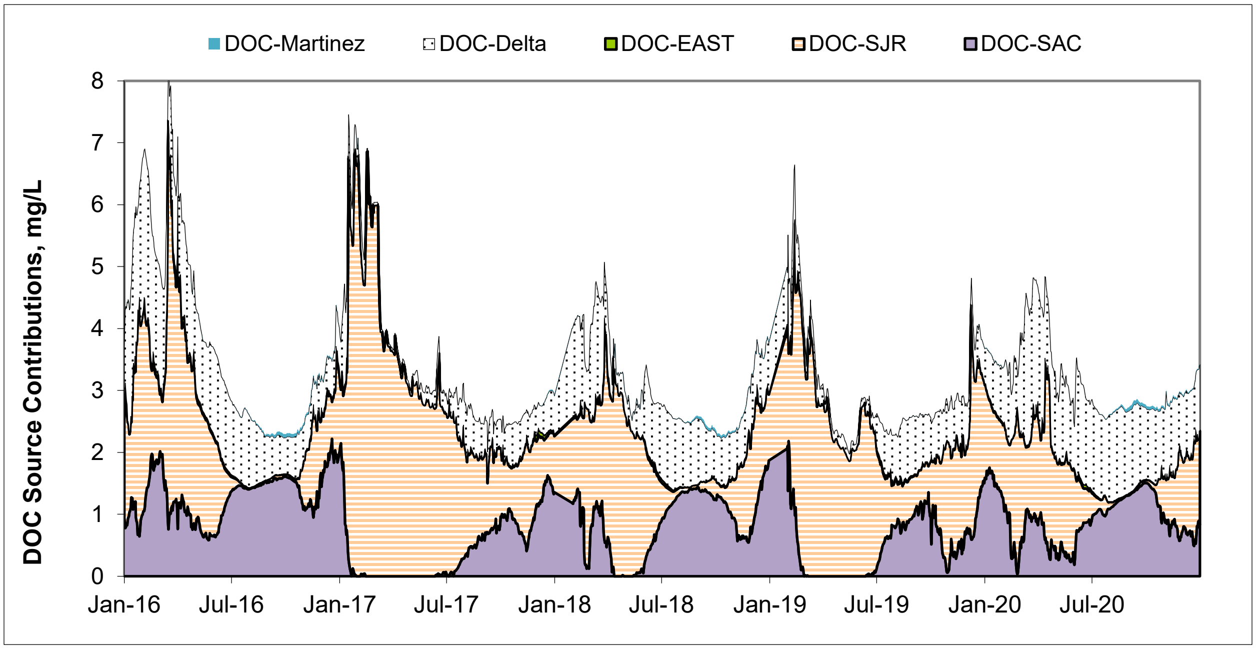


Figure 3-3. Monthly Analysis of DOC Fingerprint at Clifton Court, 2016 to 2020

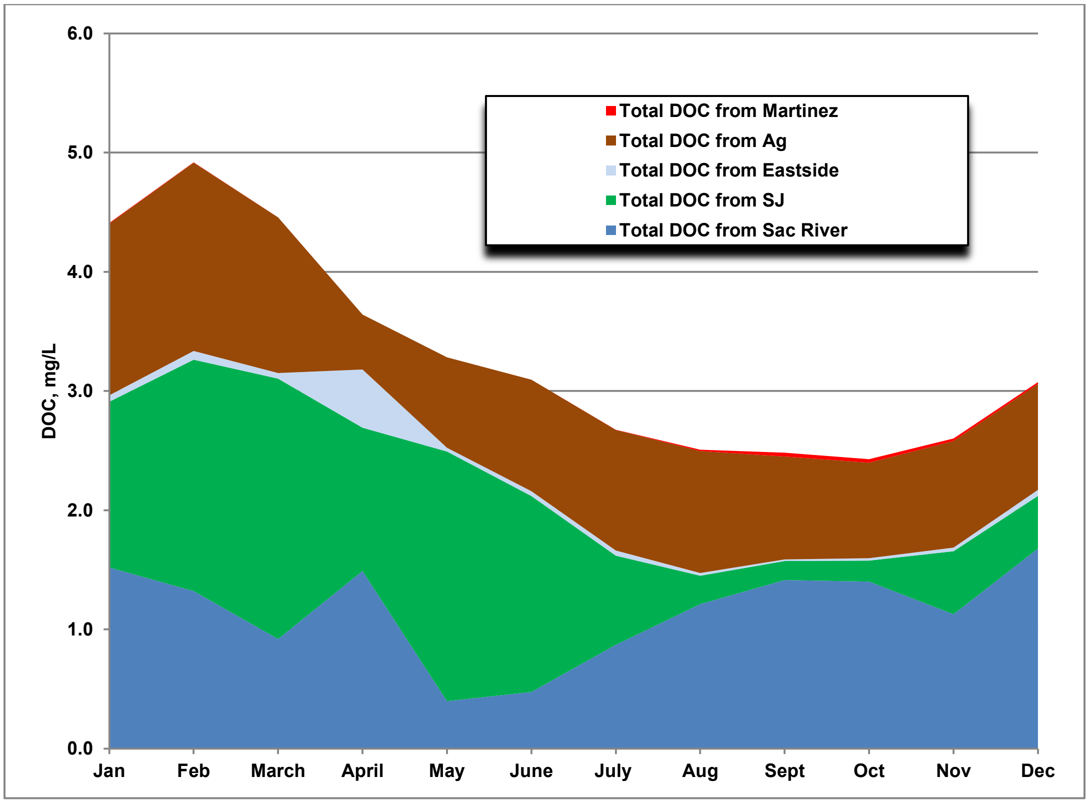
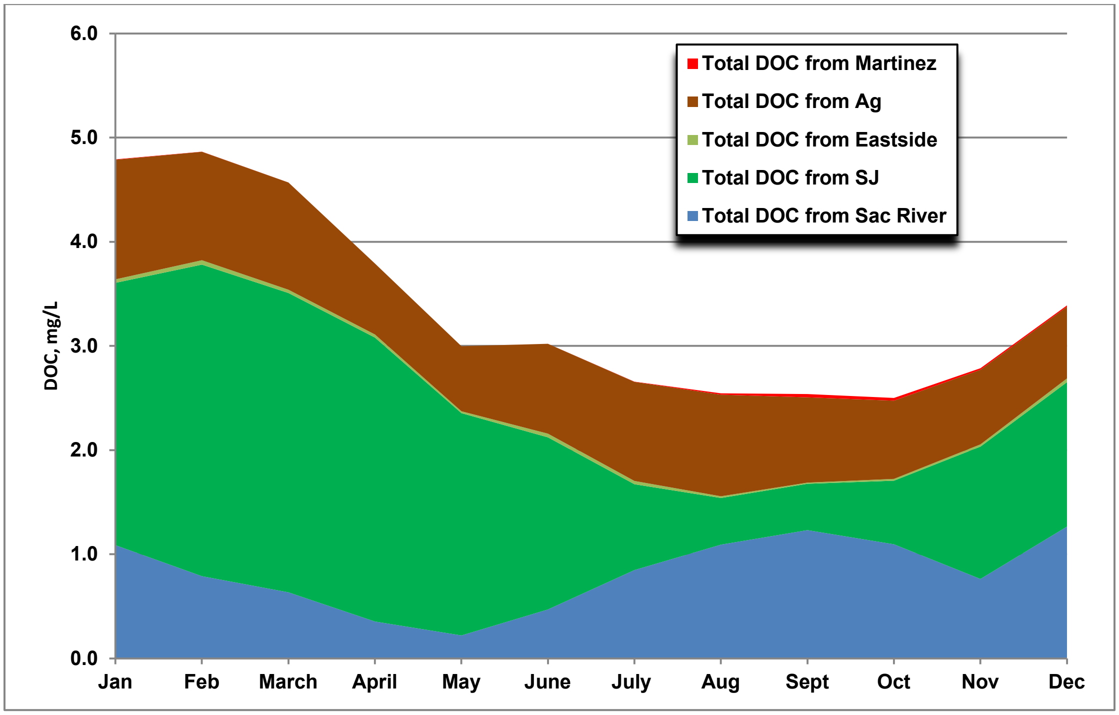


Figure 3-4. Monthly Analysis of DOC Fingerprint at Jones, 2016 to 2020



ORGANIC CARBON CONCENTRATIONS IN THE SWP

Organic carbon data are analyzed in this chapter to examine changes in concentrations as the water travels through the SWP system and to determine if there are seasonal or temporal trends. All available organic carbon data from DWR's MWQI Program and the O&M monitoring program through December 2020 were obtained for a number of locations along the SWP. Box plots are also used to show data from multiple locations on one plot and to display seasonal differences at one location. **Figure 2-25** presents an explanation of the box plots.

Table 3-2 shows the period of record available for each location. The recent study period of 2016 through 2020 represented a time period of alternating wet and dry years for the Sacramento Valley Water Year Index, with water year 2016 classified as below normal, 2017 classified as wet, 2018 classified as below normal, 2019 classified as wet, and 2020 classified as dry.

The California Department of Water Resources adopts five water year types: wet, above normal, below normal, dry, and critical. The classification is based on a water year index that is derived from full natural flow measurements. For the Sacramento River region, the water year index is called the Sacramento Valley Index (SVI) (also known as the "4 River Index" and the "40-30-30 Index") and uses the sum of calculated monthly unimpaired runoff from the following gauges: Sacramento River above Bend Bridge, Feather River at Oroville, Yuba River at Smartsville, and American River below Folsom Dam. The SVI is calculated based on the following equation:

SVI = (0.4 X current April-July runoff) + (0.3 X current October-March runoff) + (0.3 X previous year's index)

The current April-July runoff is for the sum of the runoff for the four rivers in the current water year from April to July, in million acre-feet. If the previous year's index exceeds 10 MAF, then 10 MAF is applied instead. Once the SVI is calculated, the year type classification is based on the thresholds in **Table 2-2.**

Table 3-2. Total Organic Carbon Data

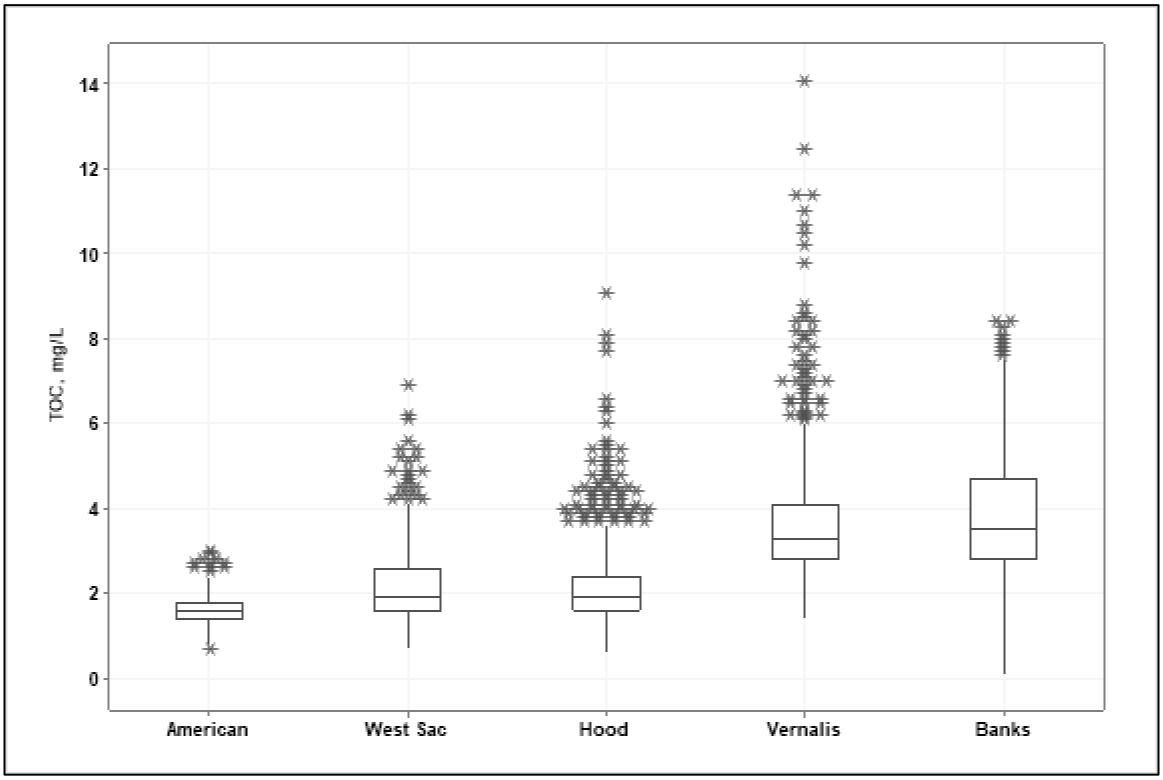
Location	**TOC**	
	Start Date	**End Date**
West Sacramento	Feb 1995	Dec 2020
American	Nov 1986	Dec 2020
Hood	Sep 1997	Dec 2020
Vernalis	Nov 1986	Dec 2020
Banks	Nov 1986	Dec 2020
Barker Slough	Sep 1988	Dec 2020
DV Check 7	Dec 1997	Dec 2020
McCabe	Dec 1997	Dec 2020
Pacheco	Apr 2000	Dec 2020
Gianelli	Mar 2012	Dec 2020
O'Neill Forebay Outlet	Jul 1988	Dec 2020
Check 21	Feb 1998	Dec 2020
Check 41	Dec 1997	Dec 2020
Castaic Outlet	Feb 1998	Dec 2020
Devil Canyon Second Afterbay*	Dec 1997	Dec 2005

*Note: Data were collected from Dec 1997 to May 2001 at Devil Canyon Afterbay, then at Devil Canyon Headworks from June 2001 to December 2010, and then at Devil Canyon Second Afterbay in early 2011. These datasets have been combined.

The SWP Watershed

Figure 3-5 presents the TOC data for the tributaries to the Delta and H.O. Banks Pumping Plant (Banks). Data from the Sacramento River at West Sacramento (West Sacramento) represent the quality of water upstream of the Sacramento metropolitan area and upstream of the American River. Hood represents the quality of water flowing into the Delta from the Sacramento River. Data collected from the San Joaquin River at Vernalis (Vernalis) are used to represent the San Joaquin River inflow to the Delta. Data presented in **Figure 3-5** is from January 1998 to December 2020**. Figure 3-5** indicates that TOC concentrations are lower in the Sacramento River than the San Joaquin River.

Figure 3-5. TOC Concentrations in the SWP Watershed, 1998 to 2020



Hood – **Figure 3-6** shows all available TOC data at Hood. The concentrations range from 0.6 to 9.1 mg/L during the period of record with a median of 1.9 mg/L.

- Comparison of Real-time and Grab Sample Data – **Figure 3-7** compares the real-time data with the grab sample data at Hood over time and **Figure 3-8** compares the real-time and grab sample data on a 1:1 basis from 2016 to 2020. The real-time instrument measures TOC every four hours, and collects five to seven data points for each sample. Therefore, the real-time data point is a daily average of 20 to 28 data points per day. MWQI staff provided daily average concentrations for this analysis. Both the grab and real-time samples are analyzed using oxidation methods; the real-time sample uses UV-persulfate oxidation and the grab samples are analyzed using USEPA Method 415.1 and USEPA Method 415.3 starting in June 2019. There is a good correspondence between the two data sets when samples collected on the same day are compared. There are a few occurrences when the grab samples were 1 to 2 mg/L higher than the real-time data, in August 2018 and July 2020. **Figure 3-8** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.8089 which is considered acceptable.

- Spatial Trends – **Figure 3-9** presents 1998 to 2020 data for West Sacramento, the American River (American), and Hood. These three locations were selected to examine the impact of the Sacramento urban area on water quality at Hood. The American median TOC concentration of 1.6 mg/L is statistically significantly lower than the median of 1.9 mg/L at West Sacramento and the median of 1.9 mg/L at Hood (Mann-Whitney, p=0.0000). There is no statistically significant difference between West Sacramento and Hood (Mann-Whitney, p=0.894), despite the fact that the high quality American River enters the Sacramento River between these two locations. This is likely due to the fact that urban runoff and treated wastewater from the Sacramento urban area are discharged to the river between West Sacramento and Hood.

- Long-Term Trends –. As stated in the previous WSS, the TOC concentrations at Hood are driven by the hydrology of the Sacramento River system. **Figure 3-6** shows peak concentrations at 8 mg/L to 9 mg/L occurring during the four-year drought, from water years 2012 through 2015.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are differences between wet years and dry years. Wet years are defined as those that are classified as wet and above normal. Dry years are defined as those that are classified as below normal, dry, and critical. The median concentration during dry years of 2.1 mg/L is statistically significantly higher than the median during wet years of 1.8 mg/L (Mann-Whitney, p=0.0000). This difference could be due to greater volumes of high quality water with low TOC concentrations being released from reservoirs during the spring and summer months of wet years. It could also be partially due to the greater influence of treated wastewater, urban runoff, and agricultural discharges during low flow periods of dry years.

- Seasonal Trends – All available data (1998 to 2020) were sorted by month and plotted on **Figure 3-10.** This figure indicates that the TOC concentrations are generally low from March to October. During the late spring and early summer months, snow melt results in high flows with low concentrations of TOC. During the late summer and fall months, high quality water is released from upstream reservoirs to maintain flows in the river. The concentrations increase during the November to February period when storm events flush the carbon from the watershed.

Figure 3-6. TOC Concentrations at Hood

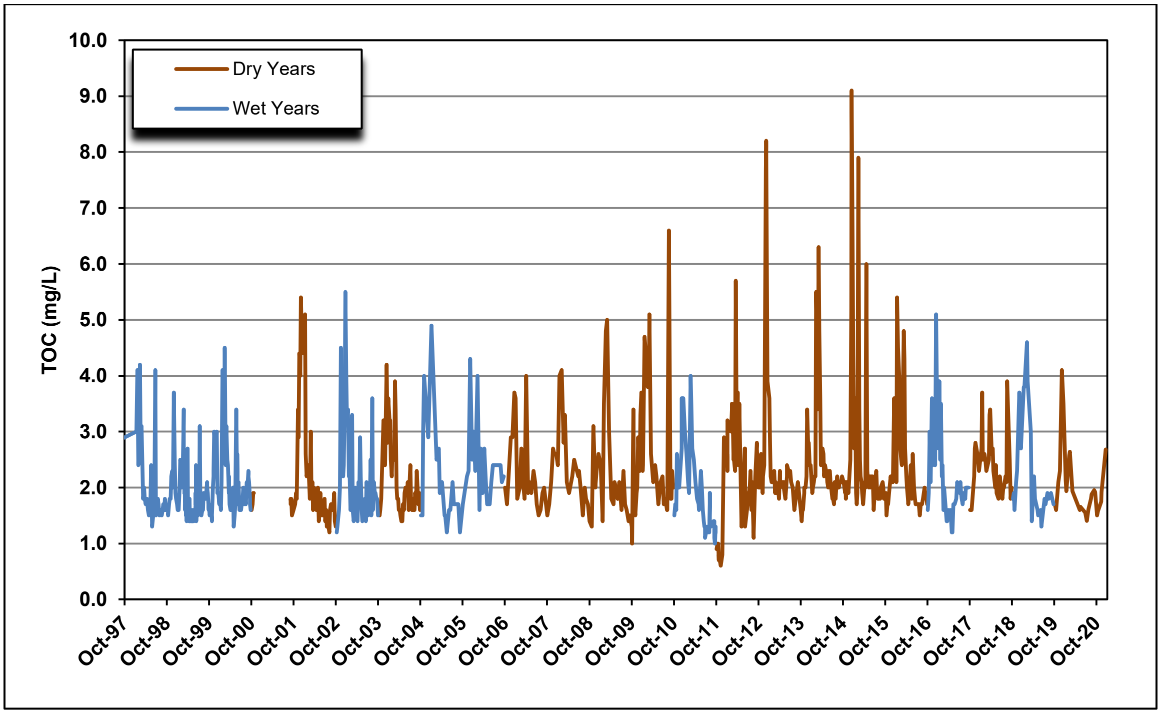


Figure 3-7. Comparison of Hood Real-time and Grab Sample TOC Data, 2016 to 2020

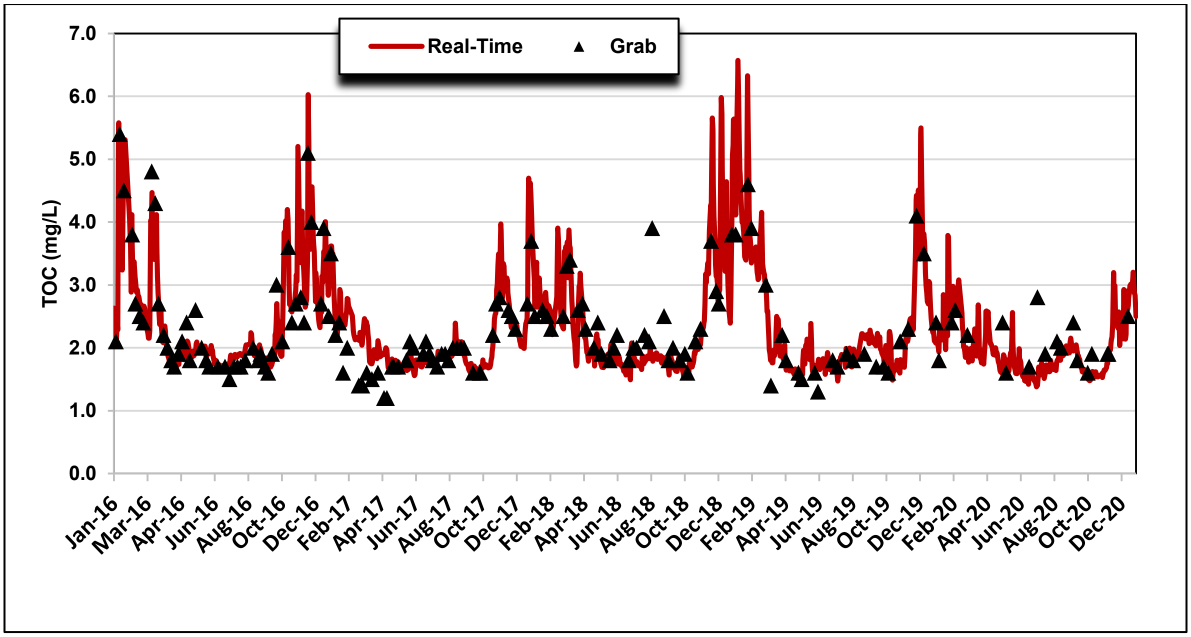


Figure 3-8. Comparison of Hood Real-time and Grab Sample TOC Data, 1:1 Graph, 2016 to 2020

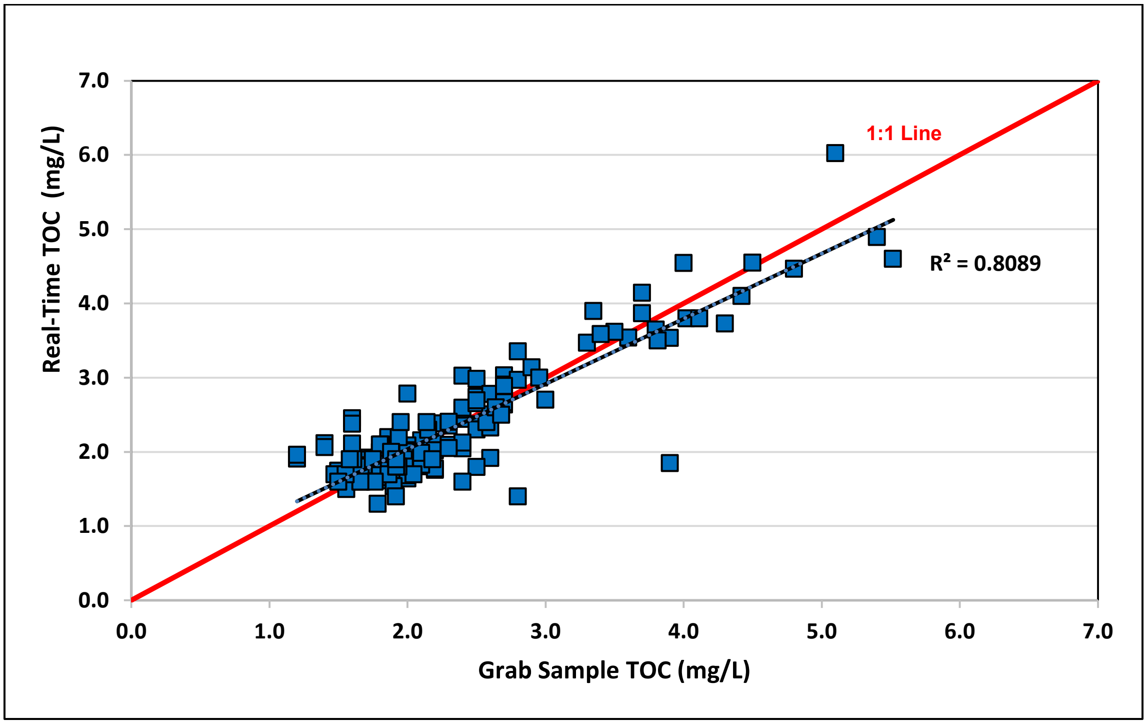


Figure 3-9. TOC Concentrations at West Sacramento, American and Hood, (1998-2020)

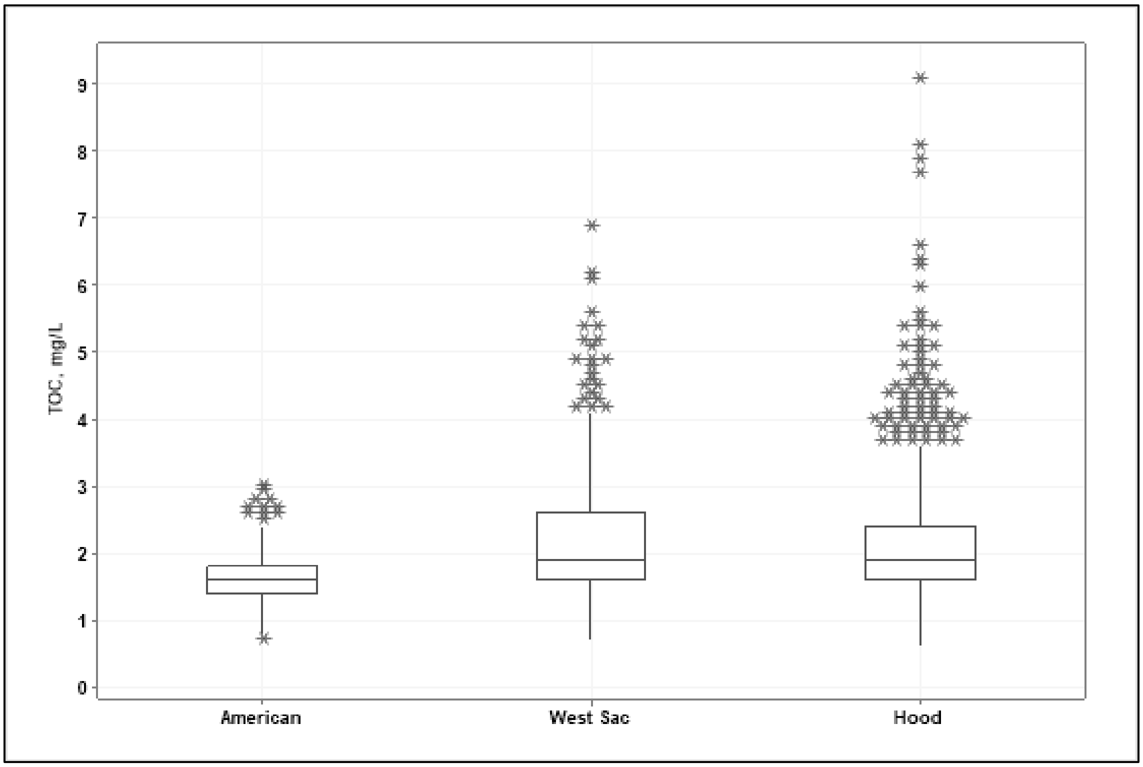
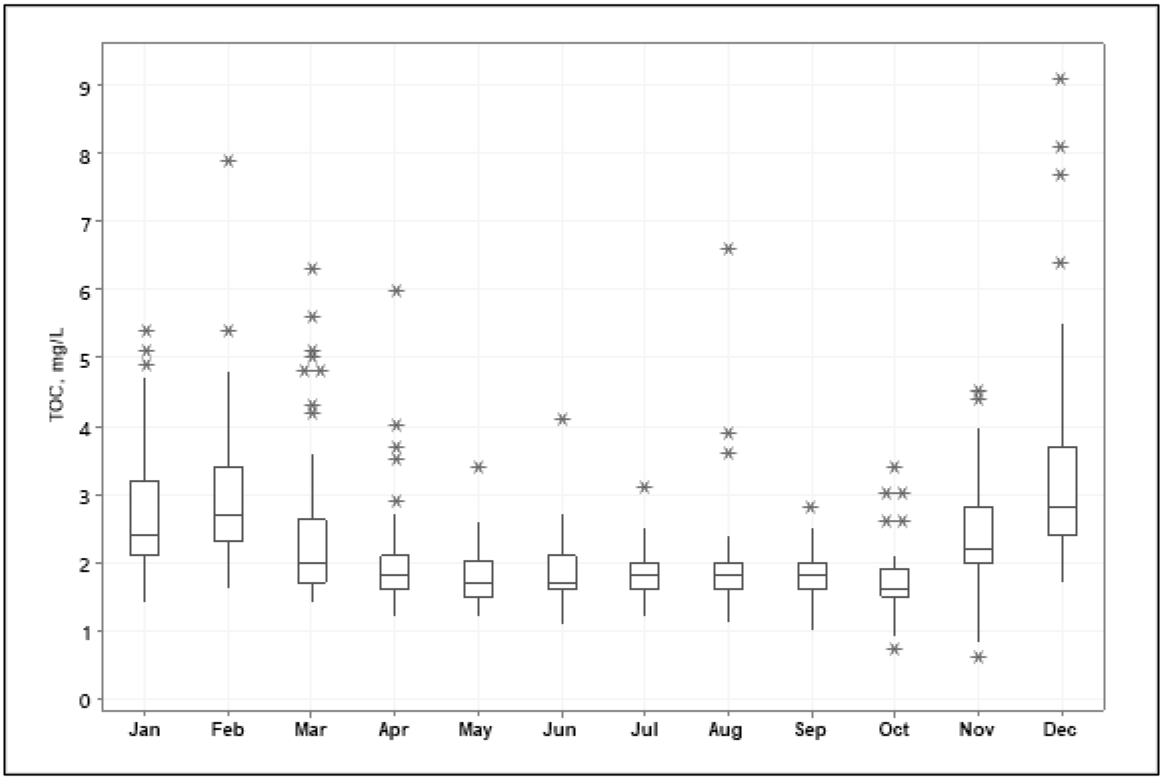


Figure 3-10. Monthly Variability in TOC at Hood, 1998 to 2020



Vernalis – **Figure 3-11** shows all available TOC data at Vernalis. The concentrations range from 1.4 to 14.0 mg/L during the period of record with a median of 3.3 mg/L.

- Comparison of Real-time and Grab Sample Data – **Figure 3-12** compares the real-time data with the grab sample data at Vernalis over time and **Figure 3-13** compares the real-time and grab sample data on a 1:1 basis. The real-time instrument measures TOC every four hours, and collects five to seven data points for each sample. Therefore, the real-time data point is a daily average of 20 to 28 data points per day. MWQI staff provided daily average concentrations for this analysis. Both the grab sample and real-time sample are analyzed using oxidation methods; the real-time sample uses UV-persulfate oxidation and the grab samples are analyzed using USEPA Method 415.1 and USEPA Method 415.3 starting in June 2019. There is a good correspondence between the two data sets when samples collected on the same day are compared. **Figure 3-13** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.8712 which is considered acceptable.

- Spatial Trends – DWR does not collect data upstream of Vernalis on the San Joaquin River so spatial trends were not examined.

- Long-term Trends – As stated in the previous WSS, the TOC concentrations at Vernalis are driven by the hydrology of the San Joaquin River system. **Figure 3-11** shows the peak concentration of 14.1 mg/L in March 2016, and high values of 11 mg/L to 12.5 mg/L occurring during the four-year drought from water years 2012 through 2015.

- Wet Year/Dry Year Comparison – The median concentration during dry years of 3.4 mg/L is statistically significantly higher than the median during wet years of 3.2 mg/L (Mann-Whitney, p=0.002). This could be due to the greater influence of agricultural drainage during dry years and to the release of high quality water from the reservoirs during the spring and summer of wet years.

- Seasonal Trends – The seasonal pattern on the San Joaquin River is different from the Sacramento River. **Figure 3-14** shows that TOC concentrations are highest during the winter months with peaks ranging from 7 to 14 mg/L. Concentrations decline during the early spring months when flows are high on the San Joaquin River, due to the Vernalis flow requirements stipulated in Decision 1641 (D-1641). D-1641 includes "spring flow" requirements that apply from February 1 through April 14 and May 16 through June 30, as well as higher spring "pulse" flows that apply from April 15 to May 15. These flow requirements set a minimum monthly average flow rate, based on the water year type. Flows are increased on the San Joaquin River by releasing high quality water from reservoirs on the Merced, Stanislaus, and Tuolumne rivers. Combined exports at the Banks and Jones pumping plants are reduced to 1,500 cfs. These actions that are taken to improve salmon smolt survival also improve water quality. TOC concentrations increase slightly in the summer (median of 3.4 mg/L in July), and then drop back down in the fall. Surface runoff from the watershed is responsible for the wet season peaks, while the probable cause of the dry season peaks is the discharge of agricultural drainage to the river. During the summer months, flows in the San Joaquin River are low, generally below 2,000 cubic feet per second (cfs), so there is minimal dilution of agricultural drainage.

Figure 3-11. TOC Concentrations at Vernalis

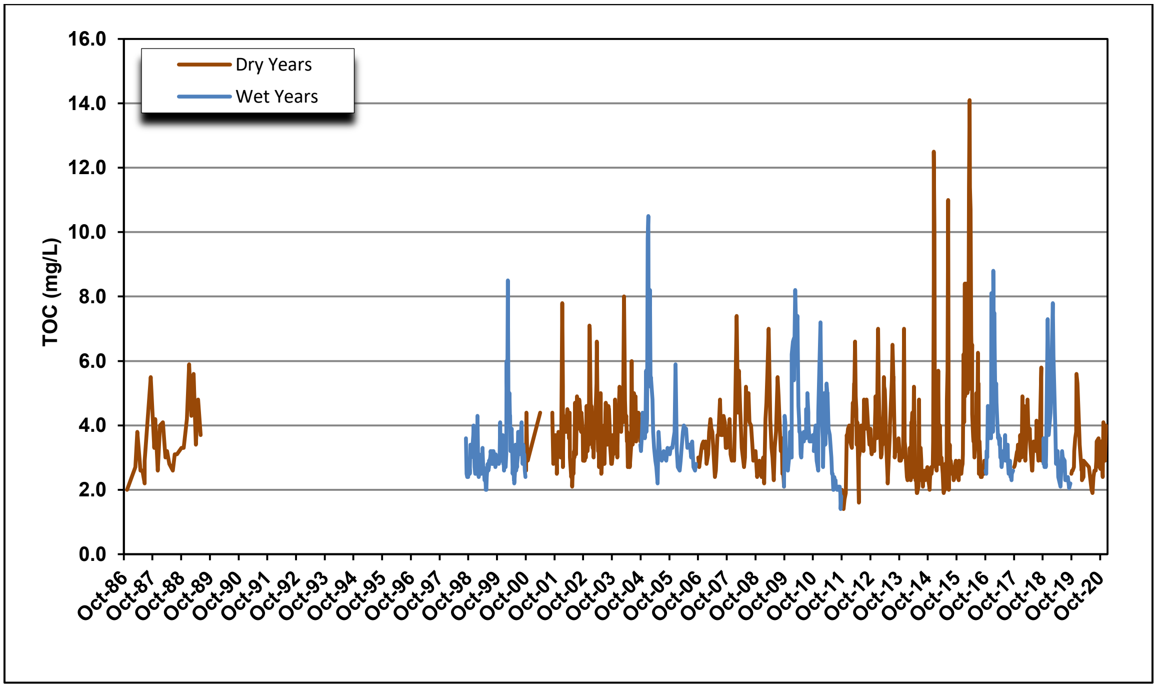


Figure 3-12. Comparison of Vernalis Real-time and Grab Sample TOC Data, 2016 to 2020

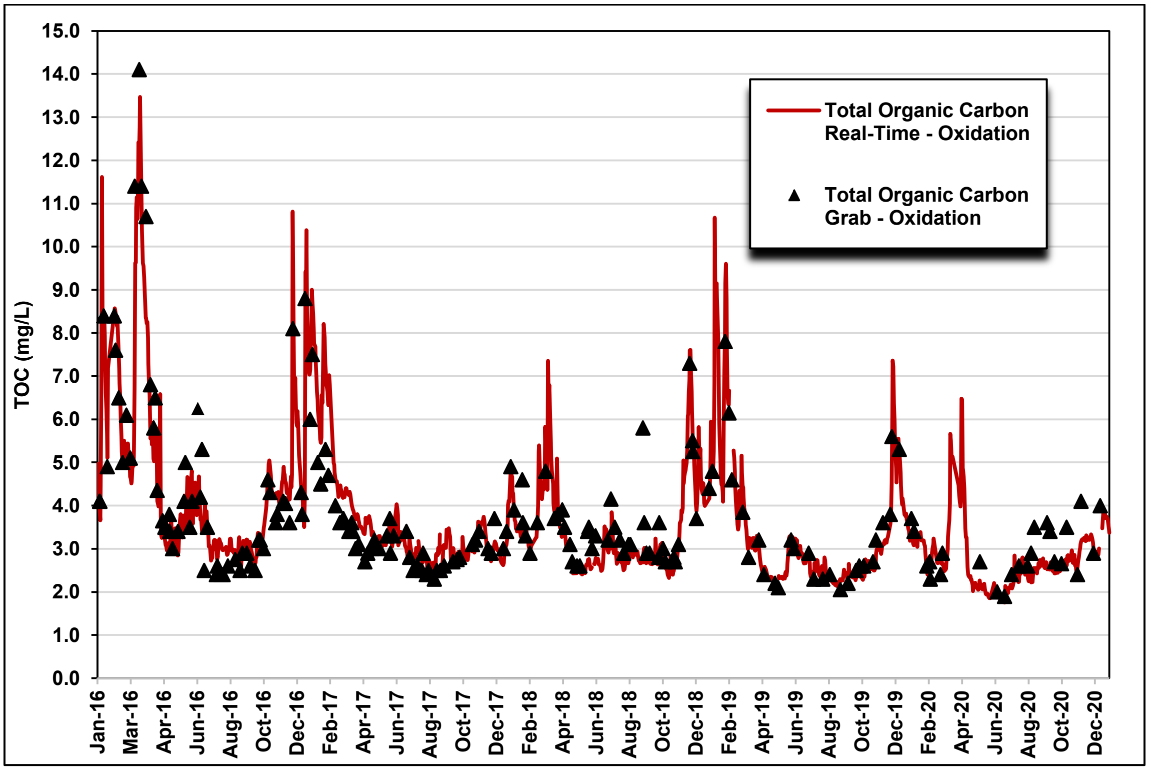


Figure 3-13. Comparison of Vernalis Real-time and Grab Sample TOC Data, 1:1 Graph, 2016 to 2020

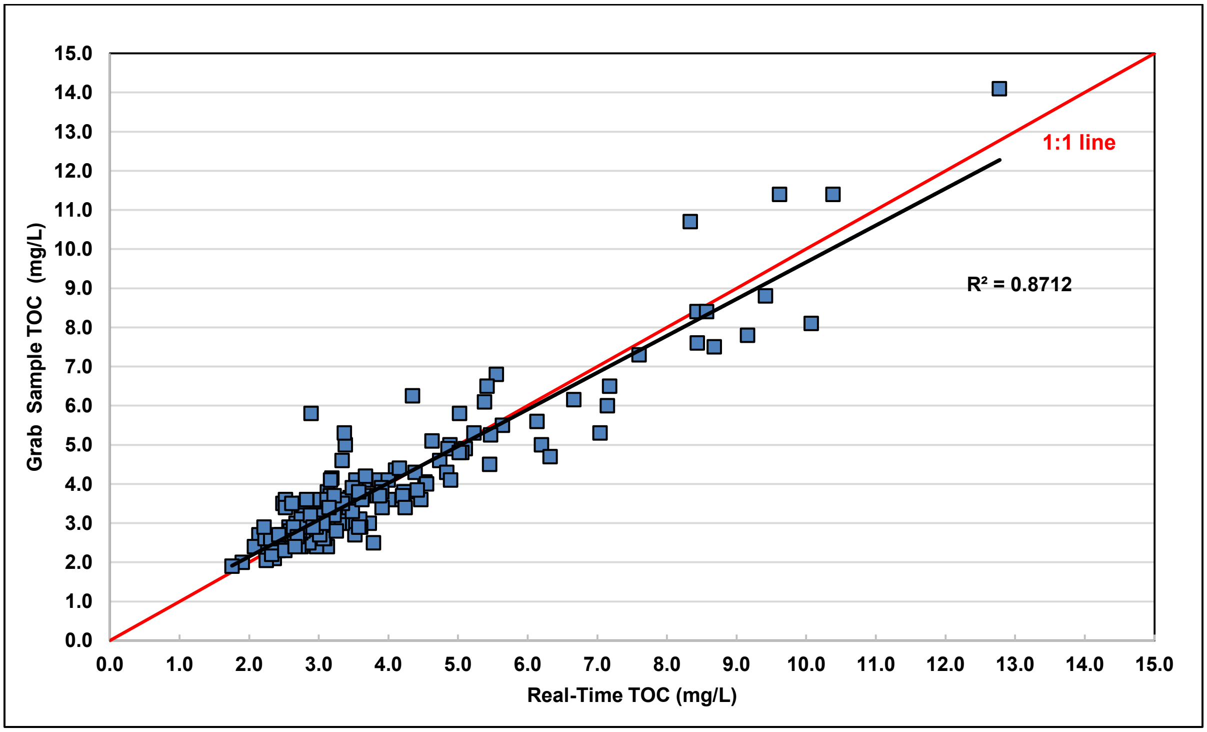
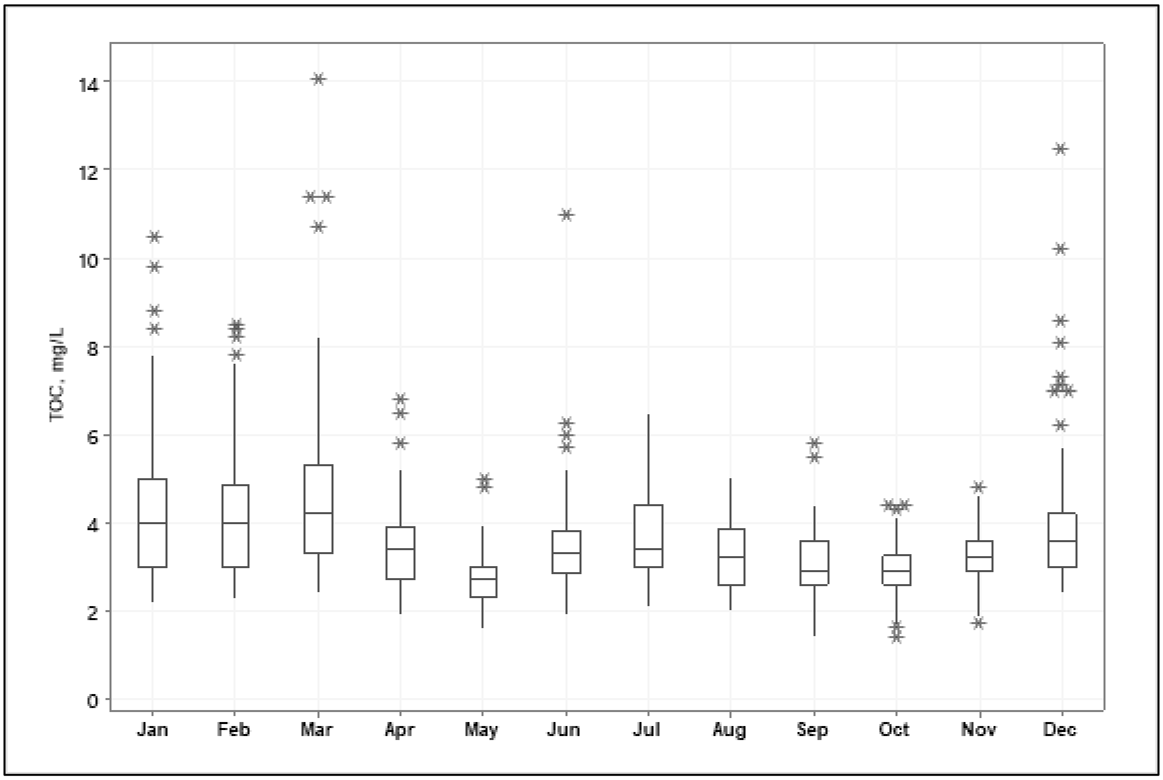


Figure 3-14. Monthly Variability in TOC at Vernalis, 1986 to 2020



Banks – As shown in **Figure 3-1**, the primary sources of organic carbon at Clifton Court and Banks are the Sacramento and San Joaquin rivers and Delta agricultural drainage. **Figure 3-15** shows all available TOC data at Banks. The concentrations range from 0.1 to 8.4 mg/L during the period of record with a median of 3.5 mg/L.

- Comparison of Real-time and Grab Sample Data – **Figure 3-16** compares the real-time data with the grab sample data at Banks over time and **Figure 3-17** compares the real-time and grab sample data on a 1:1 basis. The real-time instrument measures TOC every four hours, and collects five to seven data points for each sample. Therefore, the real-time data point is a daily average of 20 to 28 data points per day. MWQI staff provided daily average concentrations for this analysis. **Figure 3-17** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.8995 which is considered acceptable.

- Spatial Trends – Sacramento River water is degraded as it flows through the Delta by discharges from Delta islands and mixing with the San Joaquin River. As shown in **Figure 3-18**, the median TOC concentration of 3.5 mg/L at Banks is statistically significantly higher than the median of 1.9 mg/L at Hood (Mann-Whitney, p=0.0000) and the median of 3.3 mg/L at Vernalis (p=0.0000).

- Long-term Trends – Examination of **Figure 3-15** shows an increasing trend during the 2012 to 2015 drought. As discussed in the previous report, agricultural drainage water was contributing more to Clifton Court in 2012 to 2015, which is another source of TOC. An overall decrease in TOC began in the wet year of 2017, as there was more fresh water available for Delta outflow from the Sacramento and San Joaquin Rivers, as well as low TOC concentrations being released from reservoirs during the spring and summer months of wet years.

- Wet Year/Dry Year Comparison – The median concentration during dry years of 3.8 mg/L is statistically significantly higher than the median during wet years of 3.15 mg/L (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 3-19** indicates that the lowest TOC concentrations occur in the summer and fall months. This is because the Delta Cross Channel (DCC) gates are open from June 16 to November 30, allowing more Sacramento River water to flow into the Central Delta. Also, contributory flows from the San Joaquin River watershed are lower in the summer and fall due to low flows in the San Joaquin River during summer and fall. Concentrations increase in the winter when storm events wash TOC from the watershed, the DCC is closed, and when Delta island agricultural drainage increases.

Figure 3-15. TOC Concentrations at Banks

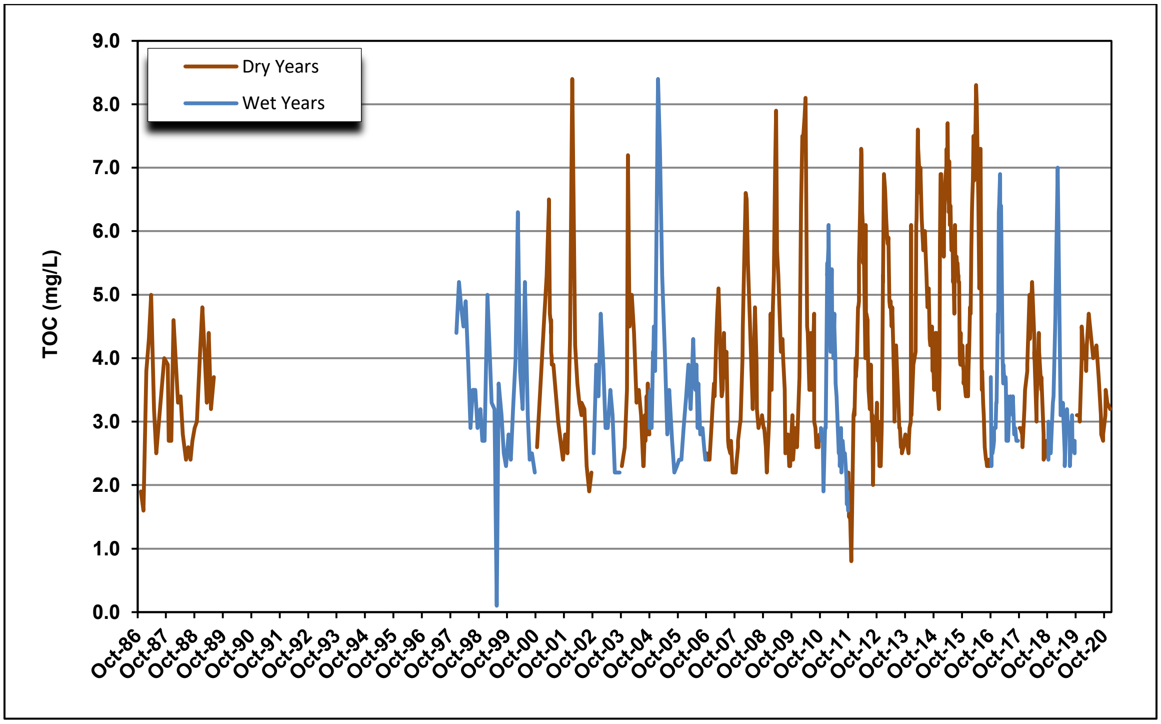


Figure 3-16. Comparison of Banks Real-time and Grab Sample TOC Data, 2016 to 2020

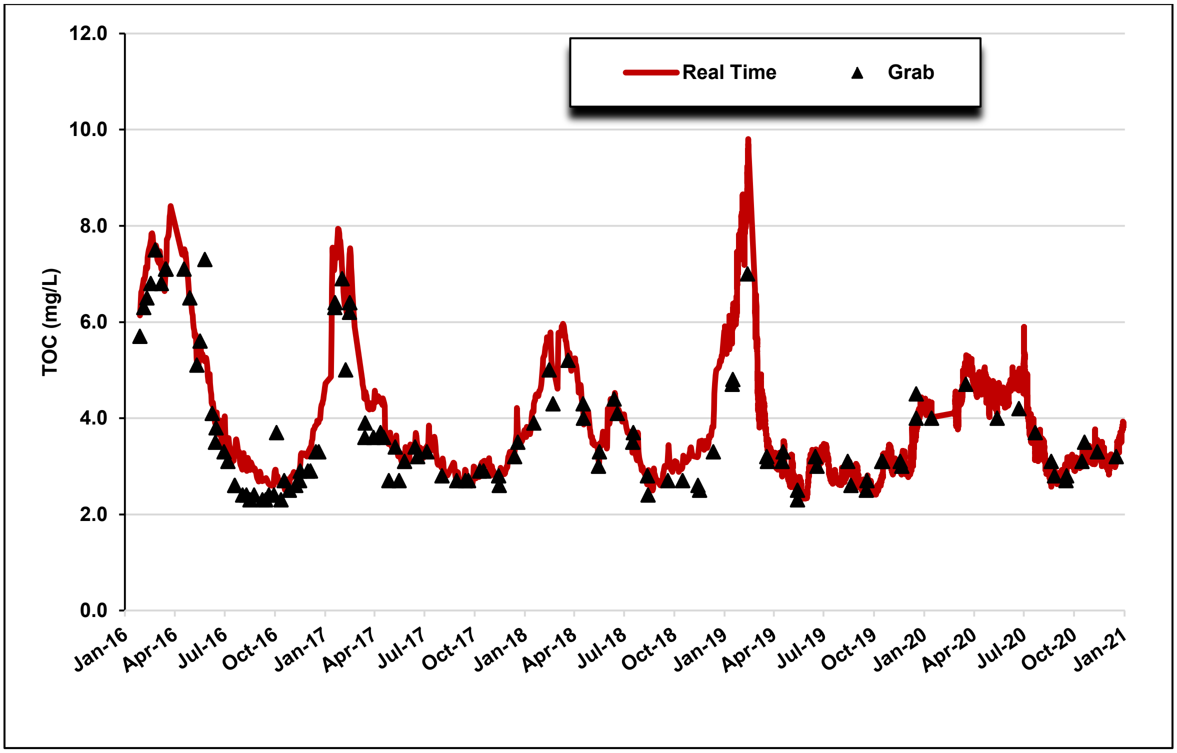


Figure 3-17. Comparison of Banks Real-time and Grab Sample TOC Data, 1:1 Graph, 2016 to 2020

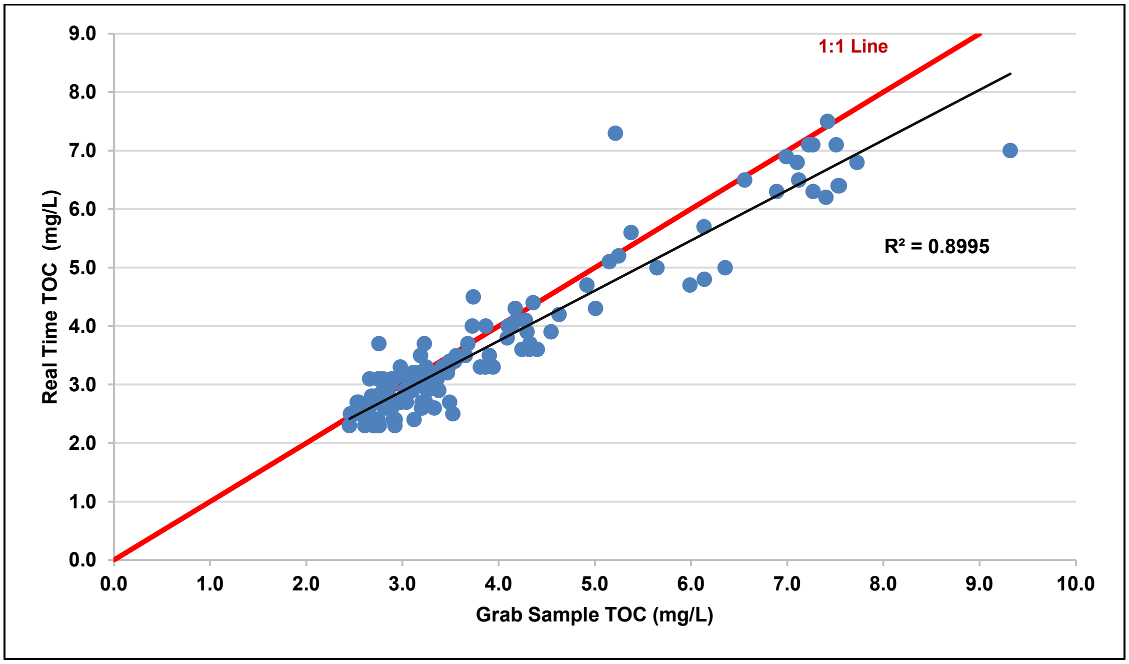


Figure 3-18. Comparison of Locations During Same Period of Record (1998-2020)

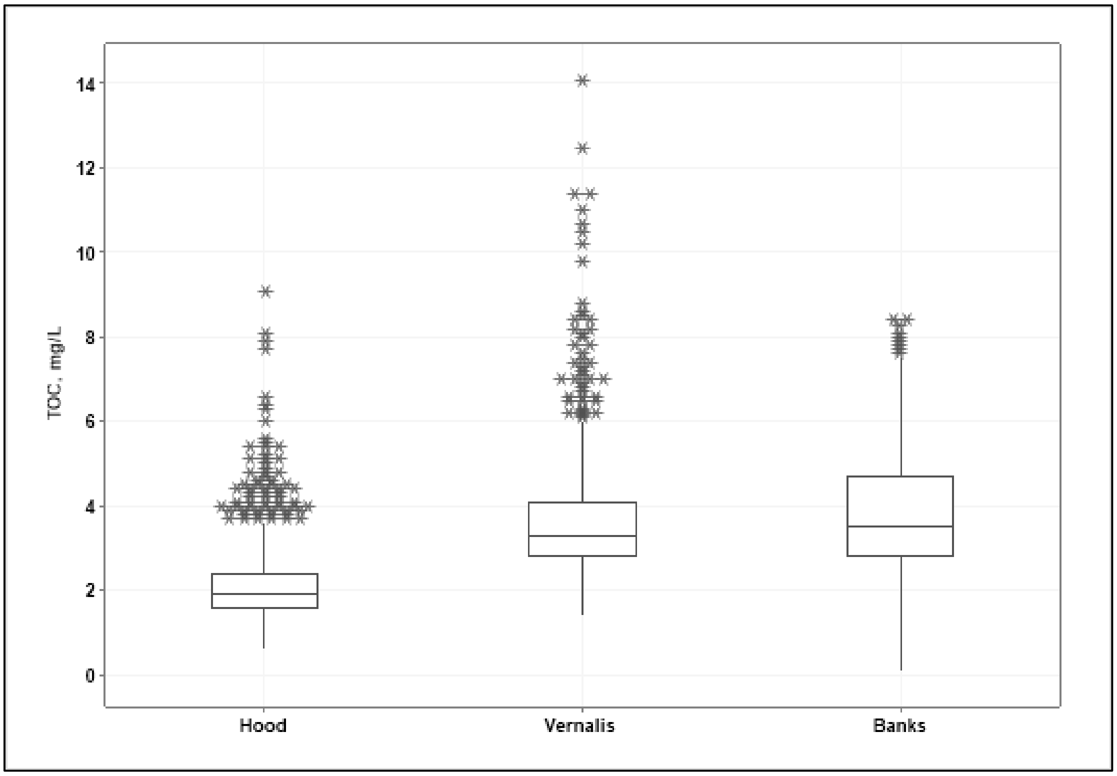
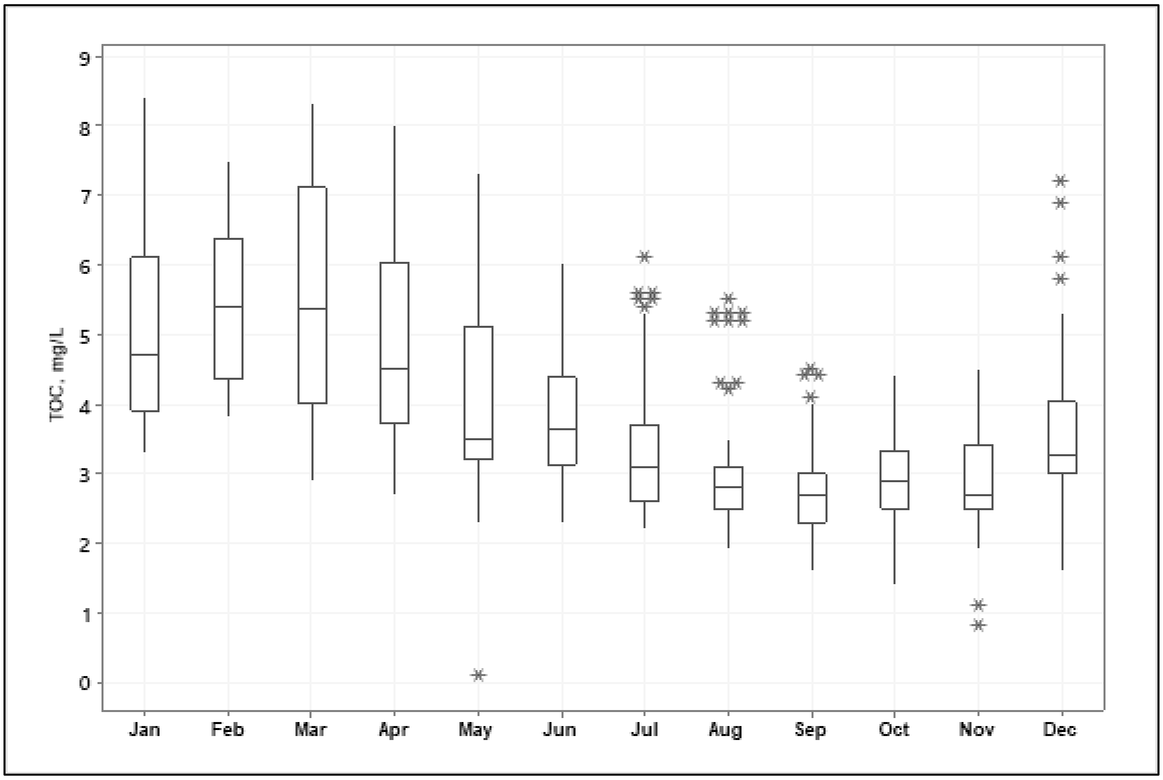


Figure 3-19. Monthly Variability in TOC at Banks, 1986 to 2020



North Bay Aqueduct

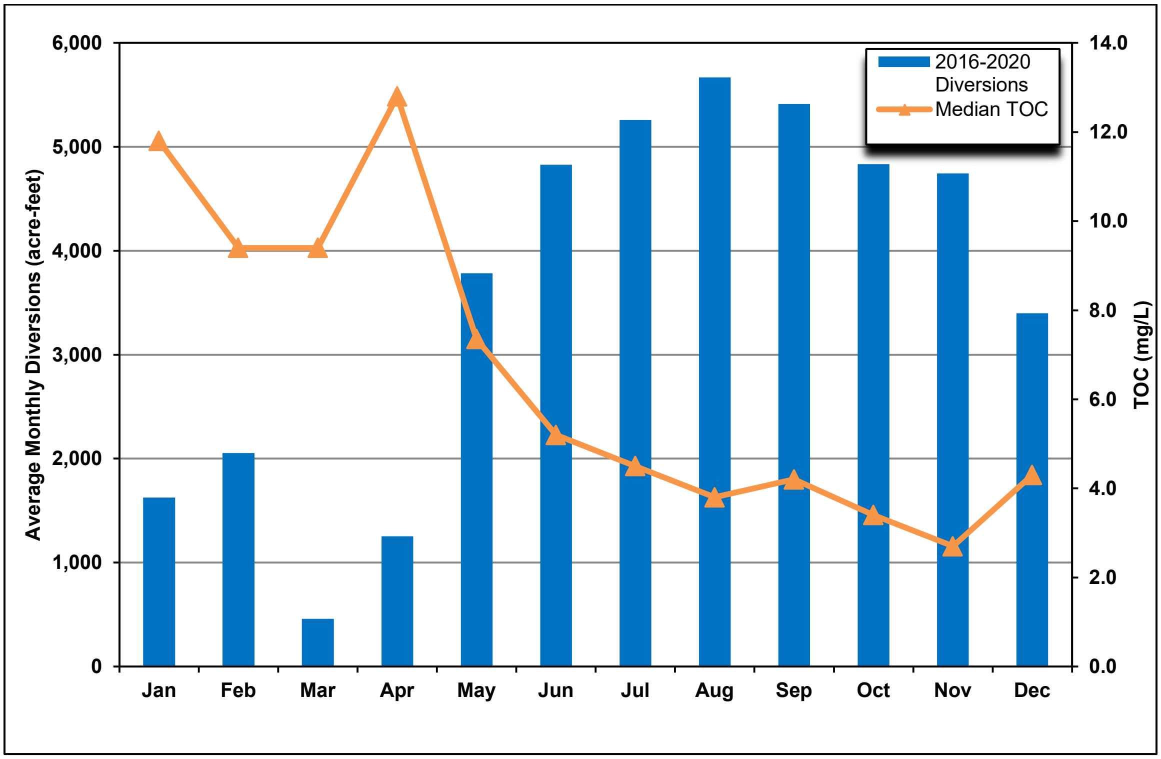
Water from the north Delta is pumped into the North Bay Aqueduct (NBA) at the Barker Slough Pumping Plant. The sources of water to the NBA are the Sacramento River, the local Barker Slough watershed, and other neighboring drainage inputs. The NBA is an enclosed pipeline between Barker Slough and the Cordelia Forebay. Water is delivered to the cities of Vacaville, Fairfield, and Travis Air Force Base between these two points. From Cordelia Forebay, enclosed pipelines deliver water to the cities of Vallejo, Benicia, and to the Napa Terminal Tanks which serve the cities of Napa and American Canyon in Napa County.

Project Operations

After the water is diverted from Barker Slough, the quality of water delivered to NBA users should not be affected by any other factors since the NBA is an enclosed pipeline. **Figure 3-20** shows average monthly diversions at Barker Slough for the 2016 to 2020 period and median monthly TOC concentrations. This figure shows that pumping is highest between May and November when TOC concentrations are lowest in Barker Slough. The pumping pattern is dictated by both the demand for water and the quality of the NBA water. During the wet season, Barker Slough can experience rapid increases in TOC concentrations that can dramatically impact the treatability of NBA water, often for several months. Many of the NBA users have alternative sources of water that are used during the winter and spring months when TOC concentrations are highest at Barker Slough. Other NBA users have limited alternative supplies and continue to take Barker Slough water during the months that TOC concentrations are high.

Nevertheless, the rapid and elevated concentrations of TOC/DOC continue to be problematic for all of the NBA users.

Figure 3-20. Average Monthly Barker Slough Diversions and Median TOC Concentrations, 1988 to 2020



TOC Concentrations in the NBA

Organic carbon data are collected at Barker Slough but not at Cordelia Forebay. **Figure 3-21** presents all available TOC data for Barker Slough. The concentrations range from 1.3 to 43 mg/L with a median concentration of 4.6 mg/L. As discussed previously, TOC removal requirements by water treatment plants are based on source water TOC and alkalinity concentrations (see **Table 3-1**). From 2016 to 2020, the average TOC concentration at Barker Slough is 6.5 mg/L and the average alkalinity concentration is 98 mg/L as $CaCO_3$. Based on these average concentrations, the water agencies treating NBA water must remove 35 percent of the TOC. There are many months when TOC concentrations exceed 8 mg/L as shown in **Figure 3-21**. Alkalinity concentrations are often low when TOC concentrations are high, leading to the requirement to remove up to 50 percent of the TOC in the source water.

- Spatial Trends –**Figure 3-22** presents TOC data at multiple locations along the SWP during the same time period (1998 to 2020). Barker Slough has the highest TOC concentrations for both the maximum and median compared to all other locations. This figure also shows that TOC concentrations in Barker Slough are substantially higher and more variable than the concentrations at Hood. The Sacramento River is the primary source of water to the NBA but the local Barker Slough watershed contributes a substantial amount of TOC.

- Long-term Trends – Visual inspection of **Figure 3-21** does not reveal any discernible long-term trend in the data.

- Wet Year/Dry Year Comparison – **Figure 3-21** shows sharp TOC concentration increases to 10 mg/L or higher during the wet season in both wet or dry years The dry year median concentration of 4.3 mg/L is statistically significantly lower than the wet year median concentration of 5.9 mg/L (Mann-Whitney, *p*=0.003). The wet year TOC median is higher than the dry year TOC median due to the Barker Slough watershed which contributes high TOC in local runoff.

- Seasonal Trends – **Figure 3-23** shows that TOC concentrations are highest during the winter and early spring months when the local watershed is contributing runoff to Barker Slough. The concentrations decline throughout the summer and fall.

Figure 3-21. TOC Concentrations at Barker Slough

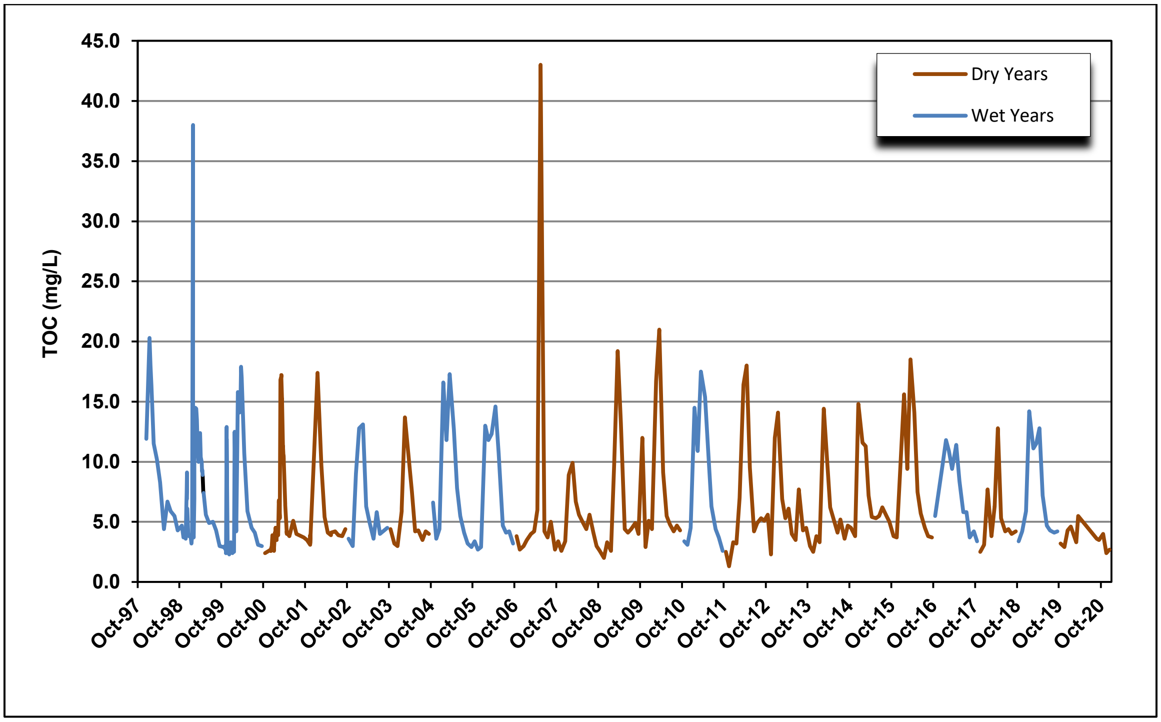


Figure 3-22. TOC Concentrations at Barker Slough and Other SWP Locations (1998-2020)

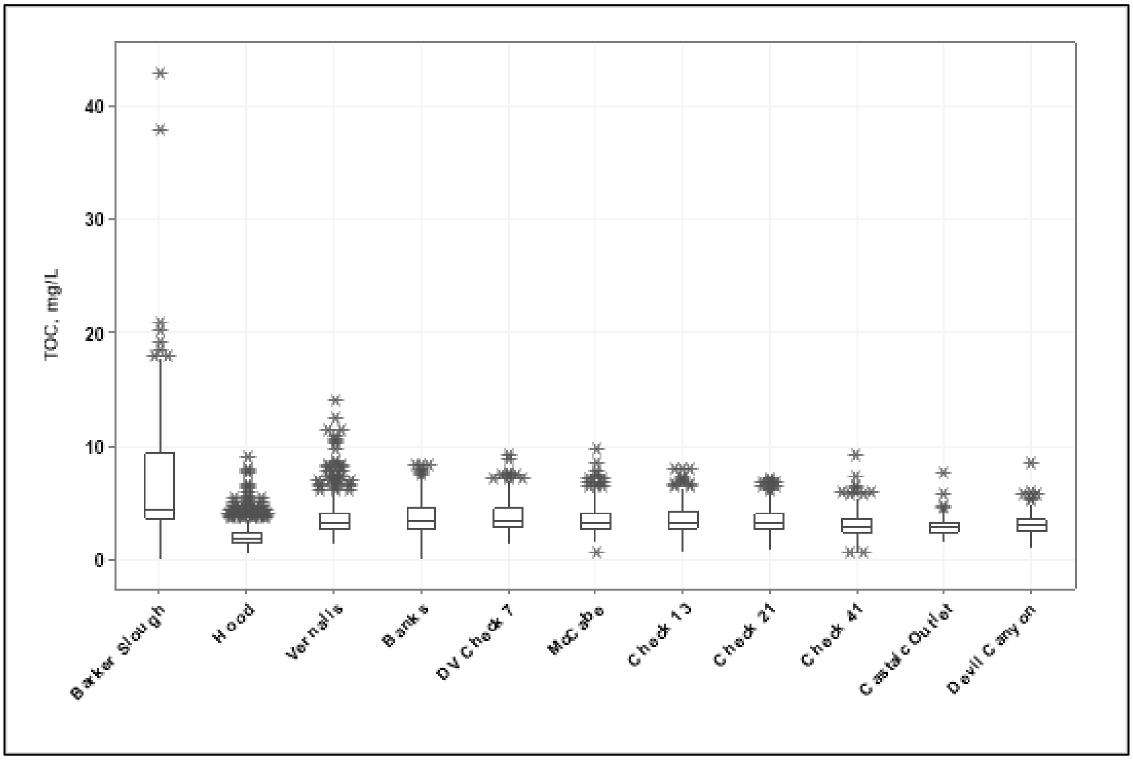
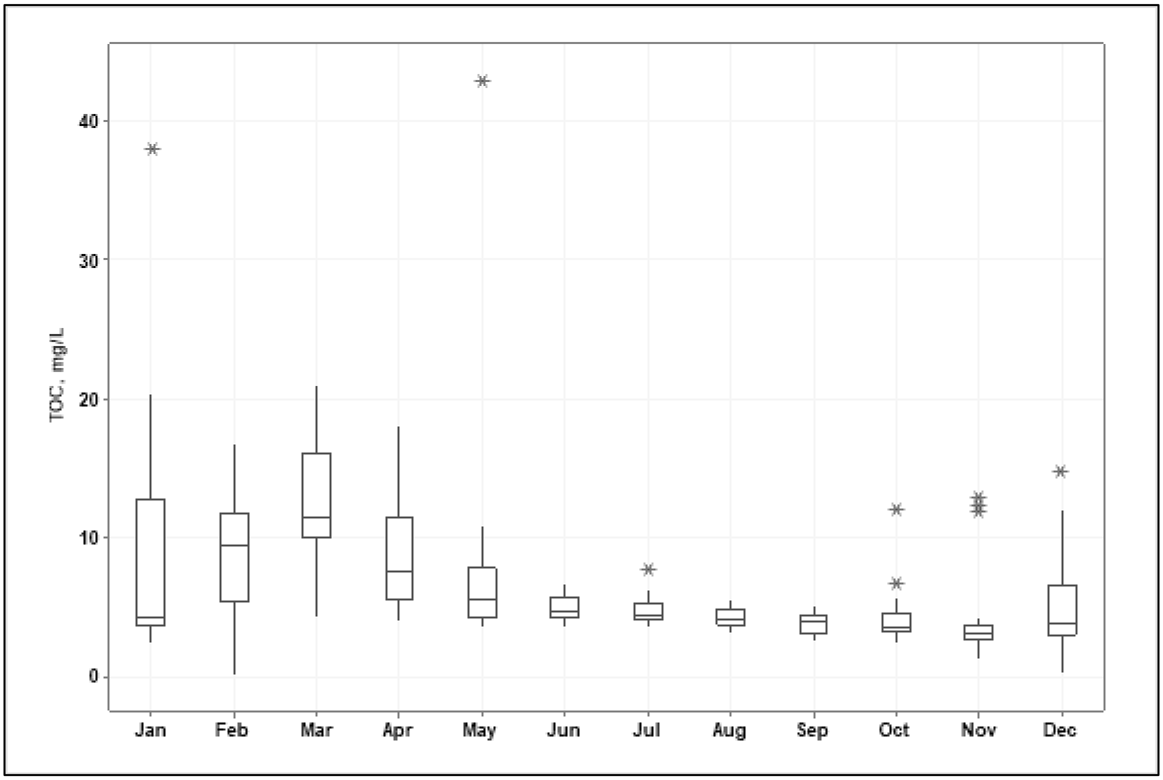


Figure 3-23. Monthly Variability in TOC at Barker Slough, 1988 to 2020



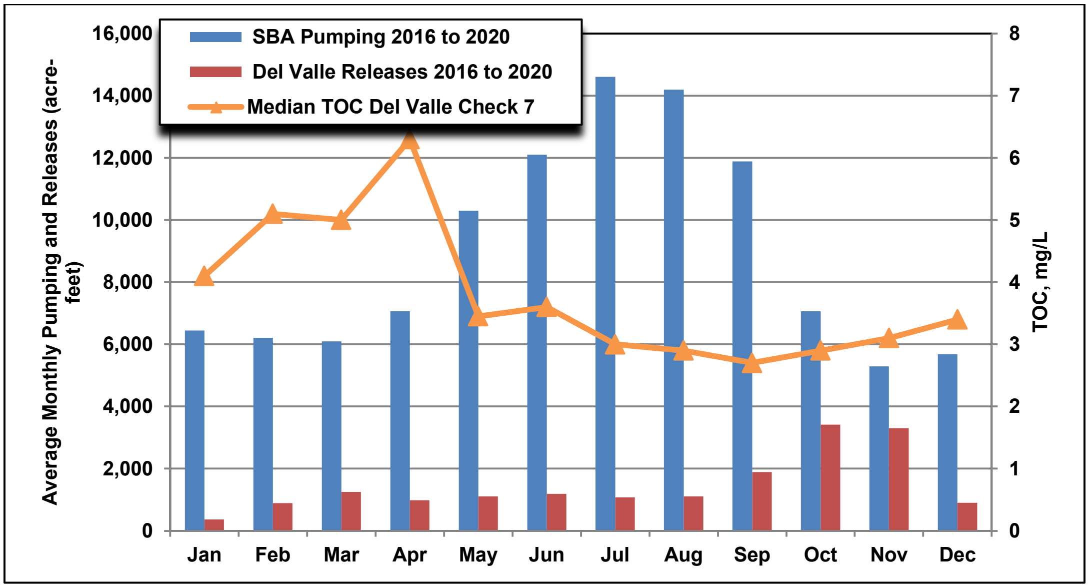
South Bay Aqueduct

The Delta is the primary source of water for the South Bay Aqueduct (SBA). Water is diverted into the SBA at the South Bay Pumping Plant on Bethany Reservoir, 1.2 miles downstream from Banks. The SBA consists of about 11 miles of open aqueduct followed by about 34 miles of pipeline and tunnel. There is some runoff from the Bethany watershed and historically a limited amount of drainage from hillsides upslope of the open canal section of the SBA flowed into the aqueduct. Water from the SBA can be pumped into or released from Lake Del Valle at the Del Valle Pumping Plant. Runoff from the Lake Del Valle watershed mingles with Delta water in the lake. Water is delivered to the Patterson Pass WTP owned by Zone 7 Water Agency of the Alameda County Flood Control and Water Conservation District (Zone 7 Water Agency) before the Del Valle Conservation Outlet (Conservation Outlet), where Lake Del Valle water is released into the SBA. Zone 7 Water Agency's Del Valle WTP and the treatment plants for Alameda County Water District (ACWD) and Santa Clara Valley Water District (Valley Water) take water downstream of Lake Del Valle. The SBA is an enclosed pipeline from Lake Del Valle to the Santa Clara Terminal Reservoir (Terminal Tank).

Project Operations

The quality of water delivered to the SBA Contractors is governed by the timing of diversions from Bethany Reservoir and releases from Lake Del Valle. **Figure 3-24** shows average monthly diversions at the South Bay Pumping Plant and releases from Lake Del Valle for the 2016 to 2020 time period. Monthly median TOC concentrations at Del Valle Check 7 (DV Check 7) are also shown. This figure shows that TOC concentrations are in the range of 2.7 to 3.5 mg/L when most of the water is diverted into the SBA during the months of May through September. TOC data are generally only collected at Lake Del Valle during the times that water is released into the SBA.

Figure 3-24. Average Monthly Diversions at the South Bay Pumping Plant, Releases from Lake Del Valle, and Median TOC Concentrations at DV Check 7, 2016 to 2020



TOC Concentrations in the SBA

TOC is measured at DV Check 7 on the SBA, located just upstream of the Del Valle Branch Pipeline. There are limited TOC data for Lake Del Valle at the Conservation Outlet and TOC is not measured at the Terminal Tank. Please refer to **Figure 2-4** for a map showing these locations. **Figure 3-25** shows all available TOC data at DV Check 7. The concentrations range from 1.5 to 9.2 mg/L during the period of record with a median of 3.5 mg/L. The average TOC concentration at DV Check 7 is 3.8 mg/L and the average alkalinity concentration is 61 mg/L as $CaCO_3$. Based on these average concentrations, the water agencies treating SBA water must remove 35 percent of the TOC. When the source water alkalinity is 60 mg/L or less, and the source water TOC is greater than 4 mg/L (but less than 8 mg/L), WTPs must achieve 45 percent removal of TOC. Over the 60 months from January 2016 to December 2020, this occurred in five months (January to March 2017, April 2018 and June 2018) as shown in **Figure 3-26**.

If a system has difficulty meeting Step 1 TOC removals, the system must conduct Step 2 testing to determine alternative minimum TOC requirements. The system may apply to the State for alternative minimum TOC removal Step 2 requirements.

- Spatial Trends – **Figure 3-27** compares data collected from the same time period (1998 to 2020) at Banks and DV Check 7. The median concentration of 3.5 mg/L at DV Check 7 is the same as the median concentration of 3.5 mg/L at Banks (Mann-Whitney, p=0.777).

- Long-term Trends – The peak TOC concentrations during water years 2009 and 2010 are higher than concentrations during the previous years. This is likely due to the fact that these are the third and fourth years of a four year drought, rather than any long-term trend. Similarly, there are peaks in 2014 and 2015 which represent the third and fourth year of a subsequent four year drought. Similar to Banks, a decrease in TOC began in the wet year of 2017 as there was more fresh water available from the Sacramento and San Joaquin Rivers.

- Wet Year/Dry Year Comparison – The dry year median concentration of 3.7 mg/L is statistically different from the wet year median concentration of 3.25 mg/L (Mann-Whitney, p=0.001).

- Seasonal Trends – **Figure 3-28** shows the monthly data for DV Check 7. TOC concentrations are highest during the winter and early spring months and then decline during the summer months. This is the same pattern exhibited at Banks.

Figure 3-25. TOC Concentrations at DV Check 7

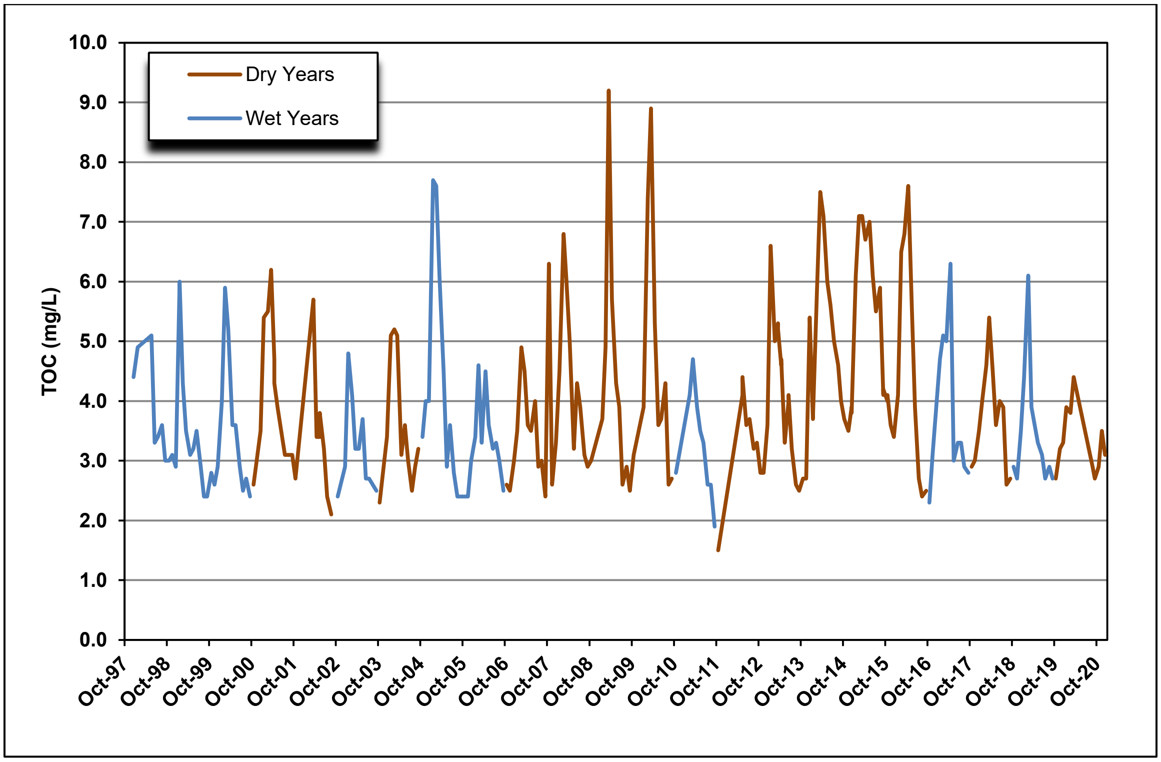


Figure 3-26. Source Water TOC and Alkalinity at DV Check 7, 2016 to 2020

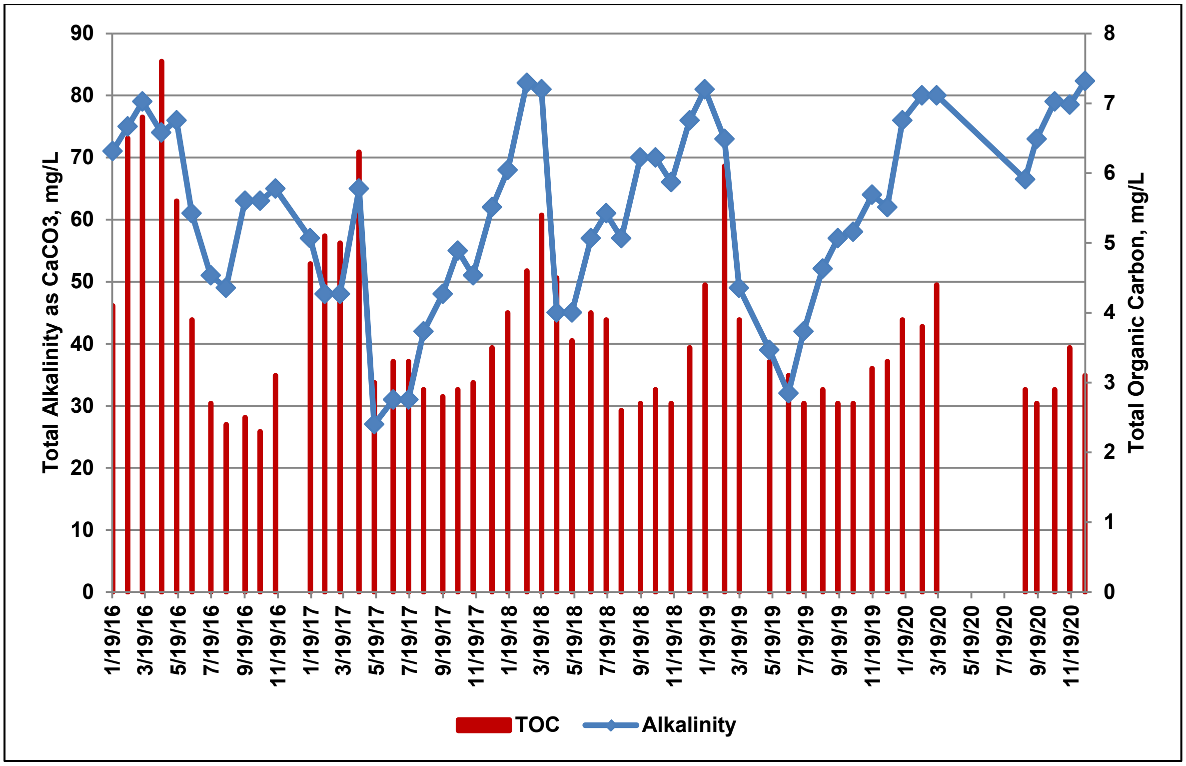


Figure 3-27. TOC Concentrations at Banks and DV Check 7 (1998-2020)

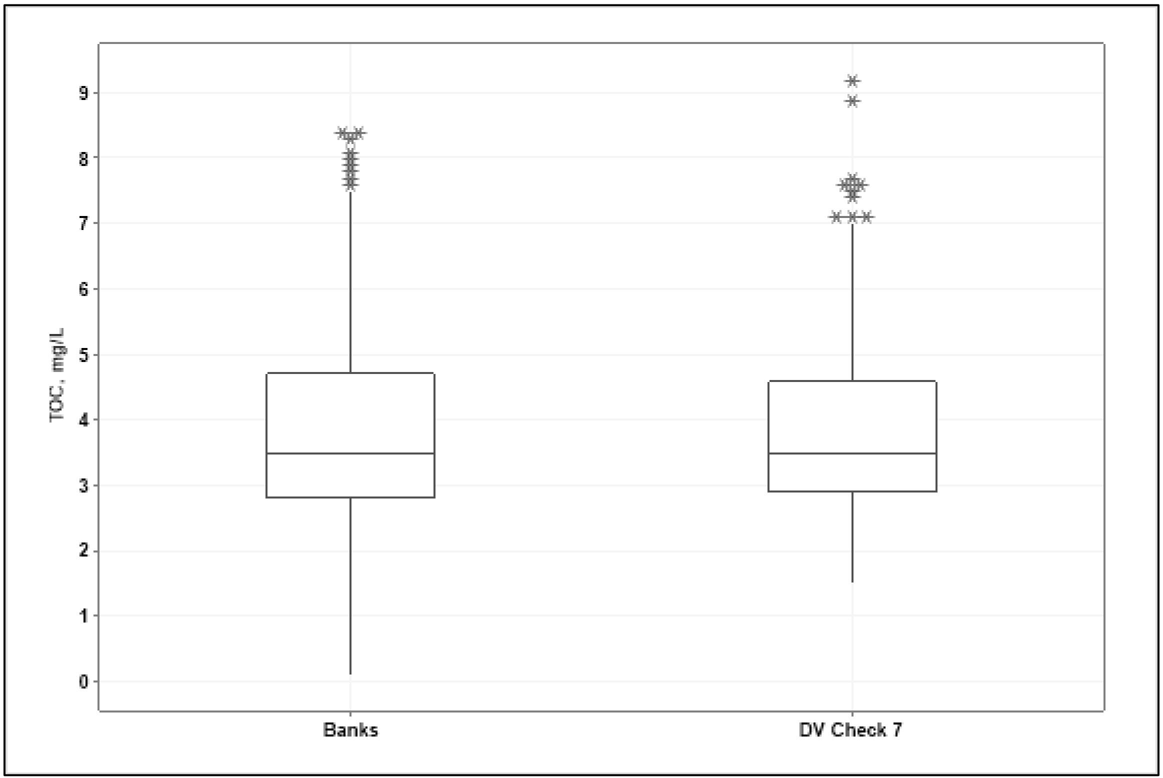
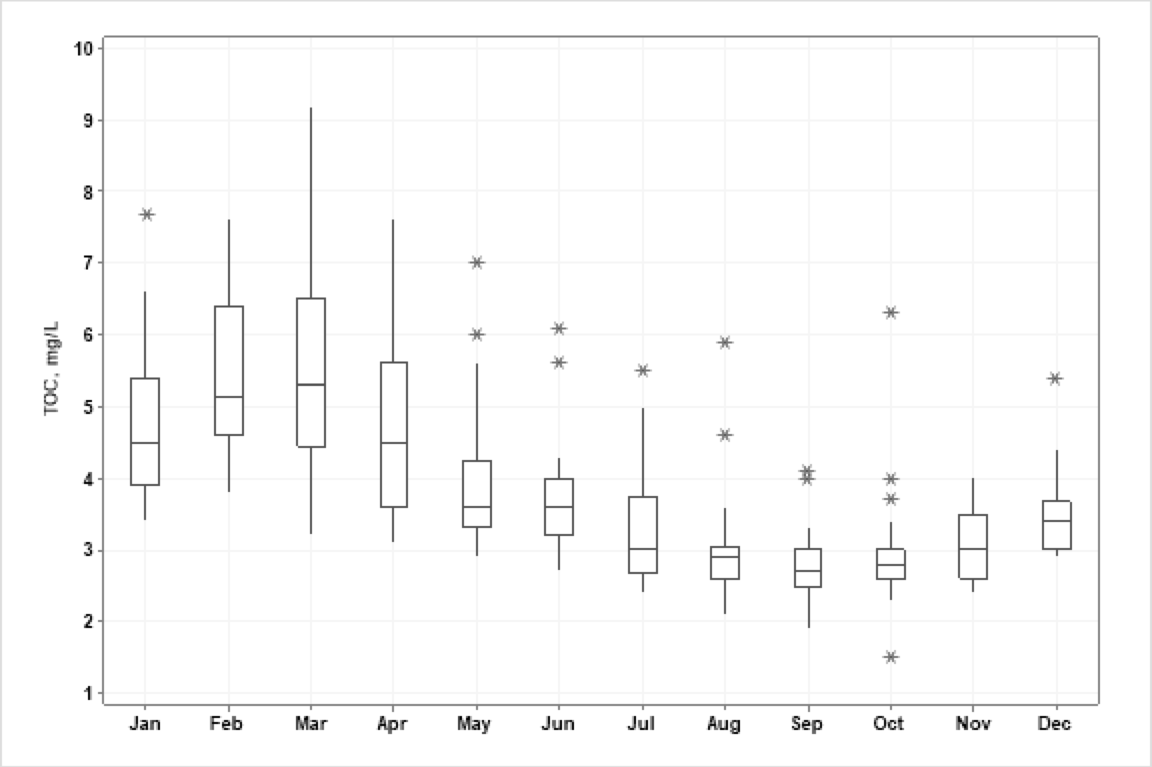


Figure 3-28. Monthly Variability in TOC at DV Check 7, 1997 to 2020



California Aqueduct and Delta-Mendota Canal

A number of SWP Contractors take water from the SWP between San Luis Reservoir and the terminal reservoirs. This section is organized by various reaches of the SWP and individual SWP contractors taking water from each reach are described in the following sections.

Project Operations

The quality of water delivered to SWP Contractors south of San Luis Reservoir is governed by the timing of diversions from the Delta at Banks, pumping into O'Neill Forebay from the Delta-Mendota Canal (DMC), releases from San Luis Reservoir, non-Project inflows to the Governor Edmund G. Brown California Aqueduct (California Aqueduct), and storage in terminal reservoirs. **Figure 3-29** shows average monthly diversions at the Banks Pumping Plant and median monthly TOC concentrations for the 2016 to 2020 time period. Diversions have been highest in the July to September time period when median TOC concentrations are less than 3.2 mg/L. A considerable amount of water is diverted during the January to March period when median TOC concentrations range from 4.7 to 6.3 mg/L.

Figure 3-30 shows the average monthly amount of water pumped from the DMC at O'Neill Pump-Generation Plant into O'Neill Forebay and the median TOC concentrations in the DMC at McCabe Road (McCabe). The pumping pattern into O'Neill Forebay is different from Banks. A limited amount of water is pumped into O'Neill Forebay during the summer months when agricultural demands on the DMC are high. Pumping increases through the fall months, peaks in January, and then declines to the low point in the summer. Median TOC concentrations range from 2.6 to 2.8 mg/L during the fall months and from 3.6 to 5.2 mg/L during the spring months.

Figure 3-29. Average Monthly Banks Diversions and Median TOC Concentrations 2016 to 2020

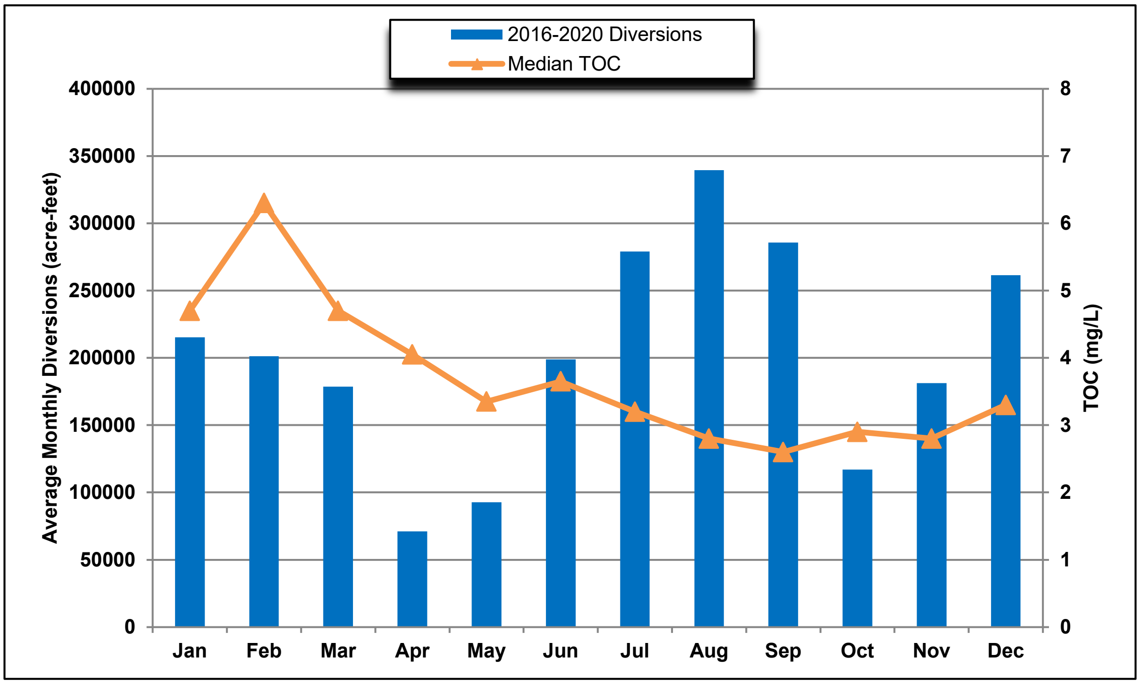
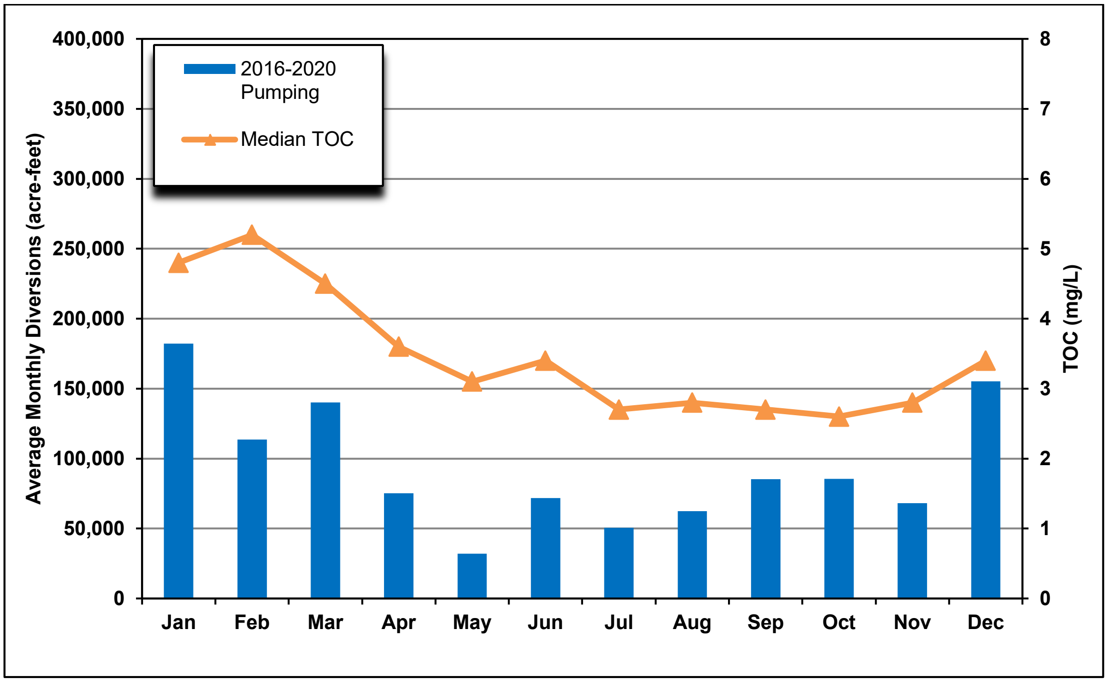


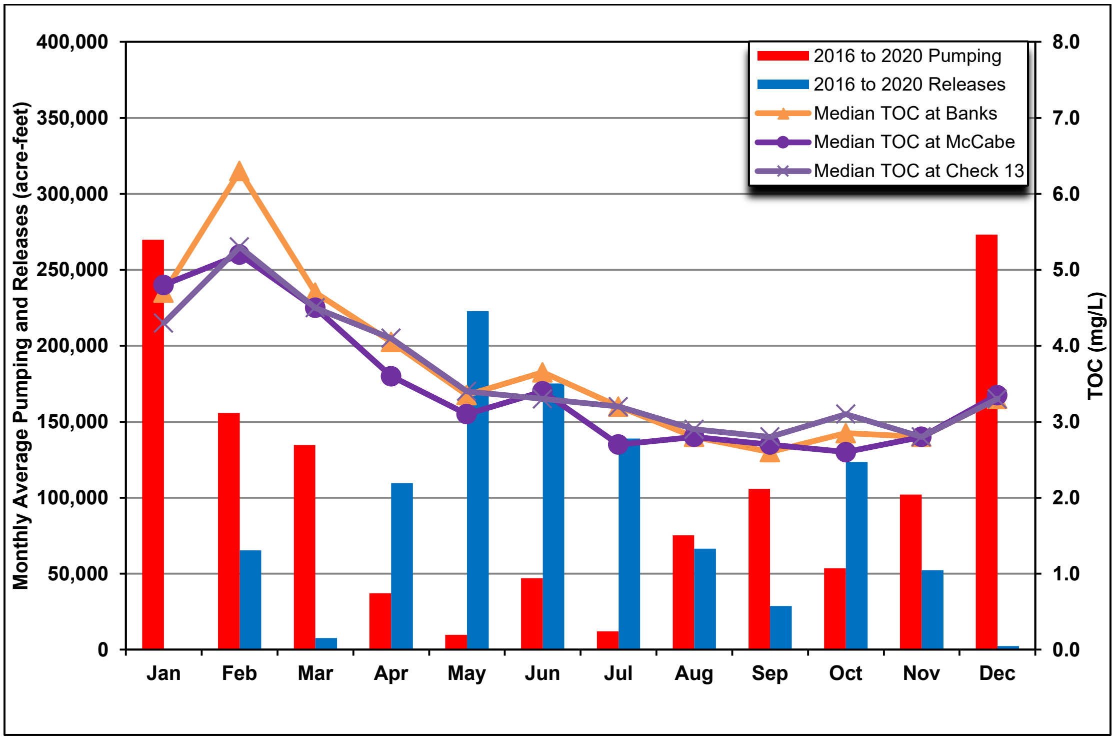
Figure 3-30. Average Monthly Pumping at O'Neill and Median TOC Concentrations at McCabe, 2016 to 2020



The operation of San Luis Reservoir impacts water quality in the California Aqueduct south of the reservoir. Water from O'Neill Forebay is pumped into San Luis Reservoir at the William R. Gianelli Pumping-Generating Plant (Gianelli) and water released from San Luis Reservoir flows into O'Neill Forebay before entering the California Aqueduct. Water is also pumped out of San Luis Reservoir on the western side at the Pacheco Pumping Plant (Pacheco) for Valley Water. In 2012, DWR installed a real-time water quality monitoring station in the channel between San Luis Reservoir and O'Neill Forebay (Gianelli Real-Time). Real-time TOC, turbidity, EC and bromide data are collected. The variation in the Gianelli data is due to operations. When pumping occurs into San Luis Reservoir, the water sample at Gianelli is O'Neill Forebay water. When releases occur from San Luis Reservoir, the water sample at Gianelli is San Luis water.

Figure 3-31 shows the pattern of (2016 to 2020) pumping into the reservoir and releases from the reservoir to O'Neill Forebay. Historically, water is generally pumped into the reservoir from September to March and released from the reservoir from April to August. However, during 2016 to 2020, there were some slight changes in the pumping/release patterns in August and October. For example, during 2016 to 2020, the average pumping and releases in August were similar, which is normally a release month. In October, the average releases were higher than the pumping, which is normally a month when water is pumped into San Luis Reservoir. This was likely due to the wet years of 2017 and 2019, and there was more than "normal" water stored in San Luis Reservoir which needed to be released in October. The median TOC concentration at Banks is shown in the figure to represent the quality of water pumped into San Luis Reservoir from the California Aqueduct. The McCabe TOC data represent the quality of water pumped into the reservoir from the DMC.

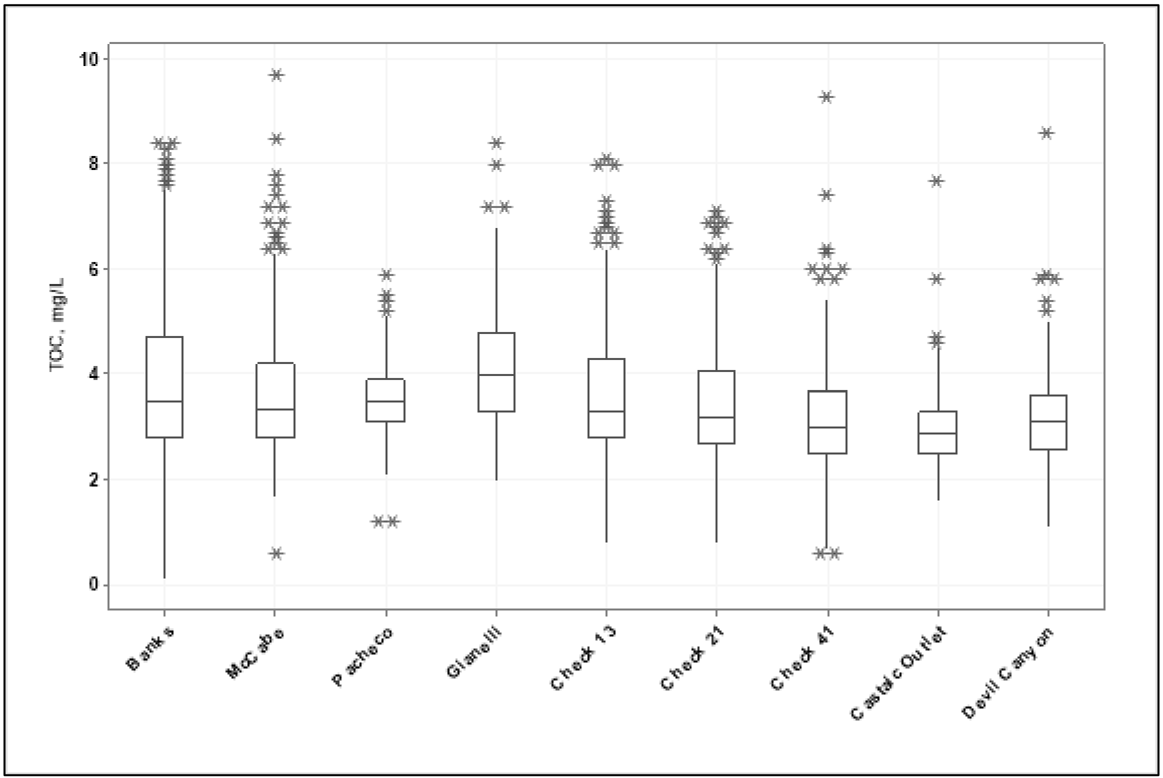
Figure 3-31. San Luis Reservoir Operations and Median TOC Concentrations, 2016 to 2020



TOC Concentrations in the DMC and SWP

Figure 3-32 presents a summary of 1998 to 2020 TOC data collected at each of the locations along the DMC, California Aqueduct, and SWP reservoirs. Data for Pacheco was not available until 2001, and 2012 for Gianelli. Once the water enters the California Aqueduct, TOC concentrations generally do not change appreciably. There is some reduction in variability in concentrations leaving San Luis and Castaic reservoirs due to the blending of water with varying concentrations over time in the reservoirs. Median TOC concentrations along the California Aqueduct range from 3.0 to 3.4 mg/L.

Figure 3-32. TOC Concentrations in the DMC and SWP, 1998 to 2020



Delta-Mendota Canal – Water from the DMC is pumped into O'Neill Forebay and comingles with water from the California Aqueduct. There are a number of locations along the DMC where drainage is allowed to enter the canal. A field survey of the DMC was conducted for the 1990 Sanitary Survey (Brown and Caldwell, 1990). There are 191 drain inlets that convey agricultural drainage into the DMC above the intake channel to O'Neill Forebay. There are also numerous "weep holes" through which shallow groundwater can rise up into the canal.

Since 1995, the San Luis and Delta- Mendota Water Authority, on behalf of eight of its member agencies (participating districts) have requested Warren contracts from the Bureau of Reclamation for the annual cumulative introduction of up to 50,000 AF of groundwater into the Delta Mendota Canal. More information on this topic is provided in Chapter 13.

Data have historically been collected at McCabe, just upstream of O'Neill Forebay. **Figure 3-33** presents the TOC data for McCabe. The concentrations range from 0.6 to 9.7 mg/L, with a median of 3.4 mg/L.

- Spatial Trends –McCabe data are compared to Banks data to determine if there are differences in the quality of water entering O'Neill Forebay from the two systems. Since the period of record is longer for Banks, a subset of the data that includes only data collected at Banks and McCabe during the same time period (1998 to 2020) was analyzed for **Figure 3-34**. The median concentration is 3.50 mg/L at Banks and 3.35 mg/L at McCabe for the 1998 to 2020 period, and they are not statistically significantly different (Mann-Whitney, p= 0.137).

- Long-Term Trends – Visual inspection of **Figure 3-33** does not display any discernible trend in the TOC concentrations.

- Wet Year/Dry Year Comparison – The dry year median concentration of 3.4 mg/L is statistically different from the wet year median concentration of 3.2 mg/L (Mann-Whitney, p=0.014).

- Seasonal Trends – **Figure 3-35** shows there is a seasonal pattern of low concentrations from May to October and then concentrations increase during the late fall and winter months. This is similar to the seasonal pattern at Banks but quite different from the pattern at Vernalis.

Figure 3-33. TOC Concentrations at McCabe

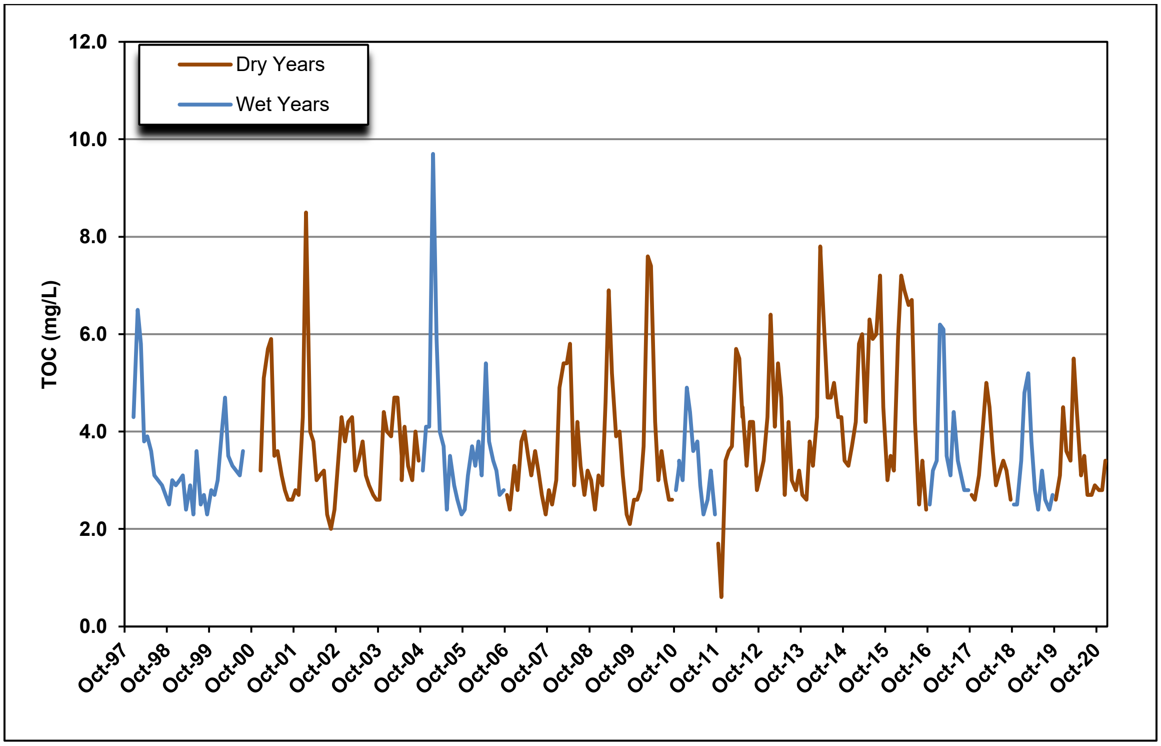


Figure 3-34. TOC Concentrations at Banks and McCabe (1997-2020)

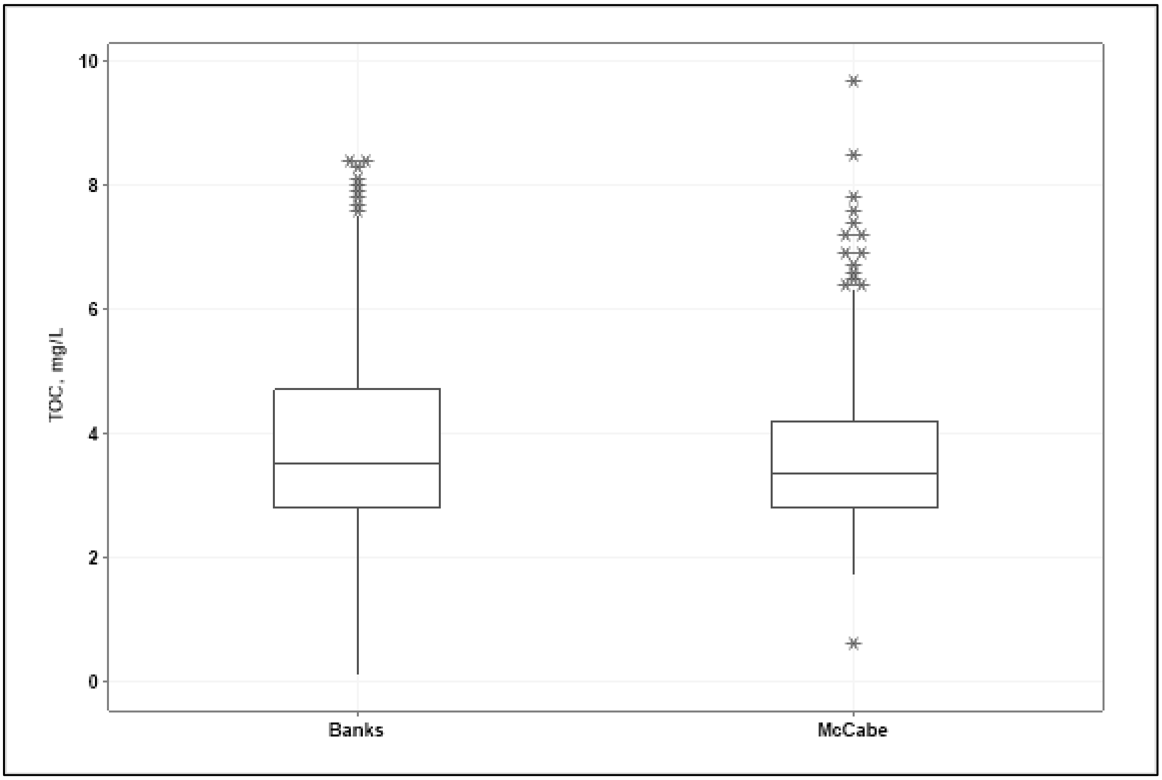


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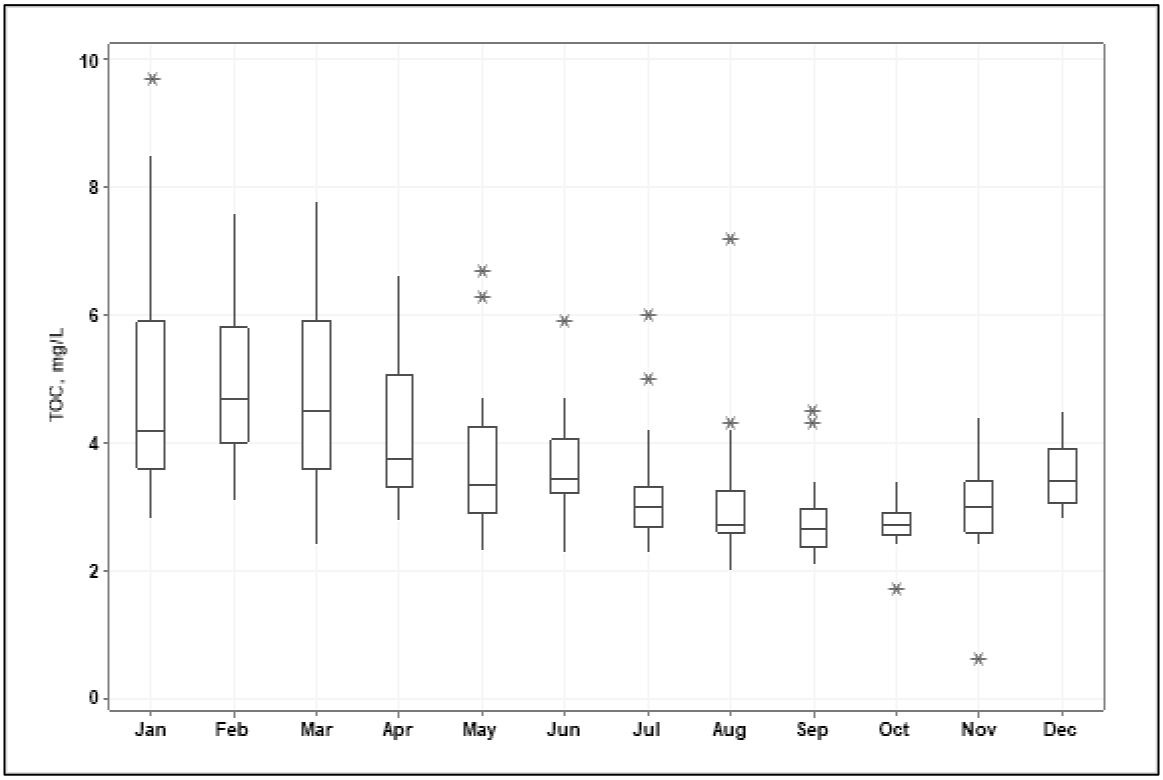
Figure 3-35. Monthly Variability in TOC at McCabe, 1997 to 2020



San Luis Reservoir – Water is pumped out of San Luis Reservoir on the western side at Pacheco for SCVWD and on the eastern side at Gianelli for SWP Contractors south of the reservoir. **Figure 3-36** presents all of the available TOC data for Pacheco. There is much less variability in TOC concentrations in the reservoir than in the aqueduct. The TOC concentrations at Pacheco range from 1.2 to 5.9 mg/L with a median of 3.5 mg/L.

- Spatial Trends –As shown in **Figure 3-37**, 2001 to 2020 data is presented for Banks, McCabe and Pacheco. The median concentration of 3.5 mg/L at Pacheco is not statistically significantly different from the median of 3.5 mg/L at Banks (Mann-Whitney, p=0.479), and also not significantly different from the median of 3.35 mg/L at McCabe (Mann-Whitney, p=0.268). Although, there are no apparent differences in TOC concentrations, the organic matter composition of water in San Luis Reservoir is different from water entering the reservoir due to algal production and degradation processes in the reservoir. Water in San Luis Reservoir has a greater propensity to form DBPs during the spring and summer months (Krause et al., 2011). This is the period when most water is released from the reservoir and flows south in the California Aqueduct.

- Long-Term Trends – Visual inspection of **Figure 3-36** shows an increasing trend of TOC concentration starting at the end of 2011 to 2015. The same trend was seen in the previous dry period between 2006 and 2010. TOC concentrations reached a record high of 5.9 mg/L in September 2015, whereas the peak concentration was 4.6 mg/L in the 2006 to 2010 dry period. TOC levels dropped in 2017 due to heavy precipitation.

- Wet Year/Dry Year Comparison – The Pacheco dry year median and wet year median are both 3.5 mg/L.(Mann-Whitney, *p*=0.913).

- Seasonal Trends – **Figure 3-38** shows there is little variability in the data from month to month; however the highest concentrations occur in the summer/fall and the lowest concentrations occur in the winter. This is opposite of the pattern seen at Banks and most other locations.

Note: Samples are collected at different depths at Pacheco, depending on the portal depth at which water is being withdrawn from the Pacheco outlet tower and the amount of water in the reservoir. Valley Water confirmed that the upper portal (elevation 376') has been capped off since 2016, and water primarily flows through the lower portal (elevation 334'). It is expected that the TOC concentrations in the hypolimnion are dependent on the TOC concentrations of water pumped into San Luis Reservoir from the Delta and, to some extent, on degradation of algae settling out of the epilimnion. Samples from the epilimnion likely have more algae and therefore may have higher TOC concentrations than samples from the hypolimnion.

Figure 3-36. TOC Concentrations at Pacheco

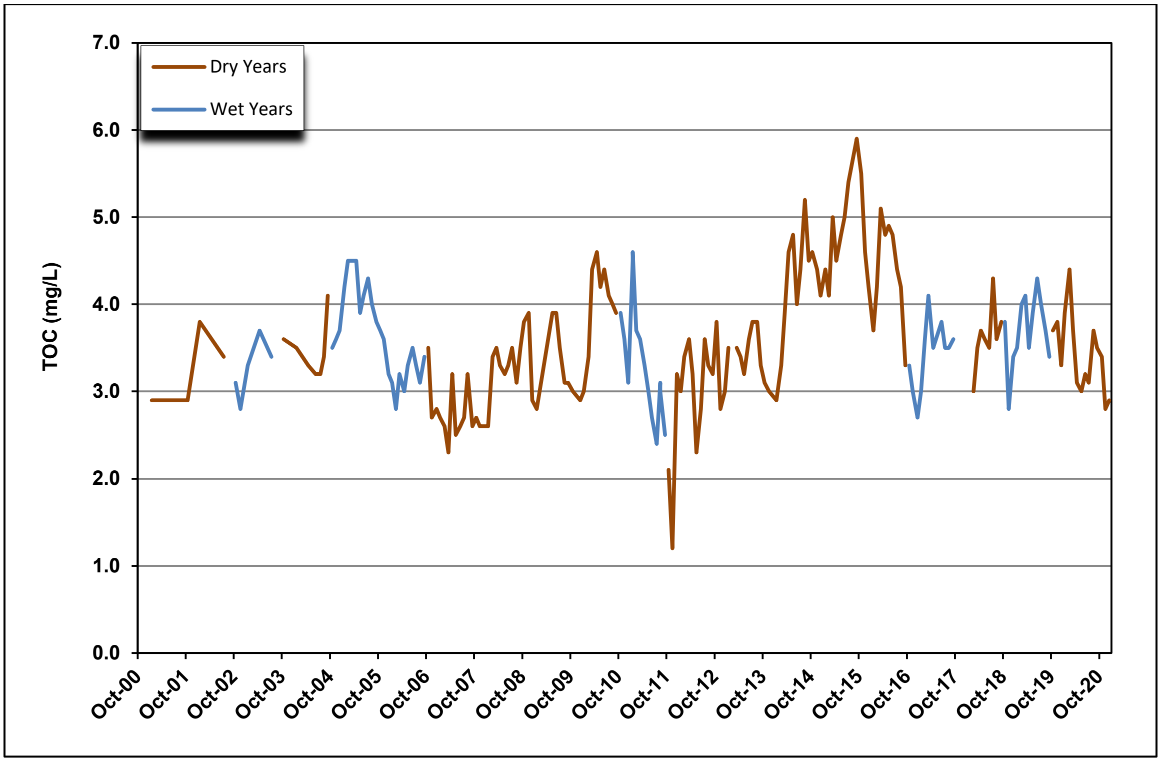


Figure 3-37. TOC Concentrations at Banks, McCabe, and Pacheco (2001-2020)

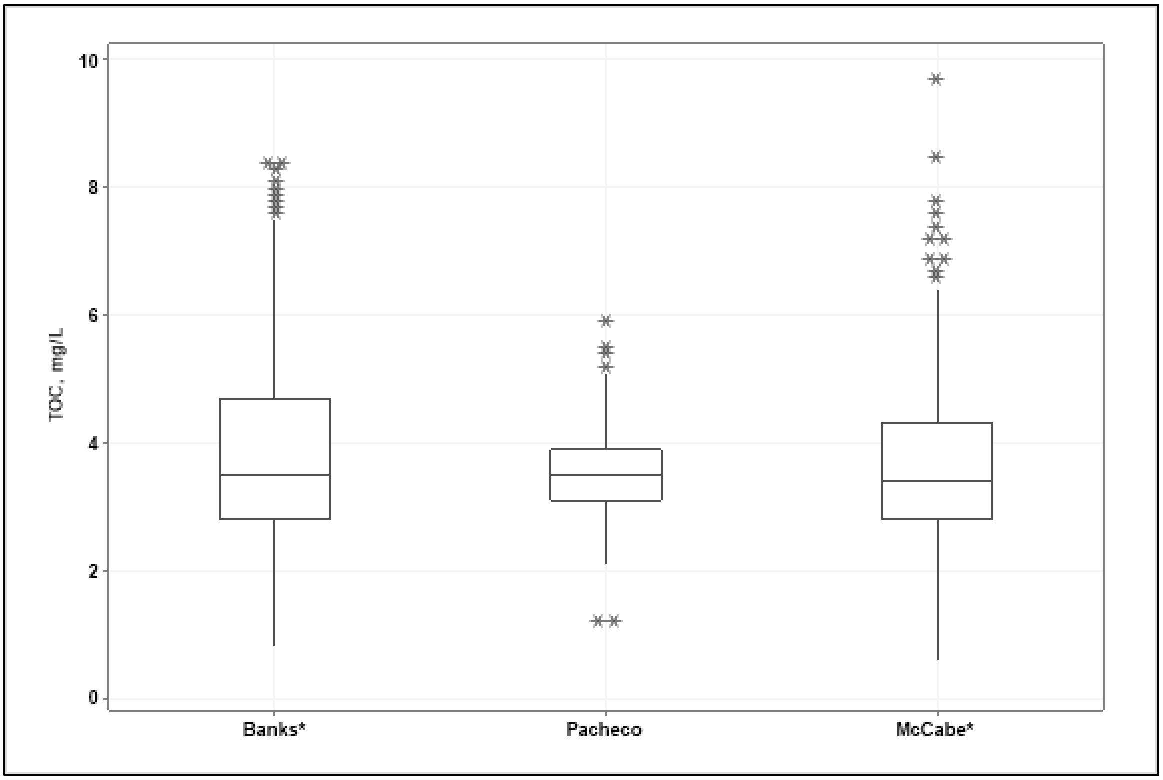
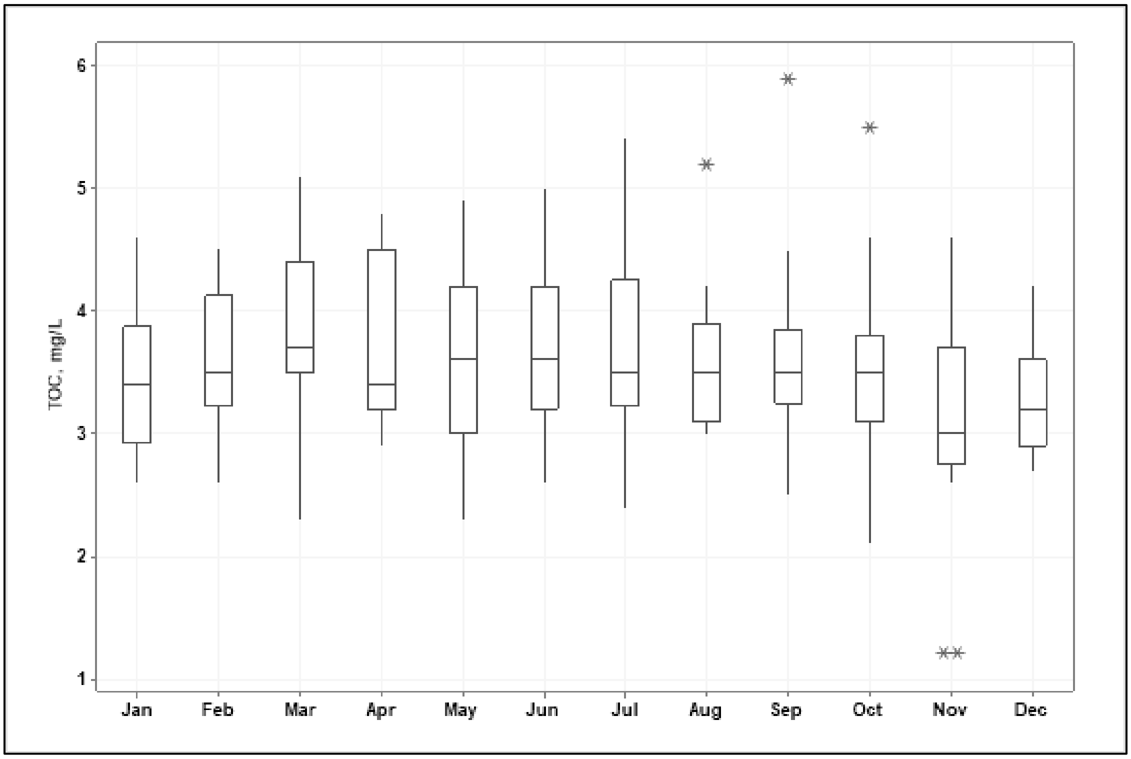


Figure 3-38. Monthly Variability in TOC at Pacheco, 2000 to 2020



***San Luis Reservoir (Gianelli)*– Figure 3-39** presents all of the available TOC data for Gianelli. TOC at Gianelli ranges from 2 to 8.4 mg/L, with a median of 4 mg/L.

- Comparison of Real-time and Grab Sample Data – **Figure 3-40** compares the real-time data with the grab sample data at Gianelli from 2016 to 2020. The real-time instrument measures TOC every four hours, and collects five to seven data points for each sample. Therefore, the real-time data point is a daily average of 20 to 28 data points per day. **Figure 3-41** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.7636 which is acceptable.

- Spatial Trends – Data from 2013 to 2020 at Gianelli and Pacheco are presented in **Figure 3-42.** The median TOC level of 3.7 mg/L at Pacheco is not statistically significant than the median TOC of 4.0 mg/L at Gianelli (Mann-Whitney, *p*=0.135).

- Long-Term Trends – **Figure 3-39** does not display any discernible long-term trends.

- Wet Year/Dry Year Comparison - The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median TOC of 4.2 mg/L in dry years is statistically significantly higher than the median of 3.3 mg/L in wet years (Mann-Whitney, *p*=0.003).

- Seasonal Trends – Seasonal trends were not conducted as water quality is more impacted on whether or not water is being released from San Luis Reservoir or being pumped from O'Neill forebay into San Luis Reservoir. Generally pumping occurs from September to March, and releases occur from April to August.

Figure 3-39. TOC Concentrations at Gianelli

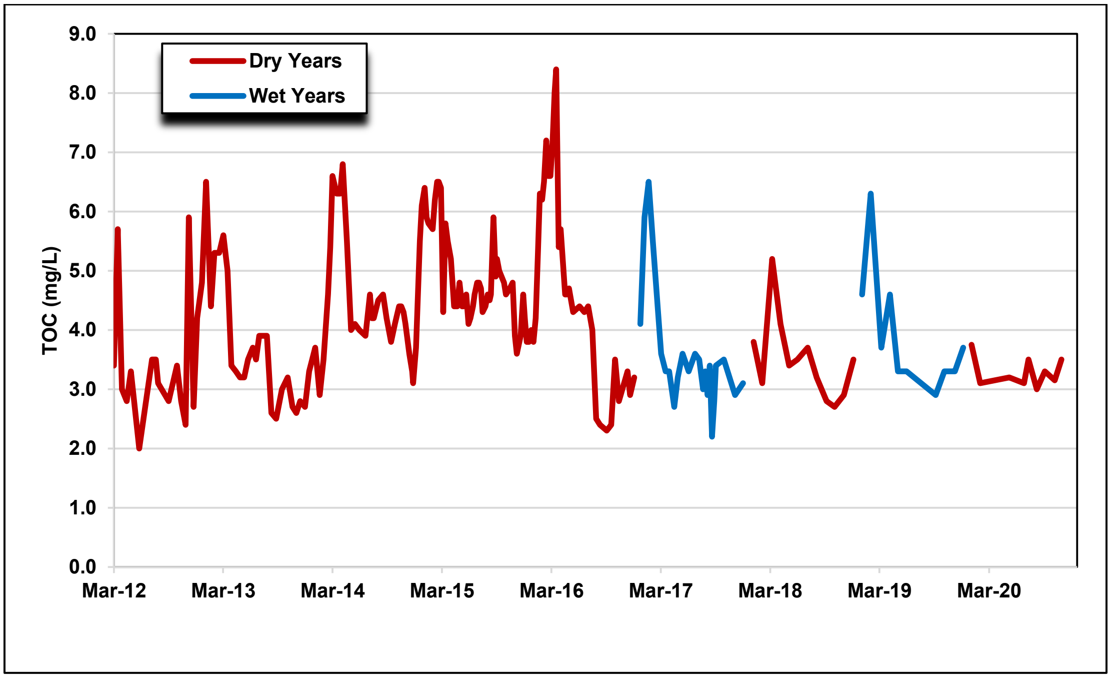


Figure 3-40. Comparison of Gianelli Real-time and Grab Sample TOC Data, 2016 to 2020

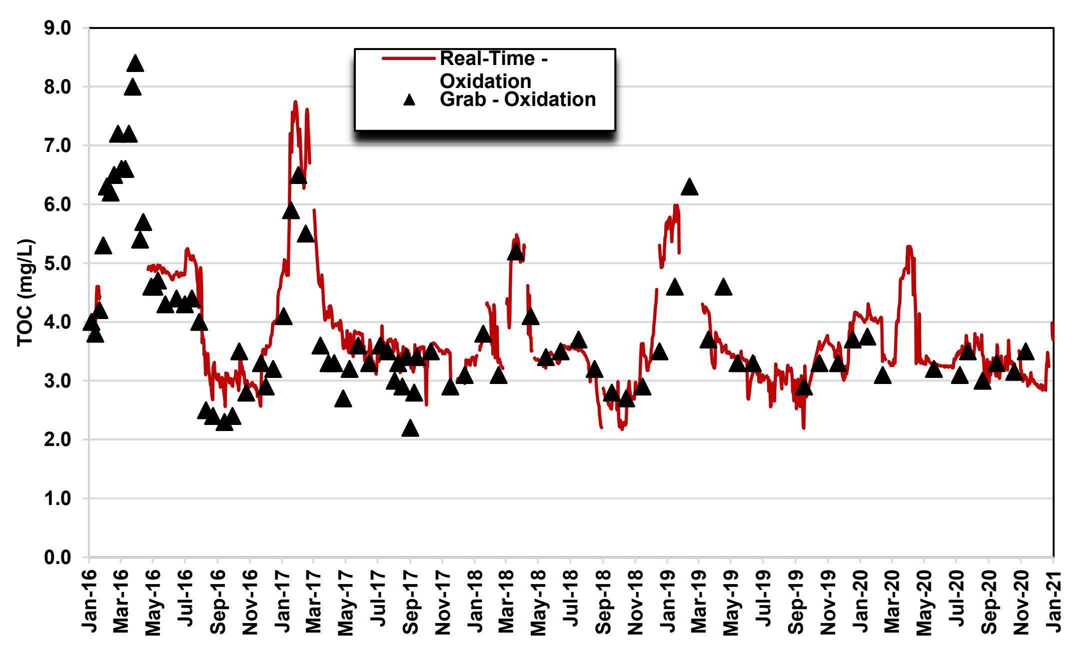


Figure 3-41. Comparison of Gianelli Real-time and Grab Sample TOC Data, 2016 to 2020, 1:1 Graph

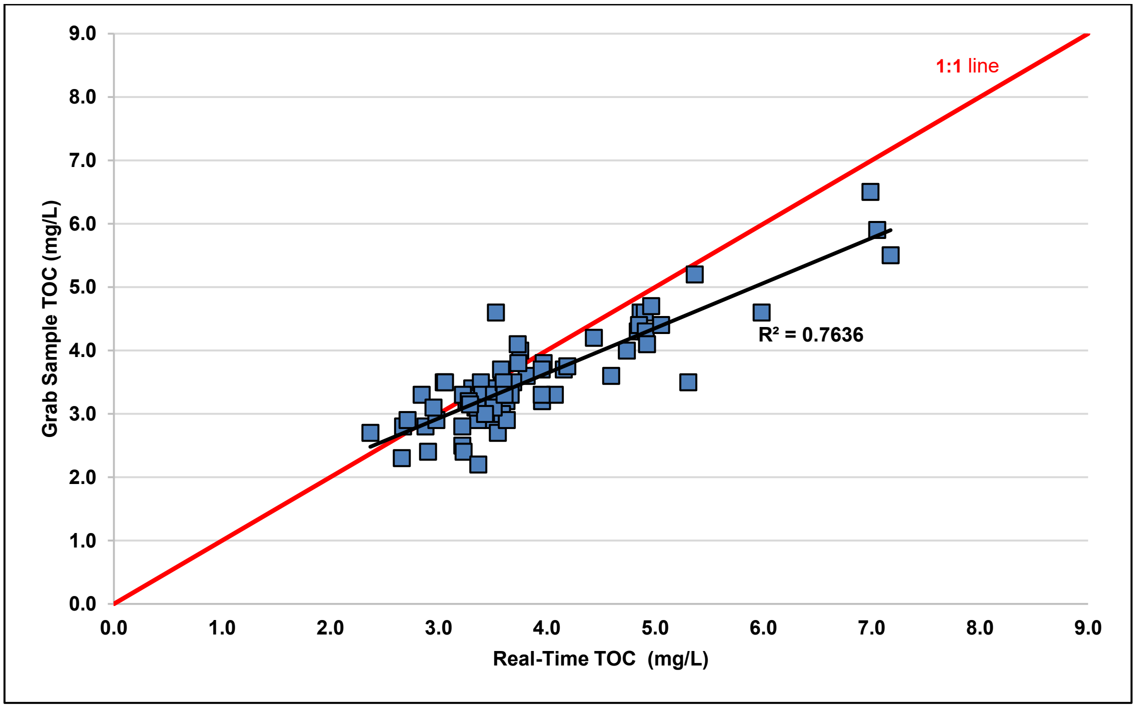
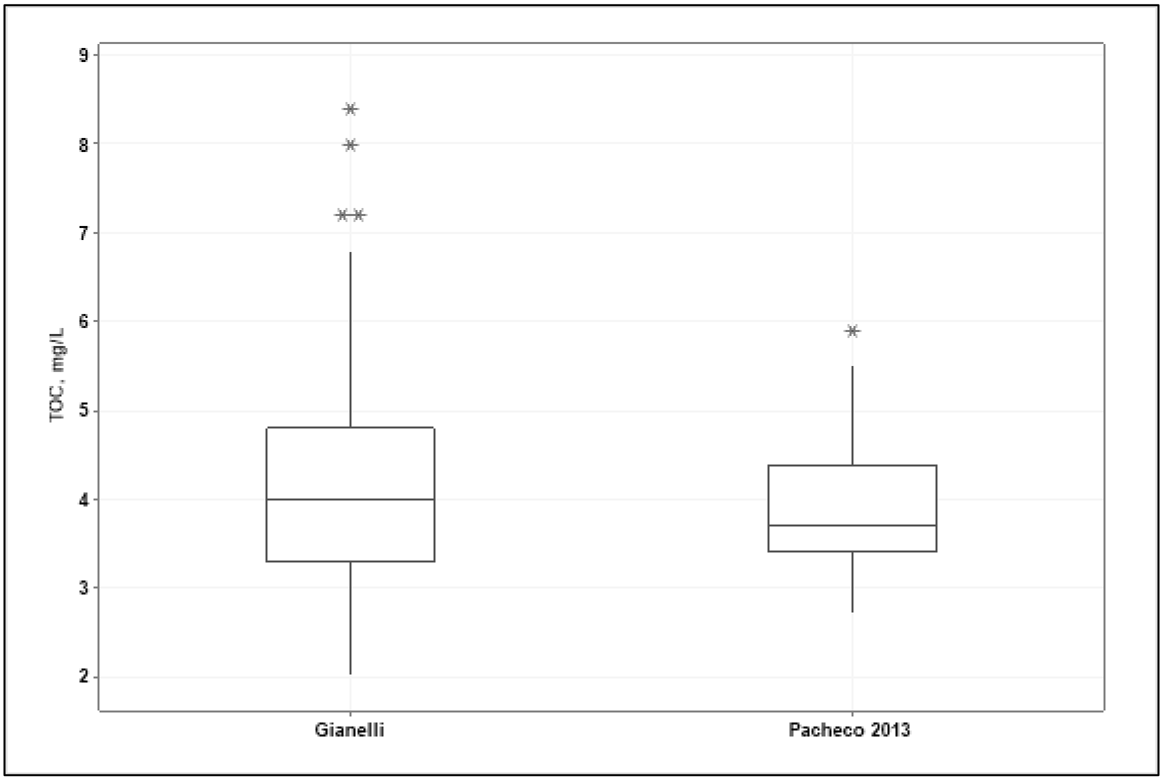


Figure 3-42. TOC Concentrations at Gianelli and Pacheco (2013-2020)



O'Neill Forebay Outlet – Water released from San Luis Reservoir flows into O'Neill Forebay before entering the San Luis Canal section of the California Aqueduct at O'Neill Forebay Outlet. Water from the DMC and the California Aqueduct also flows through O'Neill Forebay, so O'Neill Forebay Outlet can be a mixture of water from San Luis Reservoir, the California Aqueduct, and the DMC. **Figure 3-43** presents all of the available TOC data for O'Neill Forebay Outlet. The TOC concentrations at O'Neill Forebay Outlet range from 0.8 to 8.1 mg/L with a median concentration of 3.3 mg/L.

From 2016 to 2020, the average TOC concentration at O'Neill Forebay Outlet is 3.6 mg/L and the average alkalinity concentration is 66 mg/L as $CaCO_3$. Based on these average concentrations, the water agencies treating SWP water with conventional treatment must remove 25 percent of the TOC. In January and February 2017, alkalinity concentrations dropped below 60 mg/L when TOC concentrations exceeded 4.0 mg/L, leading to the requirement to remove 45 percent of the TOC in the source water.

- Spatial Trends –. As shown in **Figure 3-44**, 1998 to 2020 data from Banks, McCabe and O'Neill Forebay Outlet are presented. The median concentration at O'Neill Forebay Outlet is 3.3 mg/L, 3.35 mg/L at McCabe, and 3.5 mg/L at Banks during this period. While TOC concentrations entering the California Aqueduct at O'Neill Forebay Outlet are not statistically significantly different from the water at Banks, the organic matter composition is sometimes different (Krause et al., 2011).

- Long-Term Trends – Visual inspection of **Figure 3-43** does not display any discernible trend in the TOC concentrations in the 23 year period of record. However, TOC increases in consecutive dry years, such as from 2012 to 2015.

- Wet Year/Dry Year Comparison – The O'Neill Forebay Outlet dry year median concentration of 3.4 mg/L is statistically significantly different than the wet year median concentration of 3.2 mg/L (Mann-Whitney, p=0.013).

- Seasonal Trends – **Figure 3-45** shows there is a distinct seasonal pattern with the lowest concentrations in the summer months and the highest concentrations in March. This is the same seasonal pattern exhibited at Banks.

Figure 3-43. TOC Concentrations at O'Neill Forebay Outlet

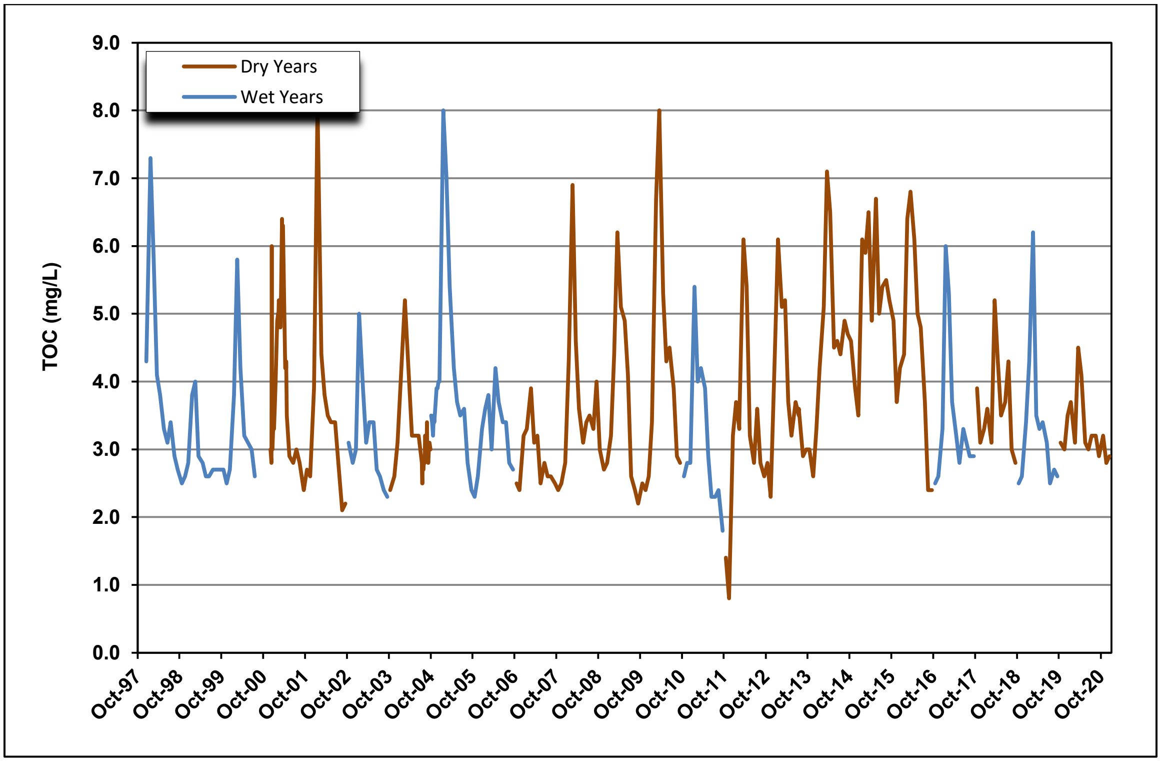


Figure 3-44. TOC Concentrations at Banks, McCabe, and O'Neill (1998-2020)

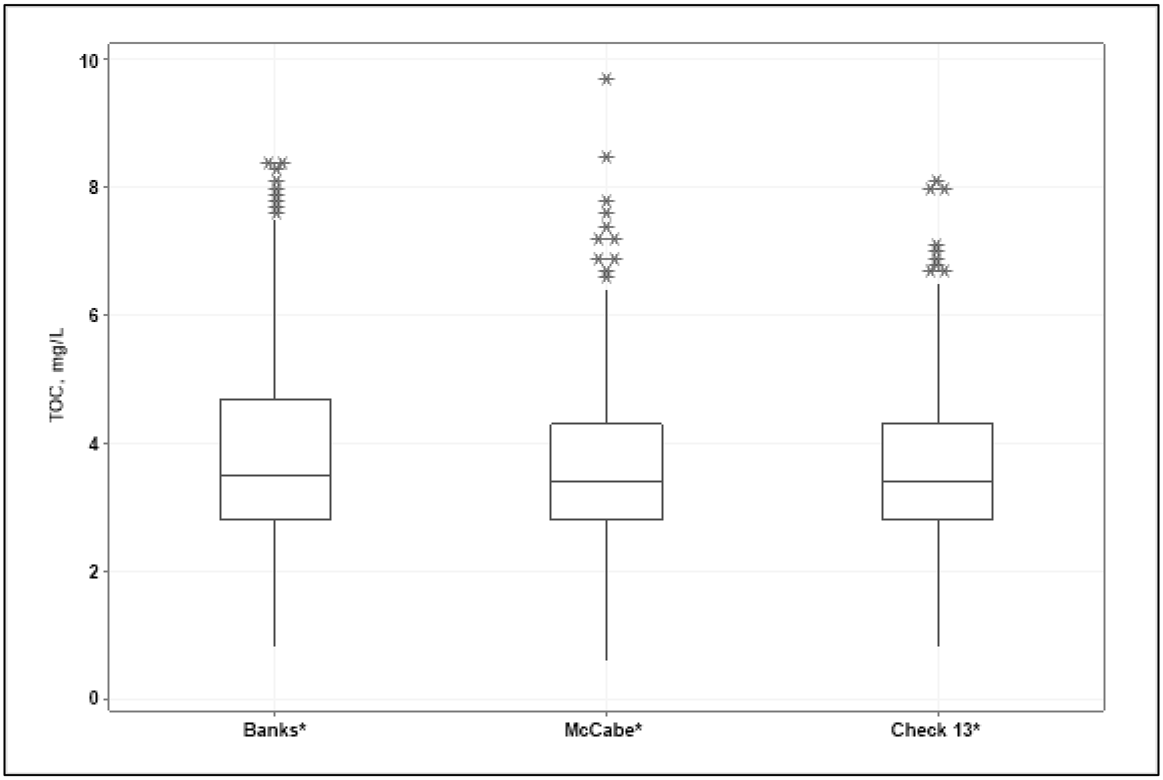
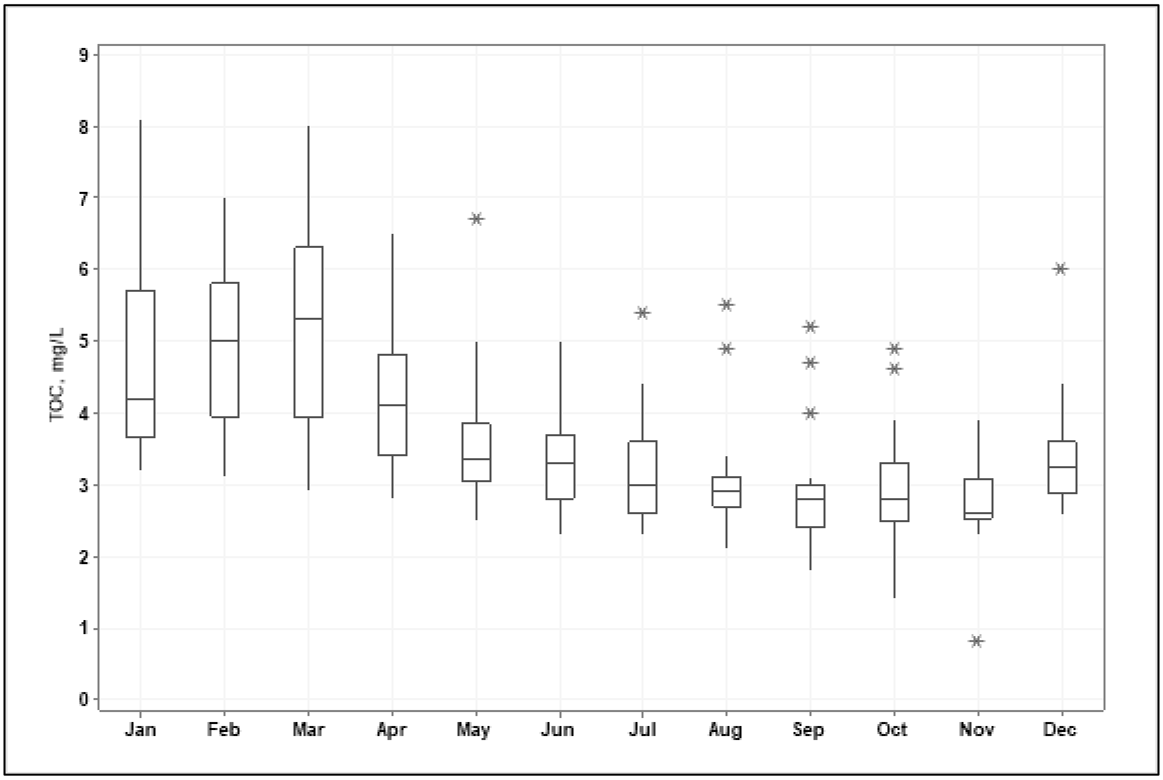


Figure 3-45. Monthly Variability in TOC at O'Neill Forebay Outlet, 1997 to 2020



Check 21 – Check 21, located on the California Aqueduct 12 miles upstream of the Coastal Branch junction is the site where the quality of water entering the Coastal Branch is measured. The Coastal Branch provides water to CCWA and San Luis Obispo County Flood Control and Water Conservation District. **Figure 3-46** presents all available data for Check 21. During the 1997 to 2020 time period, TOC concentrations ranged from 0.8 to 7.1 mg/L with a median of 3.2 mg/L.

- Spatial Trends – The median concentration of 3.2 mg/L at Check 21 is not statistically different from the median concentration of 3.3 mg/L at O'Neill Forebay Outlet during the 1998 to 2020 period that data have been collected at the two locations (Mann-Whitney, p=0.135).

- Long-Term Trends – Visual inspection of **Figure 3-46** does not display any discernible trend in the TOC concentrations in the 23 year period of record, except for an increasing trend during the four years of drought from 2012 to 2015.

- Wet Year/Dry Year Comparison – The Check 21 The dry year median concentration of 3.3 mg/L is statistically significantly different than the wet year median concentration of 3.1 mg/L (Mann-Whitney, p=0.014).

- Seasonal Trends – **Figure 3-47** shows there is a distinct seasonal pattern with the lowest concentrations in the summer months and the highest concentrations in the wet months of January to April.

Figure 3-46. TOC Concentrations at Check 21

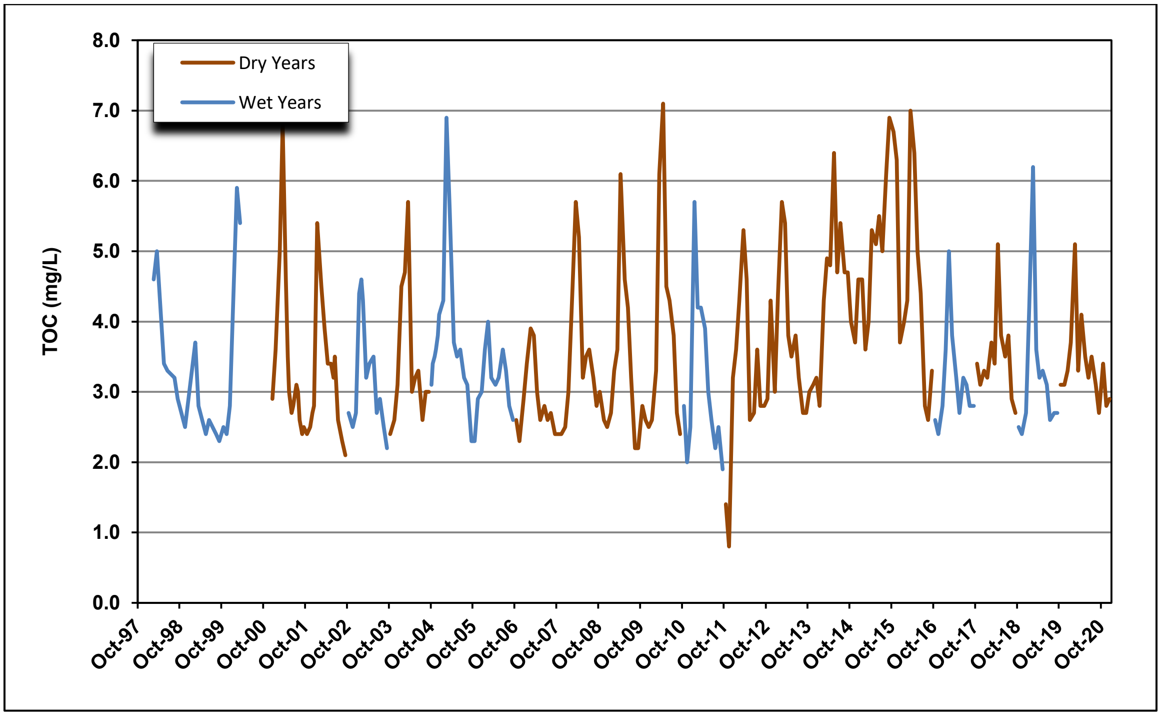
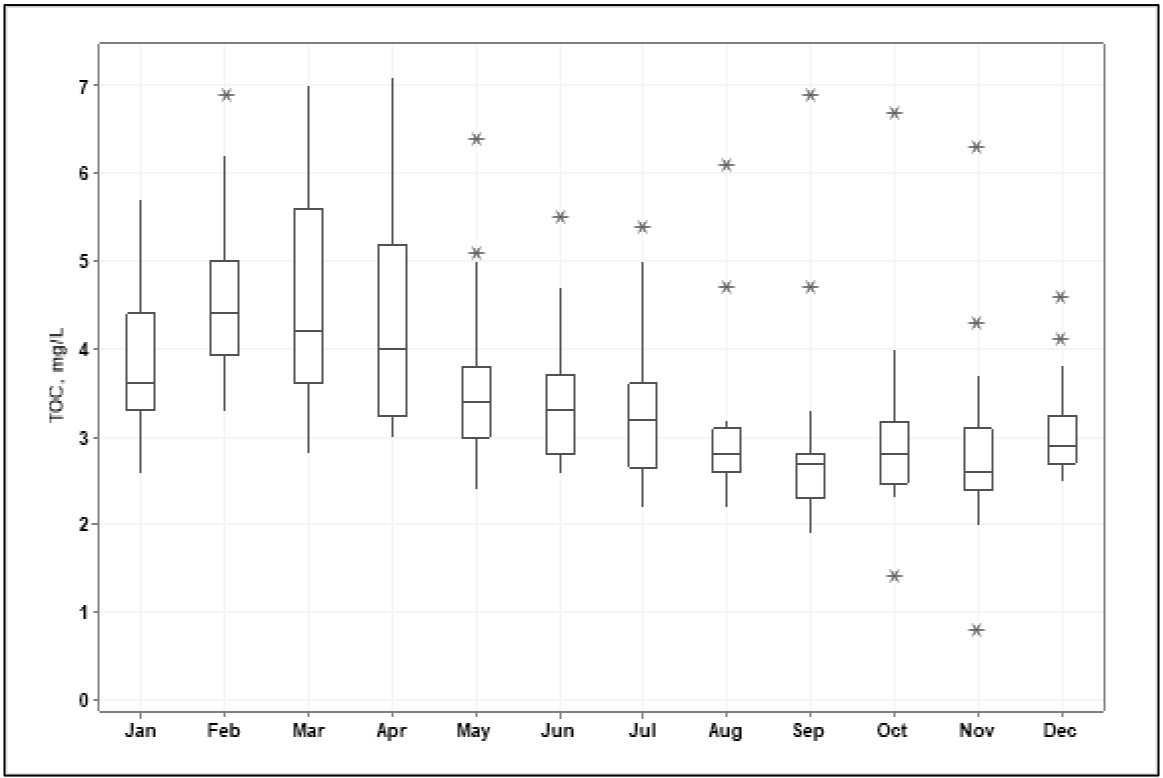


Figure 3-47. Monthly Variability in TOC at Check 21, 1998 to 2020



Check 41 – Check 41 is located on the California Aqueduct just upstream of Tehachapi Afterbay where the aqueduct bifurcates into the east and west branches. **Figure 3-48** presents all available data for Check 41. TOC concentrations range from 0.6 mg/L to 9.3 mg/L with a median of 3.0 mg/L.

- Spatial Trends – The median concentration of 3.0 mg/L at Check 41 is statistically different from the median concentration of 3.2 mg/L at Check 21 (Mann-Whitney, *p*=0.000) and statistically different from the median concentration of 3.3 mg/L at O'Neill Forebay Outlet (Mann-Whitney, *p*=0.0000) during the 1998 to 2020 period that data have been collected at the three locations. Large volumes of low TOC groundwater and surface water are allowed to be pumped into the aqueduct between Checks 21 and 41, particularly in dry years. **Figure 3-49** presents the TOC data for Check 21 and Check 41, and the volumes of non-Project water pumped into the Aqueduct between Check 21 and 41 for the last fifteen years. As shown in **Figure 3-49**, water quality at Check 21 and Check 41 are generally similar when there are no pump-ins, and the TOC decreases at Check 41 with higher volumes of non-Project water pumped into the Aqueduct.

    - Long-Term Trends – Visual inspection of **Figure 3-48** shows that TOC concentrations are more variable due to the substantial non-Project inflows of low TOC water, particularly in years 2013, 2014 and 2015. Check 41 is highly affected by non-Project turn-ins.

    - Wet Year/Dry Year Comparison – The Check 41 dry year median concentration of 3.0 mg/L is statistically significantly lower than the wet year median concentration of 3.1 mg/L (Mann-Whitney, *p*=0.020). This is due to the lower TOC concentrations in non-Project water which enters the Aqueduct in dry years.

    - Seasonal Trends – **Figure 3-50** shows the same seasonal pattern as at Check 21, but concentrations are generally lower due to the impact of low TOC groundwater and surface water pumped into the Aqueduct in dry years.

Figure 3-48. TOC Concentrations at Check 41

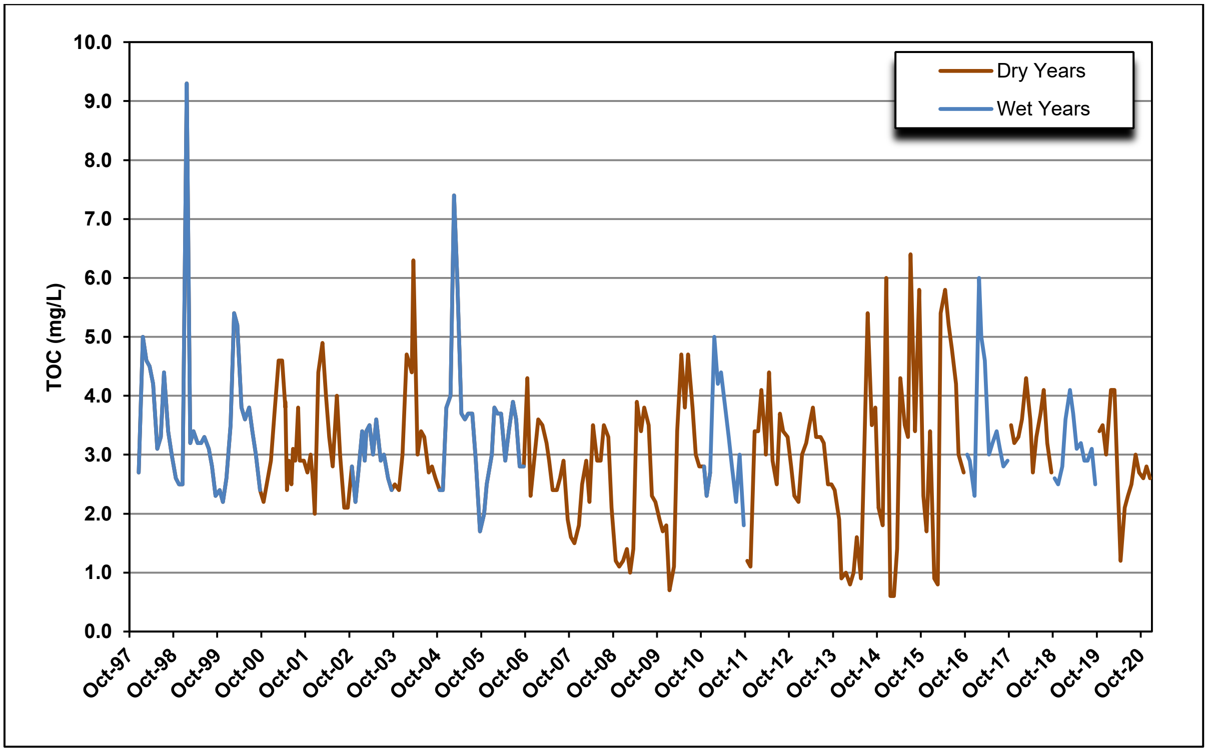


Figure 3-49. Comparison of Check 21 and Check 41 TOC Concentrations, with Turn-In Volumes

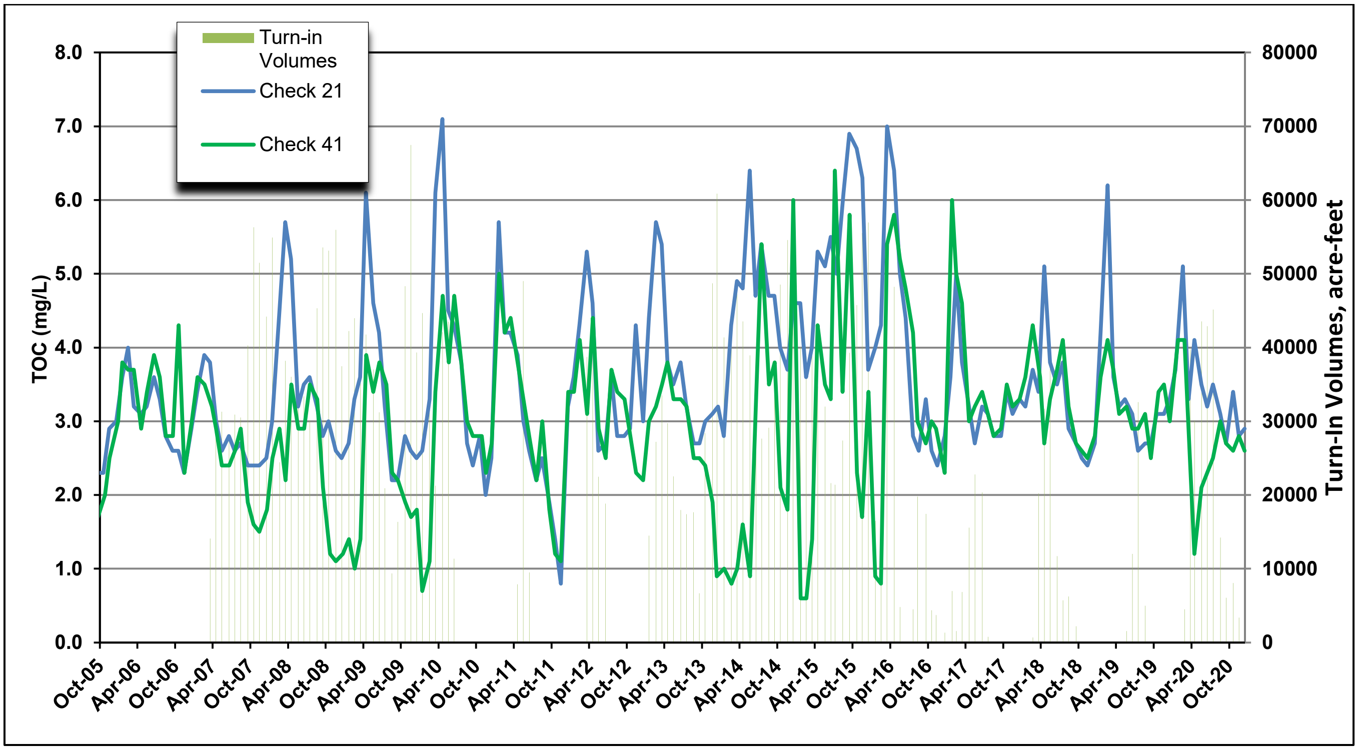
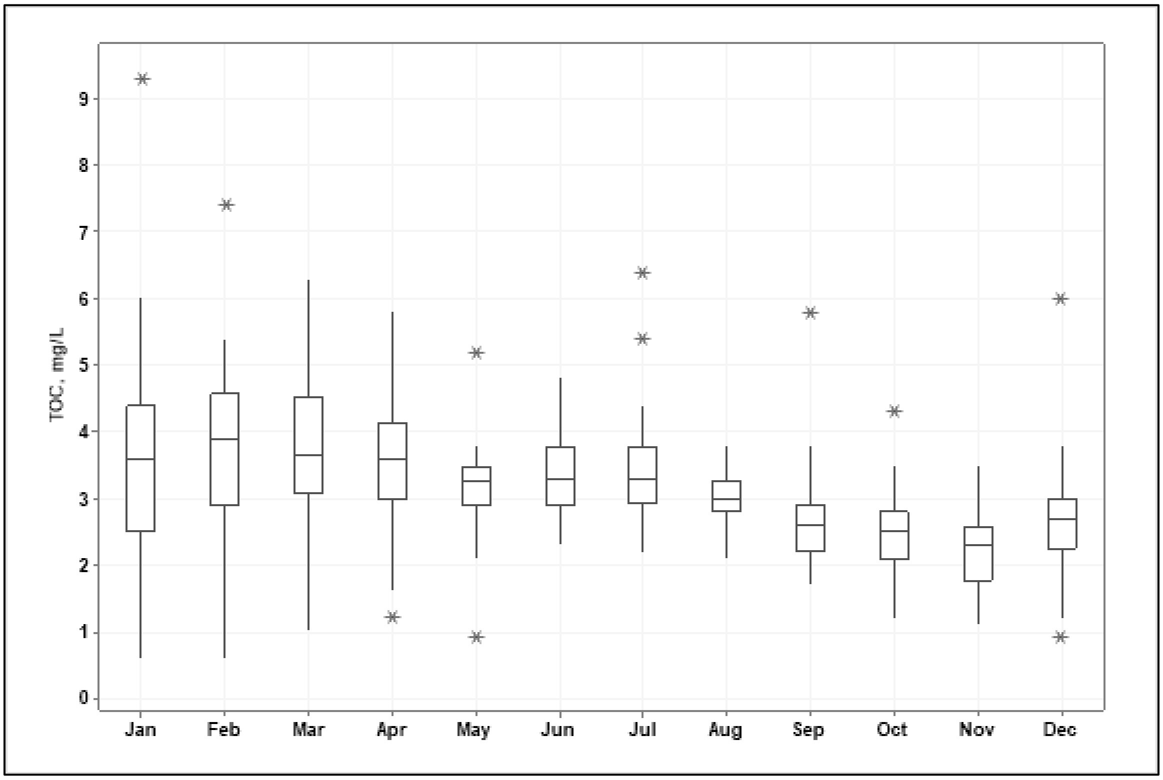


Figure 3-50. Monthly Variability in TOC at Check 41, 1997 to 2020



Castaic Outlet – Castaic Lake is the terminus of the West Branch of the California Aqueduct. Metropolitan Water District of Southern California (MWDSC) and Castaic Lake Water Agency treat water from the lake. Castaic Lake is immediately downstream of Pyramid Lake. The two lakes provide a combined 0.5 million acre-feet of storage. **Figure 3-51** presents all available DWR data for Castaic Outlet. The samples are collected at a depth of 1 meter in the epilimnion (surface layer) of the lake. TOC concentrations range from 1.6 mg/L to 7.7 mg/L with a median of 2.9 mg/L. MWDSC withdraws water from the hypolimnion (bottom layer) of Castaic Lake and treats it at the Jensen WTP. MWDSC data, collected in the influent of the Jensen WTP, are compared to DWR data collected at Castaic Outlet in **Figure 3-52**. TOC concentrations in the Jensen WTP influent range from 1.6 to 4.4 mg/L with a median of 2.7 mg/L. Peak concentrations in the influent of the Jensen WTP are considerably lower than at Castaic Outlet. The largest differences occur during the summer months, indicating that the higher concentrations in the epilimnion at Castaic Outlet are likely due to algal biomass.

- Spatial Trends – The median concentration of 2.9 mg/L at Castaic Outlet is statistically significantly different from the median concentration of 3.0 mg/L at Check 41 during the 1998 to 2020 period (Mann-Whitney, p=0.043). This may be due to the dampening effects of storage in the lake or to inflows from the local watershed.

- Long-Term Trends –**Figure 3-51** shows that the TOC has increased since 2015, with most data ranging from 3 to 4 mg/L, and never less than 2.5 mg/L

- Wet Year/Dry Year Comparison – The Castaic Outlet dry year median concentration of 2.8 mg/L is statistically significantly lower than the wet year median concentration of 3.0 mg/L (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 3-53** shows a different seasonal trend at Castaic Outlet than at the aqueduct locations. The highest concentrations of TOC occur in the summer months and the lowest concentrations occur in the winter months. Since the DWR samples are collected in the epilimnion, the higher concentrations in the summer months are likely due to algal biomass.

Figure 3-51. TOC Concentrations in the Epilimnion at Castaic Outlet

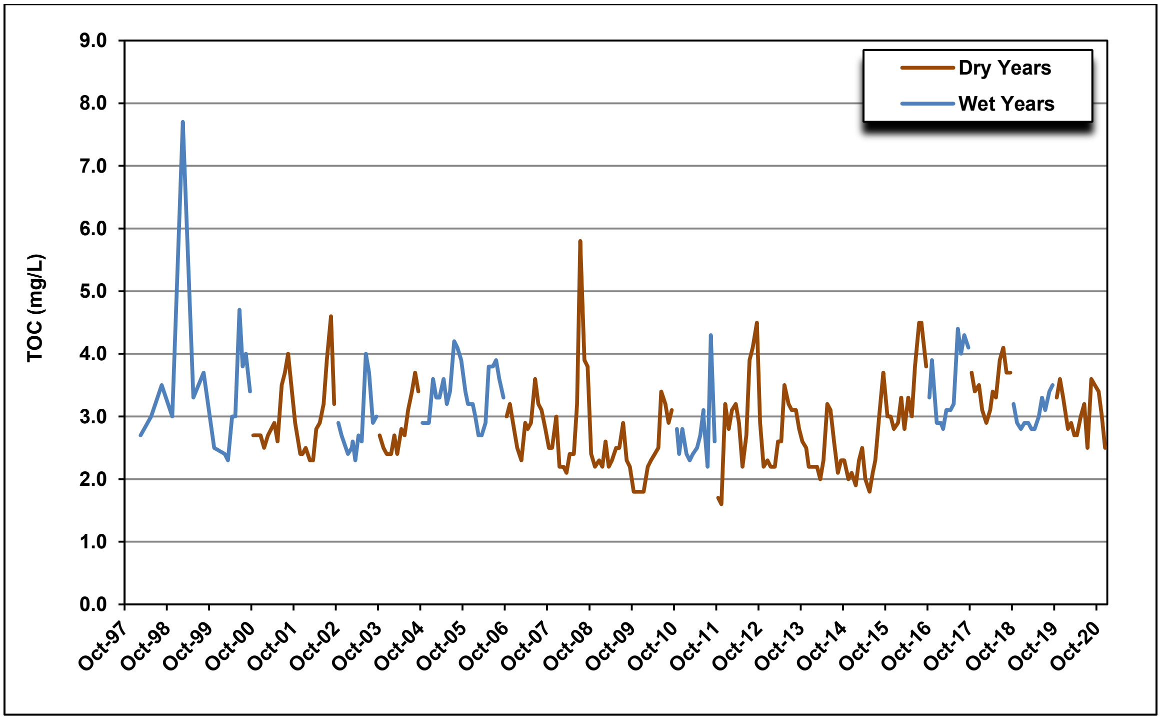


Figure 3-52. TOC Concentrations in Jensen WTP Influent and Castaic Outlet

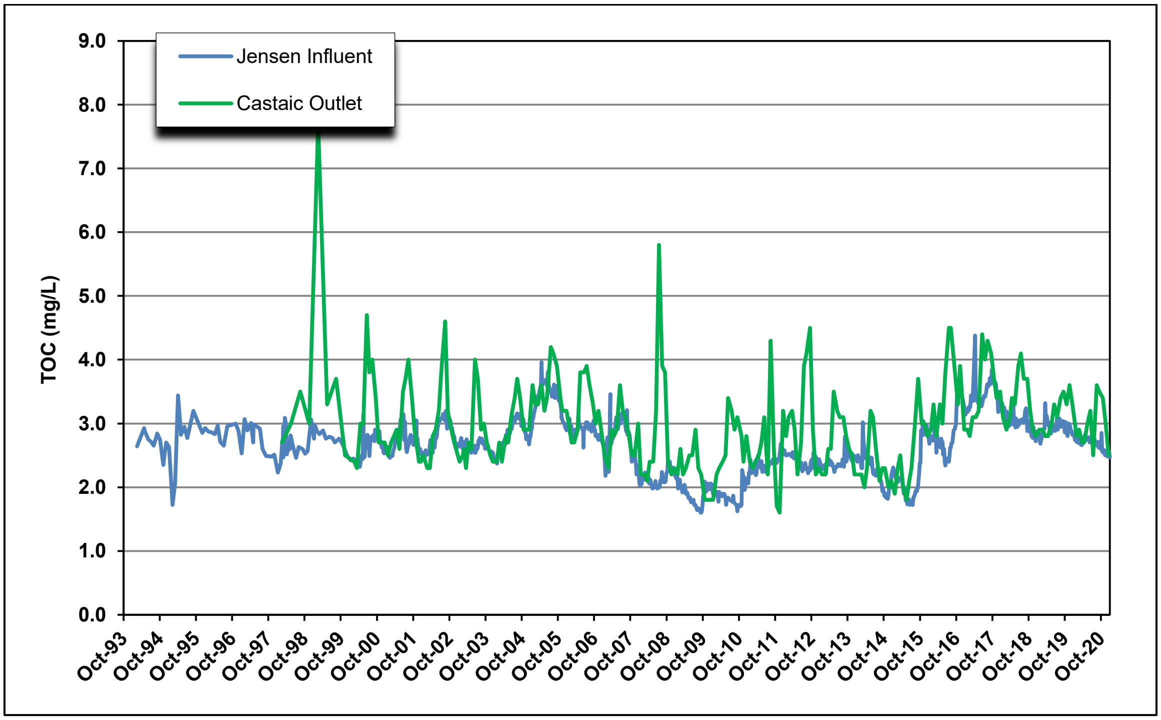
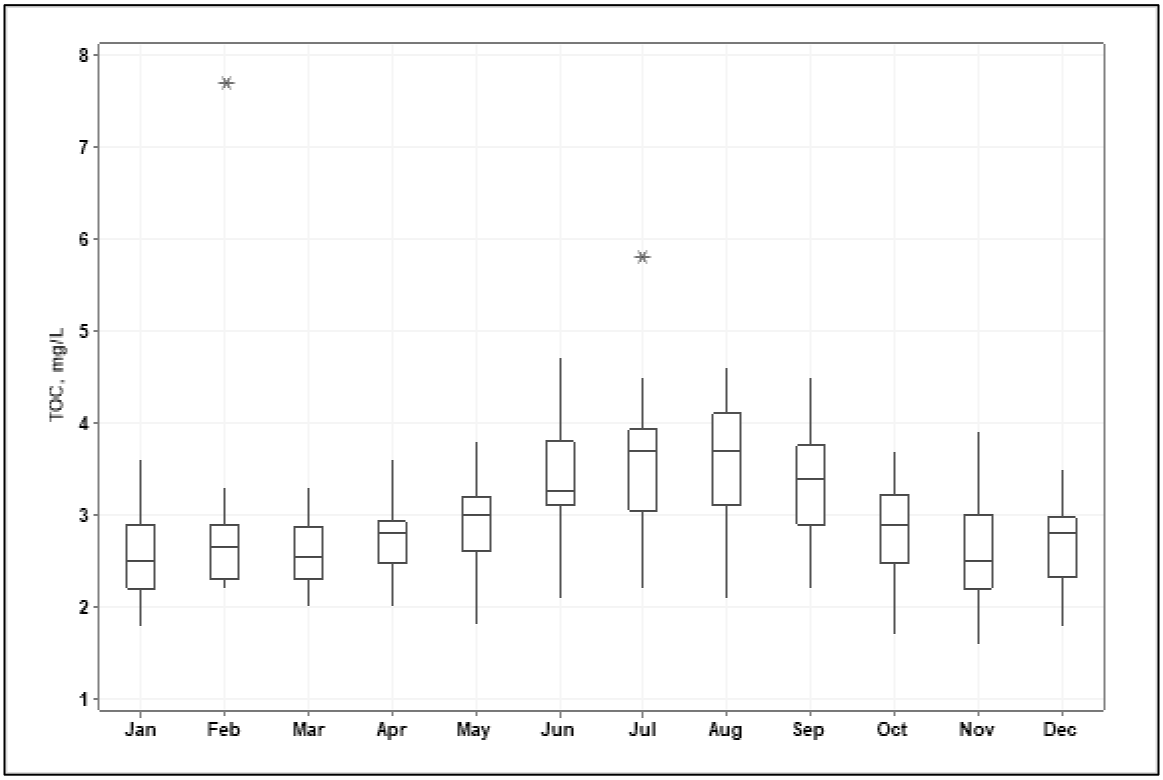


Figure 3-53. Monthly Variability in TOC at Castaic Outlet, 1998 to 2020



Devil Canyon – Silverwood Lake provides water to MWDSC, CLAWA, and San Bernardino Valley Municipal Water District. CLAWA takes water directly from Silverwood Lake and MWDSC and San Bernardino Valley Municipal Water District take water from Devil Canyon Afterbay. Water samples are collected from Devil Canyon Afterbay, which is immediately downstream of Silverwood Lake on the East Branch of the California Aqueduct. Silverwood Lake, with a capacity of 74,970 acre-feet, is small in comparison to the West Branch reservoirs. **Figure 3-54** presents all available data for Devil Canyon. Data were collected at Devil Canyon Afterbay from 1997 to 2001 and from Devil Canyon Headworks from 2001 to 2010. Samples were then changed to Devil Canyon Second Afterbay in April 2011. The data from three locations were combined in **Figure 3-54**. TOC concentrations range from 1.8 mg/L to 8.6 mg/L with a median of 3.1 mg/L.

- Spatial Trends – The median concentration of 3.1 mg/L at Devil Canyon is not statistically significantly different from the median concentration of 3.0 mg/L at Check 41 during the 1998 to 2020 period that data have been collected at both locations. Since the capacity of Silverwood Lake is small in comparison to the West Branch reservoirs, the dampening effect seen in the West Branch is not seen in the East Branch.

- Long-Term Trends – Visual inspection of **Figure 3-54** does not show a discernible trend in TOC concentrations.

- Wet Year/Dry Year Comparison – The Devil Canyon wet year median concentration of 3.1 mg/L is not statistically significantly higher than the dry year median concentration of 3.1 mg/L.

- Seasonal Trends – **Figure 3-55** shows the same seasonal trend at Devil Canyon that is seen at Check 41. The highest concentrations of TOC occur in March and the lowest concentrations occur in November.

Figure 3-54. TOC Concentrations at Devil Canyon

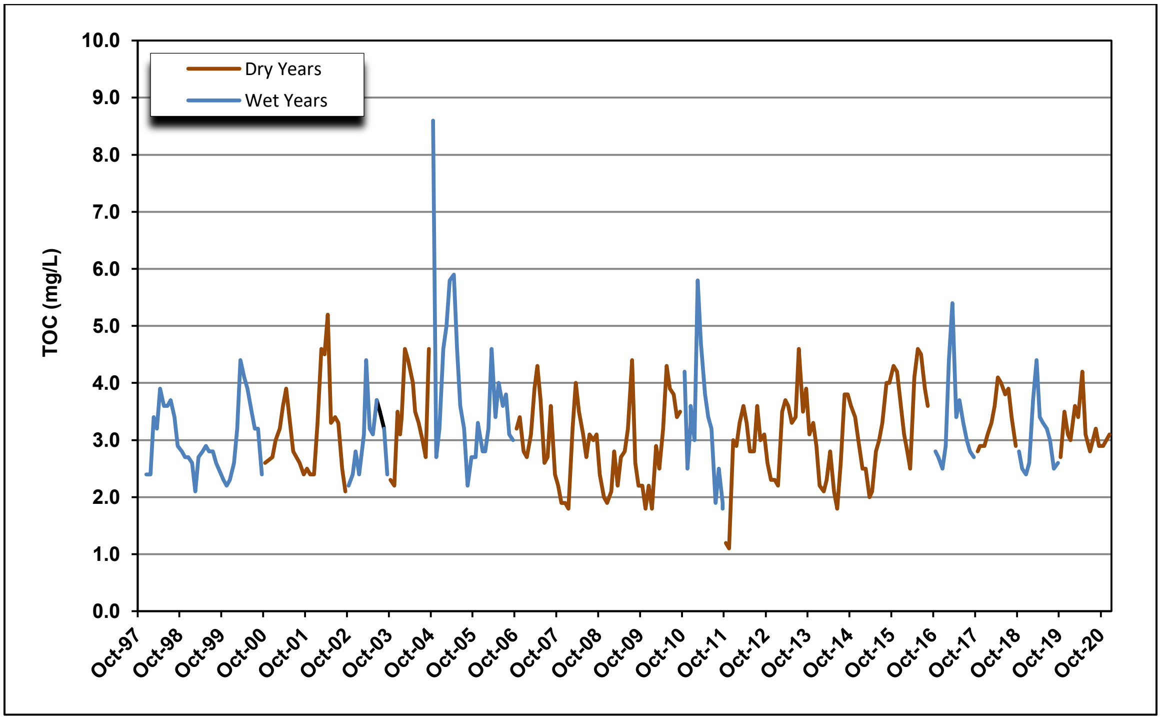
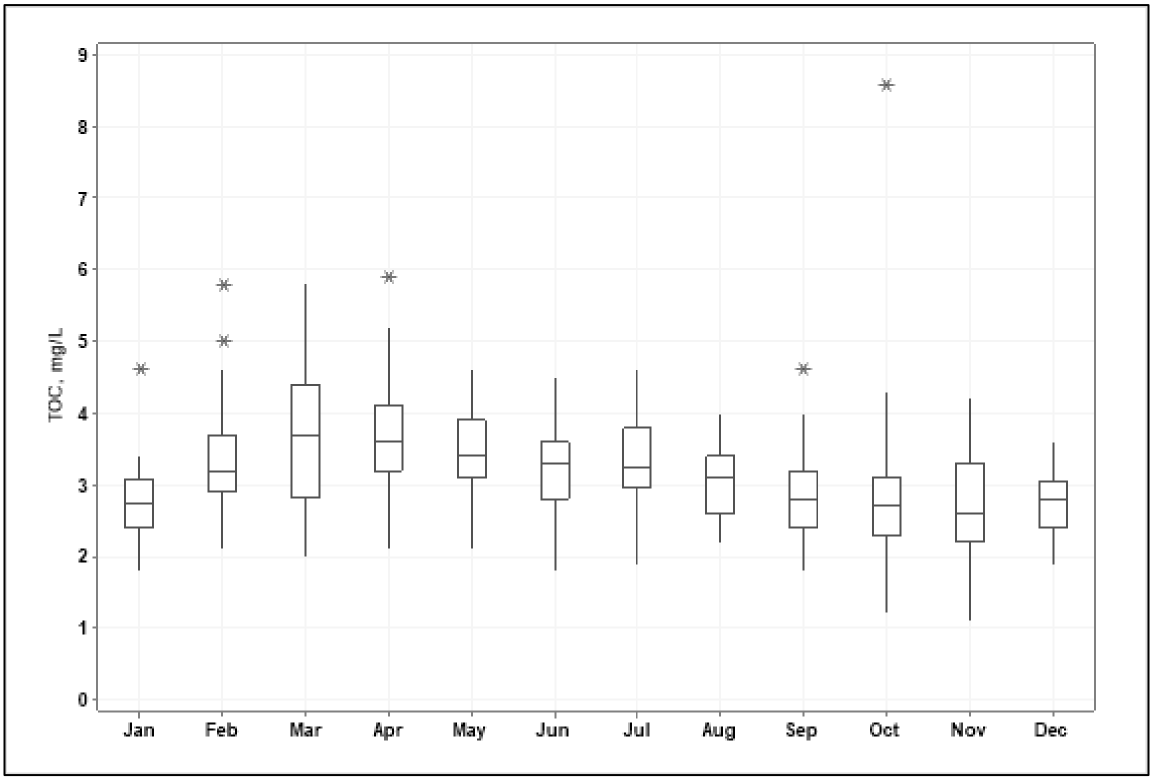


Figure 3-55. Monthly Variability in TOC at Devil Canyon, 1997 to 2020



SUMMARY

- The DOC fingerprints indicate that the San Joaquin River is the primary source of DOC at the south Delta pumping plants when flows on that river are high. During dry years, the Sacramento River has more influence on DOC concentrations at the pumping plants. Delta agricultural drainage is also a source of DOC at the pumping plants.

- The median TOC concentration of 1.9 mg/L is the same at Hood and West Sacramento. This is despite the fact that the high quality American River (median of 1.6 mg/L) enters the Sacramento River between these two locations. This is likely due to the fact that urban runoff and treated wastewater from the Sacramento urban area are discharged to the river between West Sacramento and Hood. The median TOC concentration of 3.3 mg/L at Vernalis is statistically significantly higher than the median concentration of 1.9 mg/L at Hood.

- TOC concentrations are much higher in the NBA than any other location in the SWP. The concentrations range from 1.3 to 43 mg/L, with a median of 4.6 mg/L. The local Barker Slough watershed is the source of this TOC.

- TOC concentrations do not change as water leaves Banks and flows through the SBA and the California Aqueduct. The concentrations at DV Check 7 range from 1.5 to 9.2 mg/L during the period of record with a median of 3.5 mg/L.

  The median TOC concentrations along the aqueduct from Check 13 to Check 41 range from 3.0 to 3.3 mg/L. Generally, San Luis Reservoir and Castaic Lake have less variability in TOC concentrations than the aqueduct due to the dampening effect of reservoir mixing. TOC concentrations at Check 21 and Check 41 are generally similar when there are no non-Project water pump-ins between the two locations. However, TOC decreases from Check 21 to Check 41 when high volumes of non-Project water are pumped into the Aqueduct between the two locations.

- Water agencies treating SWP water in conventional water treatment plants must remove TOC from their influent water based on the TOC and alkalinity concentrations of the source water. Agencies treating NBA water typically remove 35 percent of the TOC and at times, are required to remove up to 50 percent of the TOC.

- Based on the average TOC and alkalinity concentrations at DV Check 7, the water agencies treating SBA water must remove 35 percent of the TOC. When the source water alkalinity is 60 mg/L or less, and the source water TOC is greater than 4 mg/L (but less than 8 mg/L), 45 percent TOC removal must be achieved. Over the 60 months from January 2016 to December 2020, this occurred in five months (January to March 2017, April 2018 and June 2018).

- Based on the average TOC and alkalinity concentration at Check 13, the downstream water agencies treating SWP water in conventional water treatment plants must remove 25 percent of the TOC. In January and February 2017, alkalinity concentrations dropped below 60 mg/L when TOC concentrations exceeded 4.0 mg/L leading to the requirement to remove 45 percent of the TOC in the source water.

- The real-time analyzers at Hood, Vernalis, Banks, and Gianelli provide valuable information on the variability of TOC concentrations at these locations. The real-time monitoring data compare well with the grab sample data collected on the same day, with R squared values ranging from 0.7636 to 0.8995.

- Time series graphs at all of the other key locations were visually inspected to determine if there are any discernible trends. There are no apparent long term trends at most of the locations included in this analysis. There was an increasing trend from 2012 to 2015 for most sites, but that increasing trend was halted due to the wet year of 2017.

- Over the past 10 years, there were a number of locations where the maximum TOC occurred in either 2014, 2015 or 2016 as a result of consecutive years of dry water years since 2012. For example:
  - Hood maximum TOC concentration of 9.1 mg/L was measured in December 2014.
  - Vernalis maximum TOC concentration of 14.1 mg/L was measured in December 2016.
  - DV Check 7 maximum TOC concentration of 7.6 mg/L was measured in April 2016.
  - Pacheco maximum TOC concentration of 5.9 mg/L was measured in September 2015.
  - McCabe maximum TOC concentration of 7.8 mg/L was measured in March 2014.
  - Gianelli maximum TOC concentration of 8.4 mg/L was measured in March 2016.

- As shown in **Table 3-3**, dry year concentrations are statistically significantly higher than wet year concentrations at Hood, Vernalis, Banks, DV Check 7, McCabe, Gianelli, Check 13, and Check 21. There is no significant difference in wet and dry years at Pacheco and Devil Canyon. Wet year concentrations are statistically significantly higher than dry year concentrations at Check 41 and Castaic Outlet.

- There is a distinct seasonal pattern in TOC concentrations in the Sacramento River, the Delta, and the aqueducts. High concentrations (5 to 9 mg/L) occur during the wet season and low concentrations (2 to 3 mg/L) occur in the summer through fall months. Lower TOC concentrations in summer through fall are likely due to the operation of the Delta Cross Canal, which is open from June 16 to November 30, providing higher quality water from the Sacramento River. Vernalis has a slightly different pattern with both winter and summer peaks. The summer peak is attributed to agricultural drainage entering the river during low flow periods. Castaic Lake displays a different seasonal pattern. Concentrations are highest in the summer months and lowest in the winter months.

Table 3-3. Comparison of Dry Year and Wet Year TOC Concentrations

	Median TOC, mg/L				
Location	**Dry Years**	**Wet Years**	**TOC Difference (mg/L)**	**Percent Difference**	**Statistical Significance**
Hood	2.1	1.8	0.3	14%	D>W
Vernalis	3.4	3.2	0.2	6%	D>W
Banks	3.8	3.15	0.65	17%	D>W
Barker Slough	4.3	5.9	-1.6	-37%	D<W
DV Check 7	3.7	3.25	0.45	12%	D>W
McCabe	3.4	3.2	0.2	6%	D>W
Pacheco	3.5	3.5	0	0%	No
Gianelli	4.2	3.3	0.9	26%	D>W
Check 13	3.4	3.2	0.2	6%	D>W
Check 21	3.3	3.1	0.2	7%	D>W
Check 41	3.0	3.1	-0.1	-4%	D<W
Castaic Outlet	2.8	3.0	-0.2	-7%	D<W
Devil Canyon	3.0	3.2	-0.2	-7%	No

REFERENCES

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CHAPTER 4 SALINITY

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CHAPTER 4 SALINITY

WATER QUALITY CONCERN

Salinity of water is caused by dissolved anions (sulfate, chloride, bicarbonate) and cations (calcium, magnesium, sodium, and potassium). Salinity is measured as total dissolved solids (TDS) and electrical conductivity (EC). High levels of TDS in drinking water can cause a salty taste, and become aesthetically objectionable to consumers. The U.S. Environmental Protection Agency (USEPA) and the State Water Resources Control Board's Division of Drinking Water (DDW) have established secondary Maximum Contaminant Levels (SMCLs) for TDS and a number of other constituents that affect the aesthetic acceptability of drinking water. The federal standards are unenforceable guidelines, but the California standards are enforceable, and are based on the concern that aesthetically unpleasant water may lead consumers to unsafe sources. The California secondary MCLs related to salinity are listed in **Table 4-1**. . SMCLs are ranges set by the State Water Resources Control Board for taste and odor thresholds. Conventional water treatment adds chemicals and slightly increases salinity. Therefore, the concentration of dissolved minerals in the source water is a significant factor determining the palatability of the treated drinking water.

Table 4-1. California Secondary Maximum Contaminant Levels

Constituent	Maximum Contaminant Level Ranges		
	Recommended	Upper	Short Term
TDS (mg/L)	500	1,000	1,500
EC (µS/cm)	900	1,600	2,200
Chloride (mg/L)	250	500	600
Sulfate (mg/L)	250	500	600

High TDS in drinking water supplied to consumers can have economic impacts, in that mineralized water can shorten the life of plumbing fixtures and appliances, and create unsightly mineral deposits on fixtures and outdoor structures. An important economic effect can be the reduced ability to recycle water or recharge groundwater high in dissolved solids. For example, the Santa Ana Regional Water Quality Control Board implemented a Watershed Management Initiative that has salt management as a main component. In that area, it is not permissible to discharge recycled water or recharge groundwater if TDS concentrations exceed established limits. The trend has been toward increasingly stringent limits.

The Sacramento and San Joaquin rivers contain salts from natural sources, urban discharges, and agricultural discharges. As the water from the rivers flows through the Sacramento-San Joaquin Delta (Delta), salinity intrusion from the Pacific Ocean and agricultural and urban discharges in the Delta contribute additional salt. The Delta is connected to the Pacific Ocean through San Pablo Bay and San Francisco Bay. Freshwater outflow from the watersheds of the Delta repels seawater and maintains the Delta as a freshwater source. Because the flows of freshwater vary with hydrologic conditions and releases from upstream reservoirs, there is variation in how much seawater intrudes into the Delta. Therefore, the salinity levels in Delta waters are also impacted by hydrologic conditions and releases from upstream reservoirs, and are generally inversely related to the amount of freshwater outflow from the Delta.

WATER QUALITY EVALUATION

EC FINGERPRINTS

The Department of Water Resources (DWR) uses the fingerprinting method to identify the sources of EC at Clifton Court Forebay (Clifton Court) and the C.W. "Bill" Jones Pumping Plant (Jones). The EC fingerprints from January 2016 to December 2020 period are shown in **Figures 4-1 and 4-2.**

Figure 4-1 shows that the primary sources of EC at Clifton Court are seawater intrusion, Delta agricultural drainage, and the San Joaquin and Sacramento rivers. During the late summer and fall months, seawater intrusion contributes 300 to 600 µS/cm at Clifton Court. During wet years when seawater intrusion is reduced, the San Joaquin River and Delta agricultural drainage are the primary sources, as shown in the fall of 2017 and fall of 2019. **Figure 4-2** shows the San Joaquin River and seawater intrusions are the primary sources of EC at Jones. The San Joaquin River has a greater influence on EC at Jones than at Clifton Court.

Figure 4-1. Modeled EC Fingerprint at Clifton Court

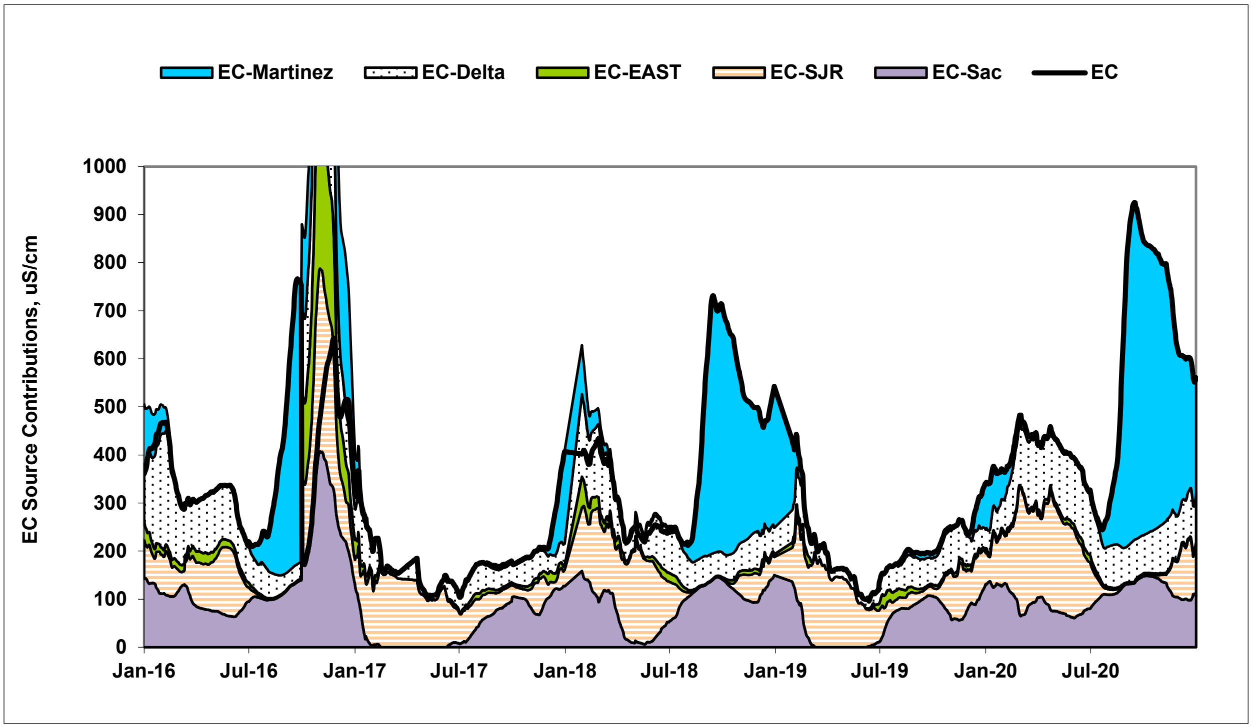
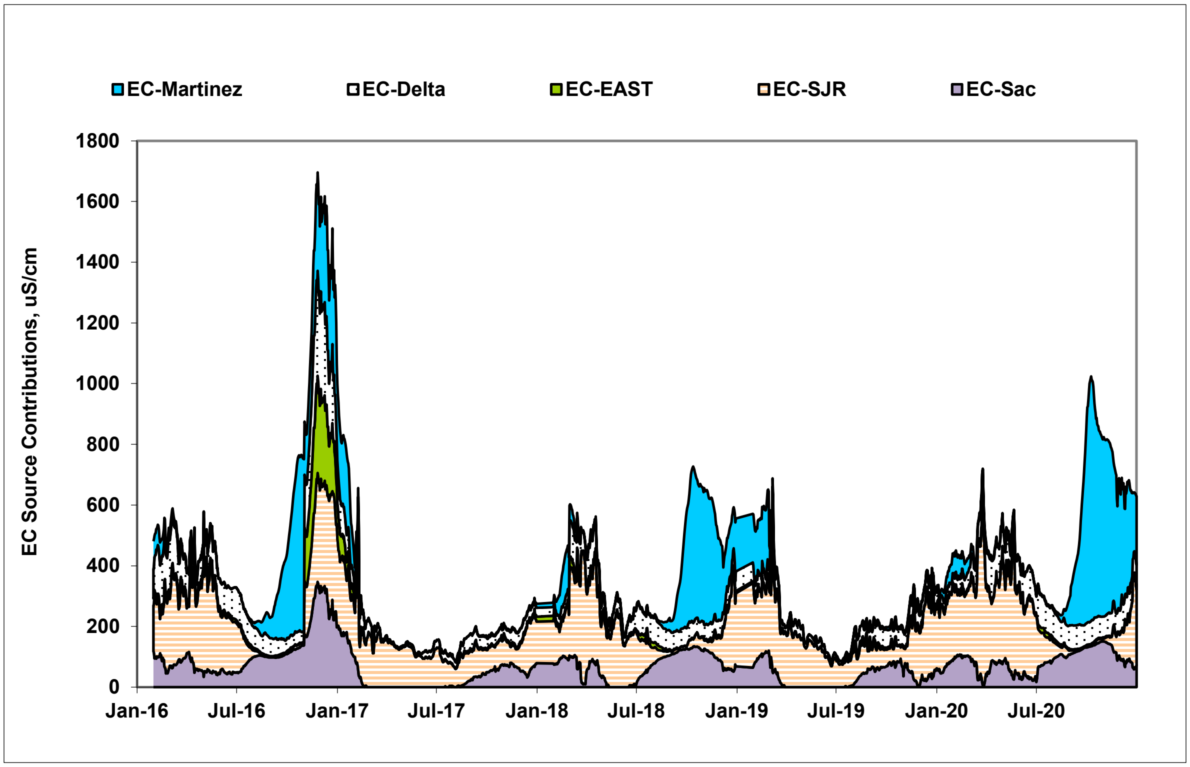


Figure 4-2. Modeled EC Fingerprint at Jones



EC LEVELS IN THE SWP

EC data are analyzed in this chapter to examine changes in salinity as the water travels through the SWP system and to determine if there are seasonal or temporal trends. All available EC data from DWR's Municipal Water Quality Investigations (MWQI) Program and the Division of Operations and Maintenance (O&M) State Water Project (SWP) monitoring program through December 2020 were obtained for a number of locations along the SWP. Both grab samples and continuous recorder data are included in this analysis. Data are presented in summary form for all locations and analyzed in more detail for a number of key locations. Box plots are also used to show data from multiple locations on one plot and to display seasonal differences at one location. **Figure 2-25** presents an explanation of the box plots. **Table 4-2** presents a summary of the period of record for data included in this analysis.

The recent study period of 2016 through 2020 represented a combination of three dry and two wet years in California, with 2016 classified as below normal, 2017 classified as wet, 2018 classified as below normal, 2019 classified as wet, and 2020 classified as dry. Generally, the new EC data included in this extended assessment represent more dry periods. There were few changes to the statistics and trends for the wet period, but there were decreases in EC throughout the system subsequent to the end of the extended dry period.

The California Department of Water Resources adopts five water year types: wet, above normal, below normal, dry, and critical. The classification is based on a water year index that is derived from full natural flow measurements. For the Sacramento River region, the water year index is called the Sacramento Valley Index (SVI) (also known as the "4 River Index" and the "40-30-30 Index") and uses the sum of calculated monthly unimpaired runoff from the following gauges: Sacramento River above Bend Bridge, Feather River at Oroville, Yuba River at Smartsville, and American River below Folsom Dam. The SVI is calculated based on the following equation:

SVI = (0.4 X current April-July runoff) + (0.3 X current October-March runoff) + (0.3 X previous year's index)

The current April-July runoff is for the sum of the runoff for the four rivers in the current water year from April to July, in million acre-feet. If the previous year's index exceeds 10 MAF, then 10 MAF is applied instead. Once the SVI is calculated, the year type classification is based on the thresholds in **Table 2-2.**

Table 4-2. EC Data

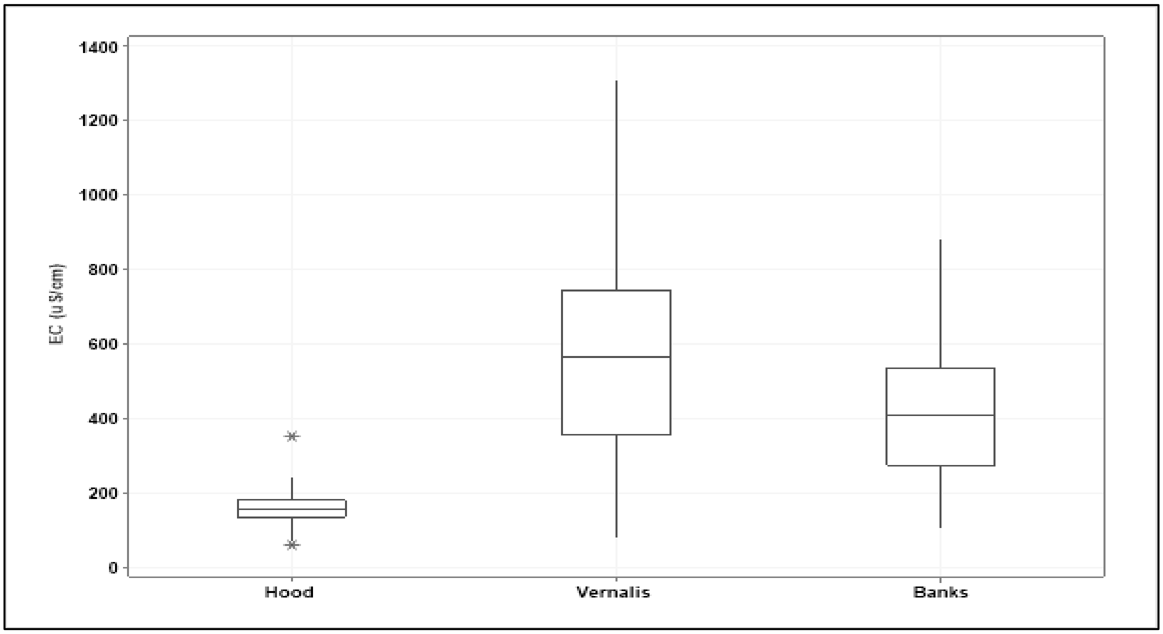
Location	Grab Samples		Real-time	
	Start Date	End Date	Start Date	End Date
Hood	Aug 1997	Nov 2020	Jan 2004	Dec 2020
Vernalis	Mar 1982	Nov 2020	Aug 1999	Dec 2020
Banks	Mar 1982	Dec 2020	Jan 1986	Dec 2020
Barker Slough	Sep 1988	Dec 2020	Feb 1989	Dec 2020
DV Check 7	Dec 1997	Dec 2020	Jun 1994	Dec 2020
McCabe	Dec 1997	Dec 2020		
Pacheco	Mar 2000	Dec 2020	Jul 1989	Dec 2020
Gianelli	Aug 2013	Dec 2020	Jan 2016	Dec 2020
O'Neill Forebay Outlet	Jul 1988	Dec 2020	Jan 1990	Dec 2020
Check 21	Dec 1997	Dec 2020	Jun 1990	Dec 2020
Check 41	Dec 1997	Nov 2020	Jun 1993	Nov 2019
Castaic Outlet	Feb 1998	Dec 2020	Jan 2000	Dec 2020
Devil Canyon Second Afterbay*	Dec 1997	Dec 2020	Feb 2006	Dec 2020

*Note: Data were collected from Dec 1997 to May 2001 at Devil Canyon Afterbay, then at Devil Canyon Headworks from June 2001 to December 2010, and then at Devil Canyon Second Afterbay in early 2011. These datasets have been combined.

The SWP Watershed

Figure 4-3 presents the EC data for the tributaries to the Delta and for Harvey O. Banks Delta Pumping Plant (Banks). EC levels are considerably lower in the Sacramento River (Hood) than the San Joaquin River at Vernalis (Vernalis).

Figure 4-3. EC Levels in the SWP Watershed, 1997 to 2020



Hood – **Figure 4-4** shows all available grab sample EC data at Hood. The levels range from 59 to 352 µS/cm during the period of record with a median of 156 µS/cm.

- Comparison of Real-time and Grab Sample Data – **Figure 4-5** compares the real-time data with the grab sample data at Hood over time. Average daily EC, calculated from hourly measurements, was downloaded from the California Data Exchange Center (CDEC) for this analysis. There is a good correspondence between the two data sets when samples collected on the same day are compared. The real-time data show that peak levels are nearly equal to those measured in grab samples. **Figure 4-6** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-6** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.97 which is acceptable.

- Spatial Trends – No analysis was conducted upstream of Hood on the Sacramento River.

- Long-Term Trends – Visual inspection of **Figure 4-4** does not show any discernible long-term trends. The increasing EC trend from 2012 to 2016 is due to five consecutive dry years, rather than a long-term pattern.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are differences between wet years and dry years. The median concentration during wet years of 142 µS/cm is statistically significantly lower than the median during dry years of 165 µS/cm (Mann-Whitney, p=0.0000). **Figure 4-7** shows the influence of flows on EC levels during different year types. Water year 2006 was a wet year with flows reaching 90,000 cubic feet per second (cfs) on the Sacramento River at Freeport (a few miles upstream of Hood). EC levels dropped as flows increased. Similarly, water year 2011 was a wet year with flows reaching 80,000 cfs, and EC levels dropped. Water year 2007 was a dry year and 2008 was a critical year. Peak flows during those two years reached 40,000 cfs and dry season flows dropped to less than 10,000 cfs. Water years 2012 to 2016 were also either below normal, dry or critical. 2017 and 2019 were wet years with peak flows over 80,000 cfs, while 2018 was below normal and 2020 was dry with low flows below 10,000 cfs. During the drier years, EC levels gradually increased. During low flow periods, the treated wastewater, urban runoff, and agricultural discharges to the river have a greater influence than during the high flow periods.

- Seasonal Trends – **Figure 4-8** presents the grab sample monthly data for the entire period of record. This figure indicates that the EC levels decline during the spring months and levels are lowest in July. During the late spring and early summer months, snow melt results in higher flows with low EC levels. The EC levels rise during the late summer and fall months when flows on the river are low.

Figure 4-4. EC Levels at Hood

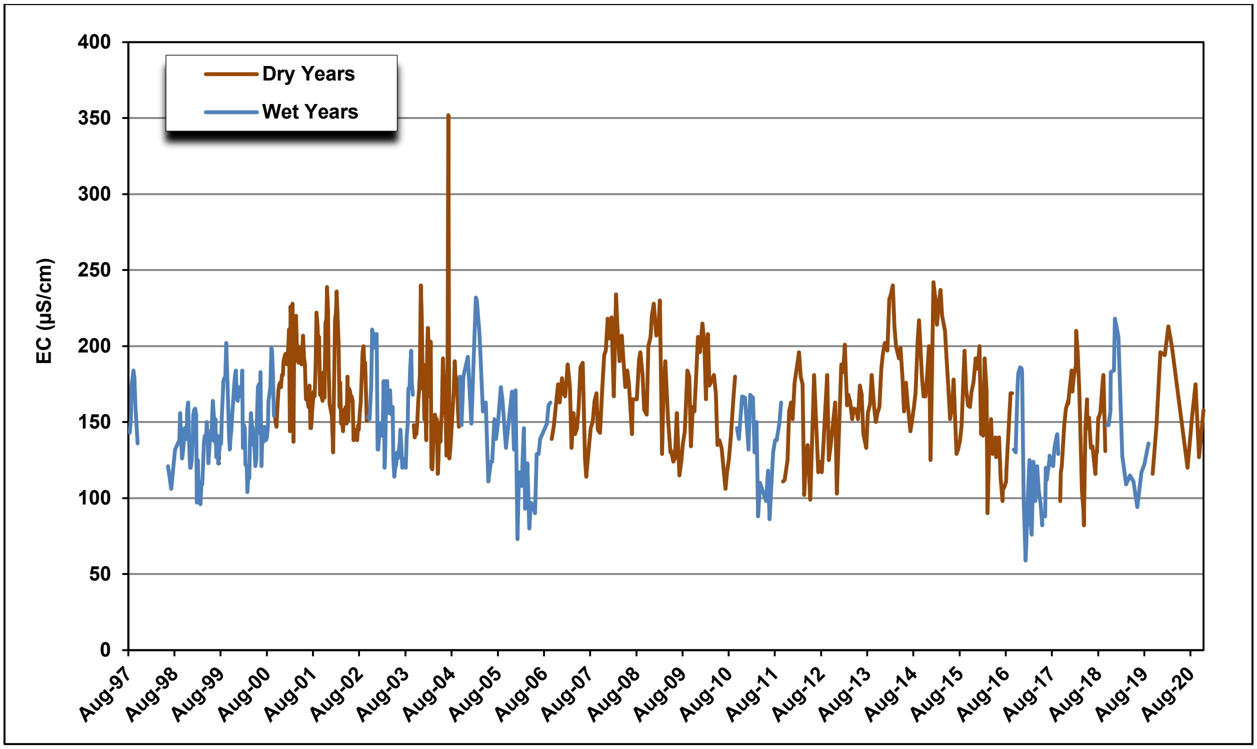


Figure 4-5. Comparison of Hood Real-time and Grab Sample EC Data Over Time

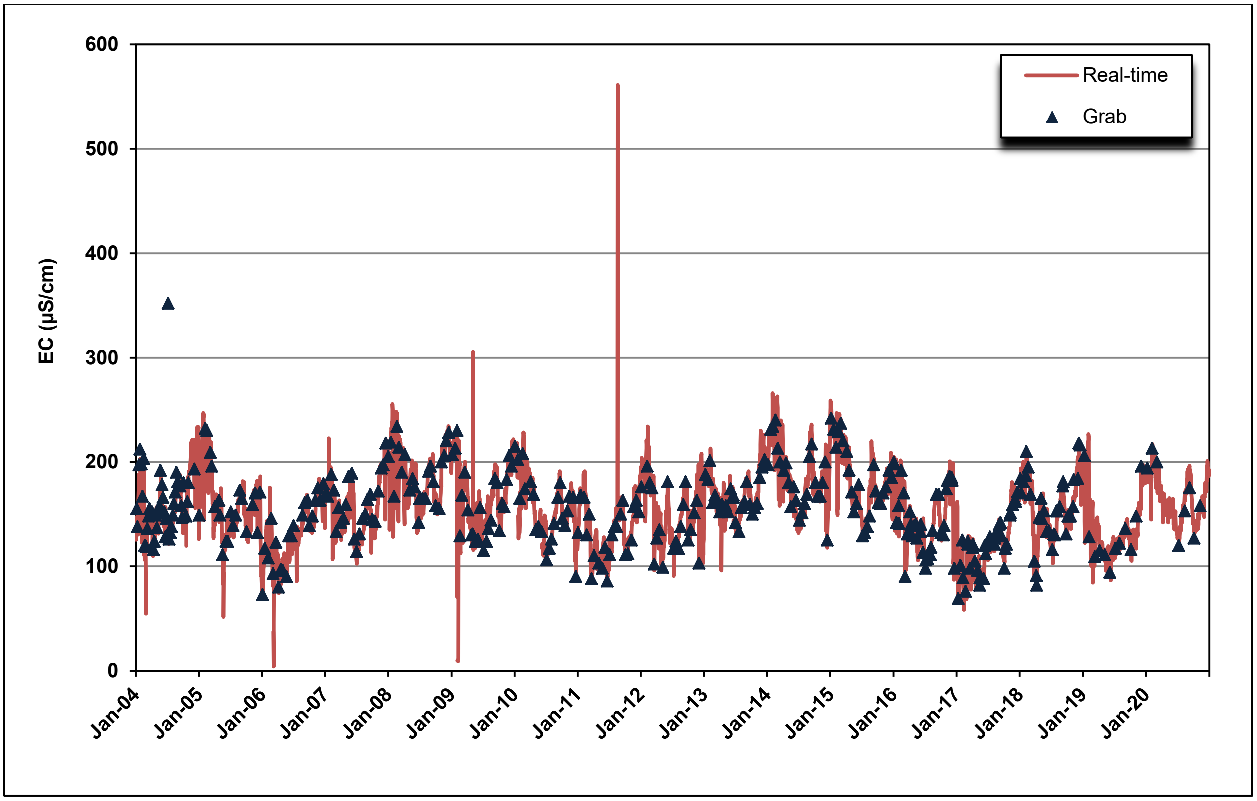


Figure 4-6. Comparison of Hood Real-time and Grab Sample EC Data, 1:1 Graph, 2011 to 2020

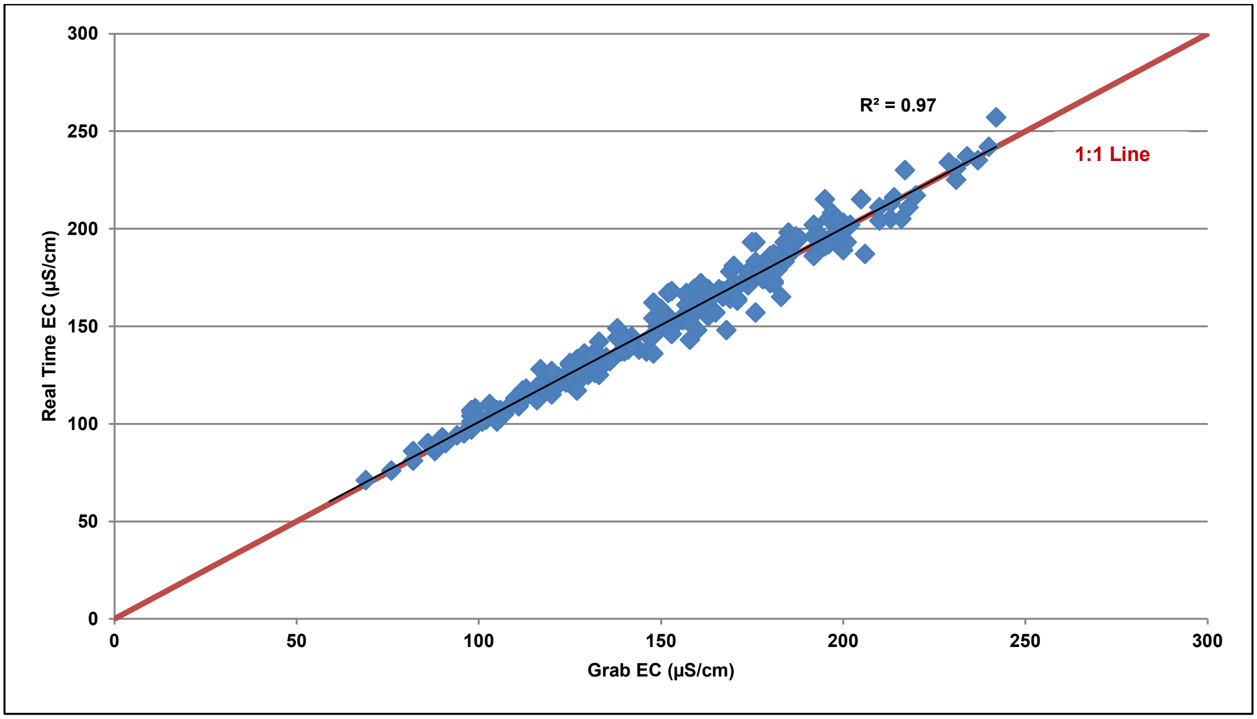


Figure 4-7. Relationship Between EC and Flow at Hood

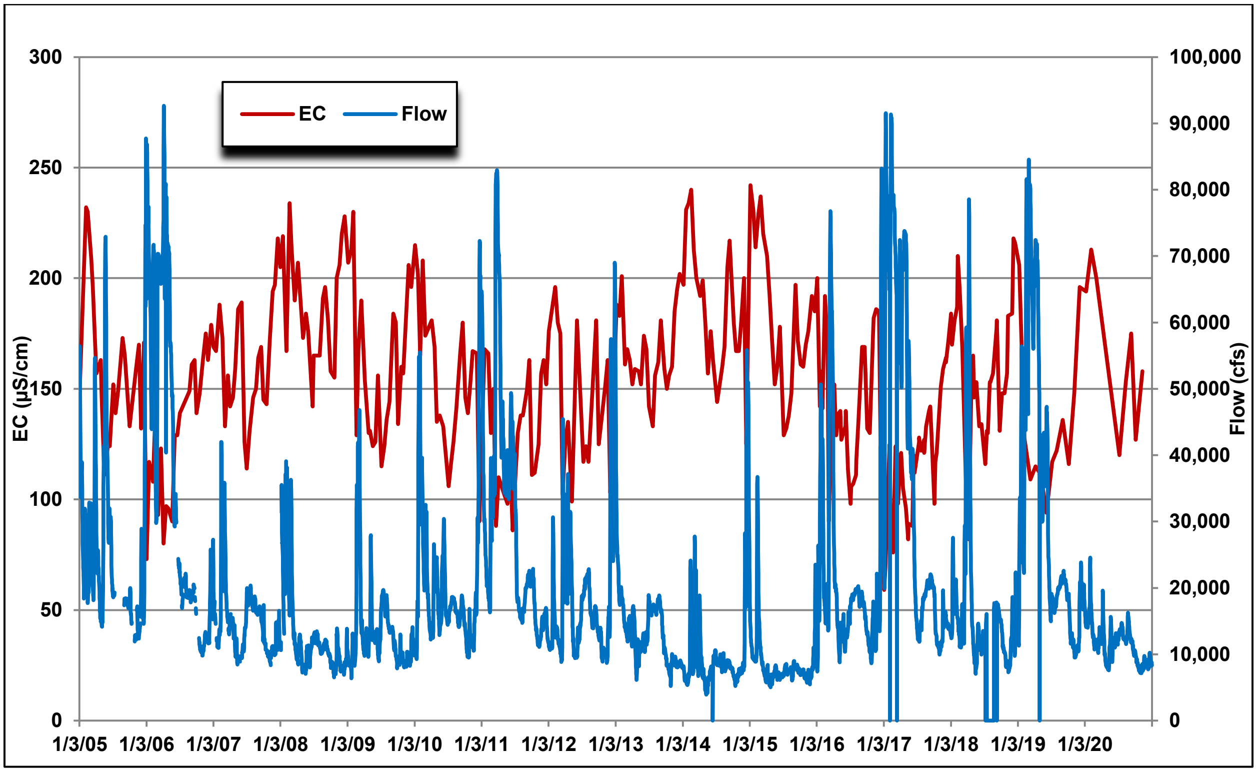
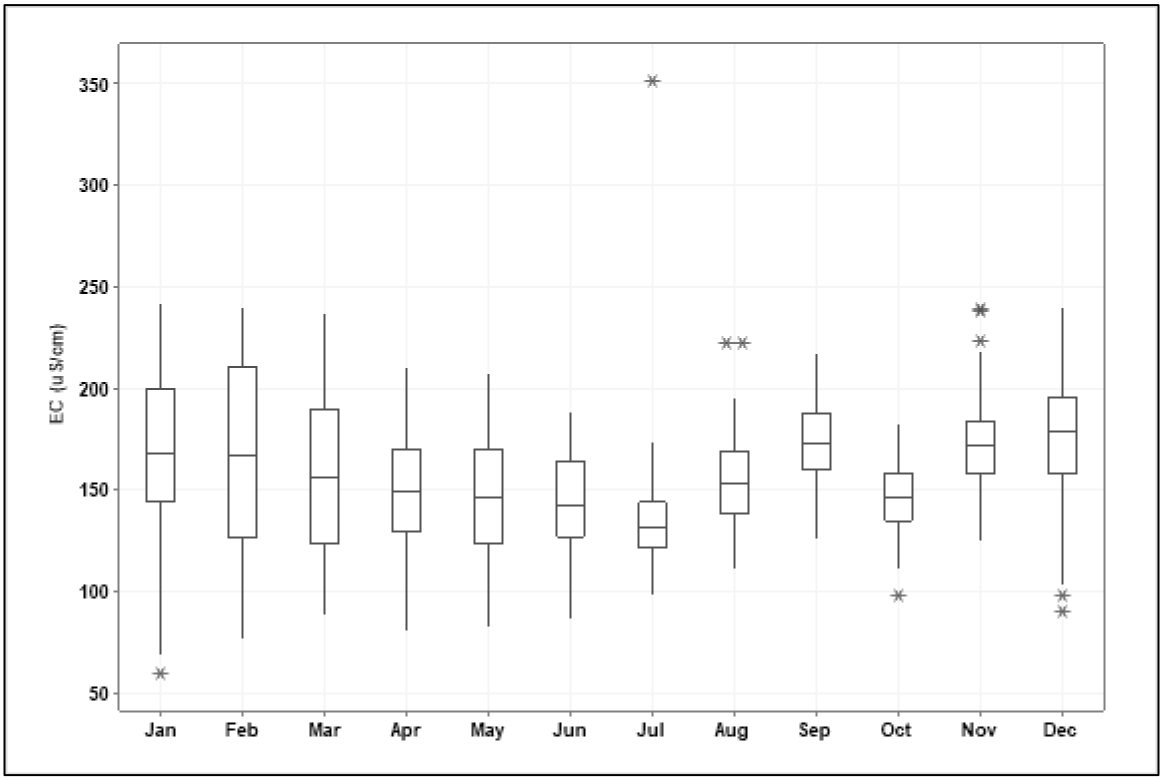


Figure 4-8. Monthly Variability in EC at Hood, 1997 to 2020



Vernalis – **Figure 4-9** shows all available grab sample EC data at Vernalis. The levels range over an order of magnitude from 76 to 1,550 µS/cm during the period of record with a median of 609 µS/cm.

- Comparison of Real-time and Grab Sample Data – **Figure 4-10** compares the real-time data with the grab sample data at Vernalis over time. Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. There is generally a good correspondence between the two data sets when samples collected on the same day are compared. **Figure 4-11** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-11** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.9913 which is acceptable.

- Spatial Trends – DWR does not collect data upstream of Vernalis on the San Joaquin River.

- Long-Term Trends – Visual inspection of **Figure 4-9** does not show any discernible long-term trend but does indicate that the hydrology of the system affects EC at Vernalis. EC levels clearly increase during dry periods and decrease during wet periods.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median concentration during wet years of 392 µS/cm is statistically significantly lower than the median during dry years of 698 µS/cm (Mann-Whitney, *p*=0.0000). **Figure 4-12** shows the influence of flows on EC levels during different year types. From 2005 to 2020, all years were either below normal, dry, or critical, except for 2005, 2006, 2011, 2017, and 2019 which were wet. Water year 2006 was a wet year with flows reaching almost 35,000 cfs on the San Joaquin River at Vernalis. EC levels dropped to 118 µS/cm as flows increased. Water year 2011 was a wet year with flows reaching 27,000 cfs and EC levels dropping to 145 µS/cm. Water year 2017 was a banner water year in the San Joaquin River basin, with flows over 40,000 cfs in February 2017, which corresponded to the lowest recorded EC levels at Vernalis later in the spring, less than 100 µS/cm. Relatively small increases in flow produce large drops in EC as shown in the spring of 2008, 2009, 2010, 2012, 2013, 2014 and 2015. This is due to the influence of the high quality eastern mountain tributaries of the San Joaquin River.

- Seasonal Trends – **Figure 4-13** presents the grab sample monthly data for the entire period of record. **Figure 4-13** indicates that the lowest EC concentrations occur during April and May when flows on the San Joaquin River are high due to the Vernalis flow requirements stipulated in Decision 1641 (D-1641). D-1641 includes "spring flow" requirements that apply from February 1 through April 14 and May 16 through June 30, as well as higher spring "pulse" flows that apply from April 15 to May 15. These flow requirements set a minimum monthly average flow rate, based on the water year type. Flows are increased on the San Joaquin River by releasing water from reservoirs on the Merced, Stanislaus, and Tuolumne rivers. Combined exports at the Banks and Jones pumping plants are reduced to 1,500 cfs. These actions that are taken to improve salmon smolt survival also improve water quality. The EC levels rise during the summer and fall months when flows on the river are low and agricultural drainage is discharged to the river. The high EC levels generally persist until late winter when there is sufficient rain to increase flows in the river.

Figure 4-9. EC Levels at Vernalis

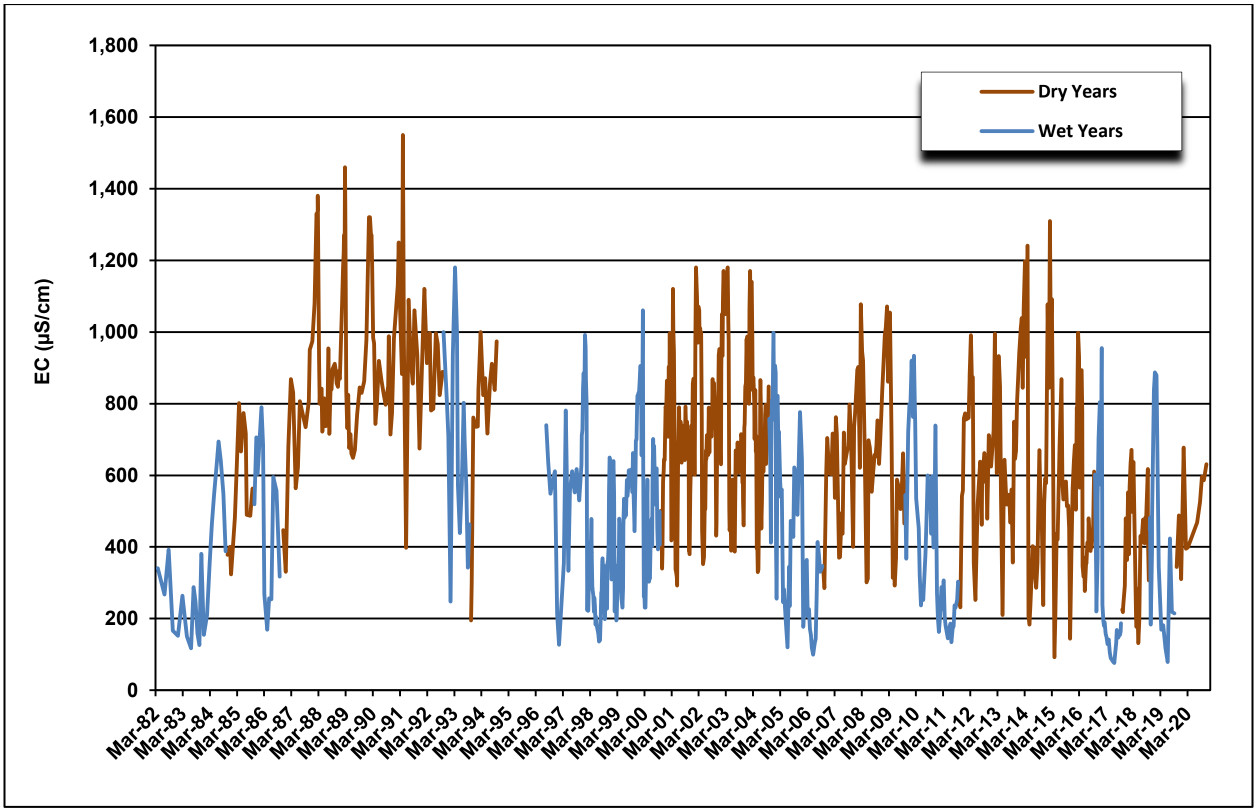


Figure 4-10. Comparison of Vernalis Real-time and Grab Sample EC Data Over Time

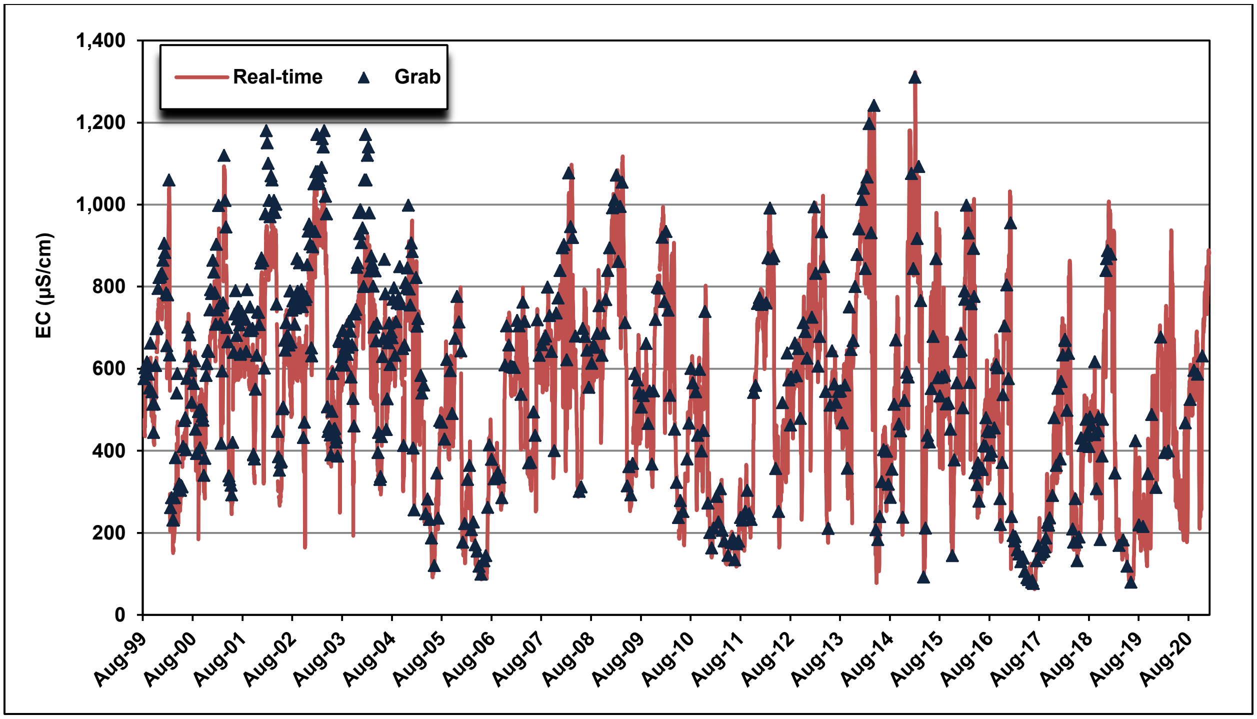


Figure 4-11. Comparison of Vernalis Real-time and Grab Sample EC Data, 1:1 Graph, 2011 to 2020

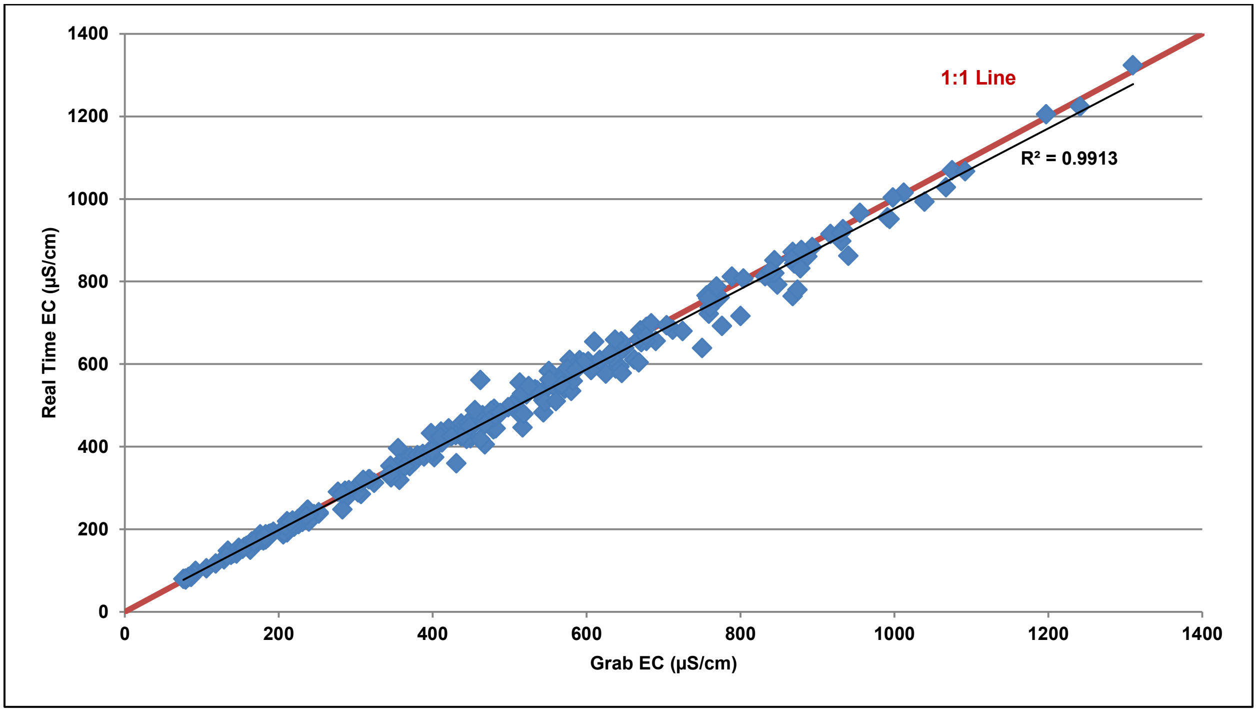


Figure 4-12. Relationship Between EC and Flow at Vernalis

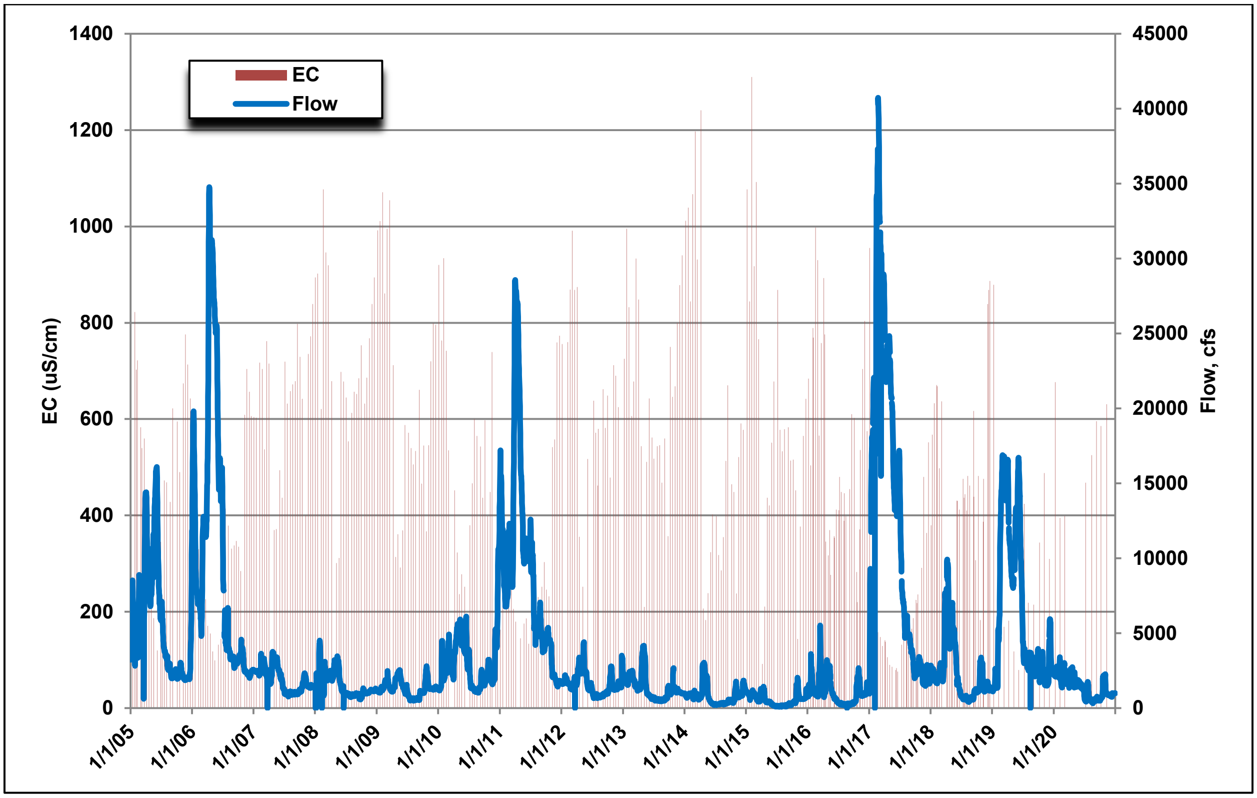
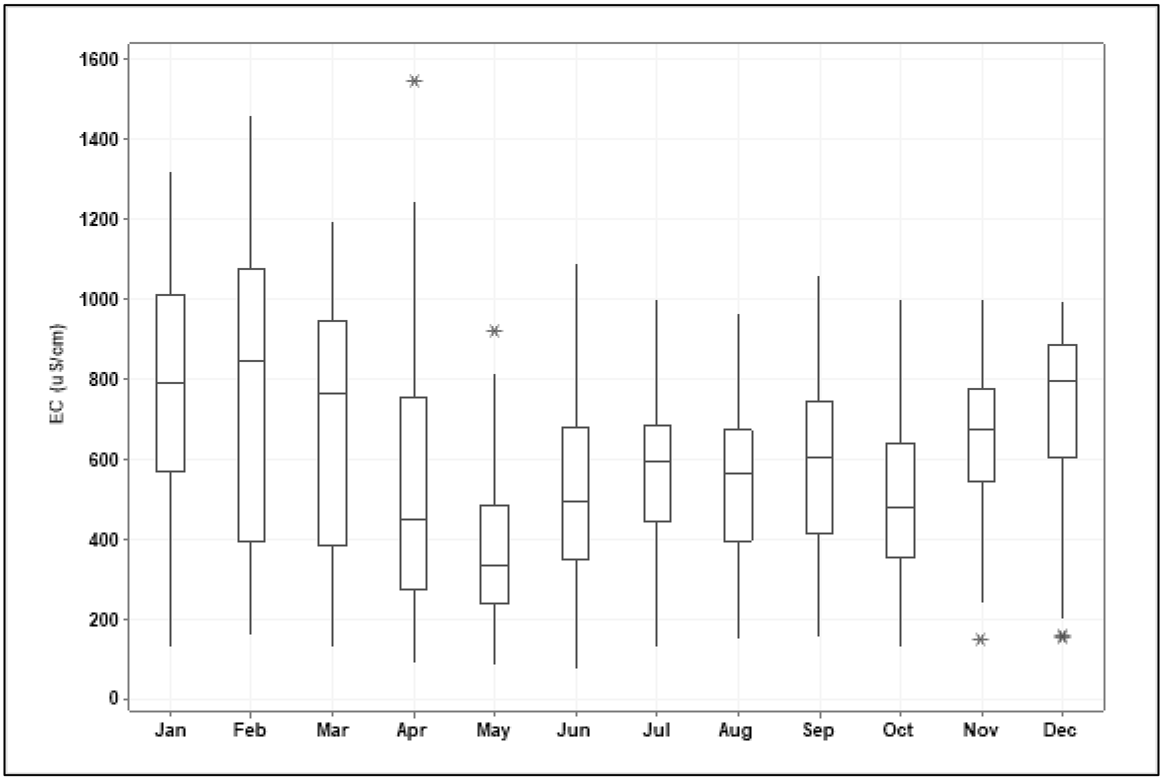


Figure 4-13. Monthly Variability in EC at Vernalis, 1982 to 2020



Banks – As shown in **Figure 4-1**, the sources of EC at Clifton Court and Banks are the Sacramento and San Joaquin rivers, seawater intrusion, and Delta agricultural drainage. **Figure 4-14** shows all available grab sample EC data at Banks. The levels range from 106 to 883 µS/cm during the period of record with a median of 432 µS/cm.

- Comparison of Real-time and Grab Sample Data – **Figure 4-15** compares the real-time data with the grab sample data at Banks over time. Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. There is generally a good correspondence between the two data sets when samples collected on the same day are compared. **Figure 4-16** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-16** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.9898 which is acceptable.

- Spatial Trends – Sacramento River water is degraded as it flows through the Delta by discharges from Delta islands and mixing with the San Joaquin River. All available data from Hood, Vernalis, and Banks are presented in **Figure 4-3**. When comparing the same period of record (August 1997 to November 2020) at all sites, it shows that the median EC at Banks (410 µS/cm) is statistically significantly higher than the median of 156 µS/cm at Hood and statistically significantly lower than the median of 566 µS/cm at Vernalis (Mann-Whitney, p=0.0000).

- Long-Term Trends – DWR conducted an assessment of long-term salinity trends at Banks using data from 1970 to 2002 and concluded that the salinity in SWP exports has neither increased nor decreased over that period (DWR, 2004). Visual inspection of **Figure 4-15** indicates that EC trends are a function of hydrology. The increasing EC trend from 2012 to 2016 is due to five consecutive dry years in the Sacramento Valley, rather than a long-term pattern. The extremely wet 2017 water year decreased EC significantly, with increases following in the dry 2018 and 2020 water years.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median concentration during wet years of 293 µS/cm is statistically significantly lower than the median during dry years of 486 µS/cm (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – **Figure 4-18** presents the grab sample monthly data for the entire period of record. This figure indicates that the EC levels decline during the spring and early summer months when flows on the rivers are high. The lowest EC levels at Banks are in July. EC generally increases from August to December due to low river flows, agricultural drainage from the San Joaquin Valley and the Delta, and seawater intrusion. The seasonal pattern at Banks is similar to the pattern at Hood.

Figure 4-14. EC Levels at Banks

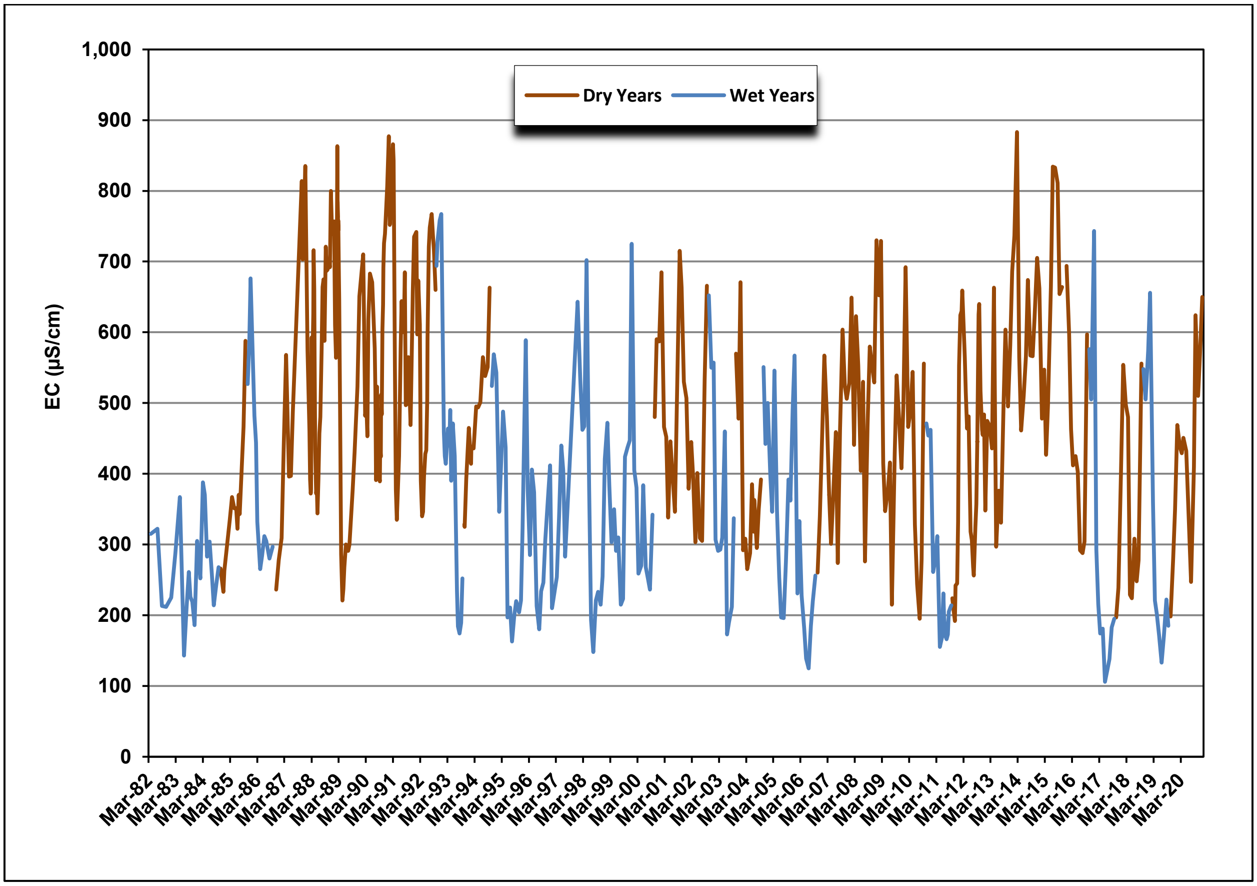


Figure 4-15. Comparison of Banks Real-time and Grab Sample EC Data Over Time

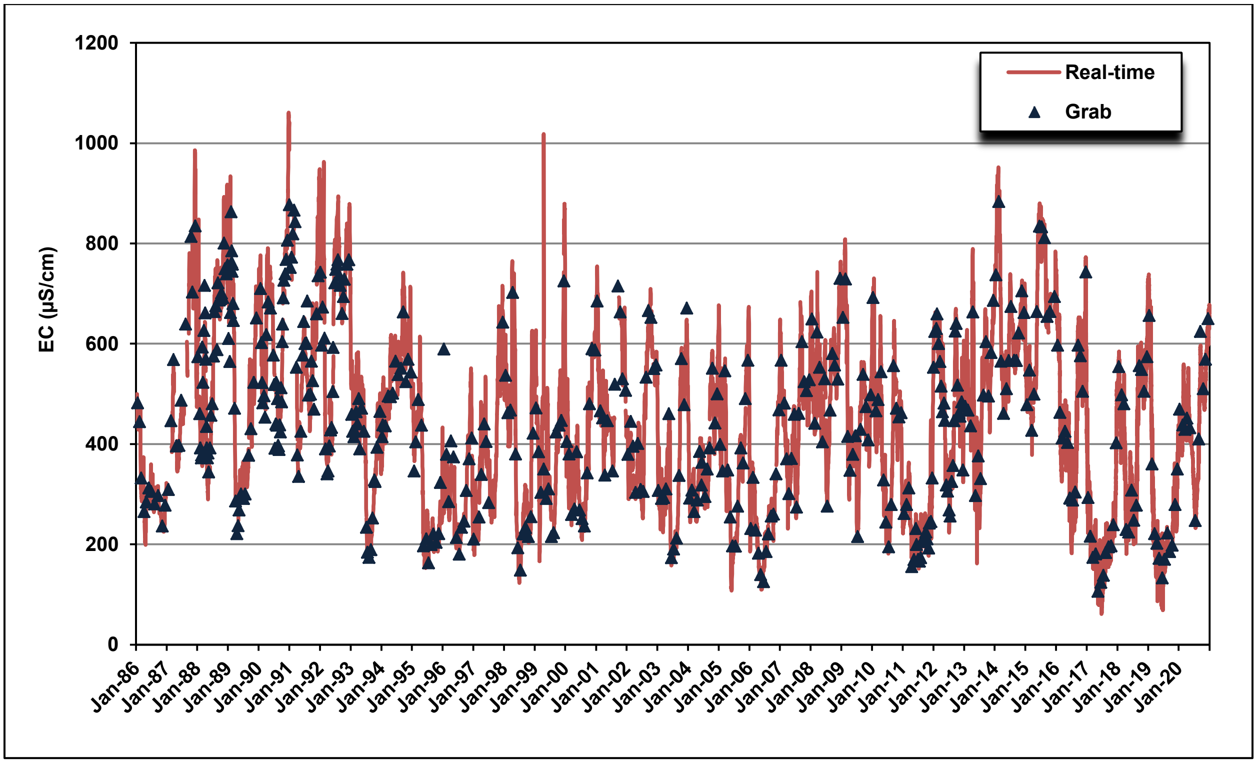


Figure 4-16. Comparison of Banks Real-time and Grab Sample EC Data, 1:1 Graph, 2011 to 2020

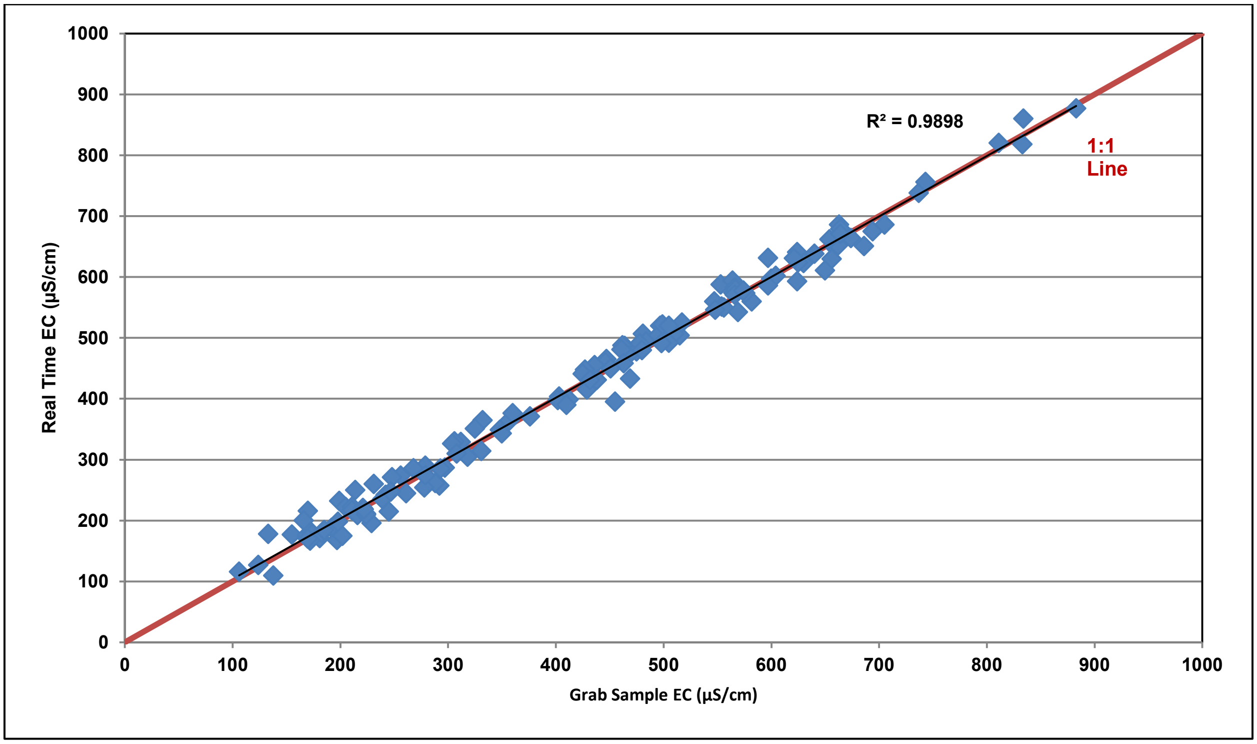
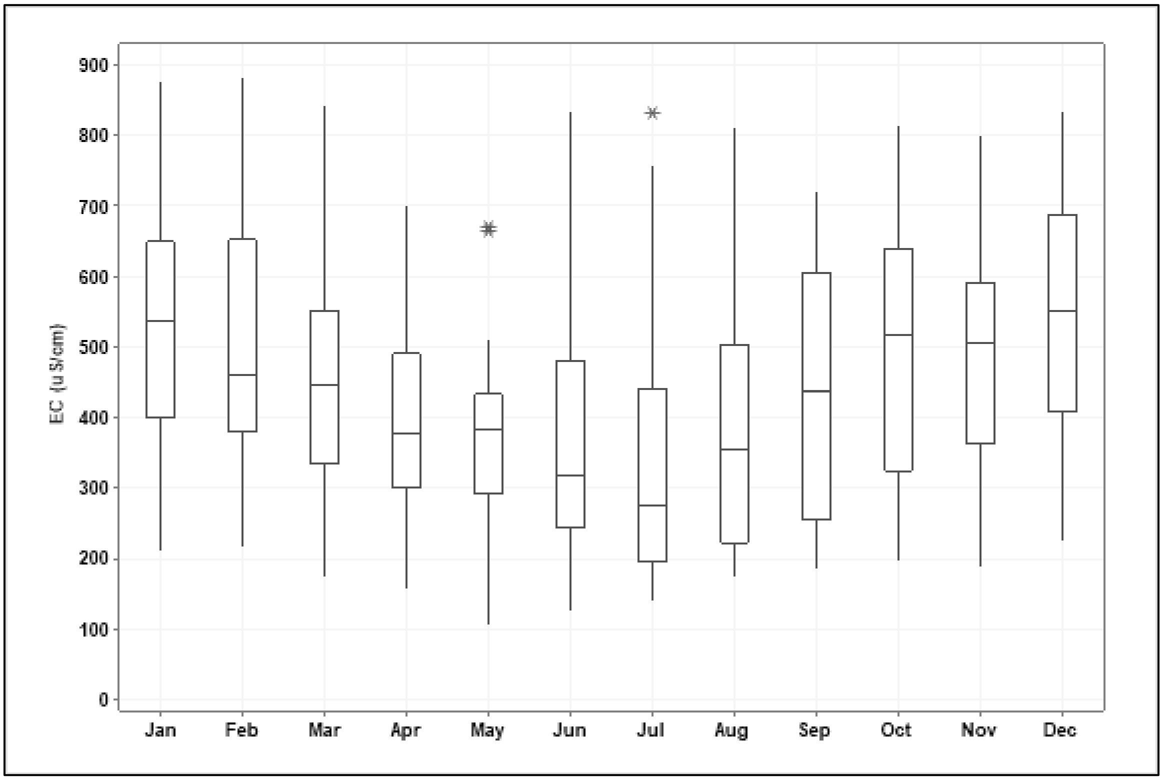


Figure 4-17. Monthly Variability in EC at Banks, 1982 to 2020



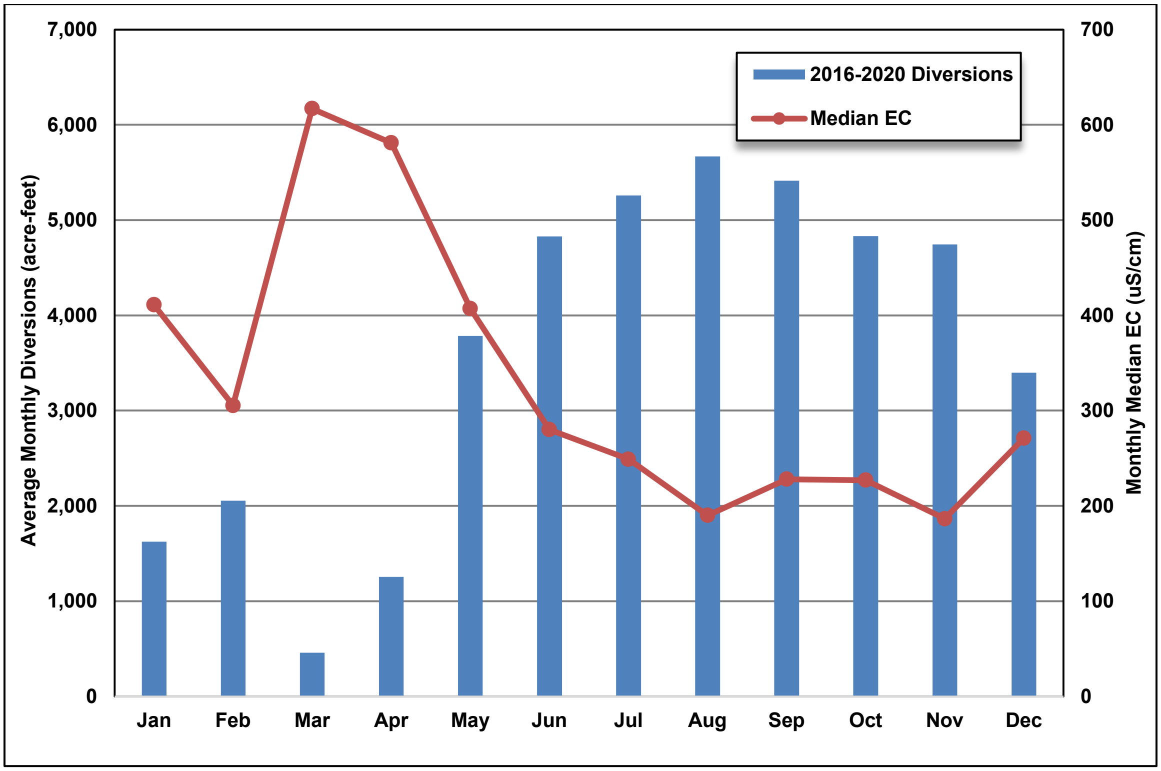
North Bay Aqueduct

Chapter 2 contains a description of the North Bay Aqueduct (NBA). The sources of water are the local Barker Slough watershed and the Sacramento River.

Project Operations

After the water is diverted from Barker Slough, the quality of water delivered to NBA users should not be affected by any other factors since the NBA is an enclosed pipeline. **Figure 4-18** shows average monthly diversions at Barker Slough for the 2016 to 2020 period and median monthly EC levels. This figure shows that pumping is highest between May and December. The median EC is 407 µS/cm during May but it declines to less than 300 µS/cm during the summer and fall months. In general, there is an inverse relationship with the lowest EC levels occurring when pumping is high. The higher pumping rates in late spring and summer pull fresher (i.e. low EC) water in from Cache Slough and the Sacramento River. During the rainy season, Barker Slough can experience elevated levels of EC primarily due to base flows and the sodic soils in the upstream Barker Slough watershed. Many of the NBA users switch to alternative supplies during the winter and spring months when EC levels are highest.

Figure 4-18. Average Monthly Barker Slough Diversions and Median EC Levels, 2016 to 2020



EC Levels in the NBA

Real-time and grab sample EC data are collected for the NBA at Barker Slough. **Figure 4-19** shows all available grab sample EC data at Barker Slough. The levels range from 104 to 826 µS/cm during the period of record with a median of 289 µS/cm.

- Comparison of Real-time and Grab Sample Data – **Figure 4-20** compares the real-time data with the grab sample data at Barker Slough over time. Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. There is generally a good correspondence between the two data sets when samples collected on the same day are compared. The real-time data suggest that there are greater fluctuations in EC than are captured by the grab samples. **Figure 4-21** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-21** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.9429 which is acceptable.

- Spatial Trends – No analysis was conducted upstream of Barker Slough on the NBA.

- Long-Term Trends – There is not a discernible long-term trend at Barker Slough based on visual inspection of **Figure 4-19.** There were notable peaks during the 2017 and 2019 wet water years.

- Wet Year/Dry Year Comparison – The Barker Slough grab sample data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median concentration during wet years of 292 µS/cm is not statistically significantly higher than the median during dry years of 286 µS/cm (Mann-Whitney, *p*=0.812).

- Seasonal Trends – **Figure 4-22** presents the grab sample monthly data for the entire period of record. This figure indicates that the EC levels are lowest in the late summer and early fall months and then increase from late fall to early spring.

Figure 4-19. EC Levels at Barker Slough

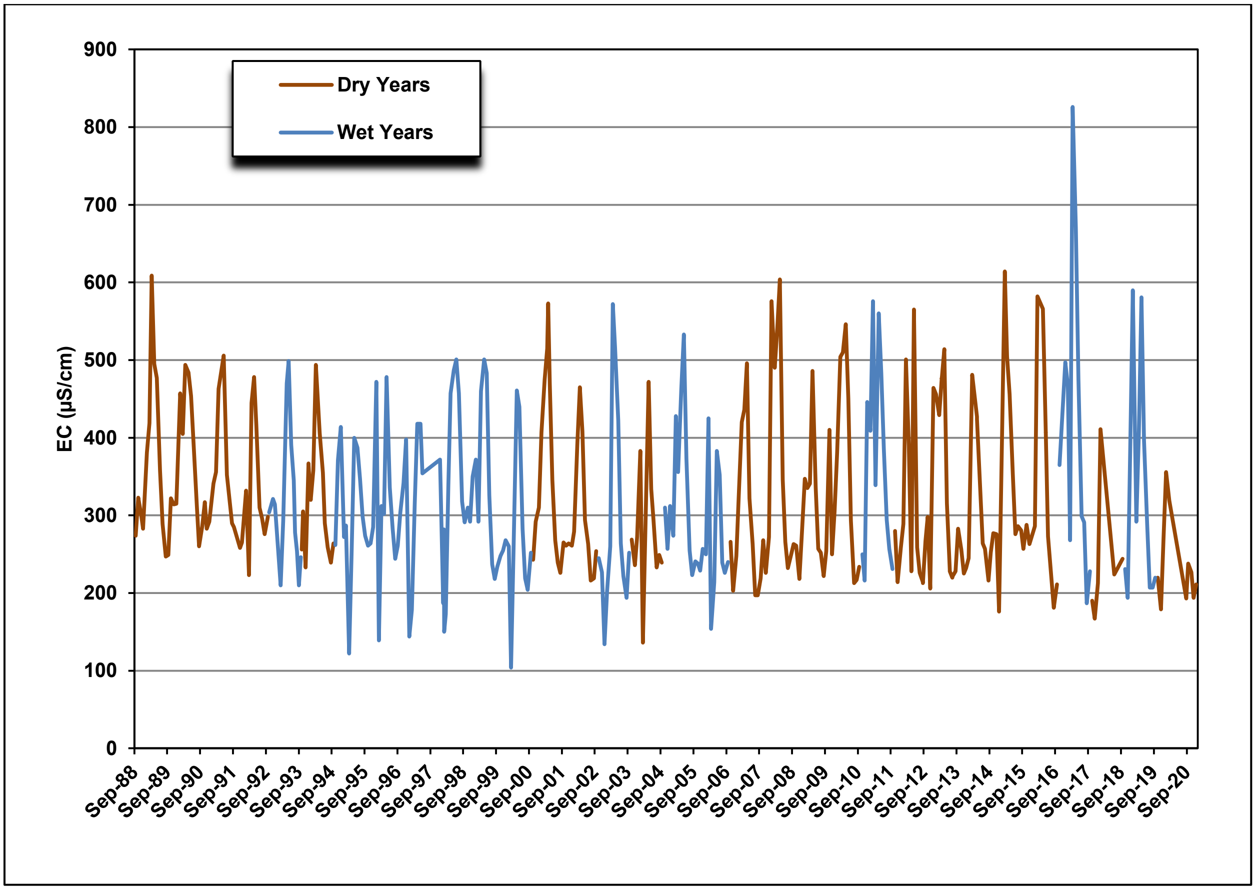


Figure 4-20. Comparison of Barker Slough Real-time and Grab Sample EC Data Over Time

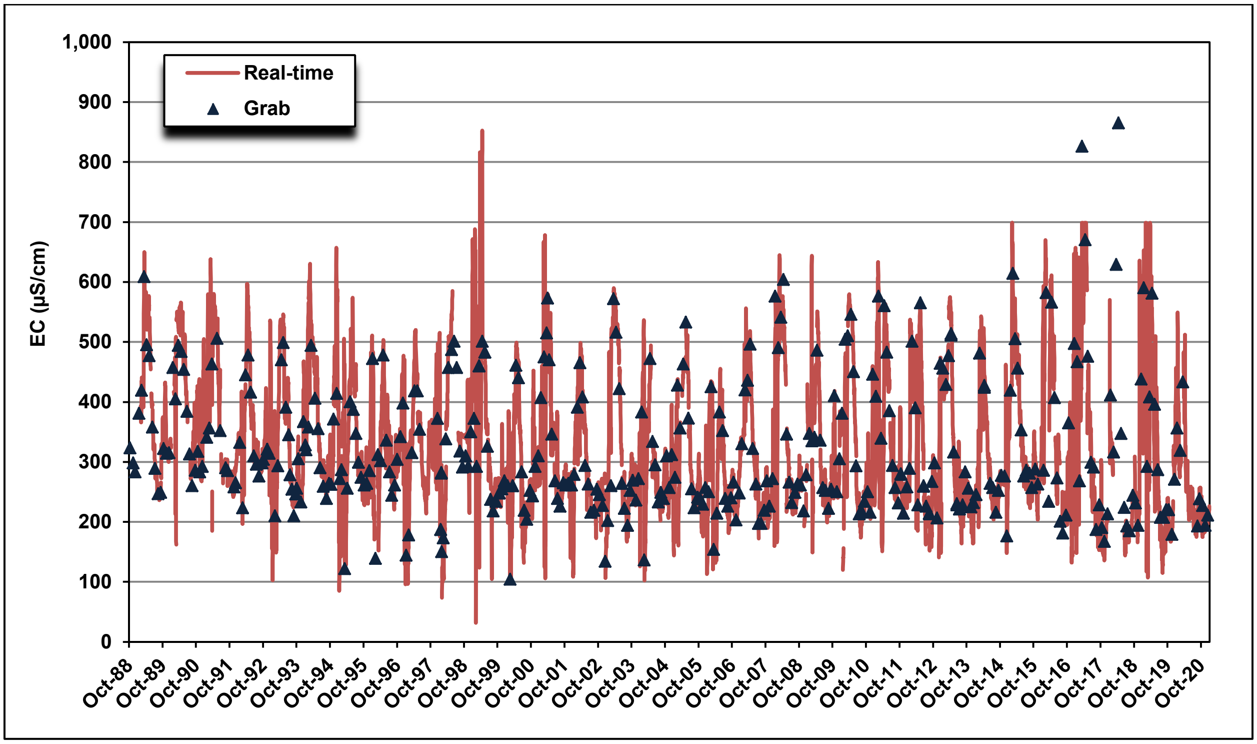


Figure 4-21. Comparison of Barker Slough Real-time and Grab Sample EC Data, 1:1 Graph, 2011 to 2020

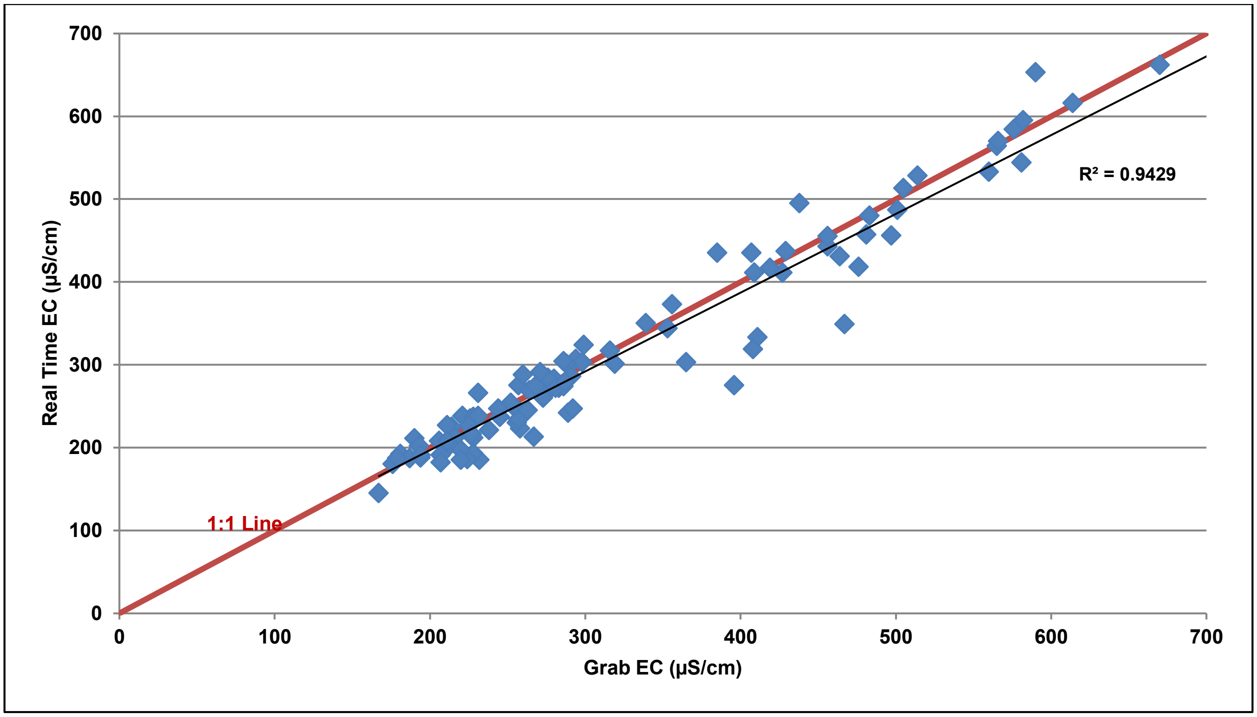
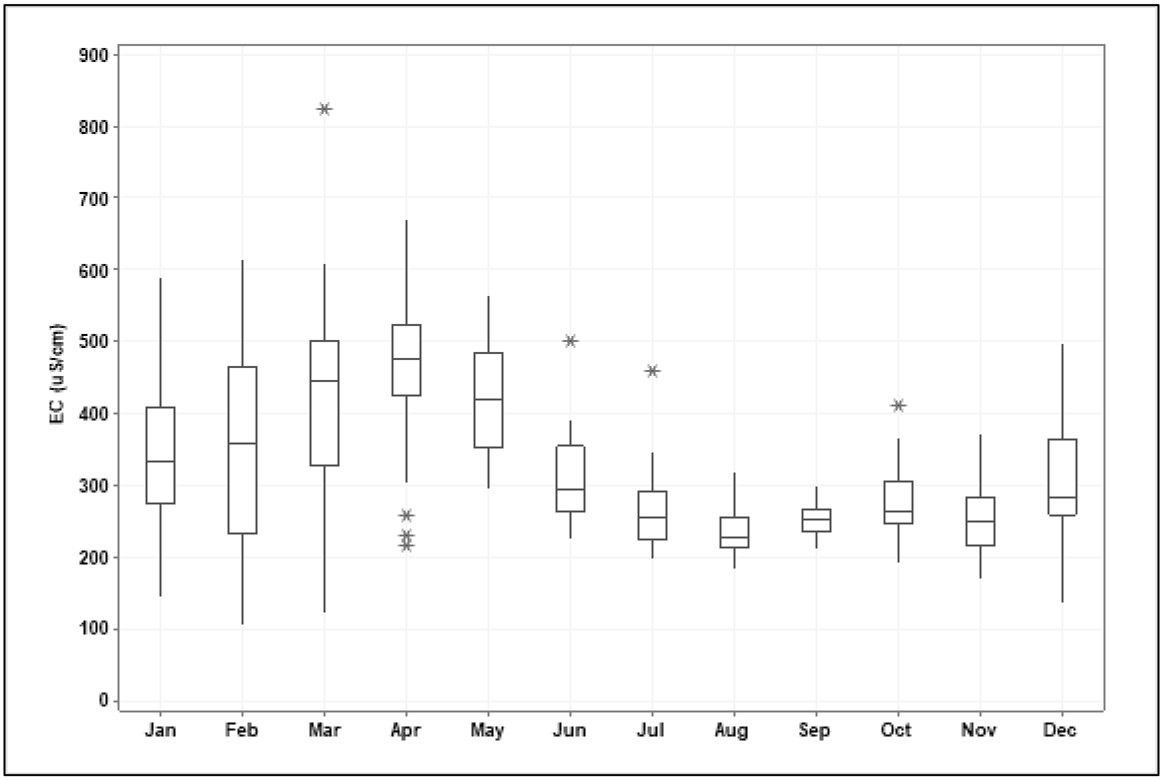


Figure 4-22. Monthly Variability in EC at Barker Slough, 1988 to 2020



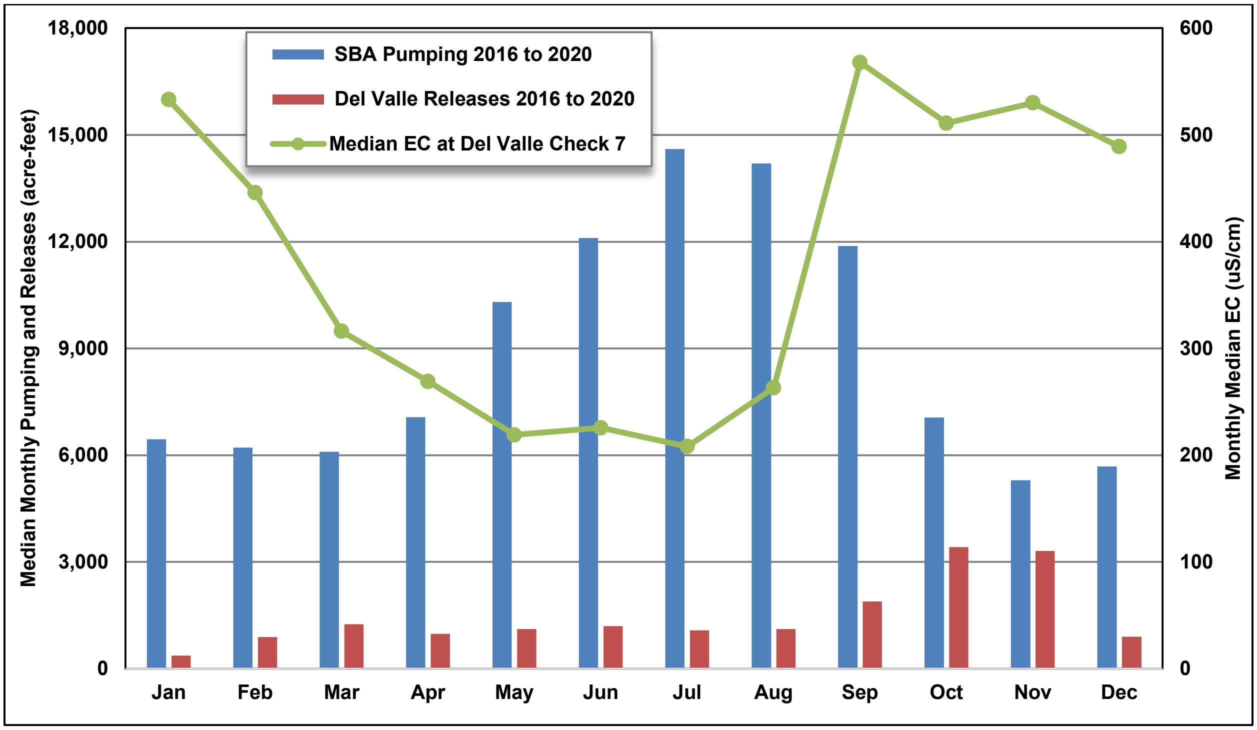
South Bay Aqueduct

Chapter 2 contains a description of the South Bay Aqueduct (SBA). The Delta is the primary source of water and Lake Del Valle is the secondary source.

Project Operations

The quality of water delivered to the SBA Contractors is governed by the timing of diversions from Bethany Reservoir and releases from Lake Del Valle. **Figure 4-23** shows average monthly diversions at the South Bay Pumping Plant and releases from Lake Del Valle for the 2016 to 2020 period. Median monthly EC levels at Del Valle Check 7 (DV Check 7) are also shown. This figure shows that during June, July and August, EC levels were less than 500 µS/cm, closer to 250 µS/cm. The median concentrations increase rapidly to over 500 µS/cm in September due to low Delta outflow and more seawater intrusion into the Delta during the fall. Water is released from Lake Del Valle primarily between September and November.

Figure 4-23. Average Monthly Diversions at the South Bay Pumping Plant, Releases from Lake Del Valle, and Median EC Levels at Del Valle Check 7, 2016 to 2020



EC Levels in the SBA

Figure 4-24 presents all available grab sample EC data at DV Check 7. The EC levels range from 111 to 894 µS/cm with a median of 406 µS/cm.

- Comparison of Real-time and Grab Sample Data – **Figure 4-25** compares the real-time data with the grab sample data at DV Check 7 over time. Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. There is generally a good correspondence between the two data sets when samples collected on the same day are compared. **Figure 4-26** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-26** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.9963 which is acceptable.

- Spatial Trends – It is not possible to compare all locations along the SBA that have been monitored due to varying periods of record. The grab sample data from 1998 to 2020 for Banks and DV Check 7 are shown in **Figure 4-27**. The median concentration at DV Check 7 (405 µS/cm) is not statistically significantly different than the median concentration at Banks (410 µS/cm). Water from Lake Del Valle enters the SBA between DV Check 7 and the Terminal Tank but does not appear to statistically significantly affect EC levels when the data are aggregated in this manner.

- Long-Term Trends – Visual inspection of **Figure 4-24** does not reveal a discernible trend in the data from DV Check 7. The increasing EC trend from 2012 to 2016 is due to five consecutive dry years, rather than a long-term pattern. The maximum concentration of 894 µS/cm was measured in February 2014. There were significant decreases in EC in 2017 and 2018 water years due to hydrologic conditions.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median concentration during wet years of 300 µS/cm is statistically significantly lower than the median during dry years of 486 µS/cm (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – **Figure 4-28** presents the grab sample monthly data for the entire period of record at DV Check 7. The EC levels at DV Check 7 show the same monthly pattern as at Banks with the lowest levels in July and increasing EC during the fall months.

Figure 4-24. EC at DV Check 7

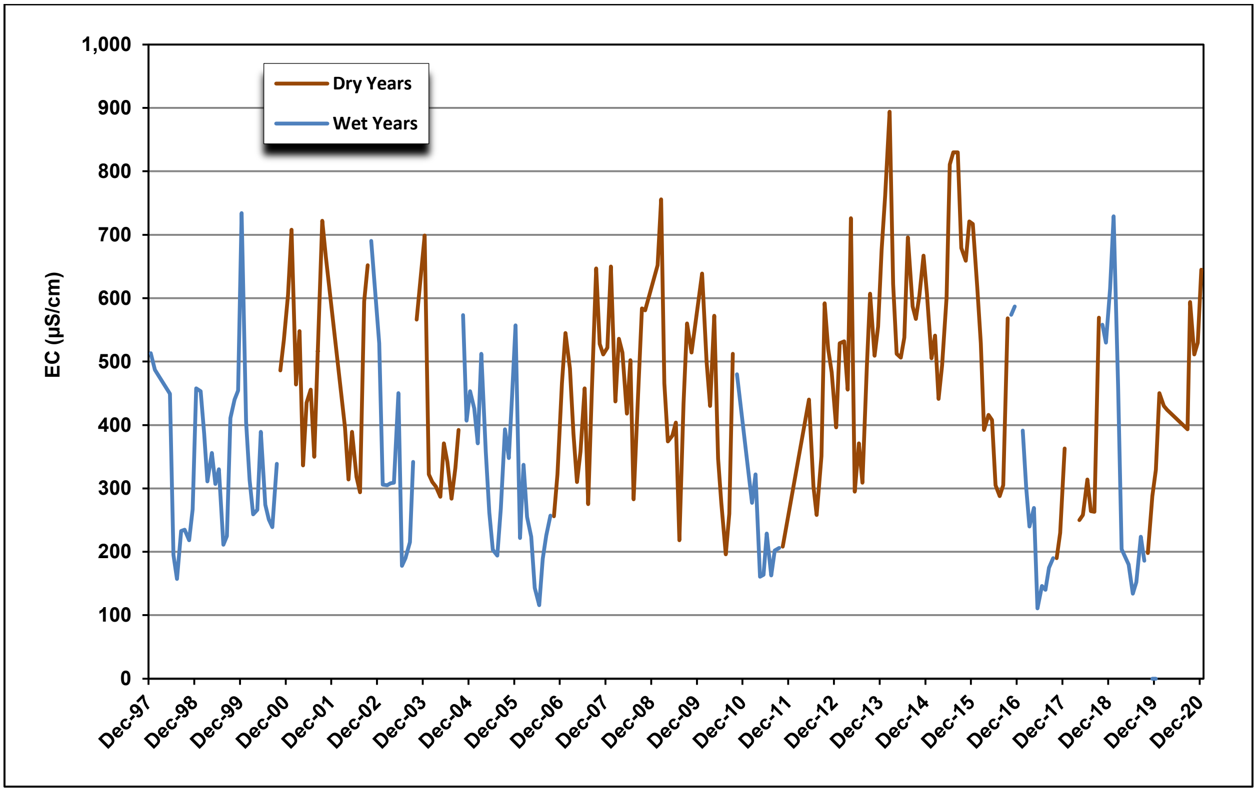


Figure 4-25. Comparison of DV Check 7 Real-time and Grab Sample EC Data Over Time

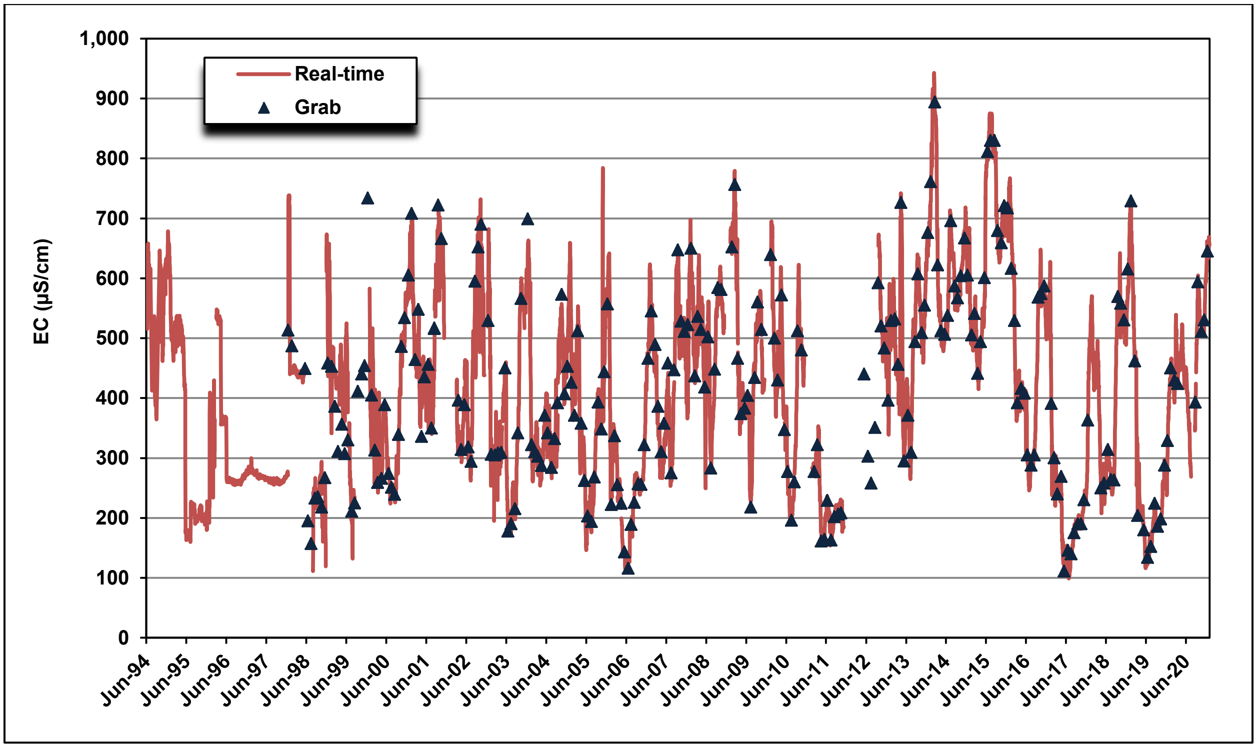


Figure 4-26. Comparison of DV Check 7 Real-time and Grab Sample EC Data, 1:1 Graph, 2011 to 2020

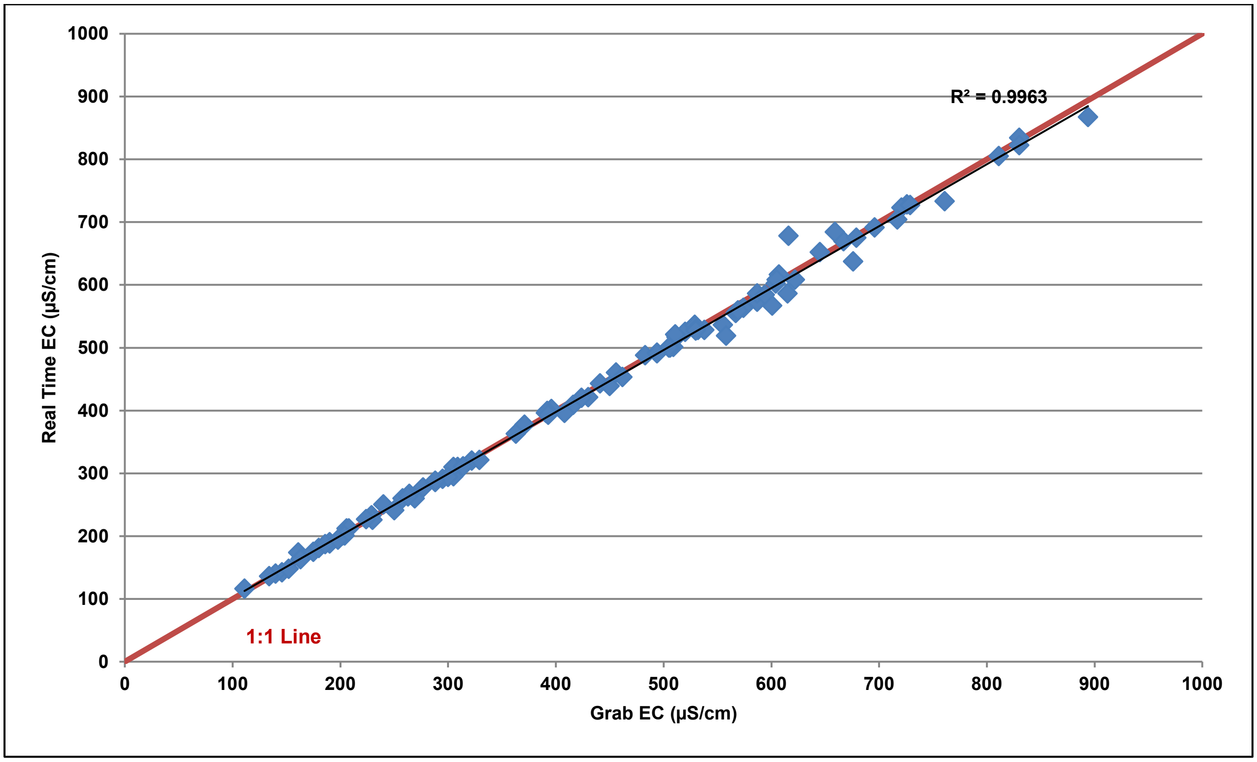


Figure 4-27. Comparison of EC at Banks and DV Check 7 (1998 to 2020)

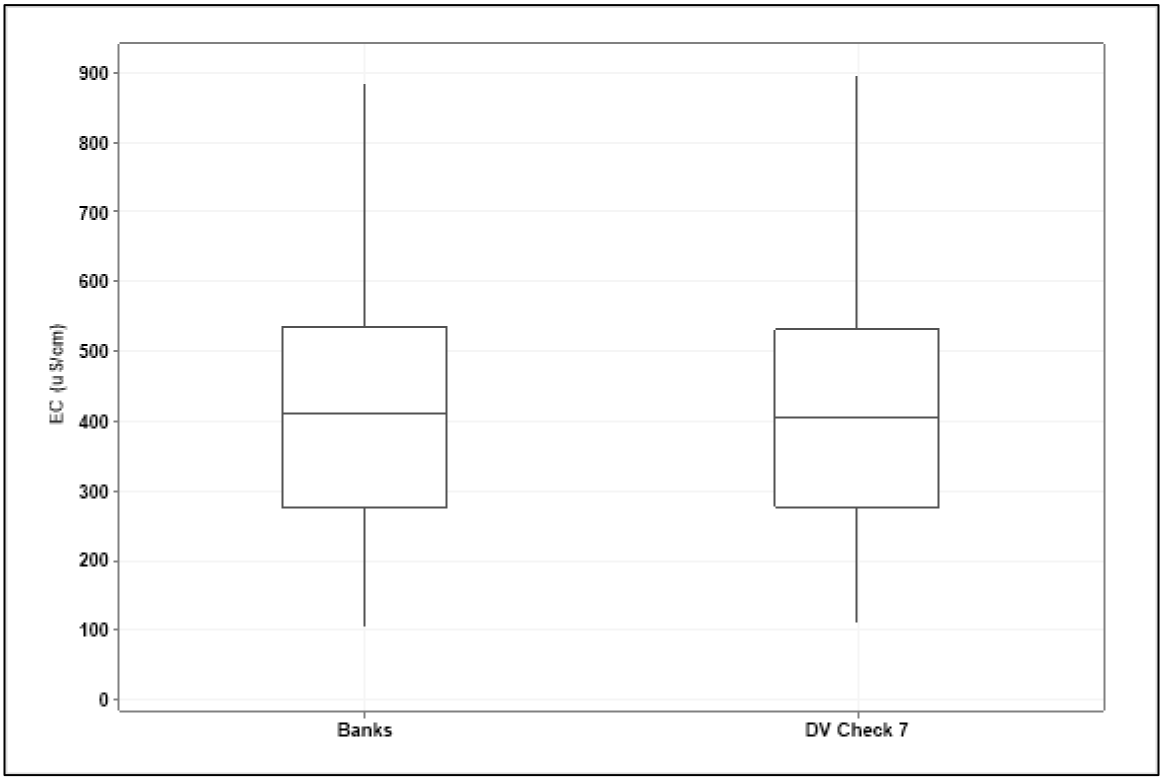
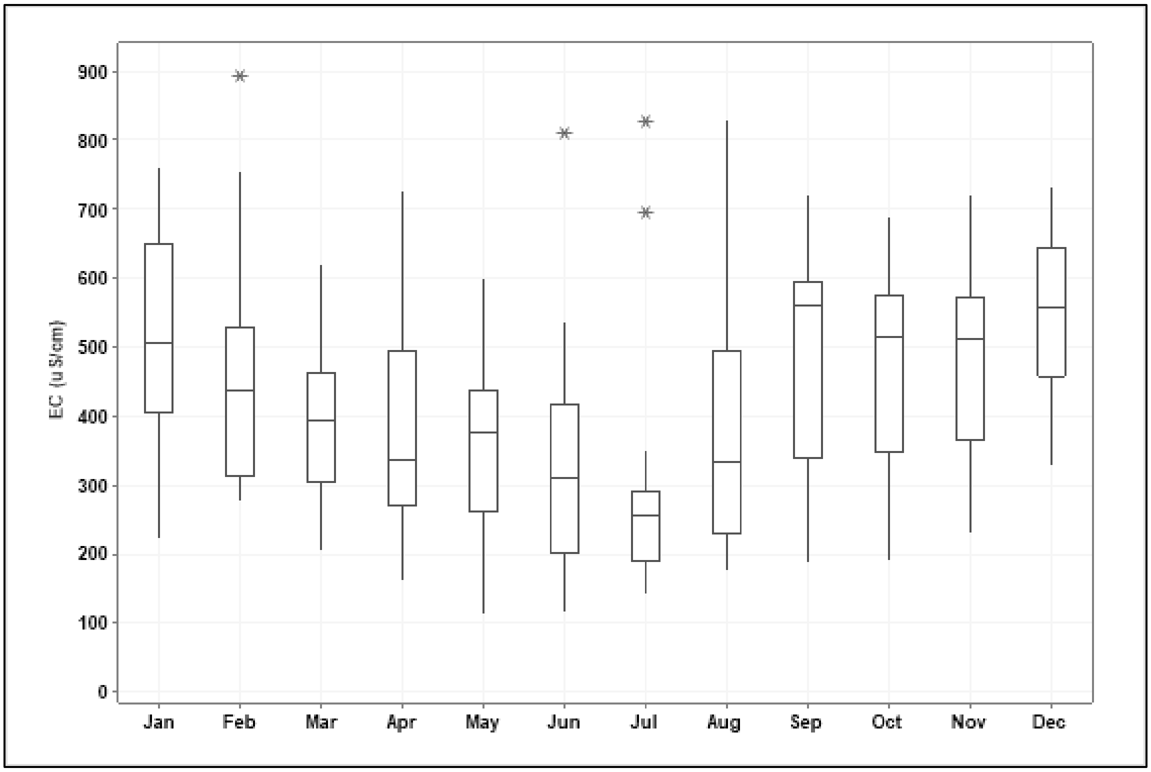


Figure 4-28. Monthly Variability in EC at DV Check 7, 1997 to 2020



California Aqueduct and Delta-Mendota Canal

A number of SWP Contractors take water from the SWP between San Luis Reservoir and the terminal reservoirs. This section is organized by various reaches of the SWP and individual SWP Contractors taking water from each reach are described in the following sections.

Project Operations

The quality of water delivered to SWP Contractors south of San Luis Reservoir is governed by the timing of diversions from the Delta at Banks, pumping into O'Neill Forebay from the Delta-Mendota Canal (DMC), releases from San Luis Reservoir, non-Project inflows to the Governor Edmund G. Brown California Aqueduct (California Aqueduct), and storage in terminal reservoirs.

Figure 4-29 shows average monthly diversions at the Banks Pumping Plant and median monthly EC levels for the 2016 to 2020 period. During this period, median EC levels range from 247 to 556 µS/cm during the peak diversion months of July to September; however the median EC levels range from 412 to 574 µS/cm during the October to March period when a substantial amount of water is diverted from the Delta at Banks. Due to constraints on pumping, very little water is diverted during the April to June period when median EC levels are less than 400 µS/cm.

Figure 4-30 shows the average monthly amount of water pumped from the DMC at O'Neill Pump-Generating Plant into O'Neill Forebay and the median EC level in the DMC at McCabe Road (McCabe). The median EC levels show the same seasonal pattern as at Banks but the EC levels at McCabe are higher, particularly in the months of January and February. The pumping pattern at O'Neill is different from the pattern at Banks. There is little pumping into O'Neill Forebay during the April to August period when EC levels are lowest. Most of the pumping occurs between December and March when median EC levels range from 387 to 617 µS/cm. During the 2016 to 2020 period that data were available, the DMC contributed between 27 and 43 percent of the water entering O'Neill Forebay with a median of 33 percent.

Figure 4-29. Average Monthly Banks Diversions and Median EC Levels, 2016 to 2020

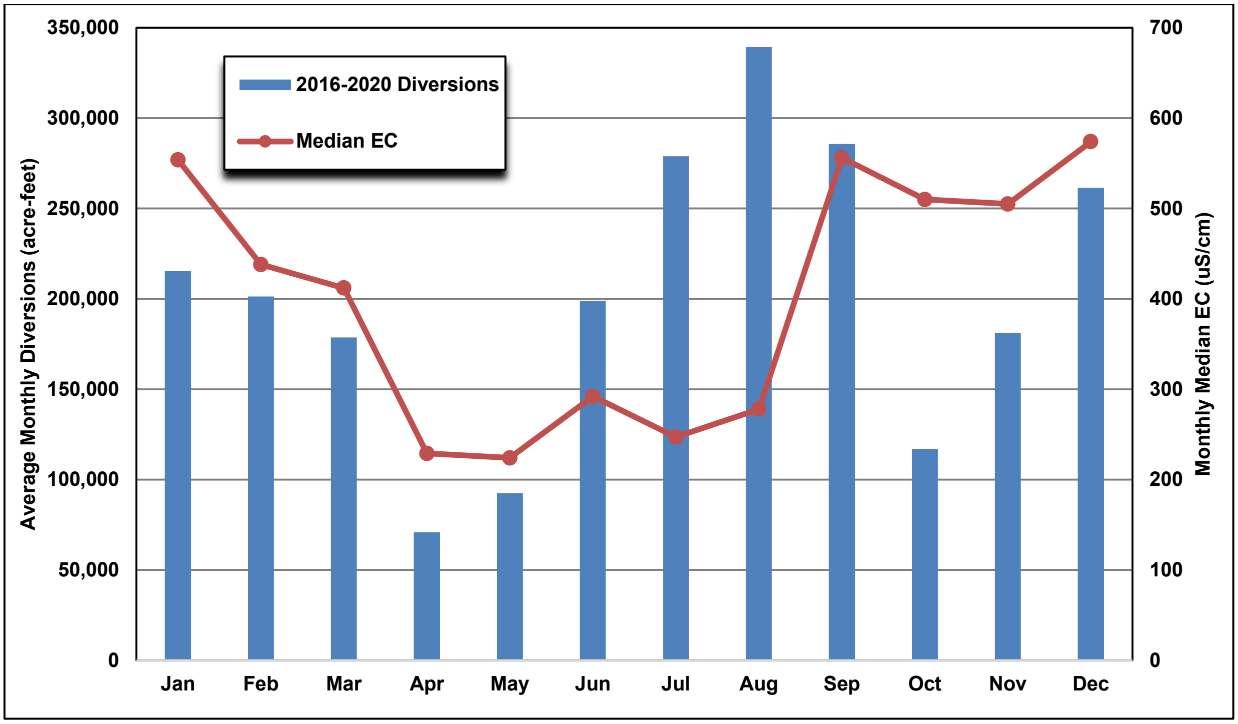
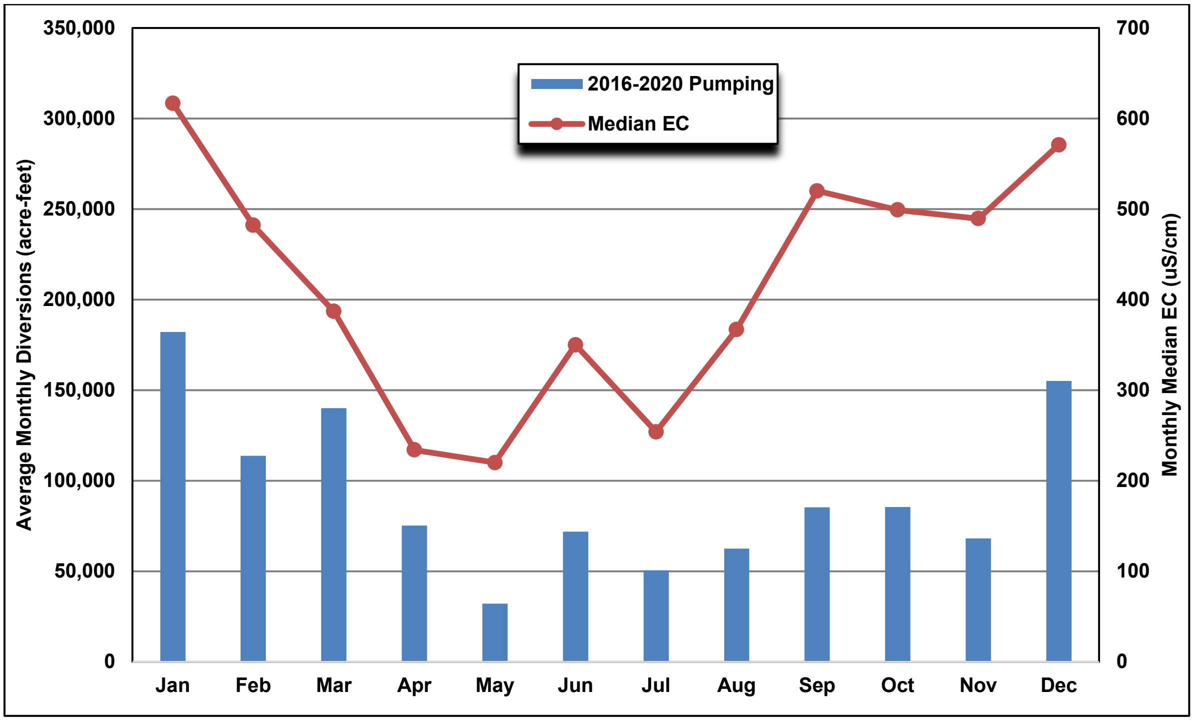


Figure 4-30. Average Monthly Pumping at O'Neill and Median EC Levels at McCabe, 2016 to 2020

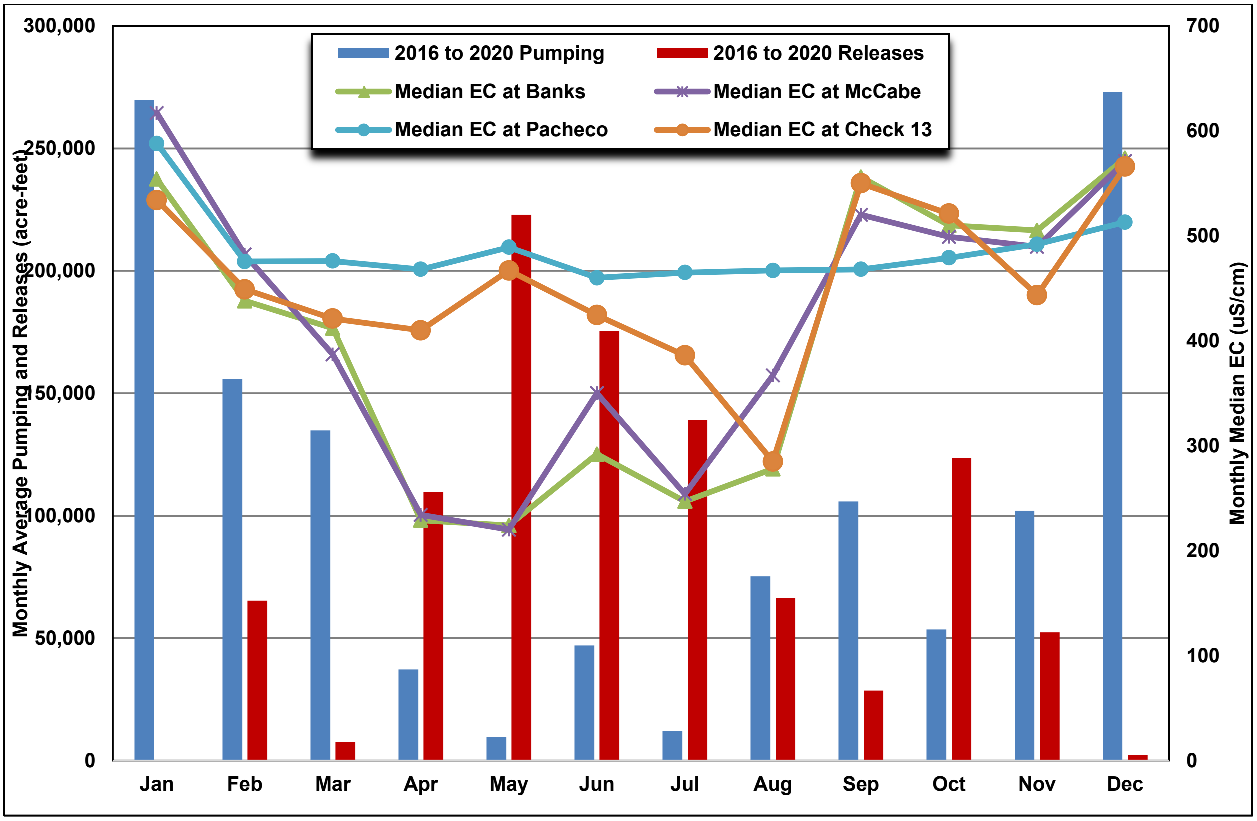


The operation of San Luis Reservoir impacts water quality in the California Aqueduct south of the reservoir. Water from O'Neill Forebay is pumped into San Luis Reservoir at the William R. Gianelli Pumping-Generating Plant (Gianelli) and water released from San Luis Reservoir flows into O'Neill Forebay before entering the California Aqueduct. Water is also pumped out of San Luis Reservoir on the western side at the Pacheco Pumping Plant (Pacheco) for Valley Water. In 2012, DWR installed a real-time water quality monitoring station in the channel between San Luis Reservoir and O'Neill Forebay (Gianelli Real-Time). Real-time TOC, turbidity, EC and bromide data are collected. The variation in the Gianelli data is due to operations. When pumping occurs into San Luis Reservoir, the water sample at Gianelli is O'Neill Forebay water. When releases occur from San Luis Reservoir, the water sample at Gianelli is San Luis water.

The operation of San Luis Reservoir impacts water quality in the California Aqueduct south of the reservoir. **Figure 4-31** shows the pattern of pumping (2016 to 2020) into the reservoir and releases from the reservoir to O'Neill Forebay from 2016 to 2020. Historically, water is generally pumped into the reservoir from September to March and released from the reservoir from April to August. However, during 2016 to 2020, there were some slight changes in the pumping/release patterns in August and October. For example, during 2016 to 2020, the average pumping and releases in August were similar, which is normally a release month. In October, the average releases were higher than the pumping, which is normally a month when water is pumped into San Luis Reservoir. This was likely due to the wet years of 2017 and 2019, and there was more than "normal" water stored in San Luis Reservoir which needed to be released in October.

The median EC level at Banks represents the quality of water pumped into the reservoir from the California Aqueduct and the median EC level at McCabe represents the quality of water pumped in from the DMC. The median EC at Pacheco represents the quality of water in San Luis Reservoir. The median EC at O'Neill Forebay Outlet (Check 13) is a mixture of water from San Luis Reservoir, the California Aqueduct, and the DMC. **Figure 4-31** shows how the concentrations at Check 13 are influenced by whether water is being pumped or released from San Luis Reservoir. For example, EC levels at Check 13 are similar to levels at Pacheco when releases occur, and Check 13 levels are similar to levels at Banks when water is pumped from O'Neill Forebay to San Luis Reservoir.

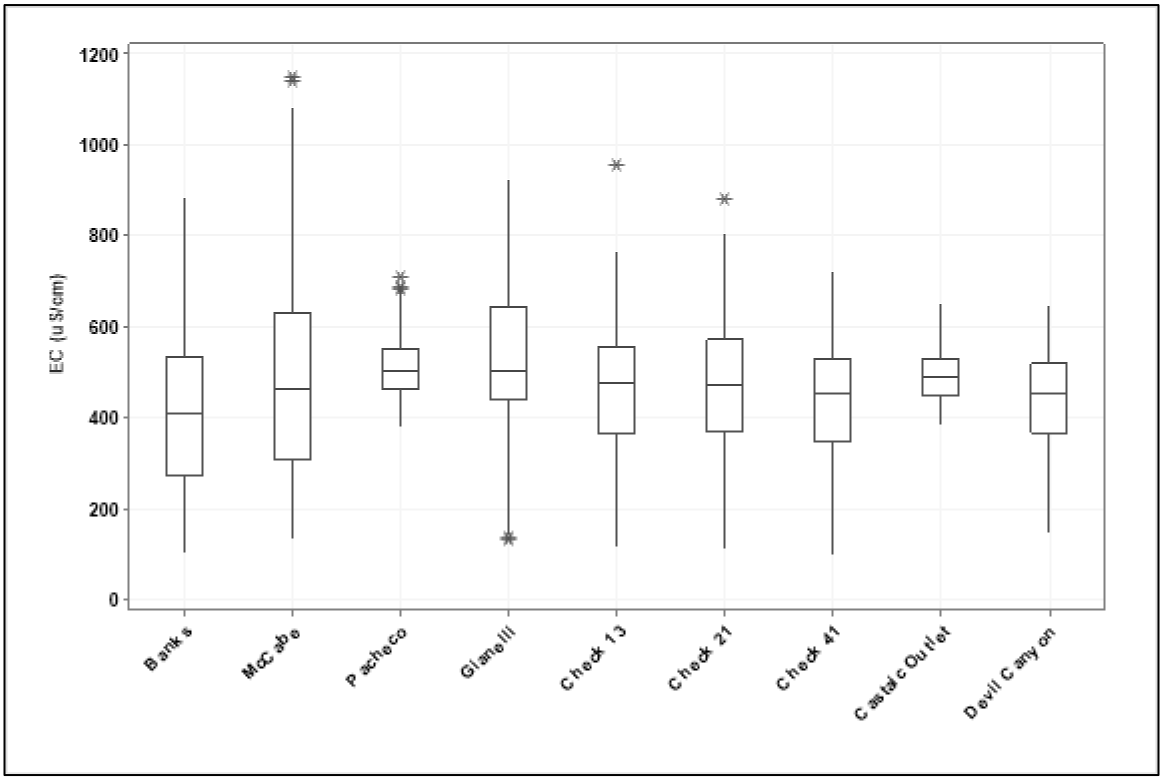
Figure 4-31. San Luis Reservoir Operations and Median EC Levels, 2016 to 2020



EC Levels in the DMC and SWP

Figure 4-32 presents a summary of all grab sample EC data collected at each of the locations along the DMC, the California Aqueduct, and SWP reservoirs. With the exception of Pacheco and Gianelli, data for all locations is from 1998 to 2020. Pacheco data is from 2000 to 2020, Gianelli data is from 2013 to 2020. Changes in EC along the aqueduct are described in the following sections. There is some reduction in variability in EC levels in the reservoirs due to the blending of water with varying EC levels over time in the reservoirs.

Figure 4-32. EC Levels in the DMC and SWP, 1998 to 2020



Delta-Mendota Canal – Grab sample EC data have been collected from McCabe and real-time data have been collected at the O’Neill Pump-Generating Plant (O’Neill Intake), which is the point at which the DMC enters O’Neill Forebay. **Figure 4-33** presents the EC data for McCabe. There is considerable variability in the data with EC levels ranging from 135 to 1150 µS/cm with a median of 467 µS/cm.

- Spatial Trends – **Figure 4-34** presents the EC data collected at Banks and McCabe between 1998 and 2020. During this period, the EC median at McCabe of 465 µS/cm is statistically significantly higher than the EC median at Banks of 410 µS/cm (Mann-Whitney, *p*=0.000). McCabe is higher due to the greater influence of the San Joaquin River at Jones.

- Long-Term Trends – Visual inspection of **Figure 4-33** does not show any discernible long-term trend in EC levels at McCabe. The increasing EC trend from 2012 to 2015 is due to four consecutive dry years, rather than a long-term pattern.

- Wet Year/Dry Year Comparison – The influence of hydrology on EC levels is clearly shown in **Figure 4-33** with dry years having higher levels of EC than wet years. The McCabe wet year median EC level of 314 µS/cm is statistically significantly lower than the dry year median of 552 µS/cm (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – **Figure 4-35** shows there is a seasonal pattern of declining EC levels during the spring months at McCabe with the lowest levels in July. Through the late summer and fall months, EC levels rise with the highest levels occurring in January and February. The EC fingerprint (**Figure 4-2**) shows that the increase in EC levels at McCabe is due to a combination of seawater intrusion, high levels of EC at Vernalis, and Delta agricultural drainage. During August through September of most years, seawater intrudes into the Delta due to low flows on the Sacramento and San Joaquin rivers. During these months, temporary barriers are installed in the south Delta. This results in the San Joaquin River mixing with lower EC water in the central Delta before it is drawn to the Jones Pumping Plant. In many years, the barriers are removed in the late fall when flows on the San Joaquin River are increasing. This results in increasing EC levels at Jones as the San Joaquin River is once again drawn directly to the pumping plant. The increase in EC at McCabe during these months depends on the degree of mixing of the San Joaquin River with lower EC water in the south Delta. Delta agricultural drainage is also responsible for an increase in EC at Jones, primarily during January to February when water is pumped off of the islands.

Figure 4-33. EC Levels at McCabe

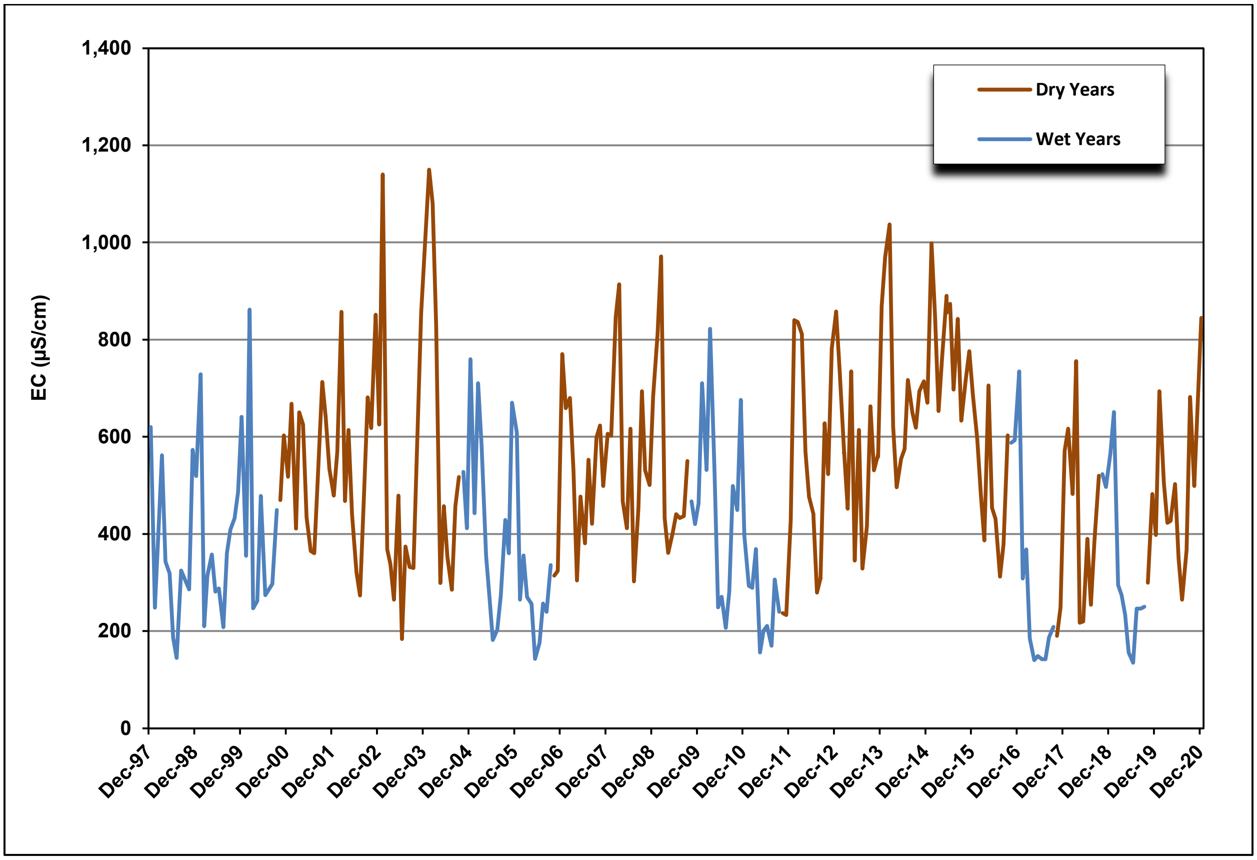


Figure 4-34. Comparison of Banks and McCabe EC Levels (1998-2020)

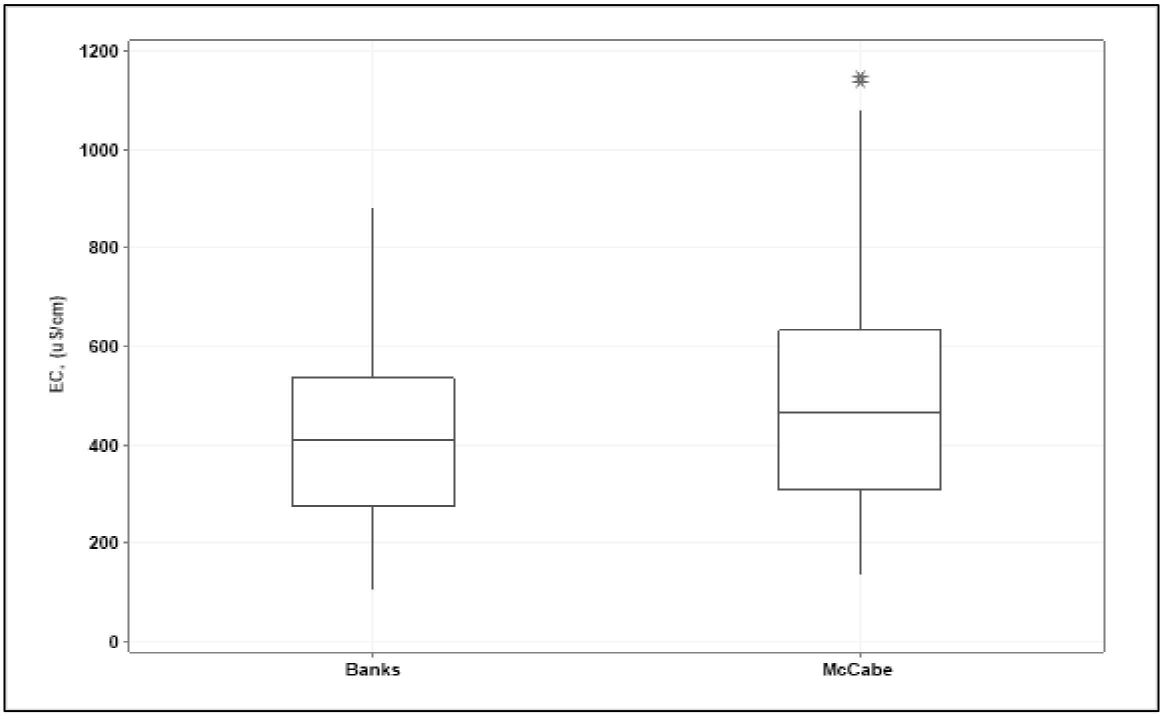
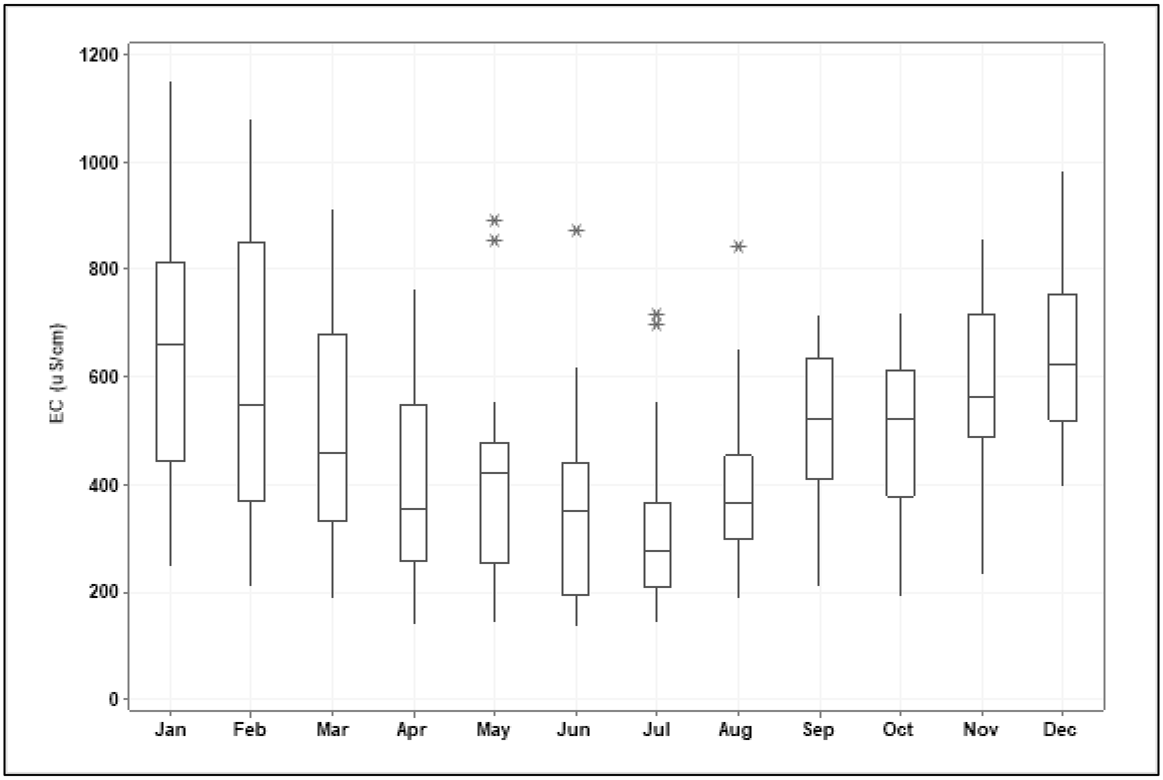


Figure 4-35. Monthly Variability in EC at McCabe, 1997 to 2020



San Luis Reservoir – Grab sample EC data have been collected at Pacheco since 2000 and real-time data have been collected since 1989. **Figure 4-36** presents all of the available grab sample EC data for Pacheco. There is much less variability in EC levels in the reservoir than in the aqueduct. The EC levels at Pacheco range from 382 to 708 µS/cm with a median of 504 µS/cm.

- Comparison of Real-time and Grab Sample Data – **Figure 4-37** shows there is good correspondence between the real-time and grab sample data collected between 2000 and 2020. Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. The real-time data indicate that EC levels were highest at Pacheco during the drought of the early 1990s and again in the mid-2010s. The peak level in 1991 was 873 µS/cm, while it peaked at 719 µS/cm in 2015. **Figure 4-38** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-38** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.9698 which is acceptable.

- Spatial Trends – The real-time data from Banks, McCabe, and Pacheco for the 2000 to 2020 period are presented in **Figure 4-39** to show the variability between Pacheco and the two sources of water to San Luis Reservoir. The median EC level at Pacheco of 504 µS/cm is statistically significantly higher than the Banks median of 421 µS/cm (Mann-Whitney, p=0.0000), and statistically significantly higher than the median EC level at McCabe of 478 µS/cm (p = 0.014). The higher EC in San Luis Reservoir is likely due to a combination of evaporation in the reservoir and pumping of water into the reservoir during the fall and winter months when Delta salinity is high.

- Long-Term Trends – **Figure 4-36** shows that EC levels have declined considerably since 1991, which was the fifth year of a six year drought. This was followed by six wet years between 1995 and 2000 so the trend is a function of hydrology rather than any long-term change in EC in the reservoir. Similarly, the increasing EC trend from 2012 to 2016 is due to five consecutive dry years, rather than a long-term pattern.

- Wet Year/Dry Year Comparison – As shown with the real-time data and the grab sample data shown in **Figure 4-36**, EC levels are generally lower in wet years than in dry years. There are a few exceptions of high EC values during wet years, such as January 2019 at 624 µS/cm, but these are infrequent. Between 2000 and 2020, the Pacheco grab sample wet year median of 495 µS/cm is statistically significantly lower than the dry year grab sample median of 521 µS/cm (Mann-Whitney, p=0.002.)

- Seasonal Trends – **Figure 4-40** shows there is no distinct seasonal pattern.

Figure 4-36. EC Levels at Pacheco

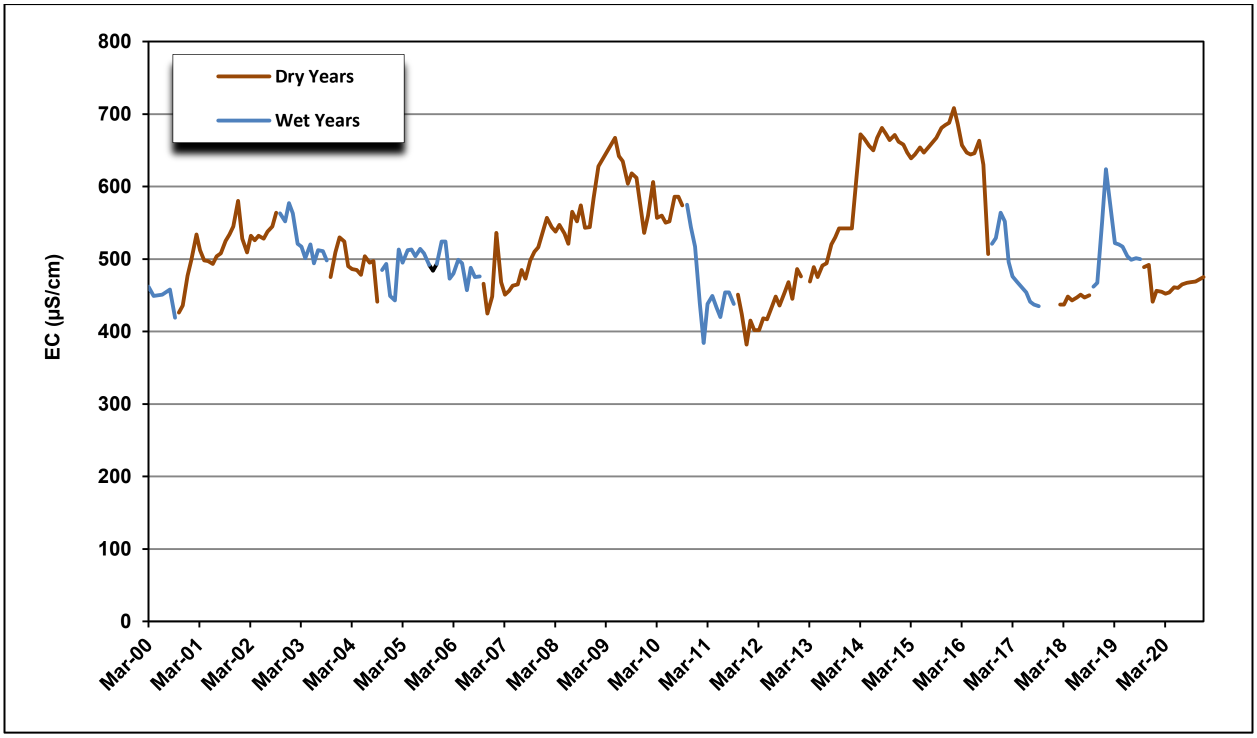


Figure 4-37. Comparison of Pacheco Real-time and Grab Sample EC Data Over Time

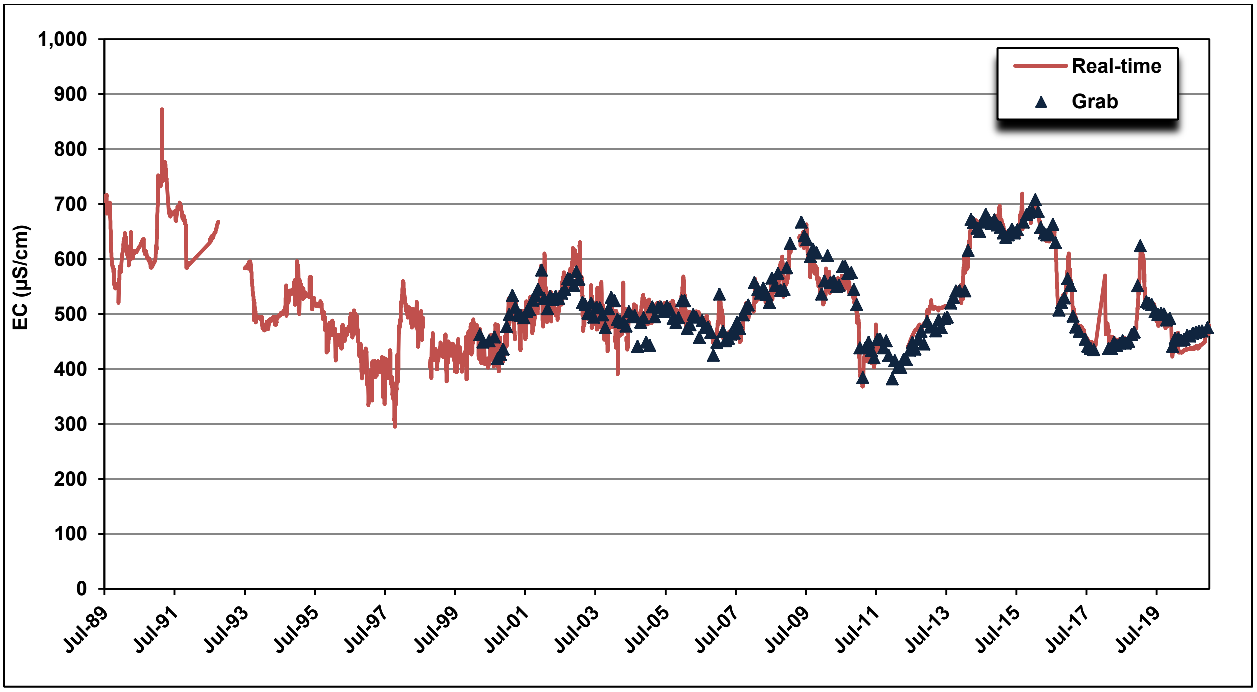


Figure 4-38. Comparison of Pacheco Real-time and Grab Sample EC Data, 1:1 Graph, 2000 to 2020

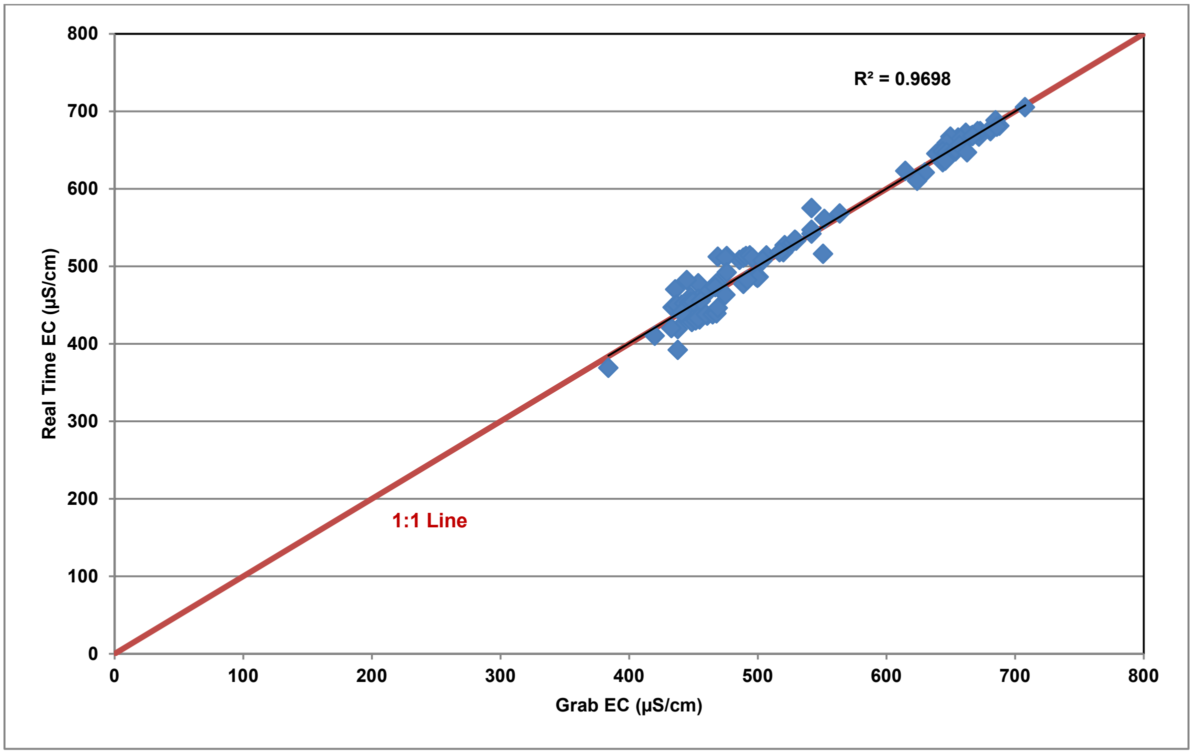


Figure 4-39. Comparison of Pacheco, Banks, and McCabe EC Levels (2000-2020)

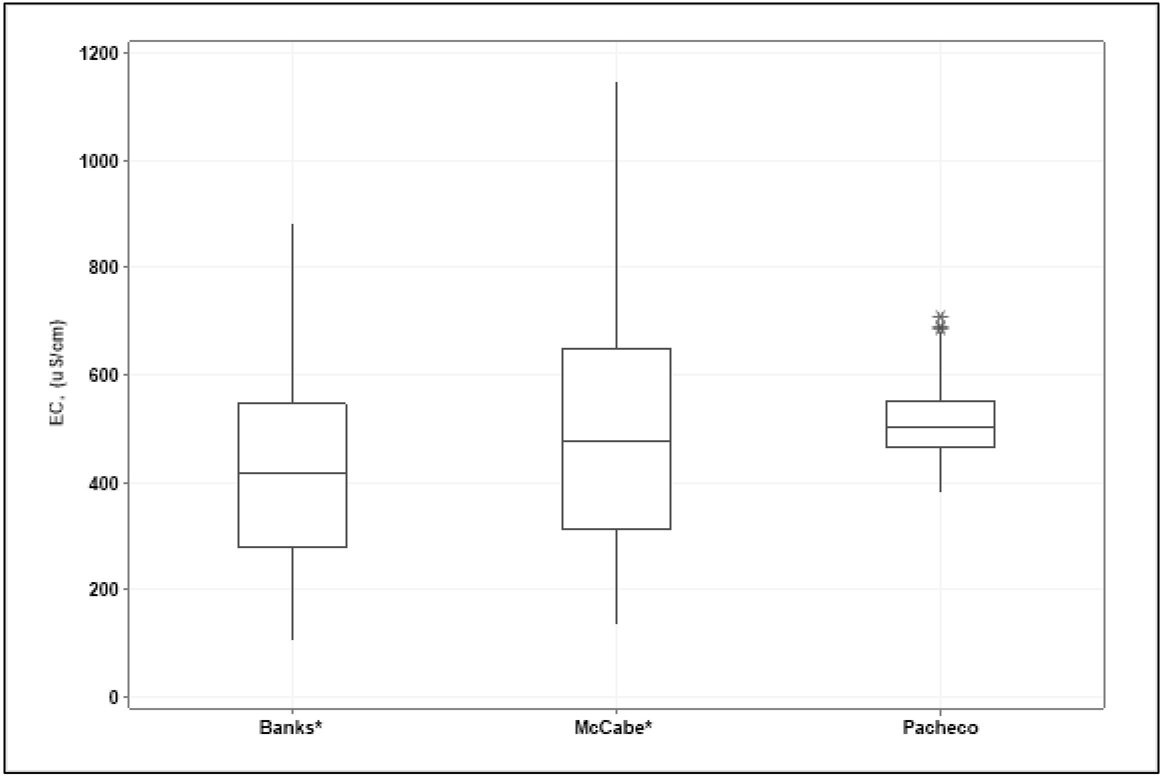
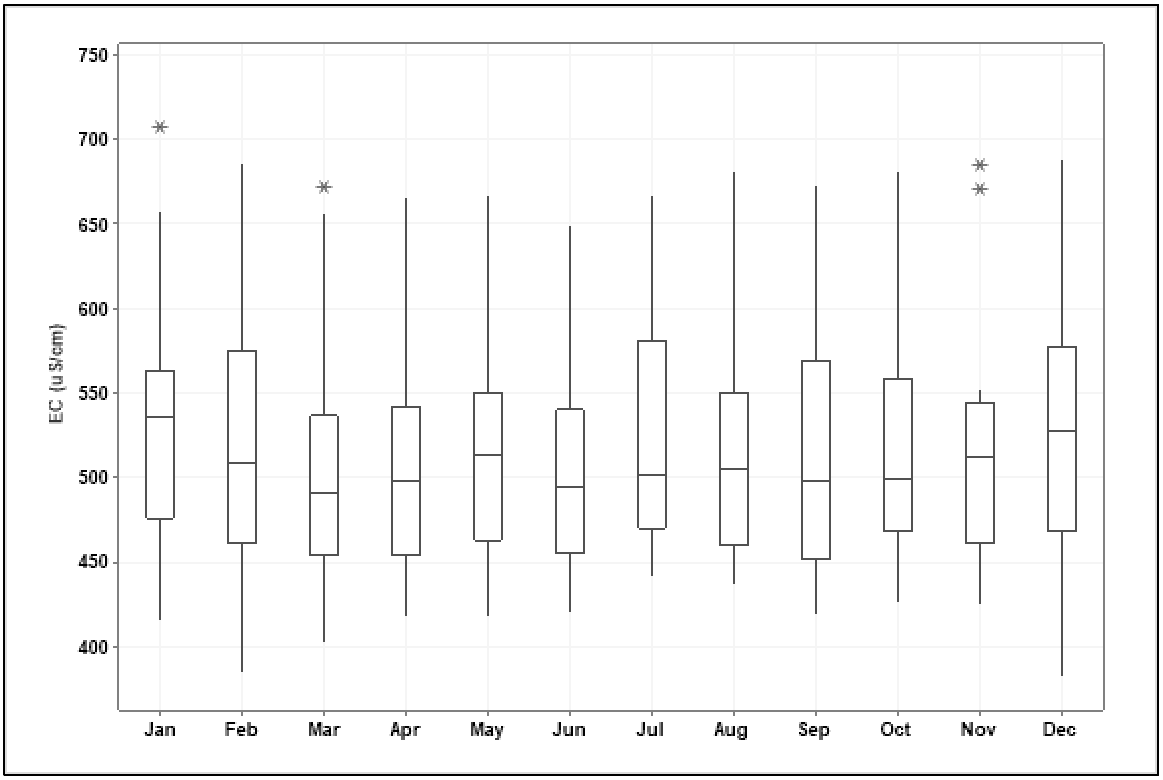


Figure 4-40. Monthly Variability in EC at Pacheco, 2000 to 2020



San Luis Reservoir (Gianelli) – **Figure 4-41** presents all available grab sample EC data at Gianelli. The EC levels range from 132 to 925 µS/cm with a median of 505 µS/cm.

- Comparison of Real-time and Grab Sample Data – **Figure 4-42** compares the real-time data with the grab sample data at Gianelli from 2016 to 2020. Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. There is generally a good correspondence between the two data sets when samples collected on the same day are compared. **Figure 4-43** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-43** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.9607.

- Spatial Trends – Data from 2013 to 2020 Gianelli and Pacheco are presented in **Figure 4-44.** During this period, the median EC level of 522 µS/cm at Pacheco is not statistically significantly different than the median EC of 505 µS/cm at Gianelli (Mann-Whitney, *p*=0.116).

- Long-Term Trends – **Figure 4-41** does not display any discernible long-term trends.

- Wet Year/Dry Year Comparison - The data shown in **Figure 4-41** were analyzed to determine if there are statistically significant differences between wet years and dry years. The median EC of 549 µS/cm in dry years is statistically significantly higher than the median of 435 µS/cm in wet years (Mann-Whitney, *p*=0.001).

- Seasonal Trends – Seasonal trends were not conducted as water quality is more impacted on whether or not water is being released from San Luis Reservoir or being pumped from O'Neill forebay into San Luis Reservoir. Generally pumping occurs from September to March, and releases occur from April to August.

Figure 4-41. EC Levels at Gianelli

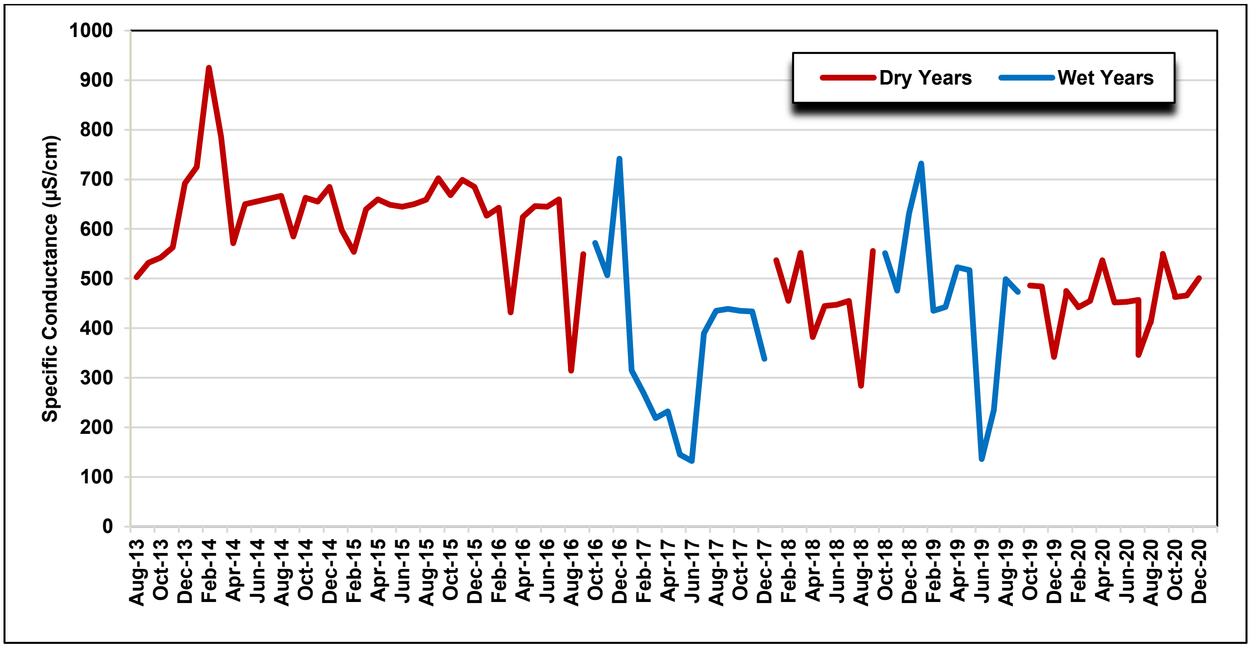


Figure 4-42. Comparison of Gianelli Real-time and Grab Sample EC Data, 2016 to 2020

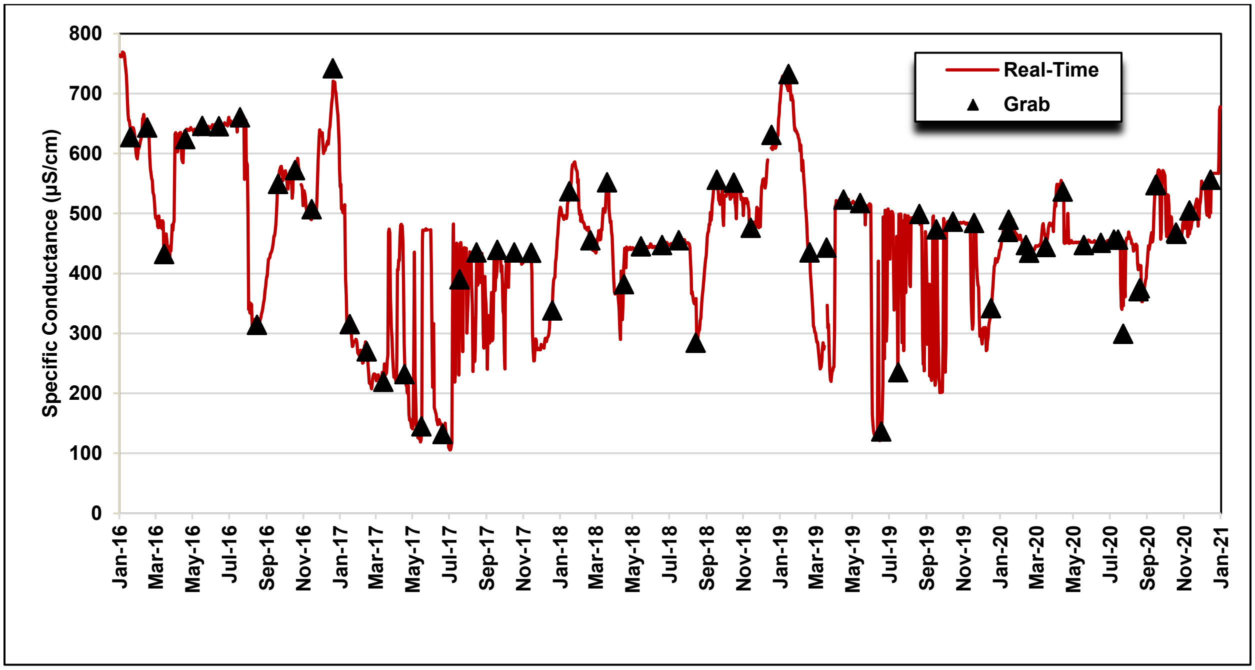


Figure 4-43. Comparison of Gianelli Real-time and Grab Sample EC Data, 2016 to 2020, 1:1 Graph

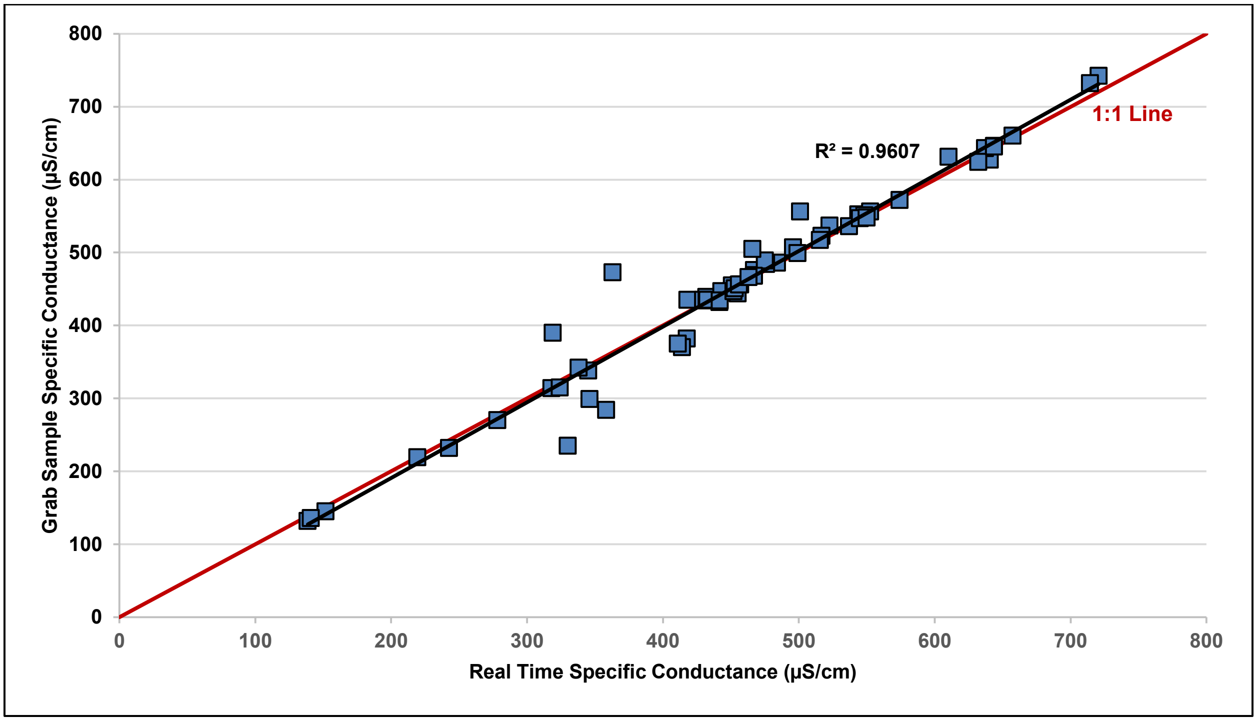
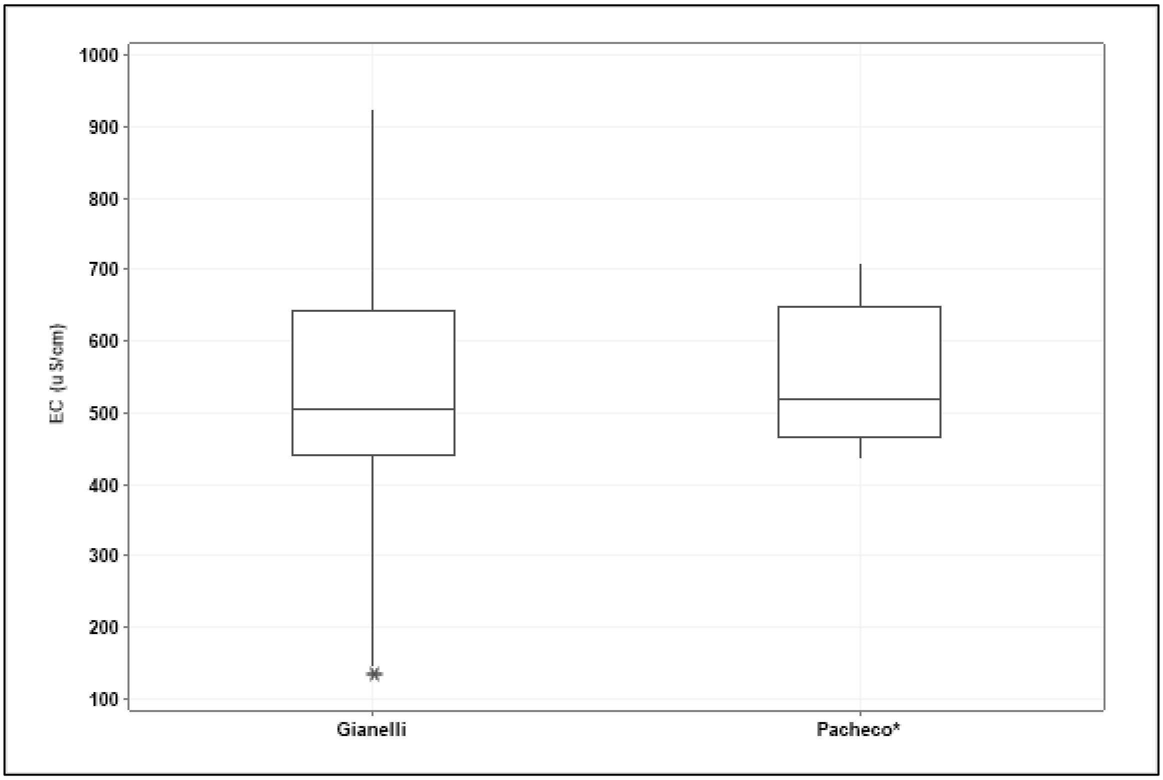


Figure 4-44. EC Concentrations at Gianelli and Pacheco (2013-2020)



O'Neill Forebay Outlet – O'Neill Forebay Outlet on the California Aqueduct is a mixture of water from San Luis Reservoir, the California Aqueduct, and the DMC. **Figure 4-45** presents the EC grab sample data for O'Neill Forebay Outlet. The EC levels at O'Neill Forebay Outlet range from 117 to 955 µS/cm with a median of 483 µS/cm.

- Comparison of Real-time and Grab Sample Data – **Figure 4-46** shows there is good correspondence between the real-time and grab sample data over time. Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. The real-time measurements captured peak levels above 900 µS/cm in 1990 and again in 2015 that were not captured by the grab samples. **Figure 4-47** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-47** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.9539 which is acceptable.

- Spatial Trends – **Figure 4-48** compares the grab sample data from Banks, McCabe and O'Neill Forebay (1998-2020). EC increases between Banks and O'Neill Forebay Outlet due to storage in San Luis Reservoir and to mixing with water from the more saline DMC in O'Neill Forebay. The O'Neill Forebay Outlet median concentration of 475 µS/cm is statistically higher than the Banks median of 410 µS/cm (Mann-Whitney, p=0.000).

- Long-Term Trends – **Figure 4-45** shows a sharp decline in EC concentrations from 1990 to 1997. As discussed previously, there was a six year drought between 1987 and 1992 with high EC levels at many locations in the SWP. This was followed by a wet period between 1995 and 2006, with low EC levels. The increasing EC trend from 2012 to 2016 is due to five consecutive dry years, rather than a long-term pattern. This reversed in 2017 due to a wet year and alternated back and forth over the next few years with wet and dry cycles.

- Wet Year/Dry Year Comparison – The O'Neill Forebay Outlet wet year median EC level of 373 µS/cm is statistically significantly lower than the dry year median of 531 µS/cm (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 4-49** shows there is a distinct seasonal pattern with the lowest concentrations in the summer months and the highest concentrations in the fall and winter. This is similar to the seasonal pattern exhibited at Banks; however, EC levels at O'Neill Forebay Outlet are higher than EC levels at Banks from April to August. Water with EC levels around 500 µS/cm is generally released from San Luis Reservoir during these months.

Figure 4-45. EC Levels at O'Neill Forebay Outlet

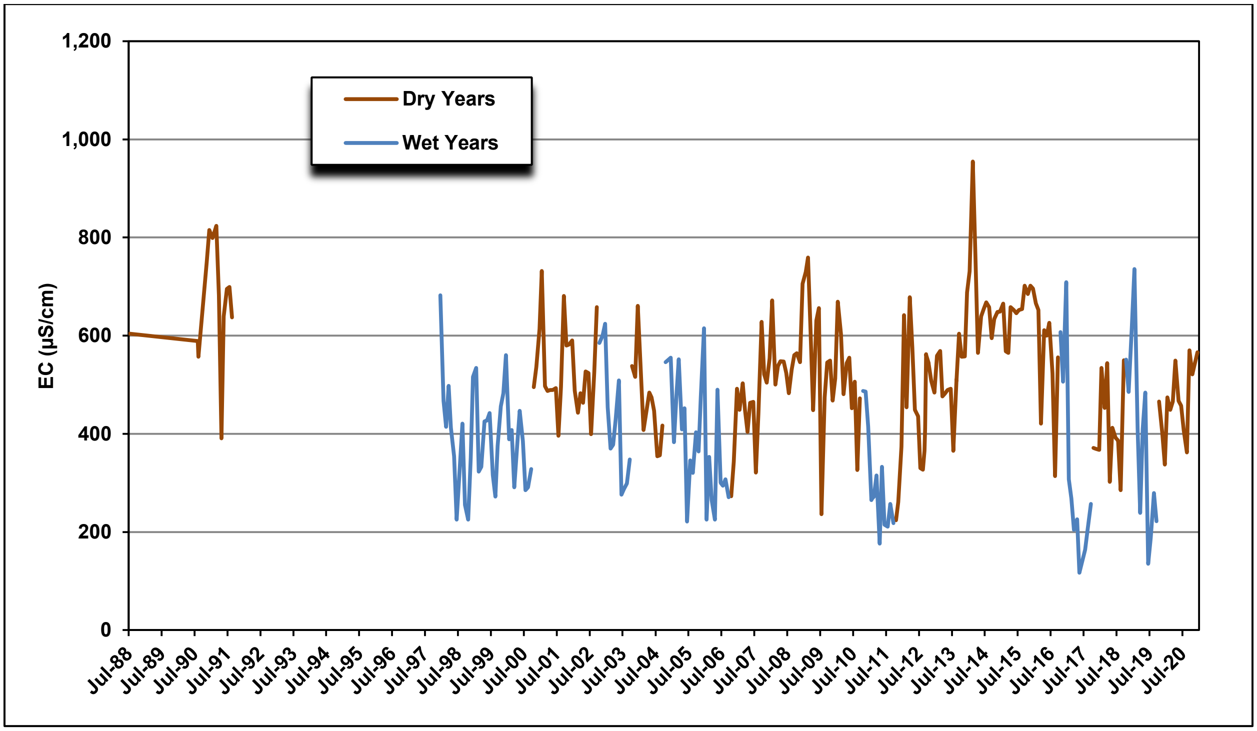


Figure 4-46. Comparison of O'Neill Forebay Outlet Real-time and Grab Sample EC Levels Over Time

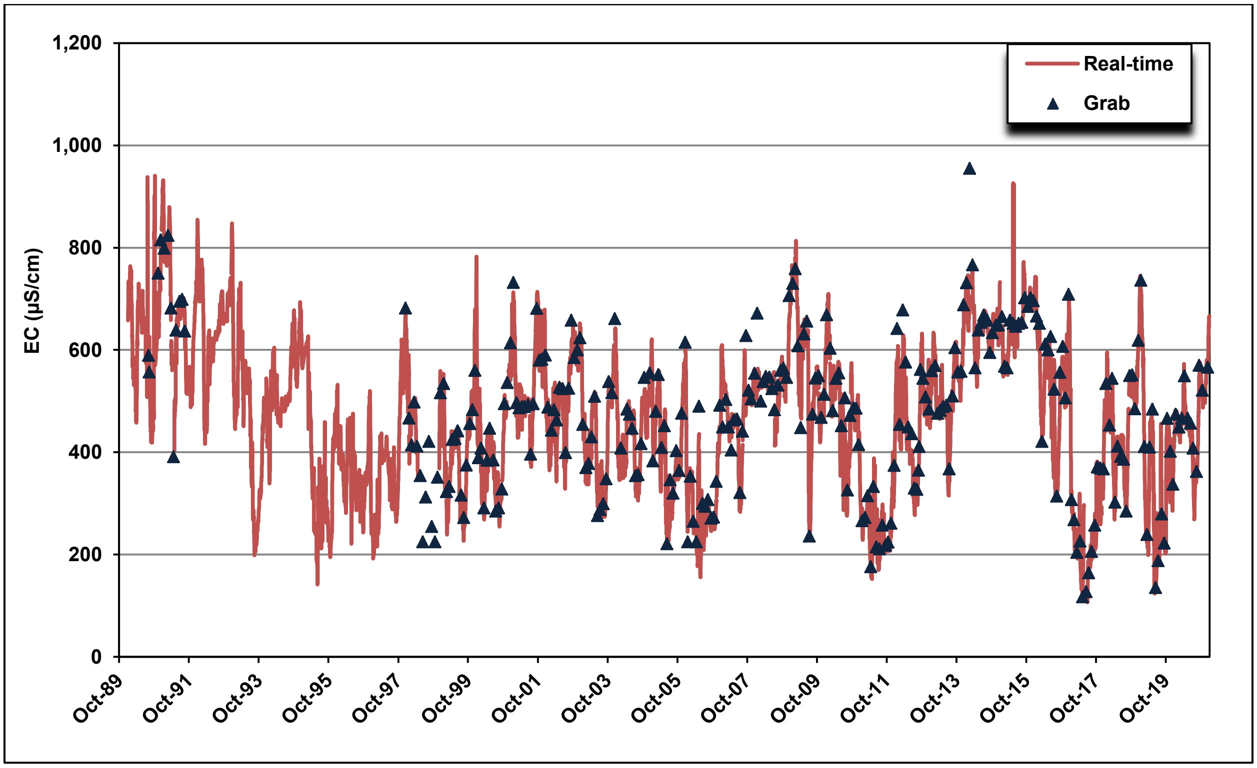


Figure 4-47. Comparison of O'Neill Forebay Outlet Real-time and Grab Sample EC Levels, 1:1 Graph, 2011 to 2020

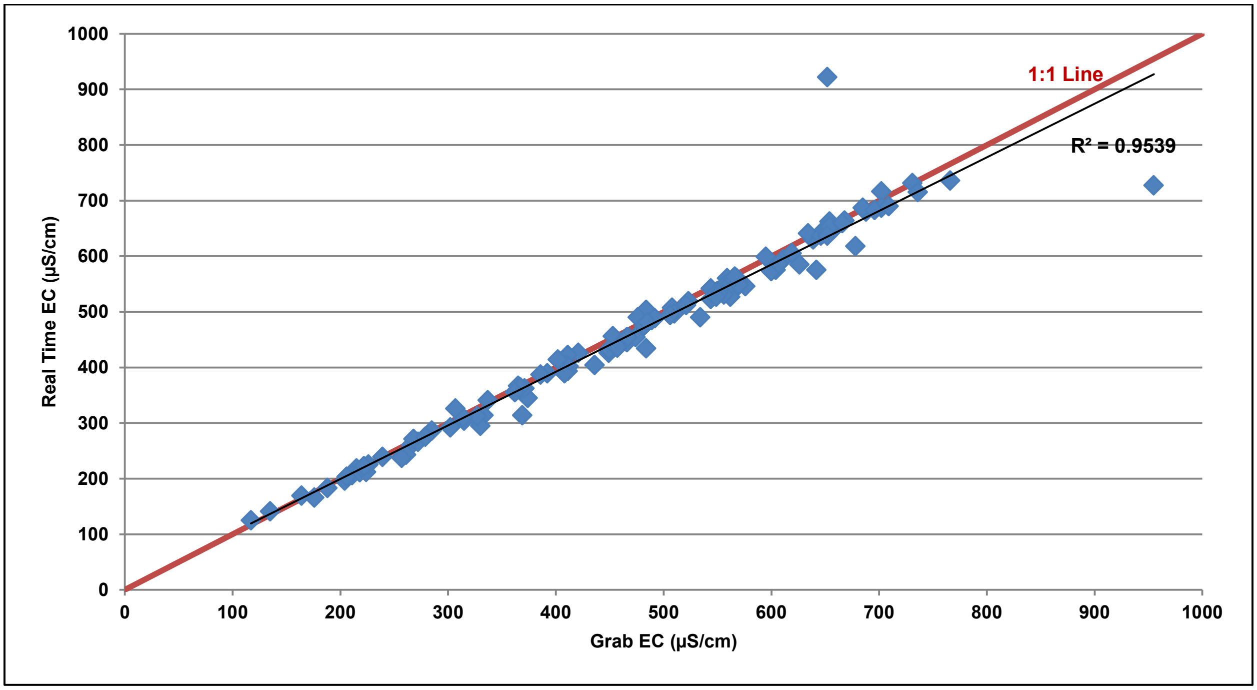


Figure 4-48. Comparison of Banks, McCabe and O'Neill Forebay Outlet EC Levels (1998-2020)

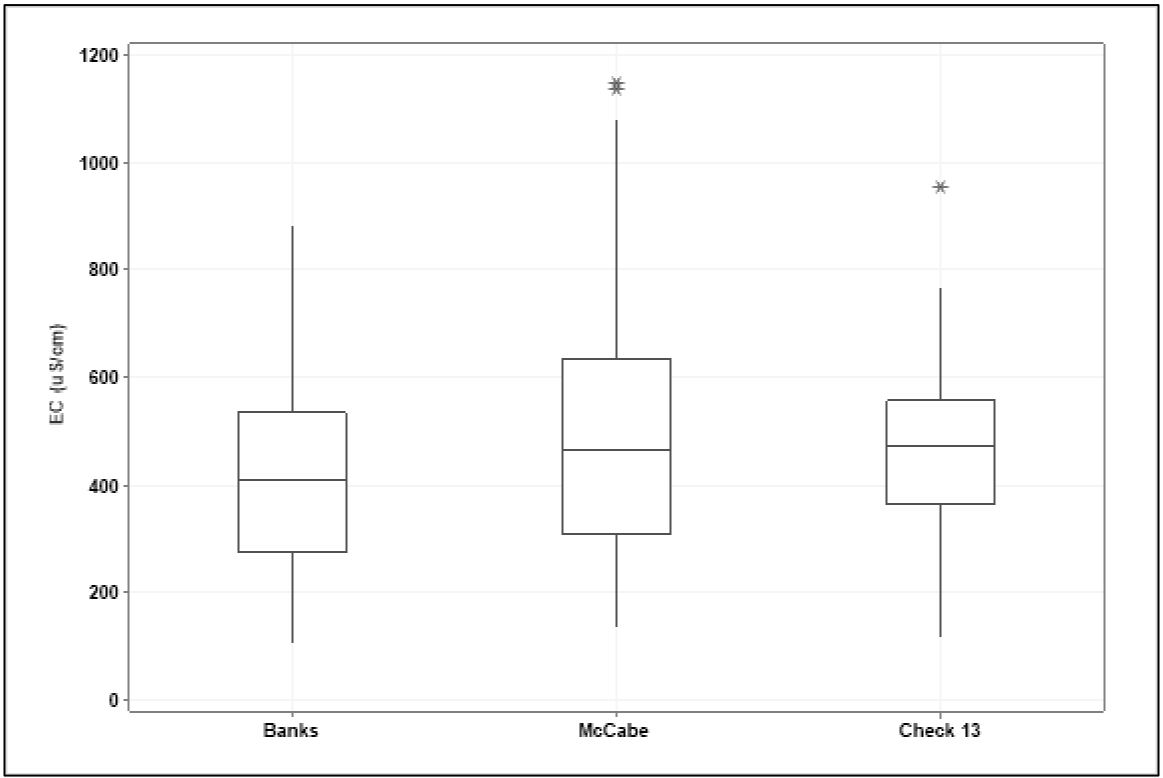
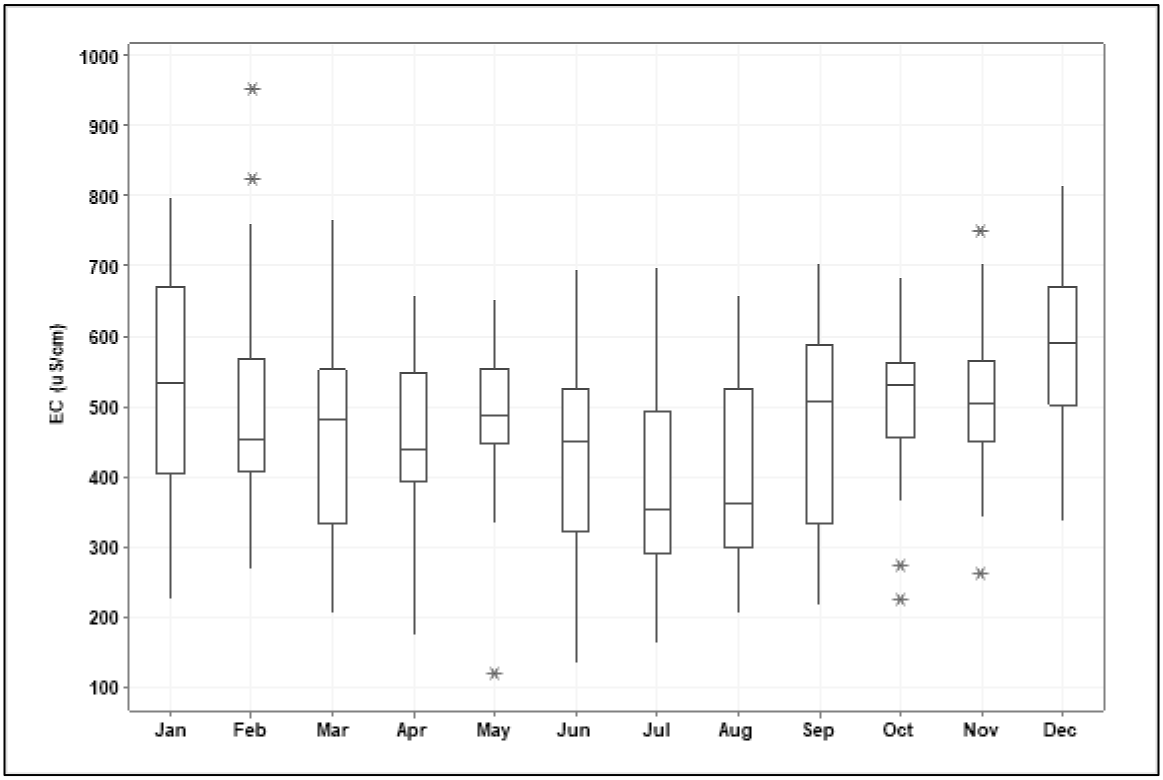


Figure 4-49. Monthly Variability in EC at O'Neill Forebay Outlet, 1988 to 2020



Check 21 – Check 21 represents the quality of water entering the Coastal Branch. **Figure 4-50** presents the EC grab sample data for Check 21. The EC levels at Check 21 range from 115 to 883 µS/cm with a median of 474 µS/cm.

- Comparison of Real-time and Grab Sample Data – **Figure 4-51** shows there is good correspondence between the real-time and grab sample data over time. Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. The real-time measurements captured peak levels above 800 µS/cm in several years that were not captured by the grab samples. **Figure 4-52** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-52** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.9779 which is acceptable.

- Spatial Trends – **Figure 4-53** compares the grab sample data collected at O'Neill Forebay Outlet to Check 21 from 1998 to 2020. Although there can be flood and groundwater non-Project inflows into the aqueduct between O'Neill Forebay Outlet and Check 21, the median EC of 473 µS/cm at Check 21 is not statistically significantly different than the median EC of 475 µS/cm at O'Neill Forebay Outlet.

- Long-Term Trends – Visual inspection of **Figure 4-50** does not reveal any discernible long-term trend. The increasing EC trend from 2012 to 2016 is due to five consecutive dry years, rather than a long-term pattern.

- Wet Year/Dry Year Comparison – The Check 21 wet year median EC of 374 µS/cm is statistically significantly lower than the dry year median EC level of 506 µS/cm (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – **Figure 4-54** shows there is a distinct seasonal pattern with the lowest concentrations in the summer (May through August) and the highest concentrations in the fall.

Figure 4-50. EC Levels at Check 21

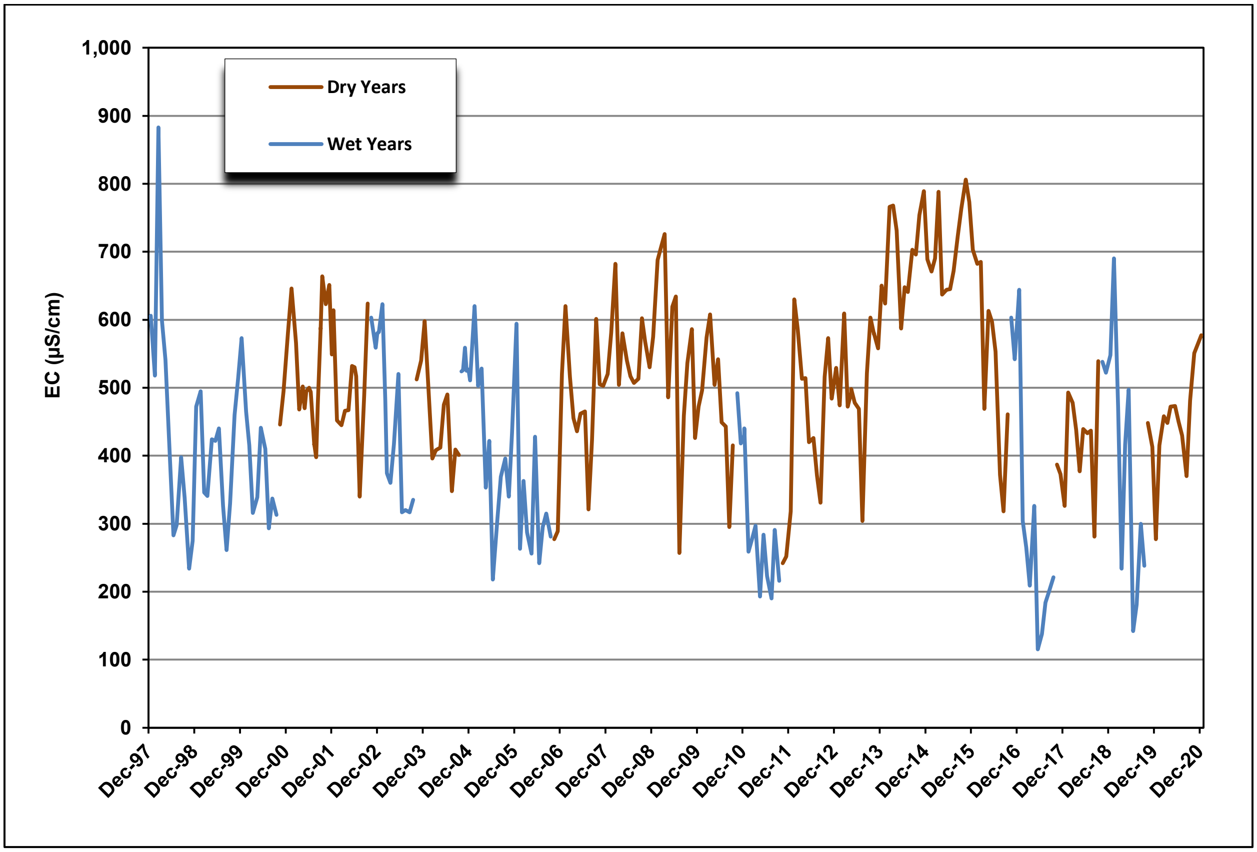


Figure 4-51. Comparison of Check 21 Real-time and Grab Sample EC Levels Over Time

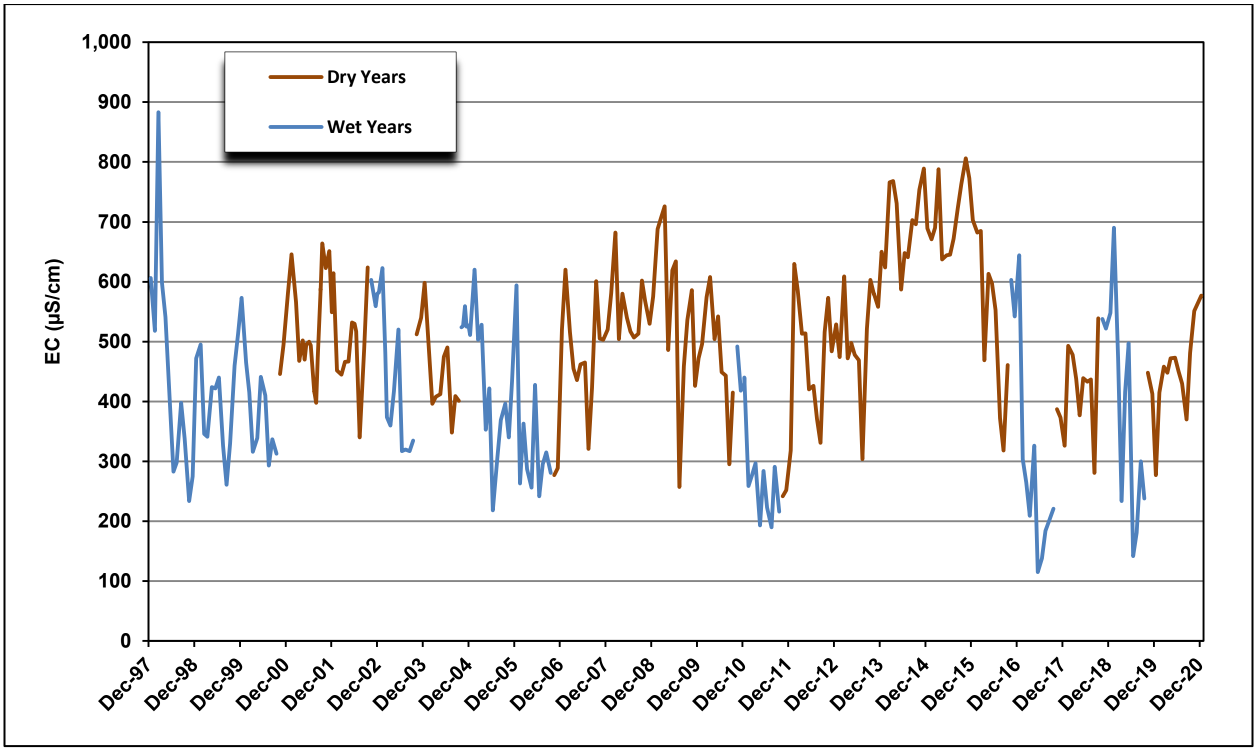


Figure 4-52. Comparison of Check 21 Real-time and Grab Sample EC Levels, 1:1 Graph, 2011 to 2020

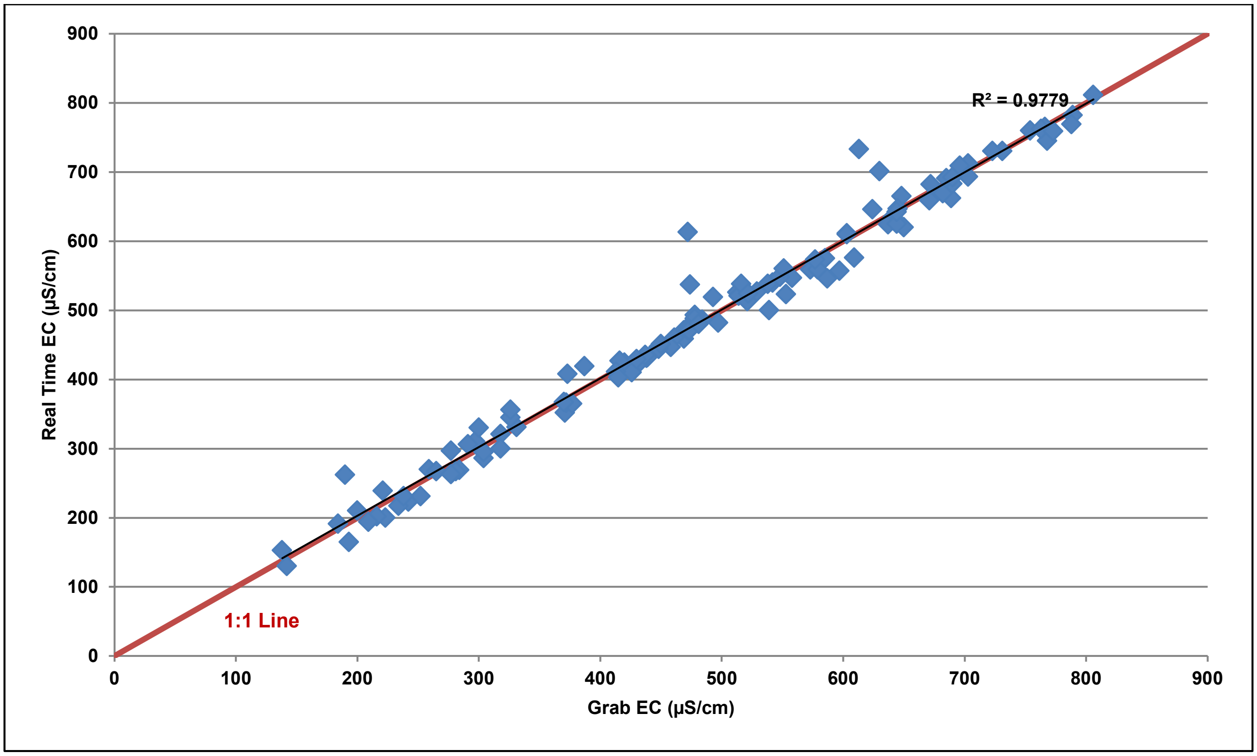


Figure 4-53. Comparison of Check 21 and O'Neill Forebay Outlet EC Levels (1998-2020)

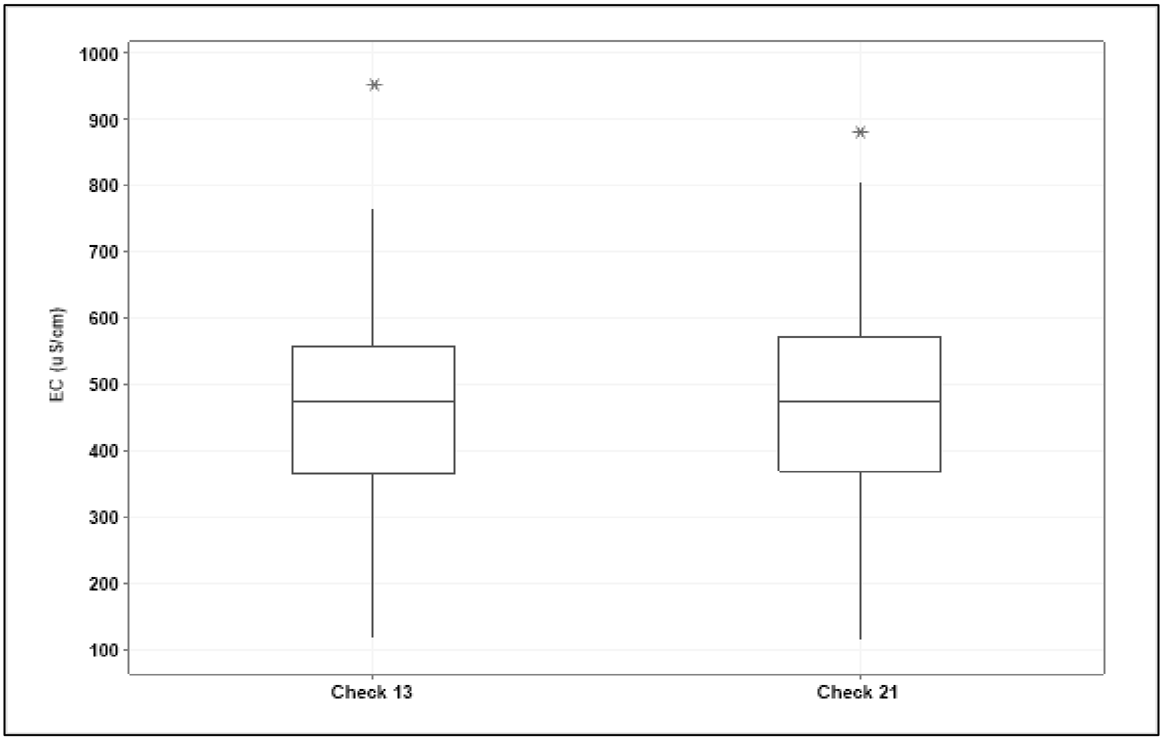
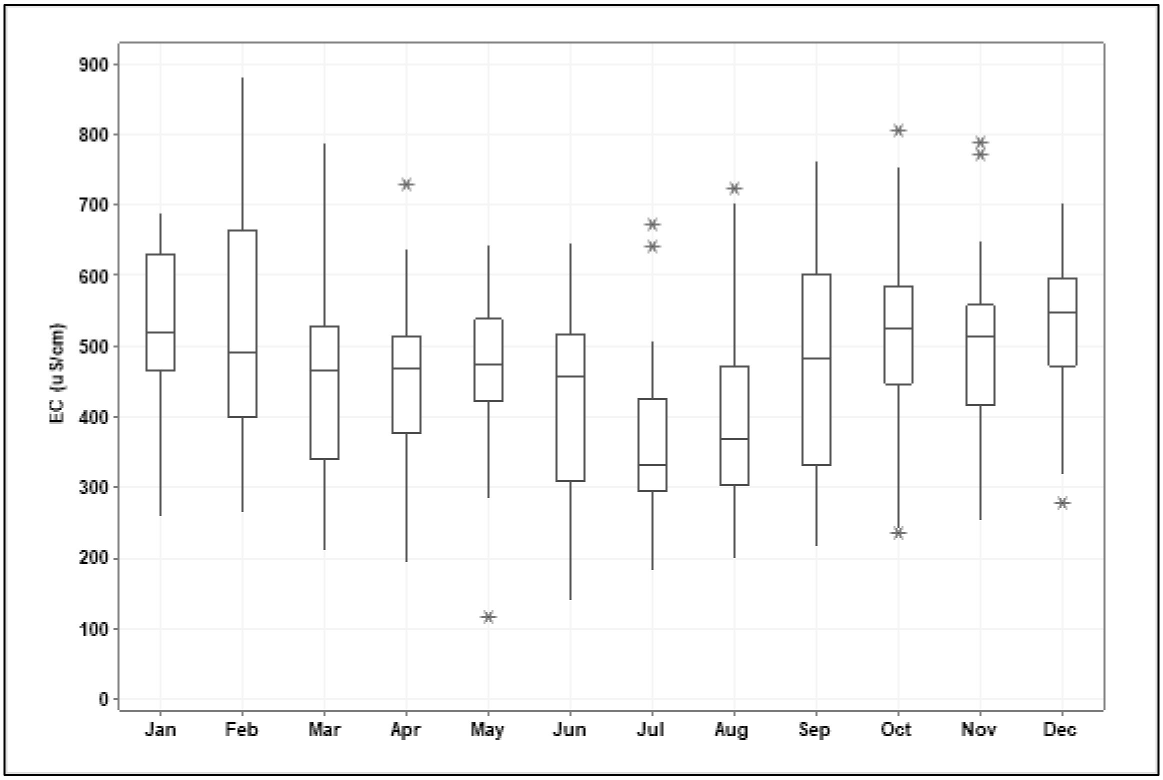


Figure 4-54. Monthly Variability in EC at Check 21, 1997 to 2020



Check 41 – Check 41 is just upstream of the bifurcation of the aqueduct. **Figure 4-55** presents the EC grab sample data for Check 41. The EC levels at Check 41 range from 106 to 722 µS/cm with a median of 455 µS/cm.

- Comparison of Real-time and Grab Sample Data – **Figure 4-56** shows there is good correspondence between the real-time and grab sample data over time. Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. The real-time captured peak levels above 600 µS/cm in several years that were not captured by the grab samples. The auto-sample results also show that EC levels were much higher in the early 1990s than in recent years. In recent years, the grab and real-time results have shown less correspondence, likely due to non-Project inflows. **Figure 4-57** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-57** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.8596 which is acceptable.

- Spatial Trends –**Figure 4-58** shows the median EC of 455 µS/cm at Check 41 is statistically significantly different from the median of 474 µS/cm at Check 21 (Mann-Whitney, *p*=0.016). Large volumes of groundwater are allowed to be pumped into the aqueduct between Checks 21 and 41, particularly in dry years. The EC levels of some non-Project inflows are lower than the levels in the aqueduct and the levels of some non-Project inflows are higher than the aqueduct. **Figure 4-58** presents the data for Check 21 and Check 41, and the volumes of non-Project water pumped into the Aqueduct between Check 21 and Check 41 for the last fifteen years. EC levels at Check 21 and Check 41 are generally similar when there are no pump-ins, yet EC decreases at Check 41 with higher volumes of non-Project water pumped into the Aqueduct, particularly during extended dry periods, such as January 2007 to July 2010 and January 2014 to April 2016.

- Long-Term Trends – **Figure 4-55** shows the same hydrology-based trend as seen at other locations. EC increases during dry years and then decreases during wet year. The wet year decreases are due to a combination of lower EC water pumped from the Delta and non-Project inflows with low EC.

- Wet Year/Dry Year Comparison – The Check 41 wet year median EC level of 350 µS/cm is statistically significantly lower than the dry year median EC level of 483 µS/cm (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – **Figure 4-59** shows there is a distinct seasonal pattern with the lowest concentrations in the summer (July and August) and the highest concentrations in the fall and winter.

Figure 4-55. EC Levels at Check 41

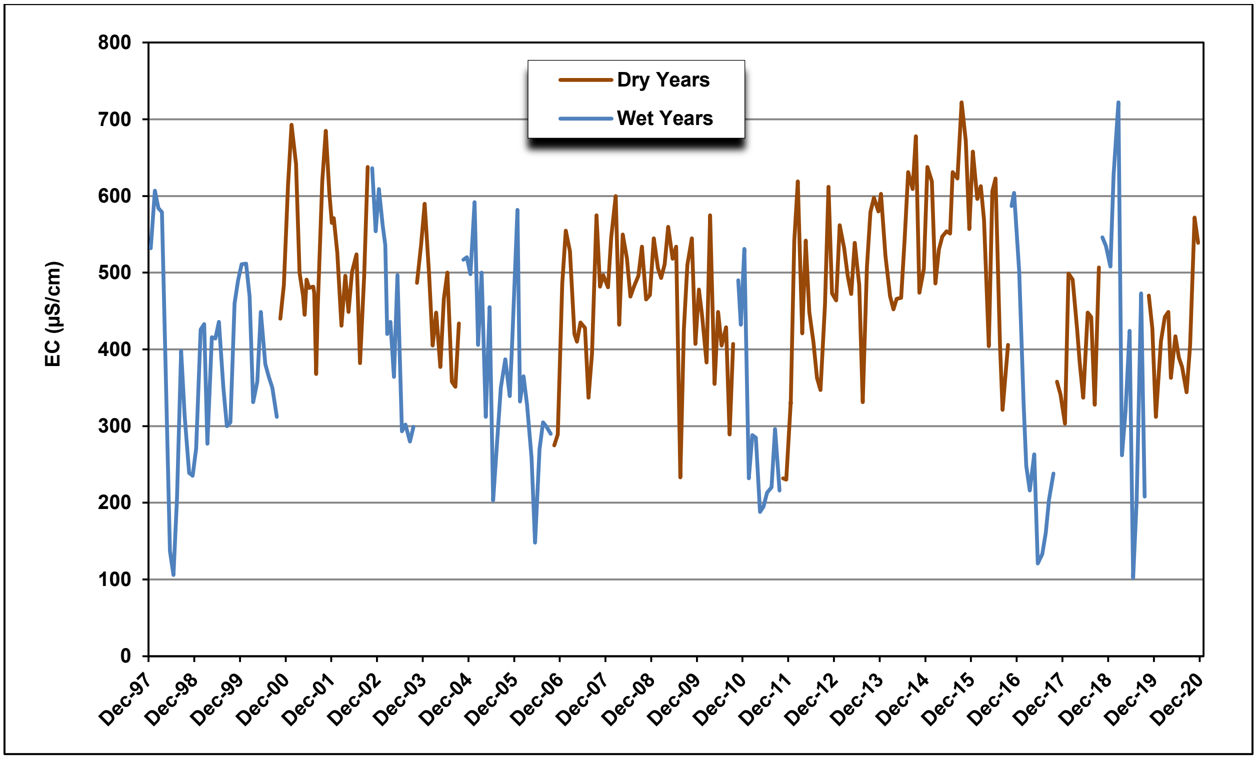


Figure 4-56. Comparison of Check 41 Real-time and Grab Sample EC Levels Over Time

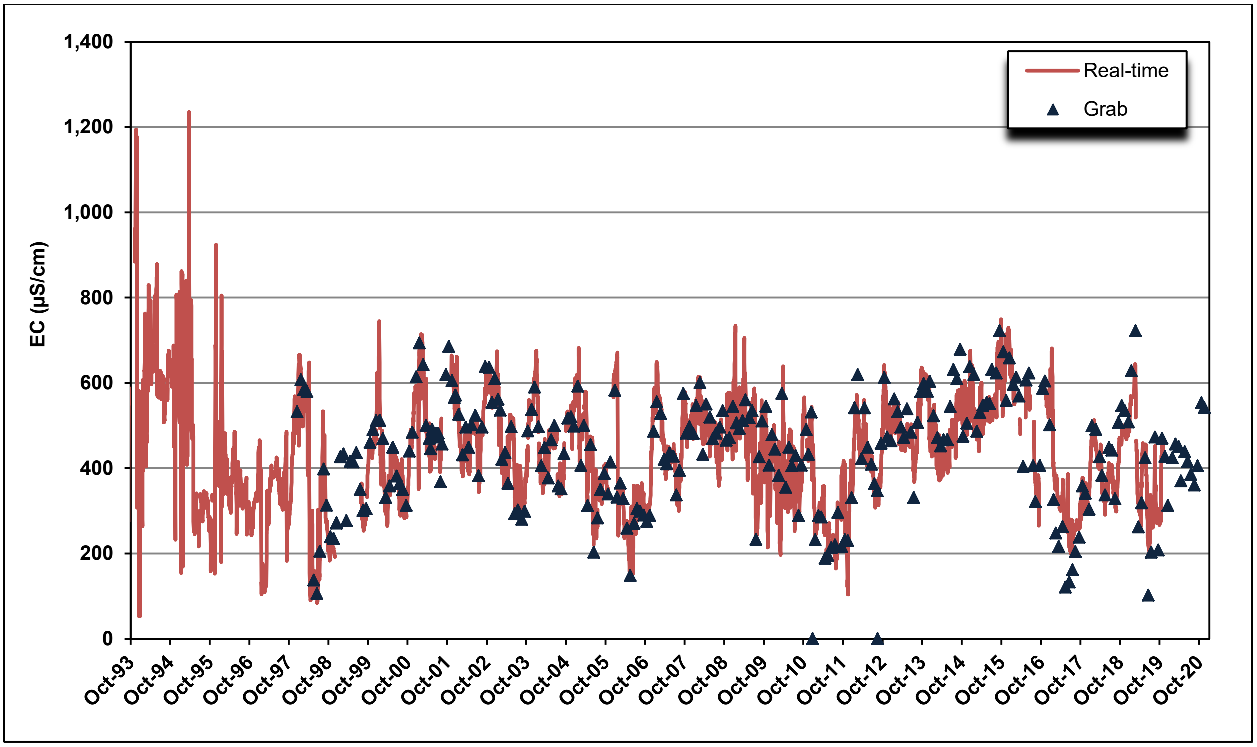


Figure 4-57. Comparison of Check 41 Real-time and Grab Sample EC Levels, 1:1 Graph, 2011 to 2020

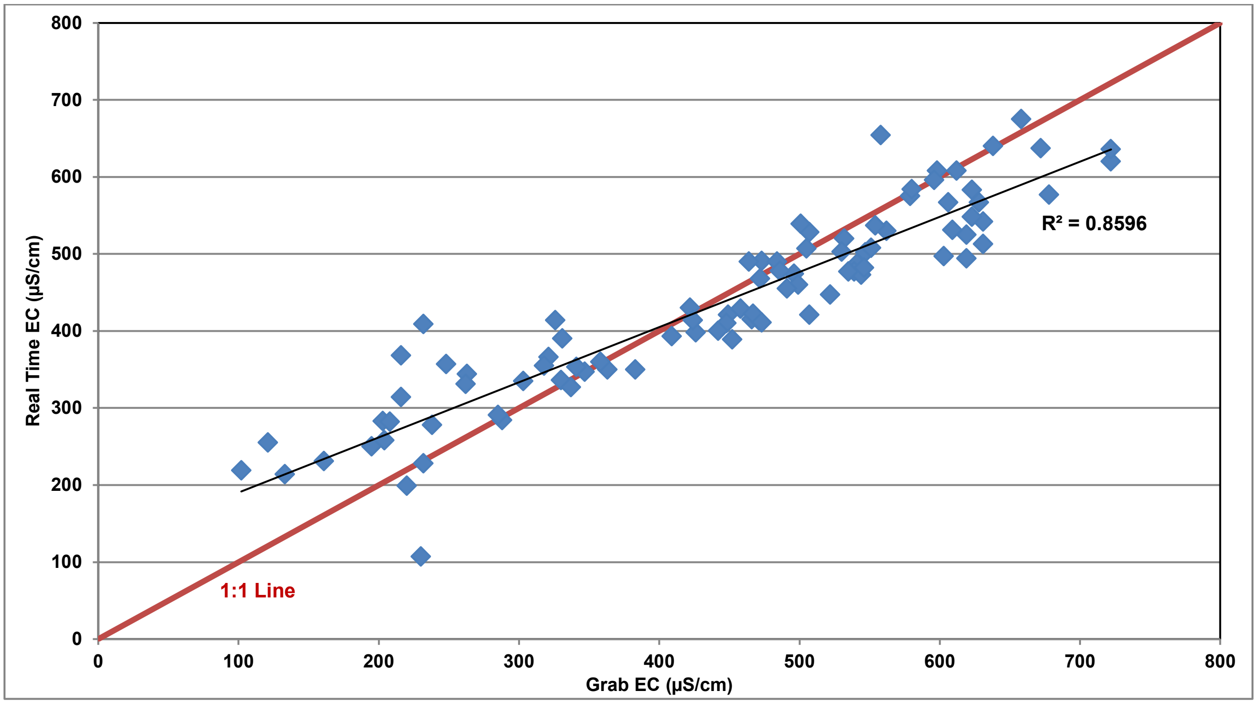


Figure 4-58. Comparison of Check 21 and Check 41 EC Levels, with Turn-In Volumes

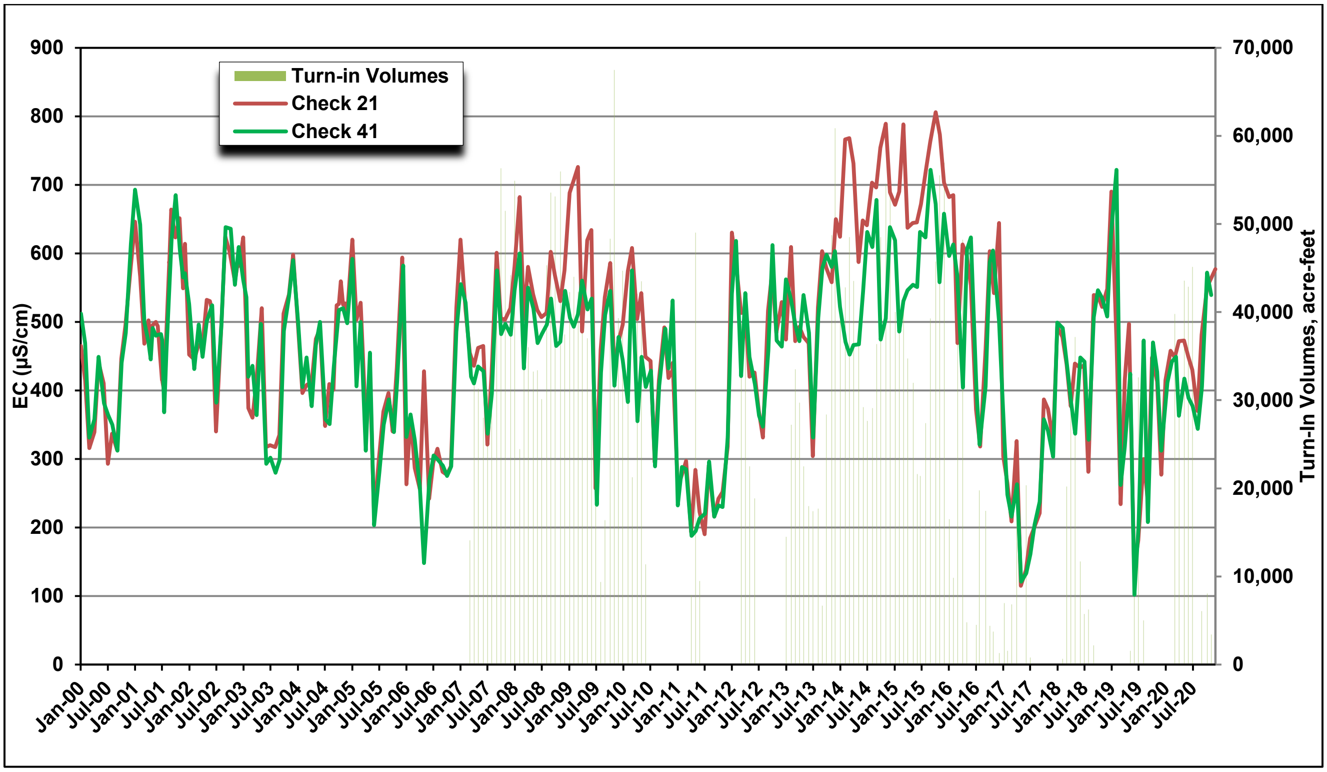
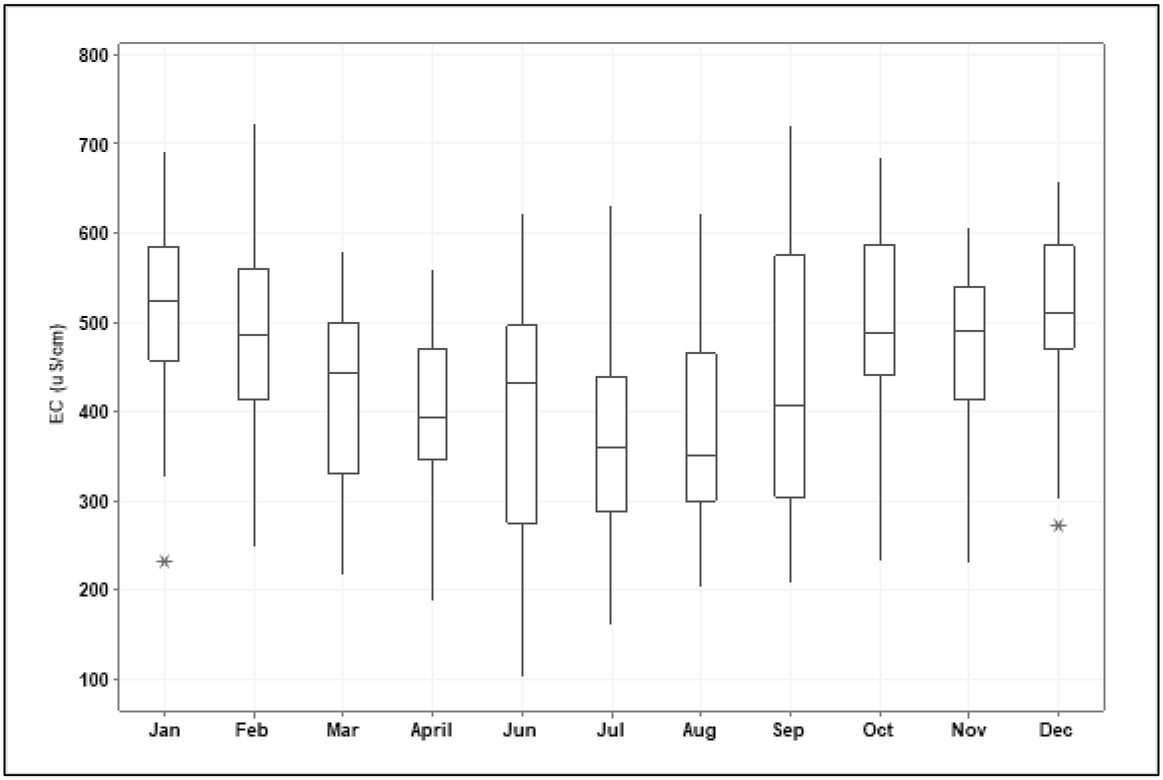


Figure 4-59. Monthly Variability in EC at Check 41, 1997 to 2020



Castaic Outlet – Castaic Lake is the terminus of the West Branch of the California Aqueduct. **Figure 4-60** presents the EC grab sample data for Castaic Outlet. The EC levels at Castaic Outlet range from 388 to 651 µS/cm with a median of 489 µS/cm. There is much less variability in the EC data in the lake compared to the Aqueduct.

- Comparison of Real-time and Grab Sample Data – Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. **Figure 4-61** shows there was good correspondence between the real-time and grab sample data during most periods, but not during the extended dry period from 2008 through 2016. **Figure 4-62** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-62** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.6872 which could be improved.

- Spatial Trends – **Figure 4-63** compares Check 41 data to Castaic Outlet data. Because samples are collected quarterly at Castaic Outlet and monthly at Check 41, only the quarterly data are included in this analysis. When comparing the same period of record, the median EC level of 489 µS/cm at Castaic Outlet is statistically significantly higher than the median EC of 452 µS/cm at Check 41 (Mann-Whitney, *p*=0.000).

- Long-Term Trends – **Figure 4-60** shows the same hydrology-based trend as seen at other locations. EC increases during dry years and then decreases during wet years.

- Wet Year/Dry Year Comparison – The Castaic Outlet wet year median EC level of 493 µS/cm is not statistically significantly different than the dry year median of 476 µS/cm (Mann-Whitney, *p*=0.33).

- Seasonal Trends – Due to the limited quarterly sampling, **Figure 4-64** does not show any clear seasonal trend.

Figure 4-60. EC Levels at Castaic Outlet

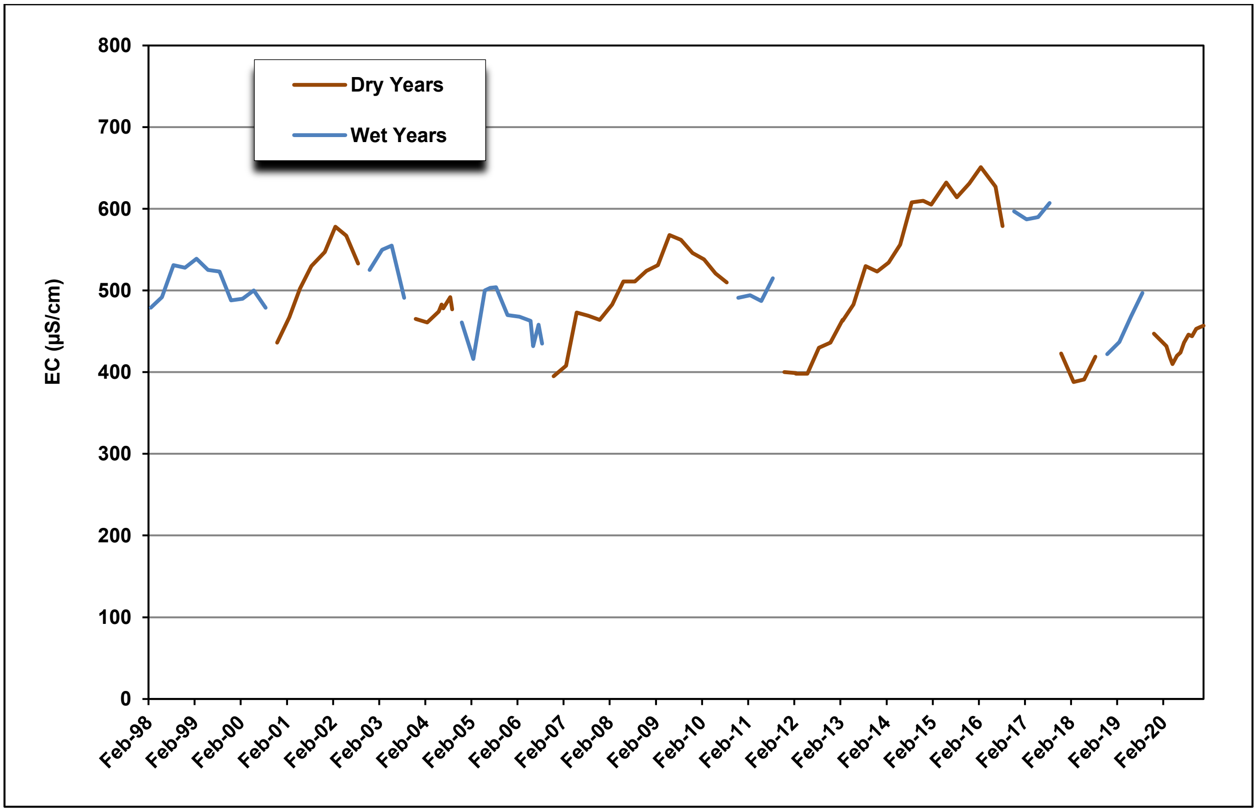


Figure 4-61. Comparison of Castaic Outlet Real-time and Grab Sample EC Levels Over Time

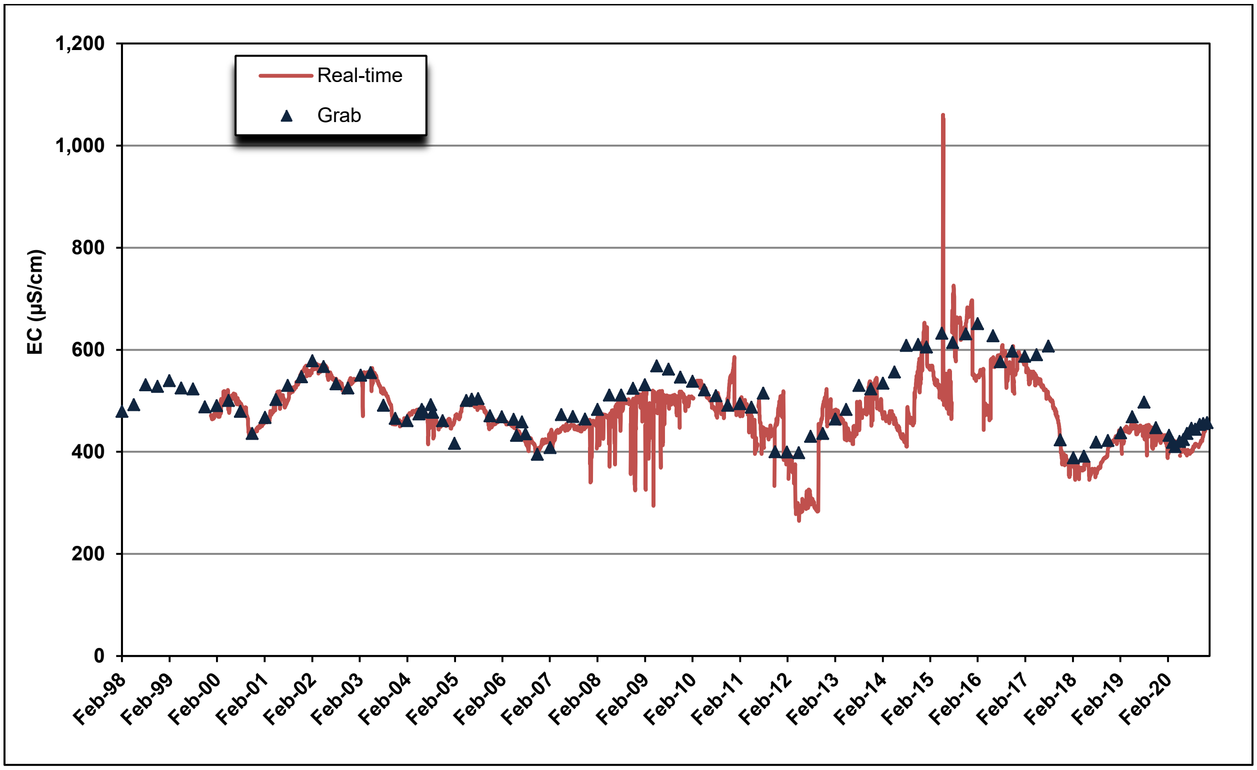


Figure 4-62. Comparison of Castaic Outlet Real-time and Grab Sample EC Levels, 1:1 Graph, 2011 to 2020

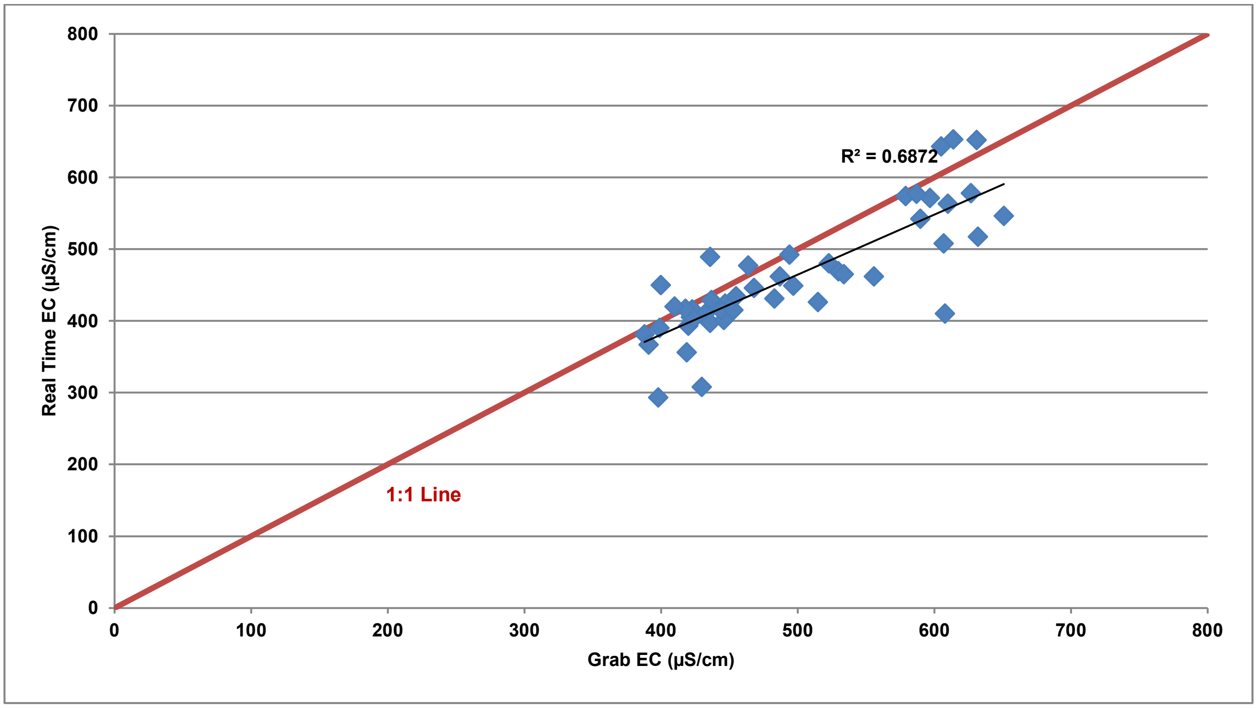


Figure 4-63. Comparison of EC Levels at Check 41 and Castaic Outlet (1998-2020)

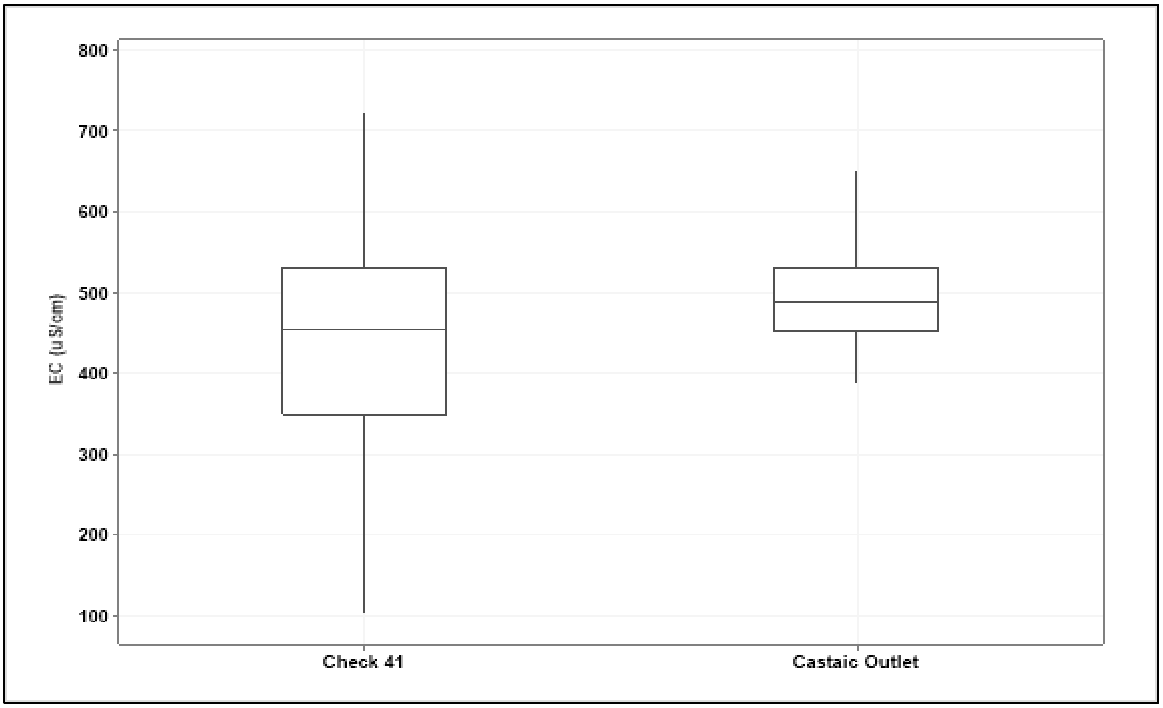
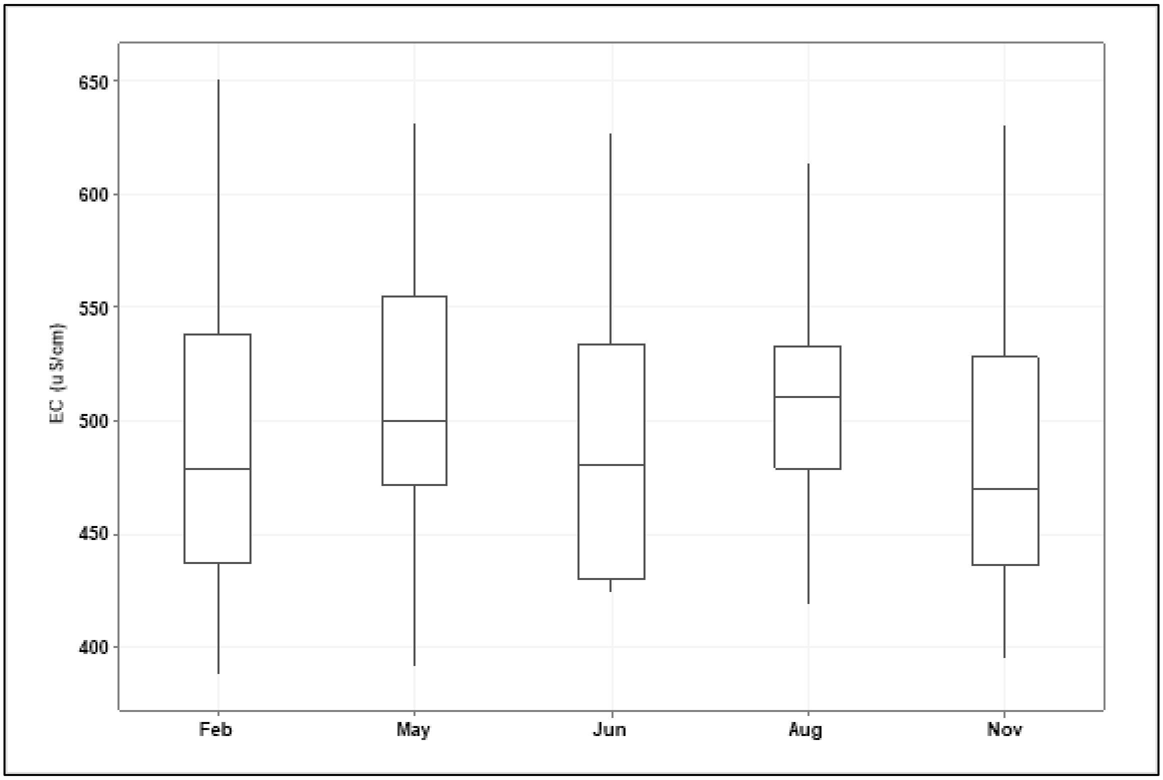


Figure 4-64. Monthly Variability in EC at Castaic Outlet, 1998 to 2020



Devil Canyon – Devil Canyon Afterbay is downstream of Silverwood Lake on the East Branch of the California Aqueduct. **Figure 4-65** presents the EC grab sample data for Devil Canyon. The EC levels at Devil Canyon range from 150 to 645 µS/cm with a median of 456 µS/cm.

- Comparison of Real-time and Grab Sample Data – Average daily EC, calculated from hourly measurements, was downloaded from CDEC for this analysis. **Figure 4-66** shows there is good correspondence between the real-time and grab sample data with the exception of data collected in 2011 and 2012. The real-time data show that peak EC levels can be higher than those captured by the grab sample data. **Figure 4-67** compares the real-time and grab sample data on a 1:1 basis. **Figure 4-67** shows that when the 2011 to 2020 data is plotted 1:1, the R squared value is 0.9348 which is acceptable.

- Spatial Trends –**Figure 4-68** compares Check 41 data to Devil Canyon data for the 1998 to 2020 period when data are available at both locations. The median EC level of 456 µS/cm at Devil Canyon is not statistically significantly different than the median EC of 455 µS/cm at Check 41 (Mann-Whitney, p=0.962).

- Long-Term Trends – **Figure 4-65** shows the same hydrology-based trend as seen at other locations. EC increases during dry years and then decreases during wet years.

- Wet Year/Dry Year Comparison – The Devil Canyon wet year median EC level of 369 µS/cm is statistically significantly lower than the dry year median of 491 µS/cm (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 4-69** shows the same bimodal seasonal pattern that exists in the aqueduct, with concentrations increasing through the fall months to a peak in January, followed by declining concentrations in the late winter and early spring, followed by a secondary peak in levels are lowest in August and September about one month later than at O'Neill Forebay Outlet.

Figure 4-65. EC Levels at Devil Canyon

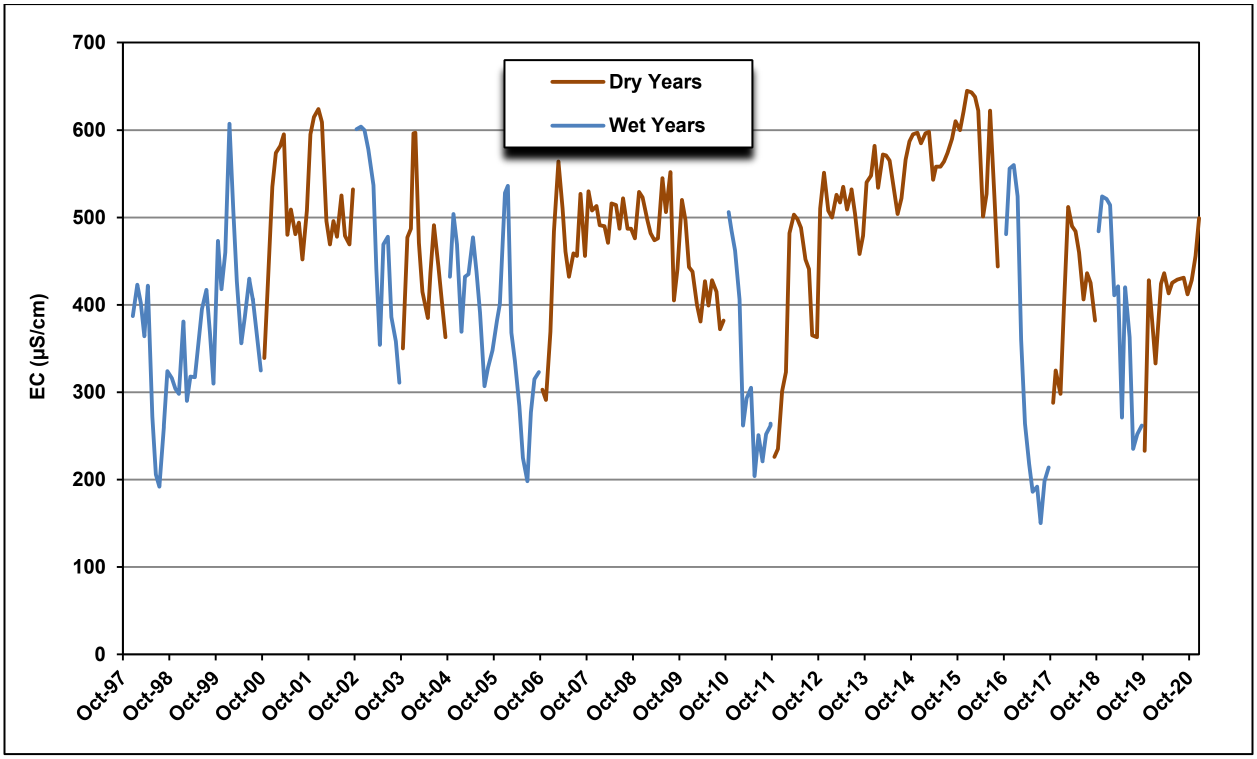


Figure 4-66. Comparison of Devil Canyon Real-time and Grab Sample EC Levels Over Time

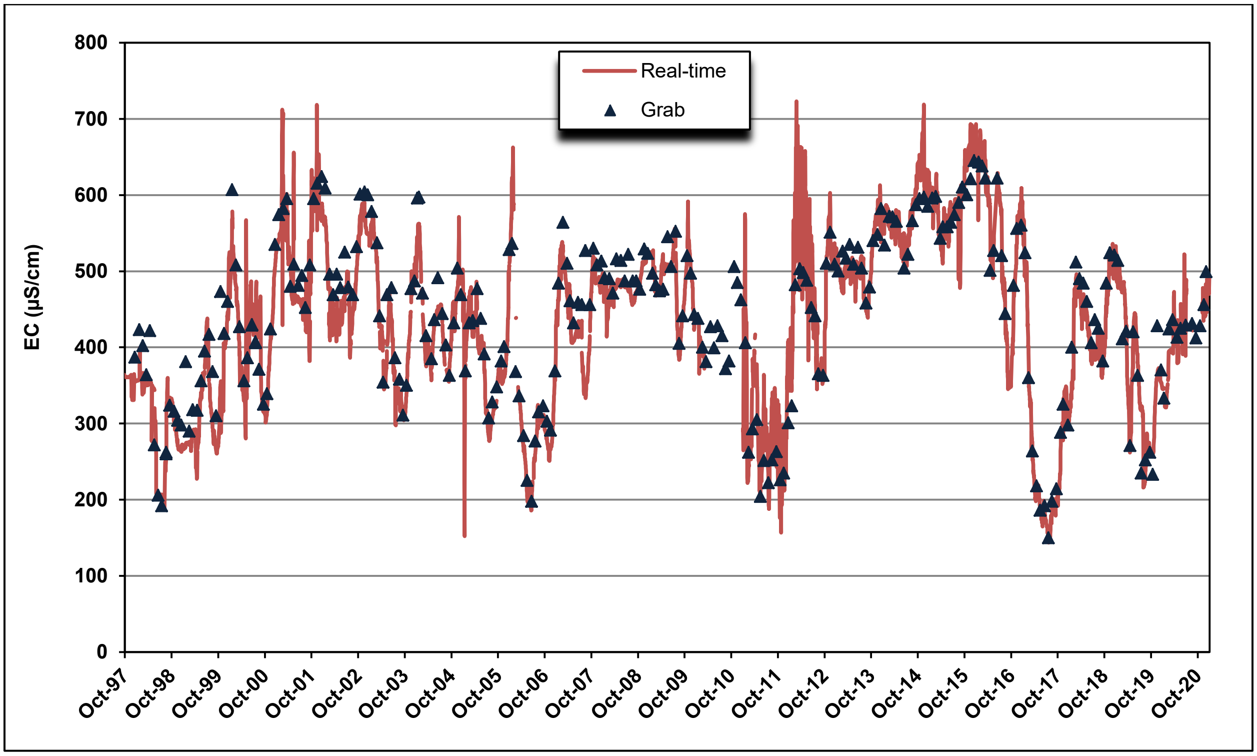


Figure 4-67. Comparison of Devil Canyon Real-time and Grab Sample EC Levels, 1:1 Graph, 2011 to 2020

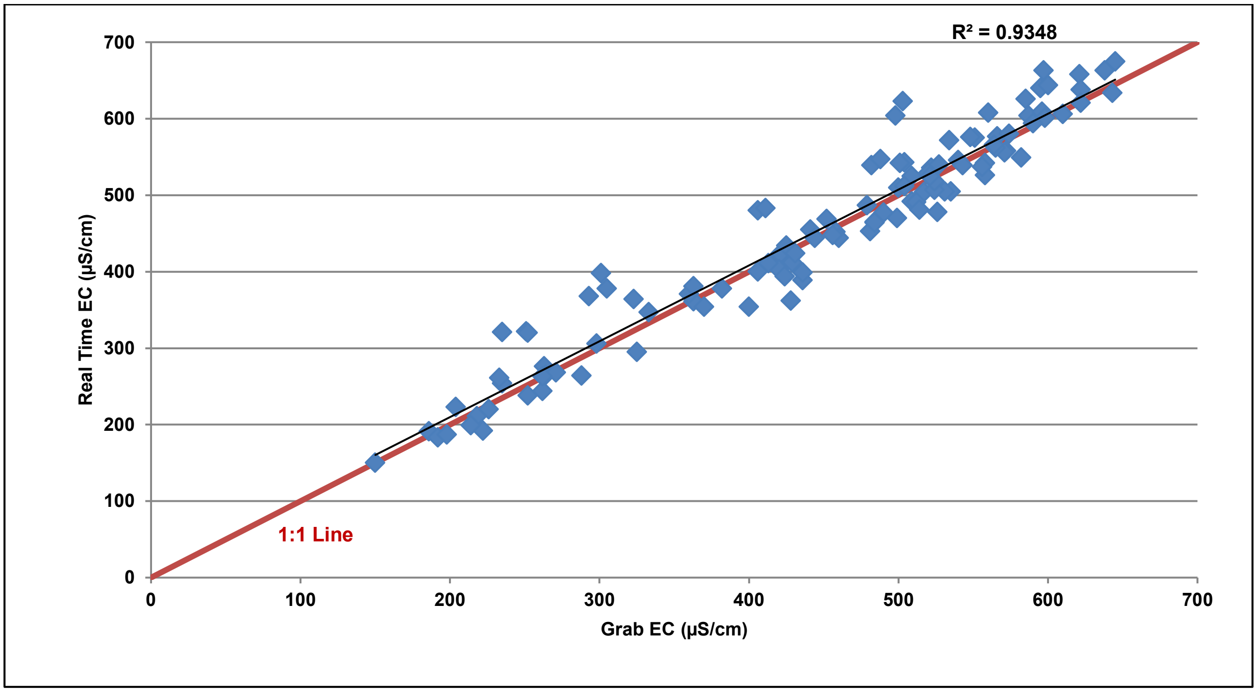


Figure 4-68. Comparison of Check 41 and Devil Canyon EC Levels

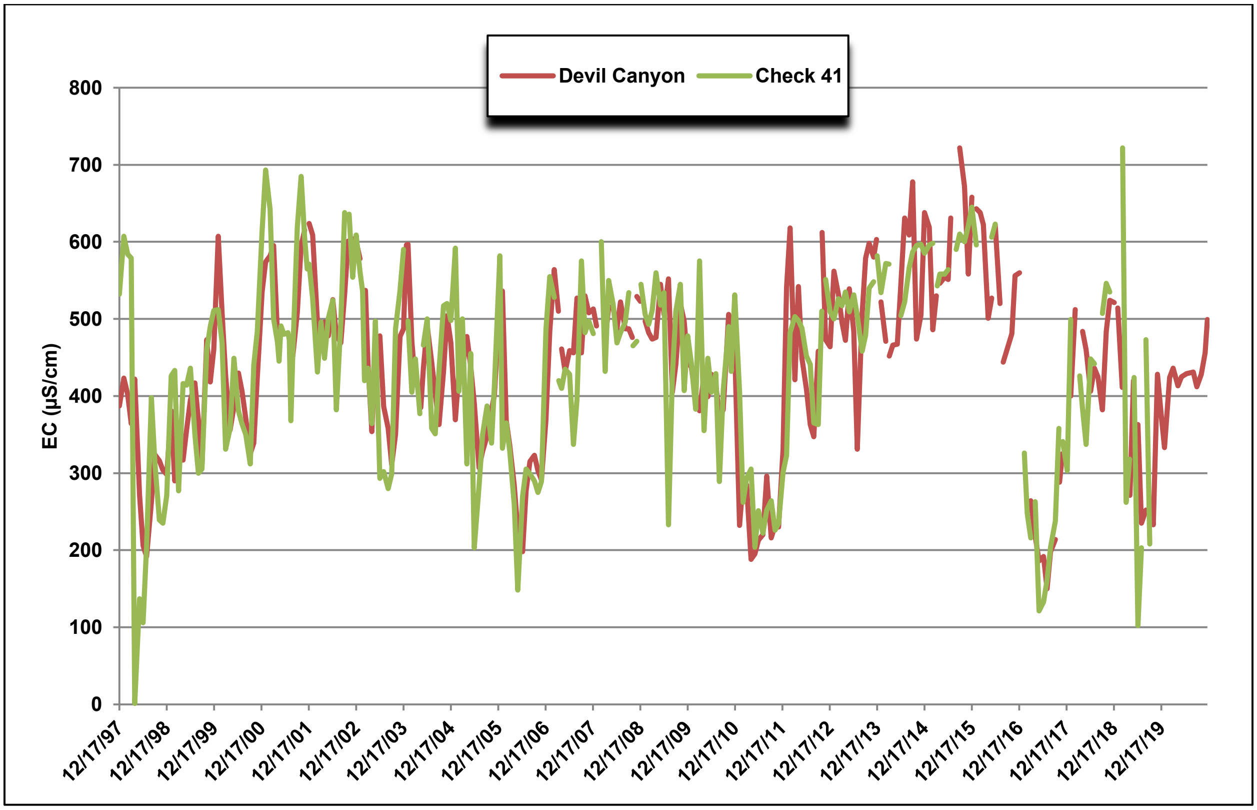
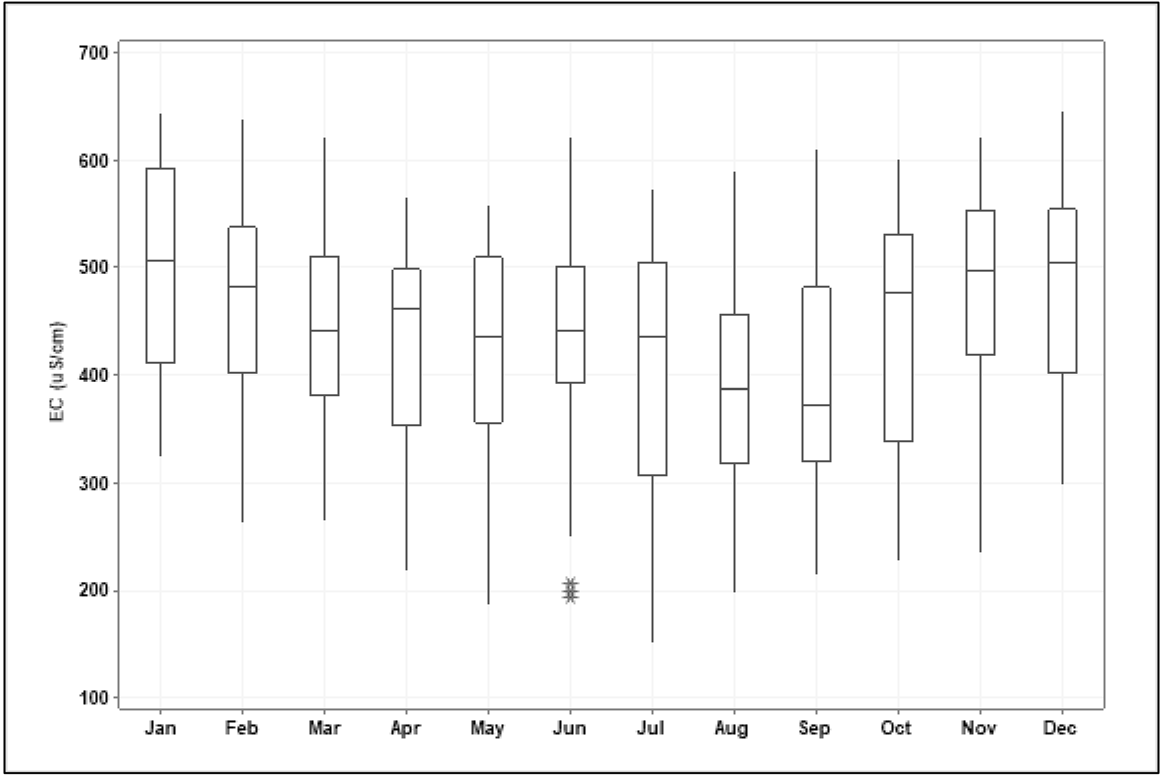


Figure 4-69. Monthly Variability in EC at Devil Canyon, 1997 to 2020



SUMMARY

- The EC fingerprints indicate that the San Joaquin River, seawater intrusion, and Delta agricultural drainage are the primary sources of EC at the south Delta pumping plants. The San Joaquin River has a greater influence on EC at Jones than at Clifton Court.

- The median EC at Hood (156 µS/cm) remained low, similar to historic data. EC levels at Vernalis (median of 609 µS/cm) are statistically significantly higher than the levels in the Sacramento River.

- EC levels in the NBA are higher and more variable than at Hood but lower than the levels at Banks. Elevated EC levels during the spring months are associated with base flows from sodic soils in the upstream Barker Slough watershed.

- EC levels in the SBA are similar to Banks, with levels ranging from 111 to 894 µS/cm and a median of 406 µS/cm. EC tends to increase in the fall months.

- Because different periods of record are available at sampling locations, it is difficult to compare all of the location using the same time period. However, the majority of locations can be compared using a common data set from 1997 to 2020. These are the 1997 to 2020 EC medians; Banks at 410 µS/cm, DV Check 7 at 406 µS/cm, McCabe at 467 µS/cm, O'Neill Forebay Outlet at 476 µS/cm, Check 21 at 474 µS/cm, Check 41 at 455 µS/cm, and Devil Canyon at 456 µS/cm. The 1997 to 2020 medians show an increase in EC moving downstream. There is a statistically significant increase between Banks and McCabe, most likely due to the influence of the San Joaquin River at Jones. There is a statistically significant decrease between Check 21 and 41, most likely due to non-Project inflows of lower EC water introduced between Check 21 and Check 41.

- EC levels at Castaic Outlet are less variable than the aqueduct locations, due to the dampening effect of about 500,000 acre-feet of storage on the West Branch. The dampening effect is not seen in Silverwood Lake on the East Branch due to its limited hydraulic residence time. The median EC at Castaic Outlet is statistically significantly higher than Check 41.

- There are a number of real-time monitoring locations in the watersheds, along the California Aqueduct, and in the reservoirs. There is good correspondence between the grab sample and real-time EC data at most locations, with poorer correspondence at Castaic.

- Time series graphs at each key location were visually inspected to determine if there are any discernible long-term trends. The only long-term trends observed in the data are related to hydrology, with EC increasing during dry years and decreasing during wet years at most sites. All of the dry year medians decreased from the 2016 WSS for all locations. All of the wet year medians decreased from the 2016 WSS for all locations, except Pacheco and Castaic Outlet which were essentially unchanged.

- There were a number of locations where the maximum EC concentration over the entire period of record occurred during the study period. For example:
    - Barker Slough maximum EC concentration of 826 µS/cm was measured in March 2017.
    - Pacheco maximum EC concentration of 708 µS/cm was measured in January 2016.
    - Check 41 maximum EC concentration of 722 µS/cm was measured in February 2019.
    - Castaic Outlet maximum EC concentration of 651 µS/cm was measured in February 2016.
    - Devil Canyon maximum EC concentration of 645 µS/cm was measured in January 2016.

- EC levels during wet years are statistically significantly lower than EC levels during dry years at all locations except Barker Slough and Castaic Outlet, as shown in **Table 4-3**. The higher levels during dry years are due to less dilution of agricultural drainage, urban runoff, and treated wastewater discharged to the rivers and Delta during low flow periods and to seawater intrusion in the Delta during periods of low Delta outflow. Barker Slough is influenced more by the local watershed than by differences in Delta conditions in different year types. There is little variability in Castaic due to the dampening effects of storage.

- There are distinct seasonal patterns in EC levels but they vary between locations. On the Sacramento River, EC levels are lowest in the early summer, increase in the fall and then decrease during the spring months. On the San Joaquin River, EC levels are lowest in the spring during the Vernalis flow requirements stipulated in Decision 1641, increase during the summer months due to agricultural drainage discharges, continue to climb during the fall due to seawater intrusion, and remain high until late winter or early spring when flow increases on the river. The seasonal pattern at Banks is similar to the Sacramento River with the lowest levels in July and the highest levels in December. The pattern seen at Banks is seen at most of the other locations except below San Luis Reservoir there is a bimodal seasonal pattern with a secondary peak in EC during May and June. Large amounts of water are released from the reservoir during these months, resulting in higher EC levels in the California Aqueduct.

Table 4-3. Comparison of Dry Year and Wet Year EC Levels

	Median EC (µS/cm)				
Location	**Dry Years**	**Wet Years**	**EC Difference (µS/cm))**	**Percent Difference**	**Statistical Significance**
Hood	165	142	23	14%	D>W
Vernalis	698	392	306	44%	D>W
Banks	486	293	193	40%	D>W
Barker Slough	286	292	6	2%	No
DV Check 7	486	300	186	38%	D>W
McCabe	552	314	238	43%	D>W
Pacheco	521	495	26	5%	D>W
Gianelli	549	435	114	21%	D>W
O'Neill Forebay Outlet	531	373	158	30%	D>W
Check 21	506	374	132	26%	D>W
Check 41	483	350	133	28%	D>W
Castaic Outlet	476	493	17	3%	No
Devil Canyon	491	369	122	25%	D>W

CHAPTER 5 BROMIDE

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CHAPTER 5 BROMIDE

WATER QUALITY CONCERN

Bromide is of concern to State Water Project (SWP) Contractors because it reacts with oxidants used for disinfection in water treatment to form disinfection byproducts (DBPs). When chlorine is used as a disinfectant, bromide reacts with chlorine and TOC to form brominated trihalomethanes (THMs) and haloacetic acids (HAA5s). The Stage 1 Disinfectants and Disinfection Byproduct (D/DBP) Rule limits the concentration of total trihalomethanes (TTHMs) to 0.080 mg/L and HAA5 to 0.060 mg/L as a running annual average in drinking water distribution systems. The Stage 2 D/DBP Rule limits the concentration of TTHMs to 0.080 mg/L and HAA5 to 0.060 mg/L as a locational running annual average. Three of the four regulated trihalomethanes, (i.e. bromodichloromethane, dibromochloromethane, and bromoform) contain bromide and two of the regulated HAA5s, monobromoacetic acid and dibromoacetic acid contain bromide. Another DBP, bromate, is formed when bromide is present and ozone is used for disinfection. The Stage 1 Maximum Contaminant Level (MCL) for bromate is 0.010 mg/L, based on a 12-month running annual average and measured at the entrance to the distribution system. Compliance with the Stage 1 and Stage 2 D/DBP Rules presents challenges for the SWP Contractors whose source water contains both bromide and organic carbon.

WATER QUALITY EVALUATION

BROMIDE CONCENTRATIONS IN THE SWP

Bromide data are analyzed in this section to examine changes in bromide as the water travels through the SWP system and to determine if there are seasonal or temporal trends. All available bromide data from the Department of Water Resources (DWR's) Municipal Water Quality Investigations (MWQI) Program and the Division of Operations and Maintenance (O&M) SWP monitoring program through December 2020 were obtained for a number of locations along the SWP. Both grab samples and real-time data are included in this analysis. Data are presented in summary form for all locations and analyzed in more detail for a number of key locations. Box plots are also used to show data from multiple locations on one plot and to display seasonal differences at one location. **Figure 2-25** presents an explanation of the box plots. **Table 5-1** shows the period of record available for each location.

The recent study period of 2016 through 2020 represented a time period of alternating wet and dry years for the Sacramento Valley Water Year Index, with water year 2016 classified as below normal, 2017 classified as wet, 2018 classified as below normal, 2019 classified as wet, and 2020 classified as dry.

The California Department of Water Resources adopts five water year types: wet, above normal, below normal, dry, and critical. The classification is based on a water year index that is derived from full natural flow measurements. For the Sacramento River region, the water year index is called the Sacramento Valley Index (SVI) (also known as the "4 River Index" and the "40-30-30 Index") and uses the sum of calculated monthly unimpaired runoff from the following gauges:

Sacramento River above Bend Bridge, Feather River at Oroville, Yuba River at Smartsville, and American River below Folsom Dam. The SVI is calculated based on the following equation:

SVI = (0.4 X current April-July runoff) + (0.3 X current October-March runoff) + (0.3 X previous year's index)

The current April-July runoff is for the sum of the runoff for the four rivers in the current water year from April to July, in million acre-feet. If the previous year's index exceeds 10 MAF, then 10 MAF is applied instead. Once the SVI is calculated, the year type classification is based on the thresholds in **Table 2-2.**

Table 5-1. Bromide Data

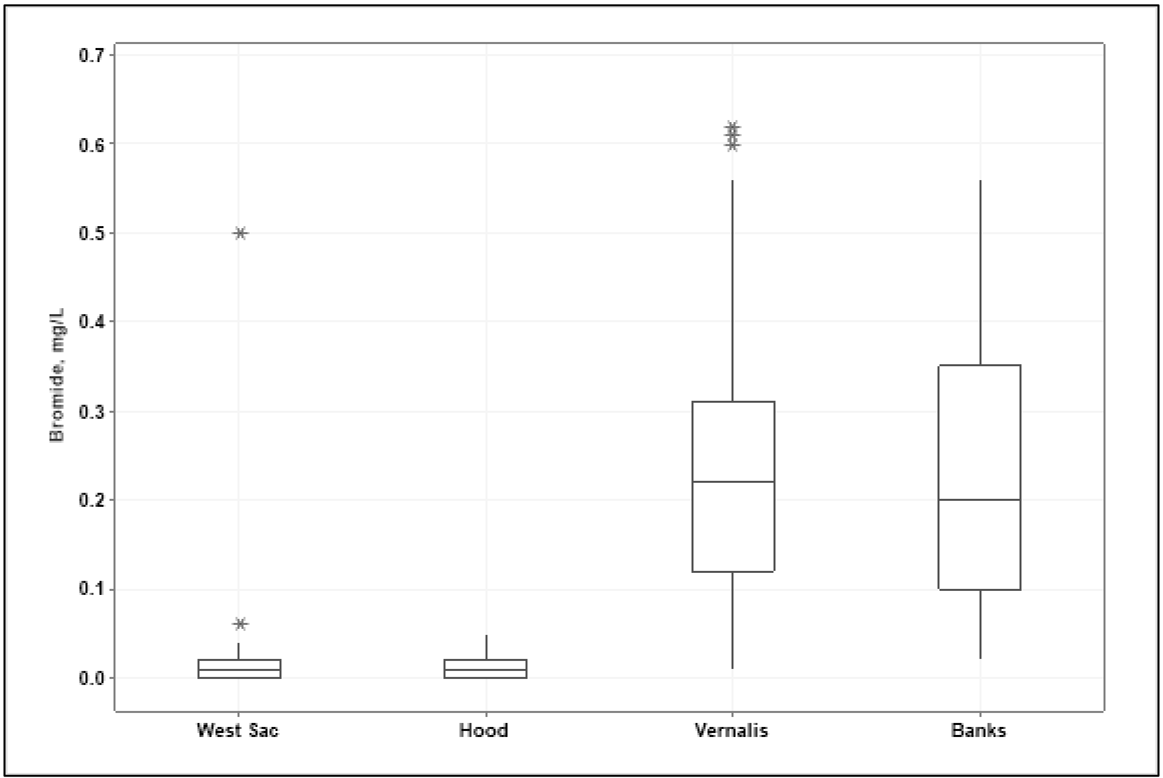
Location	Grab Samples		Real-time	
	Start Date	**End Date**	**Start Date**	**End Date**
West Sacramento	Apr 1994	Dec 2020		
American	May 1990	Dec 2020		
Hood	Aug 1997	Dec 2020		
Vernalis	Jan 1990	Dec 2020	Jun 2006	Dec 2020
Banks	Feb 1991	Dec 2020	May 2006	Dec 2020
Barker Slough	Feb 1990	Dec 2020		
DV Check 7	Dec 1997	Dec 2020		
McCabe	Dec 1997	Dec 2020		
Pacheco	Mar 2000	Dec 2020		
Gianelli	Jan 2013	Dec 2020	Jan 2013	Dec 2020
O'Neill Forebay Outlet	Aug 1990	Dec 2020		
Check 21	Feb 1998	Dec 2020		
Check 41	Dec 1997	Dec 2020		
Castaic Outlet	Nov 1998	Dec 2020		
Devil Canyon Afterbay*	Dec 1997	Dec 2020		

*Note: Data were collected from Dec 1997 to May 2001 at Devil Canyon Afterbay, then at Devil Canyon Headworks from June 2001 to December 2010, and then at Devil Canyon Second Afterbay in early 2011. These datasets have been combined.

The SWP Watershed

Figure 5-1 presents all available bromide data from 1997 to 2020 for the tributaries to the Sacramento-San Joaquin Delta (Delta) and the Harvey O. Banks Delta Pumping Plant (Banks). The American River is not shown on this figure because all measurements collected from 1997 to 2020 were below the detection limit of 0.01 mg/L. It should be noted that the detection limit was raised to 0.05 mg/L in July 2020. **Figure 5-1** clearly demonstrates that bromide concentrations in the Sacramento River are quite low, with a median concentration of 0.01 mg/L at West Sacramento and Hood. There is little variability in the bromide concentrations in the Sacramento River because it is not substantially impacted by seawater intrusion at the two sites that are shown in the figure. Due to the low levels of bromide in the Sacramento River, the data were not analyzed to evaluate seasonal and spatial trends. The San Joaquin River at Vernalis (Vernalis) has the highest median concentration in the watershed (0.22 mg/L).

Figure 5-1. Bromide Concentrations in the SWP Watershed, 1997 to 2020



Vernalis – **Figure 5-2** shows all available grab sample bromide data at Vernalis. The levels range over an order of magnitude from 0.01 to 0.65 mg/L during the period of record with a median of 0.22 mg/L.

- Comparison of Real-time and Grab Sample Data – **Figure 5-3** compares the real-time data with the grab sample data at Vernalis from 2016 to 2020. Bromide is measured every 2.5 hours with the Dionex analyzer. MWQI staff provided average daily concentrations calculated from the 2.5 hour measurements for this analysis. **Figure 5-4** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.8821 which is considered acceptable.

- Spatial Trends – DWR does not collect data upstream of Vernalis on the San Joaquin River.

- Long-Term Trends – Visual inspection of **Figure 5-2** shows that there is no discernible long-term trend in the data. Bromide concentrations increase during dry years and decrease during wet years. Bromide data were first collected at Vernalis during the drought years of the early 1990s when bromide levels were high.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median concentration during dry years of 0.26 mg/L is statistically significantly higher than the median during wet years of 0.12 mg/L (Mann-Whitney, p=0.0000). **Figure 5-5** shows the 1:1 relationship between flow and bromide concentrations at Vernalis. This figure indicates that bromide concentrations vary over a wide range at low flows but once flow on the San Joaquin River exceeds 5,000 cubic feet per second (cfs), bromide concentrations generally drop below 0.20 mg/L.

- Seasonal Trends – **Figure 5-6** indicates that the lowest bromide concentrations occur during April and May when flows on the San Joaquin River are high due to the Vernalis flow requirements stipulated in Decision 1641 (D-1641). D-1641 includes “spring flow” requirements that apply from February 1 through April 14 and May 16 through June 30, as well as higher spring “pulse” flows that apply from April 15 to May 15. These flow requirements set a minimum monthly average flow rate, based on the water year type. Flows are increased on the San Joaquin River by releasing water from reservoirs on the Merced, Stanislaus, and Tuolumne rivers. Combined exports at the Banks and Jones pumping plants are reduced to 1,500 cfs. These actions that are taken to improve salmon smolt survival also improve water quality. Concentrations gradually increase during the summer and throughout fall months with the highest median concentrations of 0.33 mg/L in December. The primary source of bromide at Vernalis is agricultural irrigation waters diverted from the Delta at Jones and returned to the river as drainage. During the summer and fall months, there is minimal flow in the river to dilute the agricultural drainage.

Figure 5-2. Bromide Concentrations at Vernalis

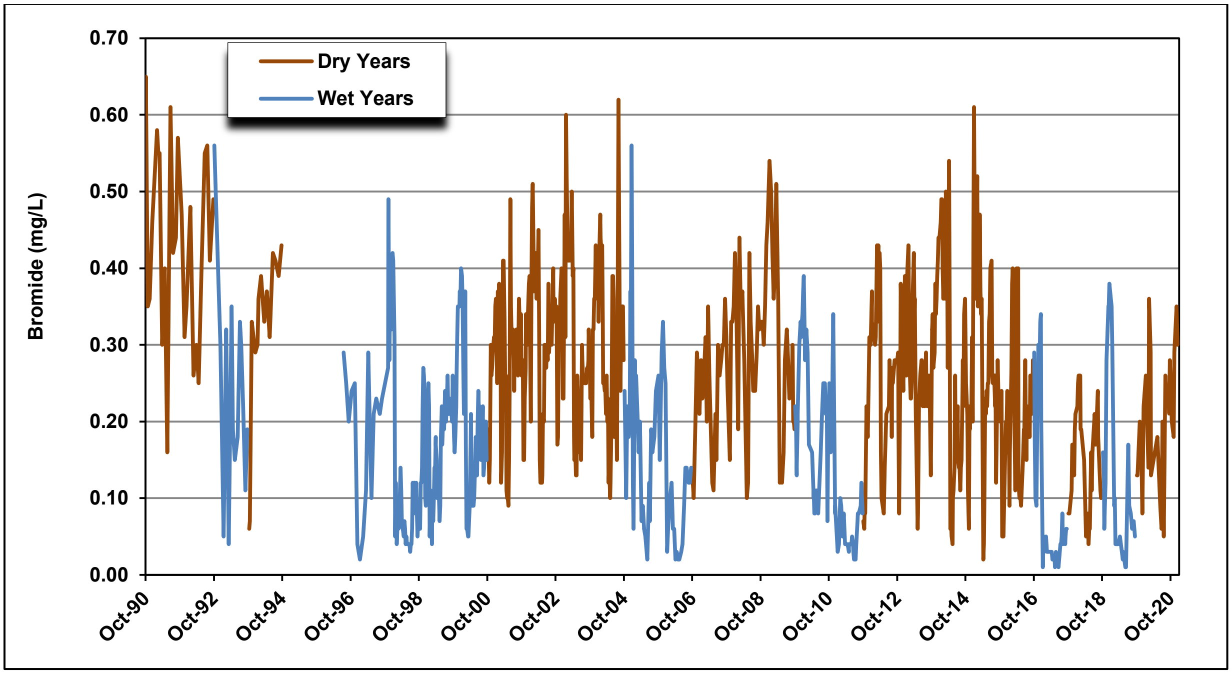


Figure 5-3. Comparison of Vernalis Real-time and Grab Sample Bromide Data

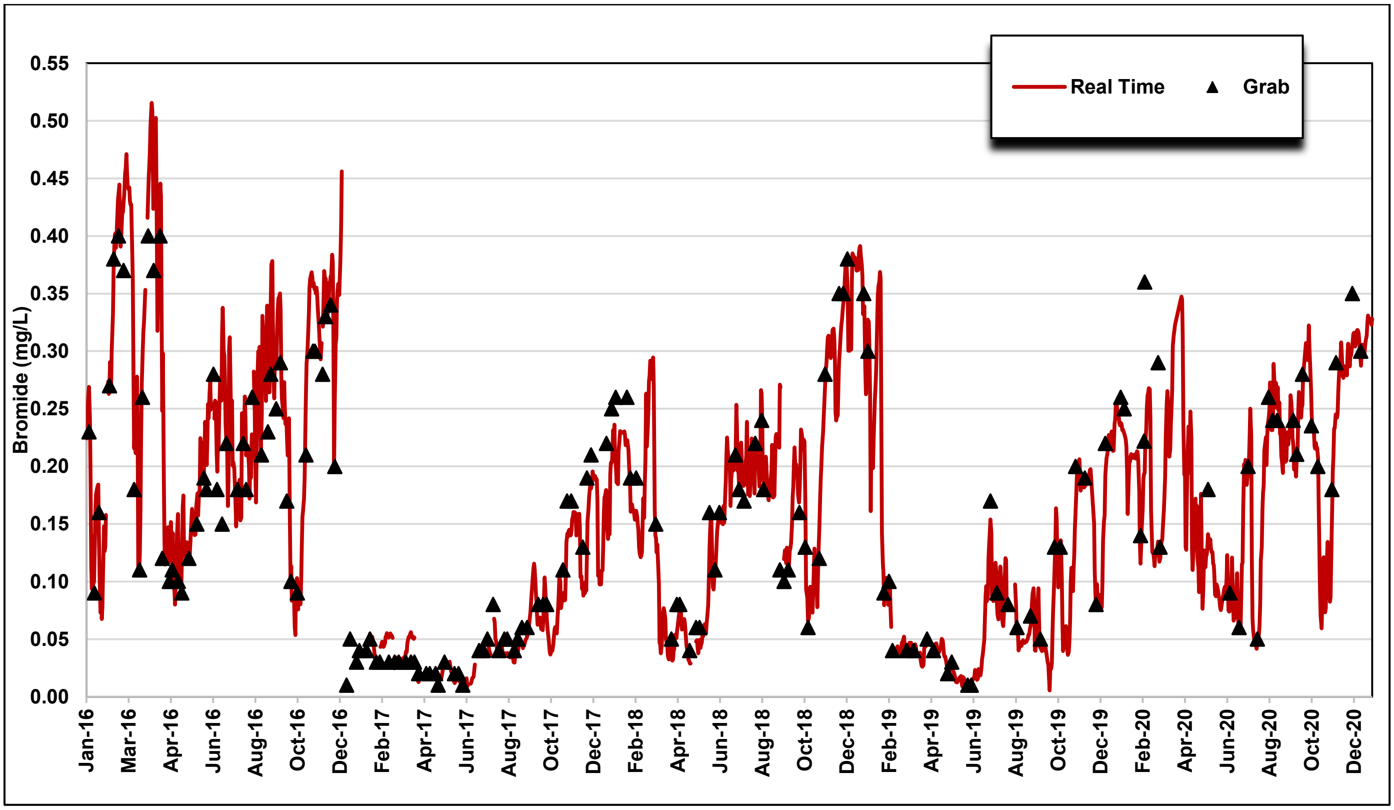


Figure 5-4. Comparison of Vernalis Real-time and Grab Sample Bromide Data, 1:1 Graph, 2016 to 2020

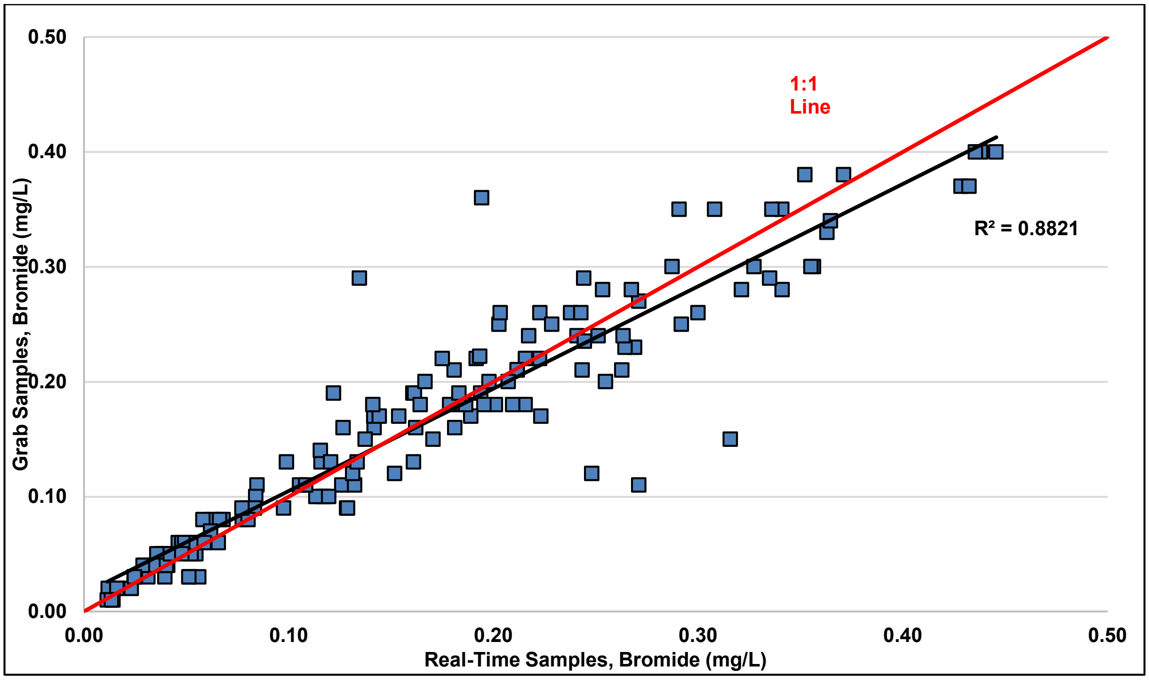


Figure 5-5. 1:1 Relationship Between Bromide and Flow at Vernalis 2005 to 2020

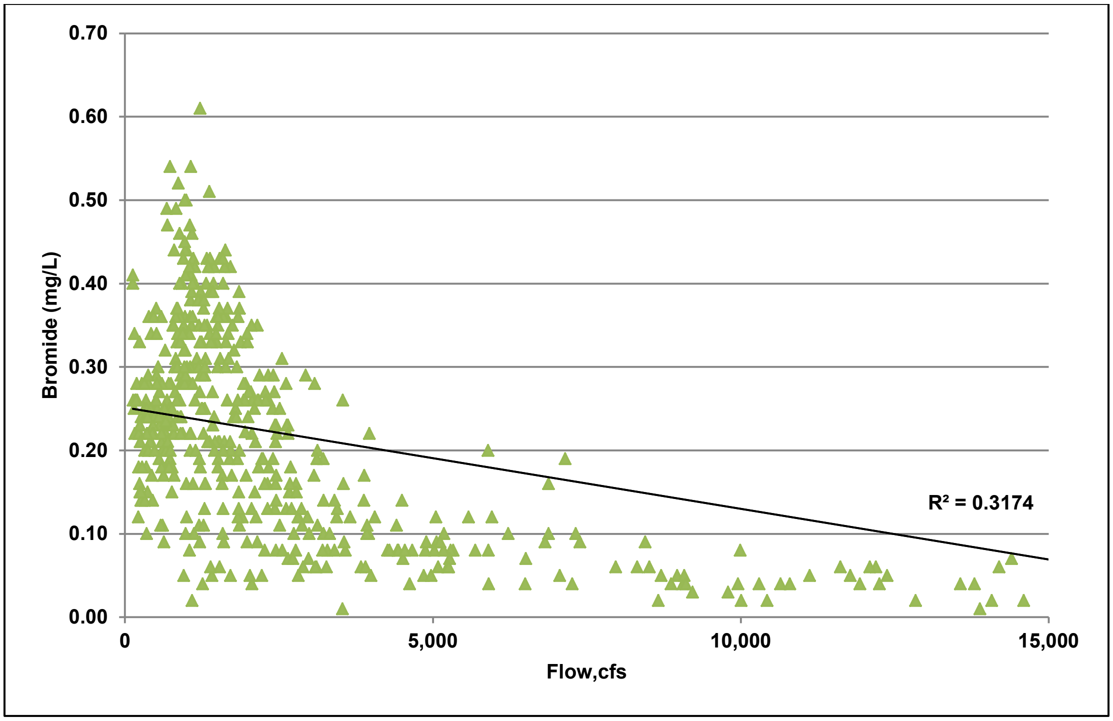
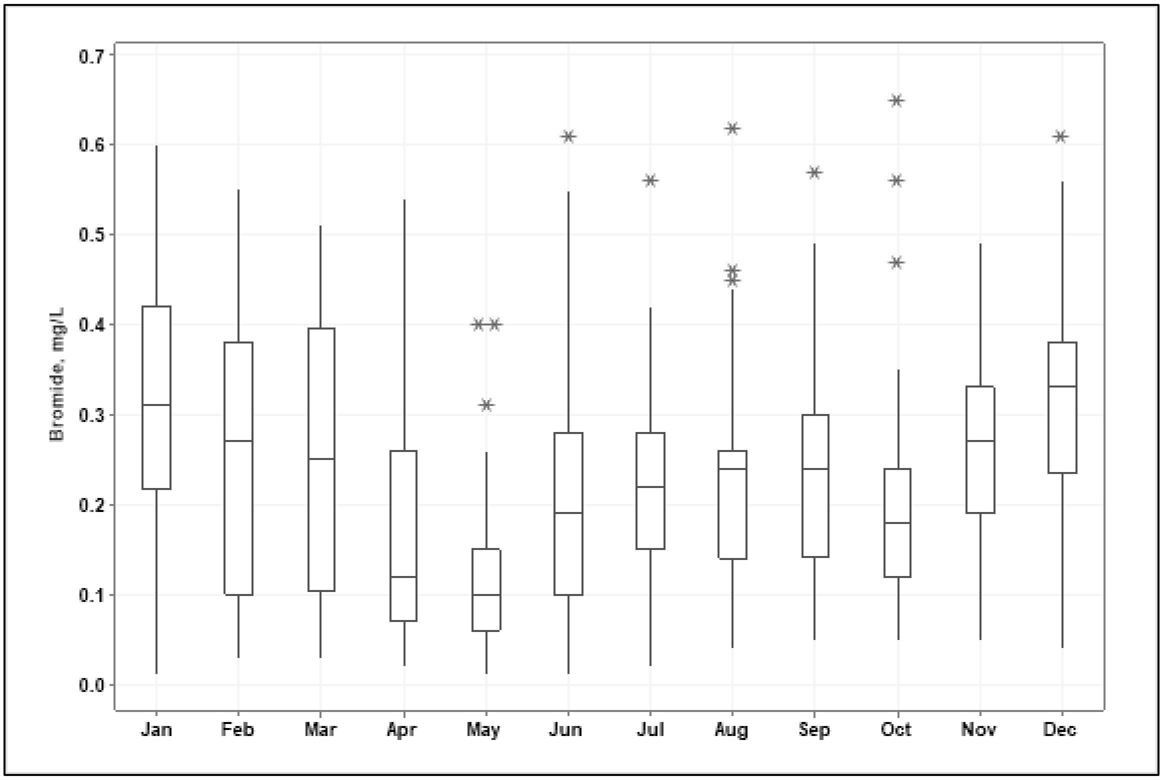


Figure 5-6. Monthly Variability in Bromide at Vernalis, 1990 to 2020



Banks – The sources of bromide at Clifton Court and Banks are primarily the San Joaquin River and seawater intrusion. Seawater contains about 68 mg/L of bromide (Riley and Chester); therefore, during periods of significant seawater intrusion, substantial amounts of bromide are mixed into the Delta. **Figure 5-7** shows all available bromide data at Banks. The concentrations range from 0.02 to 0.64 mg/L during the period of record, with a median of 0.20 mg/L.

- Comparison of Real-time and Grab Sample Data – **Figure 5-8** compares the real-time data with the grab sample data at Banks from 2016 to 2020. Bromide is measured every 2.5 hours with the Dionex analyzer. MWQI staff provided average daily concentrations calculated from the 2.5 hourly measurements. There is good correspondence between the data sets, although real-time data in fall 2018 show that peak bromide concentrations are higher than those captured by the grab sample data. **Figure 5-9** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.9835 which is considered acceptable.

- Spatial Trends – **Figure 5-1** presents 1997 to 2020 data from Hood, Vernalis, and Banks. It is obvious that the bromide concentrations at Hood are statistically significantly lower than the bromide concentrations at Vernalis and Banks. During the 1997 to 2020 period of record for Vernalis and Banks, the median bromide concentration at Banks (0.20 mg/L) is not statistically significantly lower than the median of 0.22 mg/L at Vernalis (Mann-Whitney, p=0.844).

- Long-Term Trends – Visual inspection of **Figure 5-7** shows that there is no discernible long-term trend in the data. Bromide concentrations increase during dry years and decrease during wet years. Bromide data were first collected at Banks during the drought years of the early 90s when bromide levels were high. Consecutive dry years from 2012 to 2015 resulted in an increasing bromide during these years. However, an overall decrease in bromide began in the wet year of 2017, as there was more fresh water available from the Sacramento and San Joaquin Rivers, lessening seawater intrusion into the Delta.

- Wet Year/Dry Year Comparison – The median concentration during wet years is 0.095 mg/L and the median concentration during dry years is 0.26 mg/L. Bromide concentrations were statistically significantly higher during dry years than during wet years (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 5-10** indicates that the lowest bromide concentrations occur in the spring. Concentrations increase throughout the summer and fall when flows are lower on the Sacramento and San Joaquin rivers and seawater intrudes into the Delta.

Figure 5-7. Bromide Concentrations at Banks

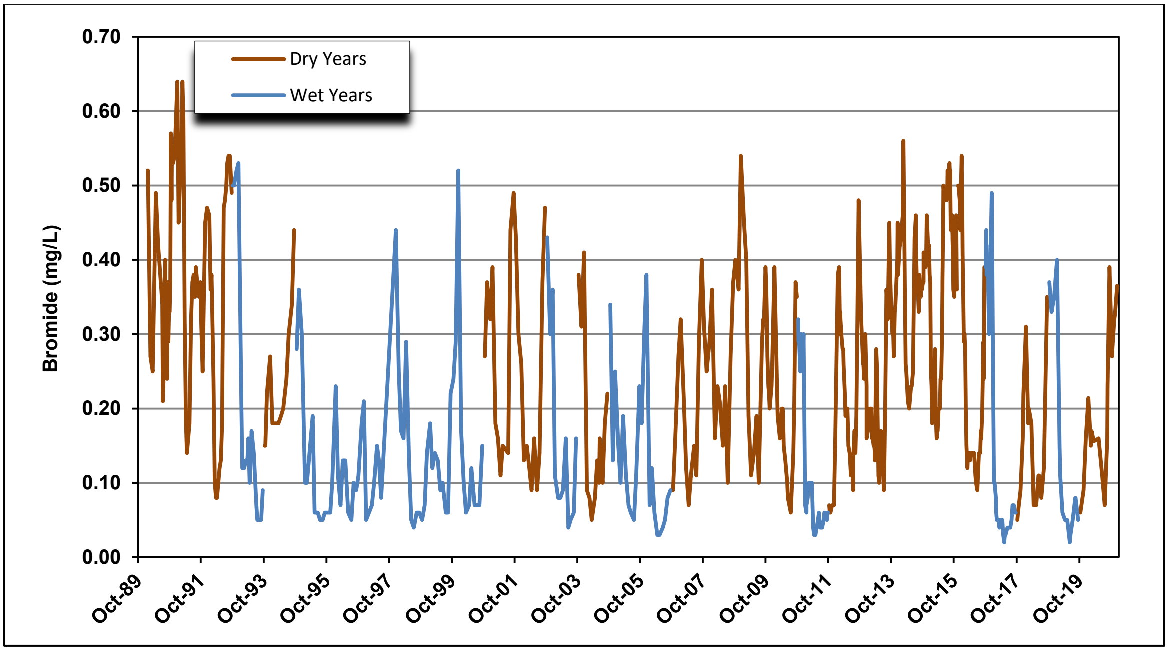


Figure 5-8. Comparison of Banks Real-time and Grab Sample Bromide Data, 2016 to 2020

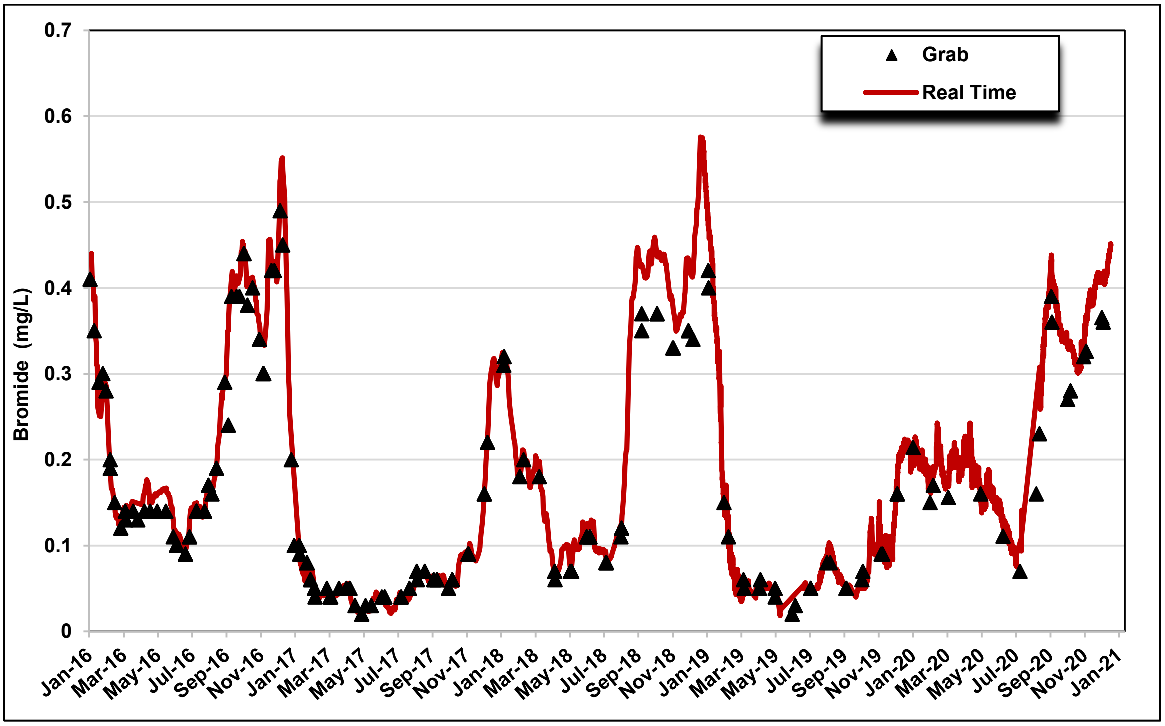


Figure 5-9. Comparison of Banks Real-time and Grab Sample Bromide Data, 1:1 Graph, 2016 to 2020

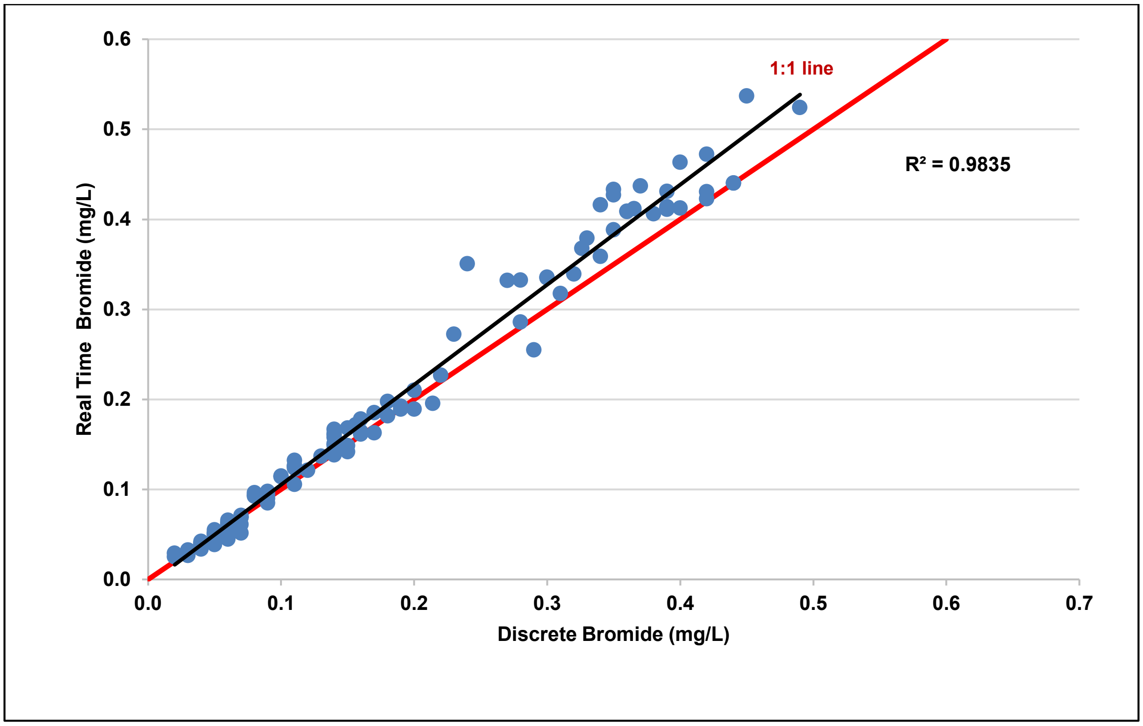
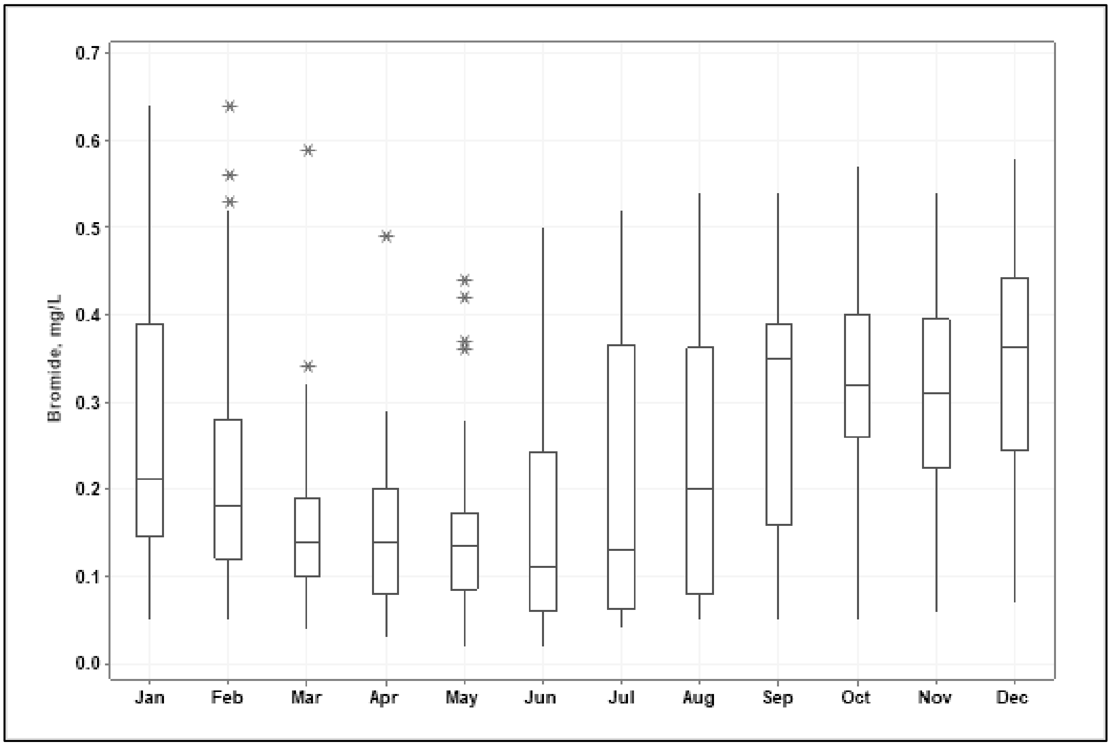


Figure 5-10. Monthly Variability in Bromide at Banks, 1990 to 2020



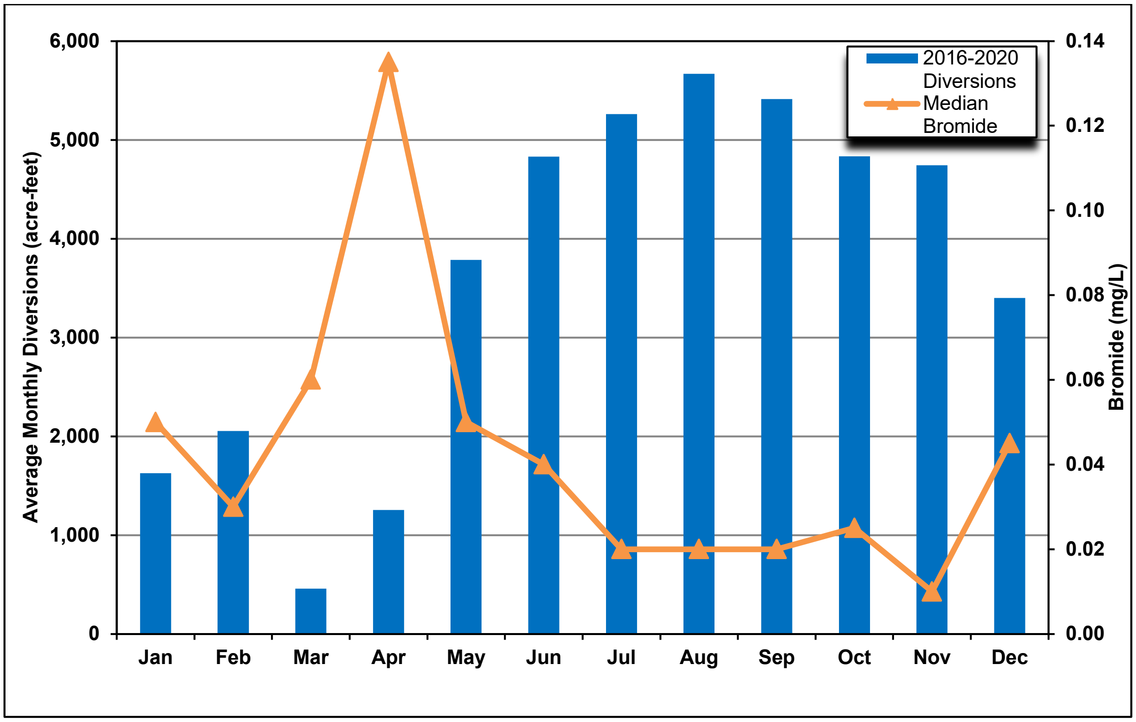
North Bay Aqueduct

Chapter 2 contains a description of the North Bay Aqueduct (NBA). The sources of water are the local Barker Slough watershed and the Sacramento River.

Project Operations

After the water is diverted from Barker Slough, the quality of water delivered to NBA users should not be affected by any other factors since the NBA is an enclosed pipeline. **Figure 5-11** shows average monthly diversions at Barker Slough for the 2016 to 2020 period and median monthly bromide concentrations. This figure shows that pumping is highest between May and November. The median bromide is 0.05 mg/L during May but it declines to 0.02 mg/L during most of the summer and fall months. The highest median for bromide occurred in April.

Figure 5-11. Average Monthly Barker Slough Diversions and Median Bromide Concentrations, 2016 to 2020



Bromide Concentrations in the NBA

Figure 5-12 shows all available bromide data at Barker Slough. The concentrations generally range from 0.01 to 0.27 mg/L during the period of record with a median of 0.04 mg/L.

- Spatial Trends – **Figure 5-13** shows that Barker Slough has higher bromide concentrations than Hood, indicating there is a source of bromide in the Barker Slough watershed. The median concentration is 0.04 mg/L at Barker Slough, whereas the median concentration at Hood is 0.01 mg/L.

- Long-Term Trends – Visual inspection of **Figure 5-12** shows there is no discernible trend in the data.

- Wet Year/Dry Year Comparison – The median concentration during both dry and wet years is 0.04 mg/L (Mann-Whitney, *p*=0.344), and the *p* value indicates no difference between water year types.

- Seasonal Trends – There is a seasonal pattern of low concentrations during the fall and winter months and peak concentrations in the spring, as shown in **Figure 5-14**. The source of bromide during the spring months is likely due to groundwater or base flows from the Barker Slough watershed (Personal Communication, Alex Rabidoux).

Figure 5-12. Bromide Concentrations at Barker Slough

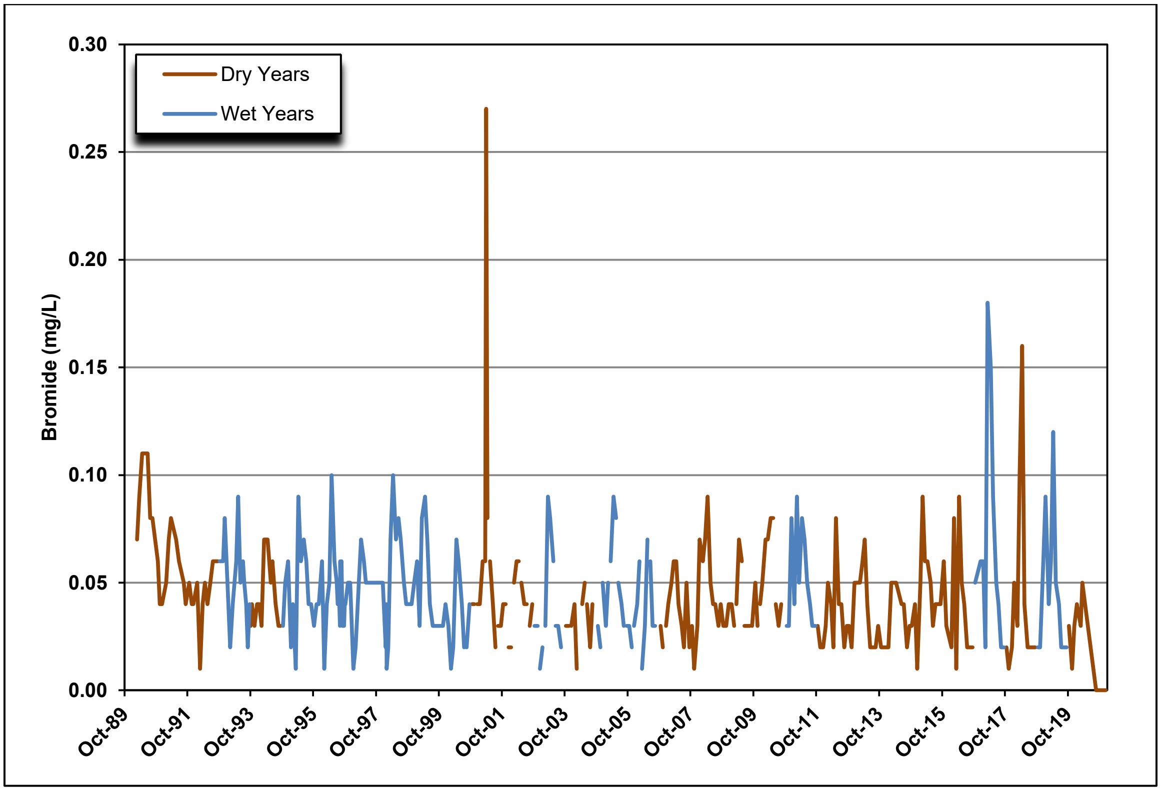


Figure 5-13. Comparison of Bromide at Hood and Barker Slough, 1997 to 2020

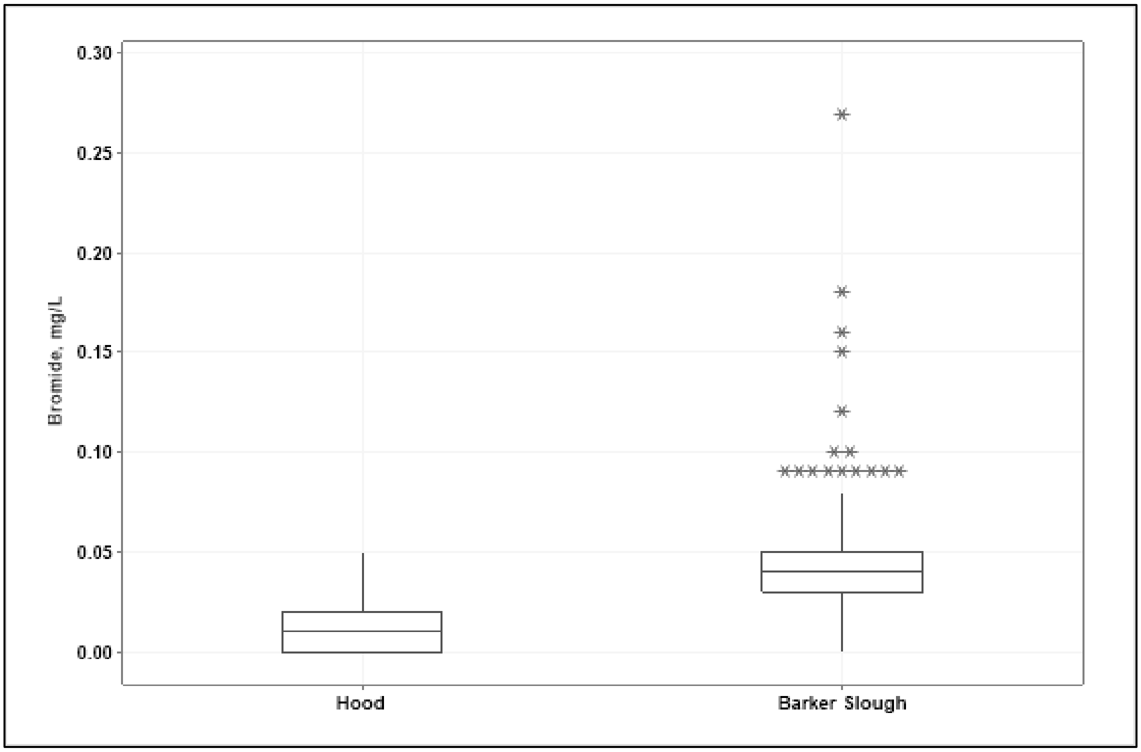
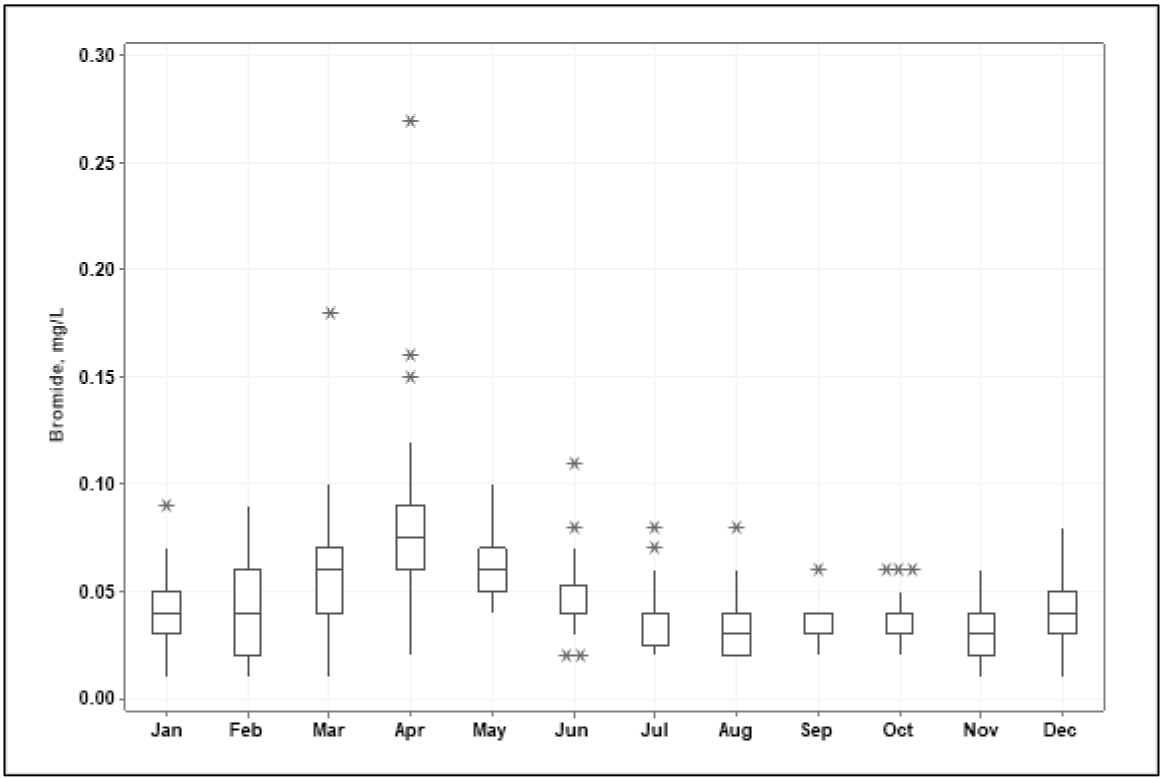


Figure 5-14. Monthly Variability in Bromide at Barker Slough, 1990 to 2020



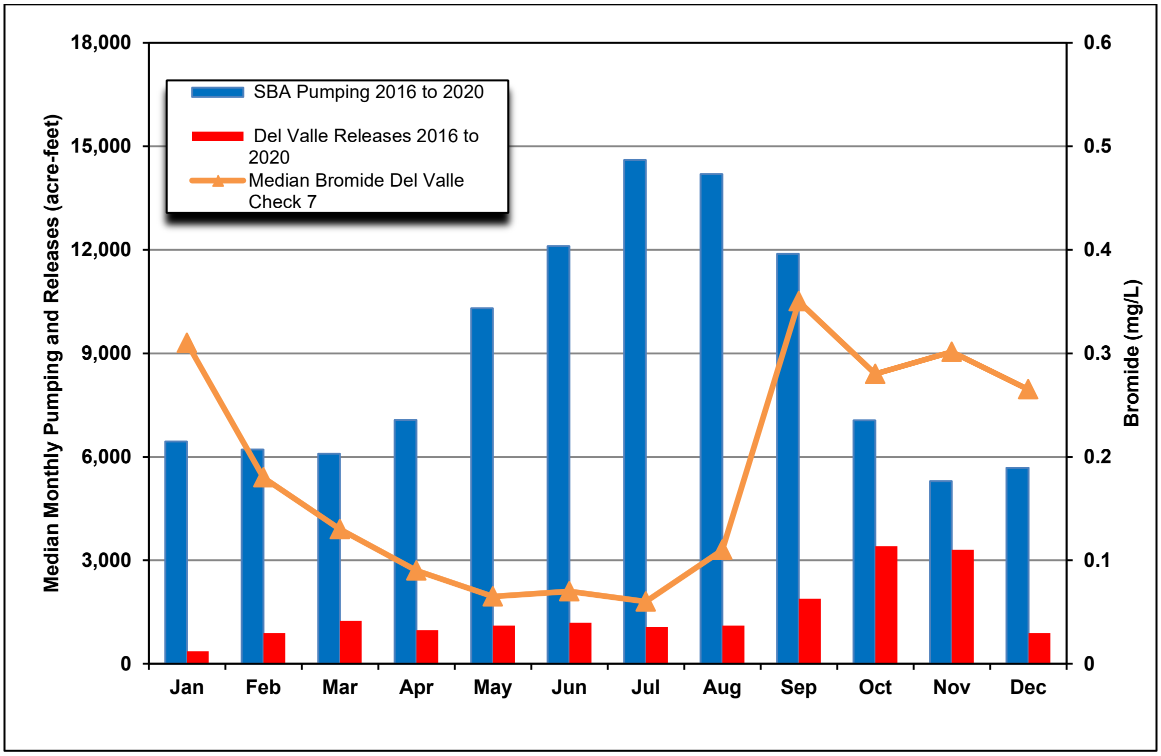
South Bay Aqueduct

Chapter 2 contains a description of the South Bay Aqueduct (SBA). The Delta is the primary source of water and Lake Del Valle is the secondary source.

Project Operations

The quality of water delivered to the SBA Contractors is governed by the timing of diversions from Bethany Reservoir and releases from Lake Del Valle. **Figure 5-15** shows average monthly diversions at the South Bay Pumping Plant and releases from Lake Del Valle from the 2016 to 2020 time period. Monthly median bromide concentrations at Del Valle Check 7 (DV Check 7) are also shown. This figure shows that median bromide concentrations are less than 0.1 mg/L during the April to July period of peak pumping into the SBA. The median concentrations increase rapidly to 0.35 mg/L in September when pumping is high. Water is released from Lake Del Valle primarily between September and November. The 2016 to 2020 median bromide concentration at the Lake Del Valle Conservation Outlet (Conservation Outlet) is 0.04 mg/L, indicating the Del Valle releases decrease the bromide concentrations of water delivered to SBA Contractors during the fall months.

Figure 5-15. Average Monthly Diversions at the South Bay Pumping Plant, Releases from Lake Del Valle, and Median Bromide Concentrations, 2016 to 2020



Bromide Concentrations in the SBA

Figure 5-16 shows all available bromide data at DV Check 7. The concentrations range from 0.03 to 0.52 mg/L during the period of record with a median of 0.16 mg/L.

- Spatial Trends – **Figure 5-17** compares bromide concentrations at Banks and DV Check 7. The period of record is longer at Banks than at DV Check 7, so the 1997 to 2020 data were evaluated. There is a statistically significant difference between the median concentration of 0.16 mg/L at DV Check 7 and the median of 0.20 mg/L at Banks (Mann-Whitney, p=0.010). There are no sources of bromide or other factors that may increase bromide concentrations between Banks, Dyer Reservoir and DV Check 7. It is likely that bromide concentrations decrease from Banks to DV Check 7 as water leaving Banks enters Bethany Reservoir and is mixed and diluted within Bethany Reservoir, and then additional dilution occurs if water enters Dyer Reservoir, or Dyer releases water into the South Bay Aqueduct.

- Long-Term Trends – **Figure 5-16** shows that there is no discernible long-term trend in the data. Bromide concentrations increase during dry years and decrease during wet years. As stated earlier for Banks, bromide levels are higher from 2012 to 2015 due to consecutive dry years, which lead to greater seawater intrusion into the Delta due to lower flows into the Sacramento and San Joaquin rivers. However, an overall decrease in bromide began in the wet year of 2017, as there was more fresh water available from the Sacramento and San Joaquin Rivers, lessening seawater intrusion into the Delta.

- Wet Year/Dry Year Comparison – The DV Check 7 median concentration of 0.21 mg/L during dry years is significantly higher than the 0.10 mg/L median during wet years (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 5-18** shows there is a seasonal pattern with the lowest concentrations in the spring. Concentrations increase during the late summer and fall months when flows are lower on the Sacramento and San Joaquin rivers and seawater intrudes into the Delta. This is similar to the pattern at Banks.

Figure 5-16. Bromide Concentrations at DV Check 7

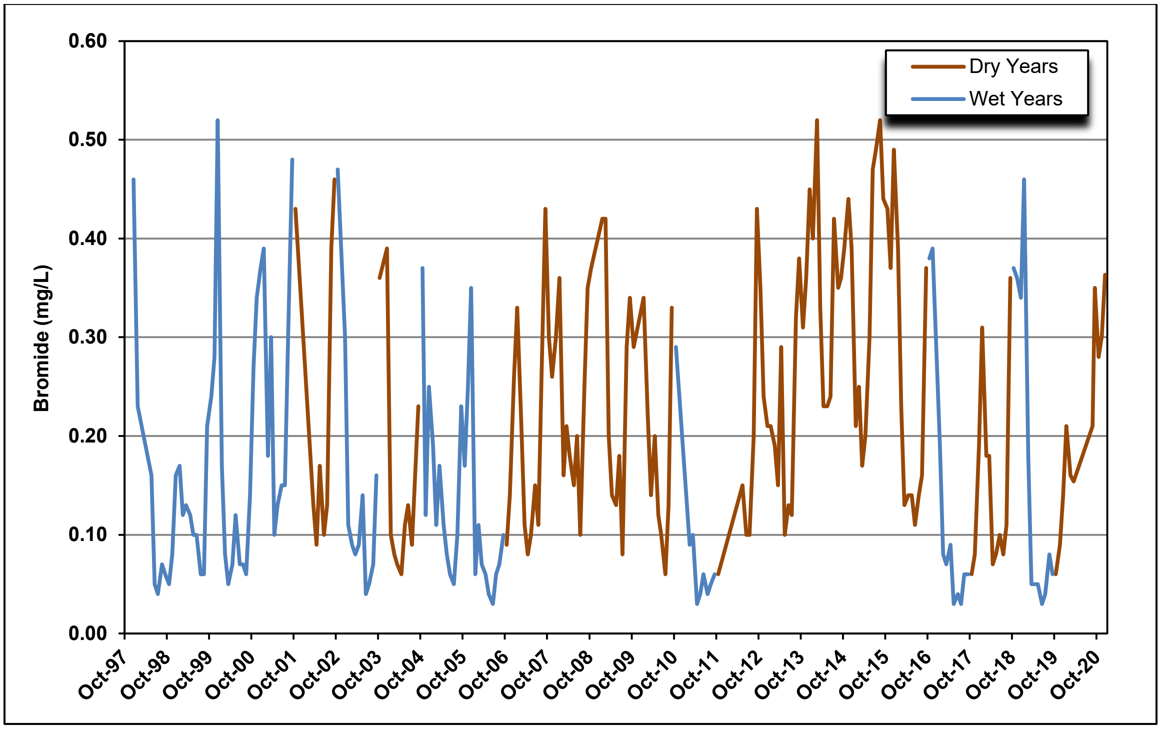


Figure 5-17. Comparison of Bromide at Banks and DV Check 7 (1997-2020)

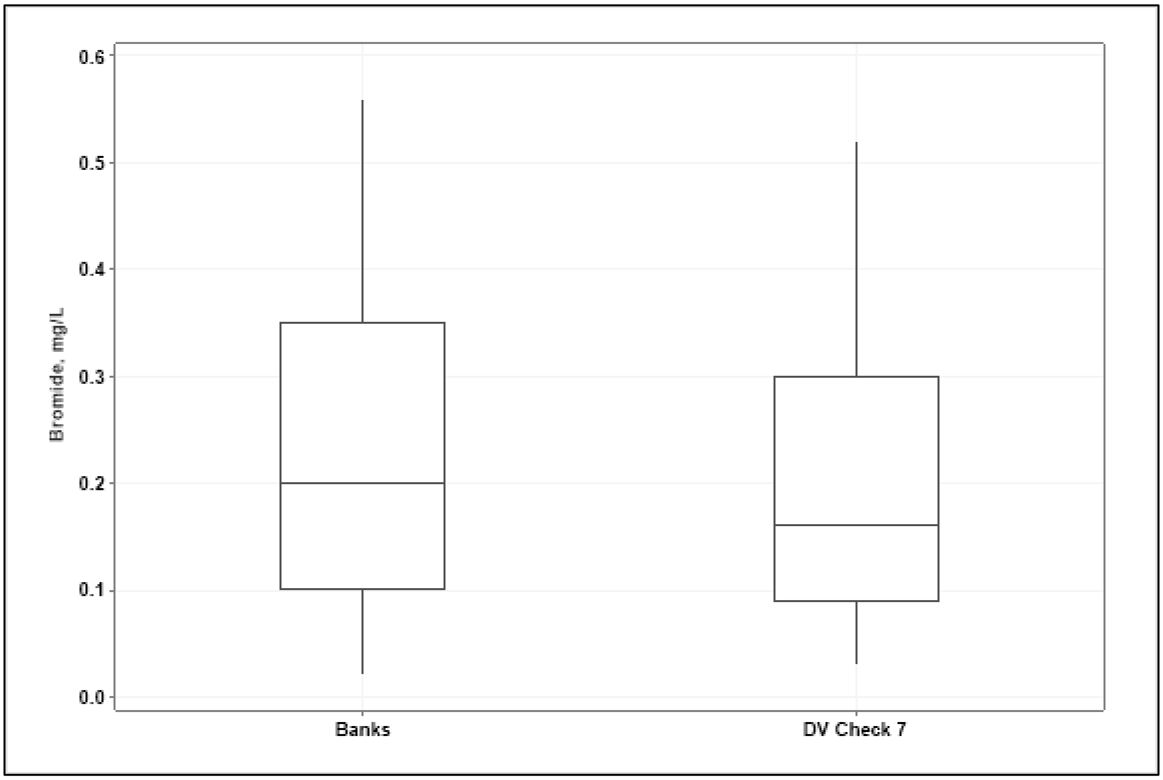
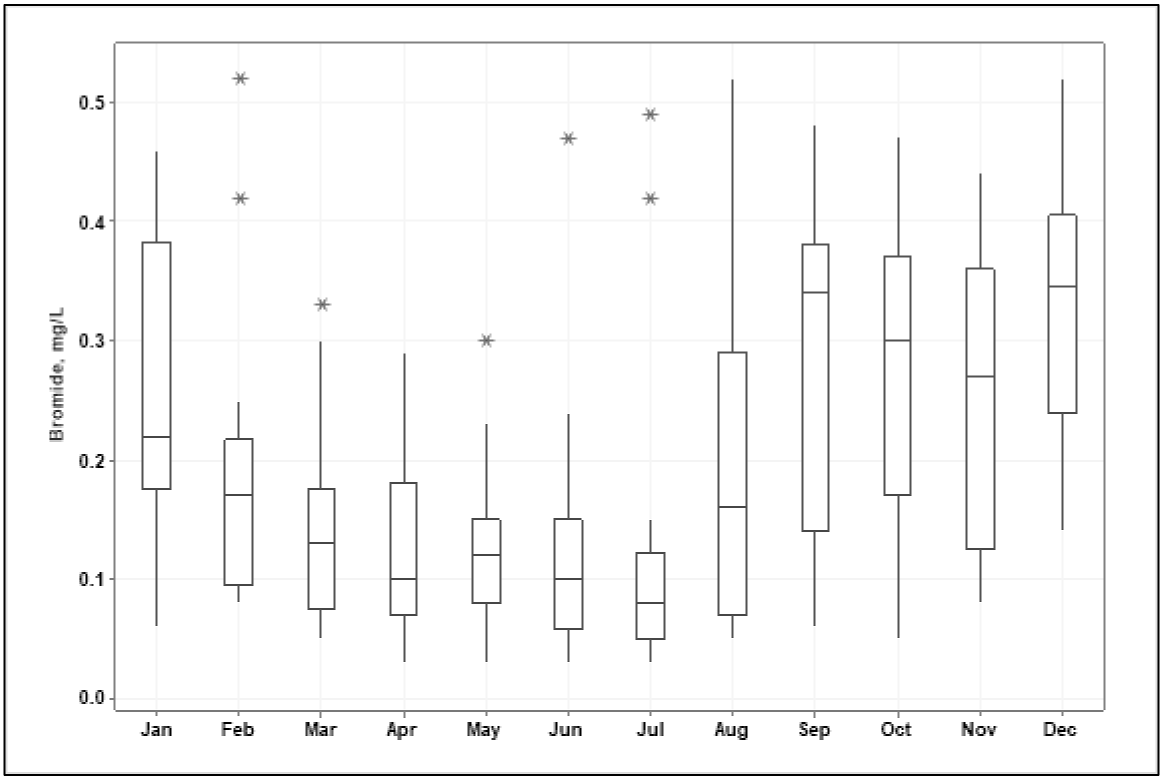


Figure 5-18. Monthly Variability in Bromide at DV Check 7, 1997 to 2020



California Aqueduct and Delta-Mendota Canal

A number of SWP Contractors take water from the SWP between San Luis Reservoir and the terminal reservoirs. This section is organized by various reaches of the SWP and individual SWP Contractors taking water from each reach are described in the following sections.

Project Operations

The quality of water delivered to SWP Contractors south of San Luis Reservoir is governed by the timing of diversions from the Delta at Banks, pumping into O'Neill Forebay from the Delta-Mendota Canal (DMC), releases from San Luis Reservoir, inflows to the Governor Edmund G. Brown California Aqueduct (California Aqueduct), and storage in terminal reservoirs.

Figure 5-19 shows average monthly diversions at the Banks Pumping Plant from 2016 to 2020 and median monthly bromide concentrations. As shown in **Figure 5-19**, the median bromide concentrations are relatively low, less than 0.15 mg/L from February to August, but then increase sharply to 0.29 mg/L in September. They remain high during the fall months through January.

Figure 5-20 shows the average monthly amount of water pumped from the DMC at O'Neill Pump-Generation Plant into O'Neill Forebay and the median bromide concentrations in the DMC at McCabe Road (McCabe). The median bromide concentrations show the same seasonal pattern as at Banks. The pumping pattern at O'Neill is different from the pattern at Banks. There is little pumping into O'Neill Forebay during the April to August period when bromide concentrations are lowest. Most of the pumping occurs between December and March when median bromide concentrations range from 0.12 to 0.35 mg/L.

Figure 5-19. Average Monthly Banks Diversions and Median Bromide Concentrations, 2016 to 2020

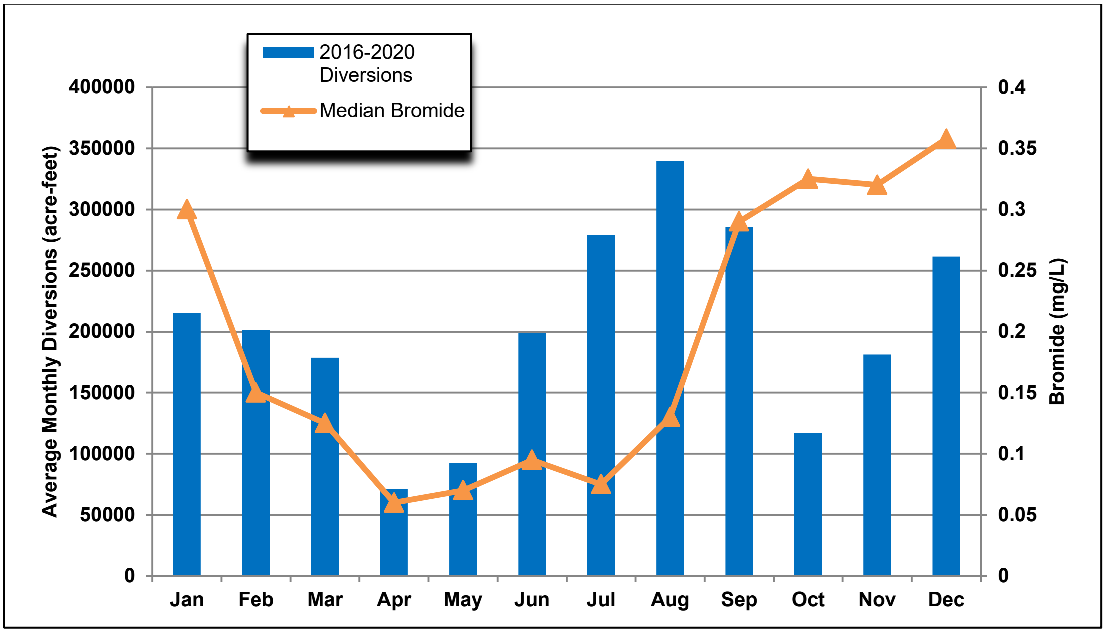
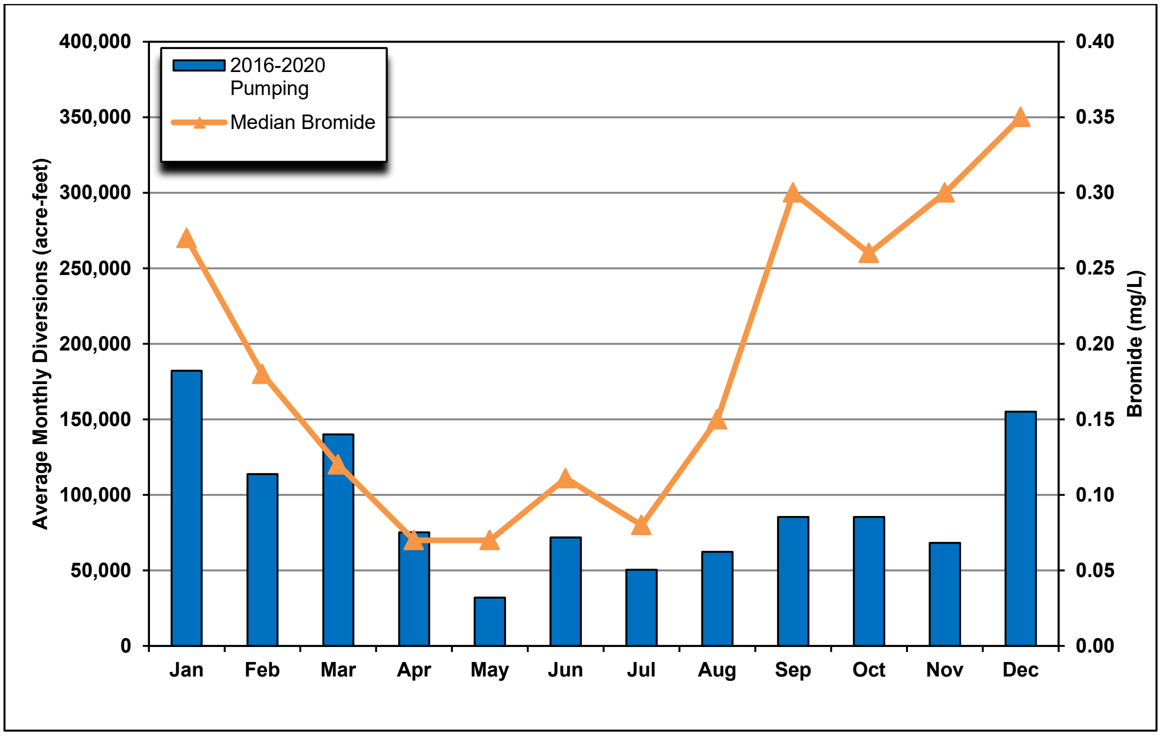


Figure 5-20. Average Monthly Pumping at O'Neill and Median Bromide Concentrations at McCabe, 2016 to 2020

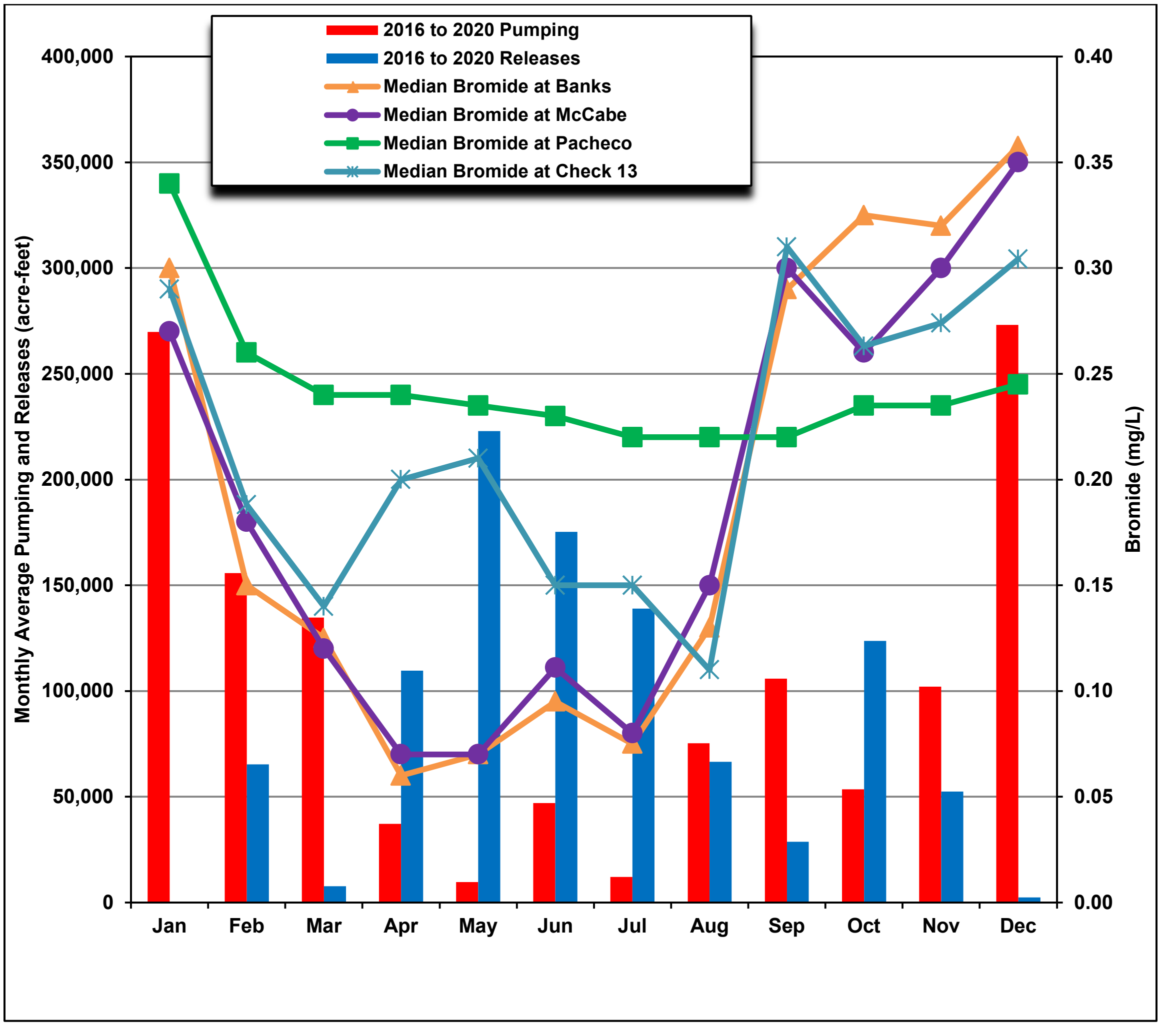


The operation of San Luis Reservoir impacts water quality in the California Aqueduct south of the reservoir. Water from O'Neill Forebay is pumped into San Luis Reservoir at the William R. Gianelli Pumping-Generating Plant (Gianelli) and water released from San Luis Reservoir flows into O'Neill Forebay before entering the California Aqueduct. Water is also pumped out of San Luis Reservoir on the western side at the Pacheco Pumping Plant (Pacheco) for Valley Water. In 2012, DWR installed a real-time water quality monitoring station in the channel between San Luis Reservoir and O'Neill Forebay (Gianelli Real-Time). Real-time TOC, turbidity, EC and bromide data are collected. The variation in the Gianelli data is due to operations. When pumping occurs into San Luis Reservoir, the water sample at Gianelli is O'Neill Forebay water. When releases occur from San Luis Reservoir, the water sample at Gianelli is San Luis water.

Figure 5-21 shows the pattern of pumping into the reservoir and releases from the reservoir to O'Neill Forebay from 2016 to 2020. Historically, water is generally pumped into the reservoir from September to March and released from the reservoir from April to August. However, during 2016 to 2020, there were some slight changes in the pumping/release patterns in August and October. For example, during 2016 to 2020, the average pumping and releases in August were similar, which is normally a release month. In October, the average releases were higher than the pumping, which is normally a month when water is pumped into San Luis Reservoir. This was likely due to the wet years of 2017 and 2019, and there was more than "normal" water stored in San Luis Reservoir which needed to be released in October.

The median bromide concentration at Banks represents the quality of water pumped into San Luis Reservoir from the California Aqueduct and the median bromide concentration at McCabe represents the quality of water pumped in from the DMC. The median bromide at Pacheco represents the quality of water in San Luis Reservoir. The median bromide at O'Neill Forebay Outlet (Check 13) is a mixture of water from San Luis Reservoir, the California Aqueduct, and the DMC. **Figure 5-21** shows how the concentrations at Check 13 are influenced by whether water is being pumped or released from San Luis Reservoir. For example, bromide levels at Check 13 are similar to levels at Pacheco when releases occur, and Check 13 levels are similar to levels at Banks when water is pumped from O'Neill Forebay to San Luis Reservoir.

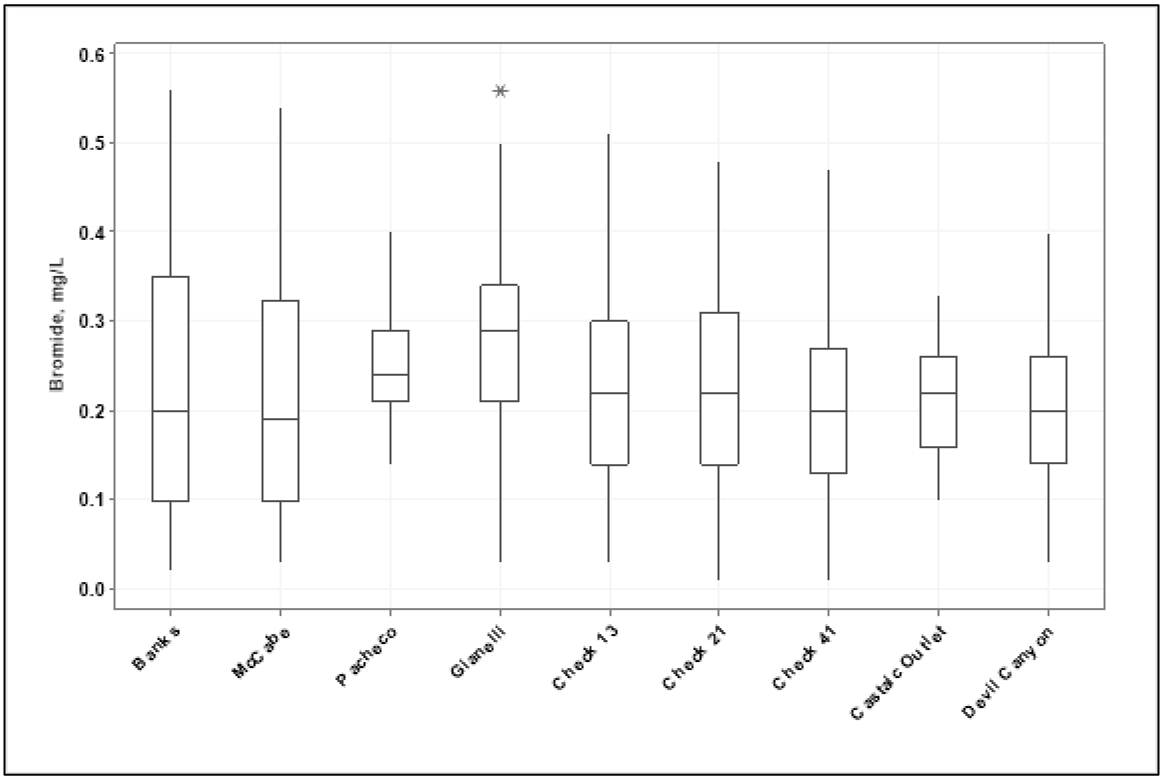
Figure 5-21. San Luis Reservoir Operations and Median Bromide Concentrations, 2016 to 2020



Bromide Concentrations in the DMC and SWP

Figure 5-22 presents a summary of grab sample bromide data collected at each of the locations along the DMC, California Aqueduct, and SWP reservoirs from 1997 to 2020. Data for Pacheco was not available until 2000, and 2012 for Gianelli. Spatial differences are examined in more detail in the following sections.

Figure 5-22. Bromide Concentrations in the DMC and SWP (1997-2020)



Delta-Mendota Canal – Grab sample bromide data have been collected at McCabe since December 1997. There are no real-time data. **Figure 5-23** indicates that there is considerable variability in the data with bromide concentrations ranging from 0.01 to 0.54 mg/L with a median of 0.19 mg/L.

- Spatial Trends – **Figure 5-22** compares the bromide data from McCabe to the bromide data collected at Banks between 1997 and 2020. The median concentration of 0.19 mg/L at McCabe is not statistically significantly higher than the median concentration of 0.20 mg/L at Banks (Mann-Whitney, p=0.478). Although the San Joaquin River has a greater influence on the DMC than it does on the aqueduct, both systems are subject to seawater intrusion in the fall months. The EC fingerprints indicate that Banks is subject to more seawater intrusion than is Jones.

- Long-Term Trends – **Figure 5-23** does not display any discernible long-term trend in bromide concentrations at McCabe. Bromide levels are higher from 2012 to 2015 at McCabe due to consecutive dry years, which lead to greater seawater intrusion into the Delta due to lower flows into the Sacramento and San Joaquin rivers. However, an overall decrease in bromide began in the wet year of 2017, as there was more fresh water available from the Sacramento and San Joaquin Rivers, lessening seawater intrusion into the Delta.

- Wet Year/Dry Year Comparison – The McCabe median concentration of 0.24 mg/L during dry years is statistically significantly higher than the median concentration of 0.10 mg/L during wet years (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 5-24** shows there is a seasonal pattern of low concentrations from March to August and then concentrations increase during the late summer and fall months. This is similar to the pattern at Banks. Seawater intrusion in the fall months is the primary factor contributing to the rising bromide concentrations.

Figure 5-23. Bromide Concentrations at McCabe

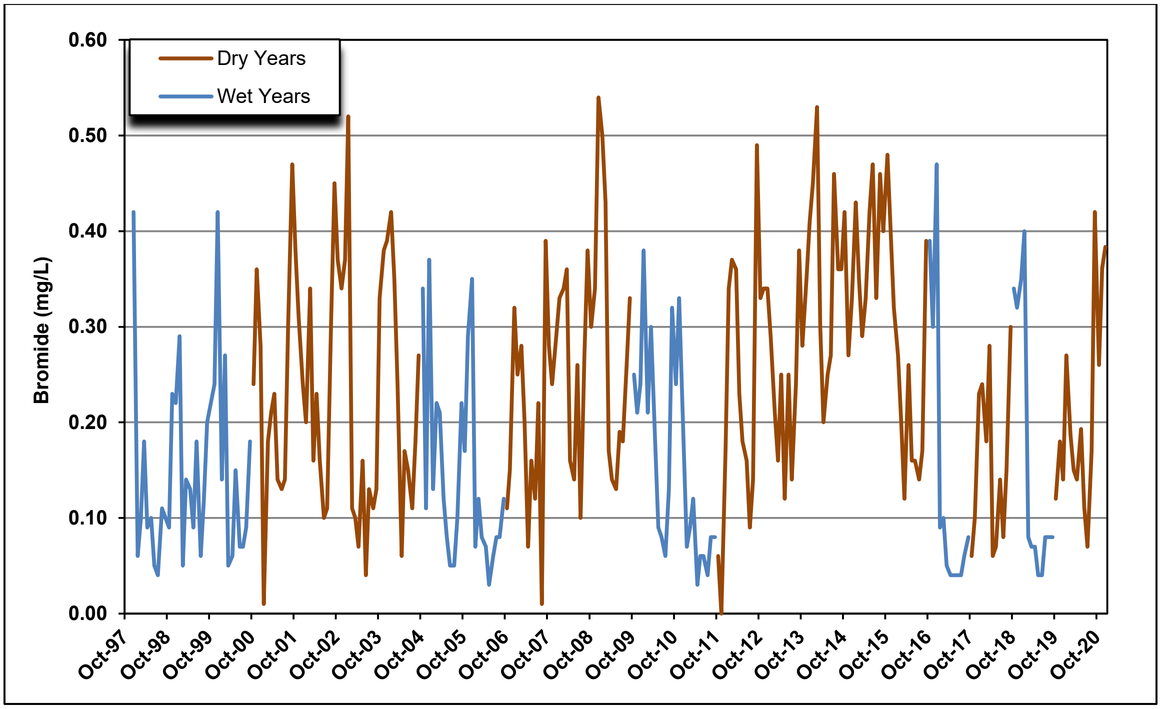
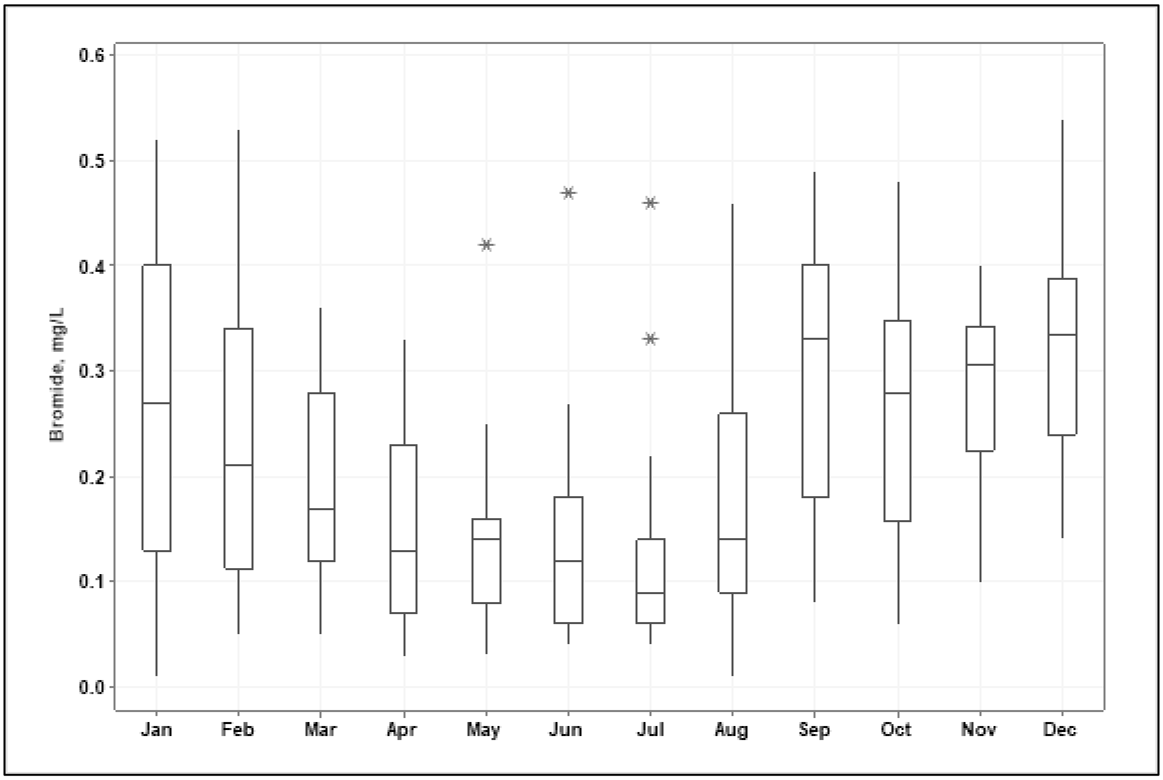


Figure 5-24. Monthly Variability in Bromide Concentrations at McCabe, 1997 to 2020



San Luis Reservoir – Grab sample bromide data have been collected at Pacheco since March 2000. **Figure 5-25** presents all of the available grab sample bromide data for Pacheco. There is much less variability in bromide concentrations in the reservoir than in the Aqueduct. The bromide concentrations at Pacheco range from 0.01 to 0.40 mg/L with a median of 0.24 mg/L.

- Spatial Trends – **Figure 5-26** shows the concentrations of bromide at Banks, Pacheco, and O'Neill Forebay Outlet that includes only data collected at the three locations during the same time period (2000 to 2020). The Pacheco 2000 to 2020 median bromide level is 0.24 mg/L, and is statistically significantly higher than the Banks median bromide level of 0.20 mg/L (Mann Whitney, p=0.000). The Pacheco 2000 to 2020 median bromide level is 0.24 mg/L, and is also statistically significantly higher than the O'Neill Forebay Outlet median bromide level of 0.22 mg/L (Mann Whitney, p=0.001). The higher bromide concentrations in San Luis Reservoir are likely due to a combination of evaporation in the reservoir and pumping of water into the reservoir during periods when Delta bromide concentrations are high.

- Long-Term Trends –As stated earlier for Banks and McCabe, bromide levels in **Figure 5-25** are increased from 2012 to 2015 due to consecutive dry years, which lead to greater seawater intrusion into the Delta due to lower flows into the Sacramento and San Joaquin rivers. However, an overall decrease in bromide began in the wet year of 2017, as there was more fresh water available from the Sacramento and San Joaquin Rivers, lessening seawater intrusion into the Delta.

- Wet Year/Dry Year Comparison – The median concentration of 0.25 mg/L during dry years is not statistically significantly higher than the median concentration of 0.24 mg/L during wet years (Mann-Whitney, p=0.109).

- Seasonal Trends – **Figure 5-27** presents the monthly data for Pacheco, which illustrates that there is a mild seasonal trend with increasing concentrations in the fall and early winter months. The same trend of increasing bromide concentrations is found at Banks and McCabe. Since water is pumped into San Luis Reservoir during the fall and winter months the trend in the reservoir mimics the trend in the source waters, although the changes in concentrations in the reservoir are smaller due to mixing with lower bromide water in the reservoir.

Figure 5-25. Bromide Concentrations at Pacheco

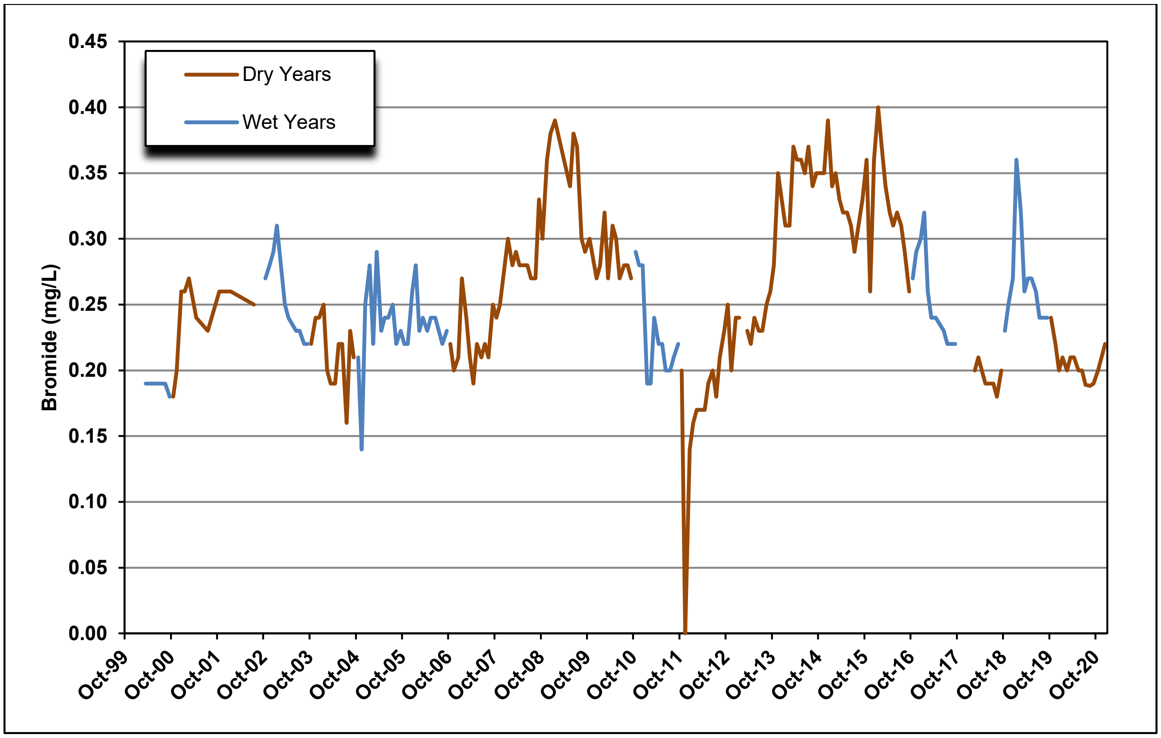


Figure 5-26. Comparison of Bromide Concentrations at Pacheco to Banks and O'Neill Forebay Outlet (2000-2020)

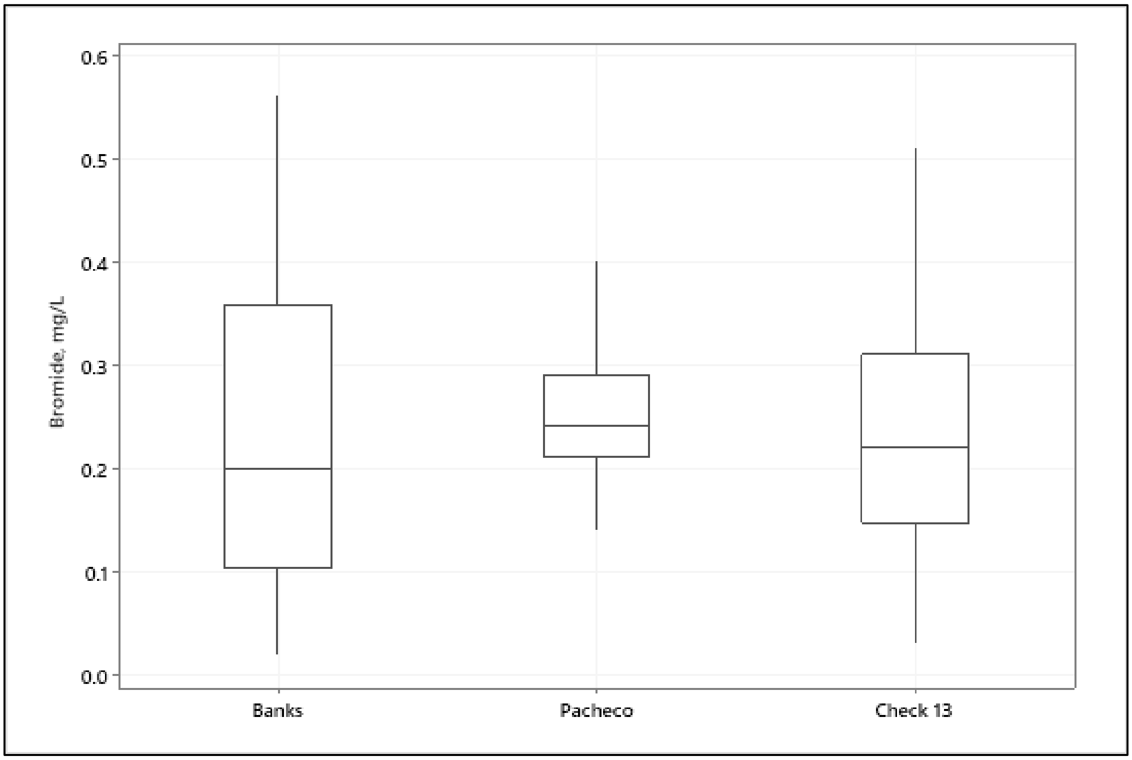
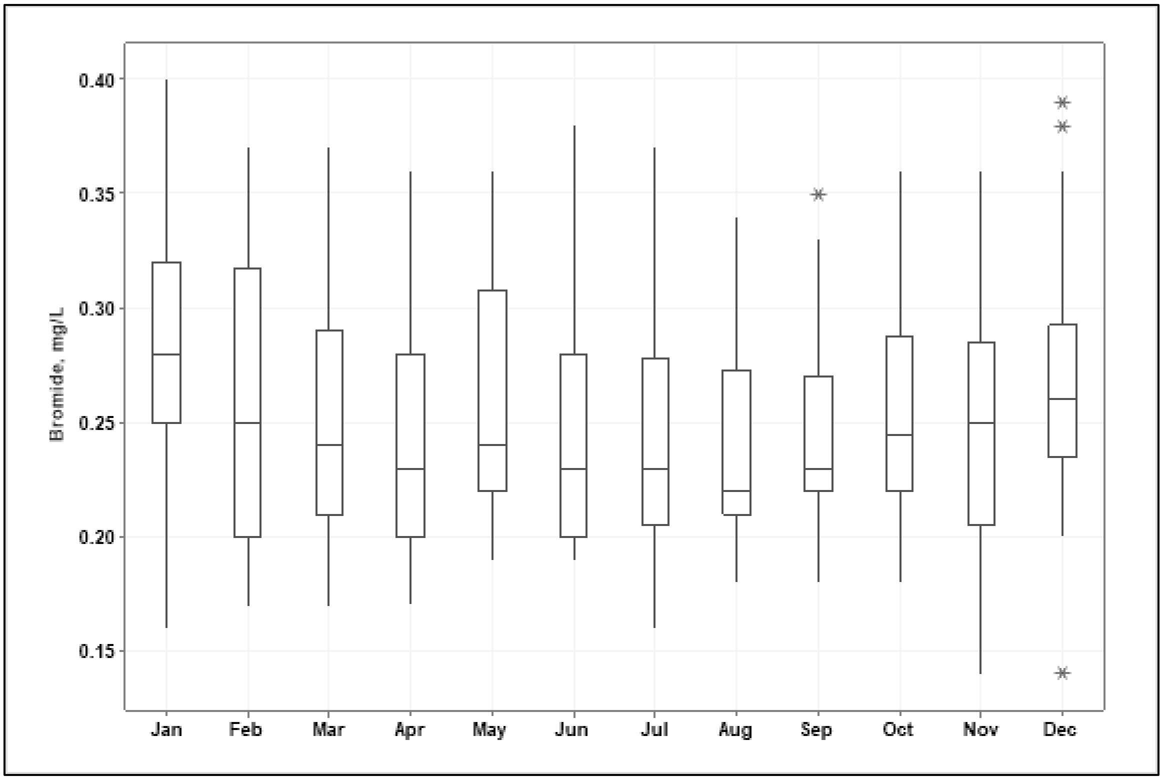


Figure 5-27. Monthly Variability in Bromide Concentrations at Pacheco, 2000 to 2020



***San Luis Reservoir (Gianelli)* – Figure 5-28** presents all of the available bromide data for Gianelli. . Bromide at Gianelli ranges from 0.03 to 0.56 mg/L, with a median of 0.29 mg/L.

- Comparison of Real-time and Grab Sample Data – **Figure 5-29** compares the real-time data with the grab sample data at Gianelli from 2016 to 2020. Bromide is measured every 2.5 hours with the Dionex analyzer. MWQI staff provided average daily concentrations calculated from the 2.5 hourly measurements. **Figure 5-30** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.9291 which is acceptable.

- Spatial Trends – Data from 2012 to 2020 Gianelli and Pacheco are presented in **Figure 5-31.** The median bromide level of 0.245 mg/L at Pacheco is not statistically significant than the median bromide of 0.29 mg/L at Gianelli (Mann-Whitney, *p*=0.206).

- Long-Term Trends – **Figure 5-28** does not display any discernible long-term trends.

- Wet Year/Dry Year Comparison - The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median bromide of 0.30 mg/L in dry years is statistically significantly higher than the median of 0.22 mg/L in wet years (Mann-Whitney, *p*=0.000).

- Seasonal Trends – Seasonal trends were not conducted as water quality is more impacted on whether or not water is being released from San Luis Reservoir or being pumped from O’Neill forebay into San Luis Reservoir. Generally pumping occurs from September to March, and releases occur from April to August.

Figure 5-28. Bromide Concentrations at Gianelli

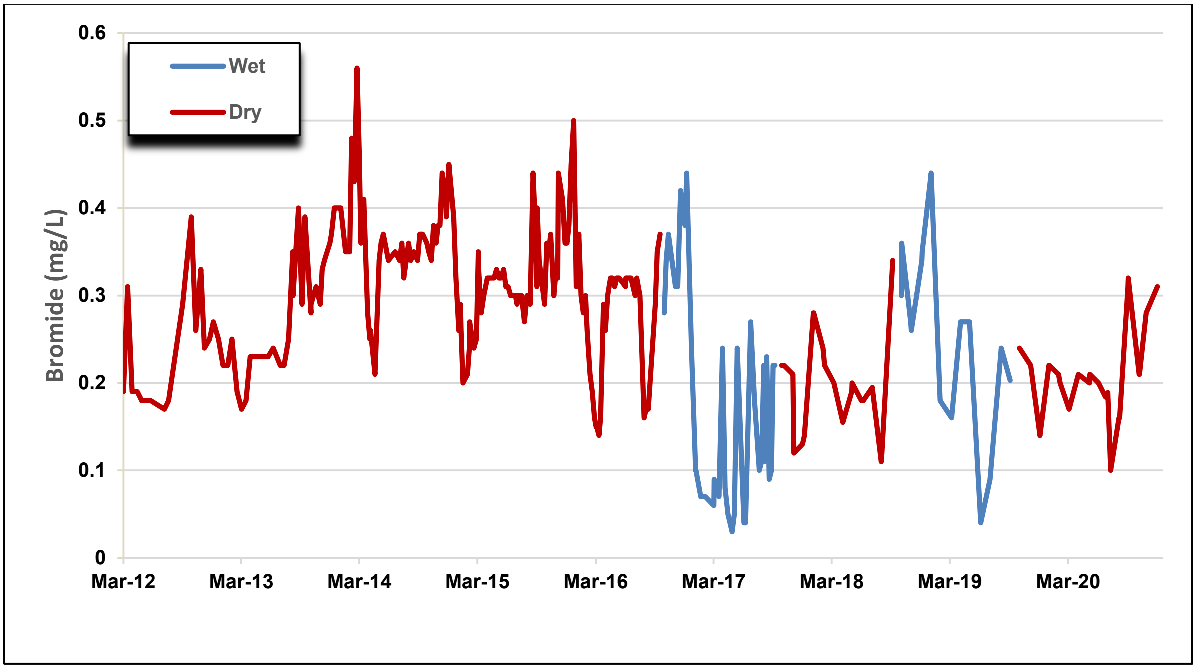


Figure 5-29. Comparison of Gianelli Real-time and Grab Sample Bromide Data, 2016 to 2020

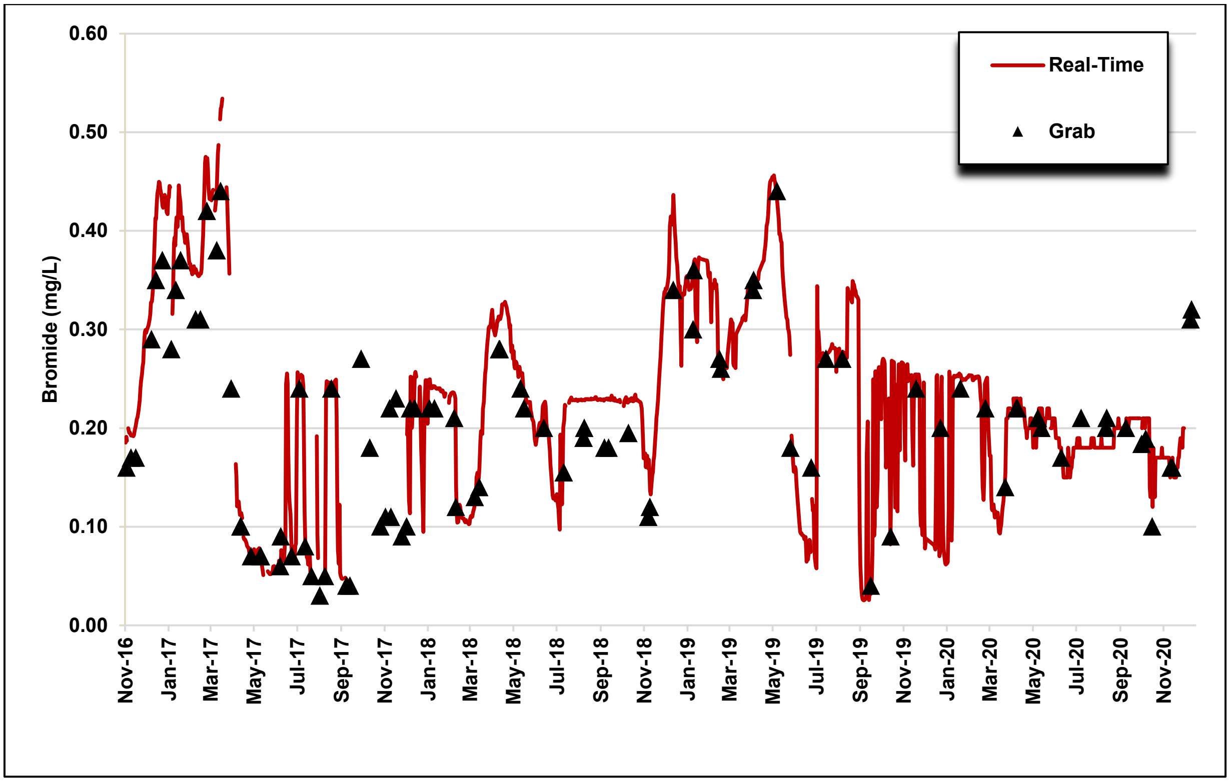


Figure 5-30. Comparison of Gianelli Real-time and Grab Sample Bromide Data, 2016 to 2020, 1:1 Graph

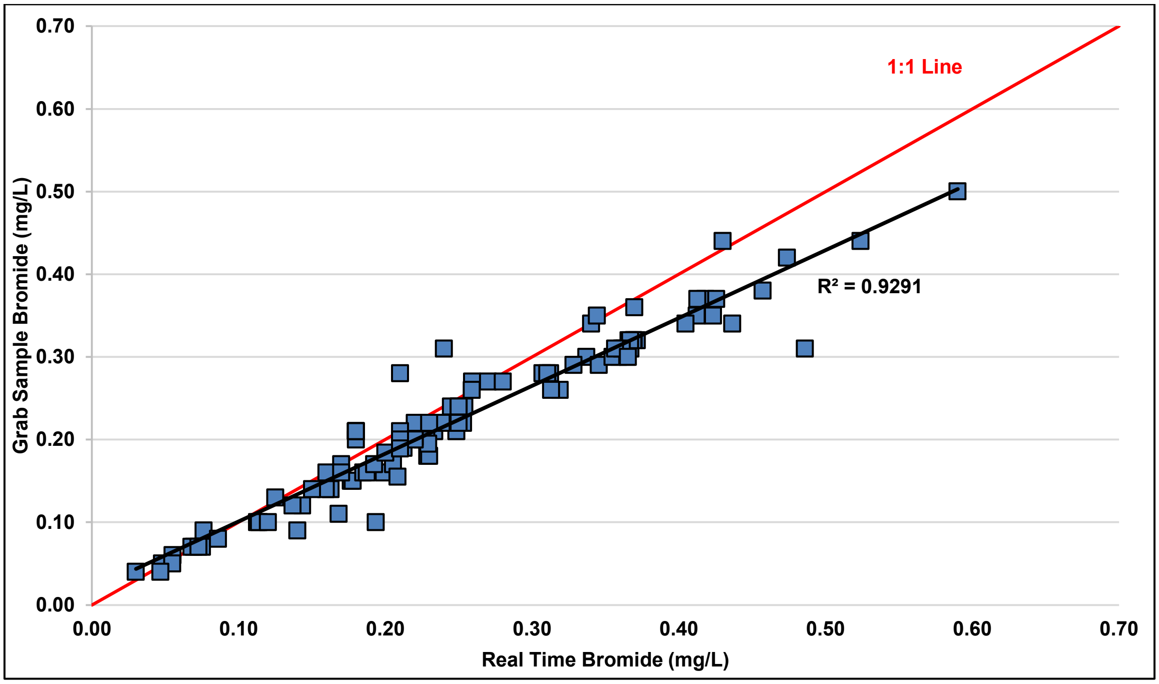
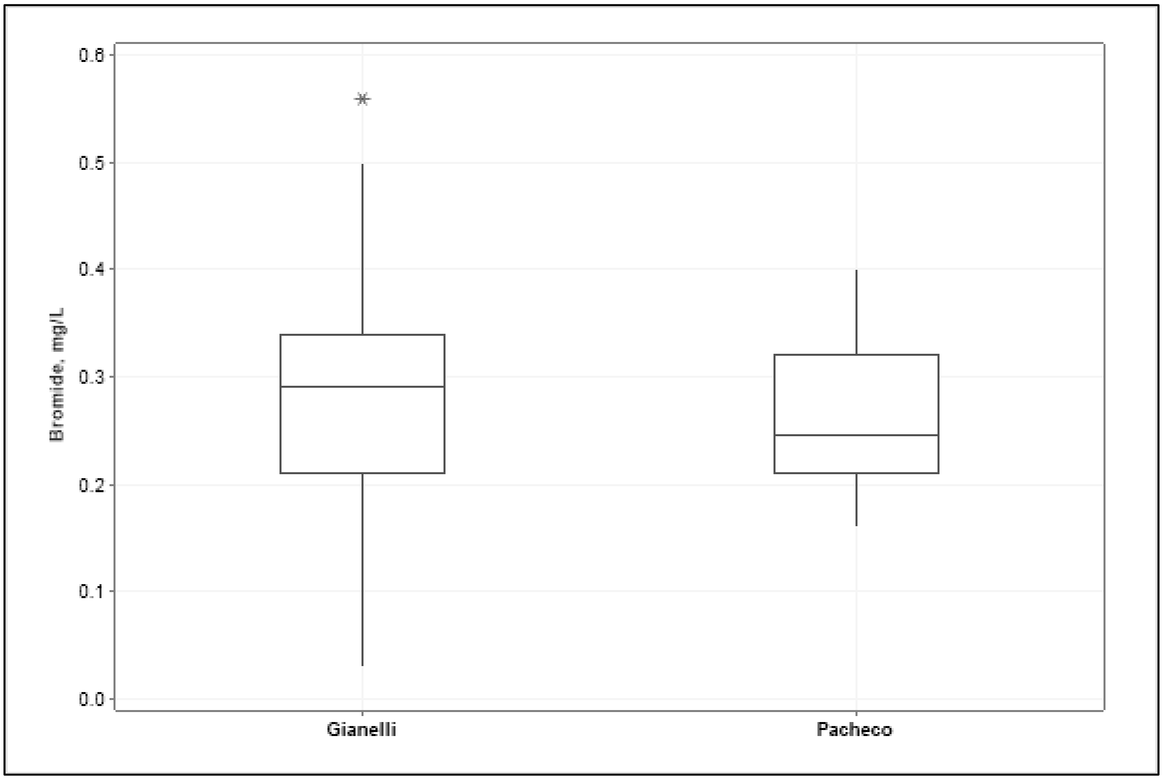


Figure 5-31. Bromide Concentrations at Gianelli and Pacheco (2012-2020)



O'Neill Forebay Outlet – O'Neill Forebay Outlet on the California Aqueduct is a mixture of water from San Luis Reservoir, the California Aqueduct, and the DMC. Grab sample data have been collected at O'Neill Forebay Outlet on a regular basis since 1998. **Figure 5-32** presents the bromide grab sample data for O'Neill Forebay Outlet. The bromide concentrations at O'Neill Forebay Outlet range from 0.03 to 0.56 mg/L with a median of 0.22 mg/L.

- Spatial Trends – **Figure 5-22** compares the data collected between 1997 and 2020 at O'Neill Forebay Outlet to a number of other locations along the aqueduct. The O'Neill Forebay Outlet median concentration is 0.22 mg/L and is not statistically significant compared to the Banks median of 0.20 mg/L (Mann-Whitney, p=0.502).

- Long-Term Trends – **Figure 5-32** shows that bromide concentrations are driven by the hydrology of the system and no apparent long-term trends are evident. Bromide levels were higher from 2012 to 2015 due to consecutive dry years, which lead to greater seawater intrusion into the Delta due to lower flows from the Sacramento and San Joaquin rivers, which increase the concentrations at Banks. However, an overall decrease in bromide began in the wet year of 2017, as there was more fresh water available from the Sacramento and San Joaquin Rivers, lessening seawater intrusion into the Delta.

- Wet Year/Dry Year Comparison – The O'Neill Forebay Outlet dry year median bromide concentration of 0.26 mg/L is statistically significantly higher than the wet year median of 0.13 mg/L (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 5-33** shows there is a distinct seasonal pattern with the lowest concentrations in the summer months (when water typically released from San Luis Reservoir) and the highest concentrations in the fall.

Figure 5-32. Bromide Concentrations at O'Neill Forebay Outlet

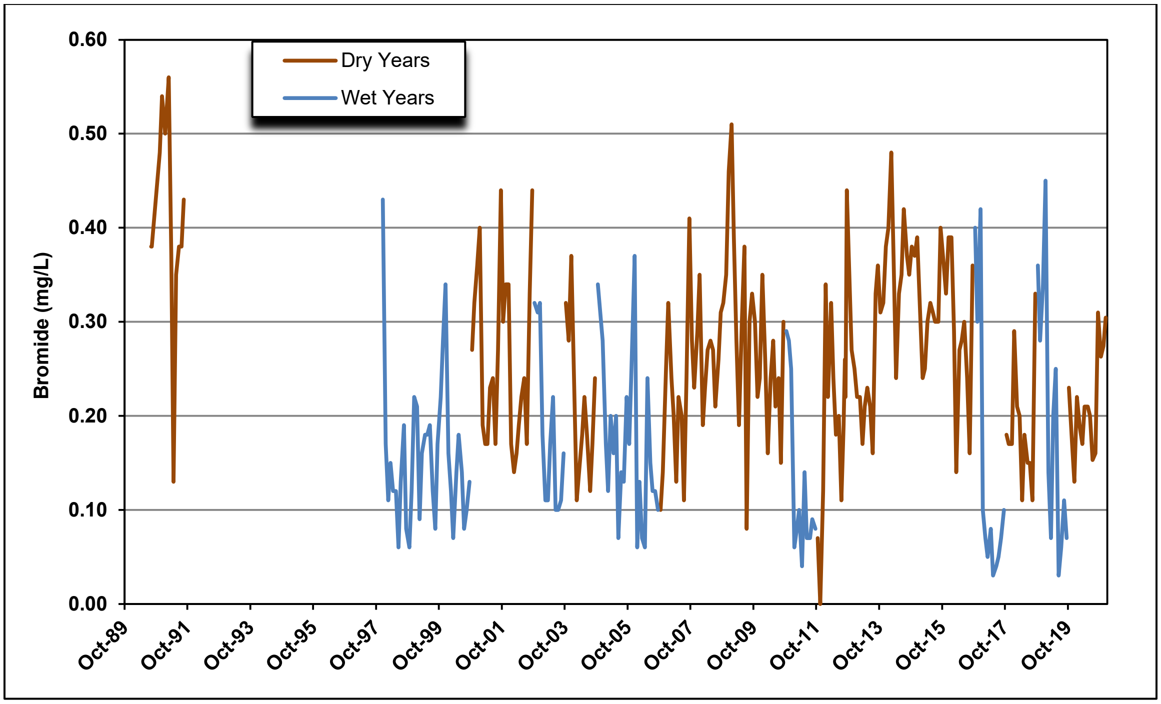
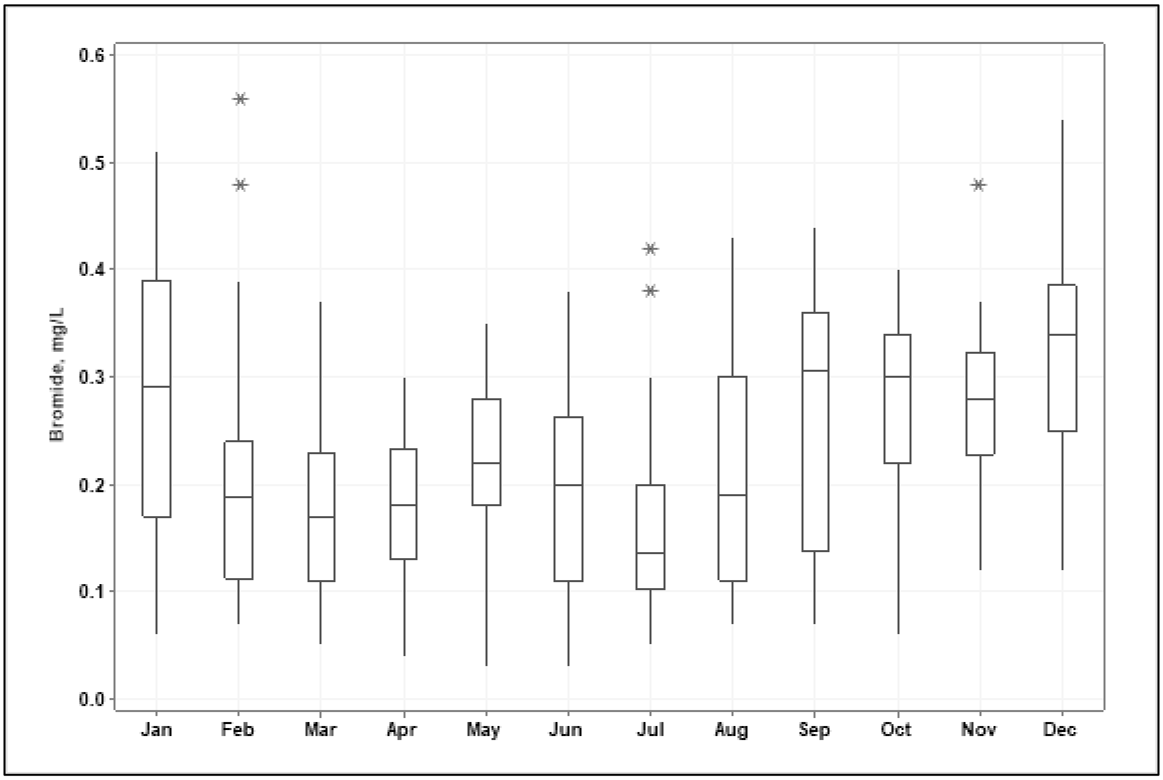


Figure 5-33. Monthly Variability in Bromide at O'Neill Forebay Outlet, 1990 to 2020



Check 21 – Check 21 represents the quality of water entering the Coastal Aqueduct. Grab sample data have been collected at Check 21 since 1998. **Figure 5-34** presents the bromide grab sample data for Check 21. The bromide concentrations at Check 21 range from 0.01 to 0.48 mg/L with a median of 0.22 mg/L.

- Spatial Trends – **Figure 5-22** compares the data collected between 1997 and 2020 at Check 21 to a number of other locations along the aqueduct. Although there are flood and groundwater inflows into the aqueduct between O'Neill Forebay Outlet and Check 21, the median bromide concentration at Check 21 is the same as the median at O'Neill Forebay Outlet and the medians are not statistically significant (Mann-Whitney, *p*=0.684).

- Long-Term Trends – **Figure 5-34** shows that bromide concentrations were lower during the wet years of the late 1990s. Bromide levels were higher from 2012 to 2015 due to consecutive dry years, which led to greater seawater intrusion into the Delta due to lower flows into the Sacramento and San Joaquin rivers. However, an overall decrease in bromide began in the wet year of 2017, as there was more fresh water available from the Sacramento and San Joaquin Rivers, lessening seawater intrusion into the Delta.

- Wet Year/Dry Year Comparison – The Check 21 dry year median bromide concentration of 0.25 mg/L is statistically significantly higher than the wet year median of 0.14 mg/L (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – **Figure 5-35** shows there is a distinct seasonal pattern with the lowest concentrations in the summer months (when water typically released from San Luis Reservoir) and the highest concentrations in the fall. The seasonal pattern at Check 21 is similar to the pattern at O'Neill Forebay Outlet.

Figure 5-34. Bromide Concentrations at Check 21

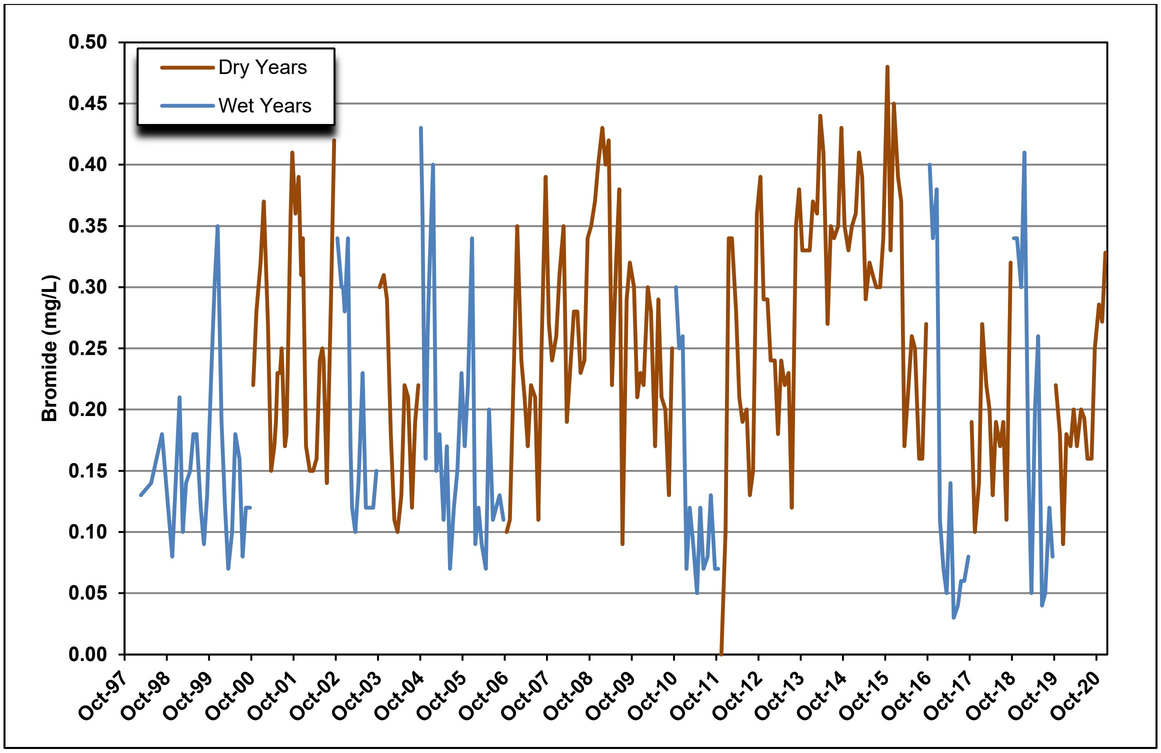
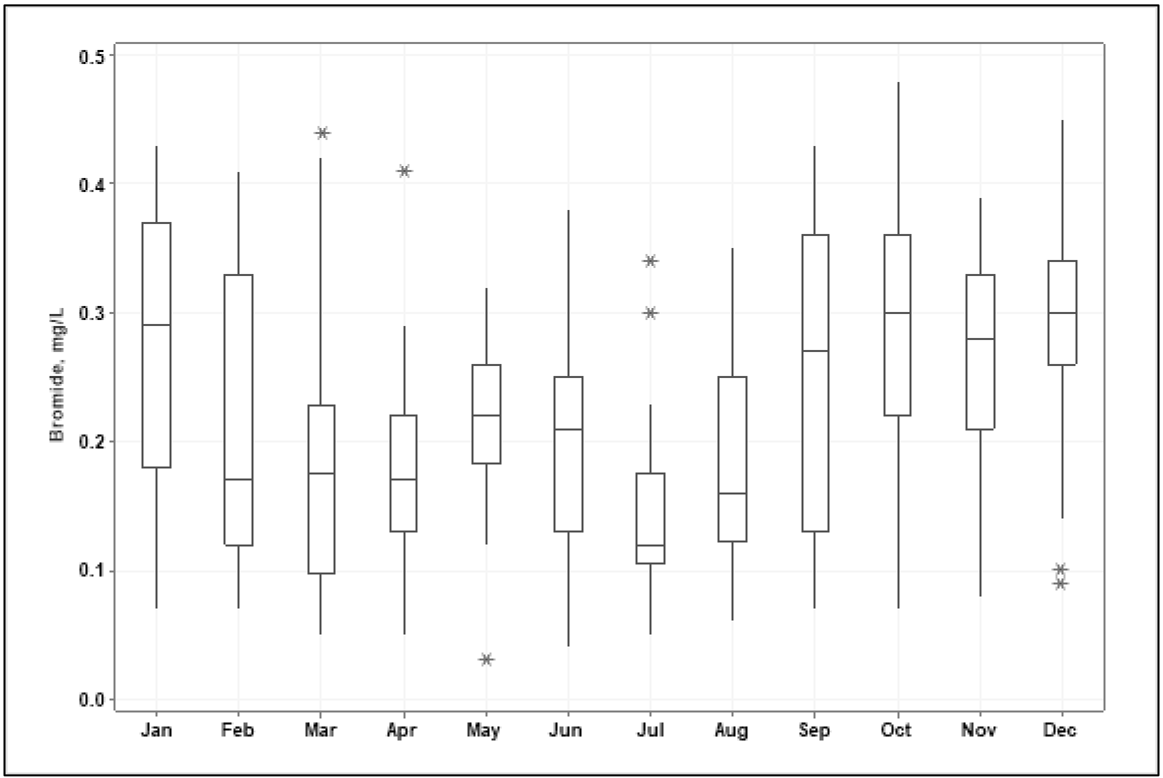


Figure 5-35. Monthly Variability in Bromide at Check 21, 1998 to 2020



Check 41 – Check 41 is immediately upstream of the bifurcation of the aqueduct. Grab sample data have been collected at Check 41 since December 1997. **Figure 5-36** presents the bromide grab sample data for Check 41. The bromide concentrations at Check 41 range from 0.01 to 0.47 mg/L with a median of 0.20 mg/L.

- Spatial Trends – **Figure 5-22** compares the data collected between 1997 and 2020 at Check 41 to a number of other locations along the aqueduct. The Check 41 median concentration of 0.20 mg/L is statistically significantly lower than the Check 21 median of 0.22 mg/L (Mann-Whitney, p=0.011). Large volumes of low bromide groundwater and surface water are allowed to be pumped into the aqueduct between Checks 21 and 41, particularly in dry years. **Figure 5-37** presents the bromide data for Check 21 and Check 41, and the volumes of non-Project water pumped into the Aqueduct between Check 21 and 41 for the last fifteen years. As shown in **Figure 5-37**, water quality at Check 21 and Check 41 are generally similar when there are no pump-ins, and the bromide decreases at Check 41 with higher volumes of non-Project water pumped into the Aqueduct.

- Long-Term Trends – **Figure 5-36** shows that there is no apparent long-term trend. Bromide concentrations at Check 41 fluctuate due to hydrology and Nonproject turn-ins between Check 21 and Check 41.

- Wet Year/Dry Year Comparison – The Check 41 dry year median bromide concentration of 0.22 mg/L is statistically significantly higher than the wet year median of 0.13 mg/L (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 5-38** shows there is a distinct seasonal pattern with the lowest concentrations in the summer months and the highest concentrations in the fall. This is the same pattern seen at Check 21; however, the monthly medians can be as much as 0.20 mg/L lower at Check 41 which is attributed to introduction of non-Project water between Checks 21 and 41.

Figure 5-36. Bromide Concentrations at Check 41

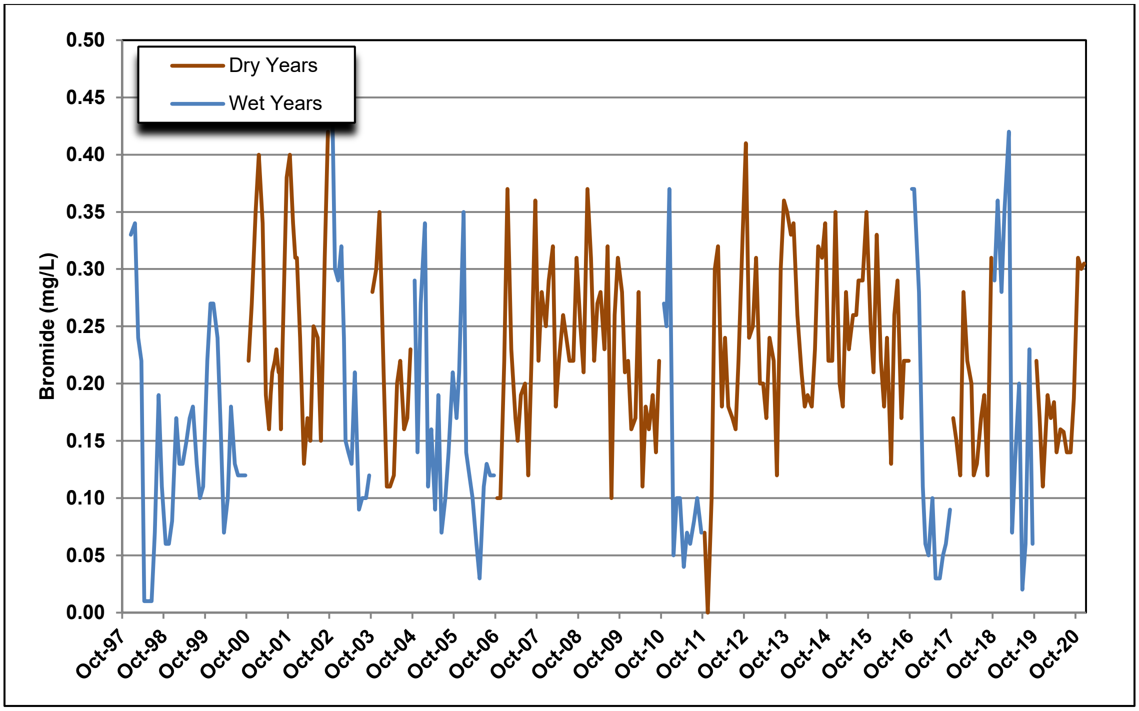


Figure 5-37. Comparison of Check 21 and Check 41 Bromide Concentrations, with Turn-In Volumes

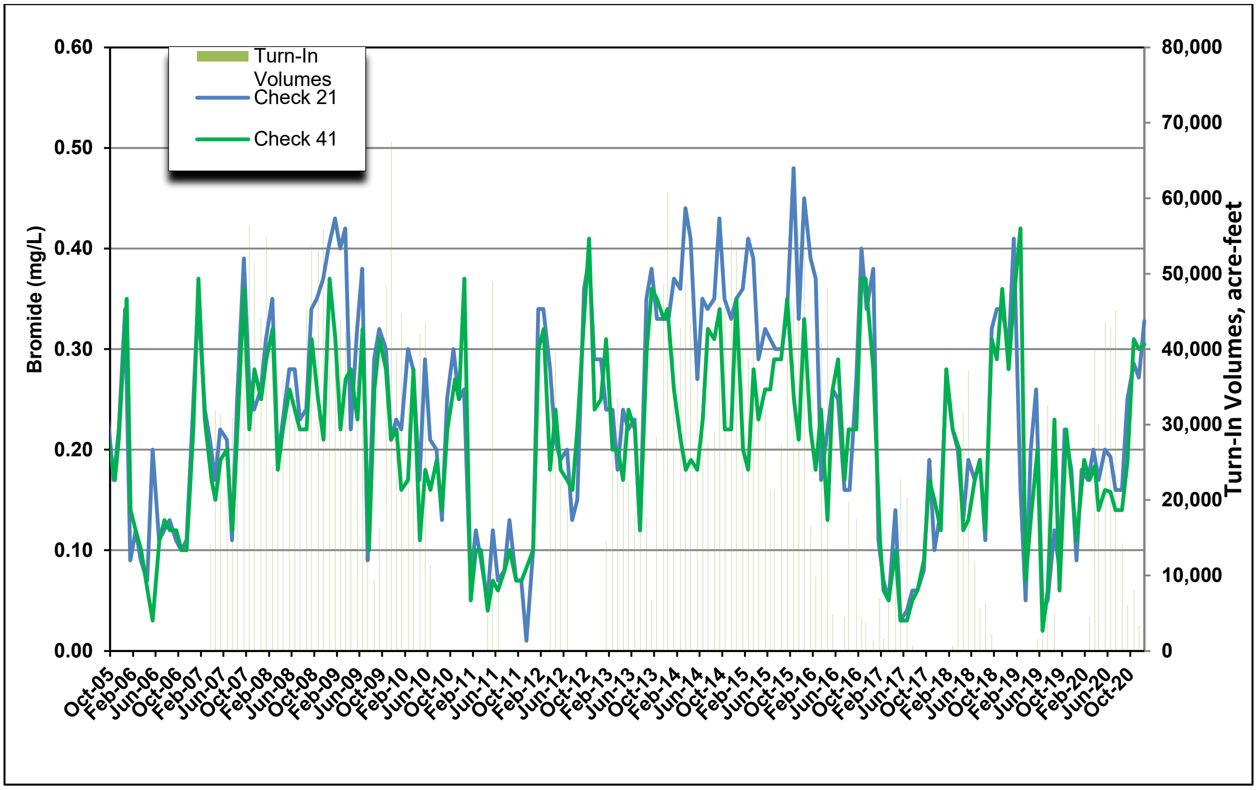
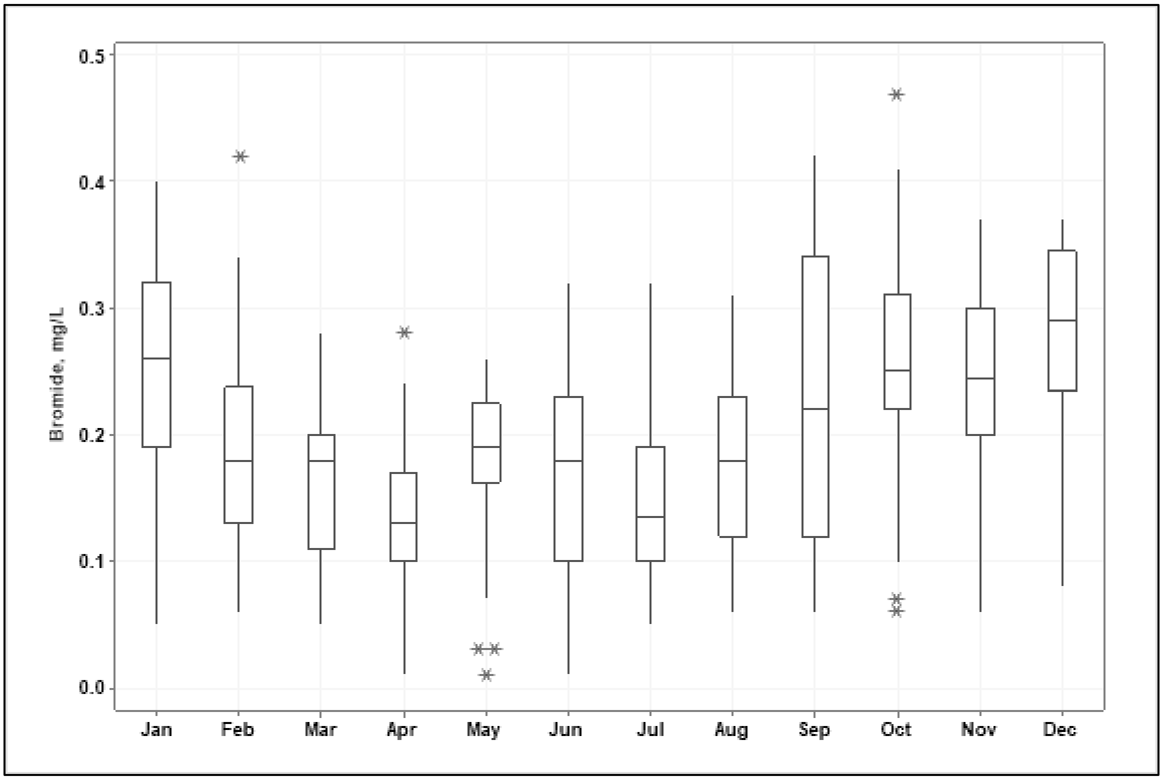


Figure 5-38. Monthly Variability in Bromide at Check 41, 1997 to 2020



Castaic Outlet – Castaic Lake is the terminus of the West Branch of the California Aqueduct. Grab sample data have been collected at Castaic Outlet since 1998. **Figure 5-39** presents the bromide grab sample data for Castaic Outlet. The bromide concentrations range from 0.1 to 0.33 mg/L with a median of 0.22 mg/L. There is much less variability in the bromide data in the lake compared to the aqueduct.

- Spatial Trends –The median bromide level of 0.20 mg/L at Check 41 was not statistically significantly different from the median bromide level of 0.22 mg/L at Castaic Outlet (Mann-Whitney, p=0.054).

- Long-Term Trends – **Figure 5-39** shows that bromide concentrations increase during dry years and decrease during wet years.

- Wet Year/Dry Year Comparison – The Castaic Outlet dry year median bromide concentration of 0.22 mg/L is statistically significantly higher than the wet year median of 0.19 mg/L (Mann-Whitney, p=0.008).

- Seasonal Trends – **Figure 5-40** shows that there is little variability in bromide concentrations throughout the year at Castaic Outlet.

Figure 5-39. Bromide Concentrations at Castaic Outlet

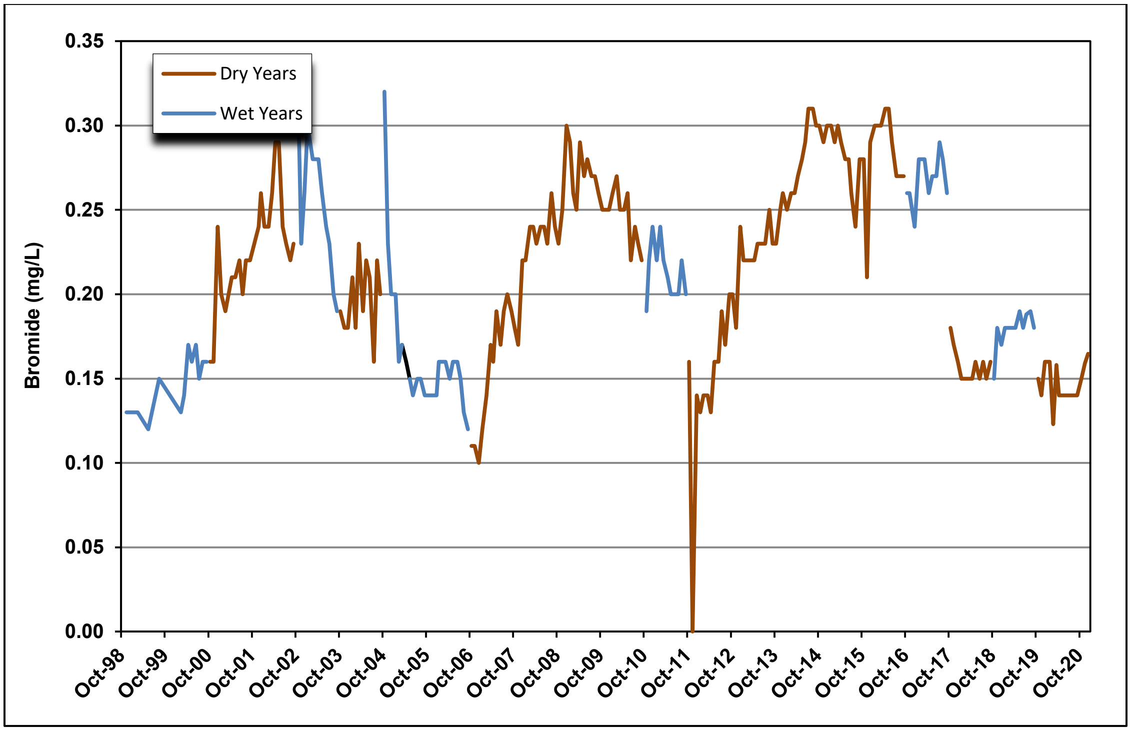
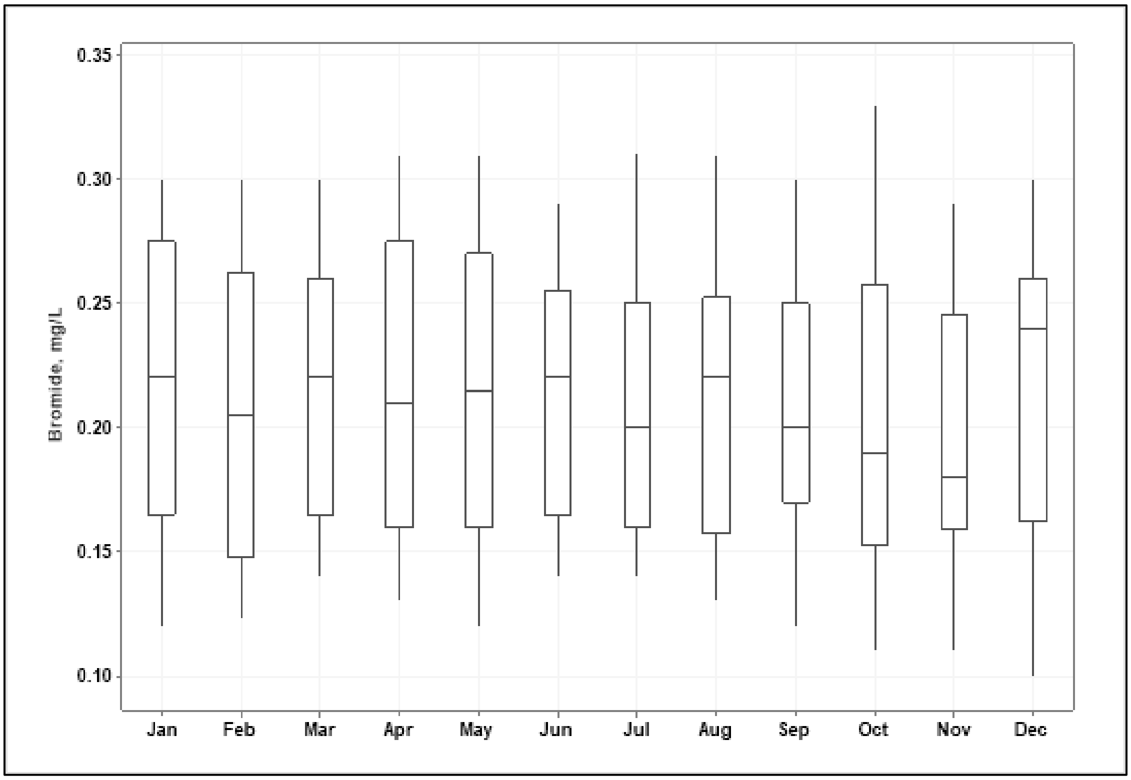


Figure 5-40. Monthly Variability in Bromide at Castaic Outlet, 1998 to 2020



Devil Canyon – Devil Canyon Afterbay is downstream of Silverwood Lake on the East Branch of the California Aqueduct. Grab sample data have been collected at Devil Canyon since December 1997. **Figure 5-41** presents the bromide grab sample data for Devil Canyon. The bromide concentrations range from 0.03 to 0.40 mg/L with a median of 0.20 mg/L.

- Spatial Trends –The median bromide concentration of 0.20 mg/L at Devil Canyon is not statistically significantly different from the median of 0.20 mg/L at Check 41 (Mann-Whitney, *p*=0.669).

- Long-Term Trends – **Figure 5-41** shows that there is no discernible long-term trend in the data. Bromide concentrations increase during dry years and decrease during wet years.

- Wet Year/Dry Year Comparison – The Devil Canyon dry year median bromide concentration of 0.23 mg/L is statistically significantly higher than the wet year median of 0.14 mg/L (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – **Figure 5-42** shows the same seasonal pattern as the upstream check structures on the aqueduct. The limited storage on the East Branch does not have the same effect of reducing the fluctuations in bromide concentrations that is seen on the West Branch.

Figure 5-41. Bromide Concentrations at Devil Canyon

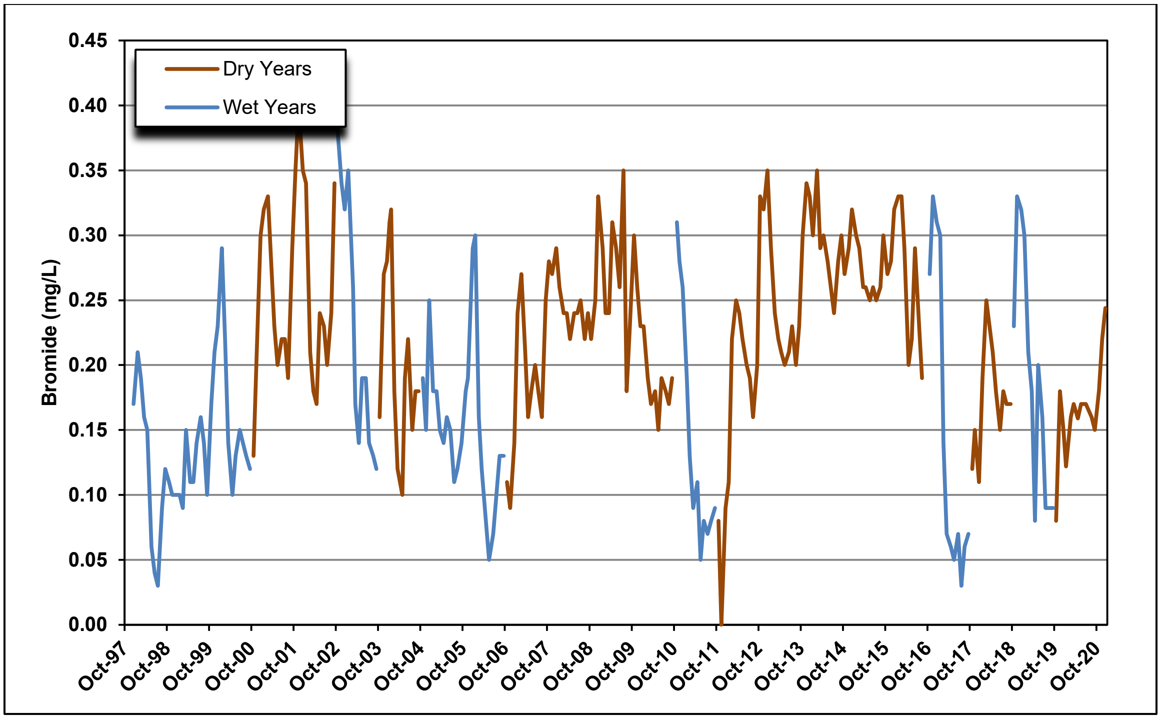
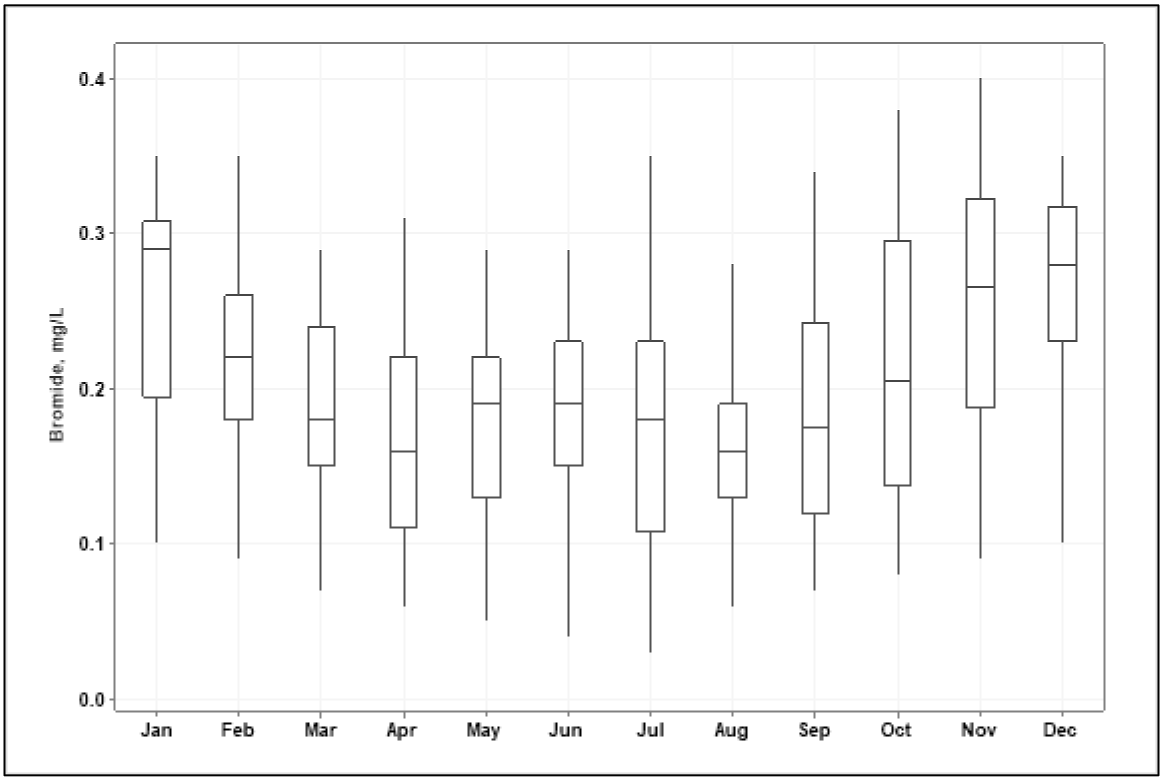


Figure 5-42 Monthly Variability in Bromide at Devil Canyon, 1997 to 2020



SUMMARY

- Bromide concentrations in the Sacramento River are low, often at or near the detection limit of 0.01 mg/L. Bromide concentrations in the American River were non-detectable from 1997 to 2020. Conversely, bromide concentrations are high in the San Joaquin River (median of 0.22 mg/L).

- Bromide concentrations in the NBA are higher and more variable than at Hood but substantially lower than the levels at Banks. The Barker Slough watershed is the source. The median bromide concentration at Barker Slough is 0.04 mg/L.

- The median concentration of bromide at Banks (0.20 mg/L) is not statistically significantly lower than the median of 0.22 mg/L at Vernalis.

- The median bromide concentration at Banks (0.20 mg/L) is statistically significantly higher than the median bromide concentration at DV Check 7 (0.16 mg/L).

- The median bromide concentration at Banks (median of 0.20 mg/L) is statistically lower than the median bromide concentration at Pacheco (median of 0.24 mg/L).

- Bromide concentrations in the DMC at McCabe (median of 0.19 mg/L) and at O’Neill Forebay Outlet are not statistically significantly different from Banks. Bromide does not change statistically significantly between O’Neill Forebay Outlet Check 13 and Check 21. However, Check 41 is statistically significantly lower in bromide than Check 21, due to large volumes of low bromide groundwater and surface water turned-into the Aqueduct between Check 21 and Check 41. Bromide concentrations at Check 41 are not statistically different compared to Castaic Outlet and Devil Canyon. Bromide concentrations in Castaic Lake are slightly less variable than the aqueduct locations; however, the dampening effect is not seen in Silverwood Lake.

- The real-time analyzers at Vernalis, Banks, and Gianelli provide valuable information on the variability of bromide concentrations at these locations. The real-time monitoring data compare well with the grab sample data collected on the same day, with R squared values ranging from 0.8821 to 0.9835.

- Bromide concentrations are a function of the hydrology of the system. Time series graphs at all of the other key locations were visually inspected to determine if there are any discernible trends. There are no apparent long term trends at most of the locations included in this analysis. Bromide concentrations increase during dry years and decrease during wet years. Consecutive dry years from 2012 to 2015 resulted in an increasing bromide during these years. However, an overall decrease in bromide began in the wet year of 2017, as there was more fresh water available from the Sacramento and San Joaquin Rivers, lessening seawater intrusion into the Delta.

- Bromide concentrations during dry years are statistically significantly higher than bromide concentrations during wet years at all locations except Barker Slough, as shown in **Table 5-2**. There are no statistically significant differences between year types at this location. The median bromide concentrations during dry years are 50 to 60 percent higher than the median concentrations during wet years. This is due to seawater intrusion in the Delta during periods of low Delta outflow.

- There are distinct seasonal patterns in bromide concentrations but they vary between locations. At Barker Slough, bromide concentrations increase during the spring months due to groundwater and subsurface flows from the Barker Slough watershed and then decrease throughout the summer and fall months. On the San Joaquin River, concentrations reach minimum levels in April and May due to spring pulse flow requirements under D-1641. The concentrations then increase throughout the summer, fall, and early winter months. Concentrations are low at Banks from February through July and then increase steadily throughout August, fall, and early winter months due to the discharge of agricultural drainage and seawater intrusion. Downstream of San Luis reservoir, bromide concentrations show the same pattern as Banks except there is a secondary peak in May and June due to the release of large amounts of water from San Luis Reservoir.

Table 5-2. Comparison of Dry Year and Wet Year Bromide Concentrations

	Median Bromide mg/L				
Location	**Dry Years**	**Wet Years**	**Bromide Difference (mg/L)**	**Percent Difference**	**Statistical Significance**
Vernalis	0.26	0.12	0.14	54%	D>W
Banks	0.26	0.095	0.165	63%	D>W
Barker Slough	0.04	0.04	0	0%	No
DV Check 7	0.21	0.1	0.11	52%	D>W
McCabe	0.24	0.1	0.14	58%	D>W
Pacheco	0.25	0.24	0.01	4%	No
Gianelli	0.23	0.14	0.09	39%	D>W
Check 13	0.26	0.13	0.13	50%	D>W
Check 21	0.25	0.14	0.11	44%	D>W
Check 41	0.2	0.13	0.09	41%	D>W
Castaic Outlet	0.22	0.2	0.03	14%	D>W
Devil Canyon	0.2	0.14	0.09	39%	D>W

REFERENCES

J.P. Riley and R. Chester. 1971. Introduction to Marine Chemistry. Academic Press London and New York.

CHAPTER 6 NUTRIENTS

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FIGURES

TABLES

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CHAPTER 6 NUTRIENTS

WATER QUALITY CONCERN

Nutrients are required for the proper functioning of aquatic ecosystems but when they are present in drinking water supplies at concentrations that exceed natural background levels, a number of adverse impacts occur. When nutrients are readily available and other environmental conditions favorable, algal growth can reach levels that cause taste and odor in drinking water, produce algal toxins, add organic carbon, obstruct water conveyance facilities, clog filters and increase the quantity and expense of handling solid waste from the treatment process. Excess algal growth can result in anaerobic conditions in the hypolimnion of reservoirs when the algae decompose and settle out of the water column. Algal toxins and taste and odor compounds will be discussed further in Chapter 7. While ammonia concentrations are typically low in surface waters, anaerobic conditions can lead to high levels.

The U.S. Environmental Protection Agency (USEPA) has established nitrogen and phosphorus reference conditions for Ecoregion I, which includes California's Central Valley. The reference concentration for total nitrogen (total N) is 0.31 mg/L, and for total phosphorus (total P) it is 0.047 mg/L (USEPA, 2001). Temperate streams were classified by Dodds et al. (1998), as shown in **Table 6-1**.

Table 6-1. Trophic Level Classification of Streams

Constituent (mg/L)	Oligotrophic - Mesotrophic Boundary	Mesotrophic - Eutrophic Boundary
Mean total N	0.700	1.500
Mean total P	0.025	0.075

The nutrient concentrations in the State Water Project (SWP) are discussed in this chapter and compared to the reference conditions and the stream trophic level boundary conditions. The impacts on algal blooms and taste and odor compounds are discussed in Chapter 7.

WATER QUALITY EVALUATION

Measurement of nutrient concentrations provides an indication of the potential for algal and vascular plant growth in systems that are not limited by other factors, such as light availability or adverse temperatures. Of the required nutrients, nitrogen and phosphorus are most important, but potassium and silicon, in addition to small quantities of various other elements are also required. Potassium is believed to be in sufficient supply in the aquatic environment of California that it does not limit algal production. Silicon is required by diatoms for growth of their "frustules," or silicon outer bodies, but it is generally present in sufficient quantities to support diatom growth. Nitrogen and phosphorus are, therefore, the subjects of this analysis.

Nitrogen in the aquatic environment can be present in several biochemically inter-convertible forms such as organic nitrogen, ammonia, nitrite, nitrate, and gaseous nitrogen. Although gaseous (atmospheric) nitrogen is actually part of the biochemical cycle, its relationship to the other nitrogen forms is complex. Nitrogen is discussed here as the summation of the forms for which SWP waters are analyzed. Total nitrogen as used in this report does not include nitrogen gas, but does include its other forms, nitrate, nitrite, ammonia, and organic nitrogen. Ammonia and nitrate are the N forms that are available for algal growth. Both N and P occur in inorganic and organic forms that are present in particulate (>0.45 µm) and dissolved fractions.

Phosphorus is present in both dissolved and particulate forms. Particulate phosphorus consists of organic phosphorus incorporated in planktonic organisms, inorganic mineral phosphorus in suspended sediments, and phosphate adsorbed to inorganic particles and colloids. The dissolved forms include dissolved organic phosphorus, orthophosphate, and polyphosphates. Dissolved orthophosphate is the only form that is readily available for algal and plant uptake; however total P is a better indicator of the productivity of a system.

It should be noted that prior to November 2020, DWR's Bryte Lab was using a modified DWR method for Standard Method 4500-NO3-F for dissolved nitrate + nitrate as N, EPA method 365.4 for total phosphorus as P, and EPA 351.2 for total Kjeldahl nitrogen as N. The modification froze samples upon arrival at the laboratory giving them a longer hold time. Beginning in November 2020, use of DWR modified methods ceased as Bryte Lab moved to National Environmental Laboratory Accreditation Institute standards which call for strict method adherence. In the case of the above mentioned methods, a pre acidified sample container is used for sample collection where the acid preserves the sample instead of freezing.

SOURCES OF NITROGEN AND PHOSPHORUS

A study on the concentrations, loads and trends of nutrients entering the Delta was completed by USGS in 2021 (Saleh and Domagalski, 2021). The SPAtially Referenced Regressions On Watershed (SPARROW) model was used to determine the sources of total nitrogen (**Figure 6-1**) and total phosphorus (**Figure 6-2**) at two locations: the Sacramento River at Freeport and the San Joaquin River near Vernalis.

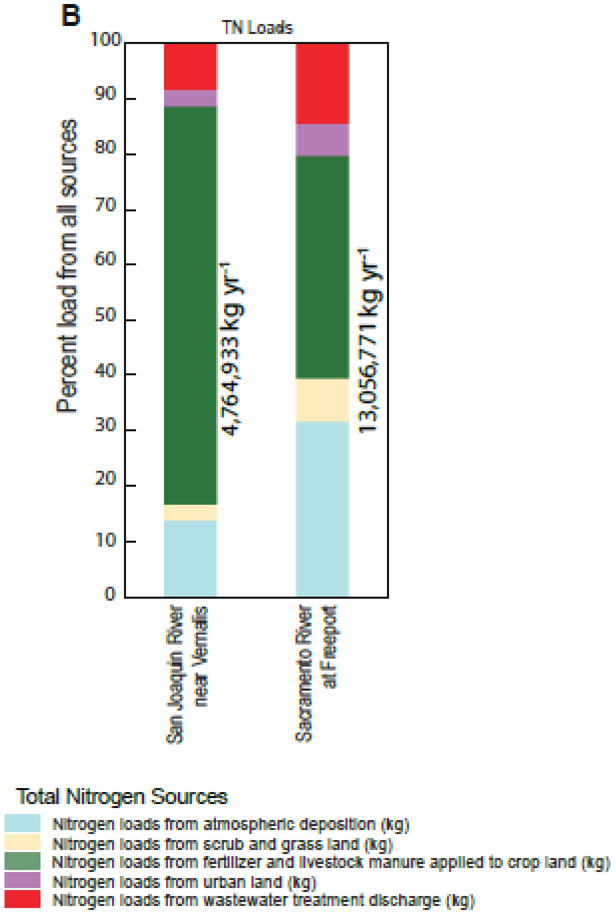
For the Sacramento River at Freeport, the model identified major sources of total nitrogen as: 40 percent from fertilizer and manure applied to agricultural areas within the Central Valley, 31.7 percent from atmospheric deposition, 14.5 percent from wastewater, 8 percent from scrub and grass land, and 5.8 percent from urban developed land.

For the San Joaquin River near Vernalis, the model identified major sources of total nitrogen as: 72.1 percent from fertilizer and manure, 13.8 percent from atmospheric deposition, 8.4 percent from wastewater, 2.8 percent from scrub and grass land, and 2.9 percent from urban runoff.

It should be noted that the source of nitrogen from treated wastewater has decreased in the Sacramento River as of the writing of this report as the Sacramento Regional County Sanitation District facility (located just upstream of Freeport) began biological nutrient removal in April 2021 which will remove most of the ammonium via nitrification, and a portion of the nitrate via denitrification.

Additionally, the City of Modesto and Turlock stopped discharging to the San Joaquin River in December 2017, and March 2020 respectively which decreased the nitrogen load to the San Joaquin River.

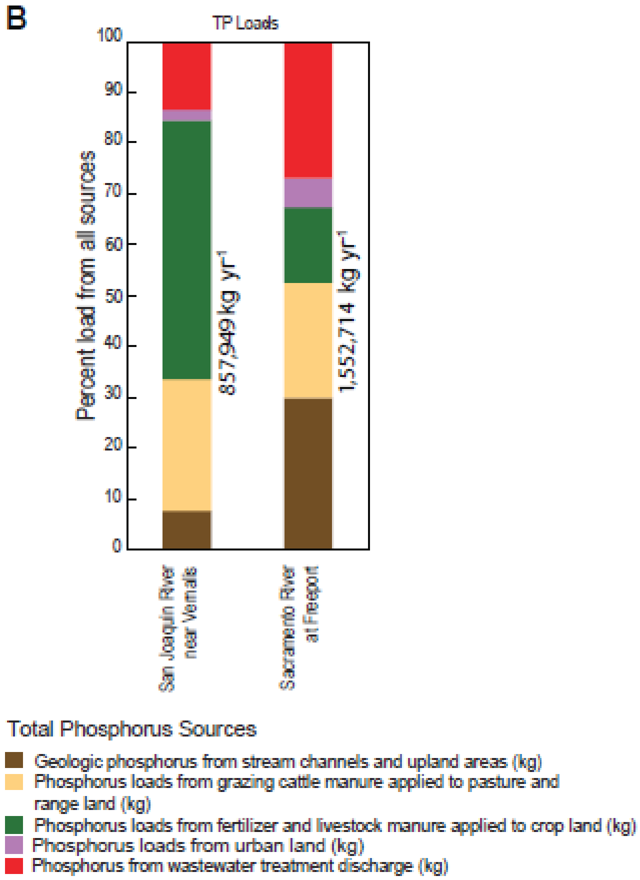
Figure 6-1. Percent of Total Nitrogen Load from all watershed sources, as calculated by 2012 SPARROW model



For the Sacramento River at Freeport, the model identified major sources of total phosphorus as 37.5 percent from fertilizer and manure applied to agricultural areas within the Central Valley, 26.9 percent from wastewater, 29.9 percent from geologic phosphorus from the stream channel and upland areas, and 5.7 percent from urban runoff.

For the San Joaquin River near Vernalis, the model identified major sources of total phosphorus as 77.2 percent from fertilizer and manure, 13.3 percent from wastewater, 7.5 percent from geologic phosphorus from the stream channel and upland areas, and 2 percent from urban runoff.

Figure 6-2. Percent of Total Phosphorus Load from all watershed sources, as calculated by 2012 SPARROW model



NUTRIENT CONCENTRATIONS IN THE SWP

Nutrient data used in this analysis were drawn from the Department of Water Resources (DWR) Municipal Water Quality Investigation (MWQI) Program and from the Division of Operations and Maintenance (O&M) water quality monitoring program. Unlike water quality constituents such as salinity, nitrogen and phosphorus are not conservative in the environment, but change forms as they are incorporated into living organisms and released back into the water at the end of the organisms' life cycles. As a consequence, examining trends can be somewhat more complex than for conservative constituents. The nutrient data were analyzed to determine if there are any changes in concentrations as water travels through the SWP system, and to identify seasonal patterns and changes over time. However, total nutrient levels can be useful for determining the trophic level classification of a waterbody (**Table 6-1).** Data are presented in summary form for all locations and analyzed in more detail for a number of key locations. Box plots are also used to show data from multiple locations on one plot and to display seasonal differences at one location. **Figure 2-25** presents an explanation of the box plots. **Table 6-2** shows the period of record available for each location that was evaluated.

The recent study period of 2016 through 2020 represented a time period of alternating wet and dry years for the Sacramento Valley Water Year Index, with water year 2016 classified as below normal, 2017 classified as wet, 2018 classified as below normal, 2019 classified as wet, and 2020 classified as dry.

The California Department of Water Resources adopts five water year types: wet, above normal, below normal, dry, and critical. The classification is based on a water year index that is derived from full natural flow measurements. For the Sacramento River region, the water year index is called the Sacramento Valley Index (SVI) (also known as the "4 River Index" and the "40-30-30 Index") and uses the sum of calculated monthly unimpaired runoff from the following gauges: Sacramento River above Bend Bridge, Feather River at Oroville, Yuba River at Smartsville, and American River below Folsom Dam. The SVI is calculated based on the following equation:

SVI = (0.4 X current April-July runoff) + (0.3 X current October-March runoff) + (0.3 X previous year's index)

The current April-July runoff is for the sum of the runoff for the four rivers in the current water year from April to July, in million acre-feet. If the previous year's index exceeds 10 MAF, then 10 MAF is applied instead. Once the SVI is calculated, the year type classification is based on the thresholds in **Table 2-2.**

The SWP Watershed

Figure 6-3 presents the total N 2002 to 2020 data and **Figure 6-4** presents the total P 2002 to 2020 data for the tributaries to the Sacramento-San Joaquin Delta (Delta) and the Harvey O. Banks Delta Pumping Plant (Banks). Total N and total P concentrations are low at the American River and the Sacramento River at West Sacramento (West Sacramento) sites. Although the period of record is longer at Banks, all other sites began nutrient monitoring in November 2002, so a subset of the Banks data was evaluated. There is a considerable increase in both nutrients at the Sacramento River at Hood (Hood) compared to West Sacramento and American River sites; however the Hood concentrations are much lower than those found in the San Joaquin River at Vernalis (Vernalis). Both the total N and total P concentrations at Banks are slightly higher than the Hood concentrations.

Table 6-2. Total N and Total P Data

Location	Total N		Total P	
	Start Date	End Date	Start Date	End Date
West Sacramento	Nov 2002	Dec 2020	Nov 2002	Dec 2020
American	Nov 2002	Dec 2020	Nov 2002	Dec 2020
Hood	Nov 2002	Dec 2020	Nov 2002	Dec 2020
Vernalis	Nov 2002	Dec 2020	Nov 2002	Dec 2020
Banks	Jan 1998	Dec 2020	Jan 1998	Dec 2020
Barker Slough	Jan 1998	Dec 2020	Dec 1997	Dec 2020
DV Check 7	Jan 1998	Dec 2020	Dec 1997	Dec 2020
McCabe	Jul 2009	Dec 2020	Jul 2009	Dec 2020
Pacheco	Mar 2000	Dec 2020	Mar 2000	Dec 2020
Gianelli	Aug 2013	Dec 2020	Aug 2013	Dec 2020
O'Neill Forebay Outlet	Jun 2004	Dec 2020	Jun 2004	Dec 2020
Check 21	Apr 2000	Dec 2020	Apr 2000	Dec 2020
Check 41	Jan 1998	Dec 2020	Dec 1997	Dec 2020
Castaic Outlet	Jan 1998	Dec 2020	Dec 1997	Dec 2020
Check 66	Jan 1998	Dec 2020	Dec 1997	Dec 2020
Devil Canyon Afterbay*	Jan 1998	Dec 2020	Dec 1997	Dec 2020

*Note: Data were collected from Dec 1997 to May 2001 at Devil Canyon Afterbay, then at Devil Canyon Headworks from June 2001 to December 2010, and then at Devil Canyon Second Afterbay in early 2011. These datasets have been combined.

Figure 6-3. Total N Concentrations in the SWP Watershed, 2002 to 2020

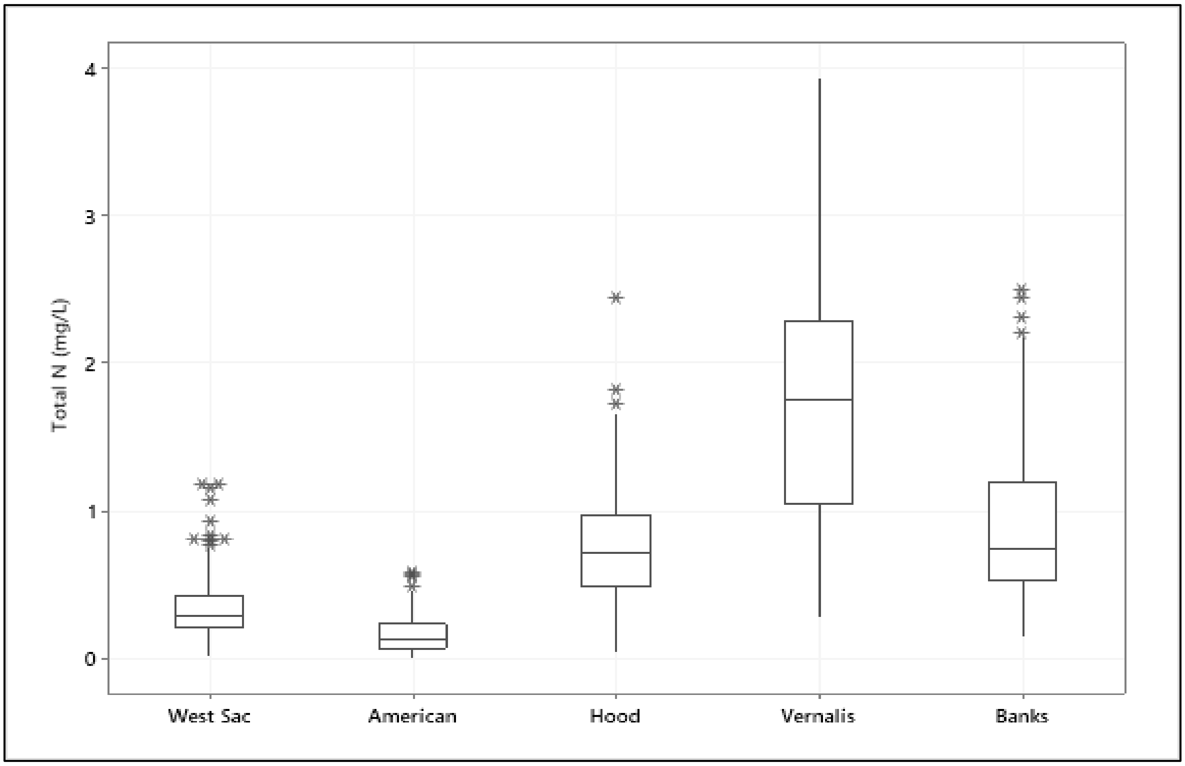


Figure 6-4. Total P Concentrations in the SWP Watershed, 2002 to 2020

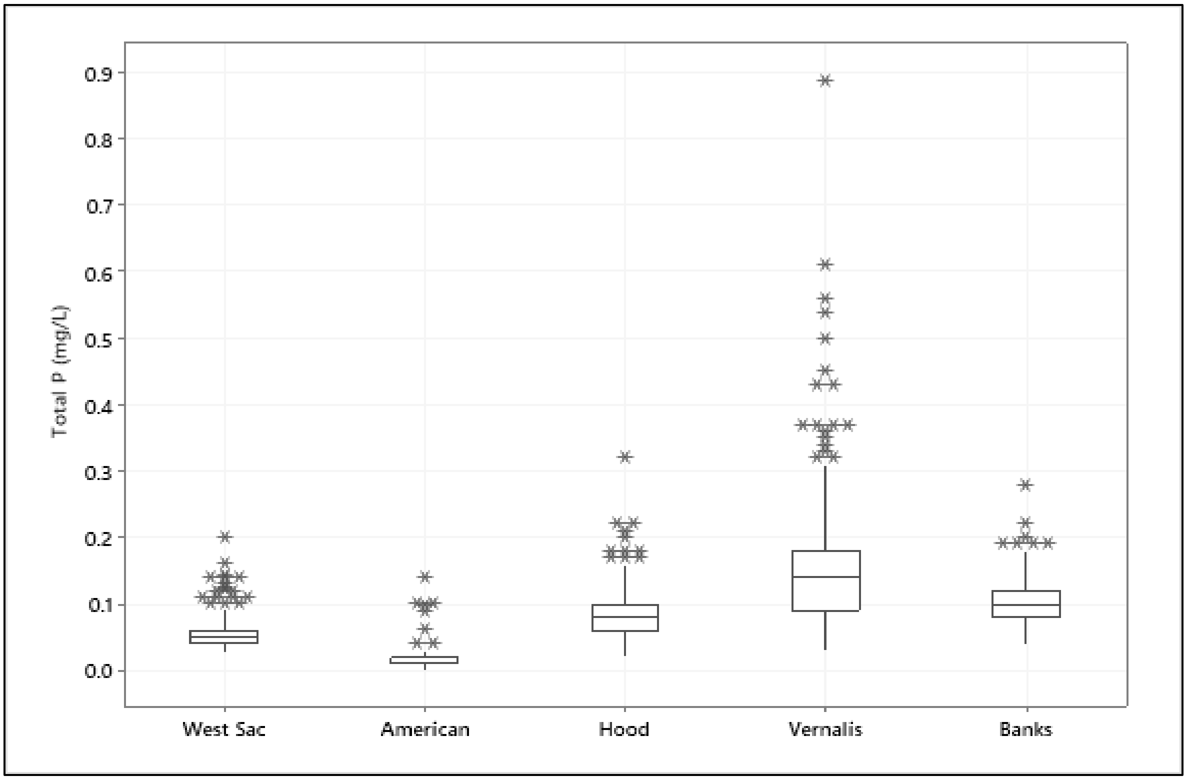


Table 6-3 presents the median concentrations of total N and total P and the resultant trophic level classification based on the values shown in **Table 6-1** from Dodds et al. (1998). Based on this classification system, the American River is oligotrophic and the Sacramento River is oligotrophic/mesotrophic at West Sacramento, upstream of the Sacramento urban area. Downstream of the urban area, the Sacramento River is classified as mesotrophic/eutrophic at Hood. The San Joaquin River is eutrophic, with median total N and total P concentrations substantially higher than the boundary condition. Although Banks is not a stream, it is shown in the table to indicate that the water pumped into the California Aqueduct is classified as mesotrophic/eutrophic.

Table 6-3. Median Nutrient Concentrations and Stream Classifications

Location	Total N (mg/L)	Total P (mg/L)	Classification
West Sacramento	0.29	0.05	Total N – Oligotrophic Total P – Mesotrophic
American	0.13	0.01	Total N – Oligotrophic Total P – Oligotrophic
Hood	0.71	0.08	Total N – Mesotrophic Total P – Eutrophic
Vernalis	1.8	0.14	Total N – Eutrophic Total P – Eutrophic
Banks	0.80	0.10	Total N – Mesotrophic Total P – Eutrophic

Hood – **Figure 6-5** shows all available total N data and **Figure 6-6** shows total P data at Hood. Total N concentrations range from 0.04 to 2.44 mg/L with a median of 0.71 mg/L, and total P concentrations range from 0.02 to 0.32 mg/L with a median of 0.08 mg/L.

- Spatial Trends – **Figures 6-3 and 6-4** present all available data for West Sacramento, American, and Hood. The period of record is the same for all three stations (November 2002 to December 2020). Total N and total P are both very low at American, with median concentrations of 0.13 mg/L for total N and 0.01 mg/L for total P. The median concentrations at West Sacramento are 0.29 mg/L for total N and 0.05 mg/L for total P. Concentrations increase considerably between West Sacramento and Hood, despite the inflow of the high quality American River, due mainly to the discharge from the Sacramento Regional Wastewater Treatment Plant. The median concentrations of total N (0.71 mg/L) and total P (0.08 mg/L) at Hood are statistically significantly higher than the respective median concentrations at West Sacramento (Mann-Whitney, p=0.0000).

- Long-Term Trends – **Figures 6-5** and **6-6** show an increase in N and P during the dry years of 2012 to 2015, and then a decrease through 2017. Trends for both N and P appear to be increasing in years 2019 to 2020. The maximum N concentration of 2.44 mg/L occurred in June 2018.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are differences between wet years and dry years. The median total N concentration during dry years of 0.79 mg/L is statistically significantly higher than the median of 0.56 mg/L during wet years (Mann-Whitney, p=0.000). The dry year median total P concentration of 0.08 mg/L is statistically significantly higher than the wet year median of 0.07 mg/L (Mann-Whitney, p=0.000). The higher total N and total P concentrations during dry years could be due to the greater influence of the Sacramento Regional Wastewater Treatment Plant. The plant discharges a relatively larger load of nitrogen than phosphorus to the river.

- Seasonal Trends – **Figures 6-7 and 6-8** show a clear seasonal pattern of higher concentrations during the wet months of October to February and lower concentrations from March to September. There is a secondary peak in total N during June. The higher concentrations in the wet months are likely due to nutrients being flushed from the watershed during storm events. The spring months may have lower nutrient concentrations due to high quality water being released from reservoirs and the summer months have lower concentrations due to biological uptake.

Figure 6-5. Total N Concentrations at Hood

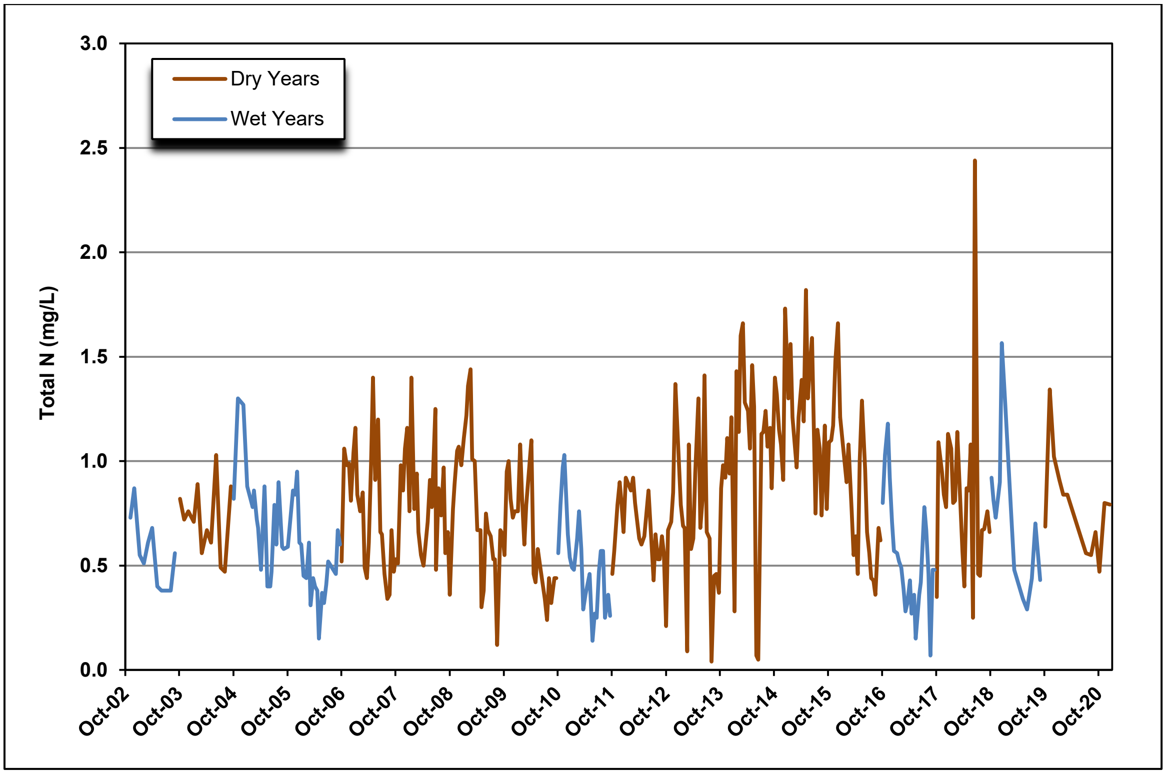


Figure 6-6. Total P Concentrations at Hood

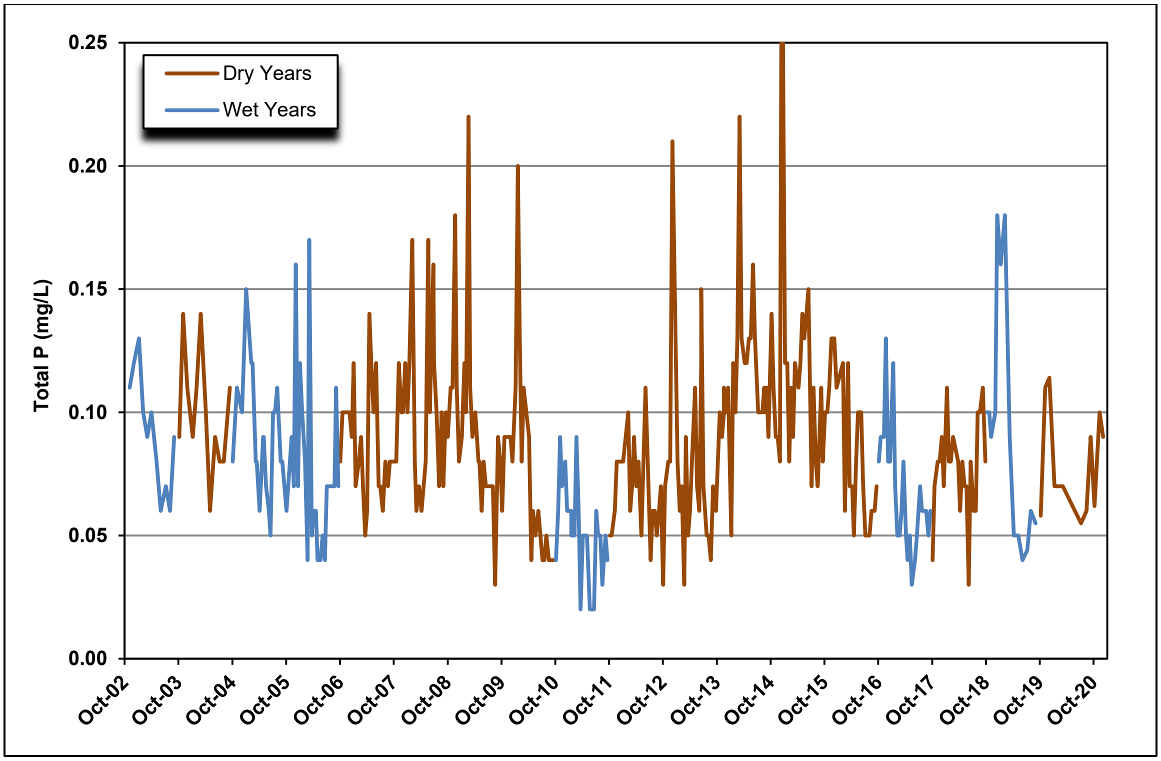


Figure 6-7. Monthly Variability in Total N at Hood, 2002 to 2020

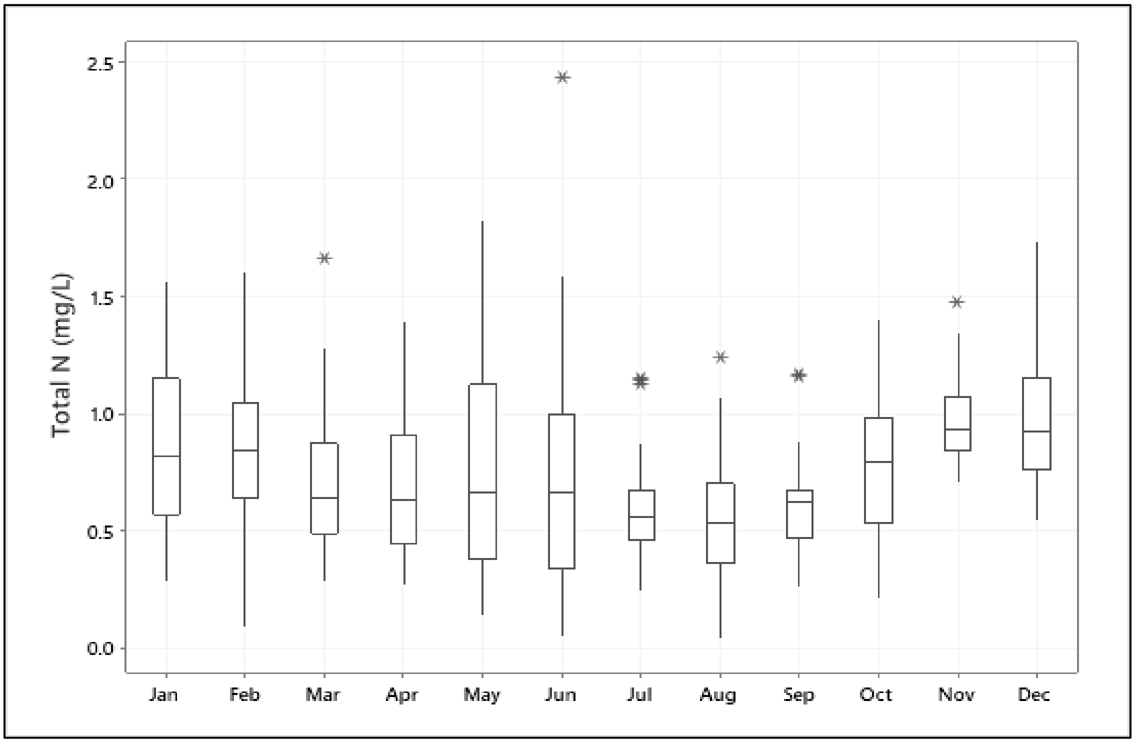
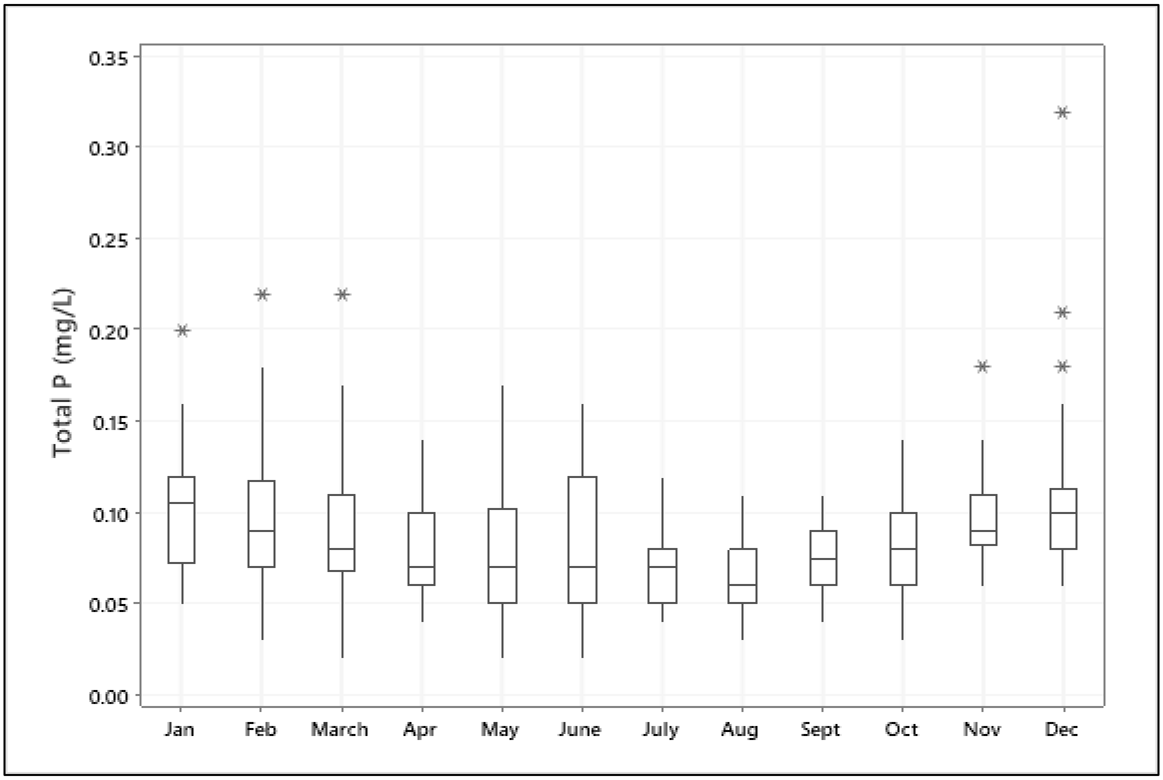


Figure 6-8. Monthly Variability in Total P at Hood, 2002 to 2020



Vernalis **- Figures 6-9 and 6-10** present the total N and total P data at Vernalis. The total N concentrations range from 0.28 to 3.9 mg/L with a median of 1.8 mg/L and the total P concentrations range from 0.03 to 0.89 mg/L with a median of 0.14 mg/L. The median total N concentration at Vernalis is more than twice the median concentration at Hood, whereas the total P concentration is almost twice the concentration at Hood. These higher concentrations are a reflection of the agricultural nature of the San Joaquin watershed.

- Spatial Trends – DWR does not collect data upstream of Vernalis.

- Long-Term Trends – **Figures 6-9** and **6-10** does not show any discernible trend in total N or total P concentrations. Concentrations of total N over the recent 5 year reporting period remained within historical range. The maximum P concentration of 0.89 mg/L occurred in December 2016 and the minimum P concentration of 0.03 mg/L occurred in March 2017.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are differences between wet years and dry years. The median total N concentration during dry years of 1.85 mg/L is statistically significantly higher than the median of 1.25 mg/L during wet years (Mann-Whitney, p=0.0000). The median total P concentration during dry years of 0.14 mg/L is statistically significantly higher than the median of 0.115 mg/L during wet years (Mann-Whitney, p=0.005).

- Seasonal Trends – **Figures 6-11 and 6-12** show a clear seasonal pattern of low concentrations in April and May, followed by progressively increasing nutrient concentrations during the summer months. The concentrations decrease slightly during the fall and then increase again in the winter months. The low concentrations in the spring occur when flows on the San Joaquin River are high due to the Vernalis flow requirements stipulated in Decision 1641 (D-1641). D-1641 includes “spring flow” requirements that apply from February 1 through April 14 and May 16 through June 30, as well as higher spring “pulse” flows that apply from April 15 to May 15. These flow requirements set a minimum monthly average flow rate, based on the water year type. Flows are increased on the San Joaquin River by releasing high quality water from reservoirs on the Merced, Stanislaus, and Tuolumne rivers. Combined exports at the Banks and Jones pumping plants are reduced to 1,500 cfs. These actions that are taken to improve salmon smolt survival also improve water quality.

  Agricultural drainage is discharged to the river during the summer months when flows on the San Joaquin River are low. The slight decrease in concentrations during the fall months may be due to less agricultural drainage entering the river during this time and the increase in the winter months is likely due to storm events flushing nutrients from the watershed.

Figure 6-9. Total N Concentrations at Vernalis

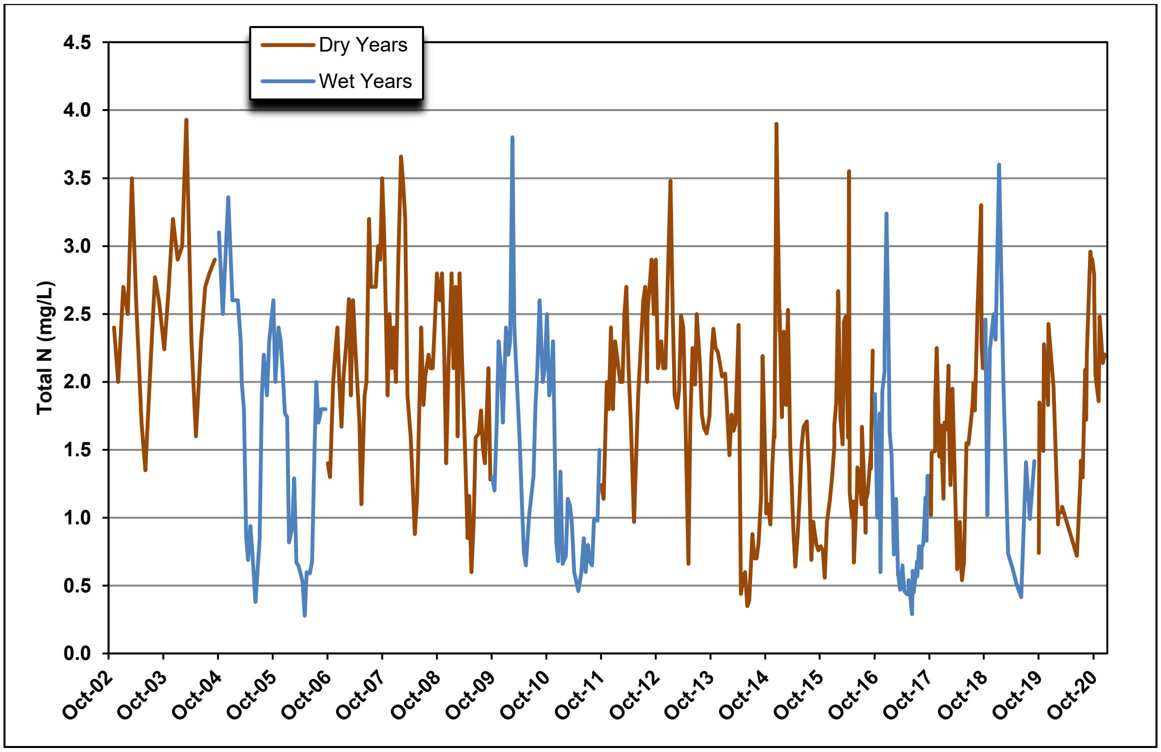


Figure 6-10. Total P Concentrations at Vernalis

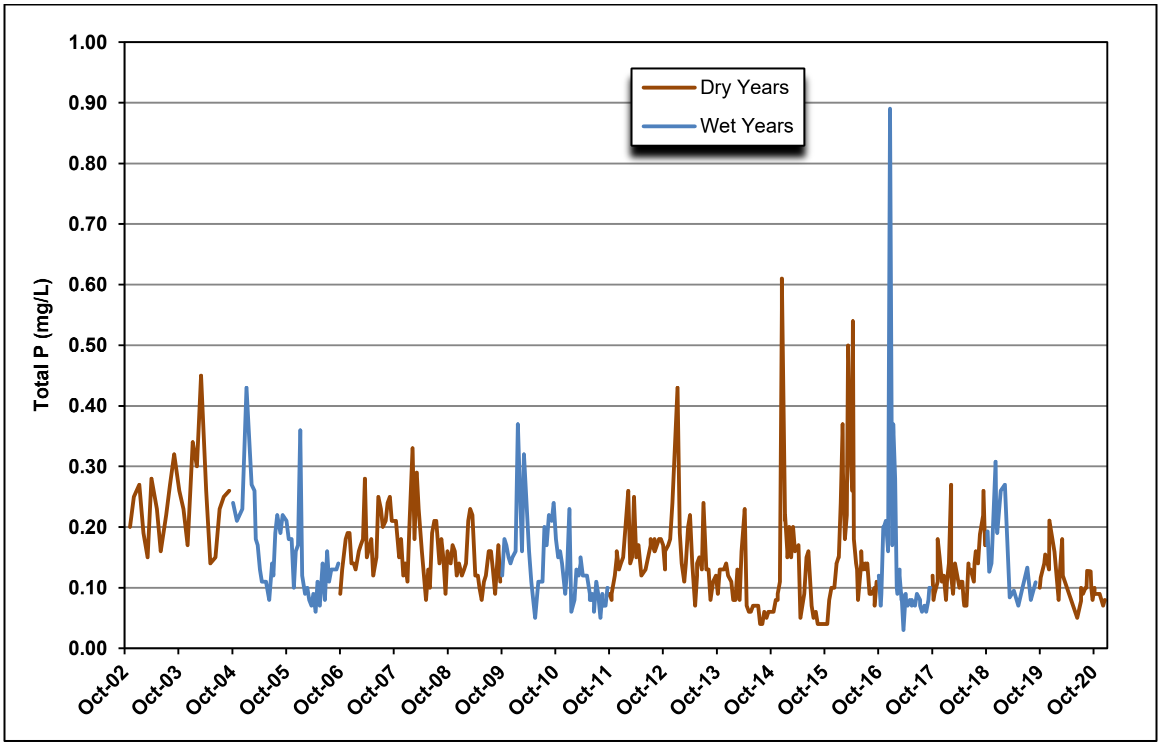


Figure 6-11. Monthly Variability in Total N at Vernalis, 2002 to 2020

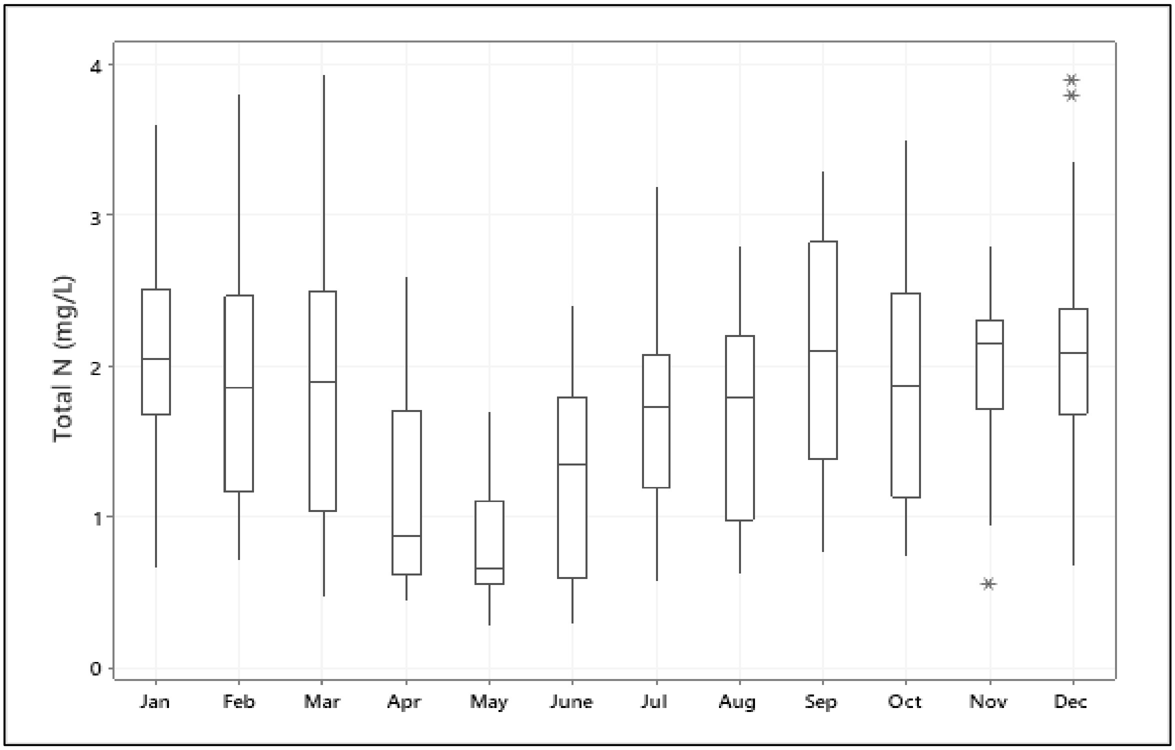
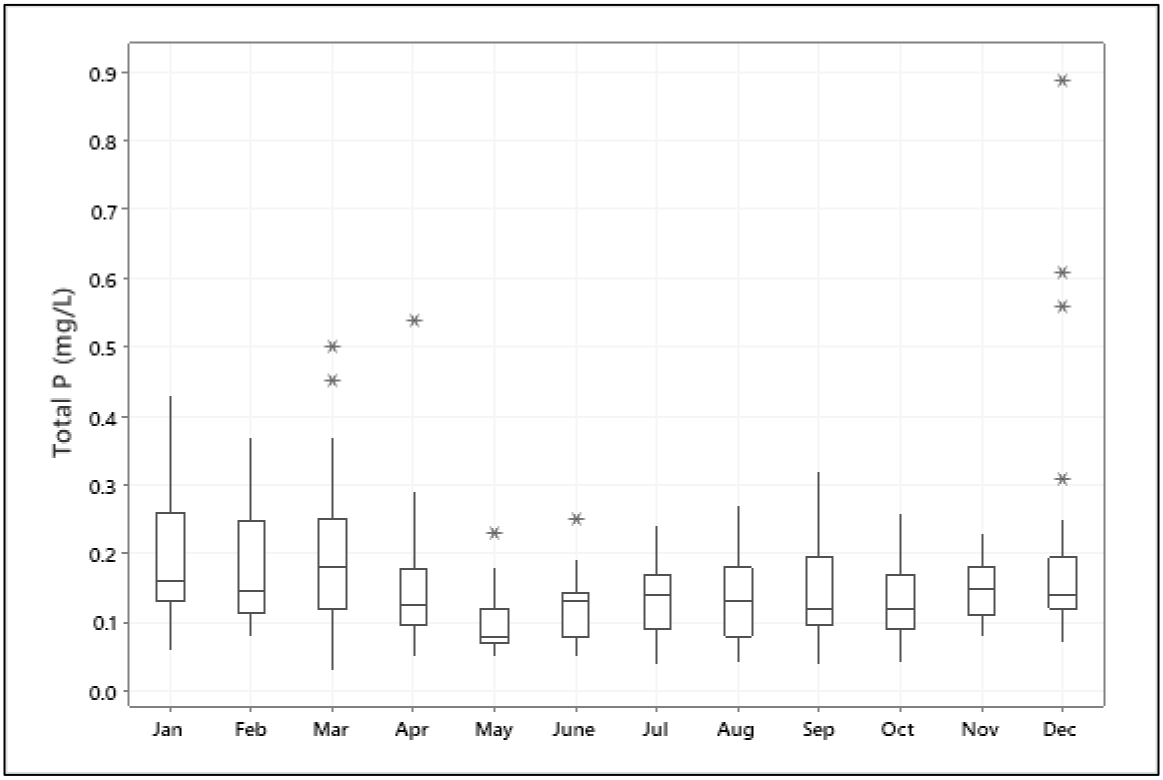


Figure 6-12. Monthly Variability in Total P at Vernalis, 2002 to 2020



Banks – **Figure 6-13** shows all available total N data and **Figure 6-14** shows total P data at Banks. The period of record is longer at Banks than at Vernalis and Hood. The total N concentrations range from 0.15 to 2.5 mg/L with a median of 0.80 mg/L and the total P concentrations range from 0.04 to 0.28 mg/L with a median of 0.10 mg/L.

- Spatial Trends – As the period of record is longer at Banks than at Vernalis and Hood, a smaller subset of the total Banks data available was evaluated, from 2002 to 2020 (**Figure 6-3** and **6-4**). The total N concentration at Banks (median of 0.74 mg/L) is statistically significantly higher than the median concentration of 0.71 mg/L at Hood (Mann-Whitney, *p*=0.018) although the difference is small. The median total P concentration of 0.10 mg/L at Banks is statistically significantly higher than the median concentration of 0.08 mg/l at Hood (Mann-Whitney, *p*=0.000). As discussed previously, the median total N concentration at Vernalis is more than twice the median concentration at Hood whereas the median total P is almost double. This explains why the total N and P concentrations at Banks are higher compared to Hood; however there are also in-Delta sources of nutrients.

- Long-Term Trends – Concentrations of total N and total P over the recent 5 year reporting period remained within historical range as shown in **Figure 6-13 and 6-14.** **Figure 6-14** indicates that total P concentrations were increasing from 2013 to 2016, decreasing from 2017 to 2019, and increasing again in 2020.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are differences between wet years and dry years. The median total N concentration during dry years of 0.84 mg/L is not statistically significantly higher than the median of 0.76 mg/L during wet years (Mann-Whitney, *p*=0.677). The median total P concentration is 0.10 mg/L in both dry and wet years.

- Seasonal Trends – **Figures 6-15 and 6-16** show different seasonal patterns for total N and total P at Banks. The total N pattern has high concentrations during the winter months, declining concentrations in the spring and summer and increasing concentrations during the fall months. The total P concentrations are slightly elevated in January and February, decrease during March, but then peak in June before declining throughout the rest of the summer and fall. Total P median concentrations are lowest in October through December. Total N median concentrations are lowest in August and September.

Figure 6-13. Total N Concentrations at Banks

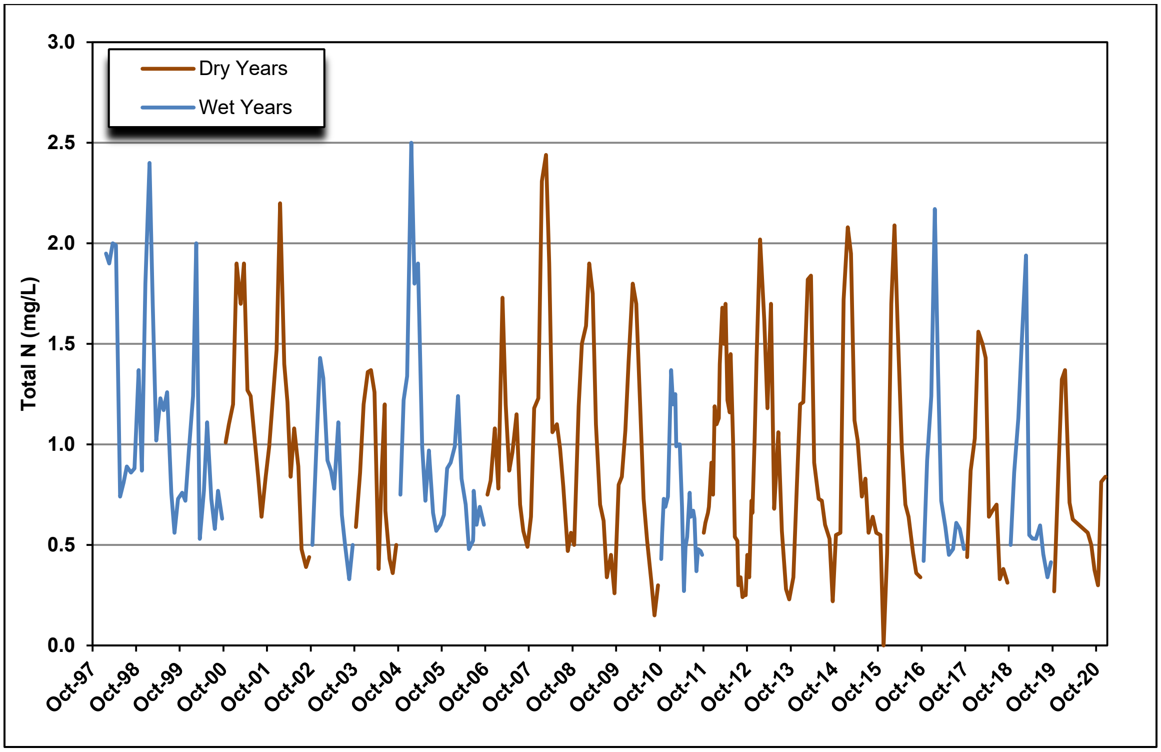


Figure 6-14. Total P Concentrations at Banks

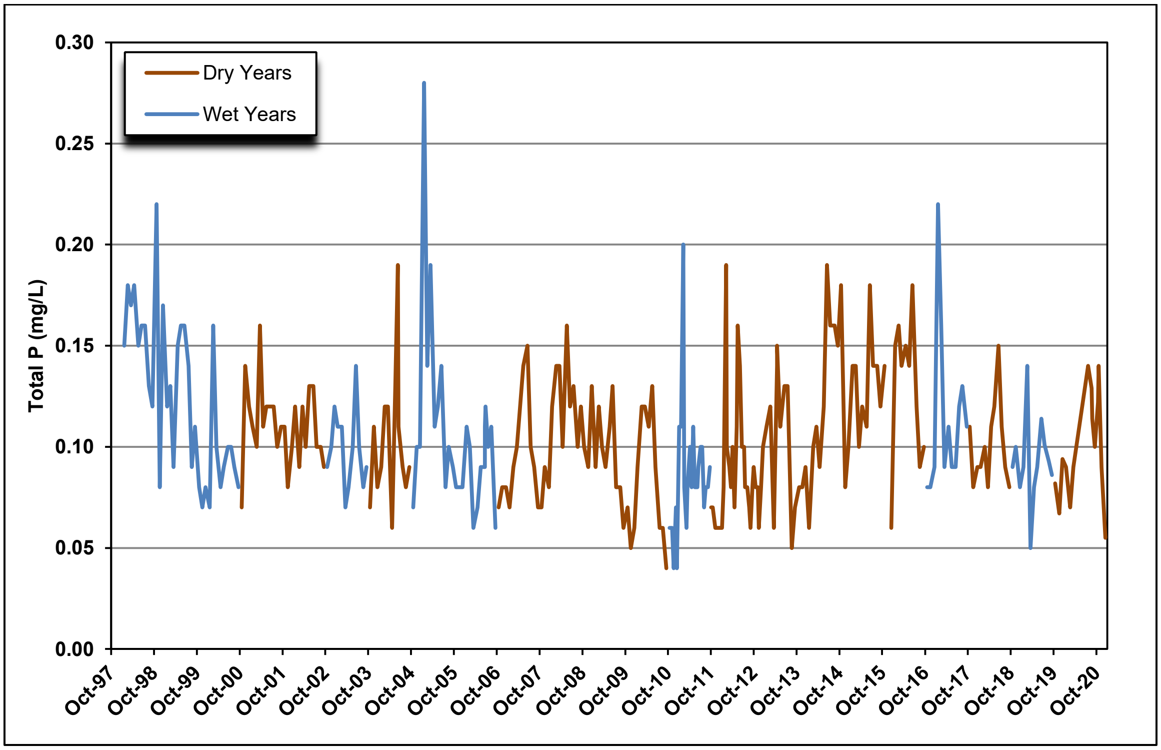


Figure 6-15. Monthly Variability in Total N at Banks, 1998 to 2020

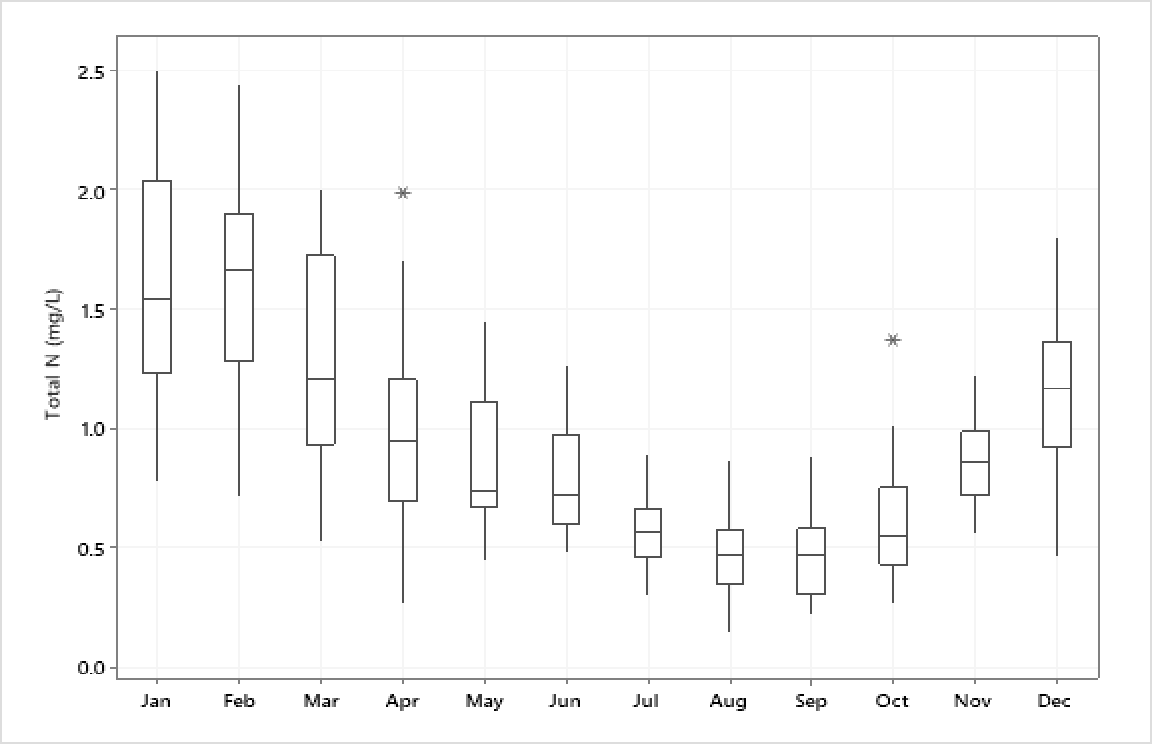
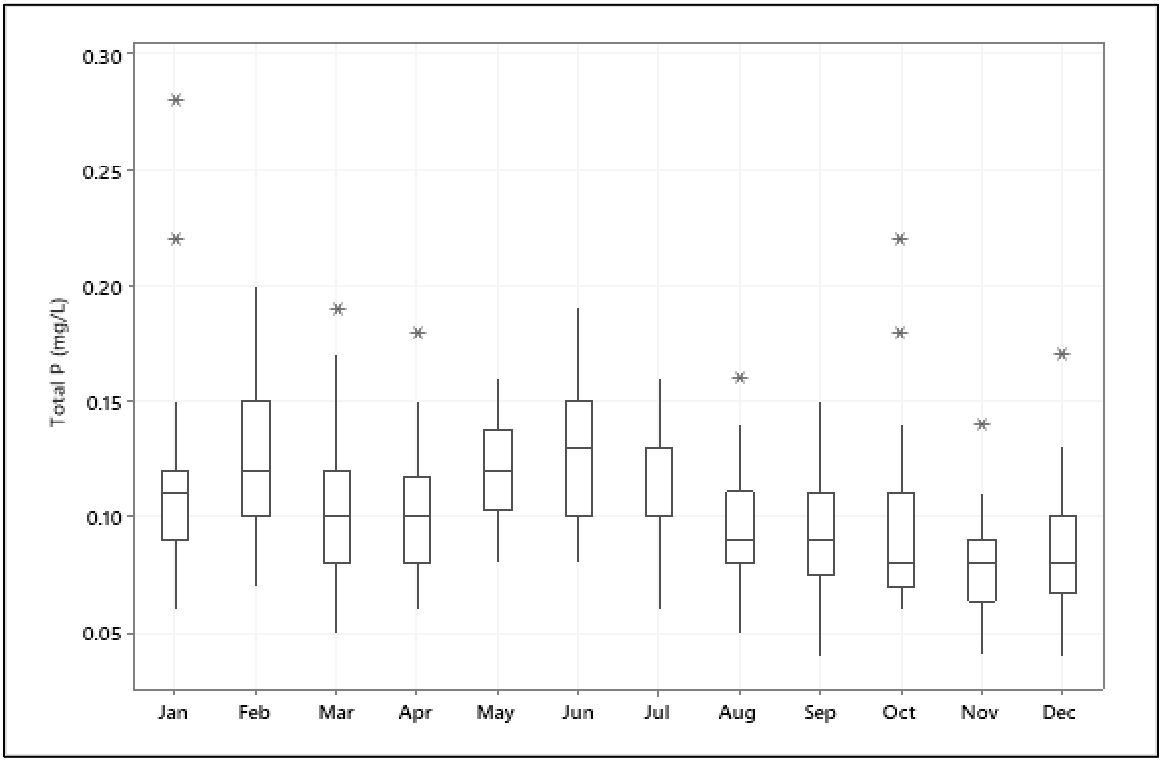


Figure 6-16. Monthly Variability in Total P at Banks, 1998 to 2020



North Bay Aqueduct

Chapter 2 contains a description of the North Bay Aqueduct (NBA). The sources of water are the local Barker Slough watershed and the Sacramento River.

Project Operations

After the water is diverted from Barker Slough, the quality of water delivered to NBA users should not be affected by any other factors since the NBA is an enclosed pipeline. **Figure 6-17** shows average monthly diversions at Barker Slough for the 2016 to 2020 period and median total N concentrations and **Figure 6-18** shows diversions and median total P concentrations. These figures show that the period of highest diversions coincides with the lowest total N concentrations, ranging from 0.36 to 0.53 mg/L. The period of highest diversions has high total P concentrations of 0.30 to 0.33 mg/L in June and July, but concentrations decline steadily through the fall.

Figure 6-17. Average Monthly Barker Slough Diversions and Median Total N Concentrations, 2016 to 2020

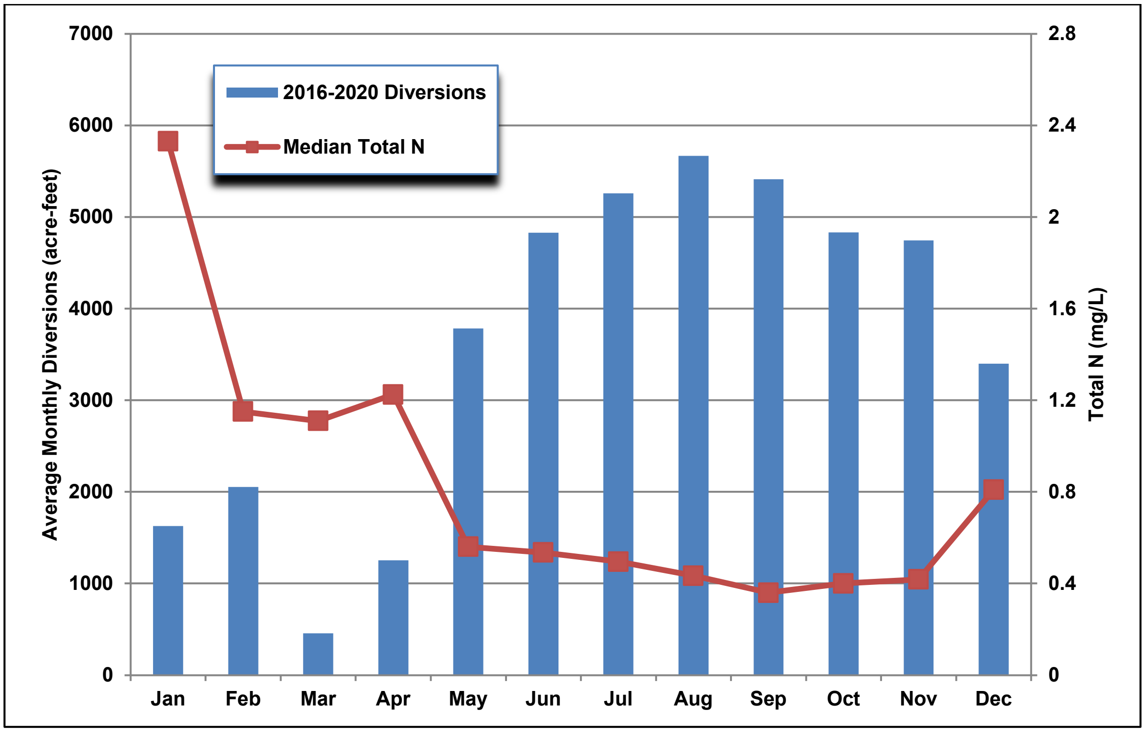
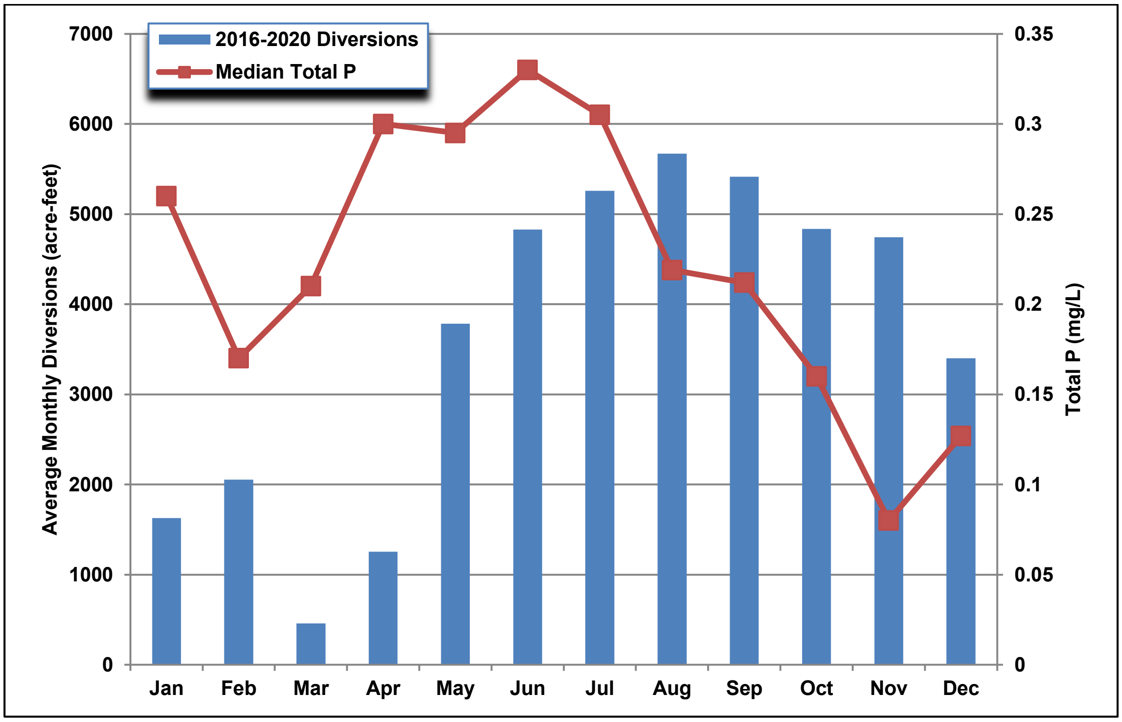


Figure 6-18. Average Monthly Barker Slough Diversions and Median Total P Concentrations, 2016 to 2020



Nutrient Concentrations in the NBA

Nutrient levels have been monitored at Barker Slough since 1997; however, total P is not monitored at Cordelia and nitrate is the only nitrogen species monitored. **Figure 6-19** shows all available total N data and **Figure 6-20** shows total P data at Barker Slough. The total N concentrations range from 0.3 to 3.23 mg/L with a median of 0.79 mg/L and the total P concentrations range from 0.05 to 1.21 mg/L with a median of 0.20 mg/L. The median nutrient concentrations were calculated to compare to the trophic levels in **Table 6-1**. The median total N concentration is 0.79 mg/L, placing Barker Slough in the mesotrophic level. The median total P concentration is 0.20 mg/L, placing Barker Slough in the eutrophic level.

- Spatial Trends – Since nutrient data have been collected for a longer period at Barker Slough than at Hood, a subset of the data were analyzed to compare medians from the same time period (2002 to 2020). During this time period, the Barker Slough total N median concentration of 0.74 mg/L is statistically significantly higher than the median of 0.71 mg/L at Hood (Mann-Whitney, p=0.021) although the difference is small. The Barker Slough total P median concentration of 0.2 mg/L is statistically significantly higher than the Hood median of 0.08 mg/L (Mann-Whitney, p=0.0000). This is about a 150 percent increase over Hood. The Sacramento River is the primary source of water to Barker Slough, so it is evident that the local watershed supplies some nitrogen and a substantial amount of phosphorus to the NBA. There is extensive cattle grazing and farming throughout the watershed, and there is a golf course in the upper part of the watershed; all potential sources of nutrients.

  - Long-Term Trends – **Figures 6-19 and 6-20** do not reveal any discernible trends in the data, except the three highest concentrations of total N occurred in the recent reporting period. The peak total N concentration of 3.23 mg/L occurred in January 2016. The peak total P concentration of 1.21 mg/L occurred on February 2014.

  - Wet Year/Dry Year Comparison – The data were analyzed to determine if there are differences between wet years and dry years. The median total N concentration during dry years of 0.74 mg/L is statistically significantly lower than the median of 0.84 mg/L during wet years (Mann-Whitney, p=0.024). Interestingly, the median total N for dry years was statistically significantly higher than the median total N for wet years in the 2017 Update. The dry year median total P concentration of 0.19 mg/L is not statistically significantly different from the wet year median of 0.21 mg/L (Mann-Whitney, p=0.066).

  - Seasonal Trends – **Figures 6-21 and 6-22** show a clear seasonal pattern of higher concentrations during the winter months and lowest concentrations in the summer and fall, with the lowest median N concentration in August and the lowest median P concentration in November. This pattern also indicates that the nutrients are from the local watershed, and are transported to Barker Slough during winter storm events.

Figure 6-19. Total N Concentrations at Barker Slough

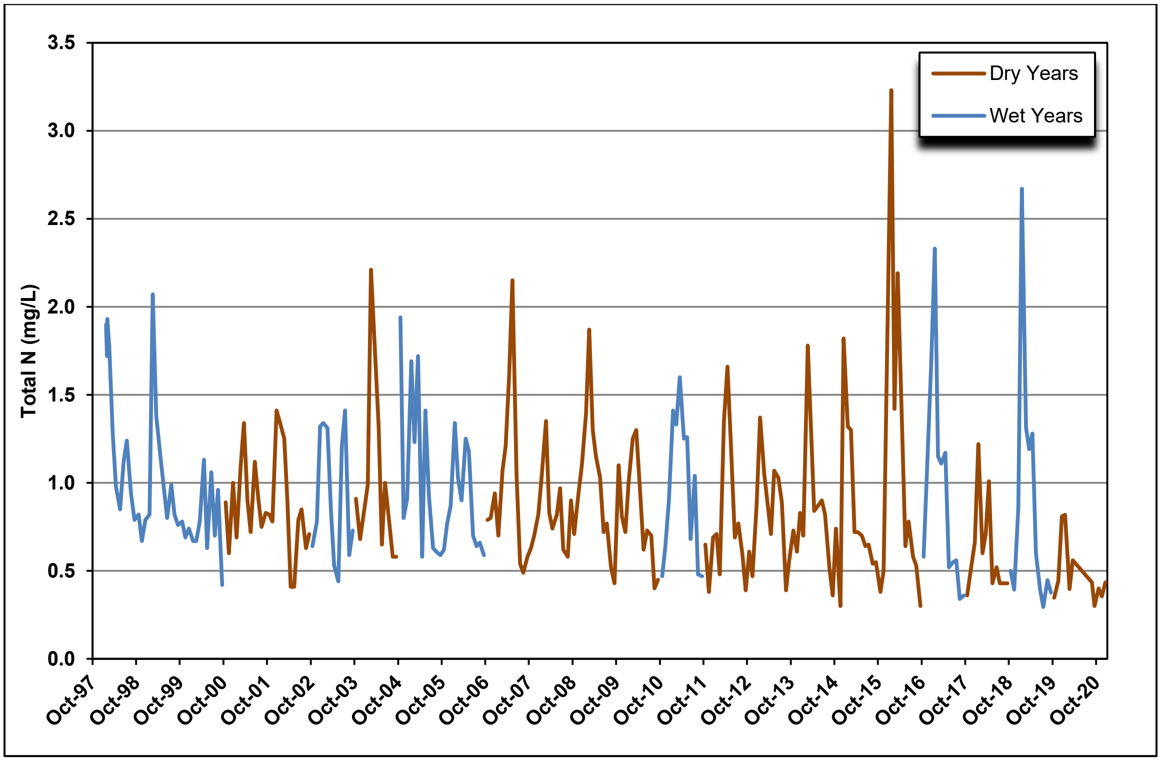


Figure 6-20. Total P Concentrations at Barker Slough

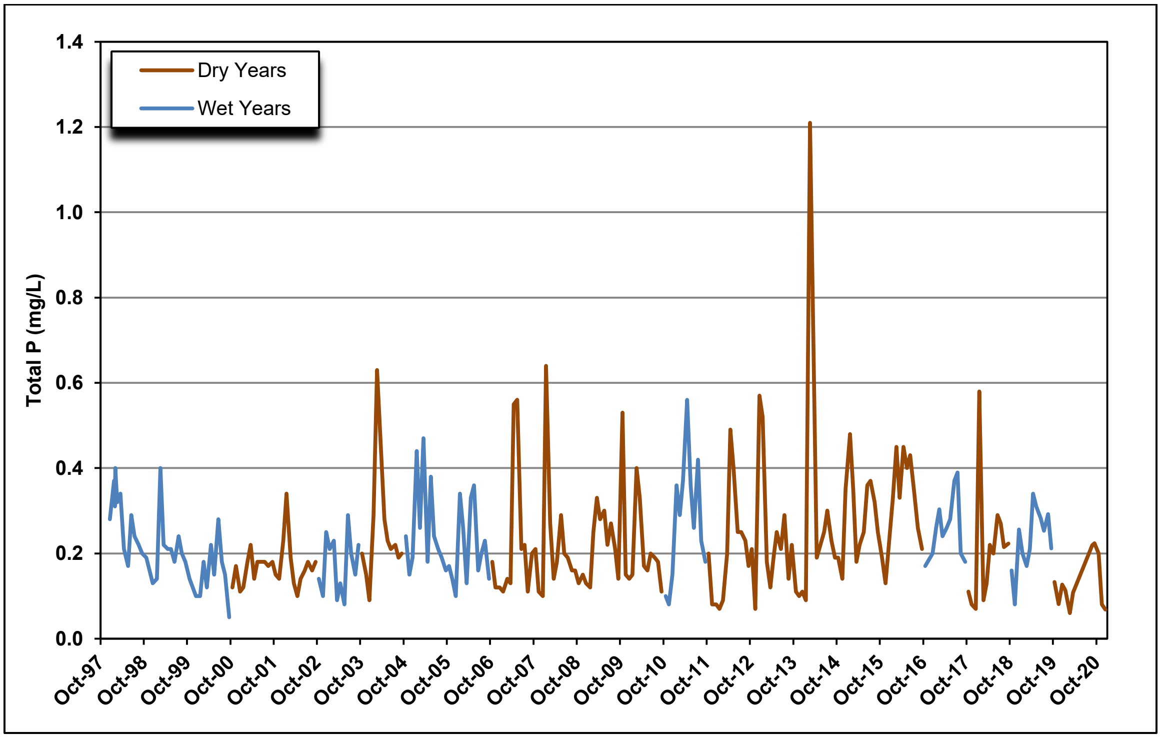


Figure 6-21. Monthly Variability in Total N at Barker Slough, 1998 to 2020

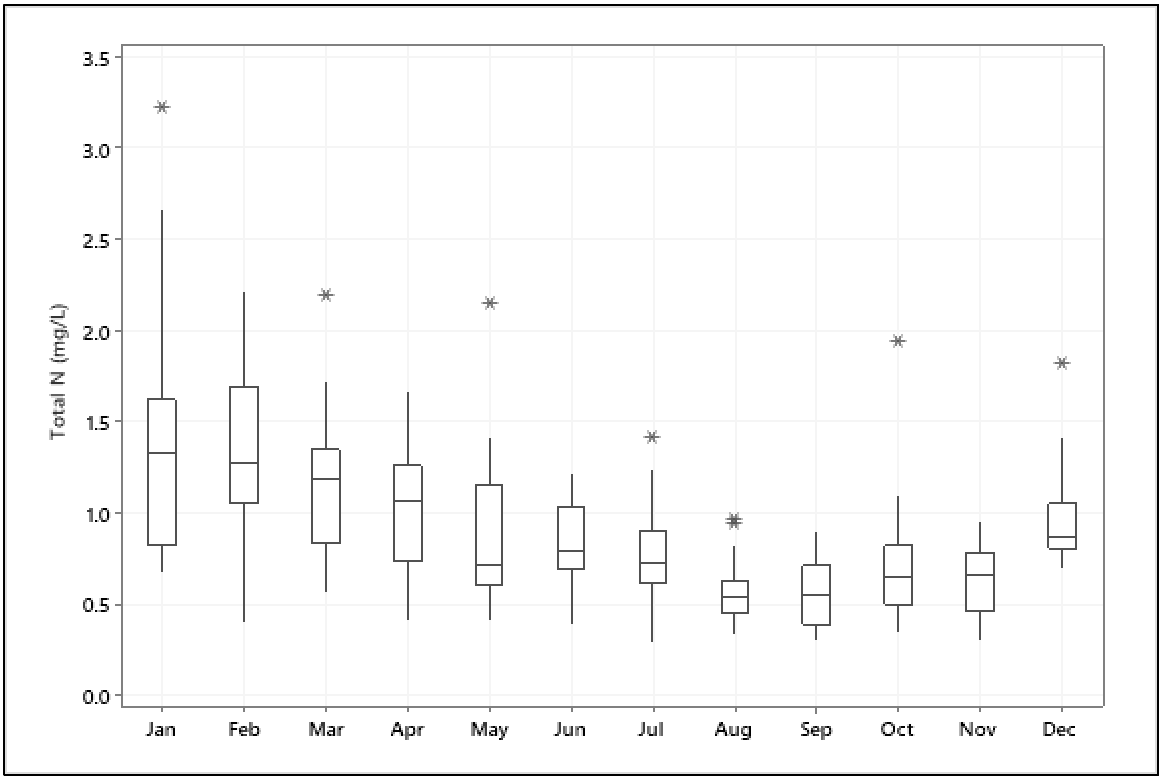
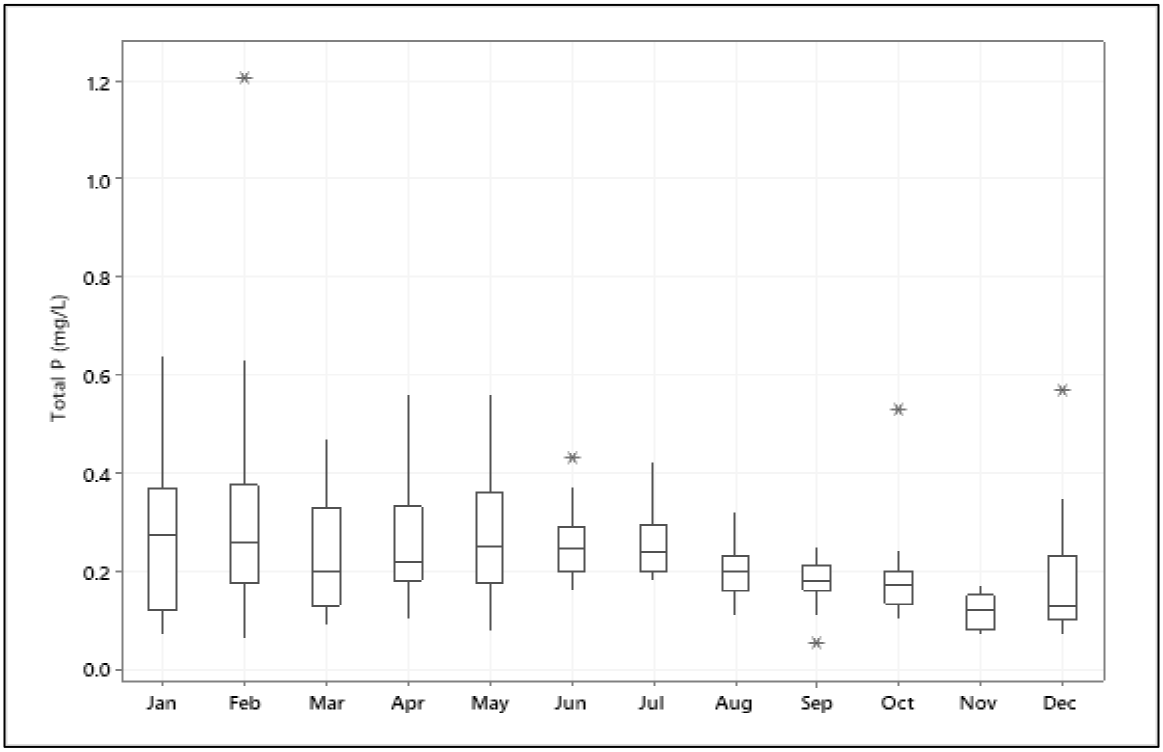


Figure 6-22. Monthly Variability in Total P at Barker Slough, 1997 to 2020



South Bay Aqueduct

Chapter 2 contains a description of the South Bay Aqueduct (SBA). The Delta is the primary source of water and Lake Del Valle is the secondary source.

Project Operations

The quality of water delivered to the SBA Contractors is governed by the timing of diversions from Bethany Reservoir and releases from Lake Del Valle. **Figures 6-23 and 6-24** show average monthly diversions at the South Bay Pumping Plant and releases from Lake Del Valle for the 2016 to 2020 period. The median total N concentrations are shown in **Figure 6-23** and the median total P concentrations are shown in **Figure 6-24**. These graphs show that nitrogen and phosphorus behave differently from each other in the system. The median total N concentrations are relatively low, ranging from 0.3 to 0.56 mg/L during the period of maximum diversions to the SBA. The median total P concentrations are highest in the May through July period (0.11 to 0.13 mg/L) and then decline for the next several months. The nutrient concentrations at the Lake Del Valle Conservation Outlet (Conservation Outlet) are lower than the concentrations in the SBA. The 1998 to 2020 median total N concentration at the Conservation Outlet is 0.45 mg/L and the median total P concentration is 0.02 mg/L, indicating that releases from Lake Del Valle in the fall months reduce the nutrient concentrations in the SBA downstream of the Del Valle Branch Pipeline.

Figure 6-23. Average Monthly Diversions at the South Bay Pumping Plant, Releases from Lake Del Valle, and Median Total N Concentrations at DV Check 7, 2016 to 2020

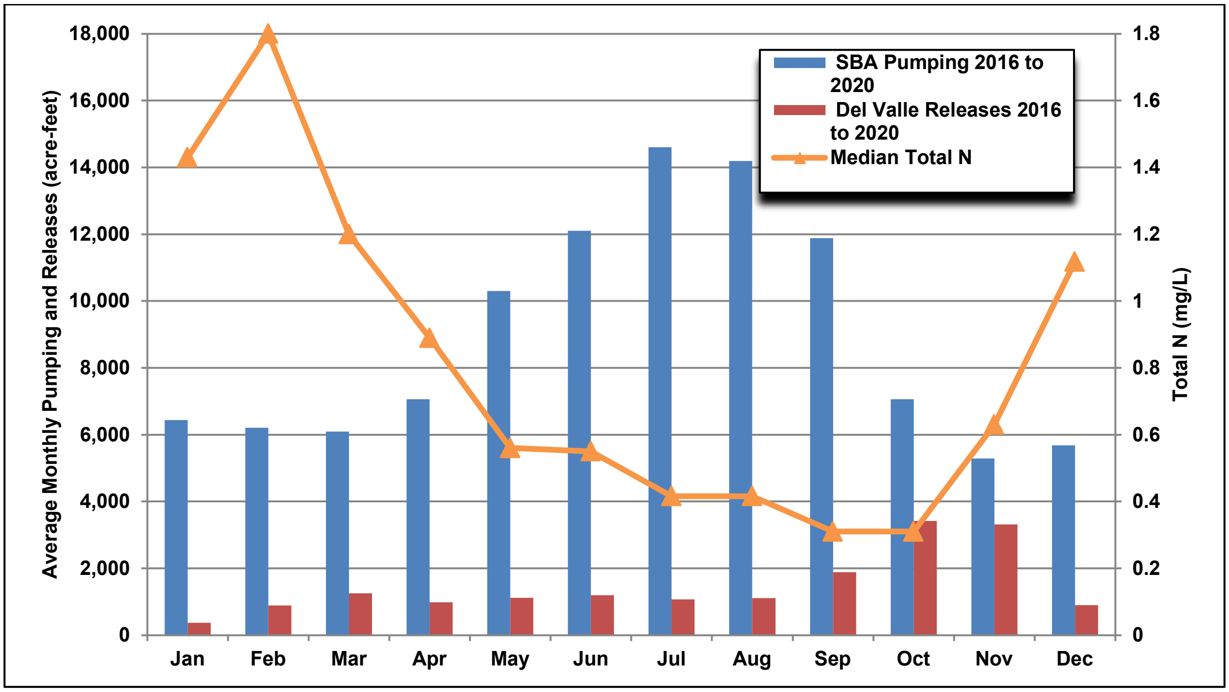
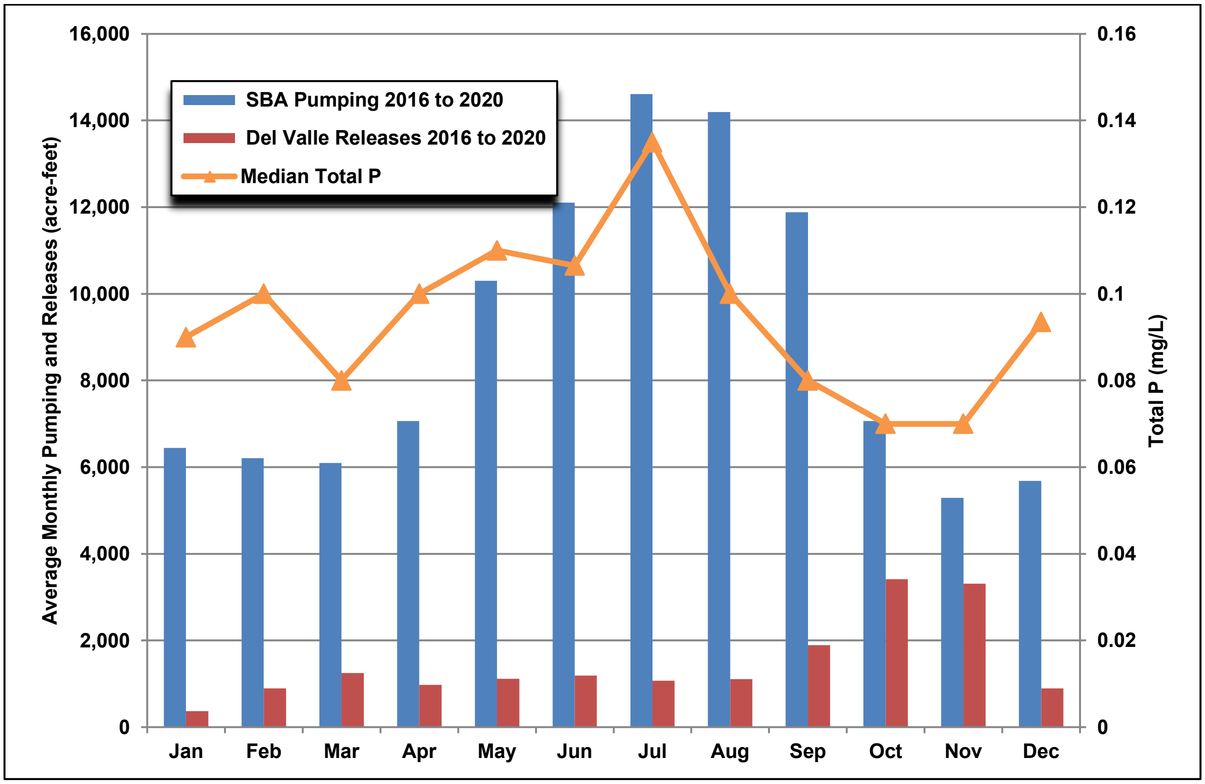


Figure 6-24. Average Monthly Diversions at the South Bay Pumping Plant, Releases from Lake Del Valle, and Median Total P Concentrations at DV Check 7, 2016 to 2020



Nutrient Concentrations in the SBA

Figures 6-25 and 6-26 present the total N and total P data for DV Check 7. Total N concentrations range from 0.11 to 2.9 mg/L with a median of 0.78 mg/L. Total P concentrations are an order of magnitude lower and range from 0.01 to 0.30 mg/L with a median of 0.093 mg/L. The median nutrient concentrations were calculated to compare to the trophic levels in **Table 6-1**. The median total N concentration is 0.78 mg/L, placing the SBA in the mesotrophic level. The median total P concentration is 0.093 mg/L, placing the SBA in the eutrophic level.

- Spatial Trends – DV Check 7 data were compared to Banks data collected between 1998 and 2020 to determine if there are any statistically significant differences between the two locations. The total N median of 0.78 mg/L at DV Check 7 is not statistically significantly different from the median of 0.80 mg/L at Banks (Mann-Whitney, p=0.43). Similarly, the total P median of 0.09 mg/L at DV Check 7 is not statistically significantly different from the median of 0.10 mg/L at Banks (Mann-Whitney, p=0.40). This is expected due to the short travel time in the SBA and because DV Check 7 is upstream of the releases from Lake Del Valle.

- Long-Term Trends – Concentrations of total N and total P over the recent 5 year reporting period remained within historical range. **Figure 6-25** indicates that total N concentrations appear to be slightly declining in the last 5 years. **Figure 6-26** indicates that total P concentrations have decreased since 2016. The nutrient plots at Banks (**Figures 6-13** and **6-14**) appear to show the same trend.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median total N concentration of 0.81 mg/L in dry years is not statistically significantly different from the median concentration of 0.78 mg/L in wet years (Mann-Whitney, p=0.572). Similarly, the median total P concentration of 0.10 mg/L in dry years is not statistically significantly different from the wet year median of 0.09 mg/L.

- Seasonal Trends – **Figures 6-27 and 6-28** show that the trend in total N and total P at DV Check 7 is the same as at Banks. The total N concentrations are high in the winter months, decline in the spring and summer, and increase during the fall months. The total P concentrations are high in the winter months, decrease during April, but then peak again in May and June. The total P concentrations then decline through the rest of the summer and fall.

Figure 6-25. Total N Concentrations at DV Check 7

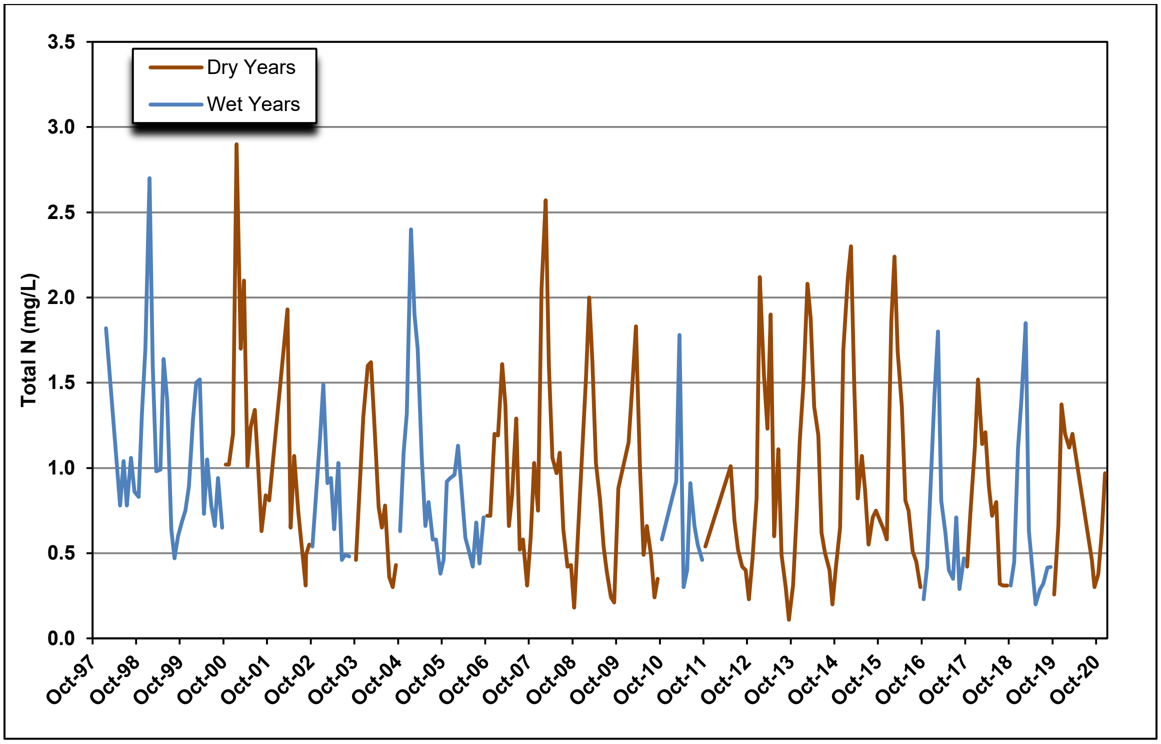


Figure 6-26. Total P Concentrations at DV Check 7

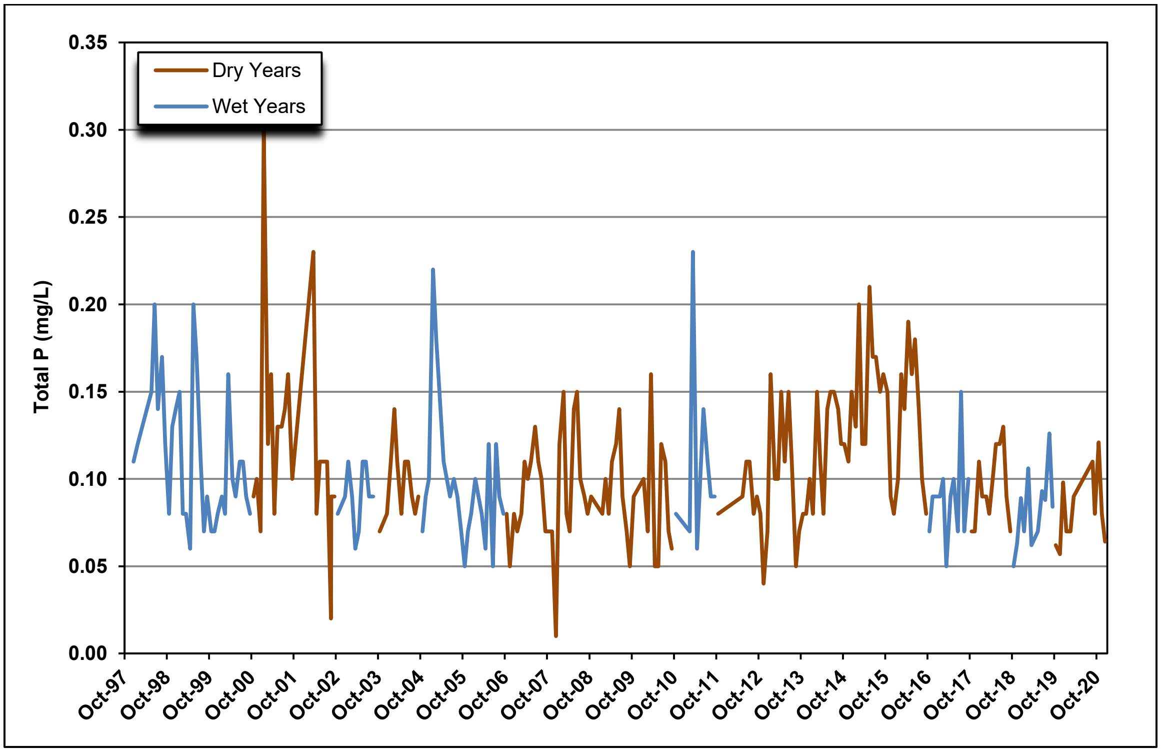


Figure 6-27. Monthly Variability in Total N at DV Check 7, 1998 to 2020

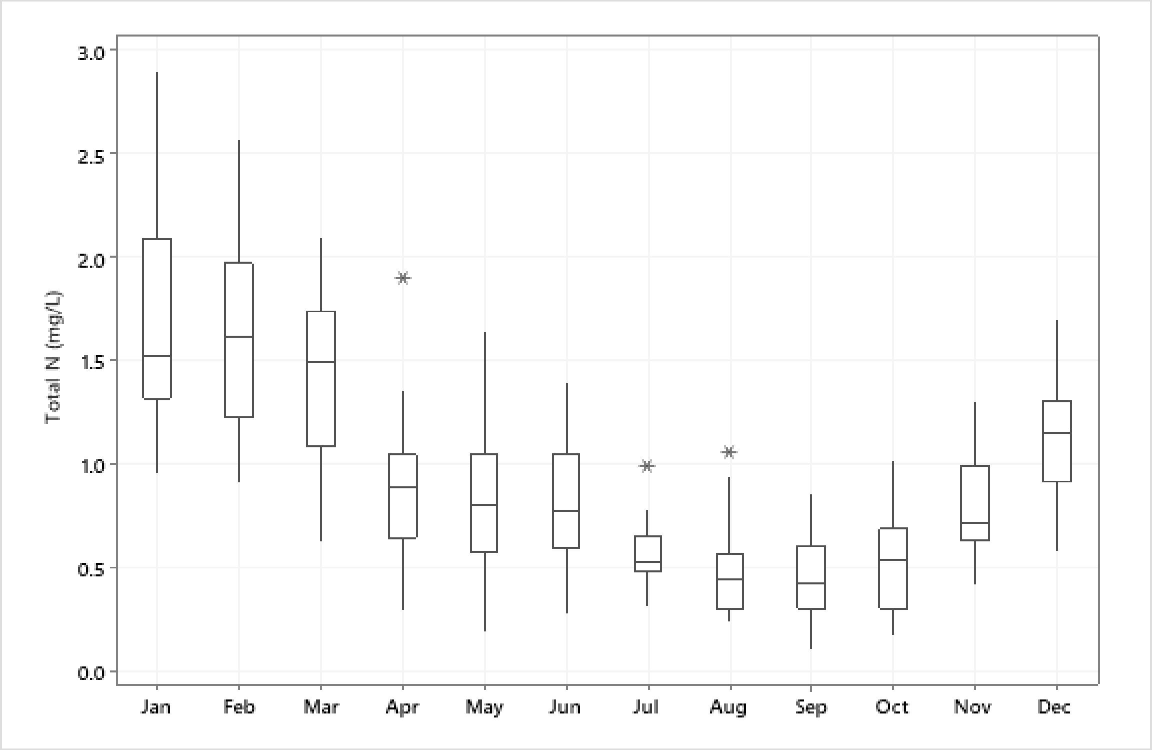
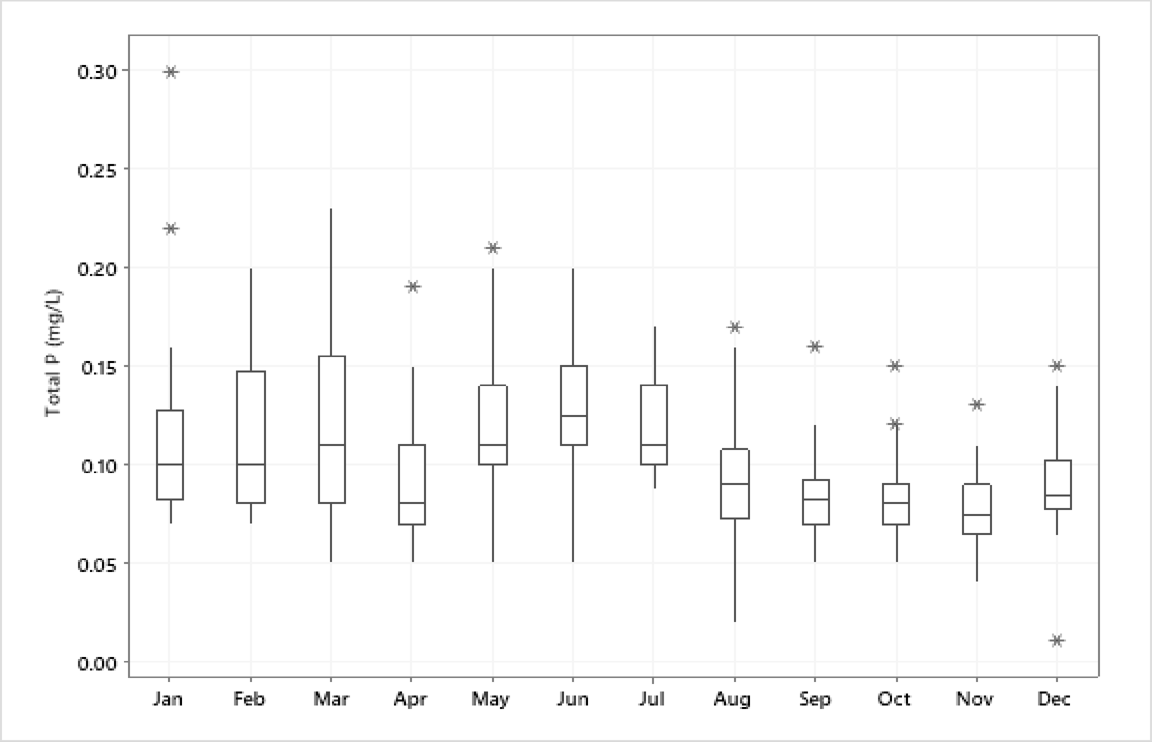


Figure 6-28. Monthly Variability in Total P at DV Check 7, 1997 to 2020



California Aqueduct and Delta-Mendota Canal

A number of SWP Contractors take water from the SWP between San Luis Reservoir and the terminal reservoirs. This section is organized by various reaches of the SWP and individual SWP contractors taking water from each reach are described in the following sections.

Project Operations

The quality of water delivered to SWP Contractors south of San Luis Reservoir is governed by the timing of diversions from the Delta at Banks, pumping into O'Neill Forebay from the Delta-Mendota Canal (DMC), releases from San Luis Reservoir, inflows to the Governor Edmund G. Brown California Aqueduct (California Aqueduct), and storage in terminal reservoirs.

Figures 6-29 and 6-30 show average monthly diversions at the Banks Pumping Plant from 2016 to 2020 and median monthly total N and total P concentrations, respectively. These graphs show that nitrogen and phosphorus behave differently in the system. The median total N concentrations are relatively low (0.4 mg/L) during the peak summer diversion months but then concentrations increase sharply during the fall months to reach a peak monthly median of 1.6 mg/L in January when diversions are still high. The peak median total P concentration of 0.14 mg/L occurred in the February. During the summer months when diversions are highest the median total P concentrations range from 0.10 to 0.12 mg/L.

Figure 6-29. Average Monthly Banks Diversions and Median Total N Concentrations, 2016 to 2020

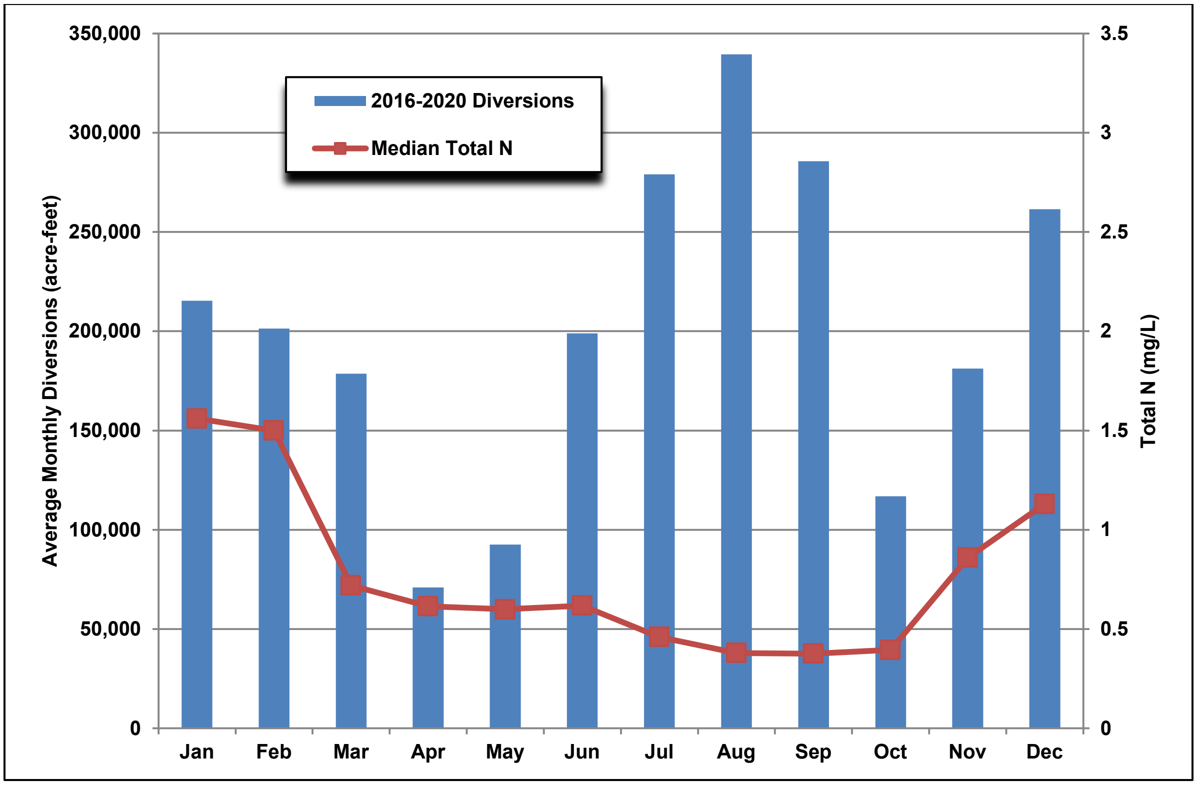
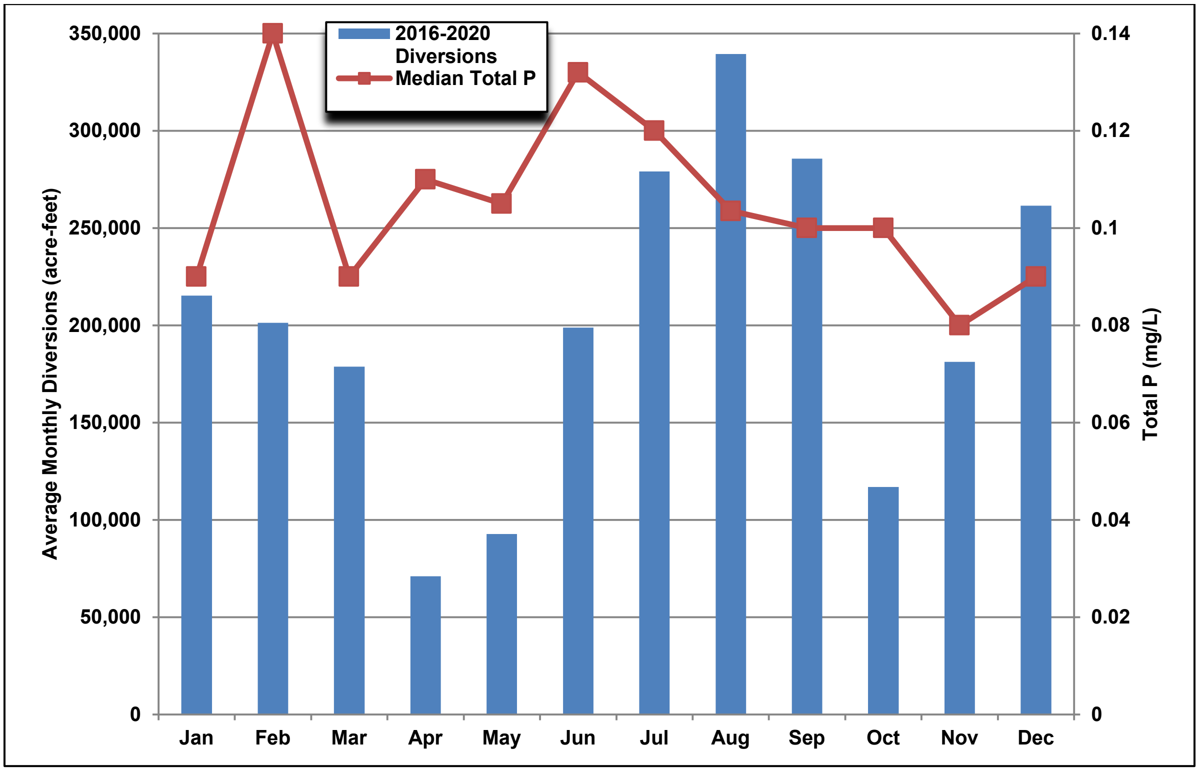


Figure 6-30. Average Monthly Banks Diversions and Median Total P Concentrations, 2016 to 2020



The operation of San Luis Reservoir impacts water quality in the California Aqueduct south of the reservoir. **Figures 6-31 and 6-32** show the pattern of 2016 to 2020 pumping into the reservoir, releases from the reservoir to O'Neill Forebay, and median nutrient concentrations. The median nutrient concentrations at Banks represent the quality of water pumped into the reservoir from the California Aqueduct and the median nutrient level at McCabe represents the quality of water pumped in from the DMC. The nutrient levels at McCabe are higher than Banks due to the heavier influence of the San Joaquin River in the DMC. Median nutrient data at Gianelli will reflect San Luis Reservoir water when there are releases, or the mixture of water from Banks and McCabe when pumping occurs. There are two distinct periods:

- Fall and Winter Filling – The reservoir is normally filled from September to March. However, during the 2016 to 2020 time period, there were higher releases in October. **Figure 6-31** shows that the highest total N concentrations occur during the December to March period. Figure **6-32** shows that the seasonal trends for P are not as clear, as total P may be higher in winter, but also were higher in June in August, notably at McCabe in June, and Pacheco and McCabe in August.

- Spring and Summer Releases – Water is normally released during the April to August, however pumping and releases were similar for the month of August during the 2016 to 2020 time period. During the releases, median total N concentrations at Pacheco are higher than the concentrations at Banks, indicating that the releases are increasing the total N concentrations in the California aqueduct downstream of San Luis Reservoir.

Total P concentrations in the releases are generally lower than the concentrations at Banks.

Figure 6-31. San Luis Reservoir Operations and Median Total N Concentrations, 2016 to 2020

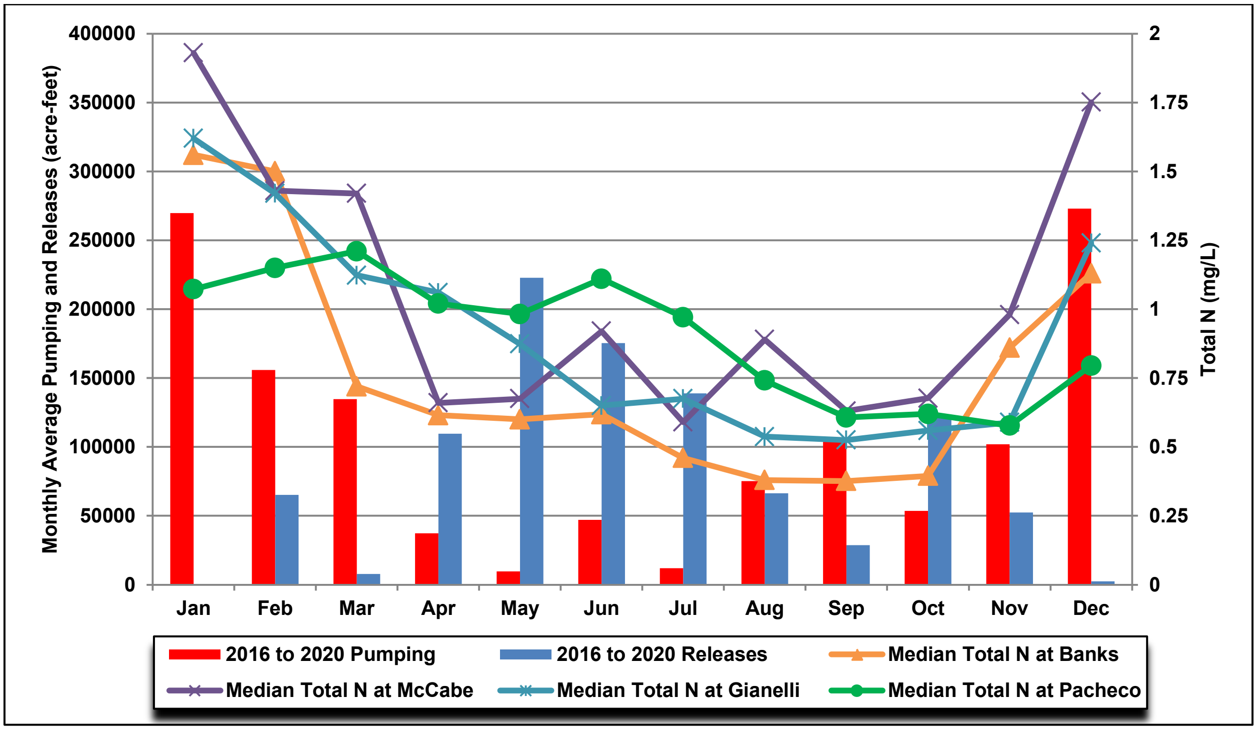
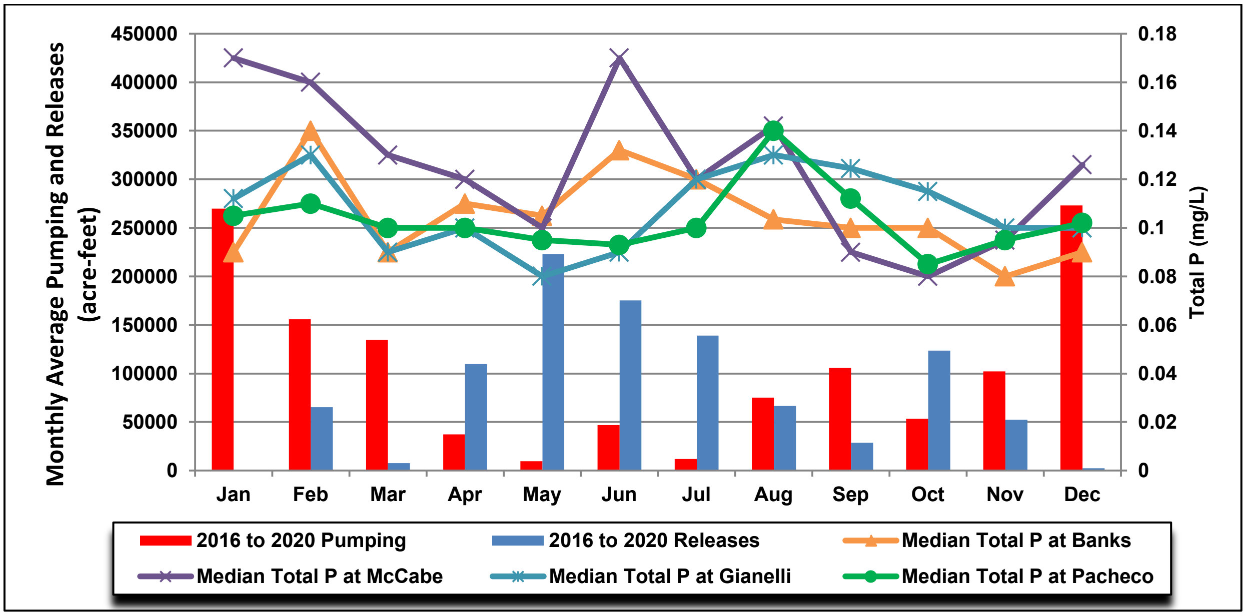


Figure 6-32. San Luis Reservoir Operations and Median Total P Concentrations, 2016 to 2020



Nutrient Concentrations in the DMC and SWP

Figures 6-33 and 6-34 present a summary of total N and total P data collected at each of the locations along the DMC, California Aqueduct, and SWP reservoirs from 2004 to 2020. Please note that nutrient data for McCabe is from 2009 to 2020, and from 2013 to 2020 for Gianelli. Spatial differences are examined in more detail in the following sections.

Figure 6-33. Total N Concentrations in the DMC and SWP (2004-2020)

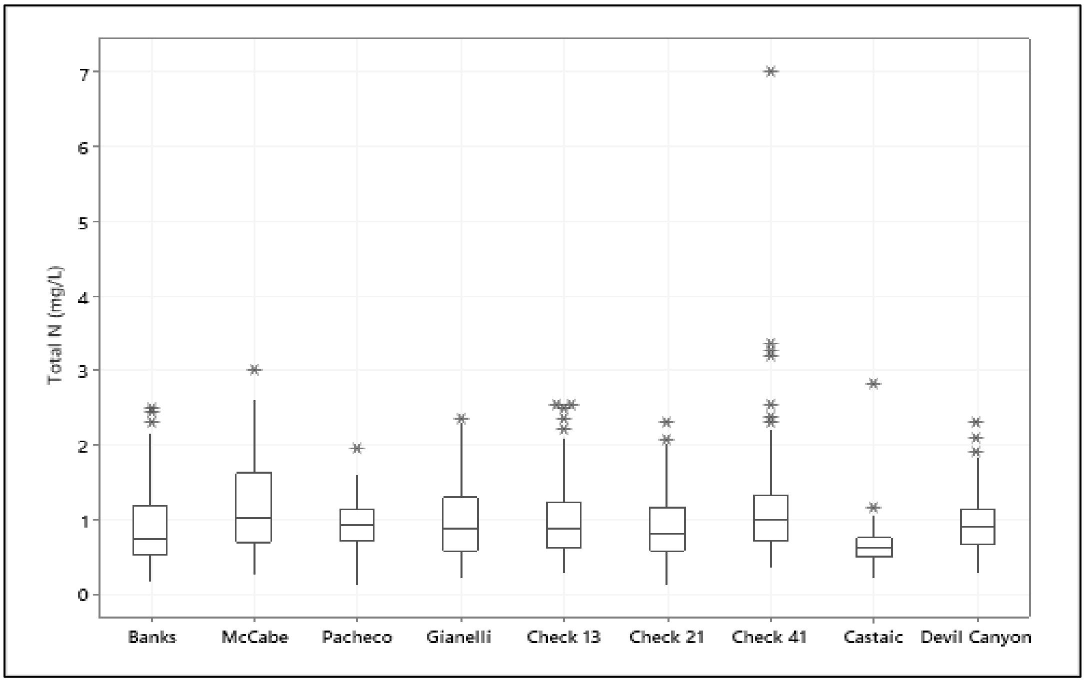
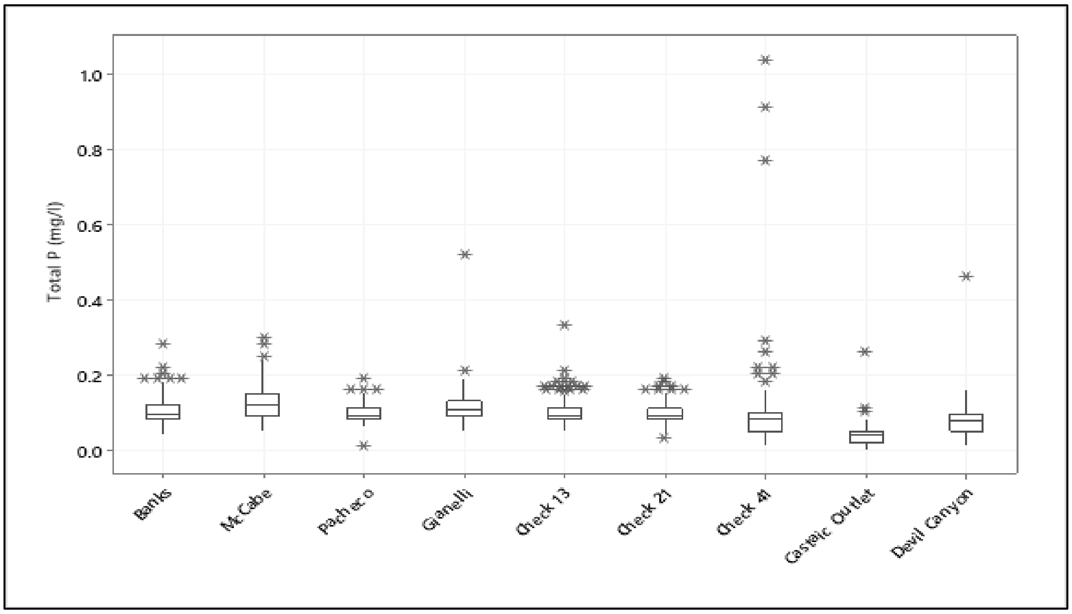


Figure 6-34. Total P Concentrations in the DMC and SWP (2004-2020)



Delta-Mendota Canal – Total N and total P data are available since July 2009 for the DMC at McCabe. **Figure 6-35** presents the total N data and **Figure 6-36** presents the total P data. The total N concentrations from 2009 to 2020 ranged from 0.26 to 3.01 mg/L, with a median of 1.02 mg/L. The total P concentrations from 2009 to 2020 ranged from 0.05 mg/L to 0.3 mg/L with a median of 0.12 mg/L. The median nutrient concentrations were calculated to compare to the trophic levels in **Table 6-1**. The median total N concentration is 1.02 mg/L, placing the McCabe in the mesotrophic level. The median total P concentration is 0.12 mg/L, placing McCabe in the eutrophic level.

One major change over the reporting period is the introduction of treated wastewater from the cities of Turlock and Modesto into the DMC at MP 37.30. There were also turn-ins of groundwater and surface water. These topics will be covered further in Chapter 13.

- Spatial Trends – The upstream location most relevant to McCabe is the Jones Pumping Plant. DWR began sampling for nutrients at the Jones Pumping Plant in September 2019 so there is not enough data to complete a spatial comparison. Nutrient McCabe data was compared to data collected at Banks between 2009 and 2020. The median total N concentration of 1.02 mg/L at McCabe is statistically significant higher than the median concentration of 0.69 mg/L at Banks (Mann-Whitney, p=0.0000). The median total P concentration of 0.12 mg/L at McCabe is statistically significant higher than the median concentration of 0.09 mg/L at Banks (Mann-Whitney, p=0.0000). Higher nutrient concentrations at McCabe compared to Banks is due to the higher nutrient concentration in the San Joaquin River, which has a higher source water influence at Jones and also McCabe.

- Long-Term Trends – Concentrations of total N and total P over the recent 5 year reporting period remained within historical range. **Figure 6-35** shows lower total N concentrations in years 2017 to 2020. **Figure 6-36** shows total P concentrations decreased from the peak in May 2015 through 2018, and began increasing in 2019 and 2020.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median total N concentration of 1.09 mg/L in dry years is statistically significantly different from the median concentration of 0.84 mg/L in wet years (Mann-Whitney, p=0.009). Similarly, the median total P concentration of 0.12 mg/L in dry years is statistically significantly different from the wet year median of 0.09 mg/L (Mann-Whitney, p=0.003).

- Seasonal Trends - **Figures 6-37 and 6-38** show a seasonal trend in total N and total P at McCabe. The total N concentrations are high in the winter months, decline in the spring and summer, and increase during the fall months. The seasonal trends for total P are not as clear; with peaks occurring in January and February and then decreasing in May and June, with the lowest P median in October. The low concentrations in the spring are due to the release of high quality water from reservoirs to meet the Vernalis Adaptive Management Plan (VAMP) flow requirements. Agricultural drainage is discharged to the river during the summer months when flows on the San Joaquin River are low. The slight decrease in concentrations during the fall months may be due to less agricultural drainage entering the river during this time and the increase in the winter months is likely due to storm events flushing nutrients from the watershed.

Figure 6-35. Total N Concentrations at McCabe

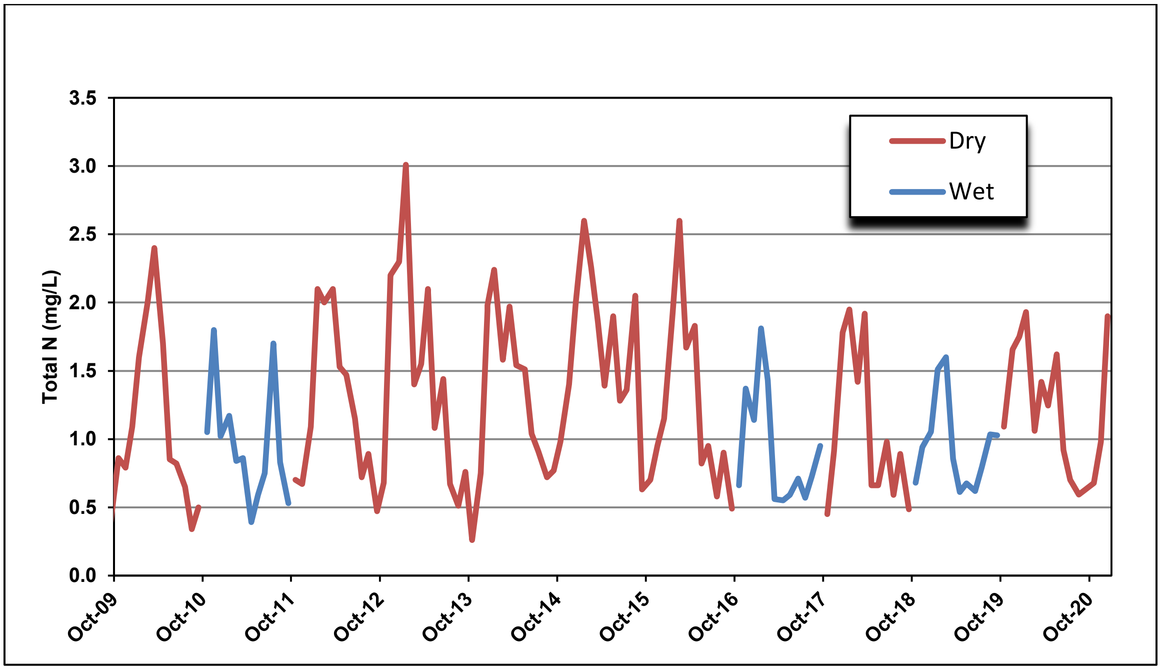


Figure 6-36. Total P Concentrations at McCabe

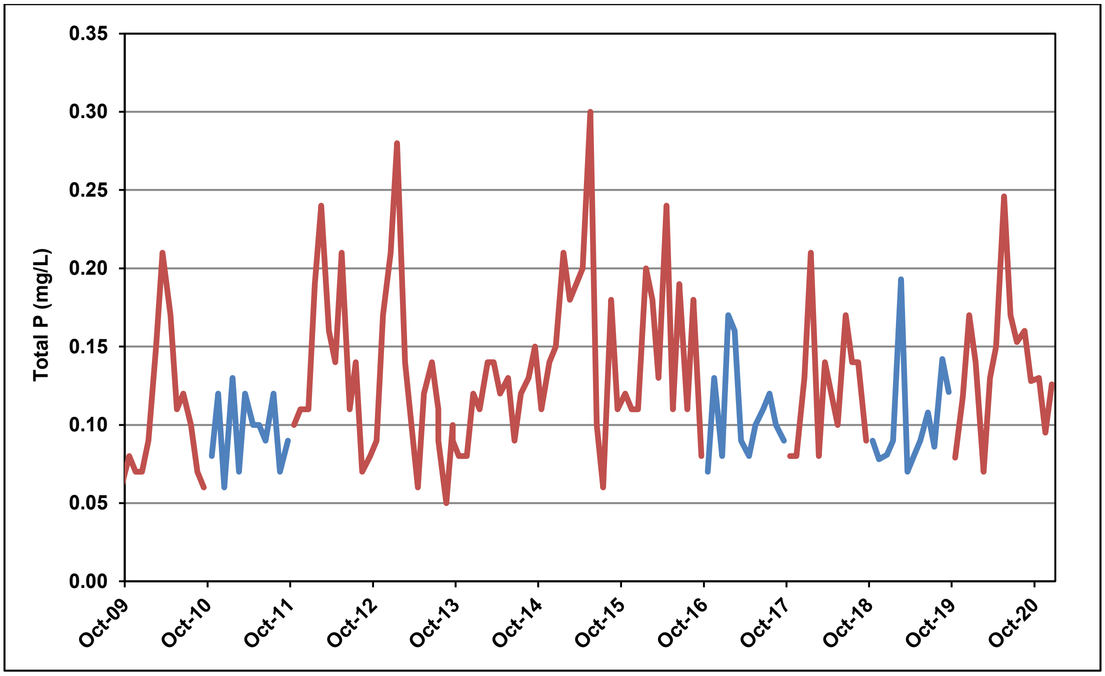


Figure 6-37. Monthly Variability in Total N at McCabe, 2009 to 2020

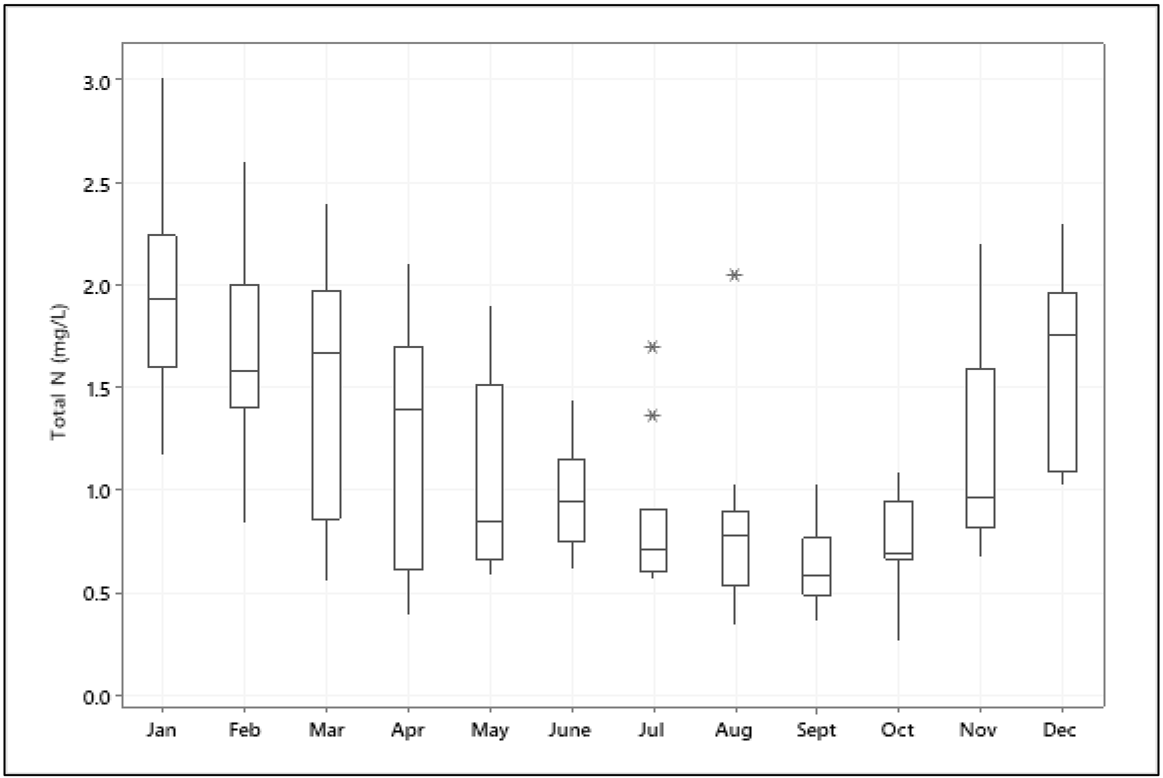
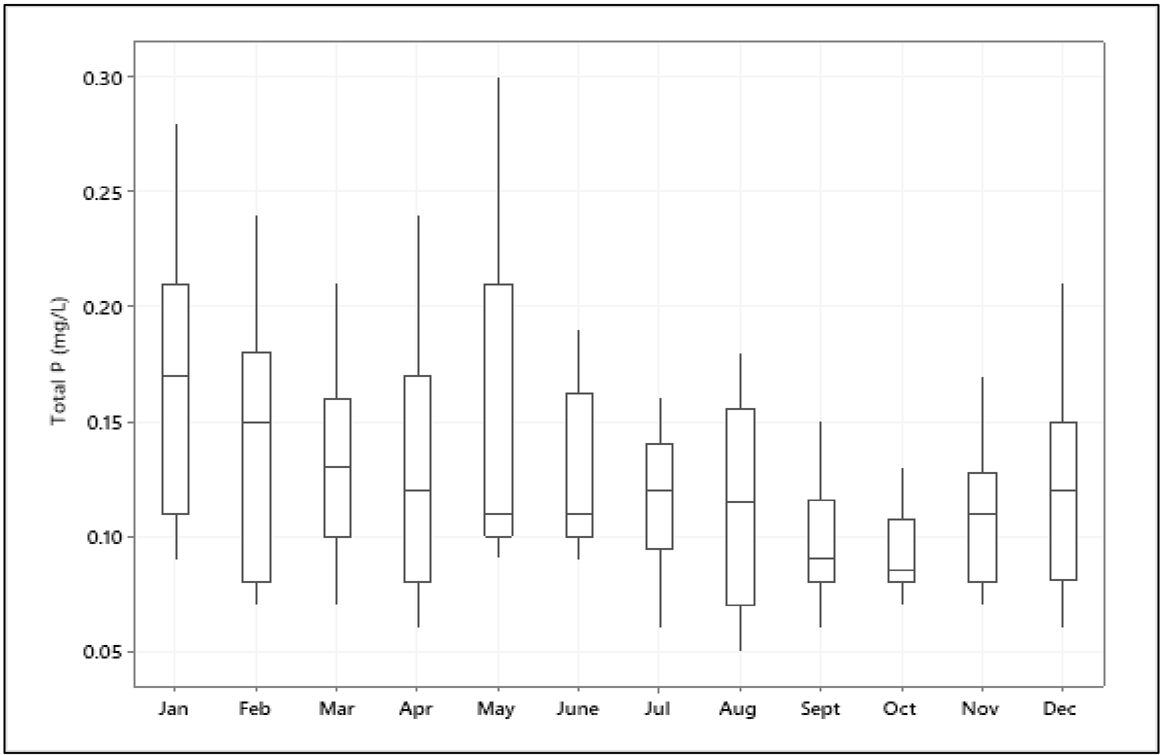


Figure 6-38. Monthly Variability in Total P at McCabe, 2009 to 2020



***San Luis Reservoir (Pacheco)*– Figure 6-39** presents the total N data for Pacheco and **Figure 6-40** presents the total P data. The total N concentrations at Pacheco range from 0.11 to 1.96 mg/L with a median of 0.94 mg/L and the total P concentrations range from 0.01 to 0.38 mg/L with a median of 0.09 mg/L.

- Spatial Trends – All available data from Banks, McCabe, and Pacheco are presented in **Figures 6-33 and 6-34**. Median P concentrations at Pacheco are similar to Banks and McCabe. Median N concentrations at Pacheco are lower than median N concentration at McCabe, but higher than median N concentrations at Banks.

- Long-Term Trends – **Figures 6-39 and 6-40** do not display any discernible trends in the nutrient concentrations. Concentrations of total N and total P over the recent 5 year reporting period remained within historical range. There was an increasing trend in total P from 2012 through 2015.

- Wet Year/Dry Year Comparison –The dry year total N median concentration of 0.84 mg/L is statistically significantly lower than the wet year median of 1.02 mg/L (Mann-Whitney, p=0.000). The dry year total P median concentration of 0.09 mg/L is statistically significantly lower than the wet year median of 0.10 mg/L (Mann-Whitney, p=0.012).

- Seasonal Trends – **Figure 6-41** shows that total N median concentrations peak in March, then decrease from spring to fall, reaching the lowest median in September, and begin increasing again in the fall through winter. There is very little variability in total P concentrations from month to month, as shown in **Figure 6-42**. It is difficult to interpret the Pacheco data because samples are collected at different depths, depending on the depth at which water is being withdrawn from the Pacheco outlet tower and the amount of water in the reservoir. Samples are collected in the hypolimnion (bottom layer) when the reservoir is full during the winter months and in the epilimnion (surface layer) when the reservoir level is low during the late summer and fall months.

Figure 6-39. Total N Concentrations at Pacheco

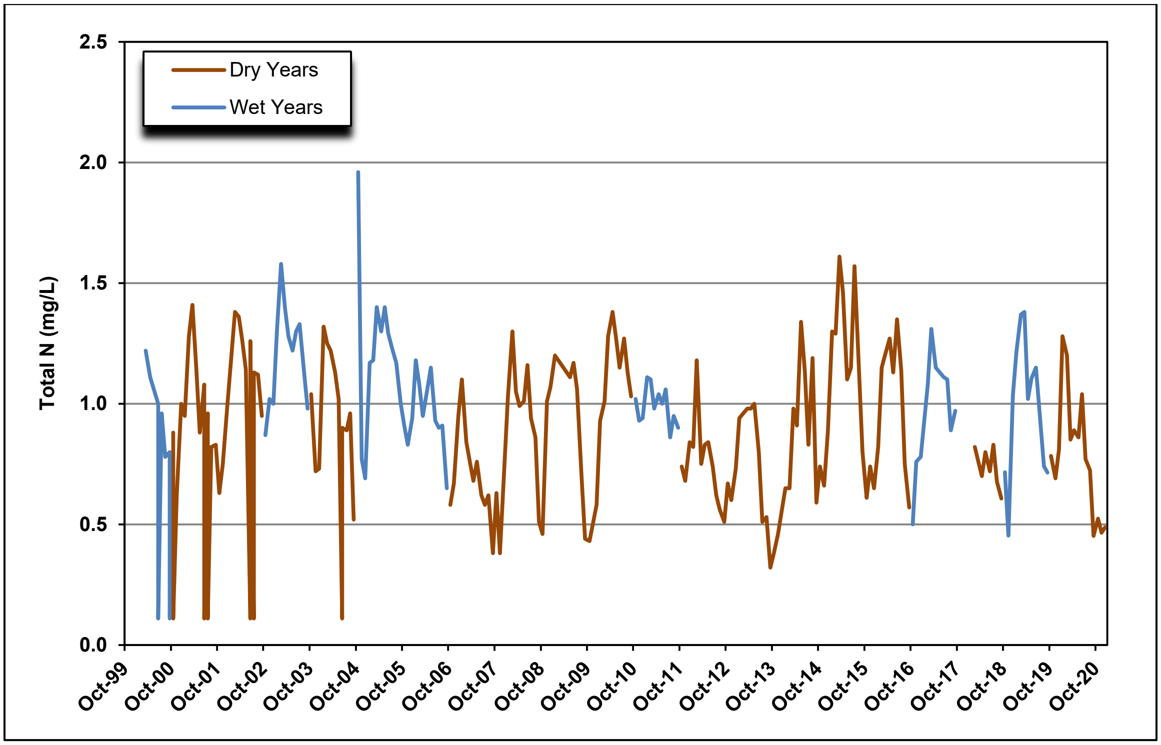


Figure 6-40. Total P Concentrations at Pacheco

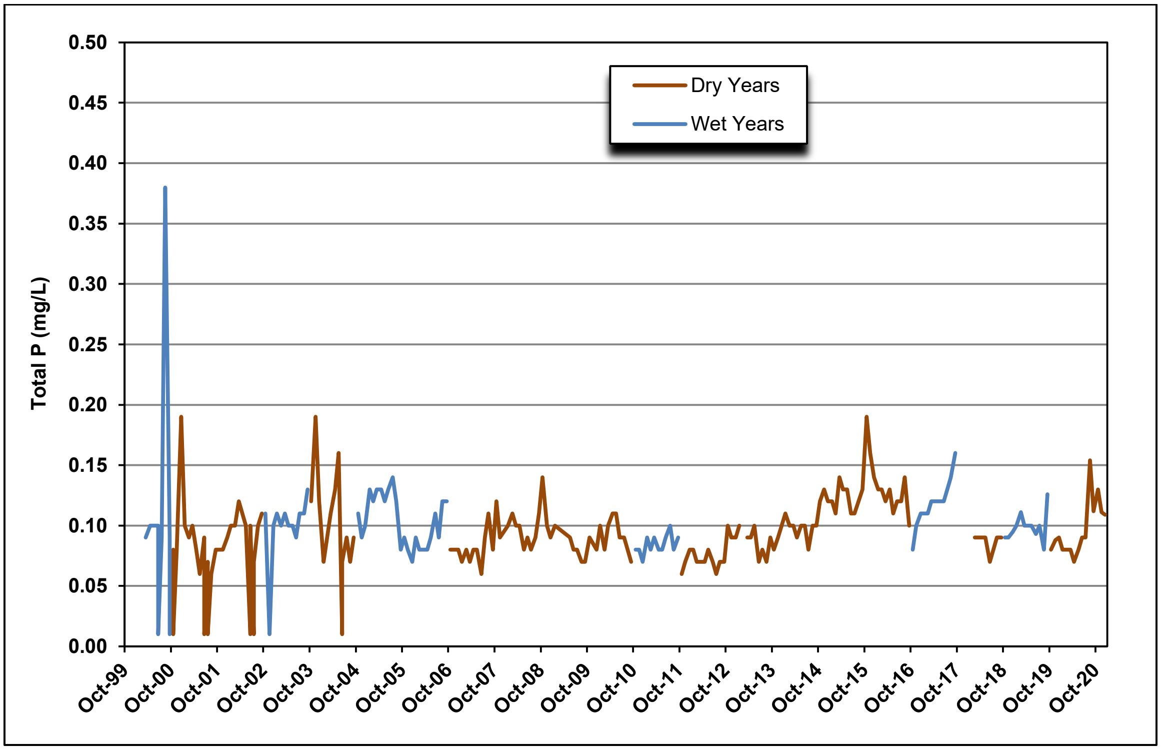


Figure 6-41. Monthly Variability in Total N at Pacheco, 2000 to 2020

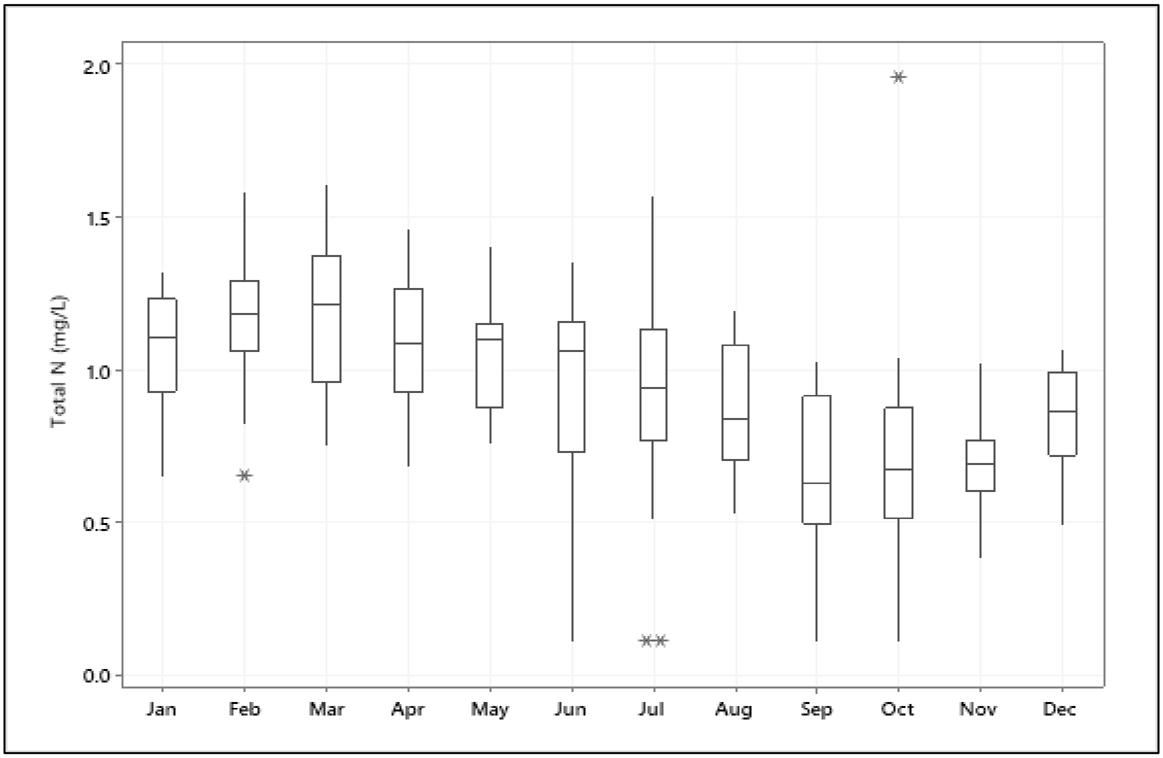
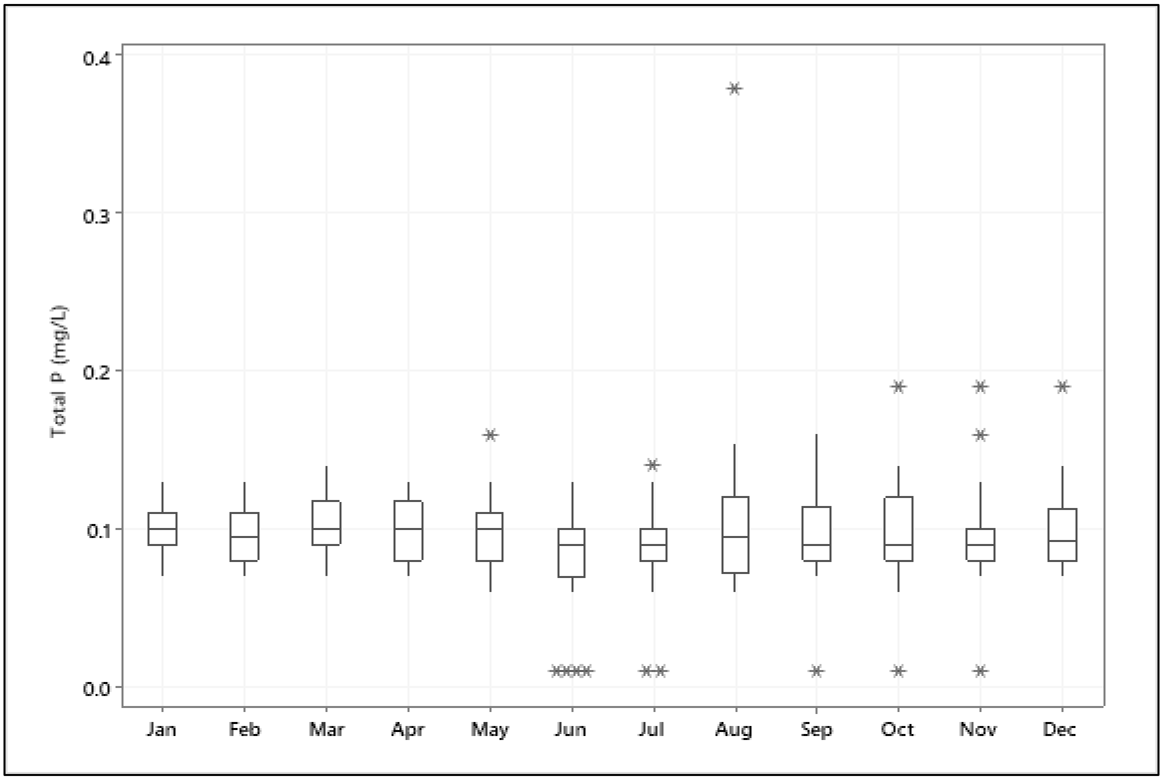


Figure 6-42. Monthly Variability in Total P at Pacheco, 2000 to 2020



***San Luis Reservoir (Gianelli)*– Figure 6-43** presents the total N data for Gianelli and **Figure 6-44** presents the total P data. The total N concentrations at Gianelli range from 0.12 to 2.36 mg/L with a median of 0.87 mg/L and the total P concentrations range from 0.05 to 0.21 mg/L with a median of 0.102 mg/L.

- Spatial Trends – All available data from Banks and Pacheco are presented in **Figures 6-33 and 6-34**. The median N concentration at Gianelli was 0.87 mg/L, which is slightly lower than the median N concentration at Pacheco of 0.93 mg/L. The median P concentration at Gianelli was 0.102 mg/L and the median P concentration at Pacheco was 0.09 mg/L.

- Long-Term Trends – **Figures 6-43 and 6-44** do not display any discernible trends in the nutrient concentrations.

- Wet Year/Dry Year Comparison –The dry year total N median concentration of 0.887 mg/L is not statistically significantly higher than the wet year median of 0.835 mg/L (Mann-Whitney, *p*=0.859). The dry year total P median concentration of 0.11 mg/L is not statistically significantly higher than the wet year median of 0.10 mg/L (Mann-Whitney, *p*=0.943).

- Seasonal Trends – Seasonal trends were not conducted as water quality is more impacted on whether or not water is being released from San Luis Reservoir or being pumped from O’Neill forebay into San Luis Reservoir. Generally pumping occurs from September to March, and releases occur from April to August.

Figure 6-43. Total N Concentrations at Gianelli

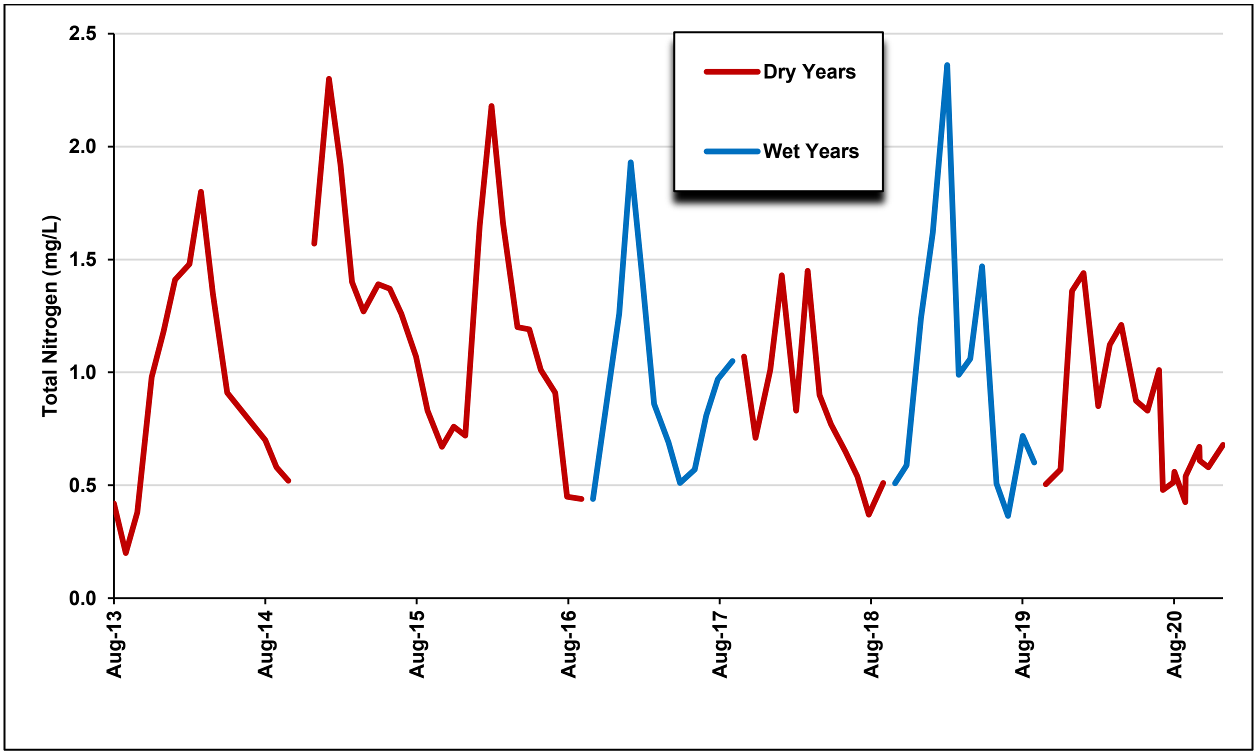
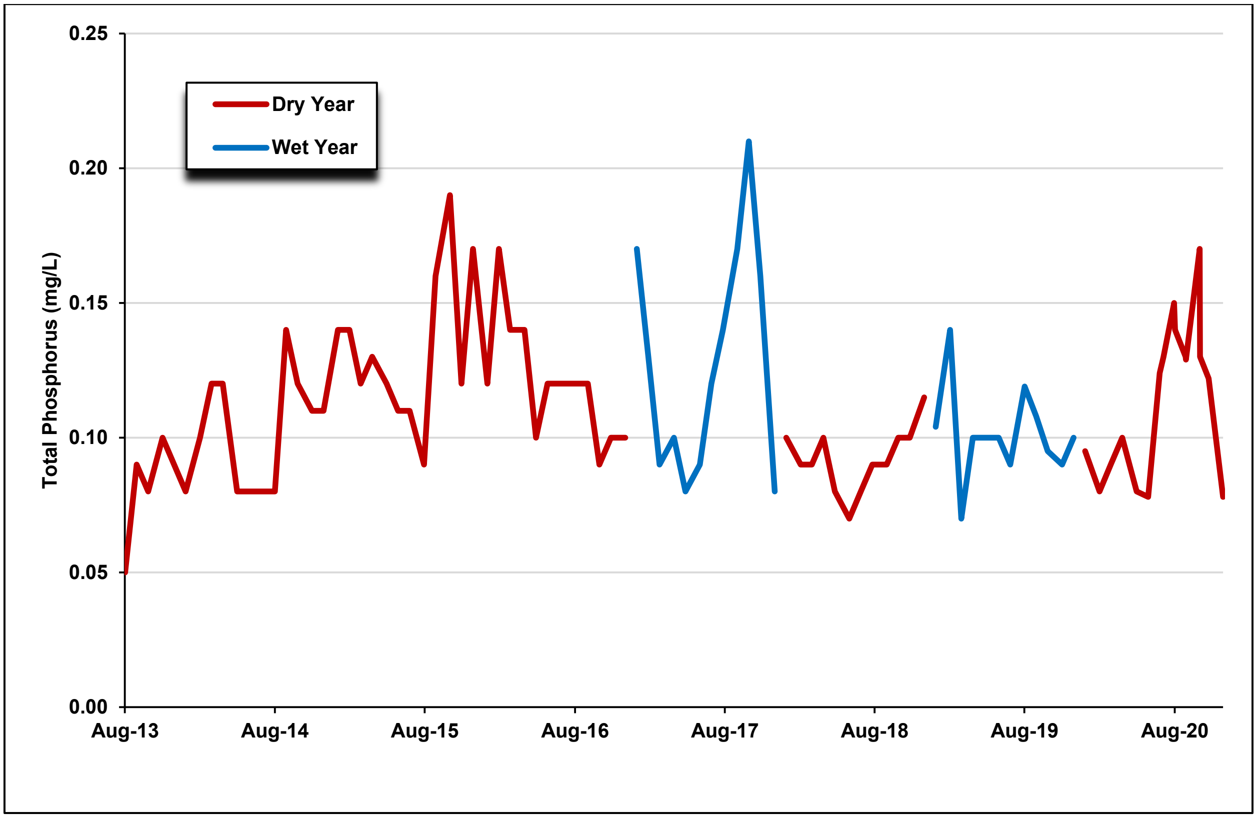


Figure 6-44. Total P Concentrations at Gianelli



O'Neill Forebay Outlet – O'Neill Forebay Outlet on the California Aqueduct is a mixture of water from San Luis Reservoir, the California Aqueduct, and the DMC. **Figure 6-45** presents the total N data and **Figure 6-46** presents the total P data for O'Neill Forebay Outlet. Total N concentrations range from 0.26 to 2.5 mg/L with a median of 0.89 mg/L. Total P concentrations range from 0.05 to 0.33 mg/L with a median of 0.09 mg/L. The median nutrient concentrations were calculated to determine the trophic level classification of water entering the California Aqueduct downstream of San Luis Reservoir. The trophic level classifications were previously shown in **Table 6-1**. The median total N concentration is 0.89 mg/L, placing it in the mesotrophic level. The median total P concentration is 0.09 mg/L, placing it in the eutrophic level.

- Spatial Trends – **Figures 6-33 and 6-34** compare the nutrient data collected between 2004 and 2020 at O'Neill Forebay Outlet to a number of other locations along the aqueduct. Median total N concentrations increase from 0.73 mg/L at Banks to 0.885 mg/L at O'Neill Forebay Outlet during this period and the increase is statistically significant (Mann-Whitney, p=0.012). Total P concentrations remain the same, with a median of 0.09 mg/L at both locations.

- Long-Term Trends – **Figures 6-45 and 6-46** shows no discernable long-term trend for total N and total P concentrations. Concentrations of total N and total P over the recent 5 year reporting period remained within historical range.

- Wet Year/Dry Year Comparison – The median nutrient concentrations are not statistically different between dry and wet years (Mann-Whitney, p=0.274 for total N and p=0.709 for total P). The total N median is 0.92 mg/L for dry years and 0.80 mg/L for wet years. The total P median is 0.09 mg/L for dry years and 0.092 mg/L for wet years.

- Seasonal Trends – **Figures 6-47 and 6-48** present the monthly nutrient data for O'Neill Forebay Outlet. The total N seasonal pattern is the same as at Banks and McCabe. The total N concentrations are high in the winter (Jan-March) months, decline in the spring and summer, and increase during the fall months. There is very little variability in total P concentrations from month to month, as shown in **Figure 6-48**.

Figure 6-45. Total N Concentrations at O'Neill Forebay Outlet

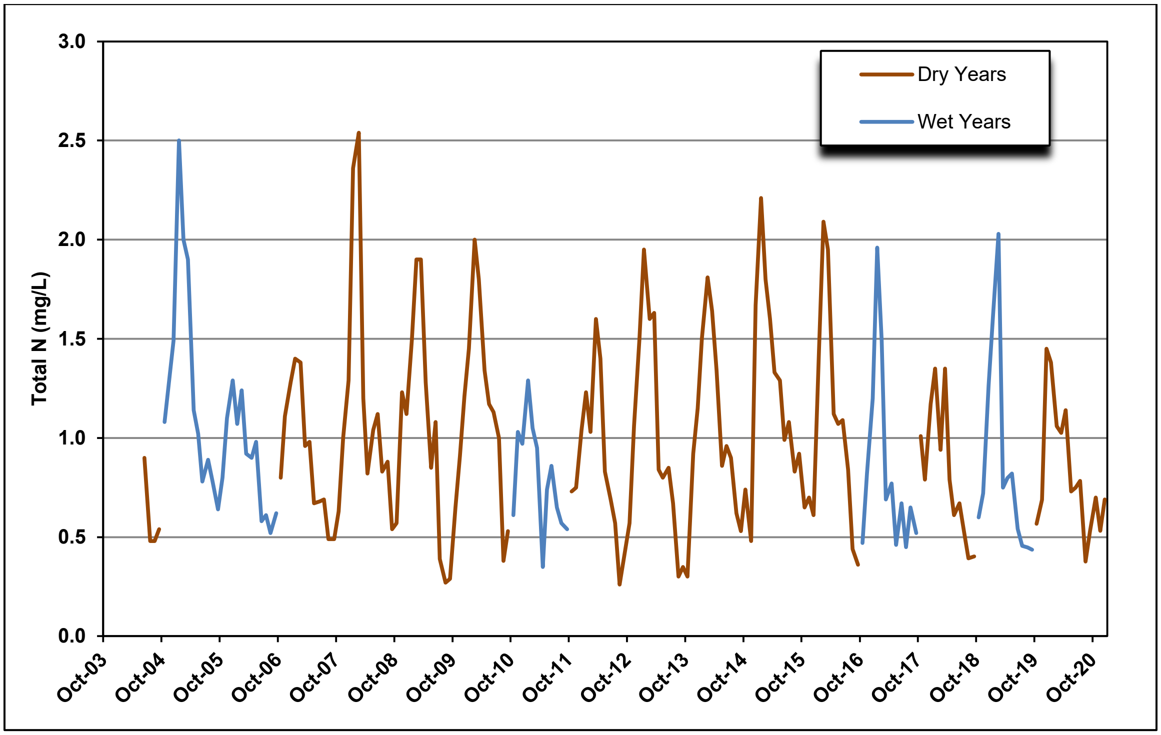


Figure 6-46. Total P Concentrations at O'Neill Forebay Outlet

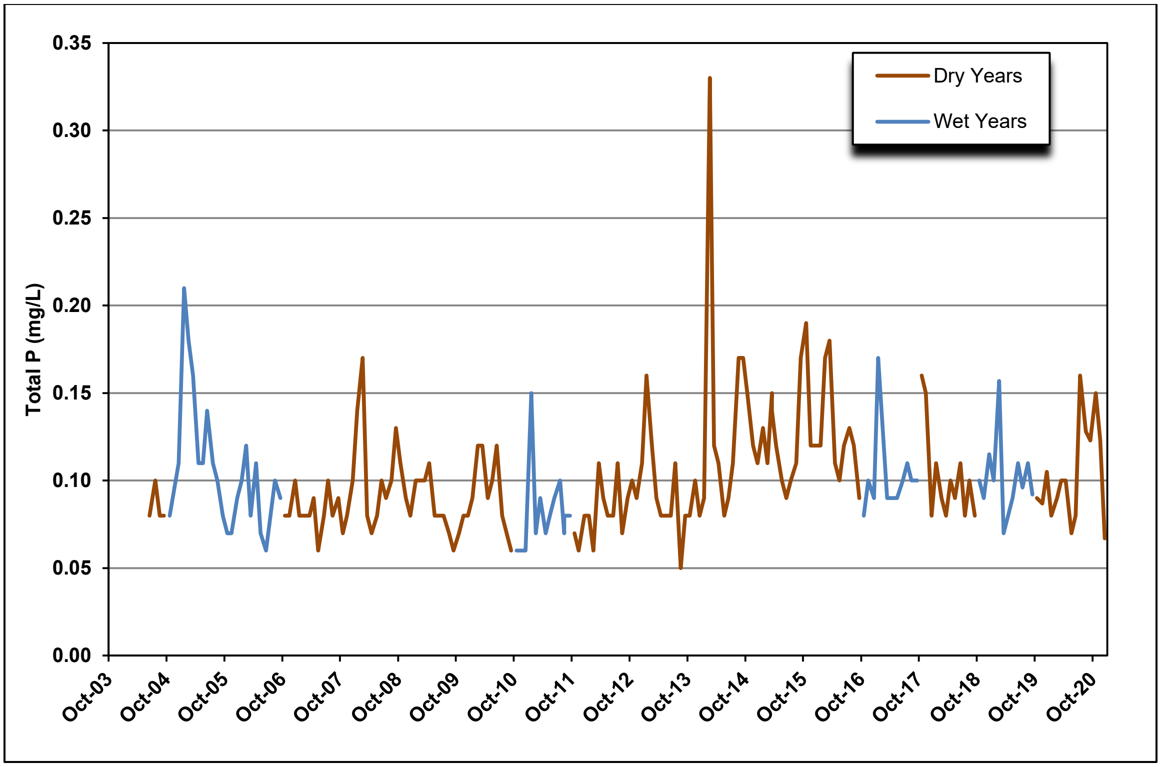


Figure 6-47. Monthly Variability in Total N at O'Neill Forebay Outlet, 2004 to 2020

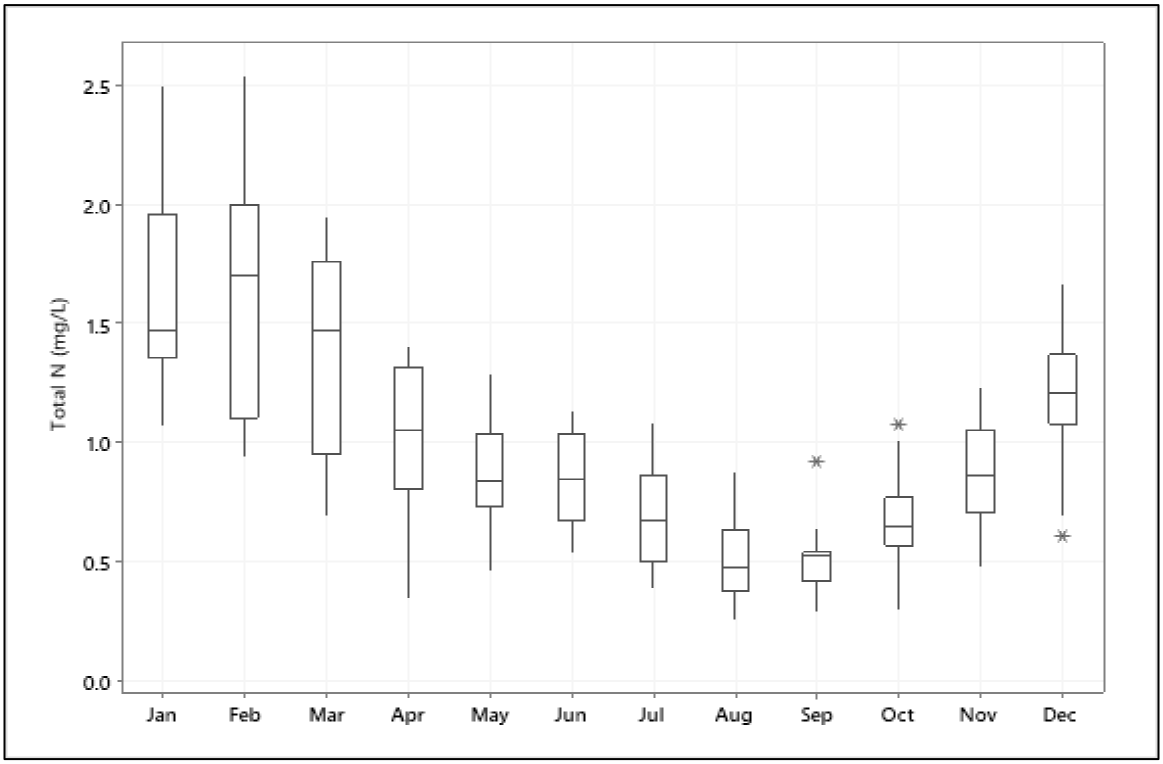
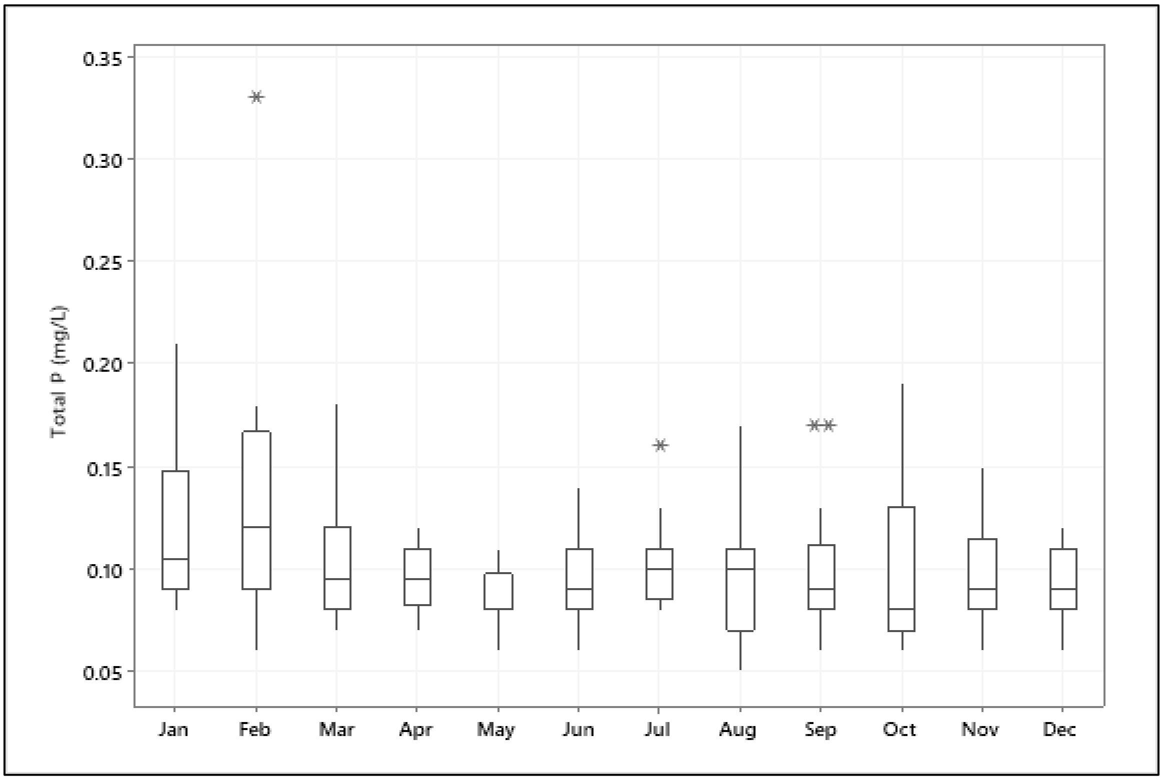


Figure 6-48. Monthly Variability in Total P at O'Neill Forebay Outlet, 2004 to 2020



Check 21 – Check 21 on the California Aqueduct is representative of the water entering the Coastal Branch. **Figure 6-49** presents the total N data and **Figure 6-50** presents the total P data for Check 21. Total N concentrations range from 0.11 to 2.4 mg/L with a median of 0.88 mg/L. Total P concentrations range from 0.01 to 0.20 mg/L with a median of 0.10 mg/L. Median nutrient concentrations were calculated to determine the trophic level classification of water entering the Coastal Branch. The trophic level classifications were previously shown in **Table 6-1**. The median total N concentration is 0.88 mg/L, placing it in the mesotrophic level. The median total P concentration is 0.10 mg/L, placing it in the eutrophic level.

- Spatial Trends – **Figures 6-33 and 6-34** compare the nutrient data collected between 2004 and 2020 at Check 21 to a number of other locations along the aqueduct. Median total N concentrations decrease from 0.88 mg/L at O'Neill Forebay Outlet to 0.8187 mg/L at Check 21 during this period but the decrease is not statistically significant (Mann-Whitney, p=0.117). Total P concentrations remain the same, with a median of 0.09 mg/L at both locations. These data indicate that there are no substantial changes in nutrient concentrations as water moves from Check 13 to Check 21, despite inflows between San Luis Reservoir and Check 21.

- Long-Term Trends – The total N and total P concentrations, shown in **Figures 6-49 and 6-50**, respectively, do not show any discernible trends. Concentrations of total N and total P over the recent 5 year reporting period remained within historical range. However, the median concentration for total N from April 2000 to December 2015 was 0.96 mg/L, and the median from April 2000 to December 2020 was 0.88 mg/L, indicating a decrease in the most recent five years. The median for total P remained the same for both time periods.

- Wet Year/Dry Year Comparison – The total N median concentration of 0.92 mg/L in dry years is not statistically significantly higher than the median of 0.80 mg/L in wet years (Mann-Whitney, p=0.529). The total P median concentration of 0.09 mg/L in dry years is not statistically significantly higher than the median of 0.10 mg/L in wet years (Mann-Whitney, p=0.334).

0

- Seasonal Trends – **Figures 6-51 and 6-52** present the monthly nutrient data for Check 21. The total N seasonal pattern is the same as at Banks. The concentrations are high in the winter months, decline in the spring and summer, and increase during the fall months. The total P concentrations are slightly higher in the winter months, decline in the spring and then have a secondary peak in July. This is similar to Banks except the summer peak occurs at Banks one month earlier, in June.

Figure 6-49. Total N Concentrations at Check 21

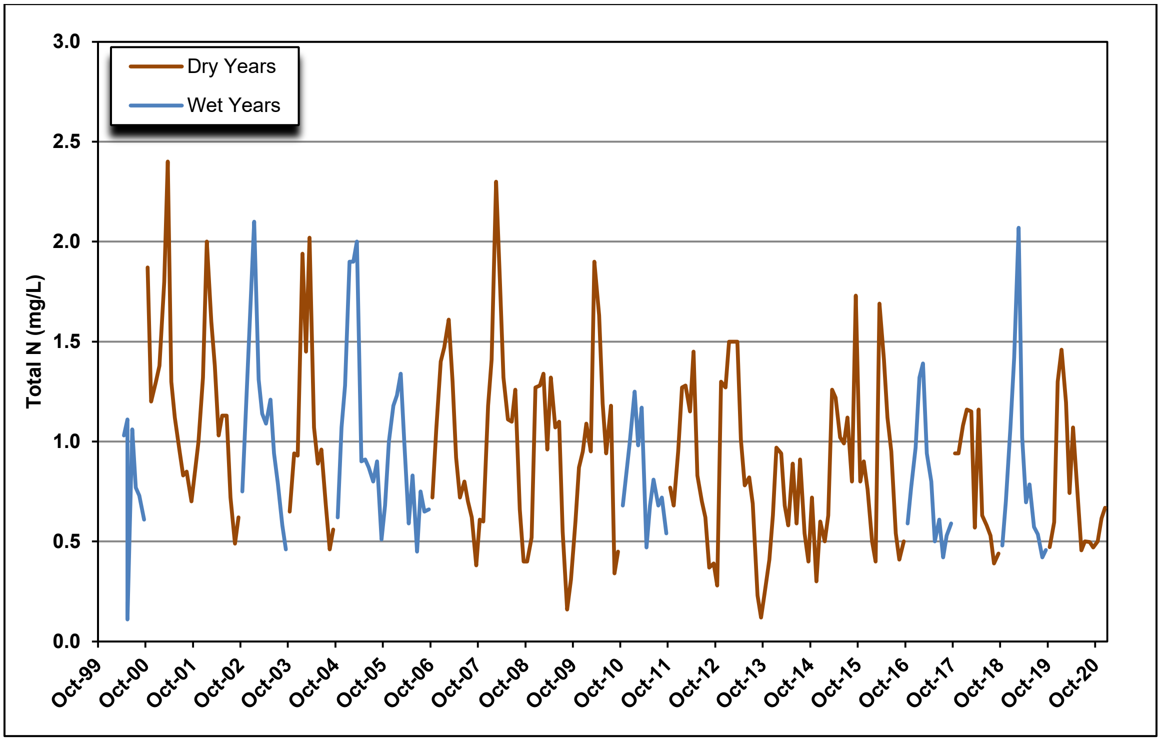


Figure 6-50. Total P Concentrations at Check 21

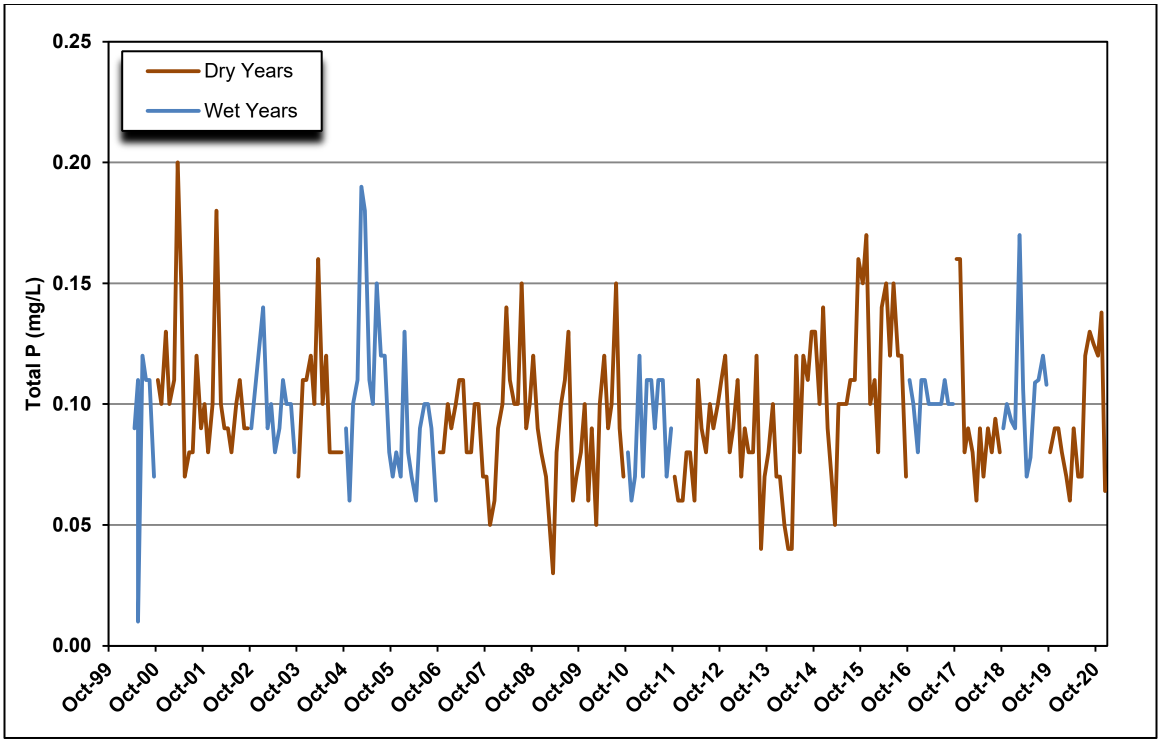


Figure 6-51. Monthly Variability in Total N at Check 21, 2000 to 2020

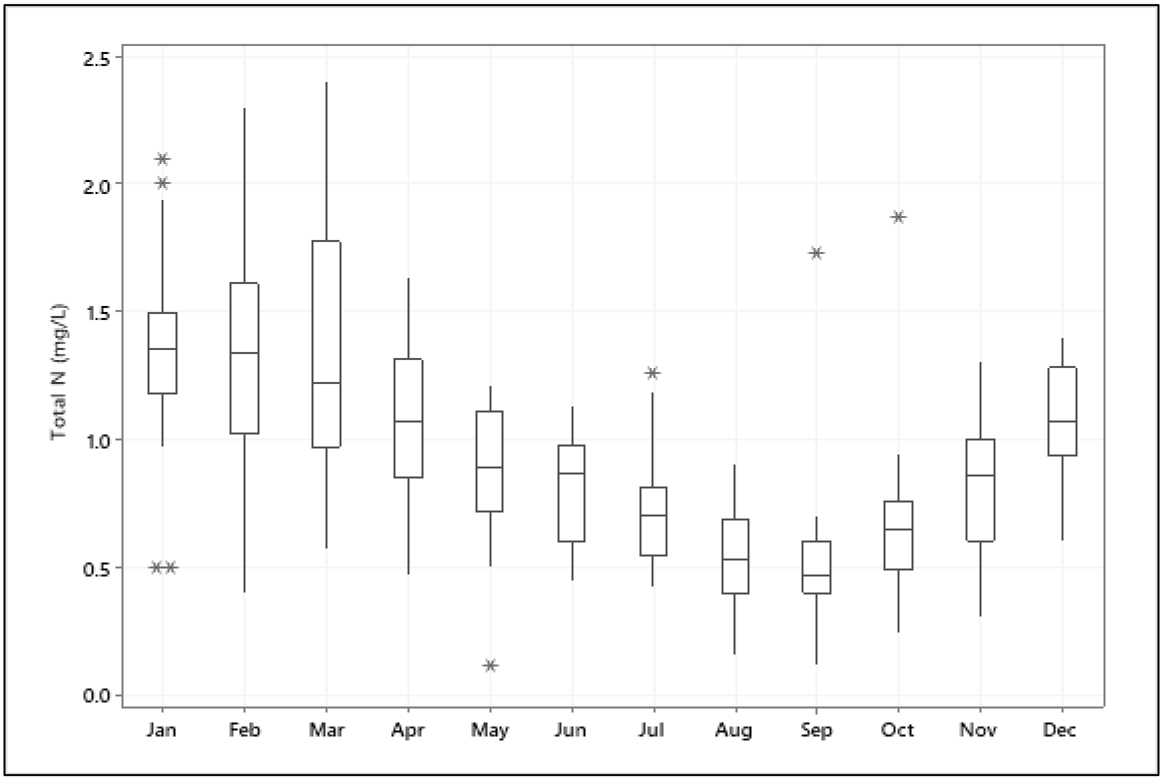
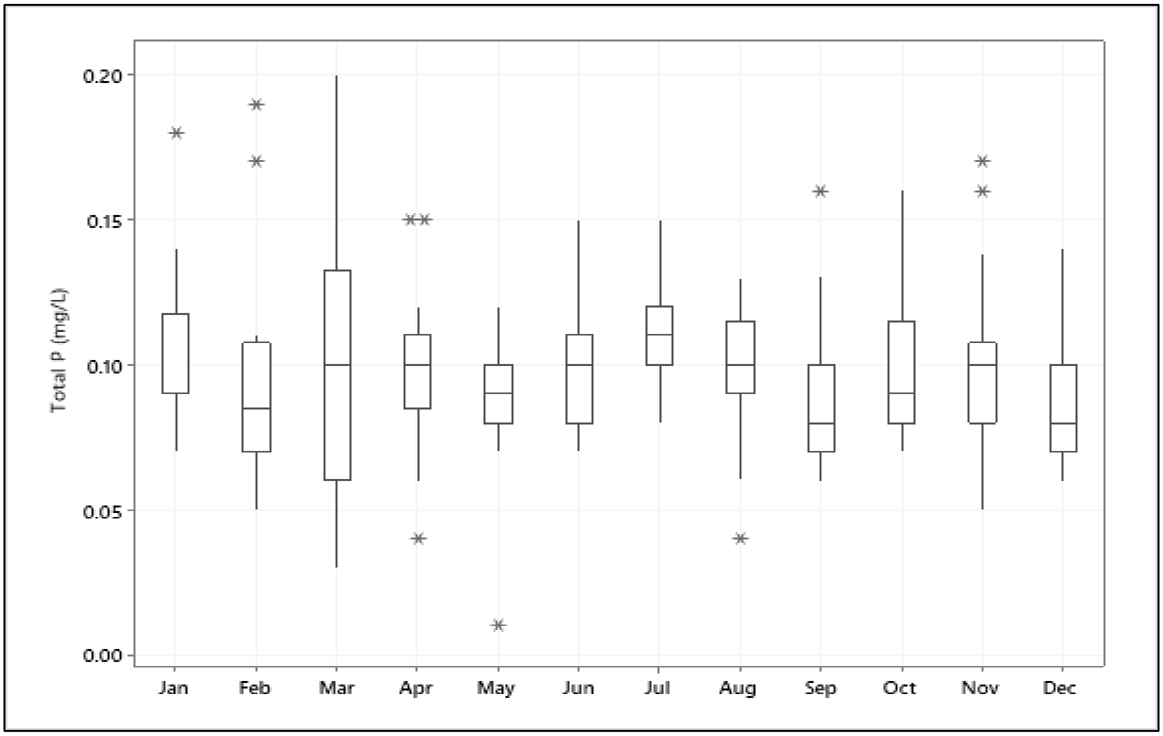


Figure 6-52. Monthly Variability in Total P at Check 21, 2000 to 2020



Check 41 – Check 41 is immediately upstream of the bifurcation of the California Aqueduct into the east and west branches. **Figure 6-53** presents the total N data and **Figure 6-54** presents the total P data for Check 41. Total N concentrations range from 0.11 to 7.0 mg/L with a median of 1.02 mg/L. Total P concentrations range from 0.01 to 1.04 mg/L with a median of 0.087 mg/L. The median nutrient concentrations were calculated to determine the trophic level classification of water entering the east and west branches of the California Aqueduct and subsequently flowing into the terminal reservoirs. The trophic level classifications were previously shown in **Table 6-1**. The median total N concentration is 1.02 mg/L, placing it in the mesotrophic level. The median total P concentration is 0.087 mg/L, placing it in the eutrophic level.

- Spatial Trends – **Figures 6-33 and 6-34** compare the nutrient data collected between 2004 and 2020 at Check 41 to a number of other locations along the aqueduct. Median total N concentrations increase from 0.81 mg/L at Check 21 to 1.00 mg/L at Check 41 during this period and the increase is statistically significant (Mann-Whitney, p=0.0001). There is a statistically significant decrease in total P concentrations from a median of 0.09 mg/L at Check 21 to a median of 0.08 mg/L at Check 41 (Mann-Whitney, p=0.000).

  Figures 6-55 and **6-56** present the nutrient data for Checks 21 and 41. These figures show that in years with high turn-in volumes (years 2014 to 2016), total N concentrations increase and total P concentrations decrease substantially between the two check structures. This is due to higher nitrate concentrations in turn-in water compared to Aqueduct water, and conversely, lower P concentrations in turn-in water compared to Aqueduct water. Additional information on turn-in volumes is provided in Chapter 13.

- Long-Term Trends – Concentrations of total N and total P over the recent 5 year reporting period remained within historical range. The total N concentrations, shown in **Figure 6-53** appear to be decreasing since the peak of 7.0 mg/L in July 2015. **Figure 6-54** shows that total P concentrations do not show any discernible trend.

- Wet Year/Dry Year Comparison – The total N median concentration of 1.1 mg/L in dry years is statistically significantly higher than the median of 0.88 mg/L in wet years (Mann-Whitney, p=0.001). Conversely, the total P median of 0.08 mg/L in dry years is statistically significantly lower than the wet year median of 0.10 mg/L (Mann-Whitney, p=0.000).

- Seasonal Trends – **Figures 6-57 and 6-58** present the monthly nutrient data for Check 41. The total N seasonal pattern is the same as at Banks. The concentrations are high in the winter months, decline in the spring and summer, and increase during the fall months. The total P concentrations are slightly higher in the winter months, decline in the spring, and then have a secondary peak in July. This is similar to Banks except the summer peak occurs one month earlier at Banks, in June.

Figure 6-53. Total N Concentrations at Check 41

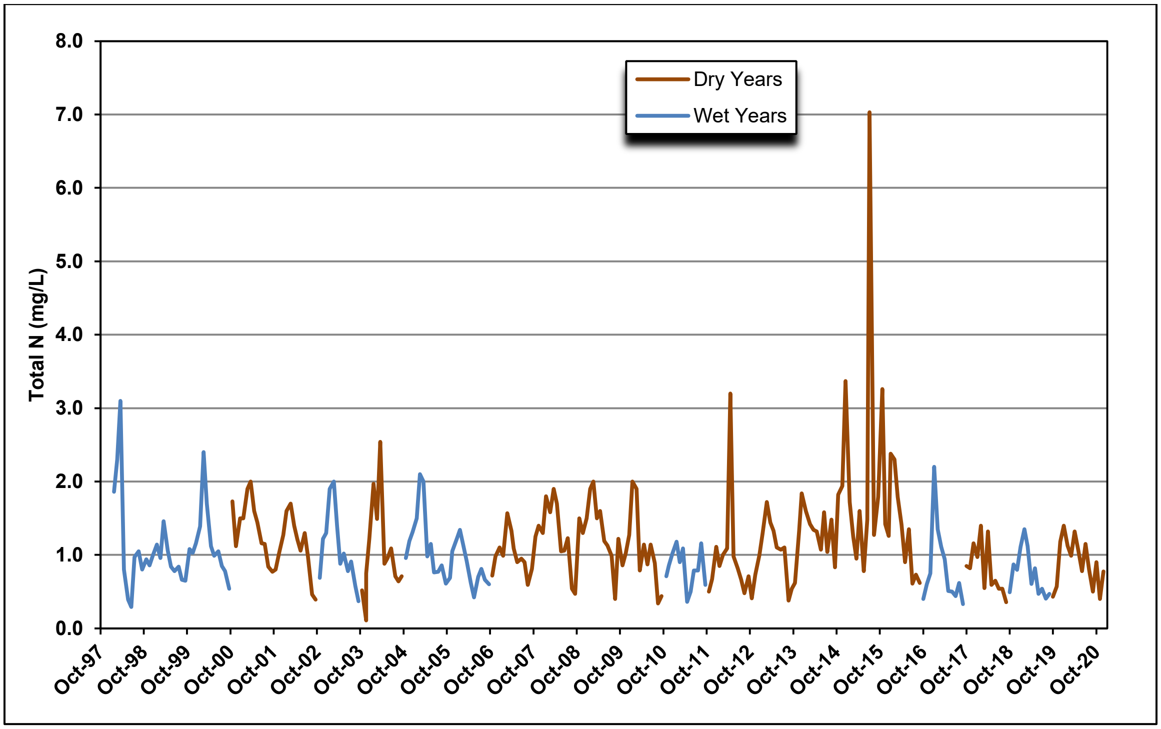


Figure 6-54. Total P Concentrations at Check 41

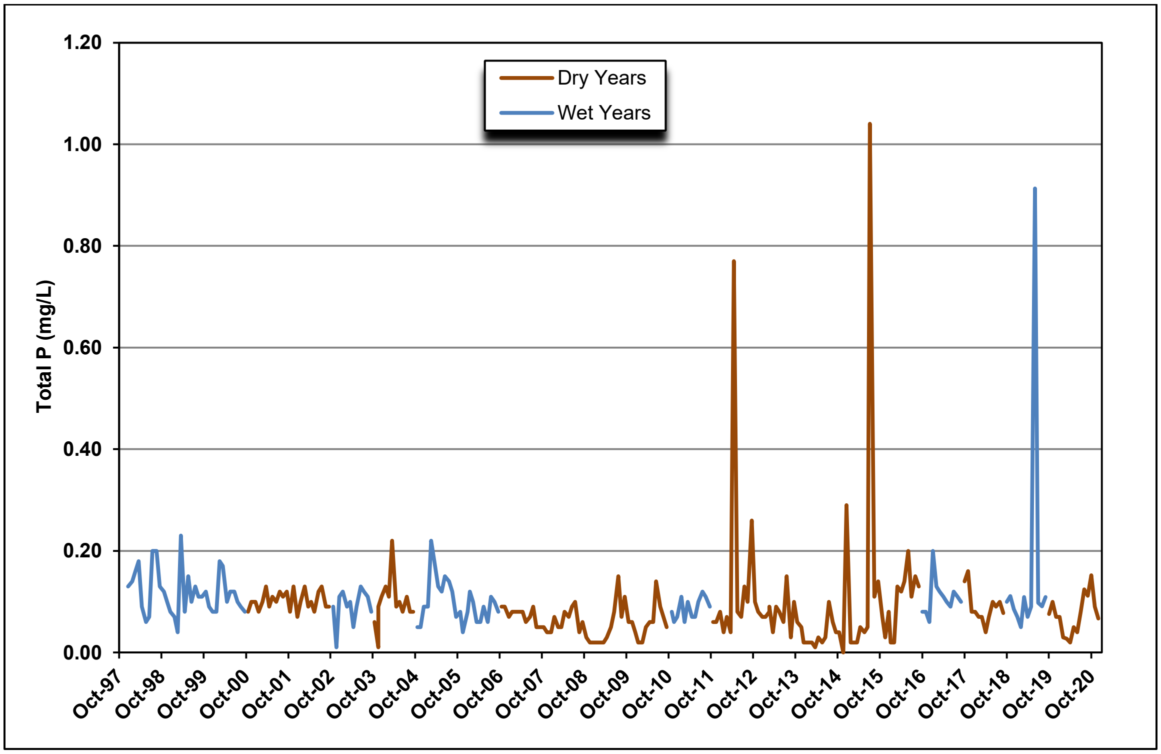


Figure 6-55. Comparison of Check 21 and Check 41 Total N Concentrations

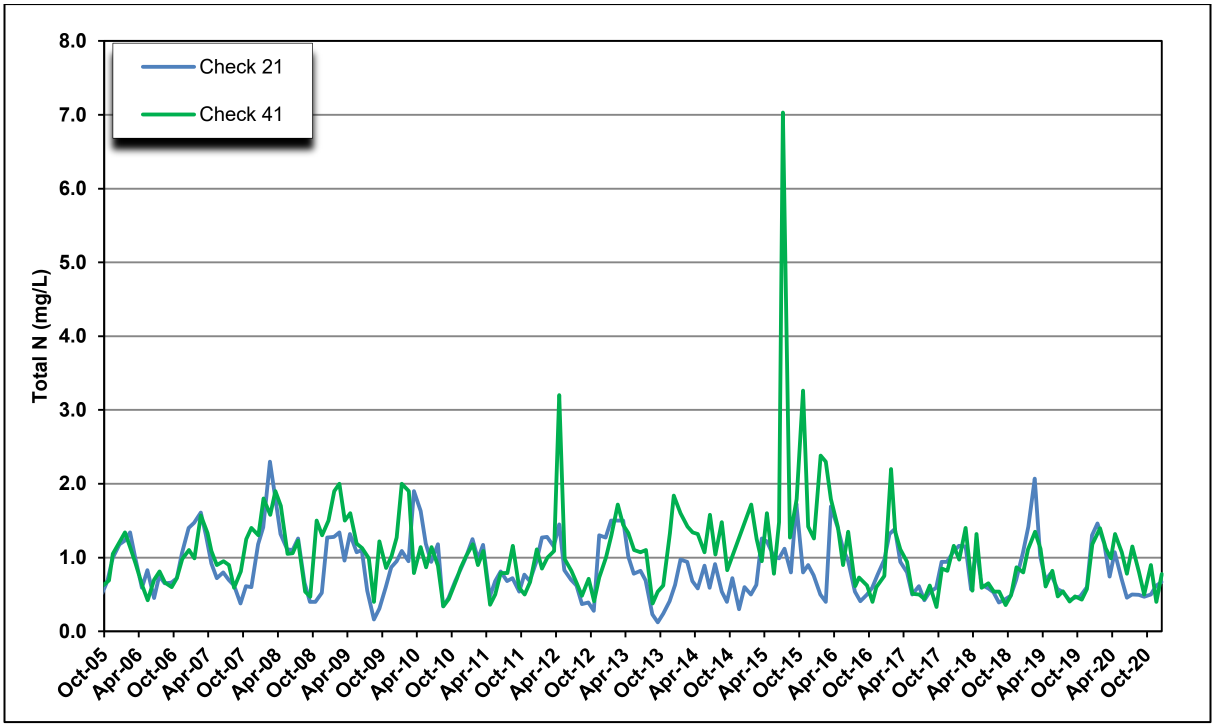


Figure 6-56. Comparison of Check 21 and Check 41 Total P Concentrations

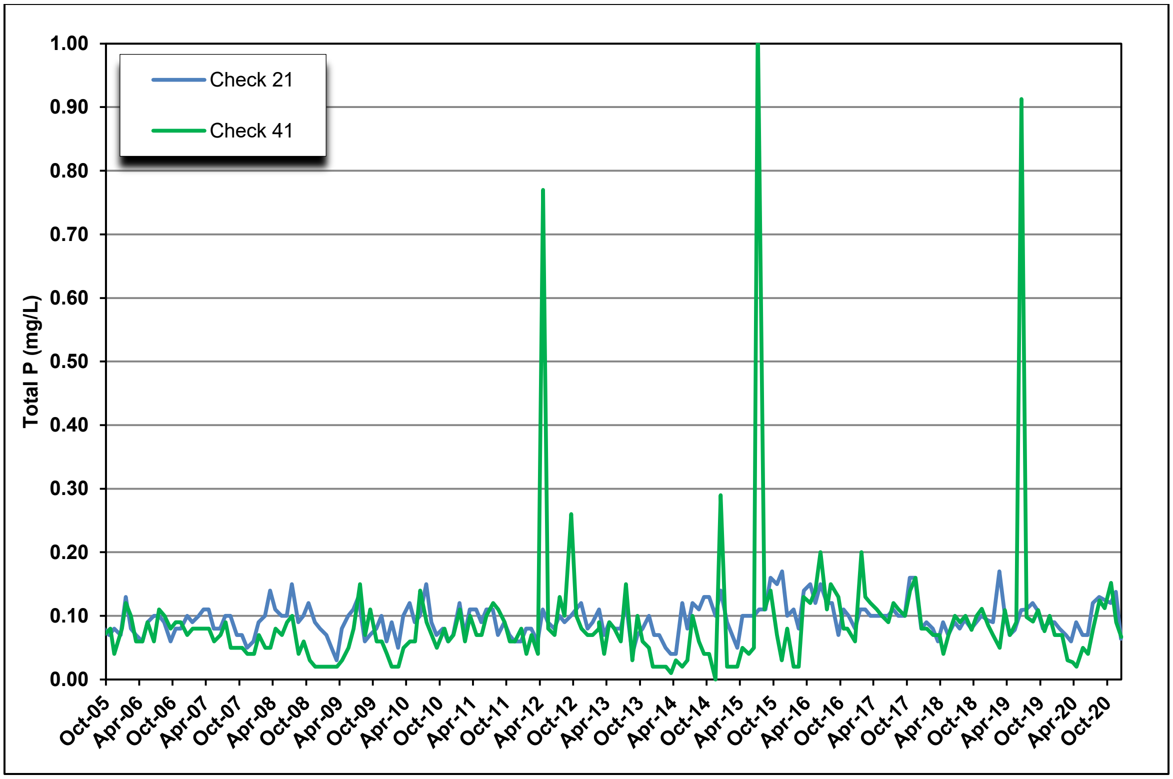


Figure 6-57. Monthly Variability in Total N at Check 41, 1998 to 2020

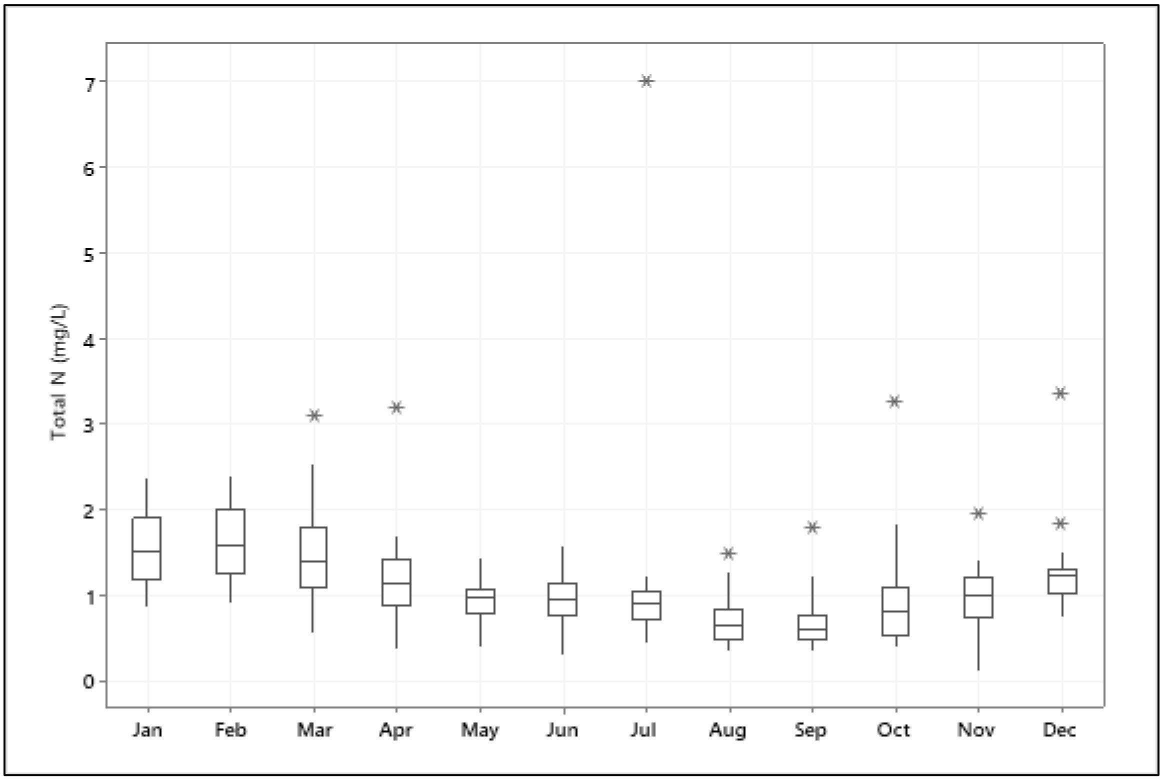
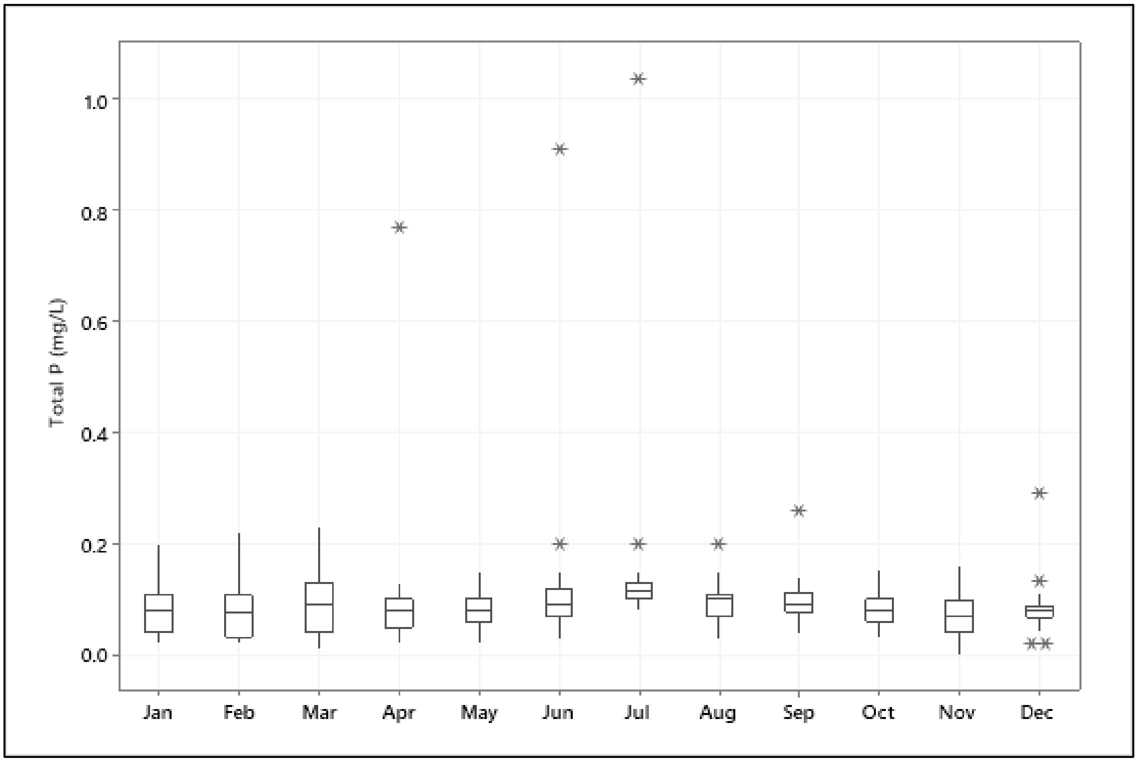


Figure 6-58. Monthly Variability in Total P at Check 41, 1997 to 2020



Castaic Outlet – **Figure 6-59** presents the total N data and **Figure 6-60** presents the total P data for Castaic Outlet. Total N concentrations range from 0.2 to 2.8 mg/L with a median of 0.62 mg/L. Total P concentrations range from less than 0.01 to 0.26 mg/L with a median of 0.04 mg/L.

- Spatial Trends – **Figures 6-33 and 6-34** compare the nutrient data collected between 2004 and 2020 at Castaic Outlet to a number of other locations along the aqueduct. There is a statistically significant decrease in median total N concentrations from 1.00 mg/L at Check 41 to 0.63 mg/L at Castaic Outlet (Mann-Whitney, p=0.0000) and median total P concentrations from 0.08 mg/L at Check 41 to 0.04 mg/L at Castaic Outlet (Mann-Whitney, p=0.0000). These data show the effect of reservoir storage in moderating the range of nutrient concentrations and, perhaps, indicate a loss of nutrients due to algal uptake and settling of organic detritus in the West Branch reservoirs. Water flows from the hypolimnion of Pyramid Lake, at an outlet portal located at about 160 feet deep, through Elderberry Forebay, through a valve that entrains air, and then into Castaic Lake. The entrained air tends to cause water entering Castaic Lake to rise to the surface where biologically available nutrients drawn from the hypolimnion of Pyramid Lake are available for algal uptake. Algal uptake and subsequent settling of organic matter in Castaic Lake, due at least in part to the unique configuration and operational pattern of this part of the SWP system, may be responsible for the lower nutrient concentrations in Castaic Outlet water. An additional factor to consider in understanding the relatively low concentrations of nutrients in Castaic compared to Check 41 is that the nutrient samples are collected at a depth of 1 meter in the epilimnion of Castaic Lake. During much of the year, virtually all of the nutrients are tied up in algal biomass which settles into the hypolimnion. Water is generally released from the hypolimnion of Castaic Lake so nutrient concentrations in water treated by MWDSC and Castaic Lake Water Agency are likely higher than the levels measured in the epilimnion.

- Long-Term Trends – Concentrations of total N over the recent 5 year reporting period remained within historical range as shown in **Figure 6-59. Figure 6-59** indicates that total N concentrations were increasing from 2012 to 2016, decreasing from 2017 to 2019, and increasing again in 2020. **Figure 6-60** do not show any discernible long-term trends for total P; the maximum P concentration of 0.26 mg/L occurred in November 2016.

- Wet Year/Dry Year Comparison – The total N median concentration of 0.66 mg/L in dry years is statistically significantly higher than the median of 0.56 mg/L in wet years (Mann-Whitney, p=0.000). The total P median of 0.04 mg/L in dry years is not statistically significantly higher than the wet year median of 0.03 mg/L (Mann-Whitney, p=0.417).

- Seasonal Trends – **Figures 6-61 and 6-62** present the monthly nutrient data for Castaic Outlet. The total N seasonal pattern is the same as at Banks except that there are smaller differences between the peak winter months and the low levels in the summer months. The total P concentrations show a strong seasonal pattern with very low levels in the summer months. This is likely due to algal uptake and subsequent settling of algae.

Figure 6-59. Total N Concentrations at Castaic Outlet

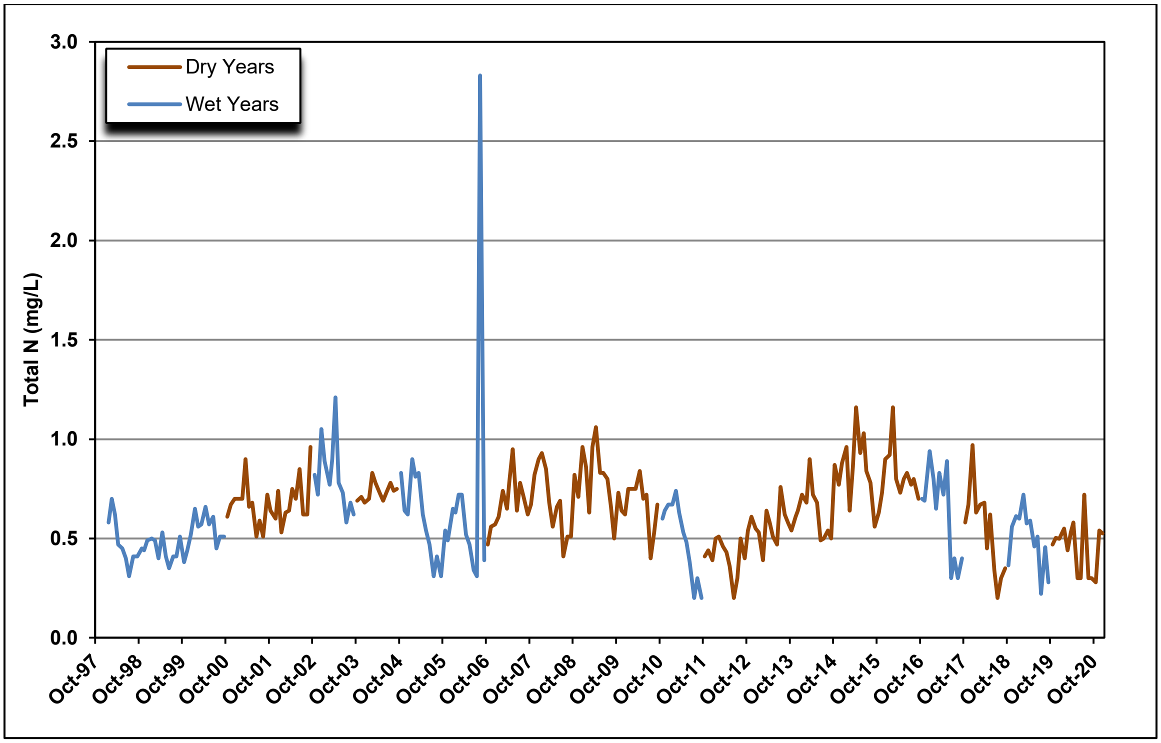


Figure 6-60. Total P Concentrations at Castaic Outlet

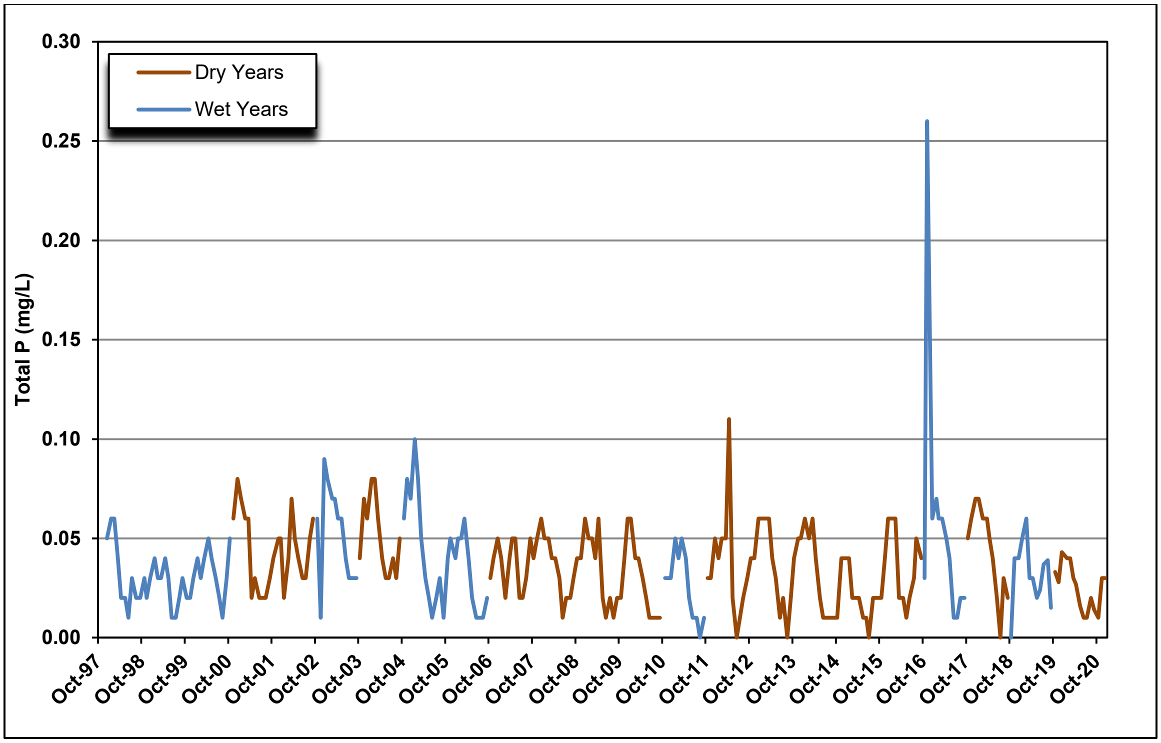


Figure 6-61. Monthly Variability in Total N at Castaic Outlet, 1998 to 2020

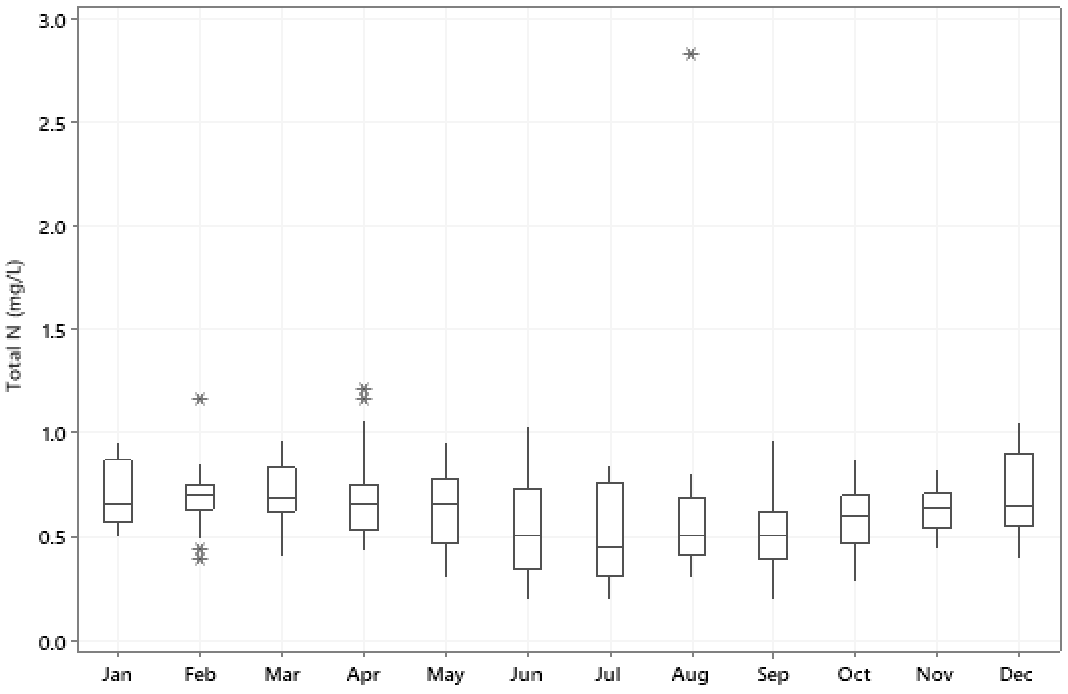
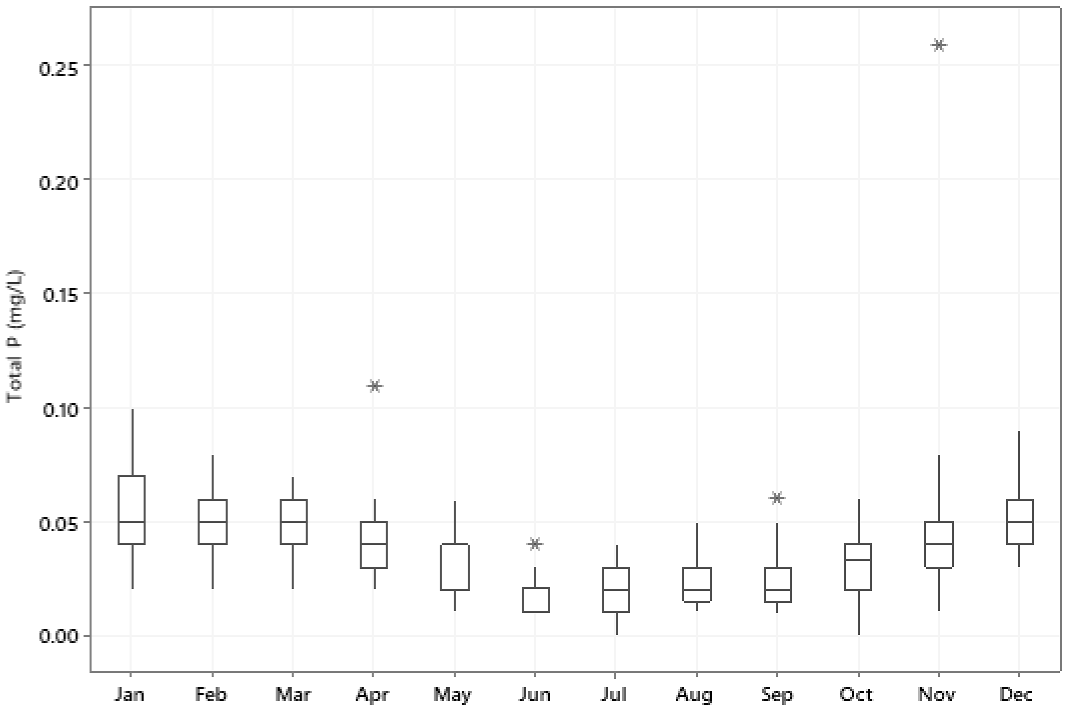


Figure 6-62. Monthly Variability in Total P at Castaic Outlet, 1997 to 2020



Devil Canyon – **Figure 6-63** presents the total N data and **Figure 6-64** presents the total P data for Devil Canyon. Total N concentrations range from 0.11 to 2.3 mg/L with a median of 0.90 mg/L. Total P concentrations range from less than 0.01 to 0.46 mg/L with a median of 0.08 mg/L.

- Spatial Trends – **Figures 6-33 and 6-34** compare the nutrient data collected between 2004 and 2020 at Devil Canyon to a number of other locations along the aqueduct. The total N median concentration at Check 41 at 1.00 mg/L is statistically significantly higher than at Devil Canyon of 0.905 mg/L (Mann-Whitney, p=0.007). The total P median concentration at Check 41 of 0.080 mg/L is not statistically significant compared to the total P median concentration of 0.076 mg/L at Devil Canyon.

- Long-Term Trends – The total N and total P concentrations, shown in **Figure 6-63** and **Figure 6-64** do not show any discernible trend. Concentrations of total N and total P over the recent 5 year reporting period remained within historical range.

- Wet Year/Dry Year Comparison – The total N median concentration of 0.93 mg/L in dry years is not statistically significantly higher than the median of 0.82 mg/L in wet years (Mann-Whitney, p=0.068). The total P median of 0.07 mg/L in dry years is statistically significantly lower than the wet year median of 0.09 mg/L (Mann-Whitney, p=0.000).

- Seasonal Trends – **Figures 6-65 and 6-66** present the monthly nutrient data for Devil Canyon. The total N seasonal pattern is the same as at Banks except the winter peak occurs one month later. The concentrations are high in the winter months, decline in the spring and summer, and increase during the fall months. The total P concentrations are slightly higher in the winter months, decline in the spring and then increase slightly in July and remain the same through October.

Figure 6-63. Total N Concentrations at Devil Canyon

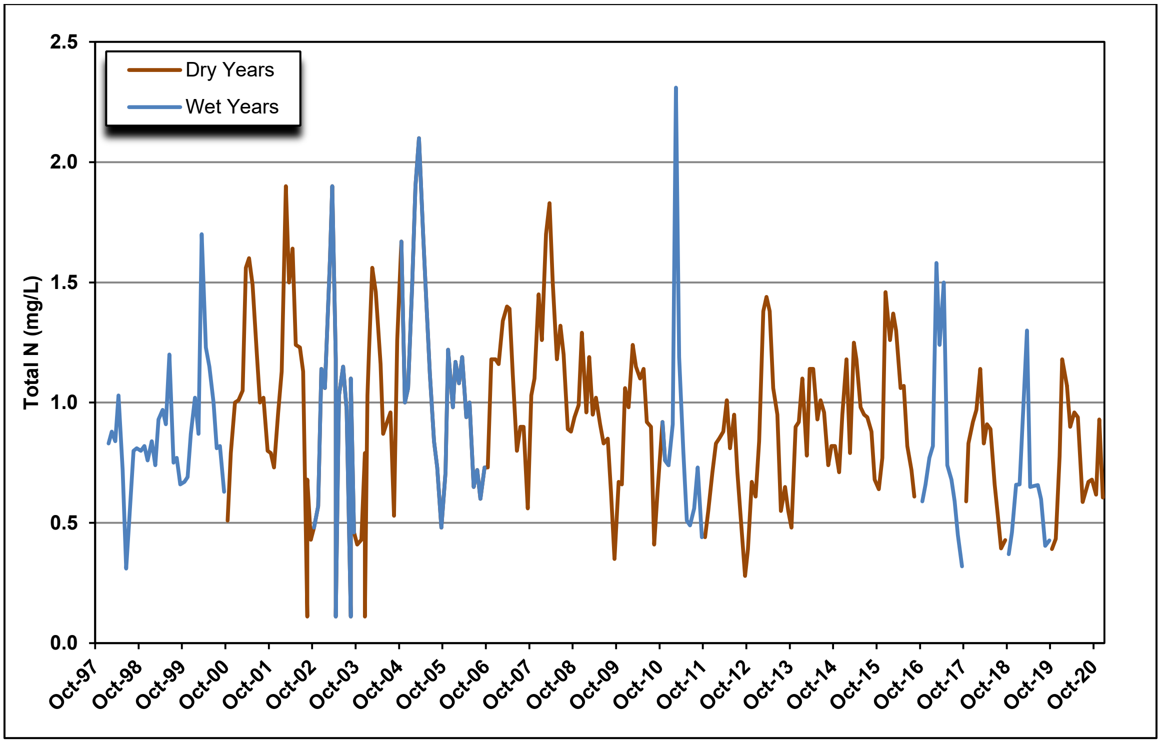


Figure 6-64. Total P Concentrations at Devil Canyon

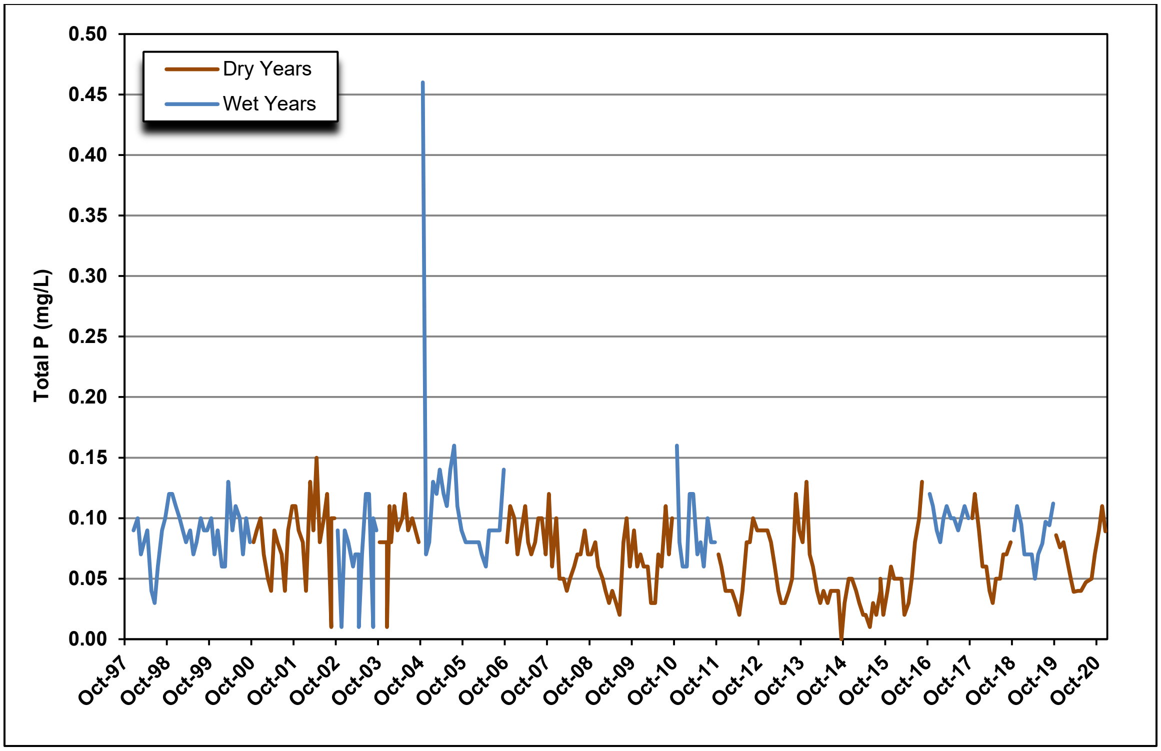


Figure 6-65. Monthly Variability in Total N at Devil Canyon, 1998 to 2020

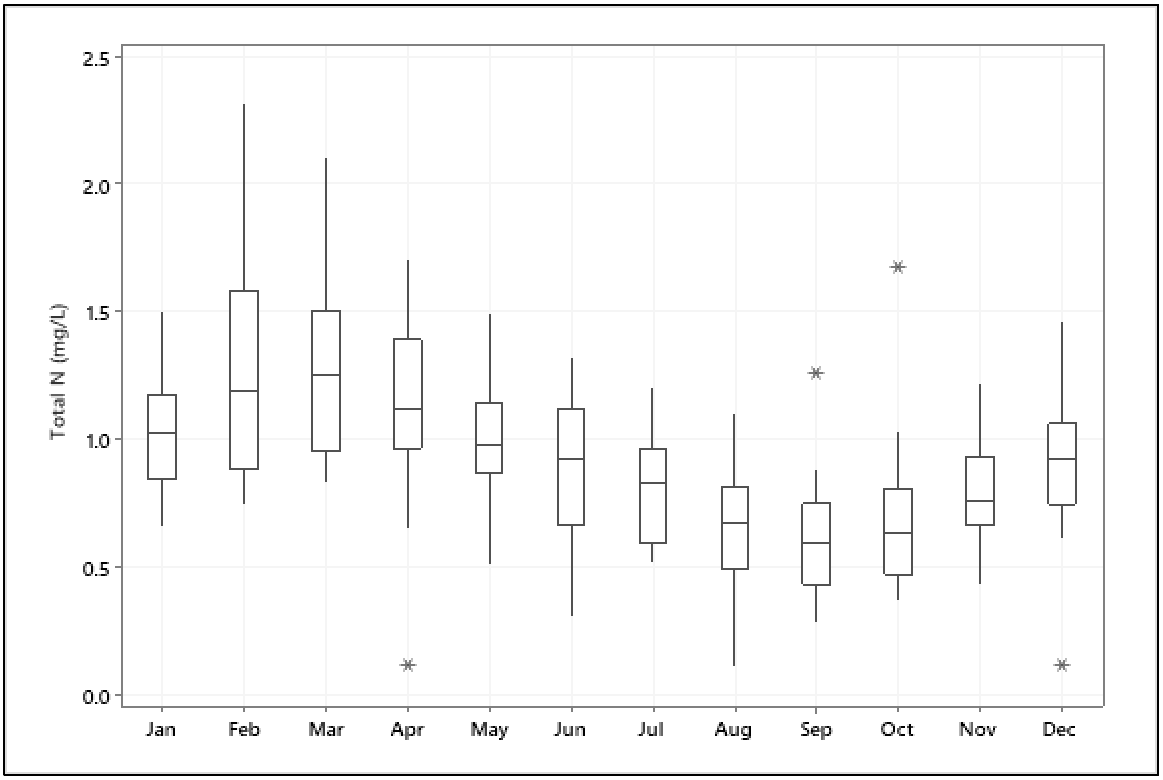
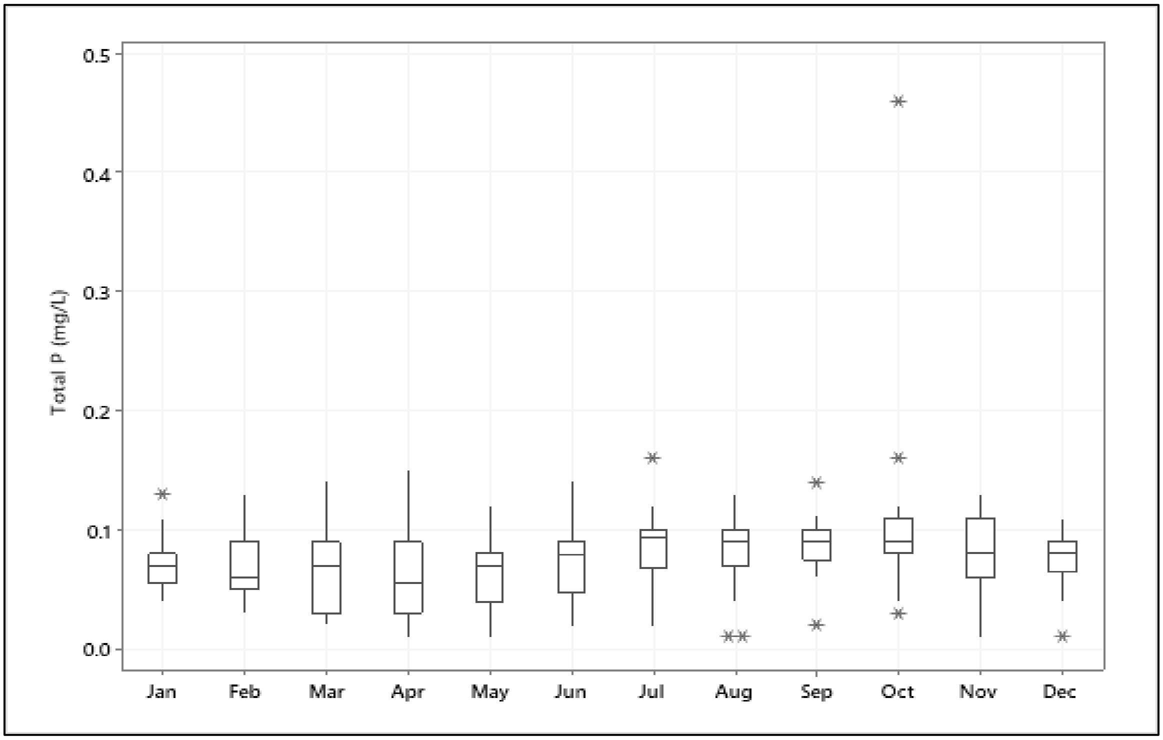


Figure 6-66. Monthly Variability in Total P at Devil Canyon, 1997 to 2020



SUMMARY

- Source modeling of nitrogen and phosphorus identifies agriculture, atmospheric deposition, and wastewater effluent as sources of total nitrogen in the Central Valley. Geologic sources, agriculture, and wastewater discharge are the primary sources of phosphorus (Saleh and Domagalski, 2021).

- Nutrient concentrations increase considerably in the Sacramento River between West Sacramento and Hood, despite the inflow of the high quality American River, due mainly to the discharge from the Sacramento Regional Wastewater Treatment Plant. The median concentrations of total N (0.71 mg/L) and total P (0.08 mg/L) at Hood are statistically significantly higher than the median concentrations of total N (0.29 mg/L) and total P (0.05 mg/L) at West Sacramento. Total N and total P concentrations in the San Joaquin River are considerably higher and more variable than concentrations in the Sacramento River. The median total N concentration at Vernalis of 1.8 mg/L is the highest in the SWP system. The total P median is 0.14 mg/L, almost twice the level found at Hood.

- Nutrient concentrations in the NBA are higher compared to the Sacramento River at Hood. The median total N concentration at Barker Slough is 0.79 mg/L and the median total P concentration is 0.20 mg/L. The highest concentrations occur in the winter months due to the influence of runoff from the local Barker Slough watershed.

- Total N and total P concentrations in water exported from the Delta at Banks are sufficiently high to cause algal blooms in the aqueducts and downstream reservoirs.

- Nutrient concentrations do not change as water flows from Banks through the SBA due to the short travel time. Median total N concentrations increase from 0.73 mg/L at Banks to 0.885 mg/L at O'Neill Forebay Outlet (Check 13) and the increase is statistically significant (Mann-Whitney, p=0.012). The increase of total N at Check 13 is likely due to the introduction of DMC water at O'Neill Forebay, as the median total N concentration of 1.02 mg/L at McCabe is statistically significant higher than the median concentration of 0.69 mg/L at Banks (Mann-Whitney, p=0.0000).

- Median total P concentrations at Banks and Check 13 are the same, with a median of 0.09 at both locations. There are no substantial changes in nutrient concentrations as water moves from Check 13 to Check 21. Median total N concentrations increased from 0.81 mg/L at Check 21 to 1.00 mg/L at Check 41 and the increase is statistically significant (Mann-Whitney, p=0.0001). There is a statistically significant decrease in total P concentrations from a median of 0.09 mg/L at Check 21 to a median of 0.08 mg/L at Check 41 (Mann-Whitney, p=0.000). These changes are due to introduction of turn-in water between Check 21 and Check 41, most evident in dry years when turn-in volumes are higher. Typically, there are higher nitrate concentrations in turn-in water compared to Aqueduct water, and conversely, lower P concentrations in turn-in water compared to Aqueduct water.

- Median nutrient concentrations are substantially lower at Castaic Outlet (total N is 0.62 mg/L and total P is 0.04 mg/L). Algal uptake and subsequent settling of particulate matter may be responsible for the lower nutrient concentrations in the terminal reservoirs. Median total N concentrations are statistically significantly lower at Devil Canyon compared to Check 41 (Mann-Whitney, p=0.007), however the total P median concentration at Check 41 of 0.080 mg/L is not statistically significant compared to the total P median concentration of 0.076 mg/L at Devil Canyon.

- Concentrations of total N over the recent 5 year reporting period remained within historical range for all locations except for Hood and Barker Slough. Total N reached a new maximum concentration of 2.44 mg/L at Hood in June 2018, as well as a new maximum concentration of 3.23 mg/L at Barker Slough in January 2016.

- Concentrations of total P over the recent 5 year reporting period remained within historical range for all locations except for Vernalis and Castaic Lake Outlet. Total P reached a new maximum concentration of 0.89 mg/L at Vernalis in December 2016, as well as a new maximum concentration of 0.26 mg/L at Castaic Lake Outlet in November 2016.

- As shown in **Tables 6-4** and **6-5**, the effect of dry versus wet years is more pronounced at the locations representing the inputs to the Delta, or a local watershed such as Barker Slough. At these locations (Hood, Vernalis, McCabe) the total N concentrations are generally higher in dry years, with Barker Slough and Pacheco as the exception, having higher total N in wet years compared to dry years. Total P is also higher in dry years at Hood, Vernalis, and McCabe, but higher in wet years at Pacheco, and no difference between wet and dry years at Barker Slough. Once the water enters the California Aqueduct at Banks, there is no statistically significant effect of dry versus wet years for both total P and total N as the water moves from Banks, DV Check 7, Check 13 and Check 21. Check 41 has higher total N and lower total P in dry years due to the impact from non-Project inflows which occur more frequently in dry years.

- Seasonal trends also vary throughout the system. Total N shows a stronger seasonal pattern than total P. Generally the same seasonal pattern for total N remains throughout from Banks, DV Check 7, Pacheco, McCabe, Check 13 and Check 21. Total N concentrations are high in the winter months (January to March), decline in the spring and summer, and increase during the fall months. The seasonal pattern weakens at Check 41 likely due to non-Project inflows. Generally the same seasonal pattern for total P remains throughout from Banks, DV Check 7, and Check 21. Total P is more stable at Pacheco and Check 13. Total P concentrations are slightly higher in the winter months, decline in the spring and then have a secondary peak in July or August before declining through the fall. Seasonal impacts are impacted by VAMP flows on the San Joaquin River in April and May, as well as agriculture drainage in the summer months.

Table 6-4. Comparison of Dry Year and Wet Year Total N Concentrations

	Median Total N (mg/L)		
Location	**Dry Years**	**Wet Years**	**Statistical Significance**
Hood	0.79	0.56	D>W
Vernalis	1.85	1.25	D>W
Banks	0.84	0.76	No
Barker Slough	0.74	0.84	W>D
DV Check 7	0.81	0.78	No
McCabe	1.09	0.84	D>W
Pacheco	0.84	1.02	W>D
O'Neill Forebay Outlet	0.92	0.80	No
Check 21	0.92	0.80	No
Check 41	1.1	0.88	D>W
Castaic Outlet	0.66	0.56	D>W
Devil Canyon	0.93	0.82	No

Table 6-5. Comparison of Dry Year and Wet Year Total P Concentrations

	Median Total P (mg/L)		
Location	**Dry Years**	**Wet Years**	**Statistical Significance**
Hood	0.08	0.07	D>W
Vernalis	0.14	0.115	D>W
Banks	0.1	0.1	No
Barker Slough	0.19	0.21	No
DV Check 7	0.1	0.09	No
McCabe	0.12	0.09	D>W
Pacheco	0.09	0.10	W>D
O'Neill Forebay Outlet	0.09	0.09	No
Check 21	0.09	0.10	No
Check 41	0.08	0.1	W>D
Castaic Outlet	0.04	0.03	No
Devil Canyon	0.07	0.09	W>D

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CHAPTER 7 TASTE AND ODOR INCIDENTS AND ALGAL TOXINS

CONTENTS

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CHAPTER 7 TASTE AND ODOR INCIDENTS AND ALGAL TOXINS

This chapter contains a discussion of algal growth in the State Water Project (SWP) aqueducts and reservoirs.

- Taste and odor (T&O) Incidents – T&O incidents are common in the Delta and the SWP. Monitoring by the Department of Water Resources (DWR) has shown that the incidents are commonly associated with geosmin and 2-methylisoborneol (MIB). This section contains a discussion of the monitoring data.

- Algal Toxins –This section contains a discussion of monitoring for algal toxins in the SWP, as well as future studies being conducted in the Delta and at Banks and Pacheco.

TASTE AND ODOR INCIDENTS

WATER QUALITY CONCERN

Certain cyanobacteria and actinomycete bacteria produce chemical compounds that are not removed in conventional water treatment processes and are capable of causing unpleasant tastes and odors in drinking water. T&O incidents in the SWP are commonly associated with geosmin and MIB that are produced by certain algae and bacteria. The ability of individuals to detect these chemicals varies, but the general population can detect either compound at a concentration of about 10 ng/L in water (parts per trillion) and sensitive individuals can detect at even lower concentrations at 4 ng/L.

This section contains an update on the monitoring for MIB and geosmin throughout the SWP.

WATER QUALITY EVALUATION

Geosmin and MIB data for the SWP were provided by O&M staff and analyzed by MWDSC. Samples have been collected from SWP facilities and analyzed for the T&O producing compounds, MIB and geosmin, since 2000. O&M staff sends out weekly email reports to the State Water Contractors with the results from the monitoring conducted earlier that week. This provides the South Bay Aqueduct (SBA) Contractors with useful information on trends and it provides the remaining State Water Contractors with advanced notice of potential T&O problems. For the reporting period, all T&O compounds were analyzed by Metropolitan Water District of Southern California (MWDSC)'s water quality lab.

Because human ability to detect tastes and odors varies, T&O thresholds are a somewhat subjective measurement. Also, agencies differ in their approaches to managing T&O, so there is no single number that reflects an acceptable level of MIB, nor of geosmin. While 10 ng/L is generally accepted as the concentration that begins to result in customer complaints, the SBA Contractors have developed lower thresholds shown in **Table 7-1.** To reflect the lower thresholds, data evaluation for SBA Contractors will be evaluated using a 8 ng/L threshold.

Table 7-1. SBA Contractor Thresholds in Raw Water

SBA Contractor	MIB (ng/L)	Geosmin (ng/L)
ACWD	6	6
SCVWD (Valley Water)	8	8

In southern California, the DWR Southern Field Division works in partnership with MWDSC to manage T&O problems and uses the magnitude and the rate of change in T&O compound concentrations in assessing the need for treatment to control algal producer growth. When early warning surveillance indicates problematic production of T&O compounds, a synoptic survey is performed to pinpoint the location of the producer for spot treatment in the case of attached algae in the east branch of the Governor Edmund G. Brown California Aqueduct (California Aqueduct) or the reservoirs or a general water column treatment for planktonic algae in the reservoirs. It is important to note that MIB and geosmin producing algae are a small minority of the cyanobacteria and further that problematic levels of these compounds can be produced by a species that is not a dominant algae in the system.

MIB and Geosmin Concentrations in the SWP

All available data are shown in this chapter; however, the period of record varies from location to location and the focus of the discussion is during the reporting period from 2016 to 2020. Peak concentrations for MIB and geosmin from 2010 to 2020 are shown in **Table 7-2**. Peak concentrations for geosmin occurred in 2020 at Banks and Check 13, and peak geosmin for MIB occurred in 2020 at Lake Del Valle Conservation Outlet.

Table 7-2. Peak MIB and Geosmin concentrations, 2010 to 2020

Monitoring Location	Peak MIB ng/L	Date	Peak Geosmin, ng/L	Date
Campbell Lake Outlet				
Clifton Court Forebay Inlet	44	7/2013 and 6/2015	30	7/2015
Banks PP	29	9/2014	79	7/2020
Dyer Reservoir Outlet*	35	9/2014	1840	6/2017
DV Check 7	24	8/2013 and 9/2014	51	5/2017
Lake Del Valle Conservation Outlet	21	11/2020	28	9/2014
Pacheco PP	301	11/2015	96	7/2016
Check 13 (O'Neill Forebay Outlet)	292	11/2015	149	11/2020
Gianelli*	294	11/2015	100	7/2016
Check 41	507	8/2014	48	9/2015
Check 66	532	8/2014	116	7/2012
Castaic Lake Surface	14	10/2018	1120	7/2018
Silverwood Lake Outlet	631	6/2018	1220	6/2014

Note: Dyer and Gianelli data is from 2012 to 2020

The SWP Watershed

Although most of the nutrients responsible for algal blooms come from the Sacramento and San Joaquin rivers, the algal blooms responsible for T&O incidents typically occur in the Delta and the aqueducts and reservoirs of the SWP system. Therefore, the rivers are not monitored for MIB and geosmin. MIB and geosmin are monitored at Clifton Court Inlet (Clifton Court) and at Banks. Monitoring started at Clifton Court Inlet in 2003 and at Banks in 2001.

Figures 7-1 and **7-2** show that peak concentrations of MIB and geosmin typically occur each summer at Clifton Court Inlet and Banks. It is important to note that the sample location for Clifton Court is at the inlet, which would indicate T&O compounds coming from the Delta. T&O compounds measured at Banks may indicate upstream sources from the Delta, or activity within Clifton Court forebay or the Banks Inlet Channel.

Over the reporting period, there were only six MIB detections at Clifton Court which exceeded 8 ng/L, with a peak concentration of 23 ng/L in July 2017. There were more detections of geosmin above 8 ng/L, totaling 21 detections over the reporting period, with a peak of 26 ng/L occurring in July 2016. Geosmin was above 8 ng/L for about five weeks in June and July 2020.

At Banks, MIB has been historically more of a problem than geosmin, due to the higher peaks of MIB compared to geosmin. However, this trend did not continue over the reporting period; as there were only three MIB detections at Banks which exceeded 8 ng/L, with the peak concentration of 12 ng/L in July 2017. There were more detections of geosmin above 8 ng/L, totaling 57 detections over the reporting period, with the peak of 79 ng/L occurring on July 13, 2020. The peak concentration of 79 ng/L for geosmin was the highest concentration in the past ten years at Banks. Elevated geosmin levels were seen at Clifton Court Inlet beginning in late May 2020, and reached 20 ng/L by June 8, 2020. It appears that the high levels at Banks in June and July 2020 were contributed by upstream sources. Additionally, endothall and copper were used to treat pondweed in Clifton Court Forebay on June 28, 2020 which may also have attributed to the peak of geosmin at Banks on July 13, 2020.

Although there was a second endothall and copper treatment on November 2, 2020 this did not result in a high peak of geosmin at Banks, likely because geosmin levels were low at Clifton Court Inlet prior to treatment.

During the summer/fall period in both 2018 and 2019, geosmin was above 8 ng/L at Banks for about 10 to 12 consecutive weeks. However, Clifton Court Inlet values were much lower (prior to and during) the elevated levels at Banks, indicating the source was within the forebay or the Banks Inlet Channel. (In 2020, the levels of geosmin were higher compared to 2018 and 2019, but were elevated for a shorter time period, about four weeks.)

Increases in T&O concentration from Clifton Court Inlet to Banks indicates the forebay can also be a source of production, most often a result of benthic algal production. There is insufficient residence time in the forebay for planktonic algae to greatly contribute to the increase in T&O concentration and it is thought that benthic cyanobacteria are the primary sources of T&O compounds in the Delta (Personal Communication, Jeff Janik, DWR, 2016 Report). Benthic cyanobacteria grow on the surface of the sediment in water. Therefore they have more time to accumulate as mats and grow compared to planktonic algae which grow in the water column and move faster through the CCF.

Figure 7-1. MIB and Geosmin at Clifton Court Inlet

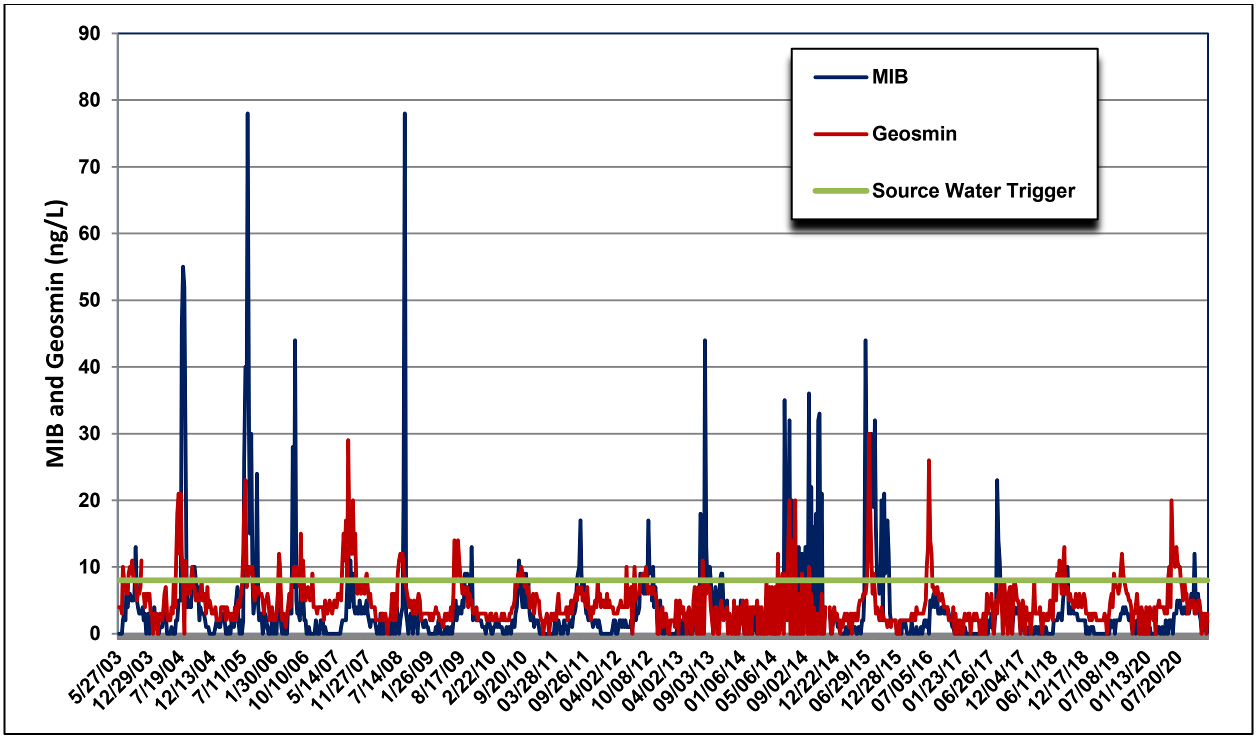
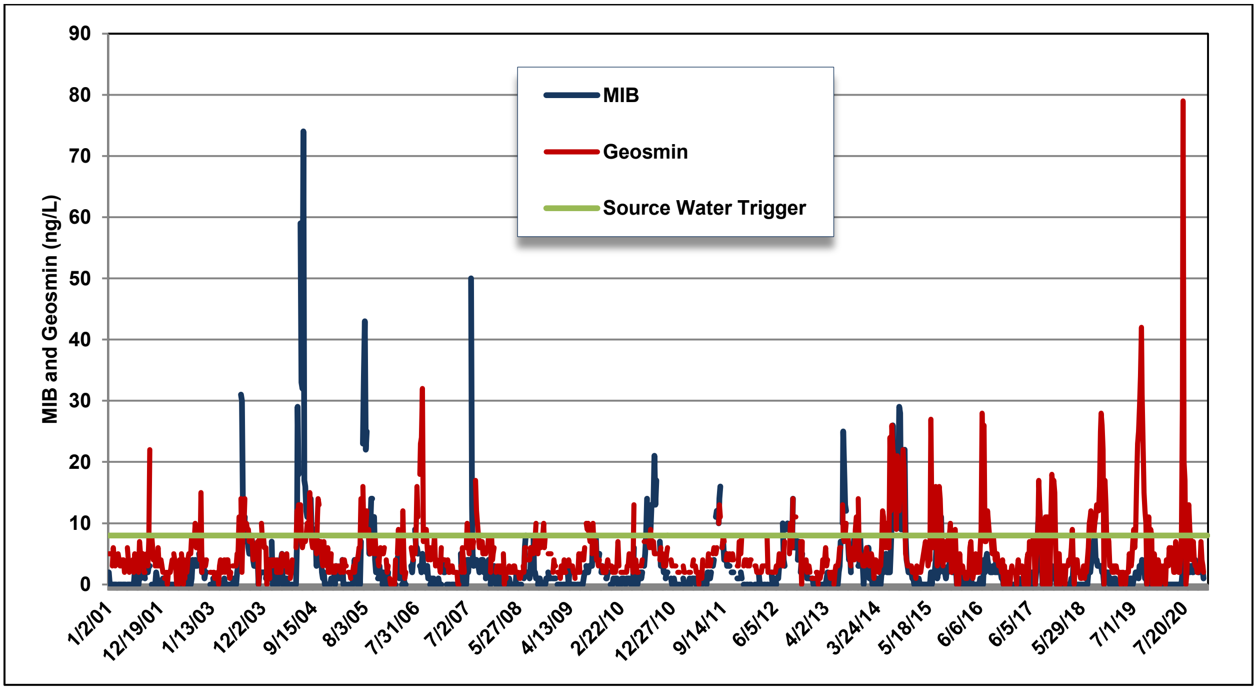


Figure 7-2. MIB and Geosmin at Banks



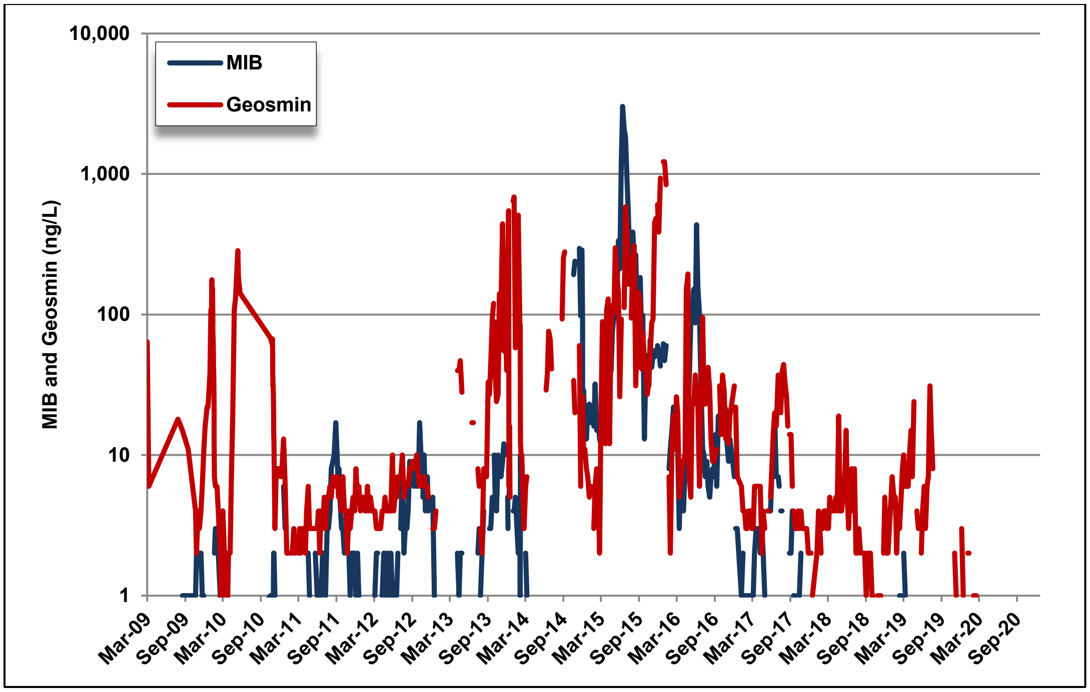
North Bay Aqueduct (NBA)

MIB and geosmin were not routinely monitored in the NBA until there was a severe T&O event in February 2009 that shut down the NBA facility for two months. Solano County Water Agency (SCWA) and DWR initiated a routine monitoring program in response to this event. Weekly samples are collected at Campbell Lake for T&O compounds. Campbell Lake is a privately owned, 37-acre shallow lake located one mile upstream of the Barker Slough Pumping Plant. Samples are also collected at Barker Slough when levels are high in Campbell Lake. **Figure 7-3** presents the Campbell Lake results for 2009 through 2020. Over the reporting period, 2016 was the only year with elevated MIB and geosmin concentrations, with a maximum geosmin concentration of 1,220 ng/L in January 2016, and a maximum MIB concentration of 436 ng/L in June 2016. MIB and geosmin were not as elevated in years 2017 through 2020.

SCWA contracts with Clean Lakes, Inc. to apply PAK^{TM}27, a peroxide-based algaecide that is fast acting and effective with cyanobacteria. When MIB and geosmin concentrations exceed 20 to 30 ng/L in Campbell Lake and T&O producing phytoplankton begin to show exponential growth, a PAK^{TM}27 treatment is done. Two algaecide treatments were completed in 2010 and 2011, four treatments in 2012, two treatments in 2013, eight treatments in 2014, seven treatments in 2015 and six treatments in 2016. There were no treatments conducted from 2017 to 2020. Although MIB or geosmin exceeded the 20 to 30 ng/L range, lake stage was at a very low risk of spilling so treatments were not necessary.

Some T&O producing phytoplankton found in Campbell Lake in 2020 were *Pseudanabaena limnetica* (potential MIB producer), *Planktothrix agardhii* (potential MIB and geosmin producer) and *Aphanizomenon gracile* (potential geosmin producer).

Figure 7-3. MIB and Geosmin at Campbell Lake Outlet

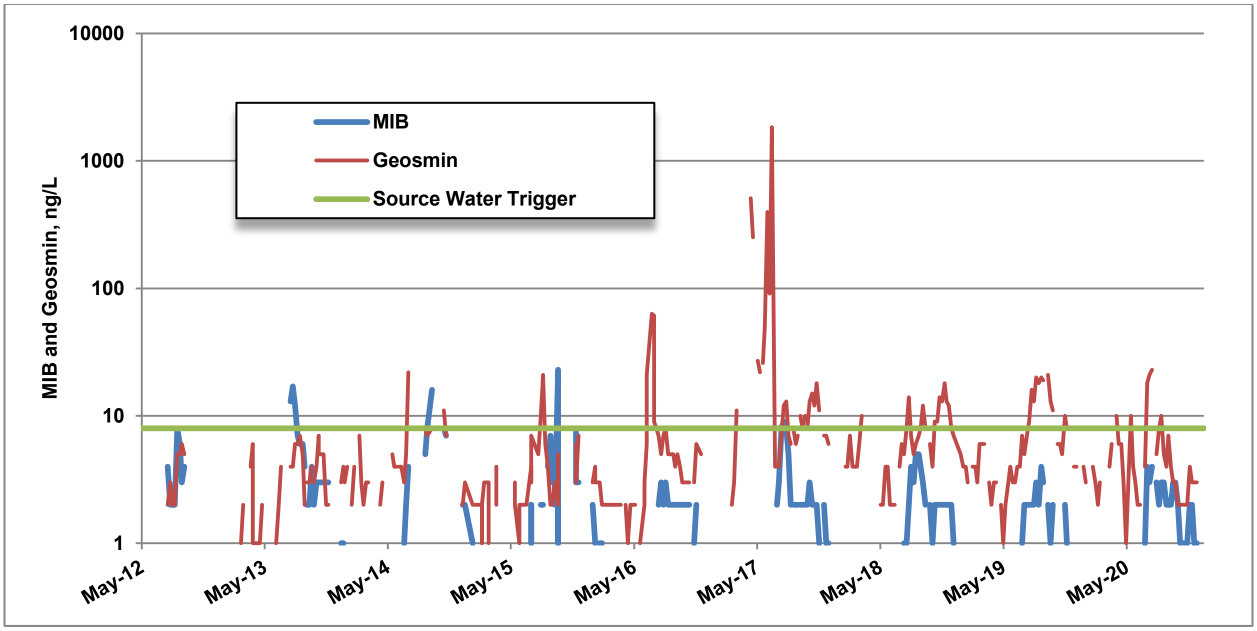


South Bay Aqueduct (SBA)

The high concentrations of nutrients, combined with shallow canal depth, abundant sunlight, and warm water temperatures during the spring, summer, and fall months can lead to excessive algal growth in the SBA. The primary mechanism for controlling algal growth in the SBA is by application of copper sulfate. Copper sulfate is applied from March or April until October, depending upon water temperatures and algal conditions. O&M uses a three-pronged approach of monitoring algal fluorescence, monitoring T&O compounds, and visual observations to determine when a copper sulfate application should be scheduled. Real-time fluorescence at Del Valle Check 7 is monitored daily, and copper sulfate treatment is considered when the weekly average reaches 200 fsu (Personal communication, Mike Taliaferro, DWR, April 2021). Copper sulfate effectively reduces algal populations. O&M provides notice to the SBA Contractors 48 hours in advance of a planned copper sulfate treatment.

As shown in **Figure 7-4**, over the reporting period, MIB exceeded 8 ng/L only once at Dyer Reservoir Outlet Channel which was in July 2017. There were more detections of geosmin above 8 ng/L, totaling 54 detections over the reporting period, with a peak of 1,840 ng/L occurring in June 2017.

Figure 7-4. MIB and Geosmin at Dyer Reservoir Outlet Channel



As shown in **Figure 7-5**, over the reporting period, there were only four MIB detections at Del Valle Check 7 which exceeded 8 ng/L. Three out of four detections occurred in June and July 2020, and the peak concentration of 12 ng/L occurred in July 2016. There were more detections of geosmin above 8 ng/L, totaling 33 detections over the reporting period, with a peak of 51 ng/L occurring in May 2017. Geosmin was above 8 ng/L for about eight weeks in the spring to early summer of 2017. During this same time period, geosmin levels were low at Banks, indicating growth in the SBA. Over the reporting period, **Figure 7-6** shows that MIB and geosmin levels are generally below threshold levels in water released from Lake Del Valle at the Conservation

Outlet (Conservation Outlet) with the exception of a few elevated MIB detections in November 2020. MIB concentrations in November 2020 were the highest detected at Lake Del Valle since 2009.

Figure 7-5. MIB and Geosmin at DV Check 7

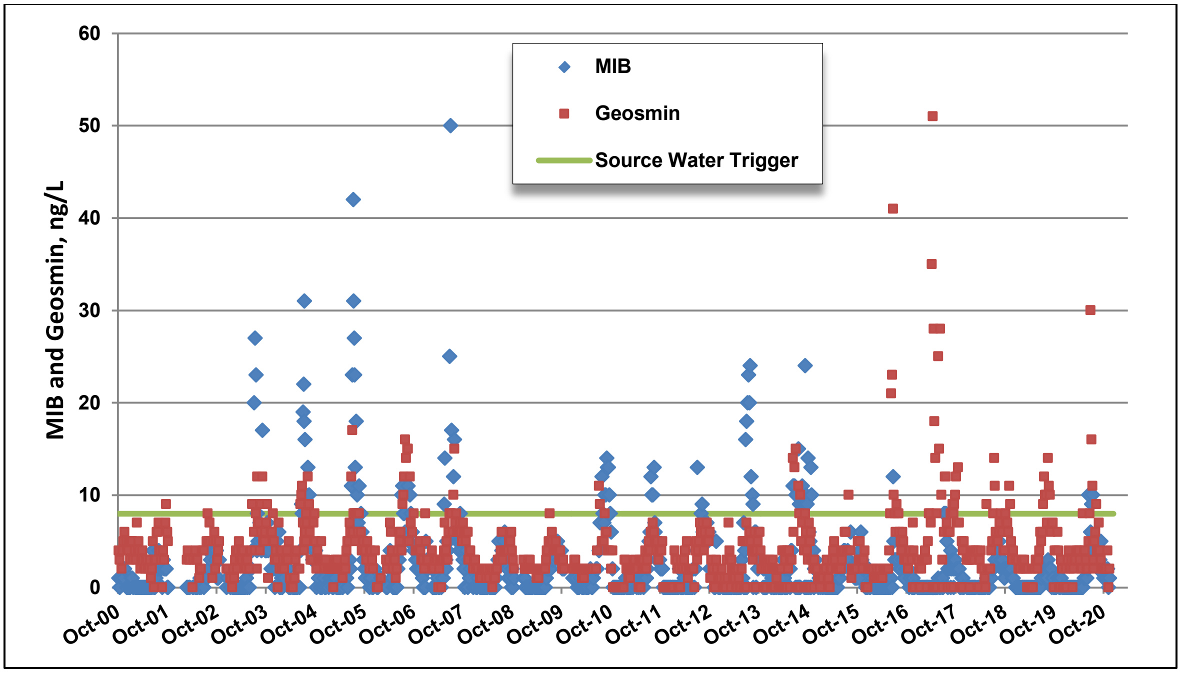
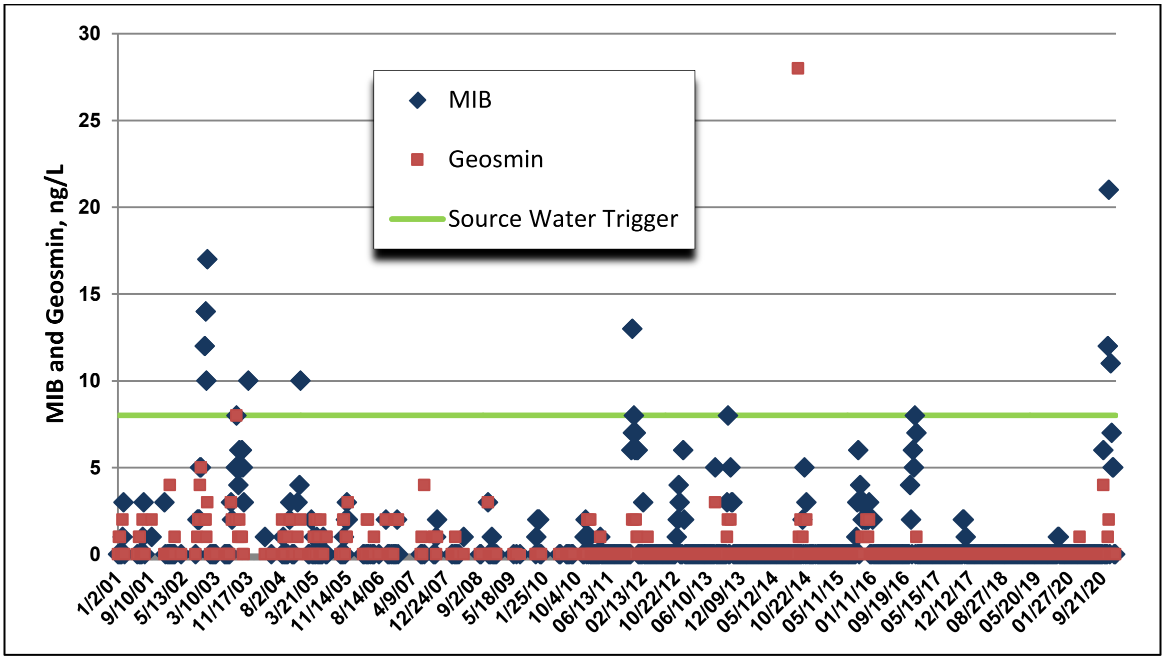


Figure 7-6. MIB and Geosmin at Lake Del Valle Conservation Outlet



California Aqueduct and Delta-Mendota Canal

Delta-Mendota Canal – MIB and geosmin data are not collected by DWR in the Delta Mendota Canal (DMC) as the DMC is part of the Central Valley Project.

San Luis Reservoir – MIB and geosmin have been monitored since 2003 at the Pacheco Pumping Plant (Pacheco) on the west side of San Luis Reservoir. The Pacheco samples are collected at varying depths, depending upon the depth that the water is being withdrawn from the reservoir through the San Luis Outlet Tower which has two portals. Monitoring began at the William R. Gianelli Pumping-Generating Plant (Gianelli Plant) inlet/outlet tower on the east side of the reservoir in 2004 and was discontinued in July 2013 due to low reservoir levels. The inlet/outlet tower site was replaced with the Gianelli water quality station in the channel between O'Neill Forebay and San Luis Reservoir. **Figure 7-7** presents the results for Pacheco and **Figure 7-8** presents the results for Gianelli water quality station.

Generally, levels of MIB and geosmin are below 8 ng/L at Pacheco and Gianelli inlet/outlet tower, with the exception of a few time periods. At Pacheco over the reporting period, MIB was always less than 8 ng/L and geosmin was above 8 ng/L for approximately 8 weeks in July and August 2016, peaking at 96 ng/L in July 2016. This was the only time period of elevated geosmin levels at Pacheco over the reporting period. For Pacheco, the extended drought from 2012 to 2016 caused San Luis Reservoir to be at historical low water volume in 2016. This is likely the reason for increased algal production and T& O issues.

Taste and odor sampling began at the Gianelli water quality station in May 2013. Over the reporting period, MIB levels were above 8 ng/L for 2 to 3 weeks in November 2020, peaking at 23 ng/L. There were two time periods when geosmin concentrations were elevated; for 4 weeks in July 2016 (peak concentration at 100 ng/L) and for 4 weeks in November 2020 (peak concentration at 64 ng/L).

Figure 7-7. MIB and Geosmin at Pacheco

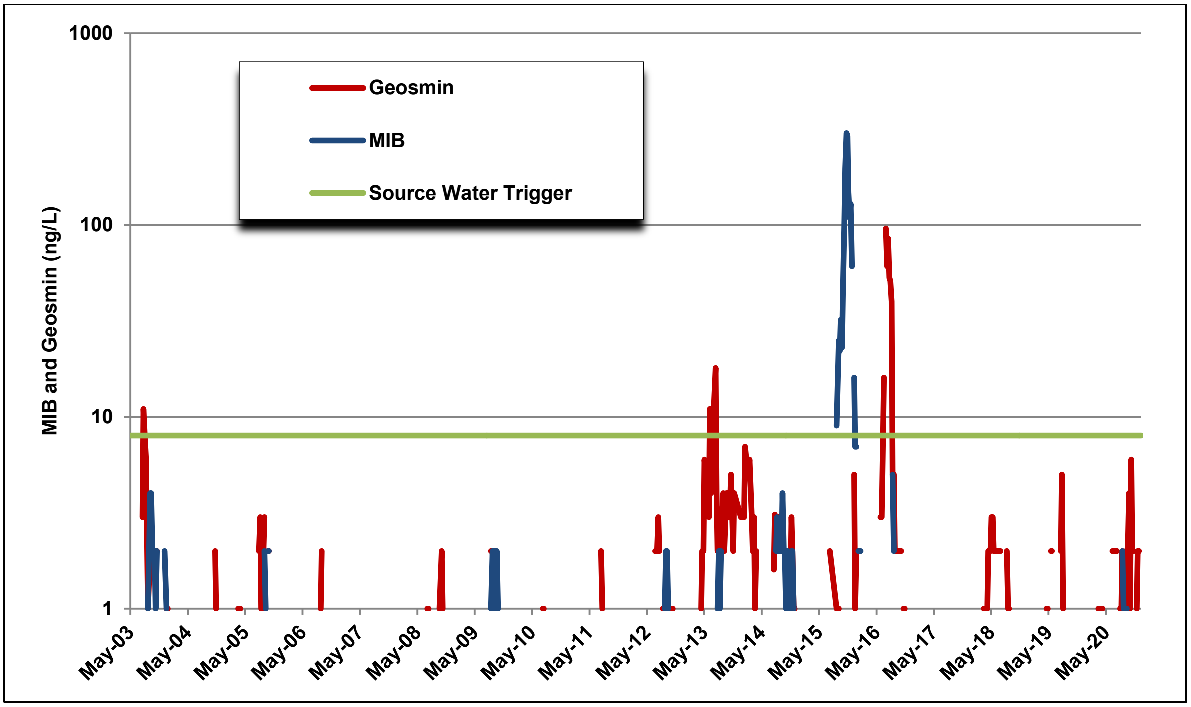
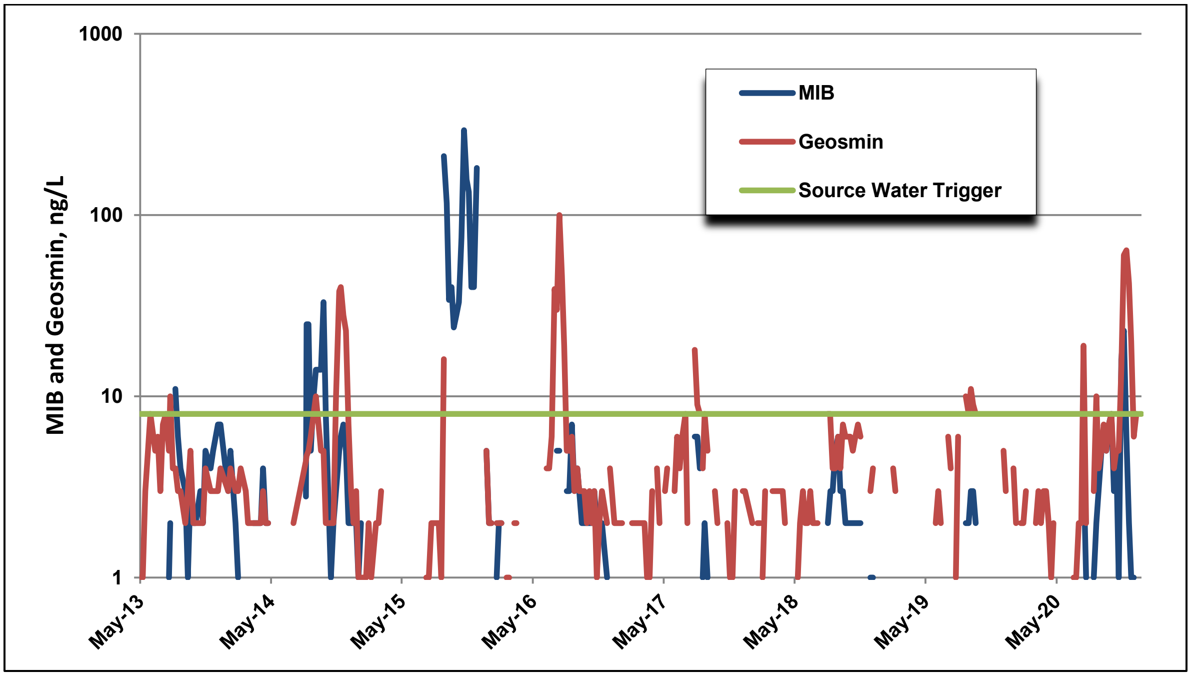


Figure 7-8. MIB and Geosmin at Gianelli Water Quality Station

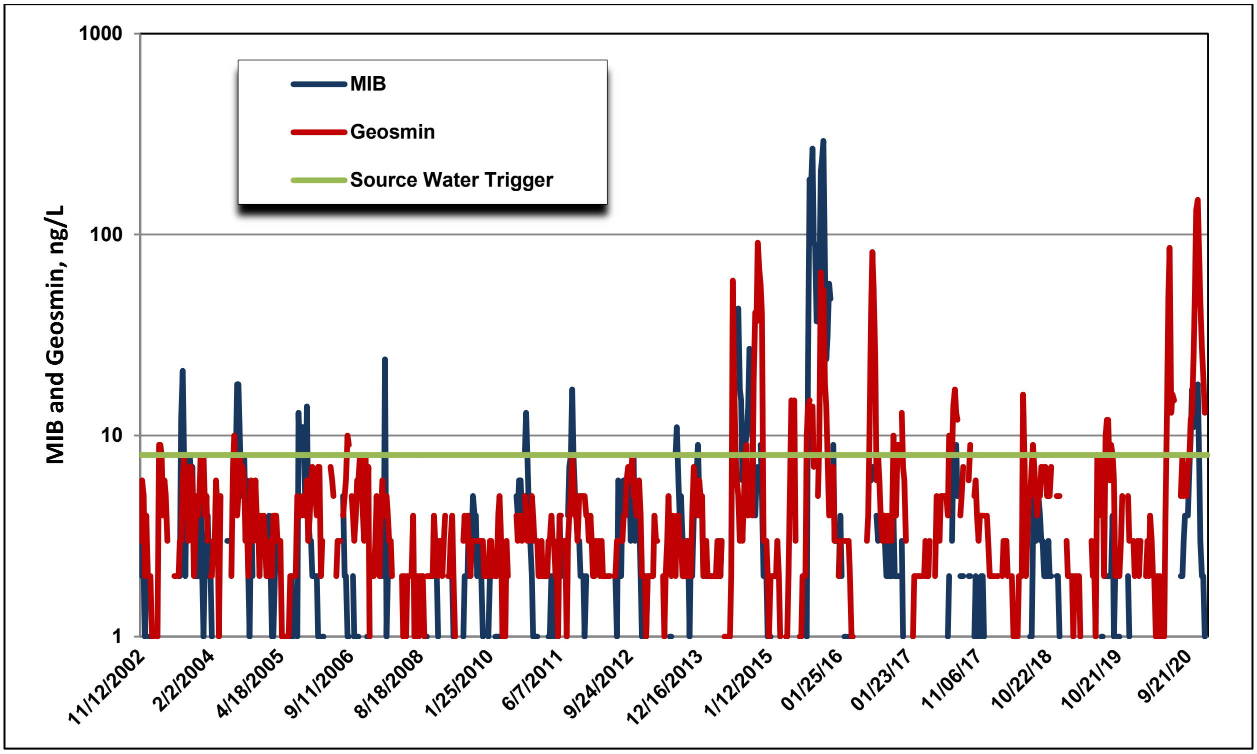


California Aqueduct Check Structures – Monitoring was initiated at O'Neill Forebay Outlet at the end of 2002. Although MIB has been more problematic historically than geosmin, it appears that over the reporting period, geosmin is of more concern in recent years as shown in **Figure 7-**

9. The only time period when MIB concentrations were above 8 ng/L was in October and November 2020 for about 6 weeks, peaking at 18 ng/L. In comparison, geosmin concentrations were above 8 ng/L in every summer period, lasting about 3 to 4 weeks. The longest duration of elevated geosmin concentrations was eleven weeks, from October to December 2020. This was also when the peak geosmin concentration of 149 ng/L occurred on November 9, 2020. Although there was an endothall treatment in Clifton Court (to eradicate aquatic vegetation) on November 3, which might have affected Aqueduct water moving downstream, geosmin levels were already increasing at Check 13 on October 19, 2020 at 25 ng/L and 51 ng/L on October 26, 2020, indicating that the source was a bloom occurring in O'Neil Forebay. (Geosmin levels at Banks were 3 ng/L on November 2, 2020 and 7 ng/L on November 9, 2020.). Central Coast Water Authority were greatly impacted by this T&O event, as high levels reached their WTP at the same time the WTP was coming back on-line after a maintenance period. Although CCWA normally addresses T&O events by adding PAC to their treatment process, this was not possible at start-up due to idle water which also had high levels of free ammonia. Therefore, CCWA customers had two days of high geosmin water.

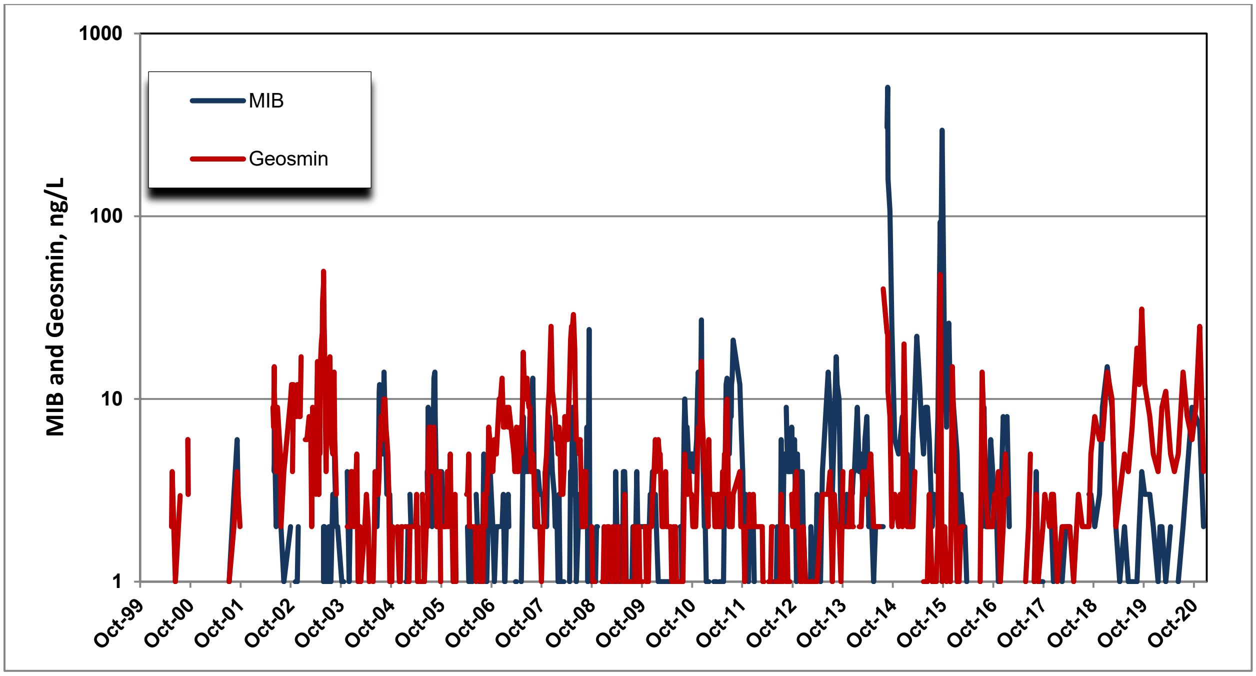
Another peak of geosmin at 82 ng/L occurred on July 11, 2016, while geosmin at Banks was 28 ng/L on June 27, 2016, indicating that upstream sources may have been the cause. However, water quality at Check 13 may also be affected by water from the Delta Mendota Canal, or releases from San Luis Reservoir (as Gianelli also had a peak geosmin level of 100 ng/L on July 18, 2016).

Figure 7-9. MIB and Geosmin at O'Neill Forebay Outlet



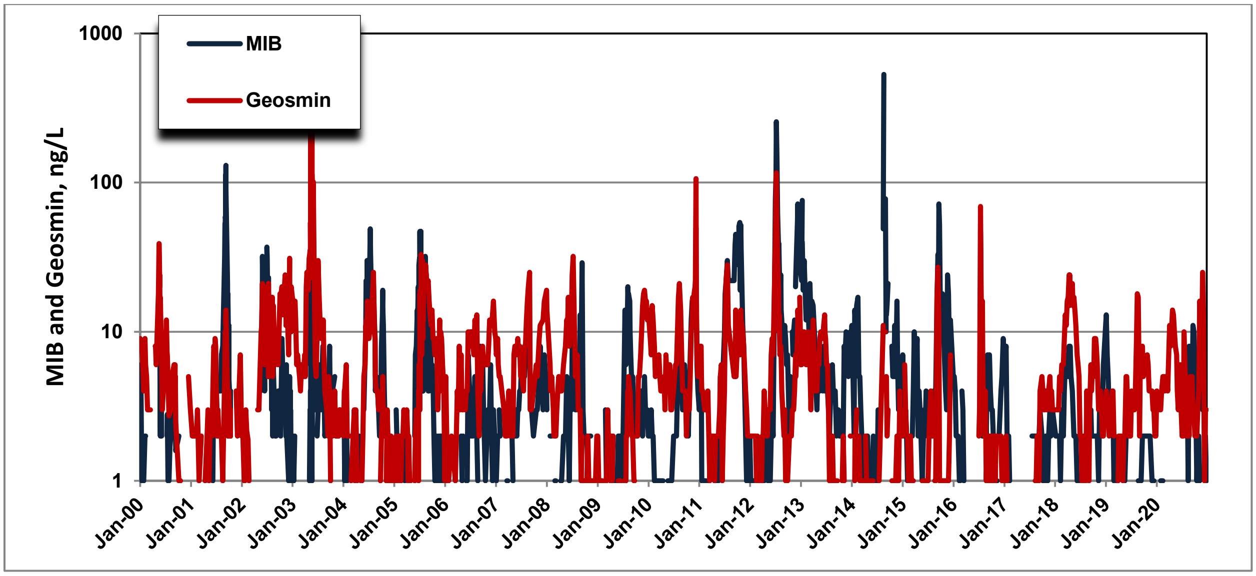
As shown in **Figure 7-10**, geosmin concentrations at Check 41 did not show similar patterns to Check 13, as elevated concentrations above 10 ng/L did not occur in every summer period. The longest duration of elevated geosmin concentrations was six weeks in August to October 2019, with a peak concentration of 31 ng/L in September 2019. In previous watershed sanitary surveys, higher and more frequent peaks of geosmin have been detected at Check 41 compared to Check 13. These data indicate that MIB and geosmin generated in the Delta or in Clifton Court Forebay can persist downstream at levels of concern and that benthic algae growing in the aqueduct can also be an additional source of T&O compounds. Over the reporting period, MIB concentrations were low, with one only detection above 10 ng/L.

Figure 7-10. MIB and Geosmin at Check 41



Similar to Check 13 and Check 41, MIB concentrations at Check 66 as shown in **Figure 7-11** were less problematic than geosmin, over the reporting period. This represents a change as MIB has historically been more problematic than geosmin. Peak concentration of MIB over the reporting period was 47 ng/L on July 18, 2016, with only two additional detections above 10 ng/L. Peak concentration for geosmin at Check 66 was 69 ng/L on July 18, 2016. As Check 41 had a geosmin concentration of 14 ng/L on July 12, 2016 this would indicate sources of geosmin traveling downstream. However, there were many more geosmin detections greater than 10 ng/L at Check 66 compared to Check 41 over the reporting period, indicating benthic algae growing in the East Branch.

Figure 7-11. MIB and Geosmin at Check 66



Castaic Lake – MIB and geosmin are measured at the Jensen plant influent and near the outlet tower. The data used in this analysis are collected near the outlet tower. The MIB and geosmin data are displayed differently than at the other locations due to the large difference between MIB and geosmin concentrations. **Figure 7-12** shows that MIB levels at and near the surface typically range from not detected to 2 ng/L with a few peaks. Data were collected from the surface from 1998 to the spring of 2005 and from a depth of one meter after that. The two data sets are combined.

The main T&O problem in Castaic Lake is geosmin. Castaic Lake has annual geosmin spikes that occur in summer and often last for several weeks, as shown in **Figure 7-13**. In August 2018, geosmin was measured as high as 1,120 ng/L.

Figure 7-12. MIB in Castaic Lake at the Surface (1998 to 2005) and 1m (2005 to current)

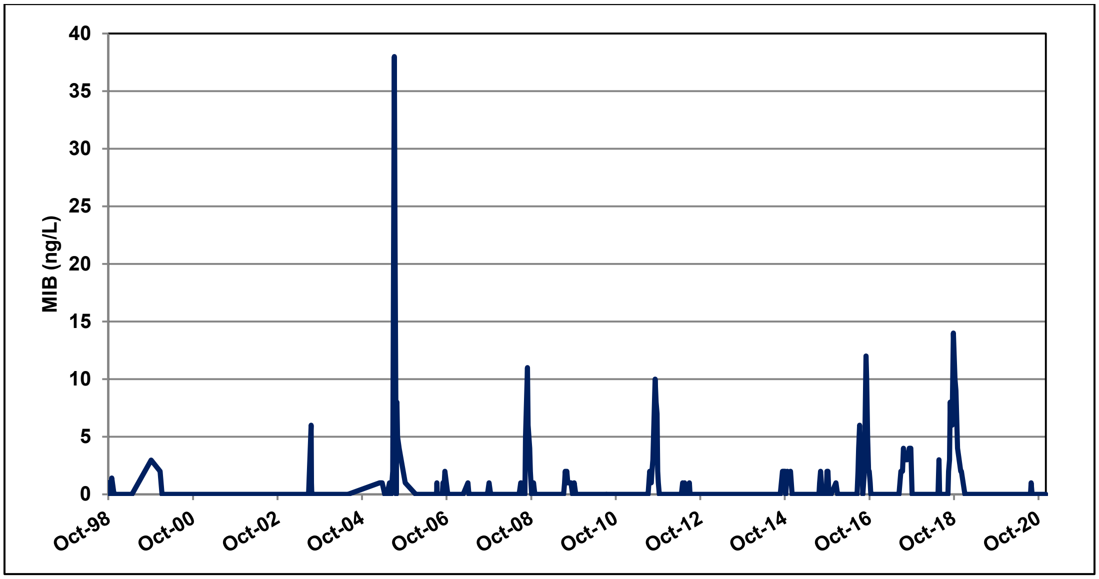
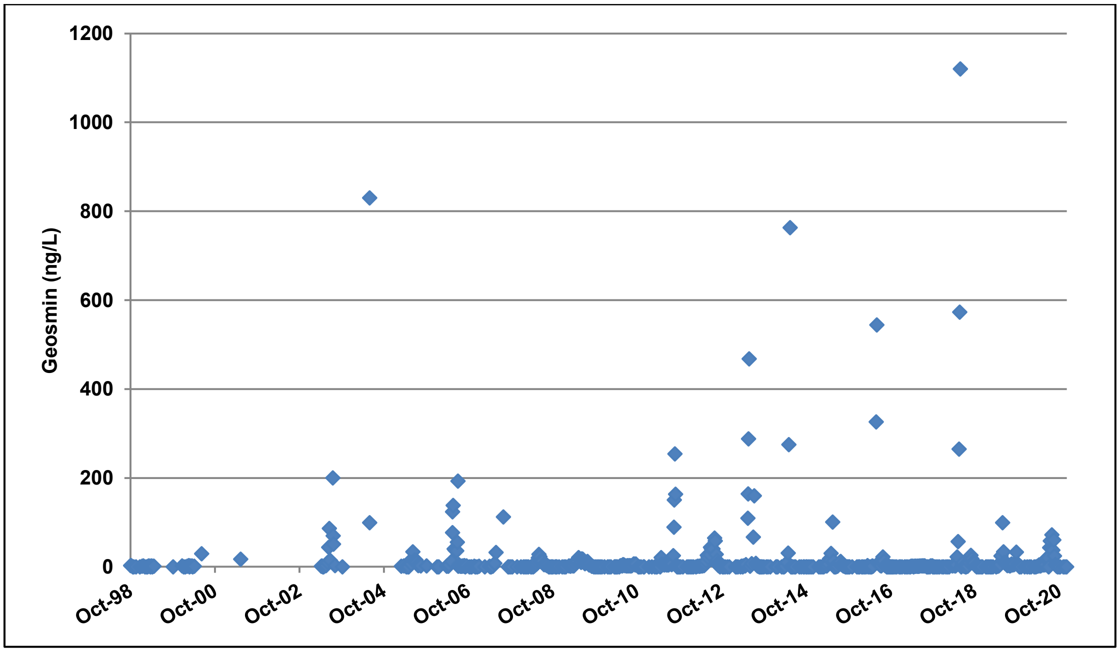
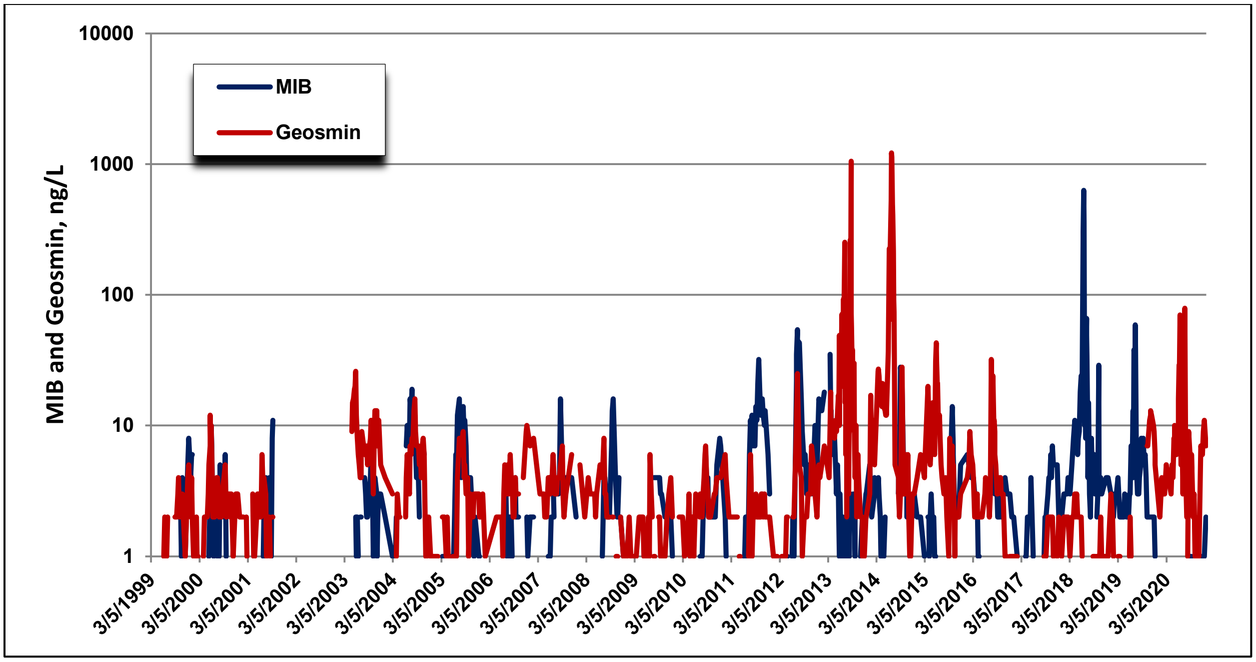


Figure 7-13. Geosmin in Castaic Lake at the Surface (1998 to 2005) and 1m (2005 to current)



Silverwood Lake – **Figure 7-14** depicts the results of monitoring at Silverwood Outlet. Over the reporting period, MIB reached a peak concentration of 631 ng/L in June 2018. It appears that the source of this peak was the lake, as MIB concentrations were low in summer 2018 at Check 66. Over the reporting period, the most detections of geosmin above 10 ng/L occurred in 2020. However, the peak geosmin concentration of 79 ng/L occurred in July 2016. Sources of geosmin may be benthic growth along the East Branch or within the lake itself. Peaks of geosmin were much lower in this reporting period compared to levels seen in 2013 and 2014.

Figure 7-14. MIB and Geosmin at Silverwood Outlet



SUMMARY

- With the exception of the southern reservoirs, MIB was detected less frequently over the threshold value of 8 ng/L than geosmin. This represents a change as MIB has historically been more problematic than geosmin.
- Although T&O compounds may be traced to an upstream source, subsequent growth in Clifton Court forebay, along the Aqueduct, and in reservoirs may also occur, so the source may not be always clear.
- Over the past ten years, a large majority of sites along the SWP had their peak MIB or peak geosmin concentration occur during the extended drought from 2012 to 2016.
- Recently, Banks experienced its highest geosmin concentration in the past ten years in July 2020, Check 13 experienced its highest geosmin concentration in the past ten years in November 2020, and Lake Del Valle (Conservation Outlet) had its highest MIB concentration in the past ten years in November 2020.
- Treatment of aquatic vegetation using endothall within Clifton Court forebay may also play a role in elevating geosmin at Banks, particularly if T&O compounds are already present at Clifton Court Inlet.
- Similarly, treatment of aquatic vegetation using endothall within O'Neill forebay may also play a role in elevating geosmin at Check 13. However, Check 13 is also impacted by water quality from the Delta Mendota Canal and if releases from San Luis Reservoir are occurring.

RECOMMENDATION

- Timely algal counts and algal speciation along the SWP was previously conducted by DWR. It is recommended to re-establish this timely water quality support for the contractors especially during elevated T&O events.

ALGAL TOXINS

WATER QUALITY CONCERN

Cyanobacteria are photosynthetic bacteria that share some properties with algae and are found naturally in lakes, streams, ponds and other surface waters. Similar to algae, when conditions are favorable, cyanobacteria can rapidly multiply in surface water and cause blooms. It may take only three to ten days for the population of cyanobacteria to double.

Freshwater cyanobacteria, or “blue-green algae” can produce cyanotoxins. It is important to note that experiencing a cyanobacteria bloom does not always result in a cyanotoxin problem in the water source. This is because multiple species of cyanobacteria can exist in a single bloom, and not all species are capable of producing cyanotoxins. Furthermore, even when toxin-producing cyanobacteria are present, they may not produce toxins. Toxin-producing bacteria contain genes that confer the ability to produce toxins and are referred to as toxigenic cells. For example, cyanobacteria that can produce microcystins contain a collection of genes, called “mcy” genes, that when expressed produce microcystins. Multiple species of cyanobacteria can contain this set of genes.

The conditions that cause cyanobacteria to produce cyanotoxins are not well understood. Conditions contributing to blooms include light intensity, total sunlight duration, nutrient availability (especially phosphorus), water clarity, water temperature, pH, precipitation events, water flow (whether water is calm or fast-flowing), and water column stability. Warm, slow moving waters that are rich in nutrients lead to algal growth. There are a number of ongoing studies which are also examining other factors such as forest fire ash, sediment, zebra mussels, and frequency of high single-day precipitation events.

According to the USEPA, *Microcystis* is the most common bloom-forming cyanobacteria genus, and is almost always toxic. The most studied and common variant (cyanotoxin) is microcystin-LR. Microcystins are water soluble and tend to remain contained within the toxigenic cell until the cell breaks and released into the water. Microcystins typically have a half-life of four to 14 days in surface waters or may persist longer, depending on factors such as photodegradation, bacteria, and the presence of organic matter (USEPA, May 2019). Microcystins can persist even after a toxigenic cyanobacterial bloom is no longer visible. Other commonly occurring genera of cyanobacteria that can contribute cyanotoxins are *Anabaena*, *Planktothrix* (*Oscillatoria*) and *Cylindrospermopsin*.

Researchers are documenting which genus or species of cyanobacteria produce toxins. **Table 7-3** lists commonly found cyanobacteria groups and the toxins they produce. This list was compiled by the State Water Resources Control Board’s Surface Water Ambient Monitoring Program. Please note that the chart was developed based on published research which continues to change, and the chart should not be used to determine risk from cyanobacteria.

Table 7-3. Cyanobacteria and Known Toxins Chart

SWAMP - HAB Field SOP - Cyanobacteria & Known Toxins Chart. Version 1.0 2/08/2017 Page 2 of 4

Cyanobacteria and Known Toxins Chart

Cyanobacteria Genus	Cyanotoxin Class										References
	CYL	MC	NOD	ATX	SAX	NEO	LYN	BMAA	DAT	APL	
Anabaenopsis		✓									Lanaras and Cook, 1994; Graham et al., 2010
Aphanizomenon	✓	✓	✓	✓	✓	✓		✓			Graham et al., 2010; Jacoby and Kann, 2007; Pilotto et al., 1997; Vezie et al., 1998; Graham et al., 2008
Aphanocapsa		✓									Graham et al., 2010
Calothrix		✓						✓			Mohamed et al., 2006; Paerl and Otten, 2013
Coelomoron		✓									Dos S Vieira et al., 2005
Coelosphaerium		✓									Graham et al., 2010; Jacoby and Kann, 2007
Cylindrospermopsis	✓	✓		✓	✓			✓			Graham et al., 2010; Griffiths and Saker, 2002; Woods and Sterling, 2003; Graham et al., 2008; Paerl and Otten, 2013
Cylindrospermum		✓		✓	✓						Borges et al., 2015; Pandey and Tiwari, 2010; Sivonen et al., 1989
Dolichospermum (Anabaena)	✓	✓		✓	✓	✓		✓			Bruno et al., 1994; Graham et al., 2010; Harada et al., 1991; Jacoby and Kann, 2007; Mohamed et al., 2006; Pilotto et al., 1997; Sivonen et al., 1989; Spoof et al., 2006; Vezie et al., 1998 ;Graham et al., 2008
Fischerella		✓									Otten and Paerl, 2015
Geitlerinema		✓			✓						Aboal et al., 2005; Borges et al., 2015; Myers et al., 2007
Gloeotrichia		✓									Carey et al., 2007; Graham et al., 2010; Jacoby and Kann, 2007
Hapalosiphon		✓									Prinsep et al., 1992
Limnothrix		✓									Graham et al., 2010
Lyngbya	✓			✓	✓	✓	✓	✓	✓	✓	Berry et al., 2004; Dos S Vieira et al., 2005; Foss et al., 2012; Harr et al., 2008; Onodera et al., 1997; Stewart and Falconer, 2008; Paerl and Otten, 2013
Microcystis		✓						✓			Botes et al., 1982; Graham et al., 2010; Jacoby and Kann, 2007; Miller et al., 2010; Oberholster et al., 2006; Pilotto et al., 1997; Ueno et al., 1996; Vezie et al., 1998; Graham et al., 2008
Nodularia		✓	✓					✓			Carmichael et al, 1988; McGregor et al., 2012; Pilotto et al., 1997; Graham et al., 2008
Nostoc		✓						✓			Mohamed et al., 2006; Sivonen and Carmichael, 1990; Sivonen et al., 1992 ;Paerl and Otten, 2013
Oscillatoria (Planktothrix)	✓	✓		✓	✓		✓	✓		✓	Brittain et al., 2000; Carmichael and Li, 2006; Graham et al., 2010; Jacoby and Kann, 2007; Luukkainen et al.,1993; Mazmouz et al., 2010; Mez et al., 1997; Sivonen et al., 1989; Graham et al., 2008
Phormidium	✓	✓		✓	✓			✓			Borges et al., 2015; Gugger et al., 2005; Harland et al., 2013; Izaguirre et al., 2007; Mez et al., 1997; Mohamed et al., 2006; Skulberg et al., 1992; Smith, 2012
Planktolyngbya					✓		✓				Graham et al., 2010
Prochlorococcus								✓			Paerl and Otten, 2013
Pseudanabaena		✓		✓							Graham et al., 2010
Raphidiopsis	✓			✓	✓						Graham et al., 2008; Otten and Paerl, 2015
Rivularia		✓									Aboal et al., 2005
Schizothrix				✓						✓	Sivonen and Jones, 1999; Paerl and Otten, 2013
Scytonema					✓			✓			Smith et al., 2011; Otten and Paerl, 2013
Synechococcus		✓						✓			Carmichael and Li, 2006; Graham et al., 2008
Synechocystis		✓						✓			Graham et al., 2008
Trichodesmium								✓			Paerl and Otten, 2013
Tychonema				✓							Shams et al., 2015
Umezakia	✓										Paerl and Otten, 2013
Woronichinia		✓		✓							Oberholster et al., 2006; Paerl and Otten, 2013

CYL = cylindrospermopsin **MC** = microcystin **NOD** = nodularin **ATX** = anatoxin-a and homoanatoxin **SAX** = saxitoxin and decarbamoylsaxitoxin **NEO** = neosaxitoxins **BMAA** = β-N-methylamino-L-alanine **LYN** = lyngbyatoxin-a **DAT** = debromoaplysiatoxin **APL** = aplysiatoxin

Source:https://www.mywaterquality.ca.gov/habs/resources/field.html#cyanobacteria

HEALTH ADVISORIES

In June 2015 the USEPA established a 10-day health advisory (HA) level for microcystin at 0.3 µg/L for children younger than school age and 1.6 µg/L for all other age groups. A 10-day HA for cylindrospermopsin was also established at 0.7 µg/L for children younger than school age and 3.0 µg/L for all other age groups.

The 10-day HA for microcystins is based upon liver toxicity (increase in weight of liver and increase in the amount of liver enzymes in blood) and the 10-day HA for cylindrospermopsin is based upon kidney damage (increased weight of kidneys and a decrease in urinary protein). USEPA defines the 10 day HAs as the "concentration in drinking water at or below which no adverse non-carcinogenic effects are expected for a ten-day exposure." Health advisories are non-regulatory values that serve as informal technical guidance to assist federal, state and local officials, and managers of public or community water systems to protect public health from contaminants.

NOTIFICATION LEVELS

In May 2021, the Office of Environmental Health Hazard Assessment (OEHHA) submitted to the State Water Resources Control Board Drinking Water Notification Levels (NLs) for microcystins at 0.03 µg/L, cylindrospermopsin at 0.3 µg/L, anatoxin-a at 4 µg/L and saxitoxin at 0.6 µg/L as shown in **Table 7-4**. OEHHA recommends that the NLs for microcystins, saxitoxins, and cylindrospermopsin are interim NLs, as OEHHA will complete review of additional recent toxicity studies and derive final recommendations.

Table 7-4. Recommended Notification Levels for Cyanotoxins, µg/L

Chemical	**Notification Level Recommendation, µg/L**	**Duration**
Saxitoxins	0.6 (interim)	1 day
Microcystins	0.03 (interim)	Up to 3 months
Cylindrospermopsin	0.3 (interim)	Up to 3 months
Anatoxin-a	4	Up to 1 month

Notification levels are health-based advisory levels for chemicals that lack MCLs. When chemicals are found above their NLs, certain requirements and recommendations apply.

CALIFORNIA RECREATIONAL ACTION LEVELS

Statewide voluntary guidance on cyanobacteria blooms in recreational waters was developed in January 2016 as a collaborative effort within the California Cyanobacteria Harmful Algal Bloom (CCHAB) network. There are three trigger levels, specified by "caution", "warning" and "danger", as shown in **Table 7-5.**

Table 7-5. Cyanobacteria Triggers for Recreational Waters, µg/L

	Caution Trigger Level	Warning Tier 1	Danger Tier 2
Microcystins[1]	0.8	6	20
Anatoxin-a	Detect[2]	20	90
Cylindrospermopsin	1	4	17

[1] Microcystins refers to the sum of all measured microcystin variants
[2] Must use an analytical method that detects <1 µg/L anatoxin-a

Using microcystin as an example, the trigger level of 0.8 µg/L prompts increased monitoring and the placement of a caution sign stating that people should stay away from scum and pets and livestock should be kept away from the water and scum. The trigger level is based on OEHHA's action level of 0.8 µg/L. The Tier 1 level of 6 µg/L would prompt the placement of a warning sign stating that swimming is not recommended and that pets and livestock should be kept away from the water. The Tier 2 level of 20 µg/L would prompt the placement of a sign stating that there is a present danger and the people, pets and livestock should stay out of the water and away from water spray.

These levels only apply to water that may be incidentally ingested during recreational activities such as water skiing or swimming. They are not intended to be applied to untreated or treated water used for drinking, which may be consumed in much larger quantities.

SWP MONITORING

O&M initiated cyanotoxin monitoring in 2006 at Barker Slough, the inlet to Clifton Court, Pacheco and O'Neill Forebay Outlet. The program was expanded to include Banks in 2007, Lake Del Valle in 2008, Gianelli in 2010, and Dyer Reservoir in 2012. By 2013, monitoring also included Silverwood Lake, Pyramid Lake, as well as Castaic Lake and Lake Perris in 2014. This evaluation will focus on total toxins data collected since 2013, as the earlier data used a different method and analyzed for dissolved toxins. **Figure 7-15** shows the SWP Cyanotoxin Monitoring locations.

Figure 7-15. SWP Cyanotoxin Monitoring Locations

Samples are collected monthly in April and May, and then twice-monthly from June to October. However, if toxins are detected, samples are collected weekly. If toxins are detected in October, monitoring will continue until two consecutive samples are non-detect at which time monitoring will stop. Samples are scanned by microscopy for potentially toxic cyanobacteria before analysis for microcystin, cylindrospermopsin, saxitoxin, and anatoxin-A. Samples are ultra-sonicated to lyse cells and release toxins. Sample analysis is conducted by GreenWater Laboratories in Florida. Microcystin and saxitoxin are analyzed using ELISA, while anatoxin-A and cylindrospermopsin are analyzed using LC-MS/MS.

The most frequently detected cyanotoxin in the SWP from 2013 to 2020 has been microcystin. The following are the samples and locations where other toxins have been detected in the SWP:

- Seven detections of saxitoxin; one saxitoxin sample at 0.05 µg/L at O'Neill Forebay Outlet in September 2015, one sample at 0.05 µg/L at Castaic Outlet (1m) in April 2017, one sample at 0.06 µg/L at Lake Del Valle (1m) in July 2018, and four samples at Pyramid Lake (1m) in September/October 2019, ranging from 0.05 to 0.30 µg/L.
- One detection of anatoxin-A sample collected at Barker Slough at 0.05 to 0.1 µg/L in July 2015 and one detection at Pyramid Lake (1m) at 0.08 µg/L in September 2019.
- Numerous low level detections of Cylindrospermopsin in Lake Perris (only)

As the majority of cyanotoxin detections are microcystin, the following discussion will focus on Microcystin. It should be noted that in 2017, recreational sites were added at swim beaches and boat launches and these sites are sampled once a week from Memorial Day to Labor Day. These are analyzed using Abraxis microcystin test strips. These sites are O'Neill Forebay Boat Launch, San Luis Reservoir Basalt Boat Launch, Pyramid Lake Emigrant Landing Swim Beach, Pyramid

Lake Vaquero Swim Beach, Castaic Lagoon Swim Beach, Castaic Lake Boat Launch, Silverwood Lake Cleghorn Swim Beach, Silverwood Lake Sawpit Swim Beach, Lake Perris Moreno Swim Beach and Lake Perris Swim Beach. These recreational sites are not shown on **Figure 7-15**.

The highest microcystin concentrations for each DWR monitoring location (excluding recreational sites) are found in **Table 7-6**. The top "three" locations with the highest peak concentrations were Pyramid Lake, Silverwood Lake, and Pacheco PP. Over the 2016 to 2020 reporting period, the most notable incident was a large algal bloom in the Central Delta in July-August 2020. Additional information about the 2020 bloom is provided in the following section.

Table 7-6. Peak microcystin concentrations, 2013 to 2020

Monitoring Location	Peak Microcystin µg/L	Date
NBA Barker Slough PP	0.73	July 2015
Clifton Court Forebay Inlet	3.87	August 2020
Banks PP	2.71	August 2020
Dyer Reservoir Outlet	4.58	July 2020
Lake Del Valle (1m)	ND	
Pacheco PP	9.95	September 2016
Check 13 (O'Neill Forebay Outlet)	5.37	July 2014
Gianelli	9.8	July 2013
Pyramid Lake PY001 (1m)	81.5	June 2015
Castaic Lake Outlet CA002 (1m)	2.34	July 2019
Silverwood Lake Outlet SI002 (1m)	31	July 2013
Lake Perris Outlet PE002 (1m)	0.78	June 2019

Figures 7-16 through **7-27** show microcystin concentrations at the Barker Slough intake, Clifton Court Forebay Inlet, Banks, Dyer Reservoir Outlet, Lake Del Valle, San Luis Reservoir at Pacheco PP, San Luis Reservoir at Gianelli, O'Neill Forebay Outlet, Pyramid Lake, Castaic Lake, Silverwood Lake and Lake Perris. The orange circles show samples that were collected but not analyzed because there were no toxin producing cyanobacteria in the samples. The blue squares show samples that had toxin producing cyanobacteria in the sample, but not analyzed due to low abundance or previous toxin analyses. The green diamonds show the microcystin concentrations. **Figure 7-28** shows cylindrospermopsin concentrations at Lake Perris.

Some of the contractors have source water triggers for cyanotoxins. For example, Valley Water and ACWD have a source water trigger level of 5 µg/L for microcystin and cylindrospermopsin. Zone 7 has a source water trigger of 0.3 µg/L for microcystin and 0.7 µg/L for cylindrospermopsin.

Figure 7-16. Microcystin Concentrations at Barker Slough Intake

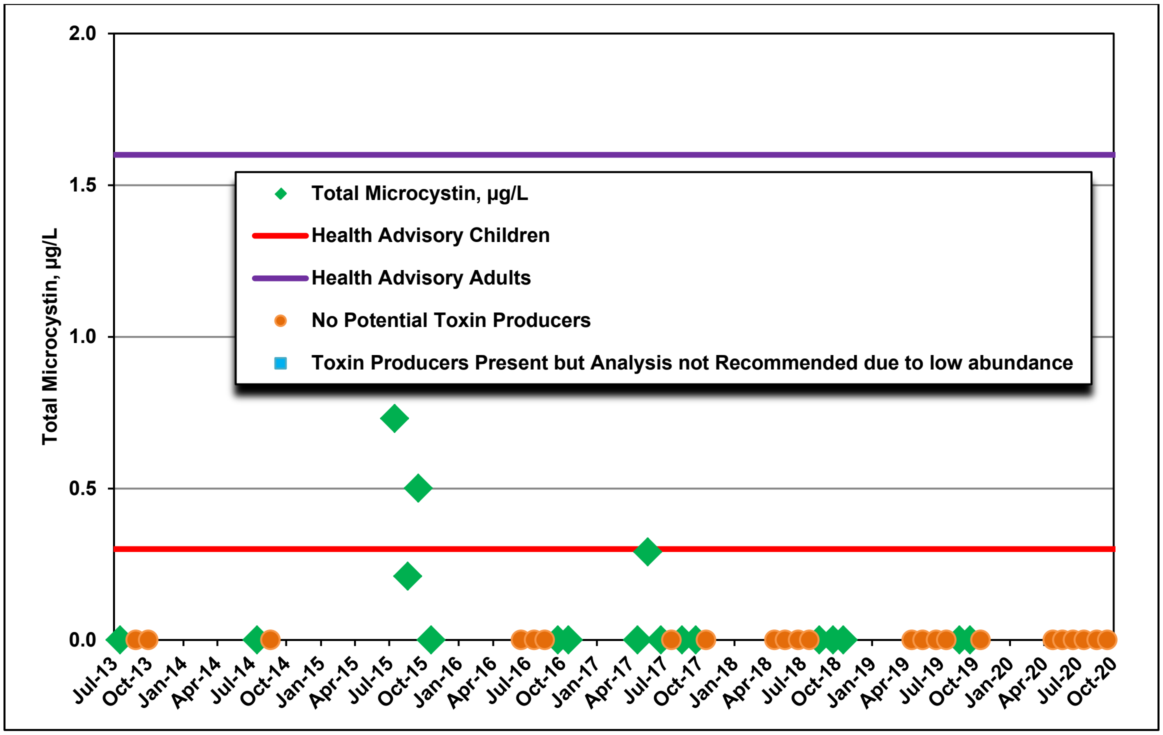


Figure 7-17. Microcystin Concentrations at Clifton Court Forebay Inlet

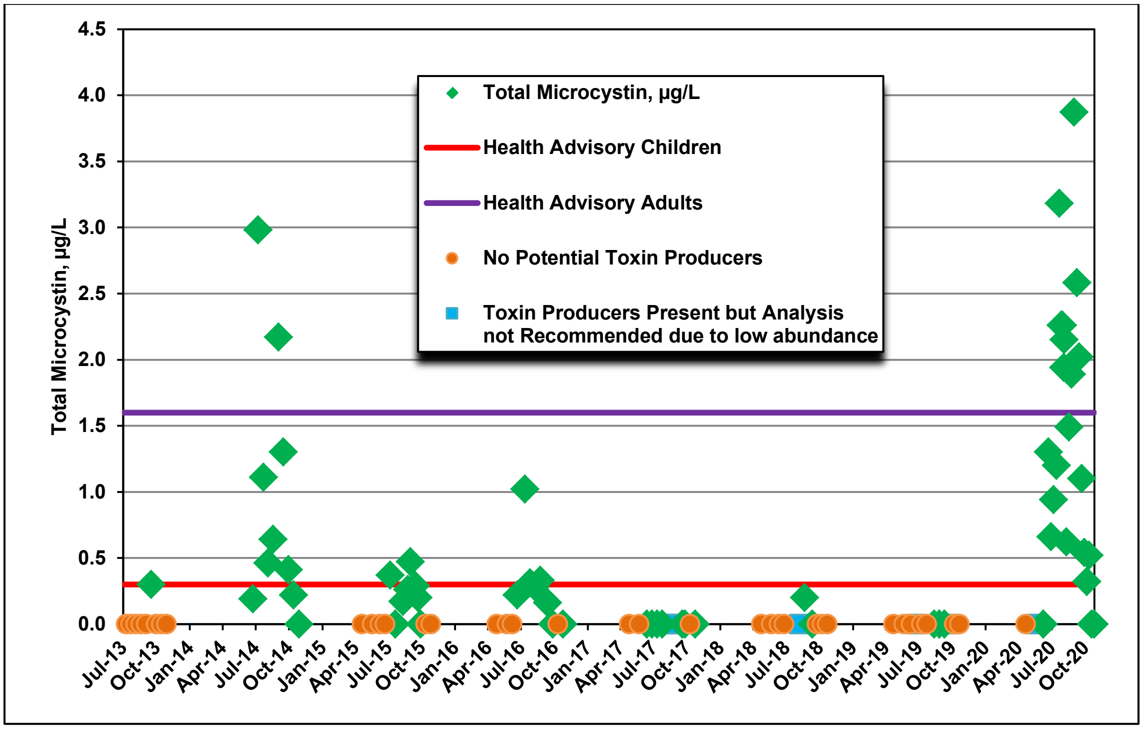


Figure 7-18. Microcystin Concentrations at Banks

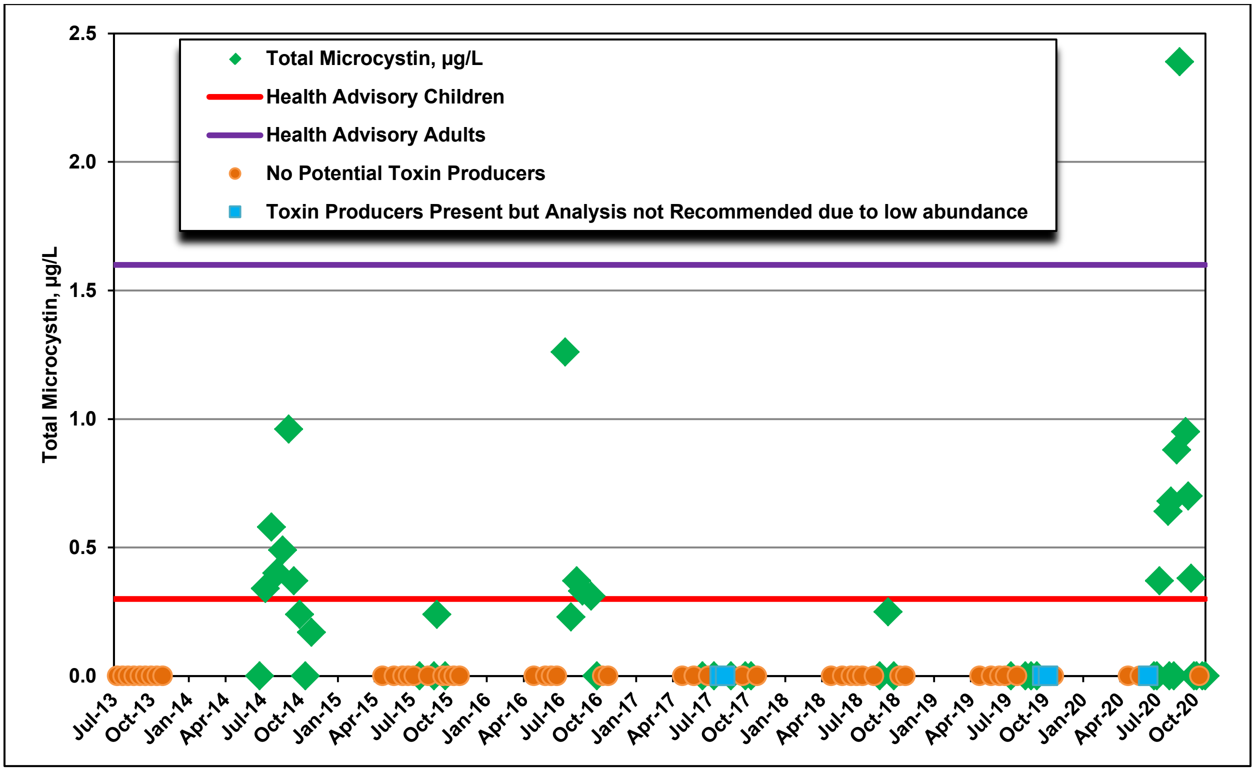


Figure 7-19. Microcystin Concentrations at Dyer Reservoir Outlet

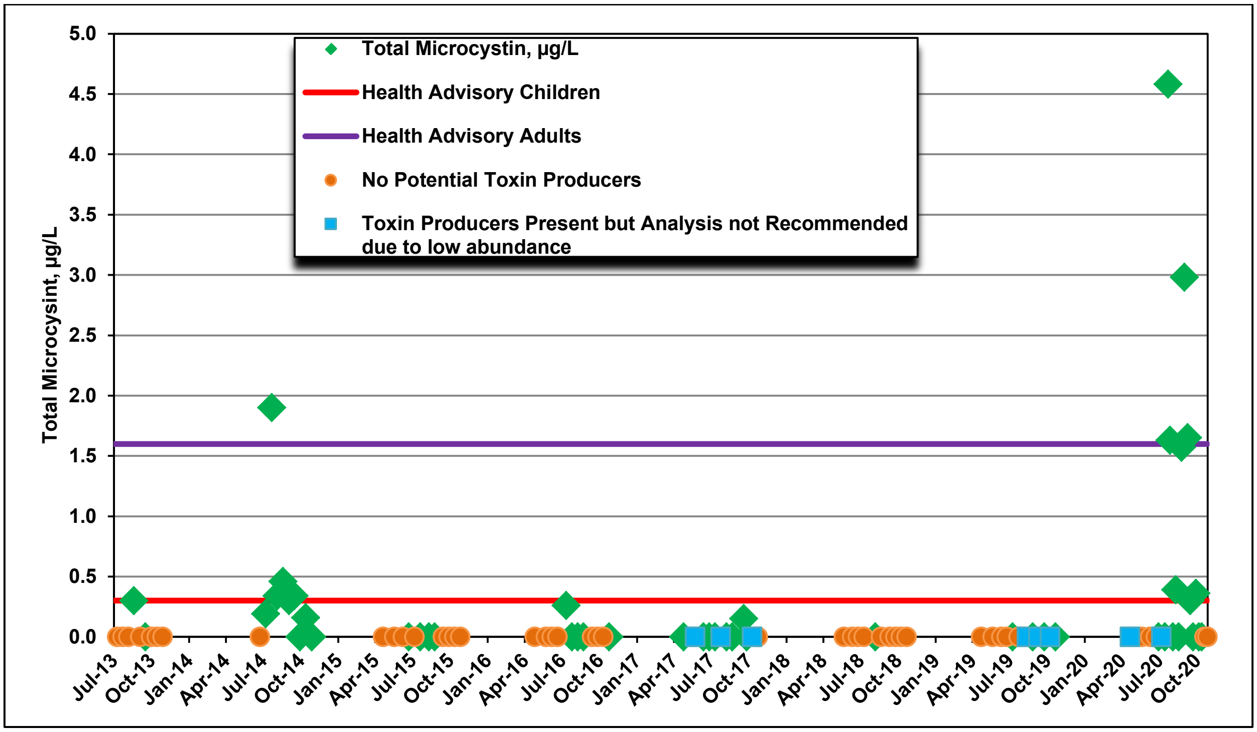


Figure 7-20. Microcystin Concentrations at Lake Del Valle (1m)

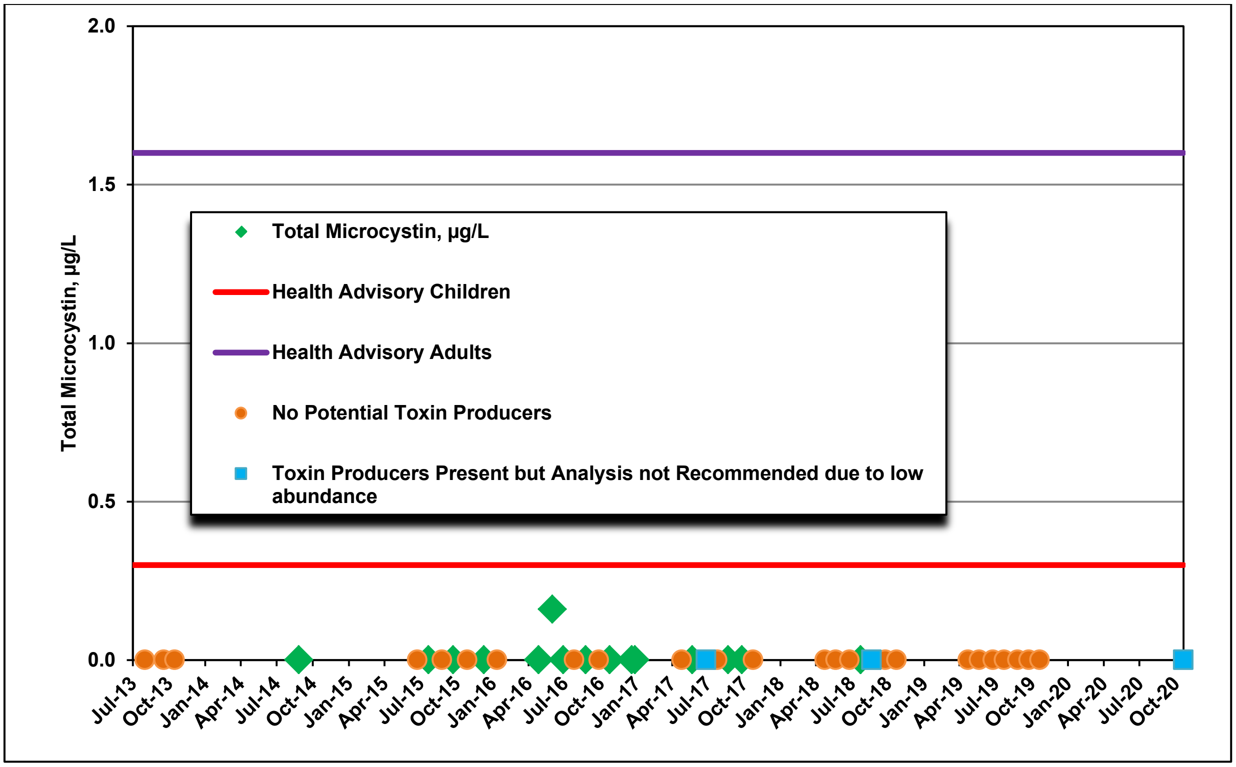


Figure 7-21. Microcystin Concentrations at San Luis Reservoir, Pacheco

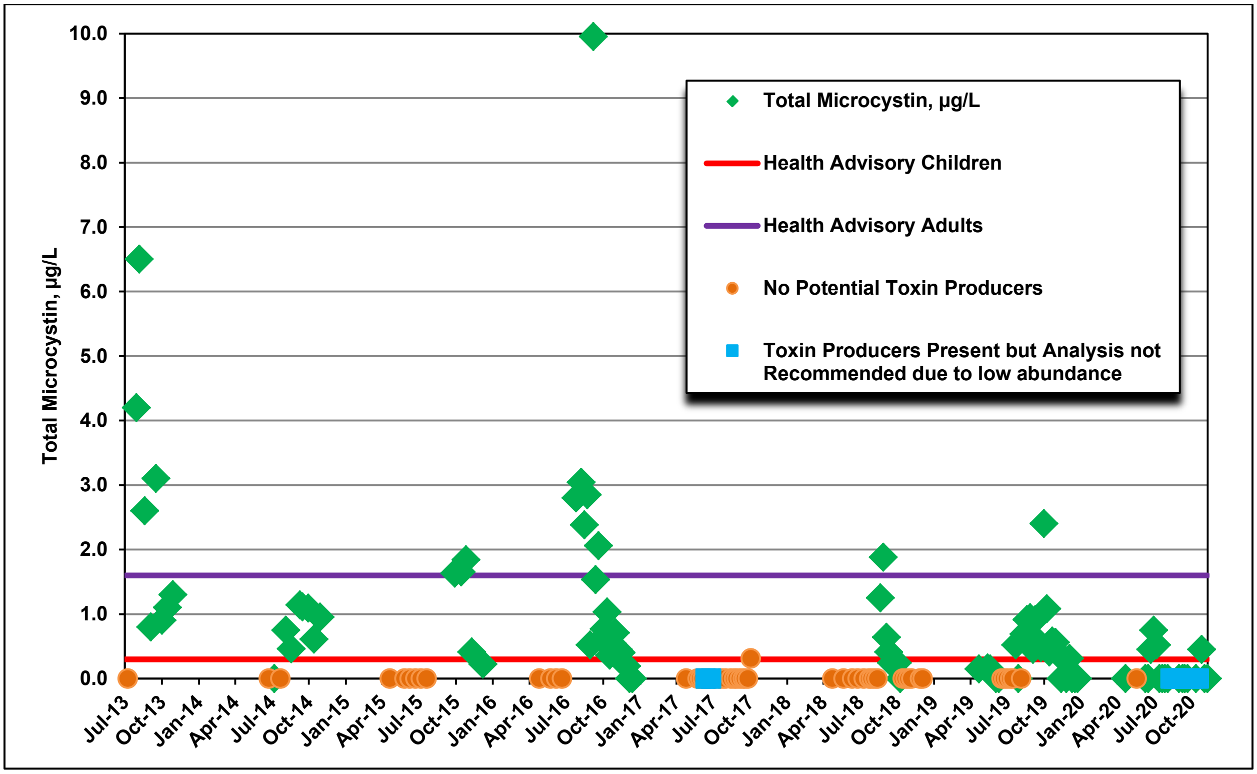


Figure 7-22. Microcystin Concentrations at San Luis Reservoir, Gianelli PP

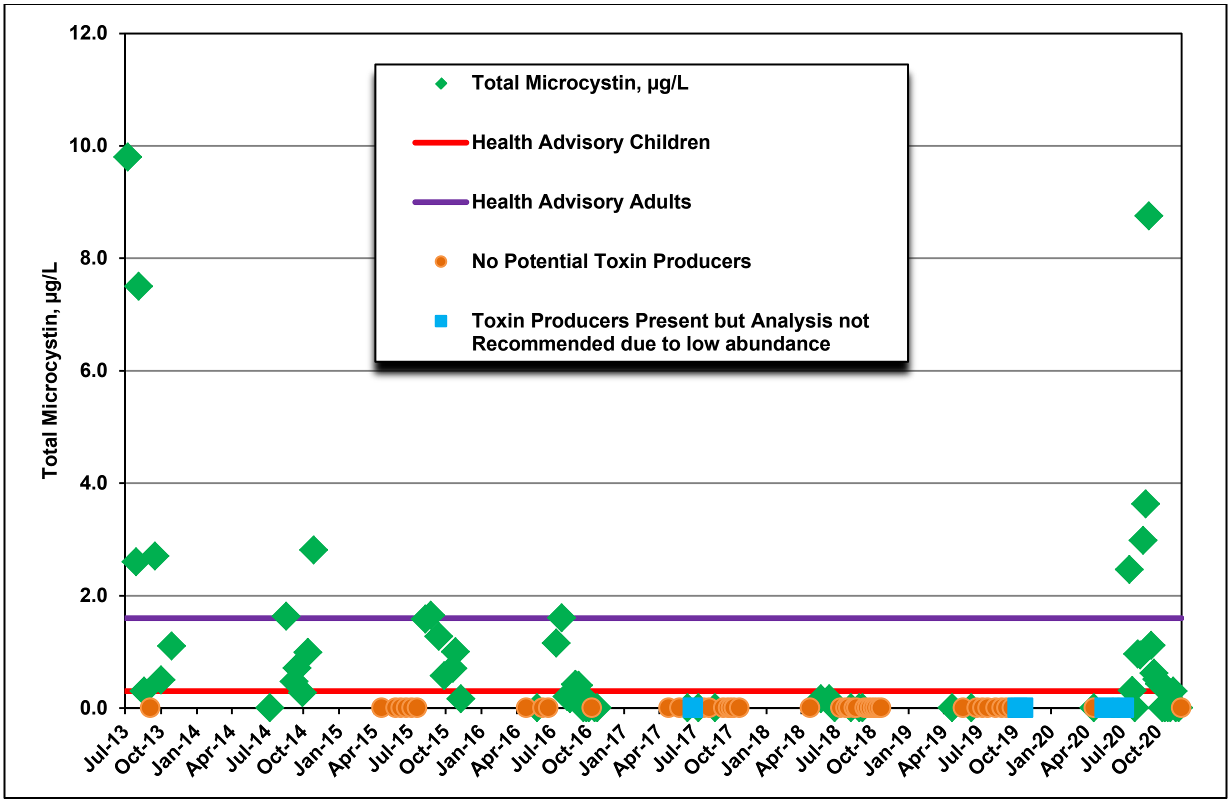


Figure 7-23. Microcystin Concentrations at O'Neill Forebay Outlet (Check 13)

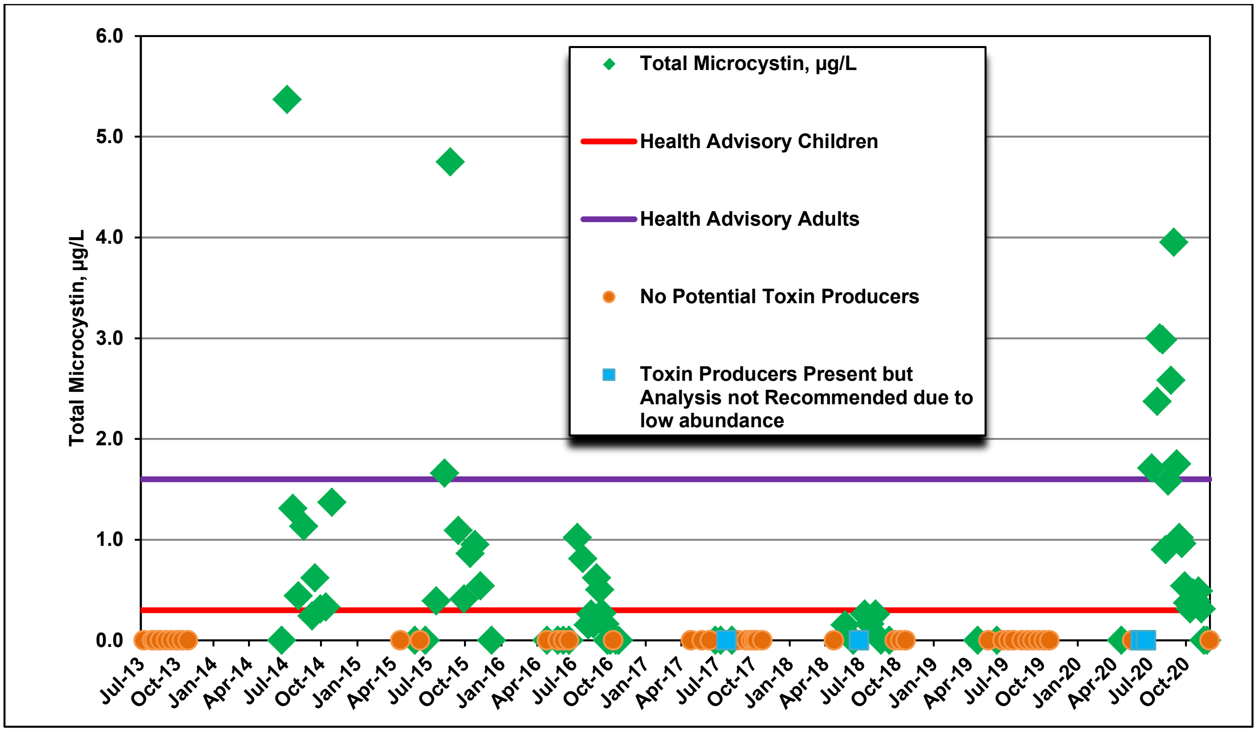


Figure 7-24. Microcystin Concentrations at Pyramid Lake (1m)

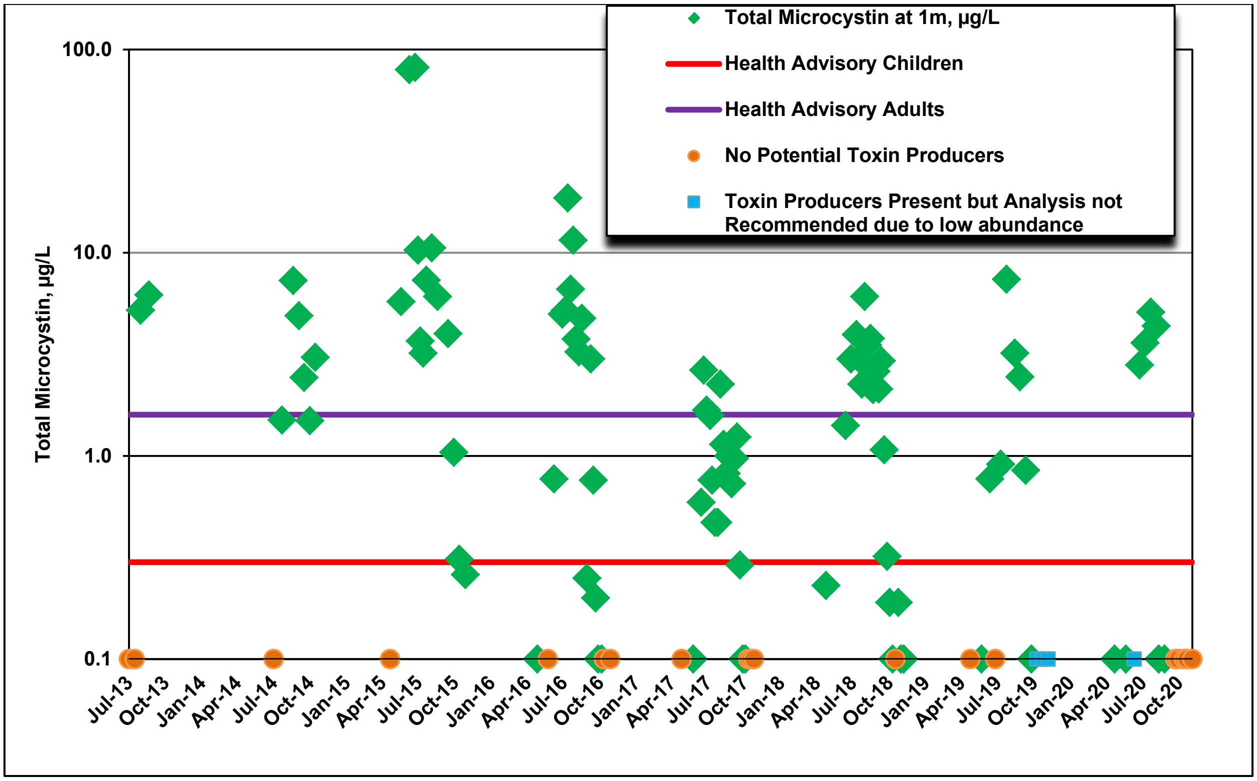


Figure 7-25. Microcystin Concentrations at Castaic Lake Outlet (1m)

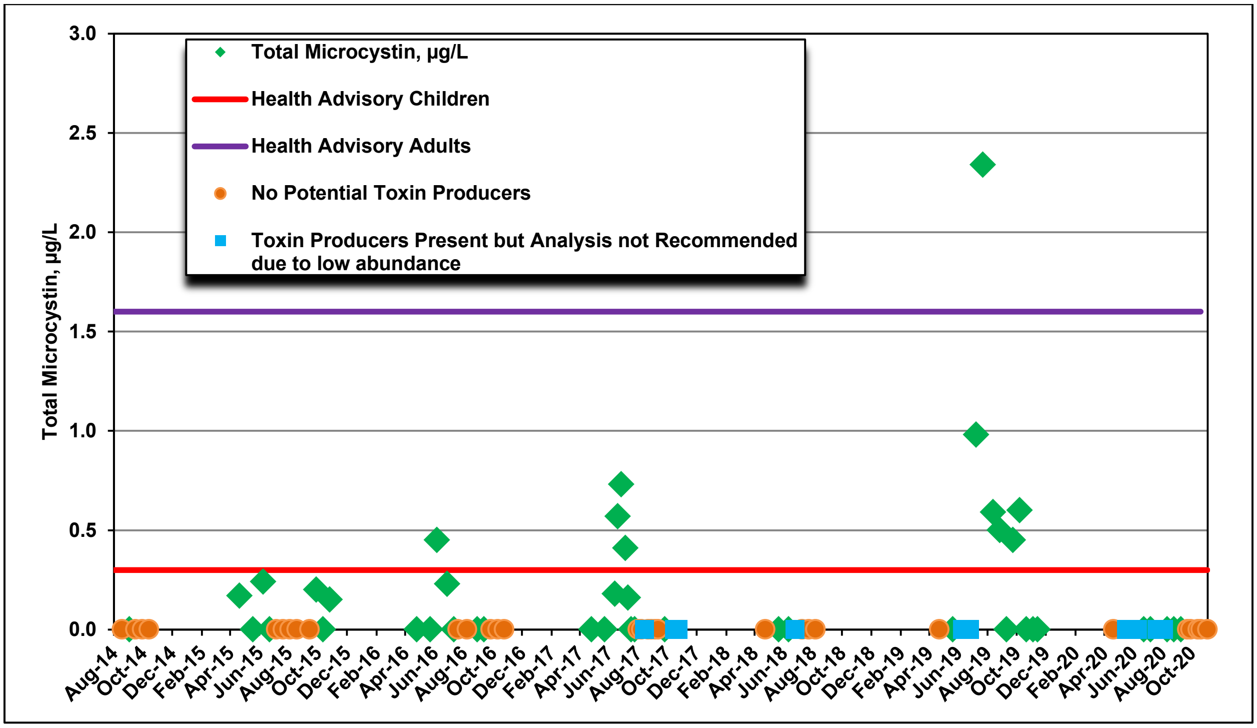


Figure 7-26. Microcystin Concentrations at Silverwood Lake Outlet (1m)

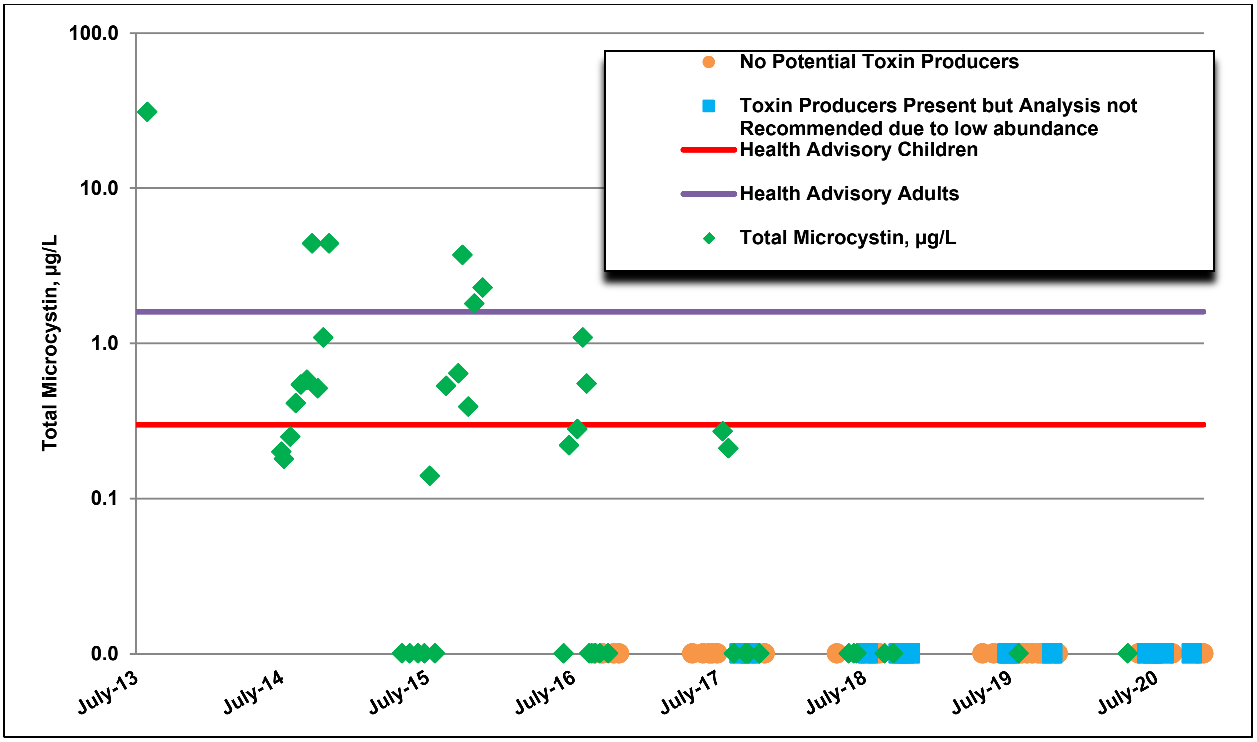


Figure 7-27. Microcystin Concentrations at Lake Perris Outlet (1m)

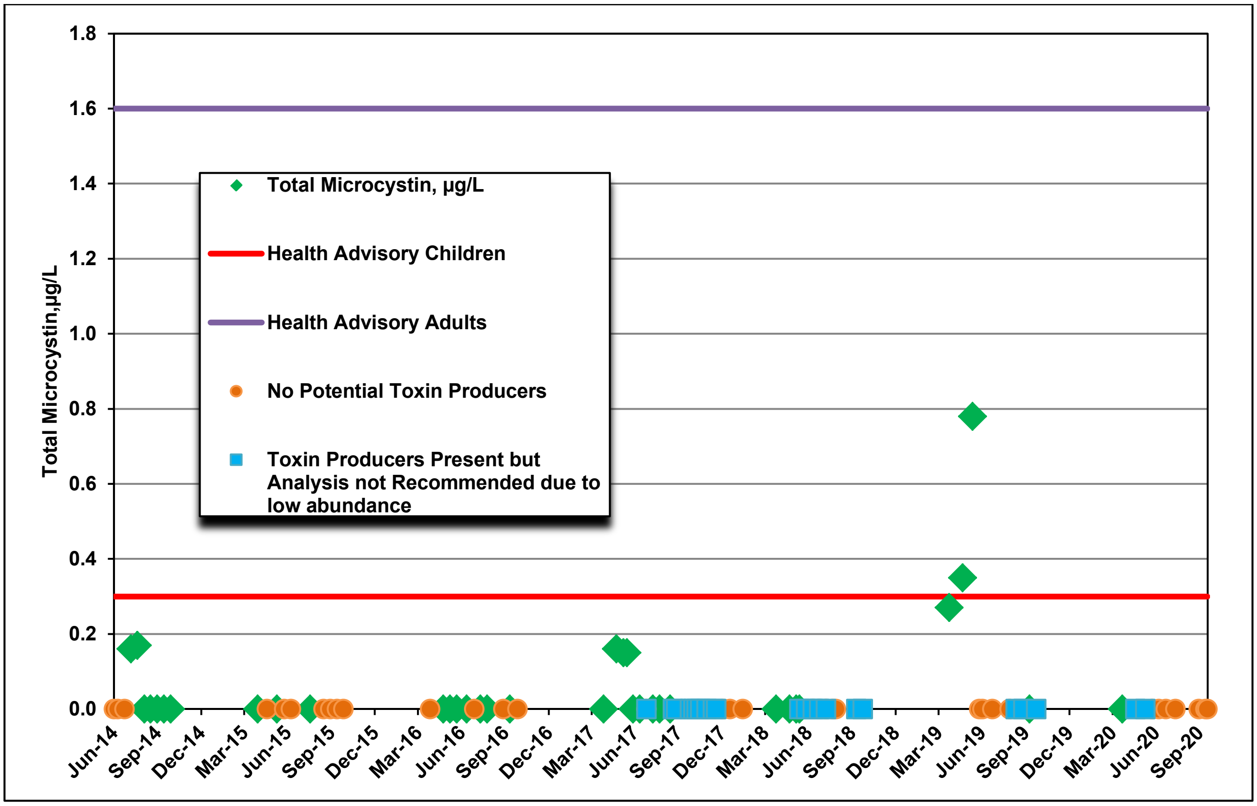
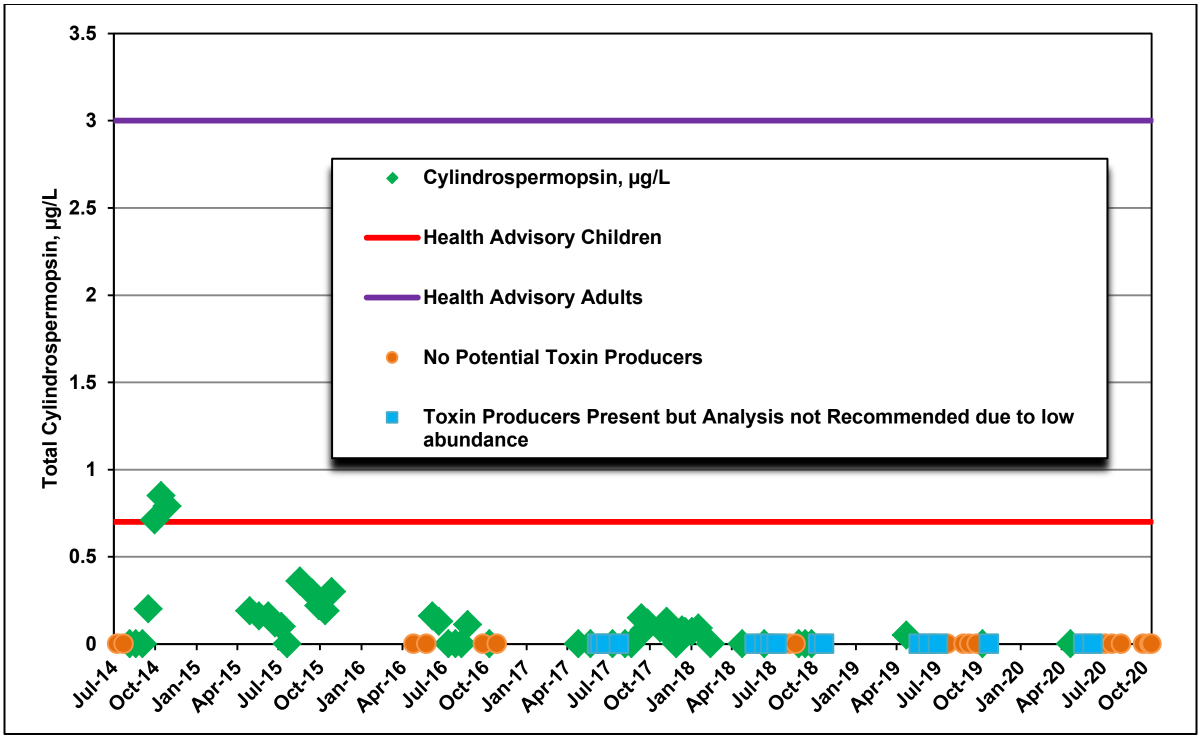


Figure 7-28. Cylindrospermopsin Concentrations at Lake Perris



CITY OF TURLOCK MONITORING

The City of Turlock conducted monitoring of cyanotoxins from April 2017 to October 2020. Background information on this monitoring is provided in **Chapter 13**. Samples were collected at two locations along the Delta Mendota Canal; at DMC-001 at MP 36.81 (upstream of the City of Turlock and City of Modesto's treated wastewater discharge) and at McCabe Rd at MP 68.03, which is upstream of O'Neill Forebay. Monthly samples were collected in April and May and twice monthly samples were collected from June to October.

In July and August 2018, and from June to October 2020, microcystin was detected at DMC-001 and at McCabe. Detectable results are shown in **Table 7-7,** please see **Section 13** for the full data set.

Table 7-7. Microcystin Detections along DMC, 2018 to 2020, µg/L

Date	DMC-001 (MP 36.81)	McCabe Rd. (MP 68.03)
7/10/2018	0.81	1.32
7/24/2018	1.02	1.43
8/14/2018	<0.15	0.16j
8/28/2018	<0.15	0.18j
6/23/2020	1.11	1.89
7/14/2020	2.24	2.15

Date	DMC-001 (MP 36.81)	McCabe Rd. (MP 68.03)
7/28/2020	4.13	3.85
8/11/2020	-	1.03
9/1/2020	3.18	3.88
9/8/2020	4.4	4.15
9/22/2020	0.73	0.95
10/13/2020	0.38	0.52
10/27/2020	0.48	0.34

j = estimated value

OTHER STUDIES

USGS Study of Cyanotoxin Occurrence in Large Rivers of US

The USGS sampled 11 large river sites throughout the United States in June through September of 2017(Graham et al, 2020). One of the river sites was the Sacramento River at Freeport, which is located just upstream of Hood. A total of four samples were collected during the June to September 2017 time period. Anatoxin-a, microcystins, saxitoxin, and cylindrospermopsin analyzed by ELISA (10% by LC/MS/MS) were not detected in any samples. The study also collected cyanotoxin synthetase genes and cyanobacteria. Interestingly, the 2017 data showed that the synthetase genes for saxitoxin (stxA) and cylindrospermopsin (cyrA) were detected in Sacramento River samples, but not the toxin itself. This could be due to differences in sampling approaches used for cyanobacteria and genes, which were composite and near-surface grabs, respectively. Other factors include the presence of nonviable DNA in the environment, or small unknown cyanobacteria that carry the measured genes.

2020 BLOOM IN CENTRAL DELTA

According to USGS, a large accumulation of *Microcystis* was visually present in the mainstem of the San Joaquin River near Prisoner's Point. Unfortunately, there are no cyanotoxin or cyanobacteria samples to quantify levels at this location. Toxin data was collected by USGS at Decker Island and Confluence in August 2020. As of the writing of this report, 2020 cyanotoxin data was not publicly available (Email from Tamara Kraus, USGS, April 2022).

As shown earlier, microcystin levels at Clifton Court Inlet were elevated (above the Health Advisory for adults) from July 22 to September 14, 2020. The highest concentration of Microcystin ever detected at Clifton Court Inlet was 3.87 µg/L on August 31, 2020. Microcystin levels at Check 13 were elevated (above the Health Advisory for adults) from July 6 to September 8, 2020. Microcystin was also detected along the Delta Mendota Canal from June to October 2020, with peak concentrations just above 4 ng/L on September 8, 2020. Based on the visual confirmation of *Microcystis* in the Central Delta by the USGS in July, August, and September, this was likely the source at Clifton Court Inlet, Banks, and Check 13.

FUTURE STUDIES

The Delta RMP Nutrients Subcommittee is funding two projects of interest, briefly described below.

Project Title: Source Tracking of Cyanobacteria Blooms in the Sacramento-San Joaquin Delta
Principal Investigators: Ellen Preece (Robertson-Bryan Inc.) and Tim Otten (Bend Genetics LLC).
This will be a one year project. The primary focus of the study is to determine where *Microcystis* is originating in the Delta. There are three study hypotheses:

1) *Microcystis* blooms in Discovery Bay and the Stockton waterfront are generated from benthic resting cells of *Microcystis* that remain in the sediment throughout the winter.
2) Benthic resting cells in Discovery Bay and the Stockton waterfront can be shown to be the source of harmful algal blooms (HABs) in other areas of the Delta.
3) Areas in the Central Delta where HABs are frequently observed will have relatively low-to-no benthic resting populations due to physical export from the system.

The objective of the study is to use molecular DNA fingerprint techniques to determine the extent to which *Microcystis* blooms in central Delta locations (San Joaquin River, Mildred Island and Franks Tract) share genetic characteristics with *Microcystis* blooms in peripheral locations (Discovery Bay and Stockton waterfront) and with *Microcystis* cells that overwinter in the sediment.

A total of six sites will be sampled for this study. Sediment and water samples will be collected at five sites known to be impacted by HABs: Stockton waterfront, Discovery Bay, San Joaquin River near Windmill Cove, Frank's Tract, and Mildred Island. Two sites (Discovery Bay and Stockton Waterfront) are hypothesized to be where HABs in the Delta originate. Three sites (San Joaquin River near Windmill Cove, Frank's Tract, and Mildred Island) are hypothesized to receive HABs from the source sites. Water samples will also be collected from the San Joaquin River at Vernalis in order to compare strain distribution of *Microcystis* cells entering the Delta from the San Joaquin watershed.

Project Title: Cyanotoxin Monitoring in the Delta: Leveraging existing USGS and DWR field efforts to identify cyanotoxin occurrence, duration, and drivers
Principal Investigators: USGS and DWR

The study will collect cyanotoxin data year round from spring 2021 to spring 2022 at four stations (Vernalis, Rough and Ready, Middle River, Liberty Island). These locations were selected as they already have multiparameter sondes which measure water temperature, specific conductance, turbidity, pH, dissolved oxygen, fluorescence of total chlorophyll, and nitrate. In addition to cyanotoxins, grab samples will also be collected for nitrate, nitrite, ammonium, total dissolved nitrogen, dissolved organic nitrogen, soluble reactive phosphate, chlorophyll-a and phaeophytin, phytoplankton enumeration, and picocyanobacteria. Cyanotoxins will be collected using SPATT (Solid Phase Adsorption Toxin Tracking) samplers and grab samples. In previous studies, SPATT samplers have detected toxins when grab samples did not. Each SPATT will be deployed for approximately two weeks.

Data collected from this study can be used to determine whether cyanotoxins are at concentrations of concern in the Delta and will help managers develop future monitoring programs. It will also help to understand where cyanotoxins are produced and how they are transported in the Delta. Finally, the study hopes to identify linkages between environmental drivers such as nutrients, flow and temperature on HAB formation, initiation, and duration.

Project Title: Developing an Early Warning System for Management of Cyanotoxins/Taste and Odor in Source Water
Principal Investigators: Valley Water District, DWR, and Water Research Australia

The two main objectives of this project is to; 1) Develop a real-time cyanotoxin management trigger by comparing fluorescence-based probe readings to analytical measurements collected through discrete sampling, and 2) Probe data will be compared to discrete samples by conducting statistical analysis. The fluorescence-based probes used in this study are the Turner Designs C3 probe and the YSI EXO2 probe. The Turner C3 measures chlorophyll a, phycocyanin, and red chlorophyll. The YSI EXO measures chlorophyll a, phycocyanin, FDOM and other water quality parameters. Samples are being collected at the Pacheco Pumping Plant and the Banks Pumping Plant.

FINISHED WATER MONITORING

Based on their voluntary monitoring of cyanotoxins in finished water, Zone 7 Water Agency, Valley Water, Central Coast Water Authority, Antelope Valley – East Kern Water Agency, and Crestline-Lake Arrowhead Water Agency confirm that all treated water samples to date have been nondetectable for cyanotoxins.

The SBA contractors (Zone 7 Water Agency, Alameda County Water District, and Santa Clara Valley Water District) conducted a bench-scale study to evaluate the efficiency of five treatment technologies for the destruction or removal of cyanotoxins. Three water samples were collected and used for the study: a raw water sample collected at ACWD's WTP2, a settled water sample from Zone 7's DVWTP, and a settled water sample from Valley Water's Penitencia WTP. Each sample was spiked with 10 µg/L each of microcystin-LR, microcystin-LA, cylindospermopsin, and anatoxin-a. Ozone, chlorine, chloramine or PAC was added to each water at different doses and some under different pH conditions. Cyanotoxin samples were analyzed using LC/MS-MS method and the ELISA method for microcystin-LR.

The following is a synopsis of the study findings, please refer to report prepared by WQTS for additional details.

- Typical ozone doses used at the WTPs, whether raw or settled water are highly effective at destroying all three types of toxins tested in the study.
- Chlorine is highly effective destroying cylindospermopsin and virtually ineffective against anatoxin-a. Chlorine can destroy microcystins to acceptable levels, but requires a longer contact time and can be assisted by a lower pH level.

- Adsorption of the three types of toxins on Hydrodarco PAC was moderate. Effective control of toxins requires coupling of PAC with another treatment technology. It is also possible that other types of PAC may result in higher toxins removal.
- Chloramines are ineffective against the types of toxins tested.

SUMMARY

- DWR began cyanotoxin monitoring at various locations in the SWP since 2006. The 2013 to 2020 data shows that microcystin is found throughout the SWP above health advisory level. Lake Perris is the only location where cylindrospermopsin has been detected. Levels at Lake Perris are rarely above the health advisory levels for children (less than six years old) and never exceed the health advisory levels for adults.

- Although cyanotoxins have been found in SWP source waters, it should be noted that the HA levels for microcystin and cylindrospermopsin apply to finished or treated drinking water. Additionally, compliance with the HA levels are not based on a single sample, but the HA is based on the concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to ten days of exposure. To date, there has been no detection of cyanobacteria in treated SWP water, based on voluntary monitoring conducted by Zone 7 Water Agency, Valley Water, Central Coast Water Authority, Antelope Valley – East Kern Water Agency, and Crestline-Lake Arrowhead Water Agency.

- Based on the DWR monitoring data, the highest microcystin concentrations are found in Silverwood Lake and Pyramid Lake.

- Pyramid has consistent detections of microcystin every year, but microcystin is not detected as frequently at Castaic Lake, which is immediately downstream of Pyramid Lake.

- A large Microcystin bloom in the Central Delta was visually confirmed by USGS in summer 2020. USGS plans to expand cyanobacteria and cyanotoxin monitoring, as well as study the drivers of HABs, and the use of fluoroprobes to detect the presence of cyanobacteria.

RECOMMENDATIONS

- There are at least two HAB studies being conducted in the Delta which should be tracked by the contractors: 1) Source tracking of *Microcystis* within the Sacramento San Joaquin Delta conducted by Bend Genetics, Robertson-Bryan Inc. and the Central Valley Regional Board, and 2) Cyanotoxin monitoring in the Delta to identify occurrence, duration, and drivers is being conducted by USGS and DWR.

REFERENCES

Jennifer L. Graham, Neil M. Dubrovsky, Guy M. Foster, Lindsey R. King, Keith A. Loftin, Barry H. Rosen & Erin A. Stelzer (2020) Cyanotoxin occurrence in large rivers of the United States, Inland Waters, 10:1, 109-117, DOI: 10.1080/20442041.2019.1700749
USEPA. Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin, May 2019. EPA 822-R-19-001.

Supplemental Environmental Project Proposal FY20/21 for Source Tracking of Cyanobacteria blooms in the Sacramento-San Joaquin Delta, dated June 21, 2020.

Delta RMP Special Study Proposal – FY2020 Cyanotoxin Monitoring in the Delta: Leveraging existing USGS and DWR field efforts to identify cyanotoxin occurrence, duration, and drivers

https://nwis.waterdata.usgs.gov/nwis/uv?site_no=11312676 (Middle River site)

Bench-scale Evaluation of the Potential Destruction of Cyanotoxins with Treatment Technologies Applied to South Bay Aqueduct Water Technical Report. Prepared for Zone 7 Water Agency, Alameda County Water District, Santa Clara Valley Water District, prepared by WQTS, October 2015.

CHAPTER 8 TURBIDITY

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FIGURES

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CHAPTER 8 TURBIDITY

WATER QUALITY CONCERN

Turbidity in drinking water supplies has both beneficial and undesirable aspects. The water supplies of the State Water Project (SWP) generally contain ample nutrient concentrations to permit growths of algae and cyanobacteria to levels that can impact water treatment facilities and cause taste and odor (T&O) problems in treated drinking water. Turbidity can limit these growths by reducing light penetration in the water column. In water treatment, the presence of some turbidity can be helpful in attaining efficient flocculation and sedimentation. The State Water Resources Control Board Division of Drinking Water (DDW) has established a filtered water turbidity standard of 0.3 NTU that must be achieved 95 percent of the time and turbidity can never exceed 1 NTU. Treated water turbidity standards for alternative filtration technologies are typically lower than 0.3 NTU. Rapid increases in source water turbidity can create challenges with adequately clarifying and disinfecting the water, and can increase expenses for treatment chemicals and sludge handling. Turbidity can also harbor and be an indicator of increased microbial contamination. In parts of the SWP where water velocity tends to be slower, such as in reservoirs and forebays to pumping plants, turbidity can settle, forming sediment beds. These sediment beds can reduce the storage capacity of the system, and encourage growths of cyanobacteria responsible for T&O in drinking water. Sediment can also increase the growth of macrophytes, leading to the need to apply herbicides.

WATER QUALITY EVALUATION

TURBIDITY LEVELS IN THE SWP

Turbidity data are analyzed in this section to examine changes in turbidity as the water travels through the SWP system and to determine if there are seasonal or temporal trends. The data from the 2016 Update analysis was supplemented with data from the Department of Water Resources (DWR's) Municipal Water Quality Investigations (MWQI) Program and the Division of Operations and Maintenance (O&M) SWP monitoring program through December 2020 for a number of locations along the SWP. Both discrete samples and real-time data are included in this analysis. It should be noted that monthly grab turbidity samples were no longer analyzed by Bryte Lab after December 2017. Beginning in January 2018, monthly grab turbidity samples are analyzed in the field and are called "field" samples. Data are presented in summary form for all locations and analyzed in more detail for a number of key locations. Box plots are also used to show data from multiple locations on one plot and to display seasonal differences at one location. **Figure 2-25** presents an explanation of the box plots. **Table 8-1** presents the period of record available for each location.

The recent study period of 2016 through 2020 represented a time period of alternating wet and dry years for the Sacramento Valley Water Year Index, with water year 2016 classified as below normal, 2017 classified as wet, 2018 classified as below normal, 2019 classified as wet, and 2020 classified as dry.

The California Department of Water Resources adopts five water year types: wet, above normal, below normal, dry, and critical. The classification is based on a water year index that is derived from full natural flow measurements. For the Sacramento River region, the water year index is called the Sacramento Valley Index (SVI) (also known as the "4 River Index" and the "40-30-30 Index") and uses the sum of calculated monthly unimpaired runoff from the following gauges: Sacramento River above Bend Bridge, Feather River at Oroville, Yuba River at Smartsville, and American River below Folsom Dam. The SVI is calculated based on the following equation:

SVI = (0.4 X current April-July runoff) + (0.3 X current October-March runoff) + (0.3 X previous year's index)

The current April-July runoff is for the sum of the runoff for the four rivers in the current water year from April to July, in million acre-feet. If the previous year's index exceeds 10 MAF, then 10 MAF is applied instead. Once the SVI is calculated, the year type classification is based on the thresholds in **Table 2-2.**

Real-time turbidity at Hood, Vernalis, and Gianelli are collected using YSI EXO sondes which are calibrated monthly and the field data comes from YSI Pro-DSS hand held devices that are calibrated before each run. Real-time turbidity at the remaining stations are collected using Hach Surface Scatter 7 instruments. They are usually calibrated once a month, cleaned once a week, and verified against a handheld meter after cleaning. Field turbidity at the remaining stations is collected using a Hach 2100 handheld meter which is calibrated once a month or before usage.

Table 8-1. Turbidity Data

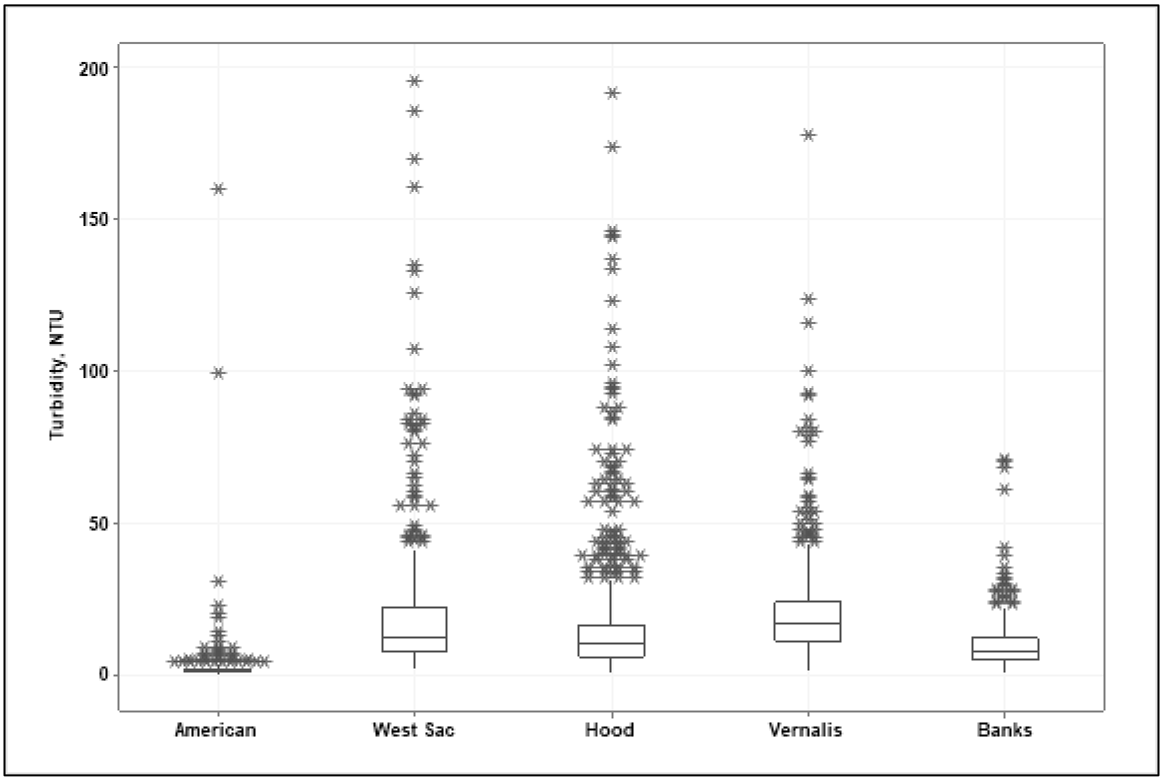
Location	**Lab Grab or Field Samples**		**Real-time**	
	Start Date	**End Date**	**Start Date**	**End Date**
American	Nov 1986	Dec 2020		
West Sacramento	Apr 1994	Dec 2020		
Hood	Aug 1997	Dec 2020	2008	Dec. 2020
Vernalis	Jan 1984	Dec 2020	2005	Dec. 2020
Banks	Mar 1982	Dec 2020	Jun 1988	Dec 2020
Barker Slough	Sep 1988	Dec 2020	Jun 1989	Dec 2020
DV Check 7	Dec 1997	Dec 2020	Jun 1994	Dec 2020
McCabe	Dec 1997	Dec 2020		
Pacheco	Apr 2000	Dec 2020	Jul 1989	Dec 2020
Gianelli	Aug 2013	Dec 2020	Aug 2013	Dec 2020
O'Neill Forebay Outlet/Check 13	Aug 1990	Dec 2020	Jul 1991	Dec 2020
Check 21	Dec 1997	Dec 2020	Jun 1990	Dec 2020
Check 41	Dec 1997	Dec 2020	Jun 1993	Dec 2020
Castaic Outlet	Feb 1998	Dec 2020	Jan 2000	Dec 2020
Devil Canyon Second Afterbay*	Dec 1997	Dec 2020	Oct 1995	Dec 2020

*Note: Data were collected from Dec 1997 to May 2001 at Devil Canyon Afterbay, then at Devil Canyon Headworks from June 2001 to December 2010, and then at Devil Canyon Second Afterbay in early 2011. These datasets have been combined.

The SWP Watershed

Figure 8-1 presents the turbidity data for the American, Sacramento and San Joaquin Rivers and for the Harvey O. Banks Delta Pumping Plant (Banks). As turbidity data was not consistently collected at Hood until August 1997, data presented in **Figure 8-1** is from August 1997 to December 2020. Data from the Sacramento River at West Sacramento (West Sacramento) represent the quality of water upstream of the Sacramento metropolitan area and upstream of the American River. Hood represents the quality of water flowing into the Delta from the Sacramento River. Data collected from the San Joaquin River at Vernalis (Vernalis) are used to represent the San Joaquin River inflow to the Delta. **Figure 8-1** shows that turbidity levels in the Sacramento River are lower than levels in the San Joaquin River.

Figure 8-1. Turbidity Levels in the SWP Watershed, 1997 to 2020



Hood – **Figure 8-2** shows all available field or lab grab sample turbidity data at Hood. Field data was used during the 2016 to 2020 time period. The levels range from 1 to 192 NTU during the period of record with a median of 10 NTU.

- Comparison of Real-time and Field Data – **Figure 8-3** compares the real-time data with the field data at Hood over the 2016 to 2020 reporting period and **Figure 8-4** compares the real-time and field data on a 1:1 basis. **Figure 8-4** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.9469 which is acceptable.

- Spatial Trends – No sites upstream of Hood were evaluated and no spatial trend is presented.

- Long-Term Trends – **Figure 8-2** does not show any discernible long-term trends other than the peak turbidities occur during the December to February time period.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are differences between wet years and dry years. The median turbidity level of 8 NTU during dry years is statistically significantly lower than the 12 NTU median during wet years (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – On the Sacramento River, turbidity is directly related to flow in the river, as shown in **Figure 8-5**. When flows at Freeport (Freeport Bridge in South Sacramento County) increase, turbidity increases (maximum measured value of 192 NTU). When flows drop below about 20,000 cubic feet per second (cfs), turbidity is generally less than 10 NTU. **Figure 8-6** presents the grab sample monthly data for the period of record. This figure indicates that the turbidity levels decline during the spring and summer months and reach the lowest levels in the fall when flows on the river are lowest. Turbidity levels rise when storm events result in increasing flows during the winter months.

Figure 8-2. Turbidity Levels at Hood

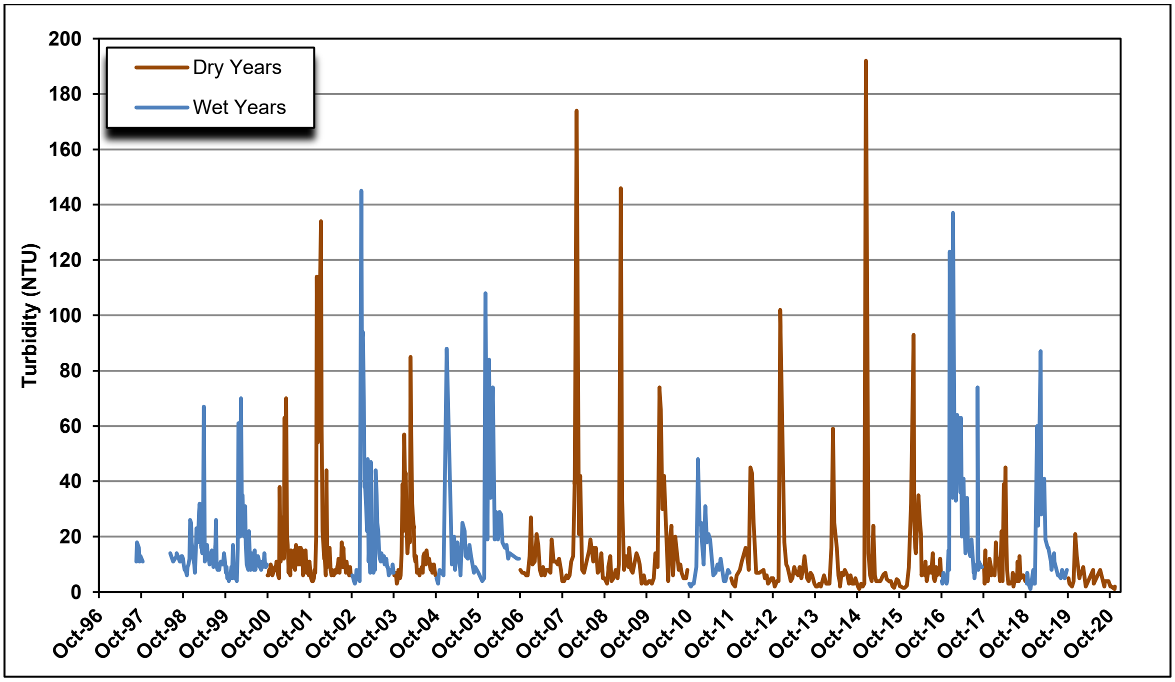


Figure 8-3. Comparison of Hood Real-time and Field Turbidity Data, 2016 to 2020

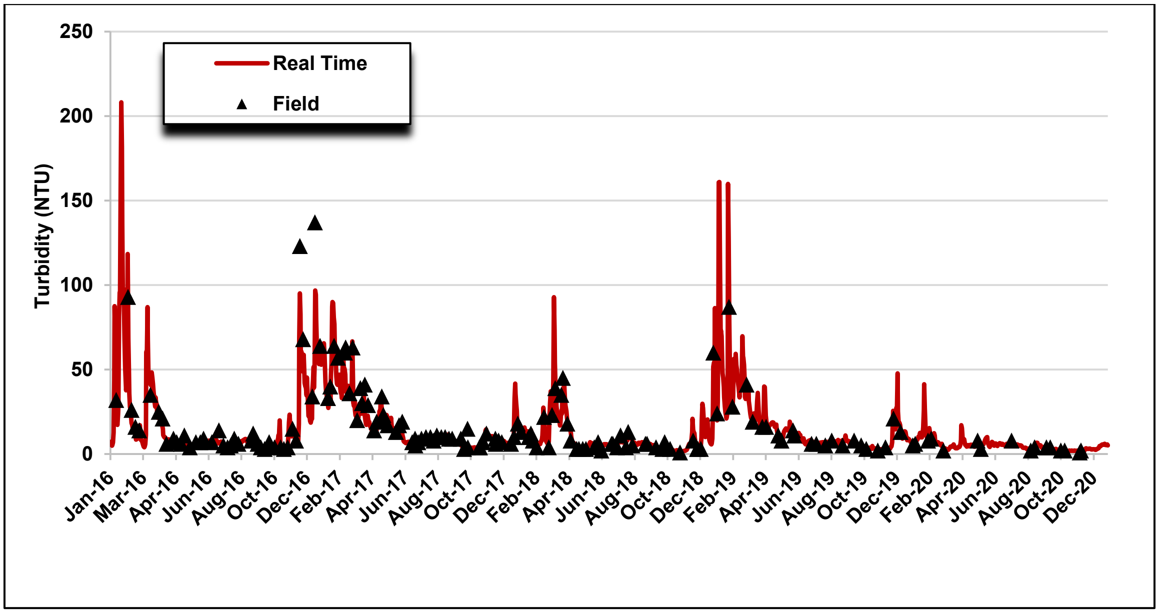


Figure 8-4. Comparison of Hood Real-time and Field Turbidity 2016 to 2020 Data, 1:1 Graph

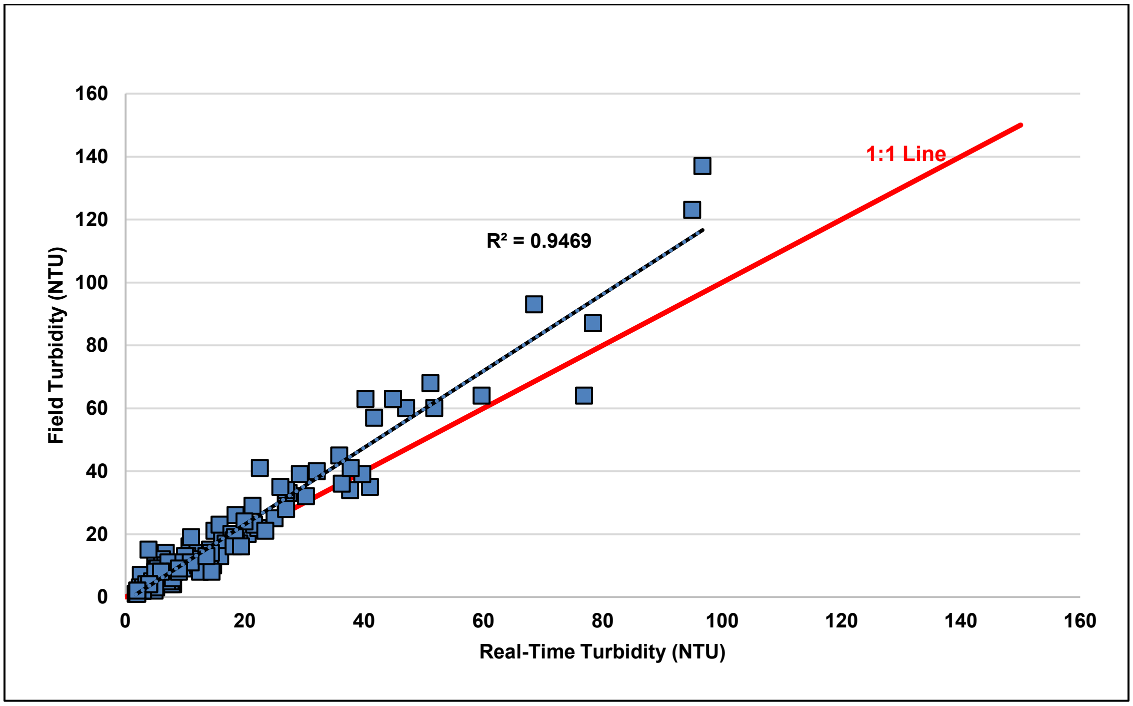


Figure 8-5. Relationship Between Flow and Turbidity at Hood

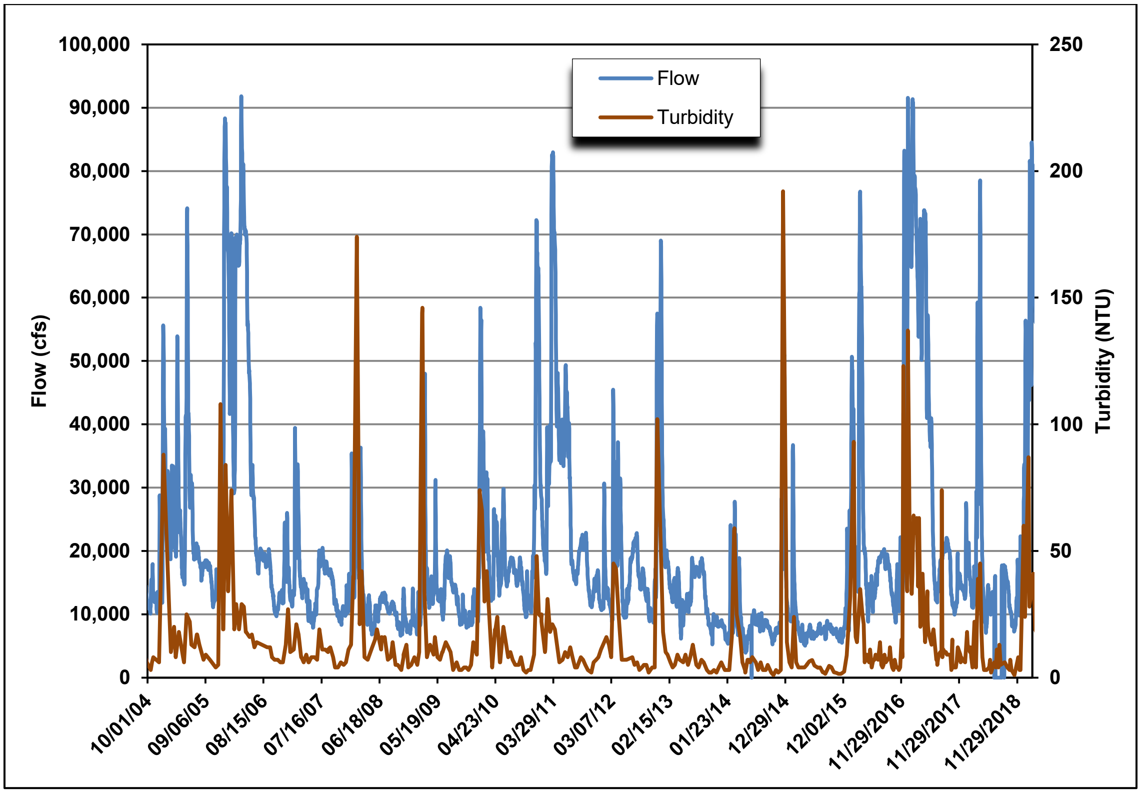
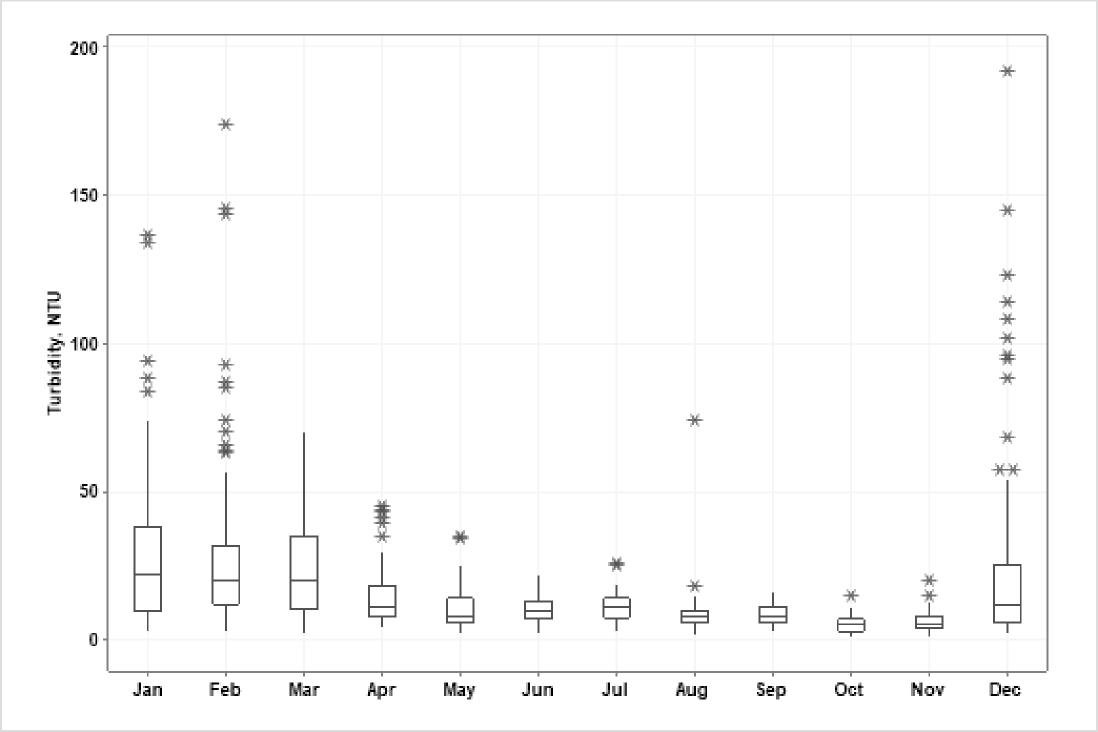


Figure 8-6. Monthly Variability in Turbidity at Hood, 1997 to 2020



Vernalis – **Figure 8-7** presents all available lab grab or field sample turbidity data at Vernalis. Field data was used during the 2016 to 2020 time period. Turbidity is highly variable, ranging from 1 to 178 NTU during the period of record with a median of 17 NTU. The range is similar to Hood but the median is almost twice the median level at Hood.

- Comparison of Real-time and Field Data – **Figure 8-8** compares the real-time data with the field data at Vernalis over the 2016 to 2020 reporting period and **Figure 8-9** compares the real-time and field data on a 1:1 basis. **Figure 8-9** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.8312 which is acceptable.

- Spatial Trends – DWR does not collect data on the San Joaquin River upstream of Vernalis.

  Long-Term Trends – **Figure 8-7** does not show any discernible long-term trends, other than the peak turbidities occur during the December to April time period.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are differences between wet years and dry years. The median turbidity level of 16 NTU during dry years is statistically significantly lower than the 18 NTU median during wet years (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 8-10** indicates that the San Joaquin River has a pattern of rapidly increasing turbidity when flows first increase in the winter months due to storm events (maximum measured value of 178 NTU); however during prolonged periods of high flows, such as in 2005, turbidity drops down to less than 20 NTU. This could be due to high quality water being released from upstream reservoirs rather than to storm-generated flows. Similarly, the highest flow over the recent reporting period of 2016 to 2020 occurred at the end of February 2017 with 40,000 cfs. However, the peak turbidity of 80 NTU occurred earlier, in January 2017. During the summer months, turbidity appears to be inversely proportional to flow. As the river flow decreases in the summer, a larger percent of the water in the river is agricultural drainage, which could be one source of the summer high turbidity levels. Another possible source is increased algal production during the summer months. **Figure 8-11** presents the grab sample monthly data for the entire period of record. This figure shows that the median turbidity level is highest in July but the variability in turbidity is greatest during the winter months due to storm events.

Figure 8-7. Turbidity Levels at Vernalis

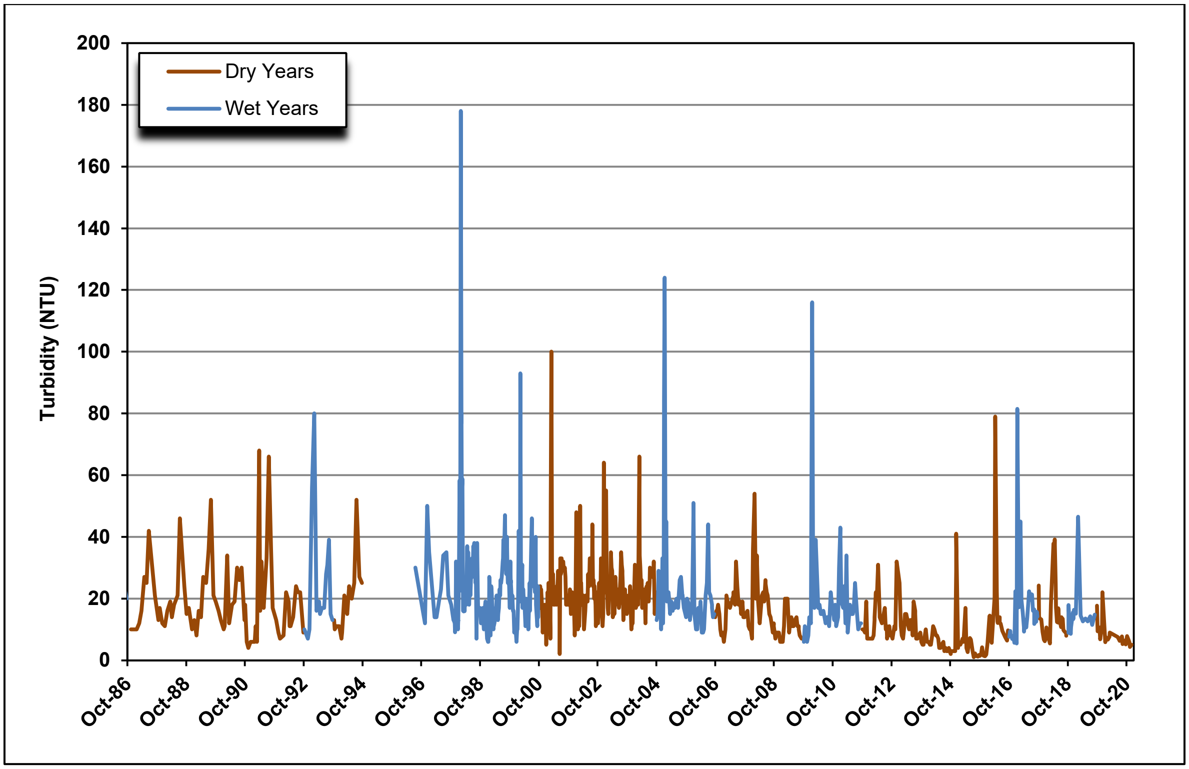


Figure 8-8. Comparison of Vernalis Real-time and Field Turbidity Data, 2016 to 2020

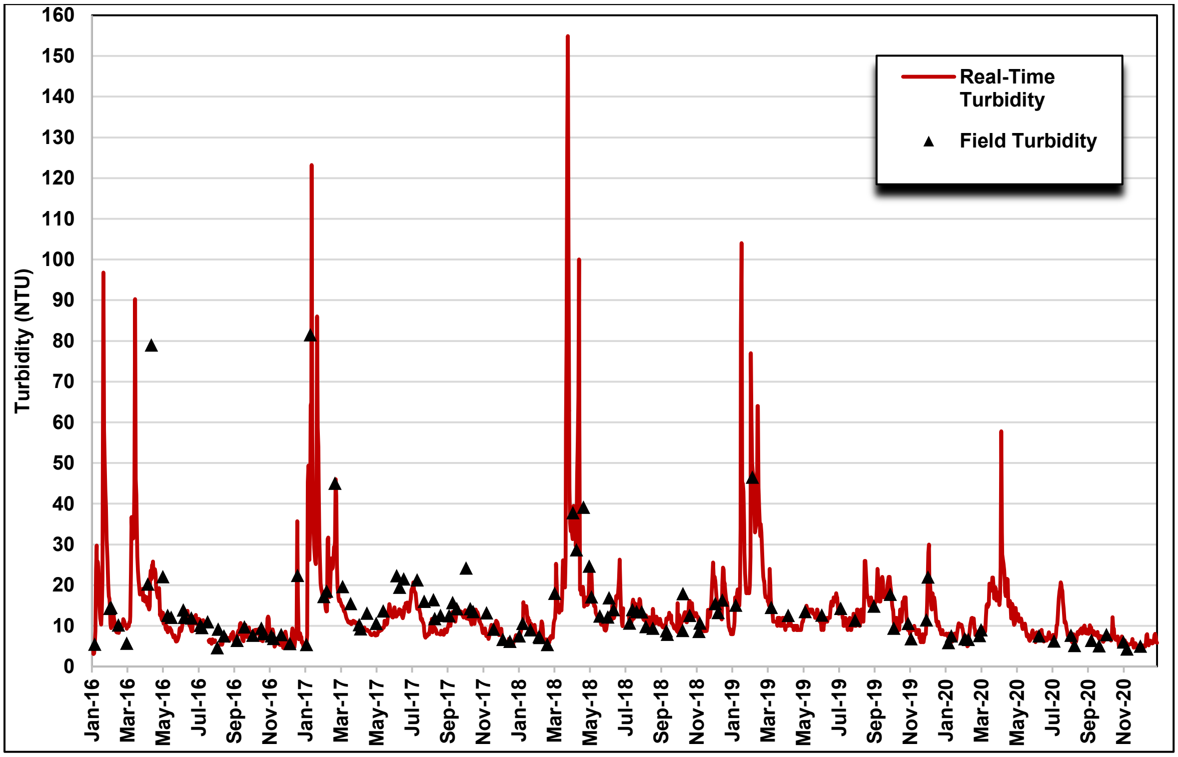


Figure 8-9. Comparison of Vernalis Real-time and Field Turbidity 2016 to 2020 Data, 1:1 Graph

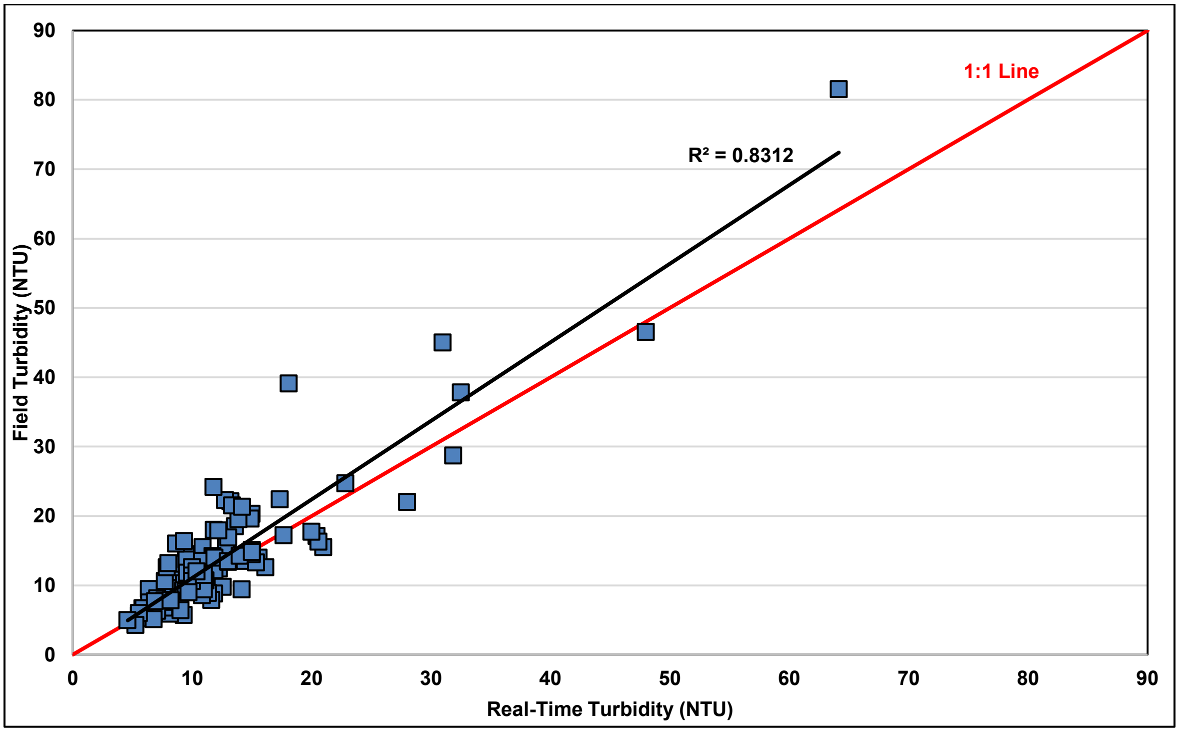


Figure 8-10. Relationship Between Turbidity and Flow at Vernalis

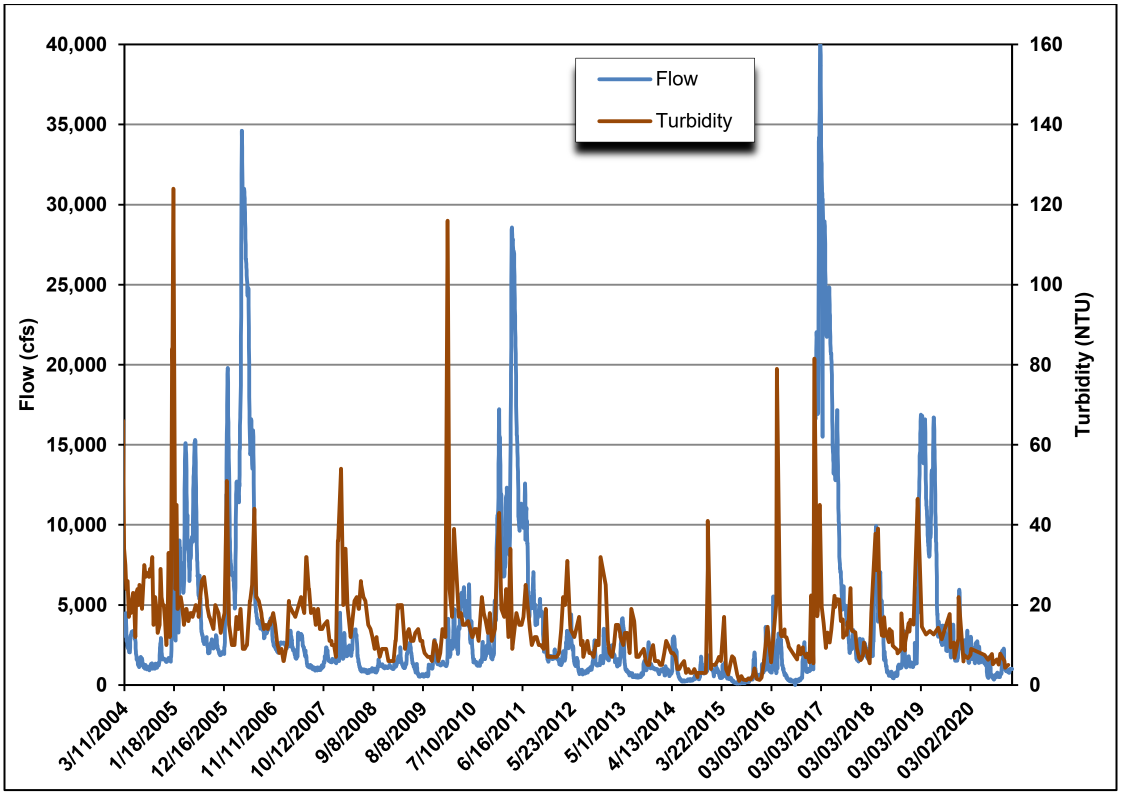
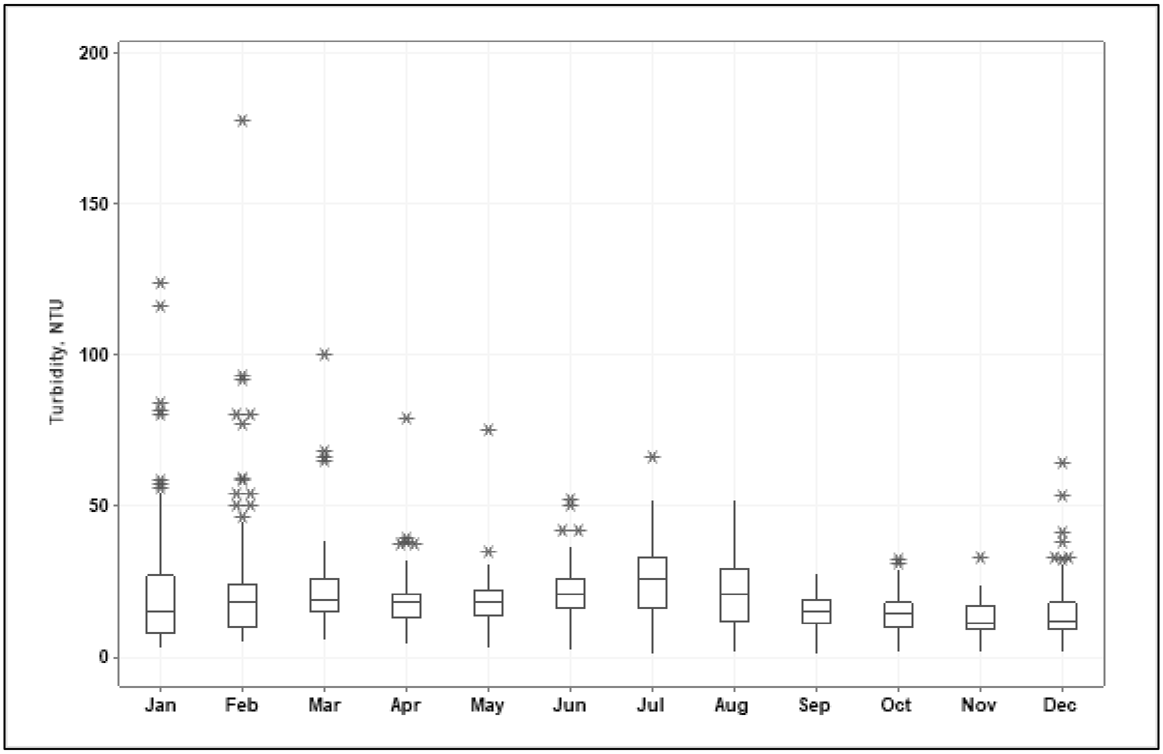


Figure 8-11. Monthly Variability in Turbidity at Vernalis, 1982 to 2020



Banks – **Figure 8-12** shows all available lab grab and field sample turbidity data at Banks. Field data was used during the 2016 to 2020 time period. There is considerable variability in turbidity at Banks with levels ranging from 1 to 71 NTU with a median of 8 NTU.

- Comparison of Real-time and Field Sample Data – **Figure 8-13** compares the real-time data with the field sample data at Banks over 2016 to 2020 and **Figure 8-14** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.9133 which is acceptable. DWR O&M staff conducted an analysis of turbidity at Banks for the South Bay Aqueduct (SBA) Contractors in 2002 that indicated that the summer peaks in turbidity are potentially due to the re-suspension of sediment in Clifton Court due to high winds in the Delta during the summer months. Wind-generated peaks in turbidity would be difficult to measure with monthly grab samples but they are measured with the real-time samplers.

- Spatial Trends – **Figure 8-1** indicates that turbidity levels at Banks are lower and less variable than the Sacramento and San Joaquin rivers. This is likely due to some settling of sediment in Delta channels and Clifton Court. Reservoirs and forebays, such as Clifton Court, act as settling basins due to the low velocity of water in the reservoir compared to the channels that feed the reservoir. All available data from Hood, Vernalis, and Banks are presented in **Figure 8-1**. The median turbidity at Banks (8 NTU) is statistically significantly lower than the median of 10 NTU at Hood (Mann-Whitney, p=0.0000) and statistically significantly lower than the median of 17 NTU at Vernalis (Mann-Whitney, p=0.0000).

- Long-Term Trends – No discernible long-term trend is evident in turbidity levels in **Figure 8-12**.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median turbidity of 7 NTU during dry years is statistically significantly lower than the median of 10 NTU during wet years (Mann-Whitney, p=0.0000).

- Seasonal Trends – **Figure 8-15** presents the grab sample monthly data for the entire period of record. This figure indicates that the peak turbidity levels at Banks occur between May and July with June having the highest levels. The summer peaks in turbidity are potentially due to the re-suspension of sediment in Clifton Court Forebay. High pumping rates in the summer create high velocities in the forebay which may re-suspend sediment and lead to higher turbidity. Re-suspension of sediment due to high winds in the Delta during the summer months is another possible cause.

Figure 8-12. Turbidity Levels at Banks

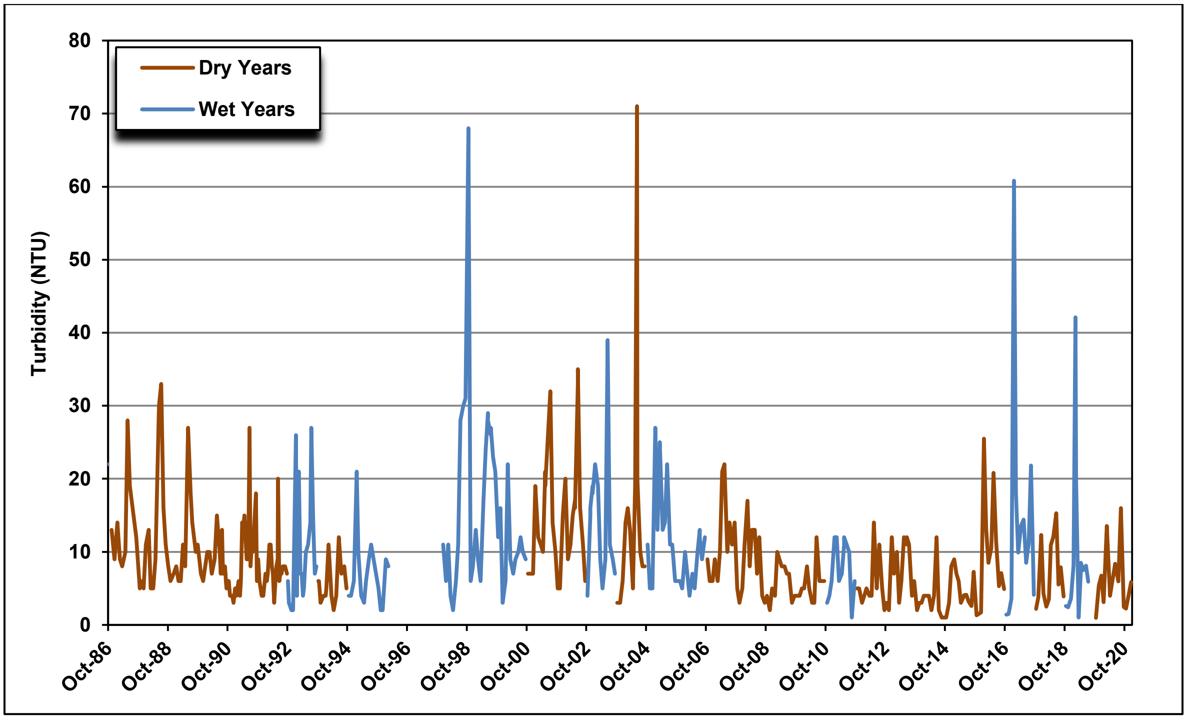


Figure 8-13 Comparison of Banks Real-time and Field Turbidity Data, 2016 to 2020

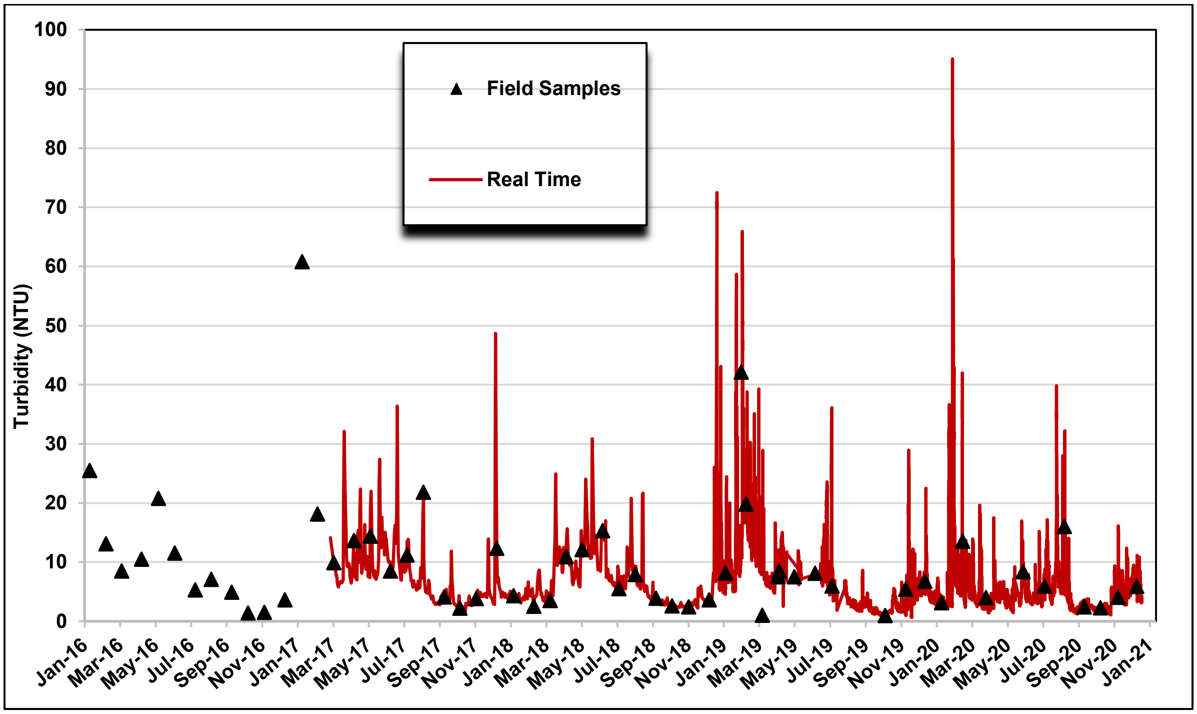


Figure 8-14. Comparison of Banks Real-time and Field Turbidity 2016 to 2020 Data, 1:1 Graph

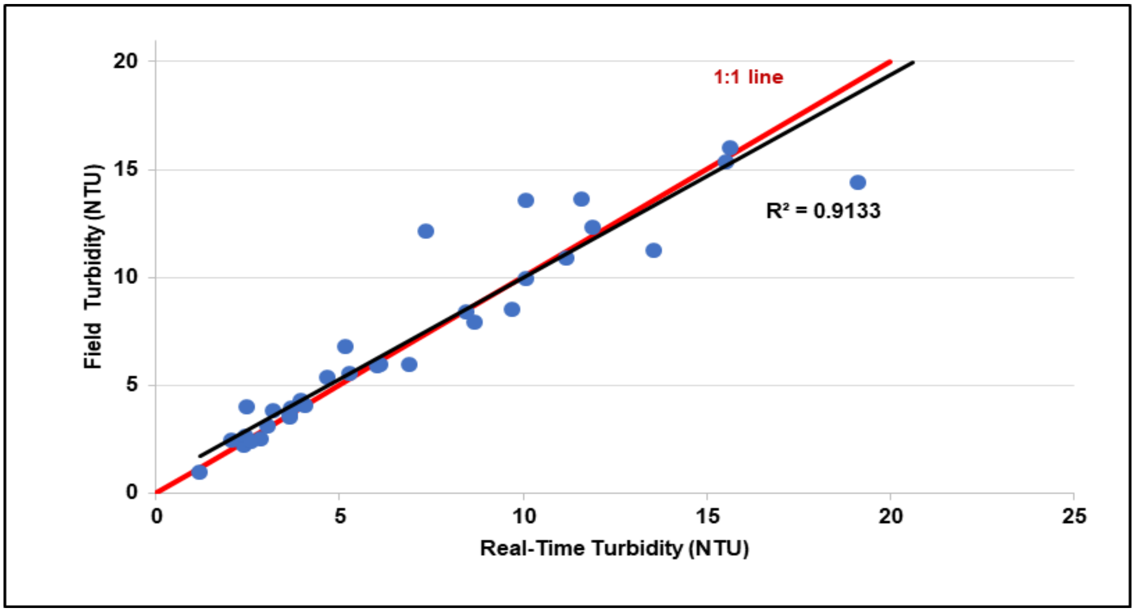
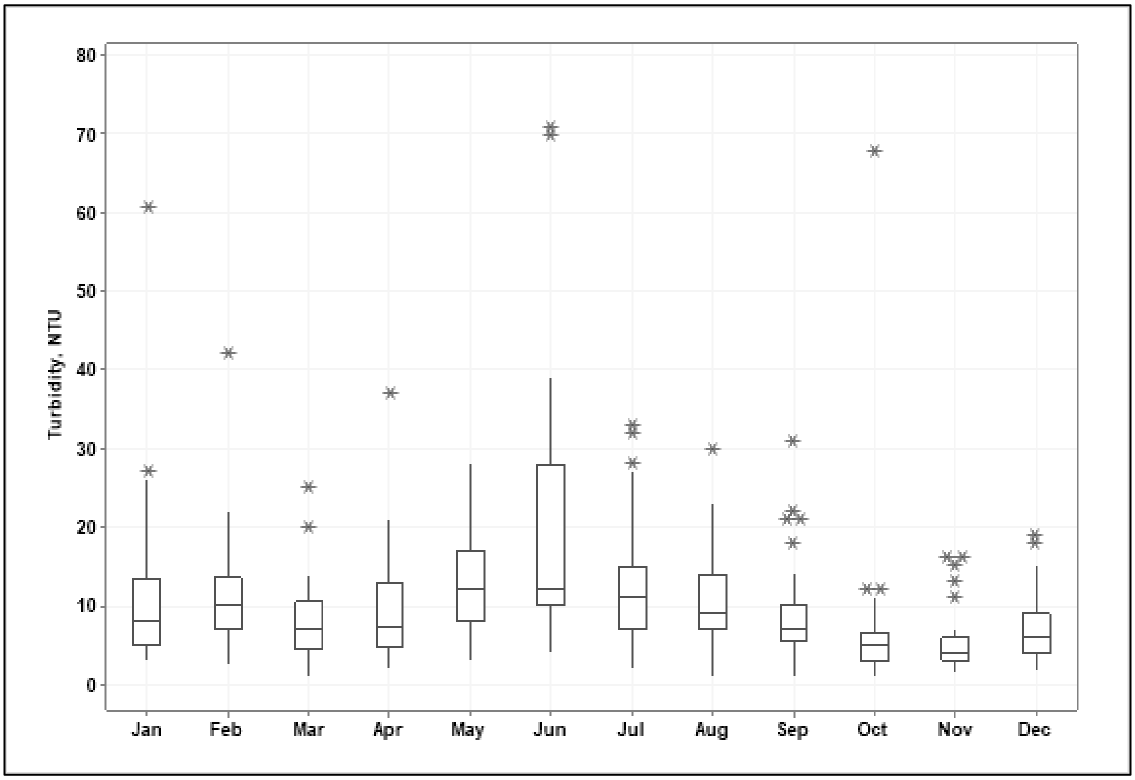


Figure 8-15. Monthly Variability in Turbidity at Banks, 1982 to 2020



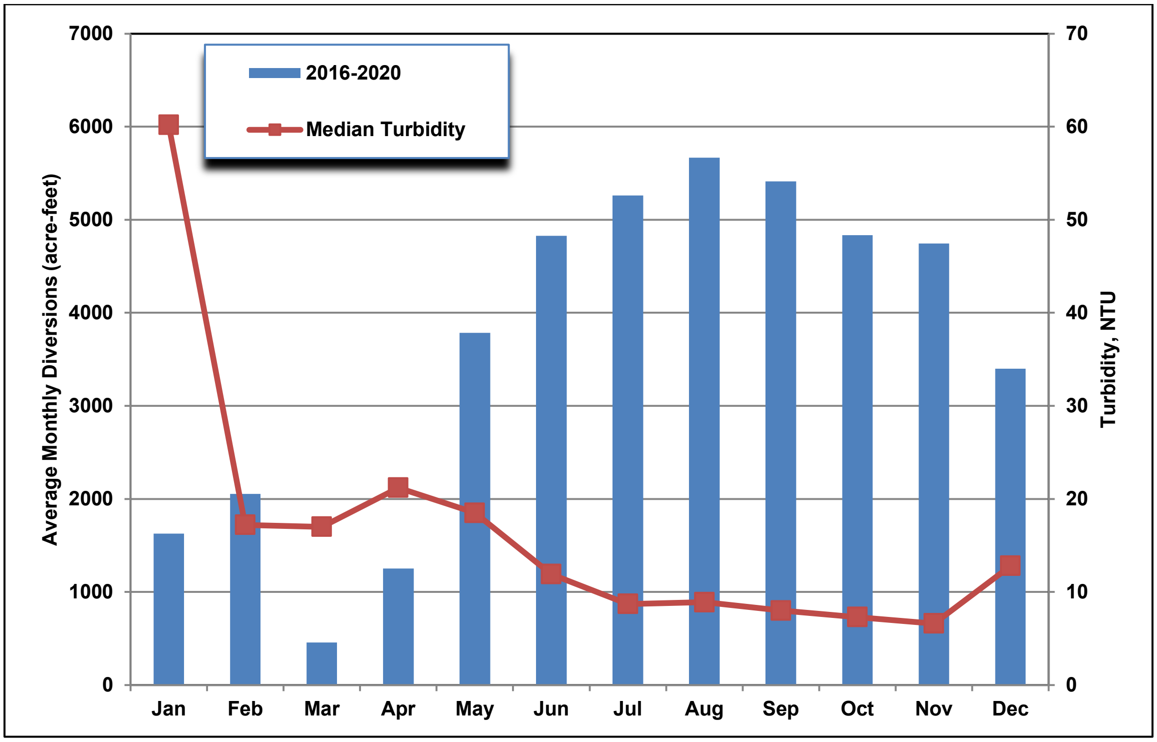
North Bay Aqueduct

Chapter 2 contains a description of the North Bay Aqueduct (NBA). The sources of water are the local Barker Slough watershed and the Sacramento River.

Project Operations

After the water is diverted from Barker Slough, the quality of water delivered to NBA users should not be affected by any other factors since the NBA is an enclosed pipeline. **Figure 8-16** shows average monthly diversions at Barker Slough for the 2016 to 2020 period and median monthly turbidity levels. This figure shows that turbidities were lower during the peak pumping period in summer. In the past, summer turbidity peaks have occurred due to phytoplankton and/or wind driven events. The winter peak is primarily due to runoff events from the upstream Barker Slough watershed.

Figure 8-16. Average Monthly Barker Slough Diversions and Median Turbidity Levels, 2016 to 2020



Turbidity Levels in the NBA

Real-time and grab sample turbidity data are collected at Barker Slough and Cordelia Forebay (Cordelia). **Figure 8-17** shows available lab grab or field sample turbidity data at Barker Slough. Field data was used during the 2016 to 2020 time period. The levels range from 2 to 975 NTU with a median of 28 NTU. The turbidity levels at Barker Slough are substantially higher and more variable than at Hood.

- Comparison of Real-time and Field Data – **Figure 8-18** compares the real-time data with the field data at Barker Slough over the 2016 to 2020 reporting period and **Figure 8-19** compares the real-time and field data on a 1:1 basis. **Figure 8-19** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.9778 which is acceptable.

- Spatial Trends – **Figure 8-20** compares the grab sample data at Barker Slough and various locations along the SWP for the January 1998 to December 2020 period. For this period, the Hood grab sample median of 10 NTU is statistically significantly lower than the Barker Slough grab sample median of 30 NTU (Mann-Whitney, *p*=0.0000). Compared to the other SWP locations, Barker Slough has the highest variability and median value of turbidity.

- Long-Term Trends – **Figure 8-17** shows no discernible long-term trend at Barker Slough.

- Wet Year/Dry Year Comparison – The Barker Slough grab sample data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median turbidity of 24 NTU in dry years is statistically significantly lower than the median of 35.5 NTU in wet years (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – **Figure 8-21** presents the Barker Slough grab sample monthly data for the entire period of record. This figure indicates that turbidity levels are relatively high and variable in most months of the year with the highest and most variable turbidities found in January and February.

Figure 8-17. Turbidity Levels at Barker Slough

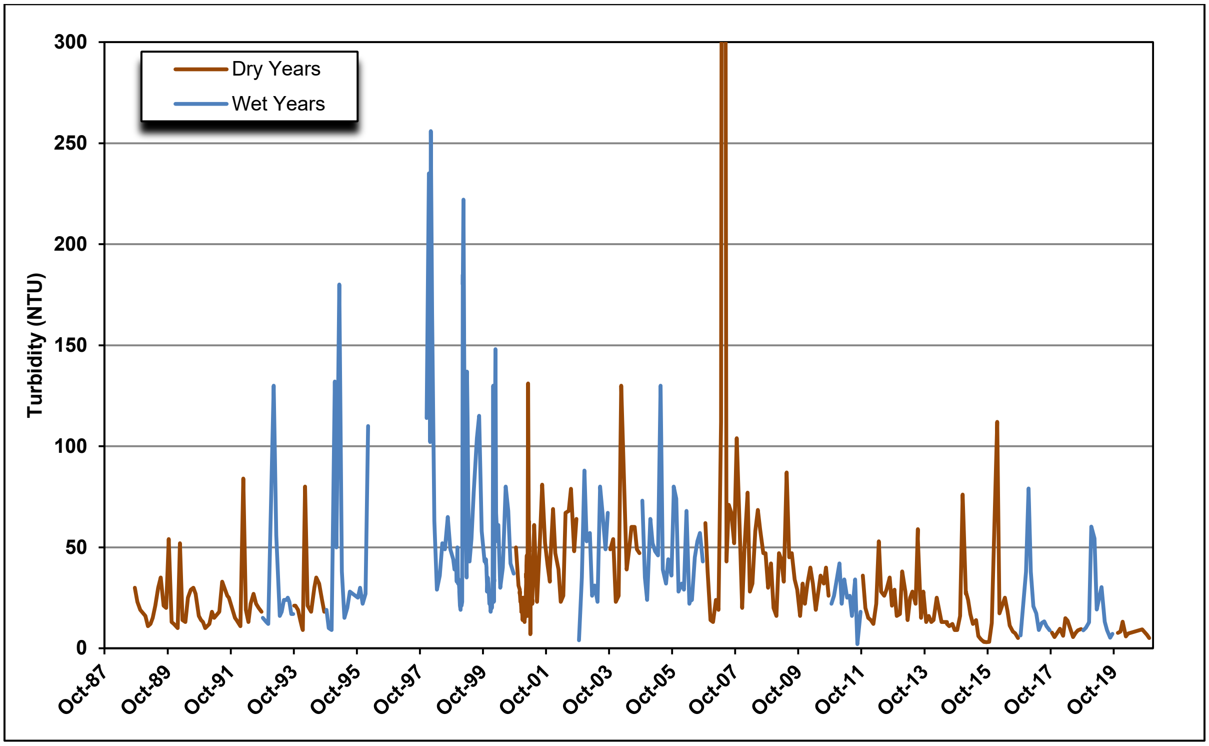


Figure 8-18. Comparison of Barker Slough Real-time and Field Turbidity Data, 2016 to 2020

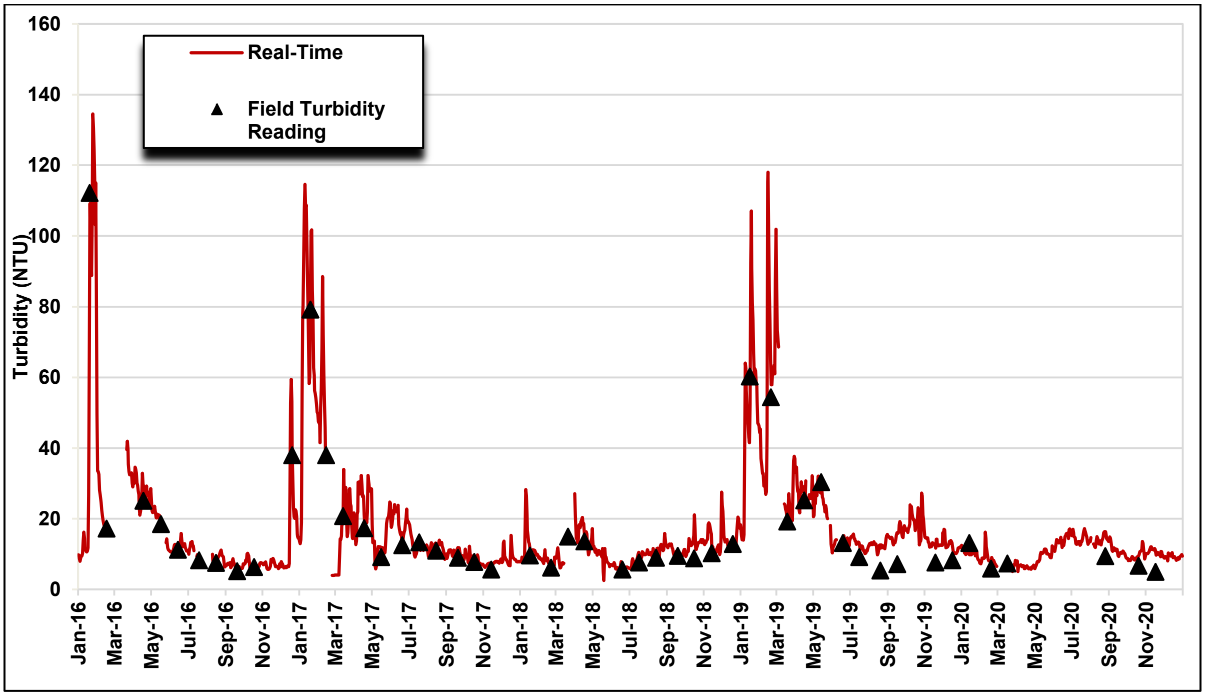


Figure 8-19. Comparison of Barker Slough Real-time and Field Turbidity 2016 to 2020 Data, 1:1 Graph

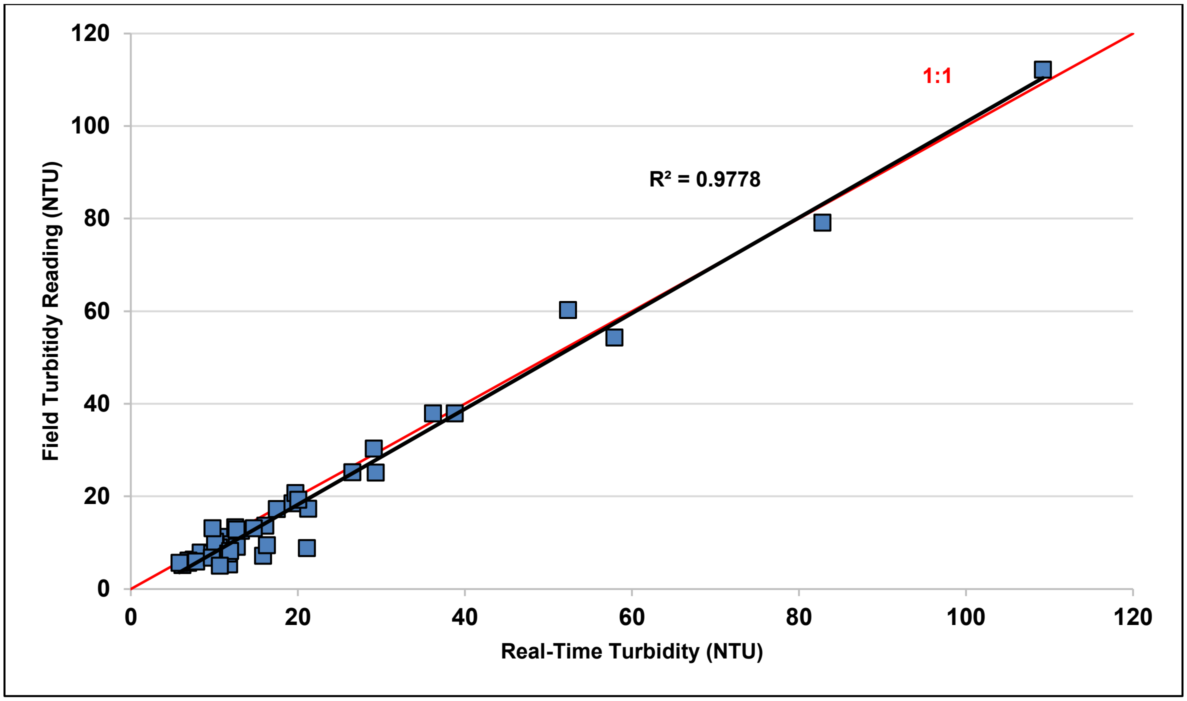


Figure 8-20. Comparison of Turbidity at Barker Slough and Other SWP Locations, 1998 to 2020

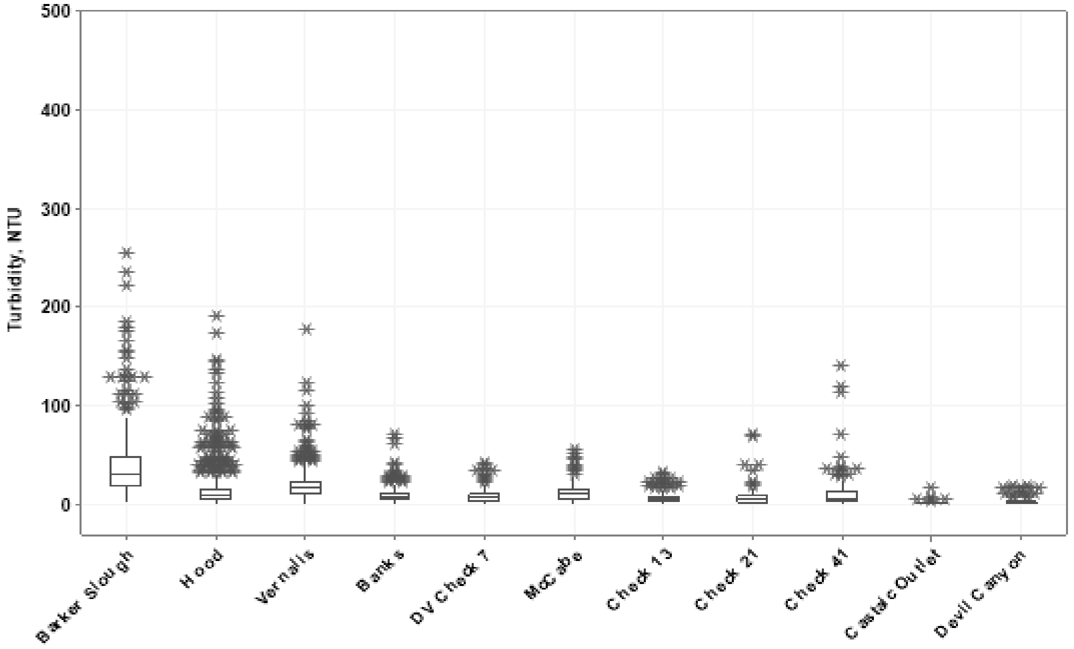
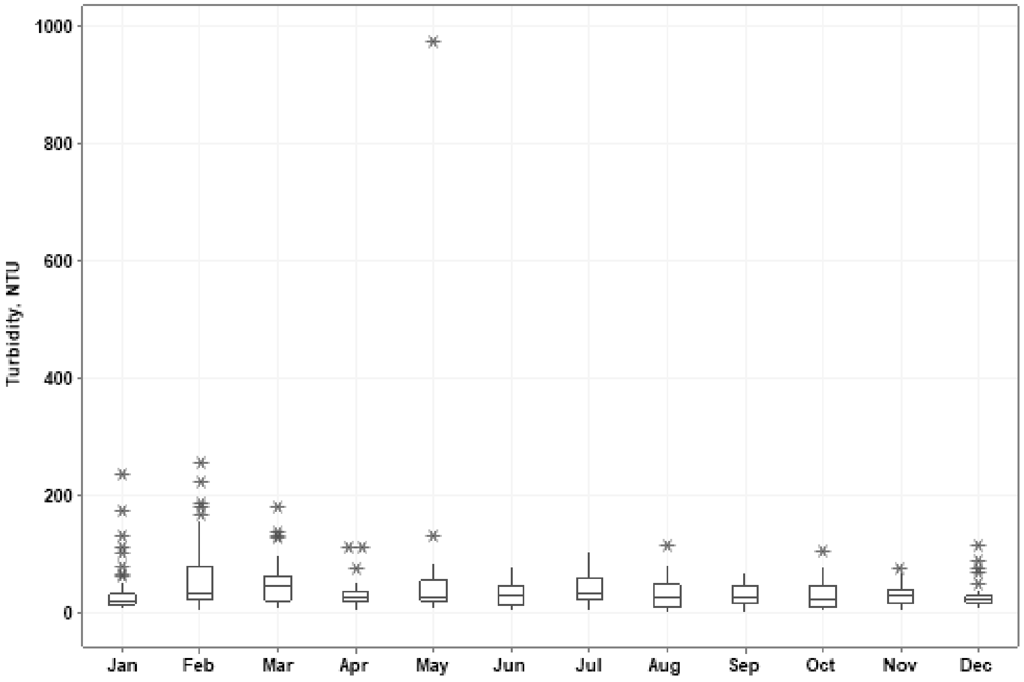


Figure 8-21. Monthly Variability in Turbidity at Barker Slough, 1988 to 2020



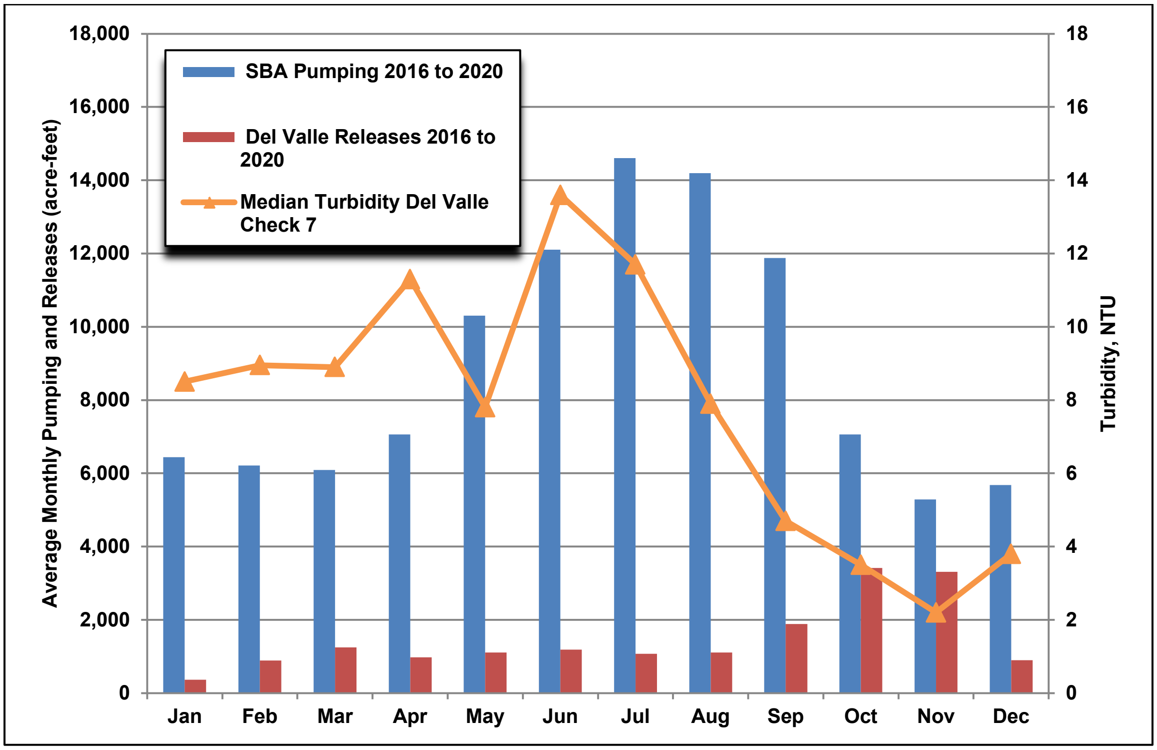
South Bay Aqueduct

Chapter 3 contains a description of the SBA. The Delta is the primary source of water and Lake Del Valle is the secondary source.

Project Operations

The quality of water delivered to the SBA Contractors is governed by the timing of diversions from Bethany Reservoir and releases from Lake Del Valle. **Figure 8-22** shows average monthly diversions from 2016 to 2020 at the South Bay Pumping Plant, releases from Lake Del Valle, and median monthly turbidity at Del Valle Check 7 for 2016 to 2020 (DV Check 7). **Figure 8-22** shows that median turbidity levels are highest at DV Check 7 during the summer months when diversions at the South Bay Pumping Plant are high. The summer peak may be due to wind-driven suspension of sediment in Clifton Court or to higher pumping. Another potential cause is increased algal production during the summer months. Water is typically released from Lake Del Valle primarily between September and November.

Figure 8-22. Average Monthly Diversions at the South Bay Pumping Plant, Releases from Lake Del Valle, and Median Turbidity Levels at DV Check 7, 2017 to 2020



Turbidity Levels in the SBA

Figure 8-23 presents available field or lab grab sample turbidity data at DV Check 7. Field data was used during the 2016 to 2020 time period. The turbidity levels range from 1 to 42 NTU with a median of 7.5 NTU.

- Comparison of Real-time and Grab Sample Data – **Figure 8-24** compares the real-time data with the field sample data at DV Check 7 over 2016 to 2020 and **Figure 8-25** compares the real-time and field sample data on a 1:1 basis. **Figure 8-25** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.8494 which is acceptable.

- Spatial Trends – The grab sample data from January 1998 to December 2020 for Banks and DV Check 7 are shown in **Figure 8-26**. There is no statistically significant difference between the median level for this period of 7.5 NTU at DV Check 7 and the median of 8 NTU at Banks (*p*=0.214).

- Long-Term Trends – **Figure 8-23** shows no discernible long-term trend at DV Check 7.

- Wet Year/Dry Year Comparison – The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median turbidity of 7 NTU in dry years is statistically significantly lower than the median of 8.2 NTU in wet years (Mann-Whitney, *p*=0.004).

- Seasonal Trends – **Figure 8-27** presents the grab sample monthly data for the entire period of record at DV Check 7. Peak turbidity levels occur in the winter and in the summer. The winter peak is due to winter storms when turbidity in the rivers and Delta is high. The summer peak may be due to wind-driven suspension of sediment in Clifton Court or to higher pumping. Another potential cause is increased algal production during the summer months.

Figure 8-23. Turbidity at DV Check 7

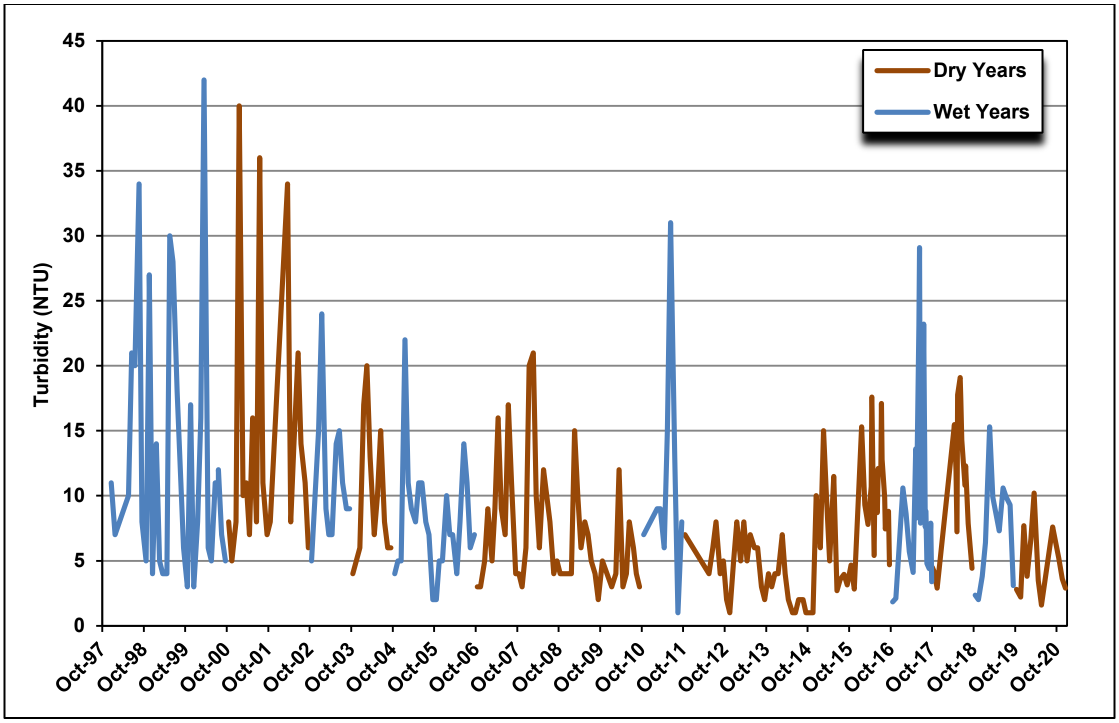


Figure 8-24. Comparison of DV Check 7 Real-time and Field Turbidity Data, 2016 to 2020

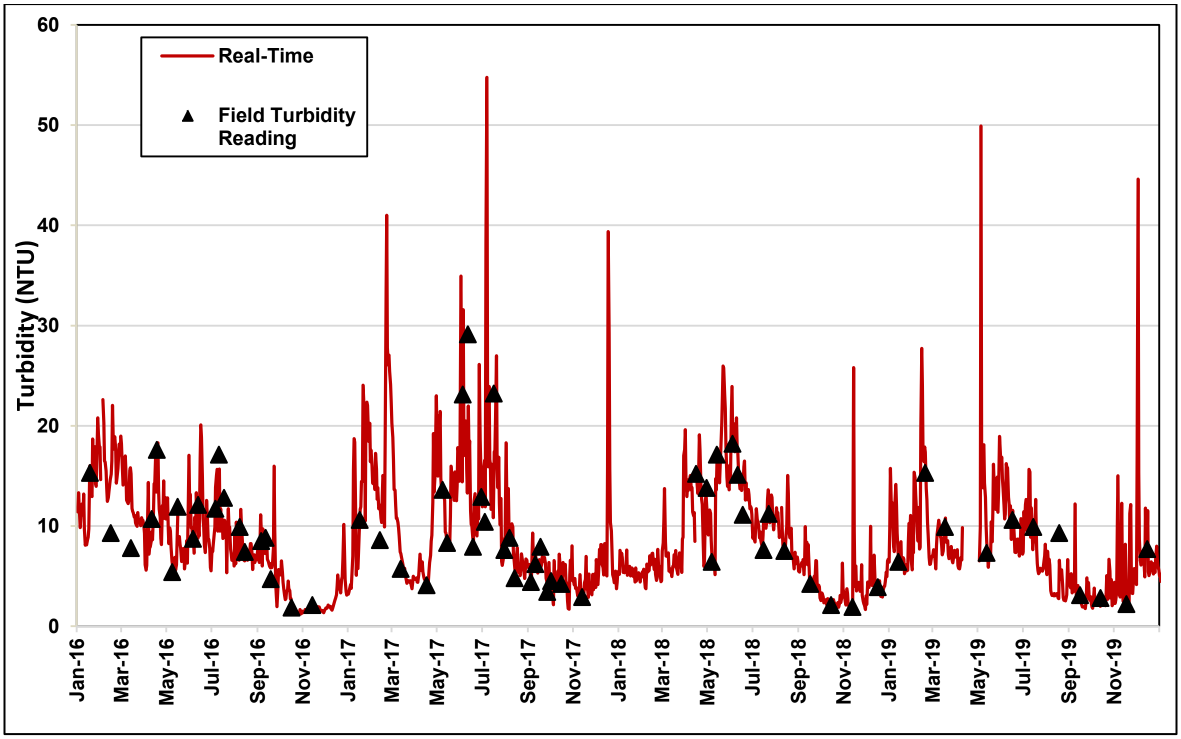


Figure 8-25. Comparison of DV Check 7 Real-time and Field Turbidity Data, 2016 to 2020, 1:1 Graph

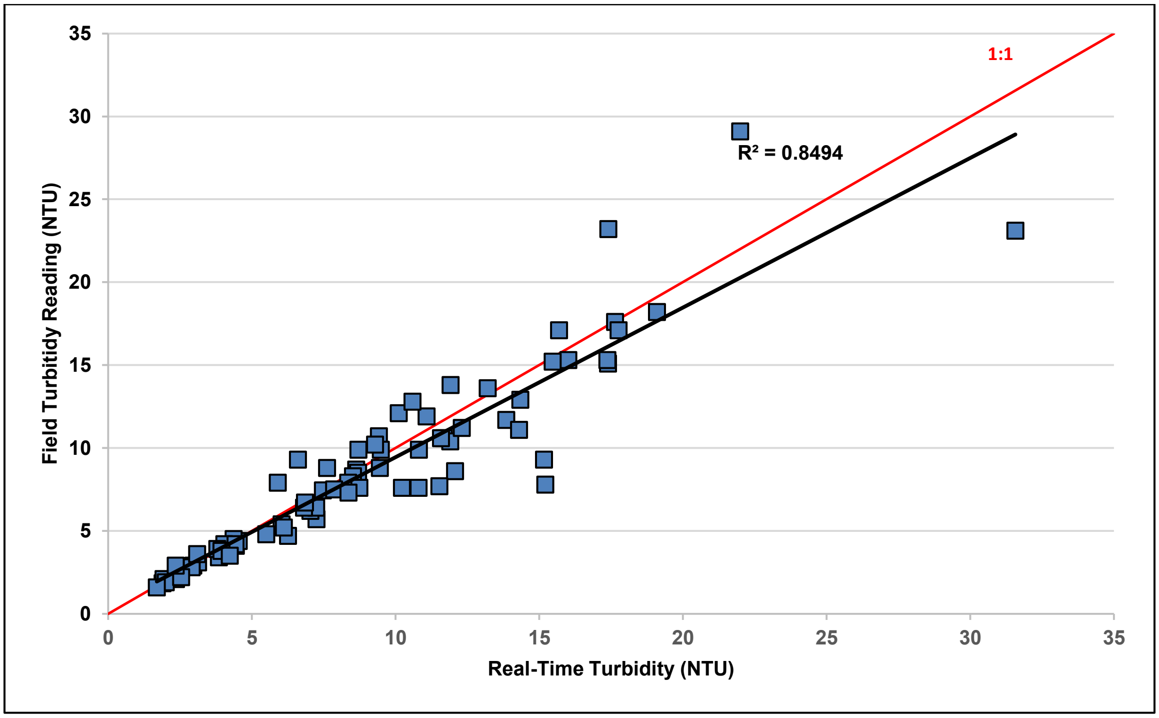


Figure 8-26. Comparison of Turbidity at Banks and DV Check 7 (January 1998 - December 2020)

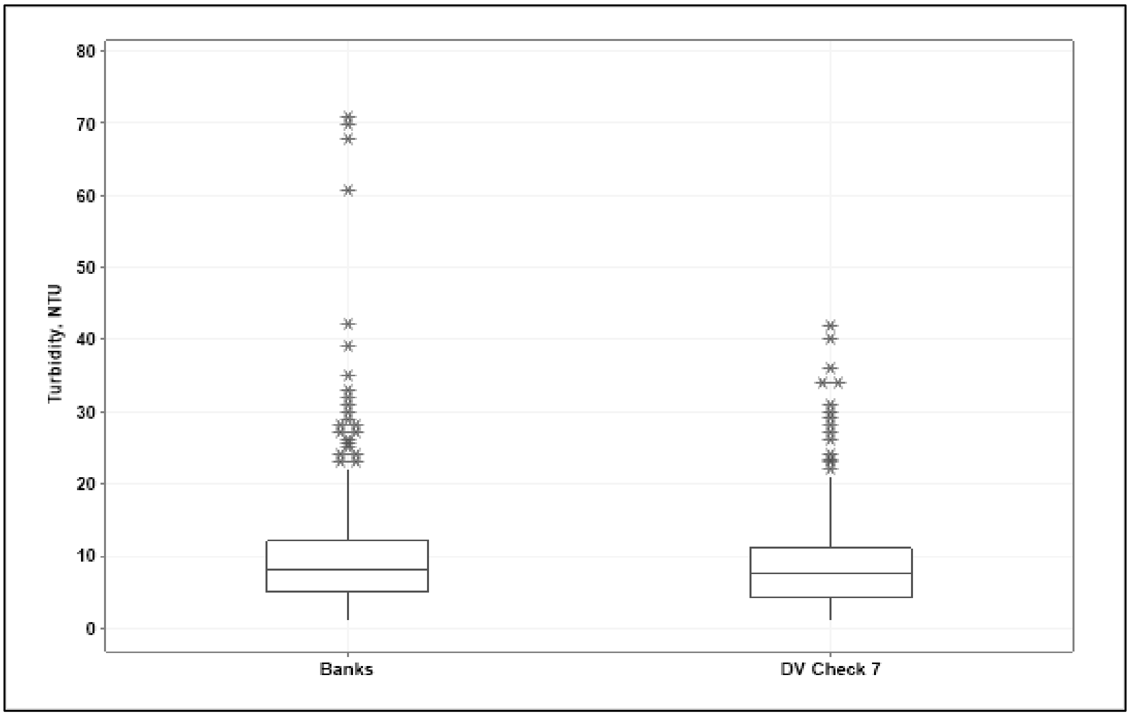
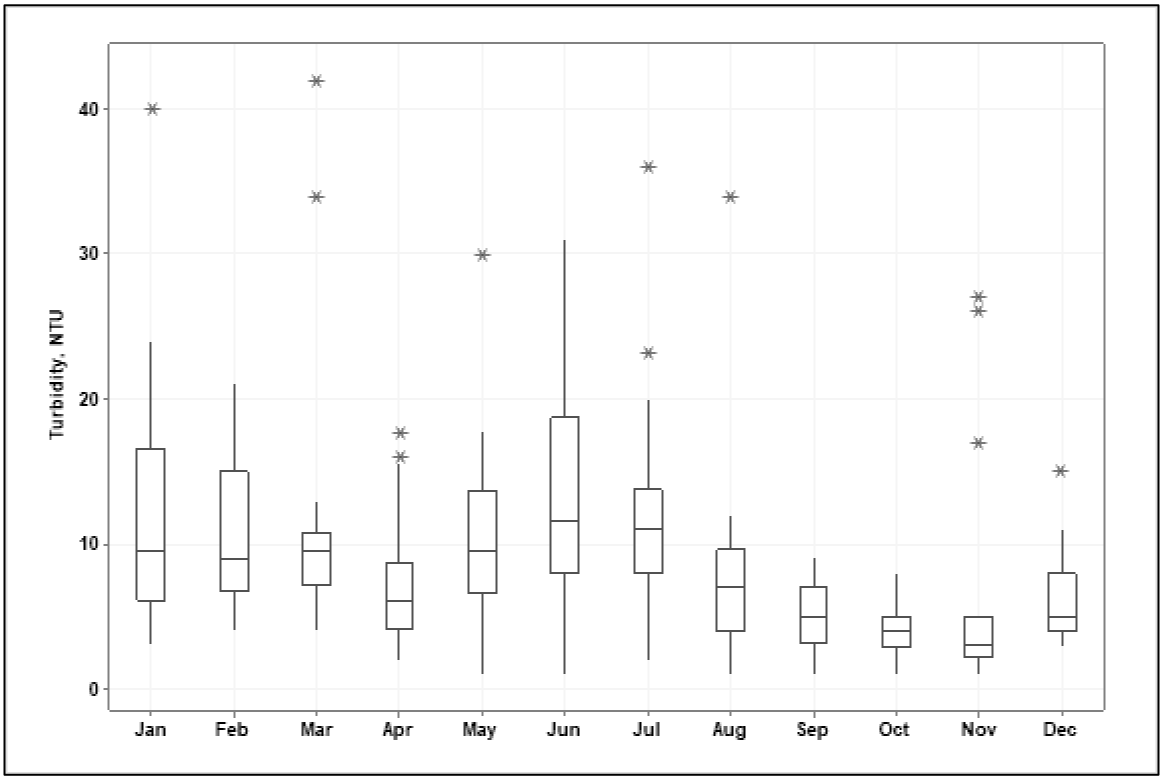


Figure 8-27. Monthly Variability in Turbidity at DV Check 7, 1997 to 2020



California Aqueduct and Delta-Mendota Canal

A number of State Water Contractors take water from the SWP between San Luis Reservoir and the terminal reservoirs. This section is organized by various reaches of the SWP and individual SWP Contractors taking water from each reach are described in the following sections.

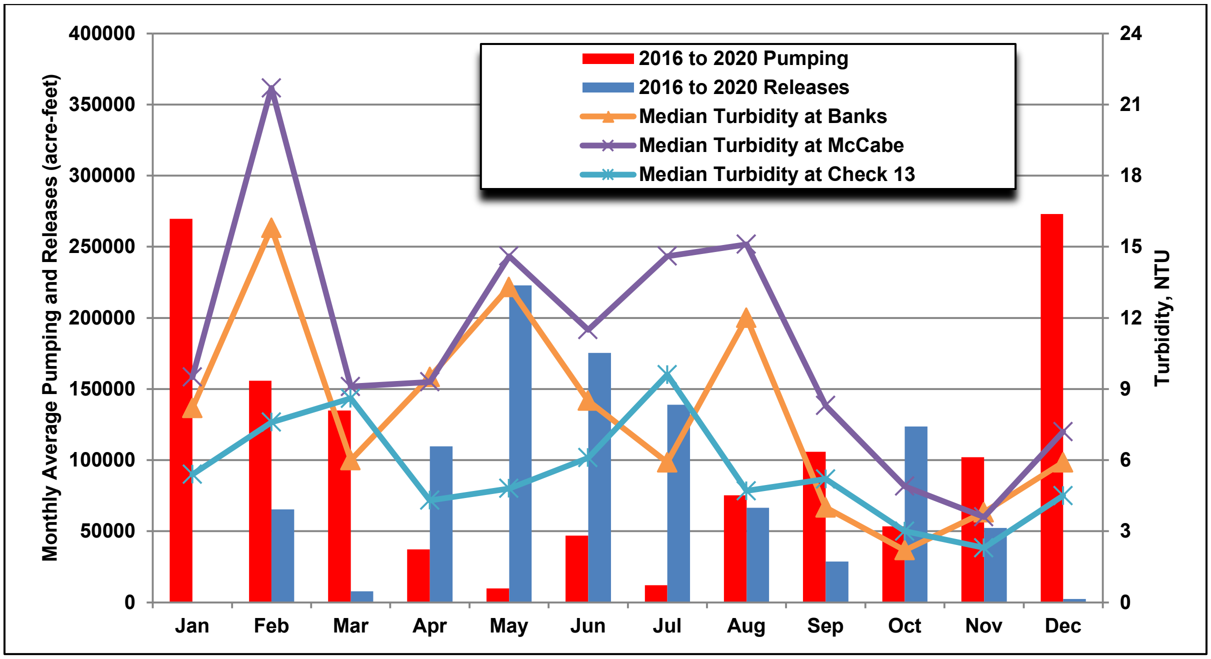
Project Operations

San Luis Reservoir acts as a large settling pond for the sediment that is pumped in with water from the Governor Edmund G. Brown California Aqueduct (California Aqueduct) and the Delta-Mendota Canal (DMC). The timing of diversions at Banks and pumping into O'Neill Forebay at the O'Neill Pump-Generation Plant do not ultimately affect the turbidity of water released from San Luis Reservoir. The turbidity of water delivered to SWP Contractors south of San Luis Reservoir is governed by the turbidity of water leaving O'Neill Forebay, the operations of the pumping plants along the California Aqueduct and inflows to the aqueduct.

Figure 8-28 shows the pattern of pumping (2016 to 2020) into the reservoir and releases from the reservoir to O'Neill Forebay from 2016 to 2020. Historically, water is generally pumped into the reservoir from September to March and released from the reservoir from April to August. However, during 2016 to 2020, there were some slight changes in the pumping/release patterns in August and October. For example, during 2016 to 2020, the average pumping and releases in August were similar, which is normally a release month. In October, the average releases were higher than the pumping, which is normally a month when water is pumped into San Luis Reservoir. This was likely due to the wet years of 2017 and 2019, and there was more than "normal" water stored in San Luis Reservoir which needed to be released in October.

The monthly median turbidity levels at O'Neill Forebay Outlet (Check 13) are shown to illustrate the turbidity level of water entering the California Aqueduct south of the reservoir. The median turbidity at Banks and McCabe are shown to illustrate that the seasonal pattern of turbidity at O'Neill Forebay Outlet is similar to the patterns in the source waters but the levels are much lower during the period that water is released from San Luis Reservoir. For example, the higher turbidities of 13 and 14 NTU in May at Banks and McCabe are not seen at Check 13 due to the high volumes of water released from San Luis Reservoir in May.

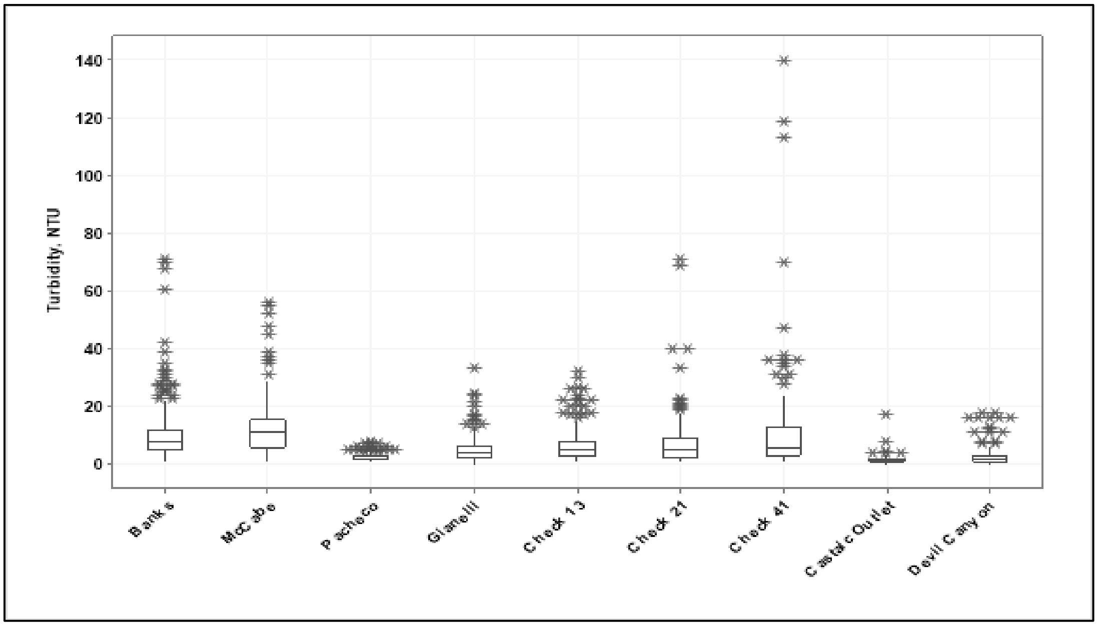
Figure 8-28. San Luis Reservoir Operations and Median Turbidity Levels, 2016 to 2020



Turbidity Levels in the DMC and SWP

Figure 8-29 presents a summary of all grab sample turbidity data (1998 to 2020) collected at each of the locations along the DMC, California Aqueduct, and SWP reservoirs. Spatial differences are examined using this data set in more detail in the following sections.

Figure 8-29. Turbidity Levels in the California Aqueduct (1998-2020)



Delta-Mendota Canal – Grab sample turbidity data have been collected at McCabe since 1997. **Figure 8-30** presents available field or lab grab turbidity data for McCabe. Field data was used during the 2016 to 2020 time period. There is considerable variability in the data with turbidity levels ranging from 1 to 56.3 NTU with a median of 11 NTU.

- Spatial Trends – **Figure 8-29** compares the turbidity data collected at McCabe to Banks. The median turbidity of 11 NTU at McCabe is statistically significantly higher than the median turbidity of 8 NTU at Banks (Mann-Whitney, *p*=0.000). **Figure 8-31** also shows that turbidity is more variable at McCabe. The higher turbidity at McCabe is most likely due to the greater influence of the San Joaquin River at Jones, as the San Joaquin River has higher turbidity than the Sacramento River. Additionally, there are treated wastewater and surface water inputs discharged to the Delta Mendota Canal between Jones and McCabe.

- Long-Term Trends – **Figure 8-30** shows that turbidities were on a declining trend from the start of monitoring through the end of 2015, but began increasing during the wet years of 2017 and 2019.

- Wet Year/Dry Year Comparison –The dry year median turbidity of 9 NTU is statistically significantly lower than the wet year median of 14 NTU (Mann-Whitney, *p*=0.000)
- Seasonal Trends – **Figure 8-31** shows that the peak turbidity levels at McCabe occur in June and July and there is another peak in January and February. This is similar to the seasonal pattern at Banks.

Figure 8-30. Turbidity Levels at McCabe

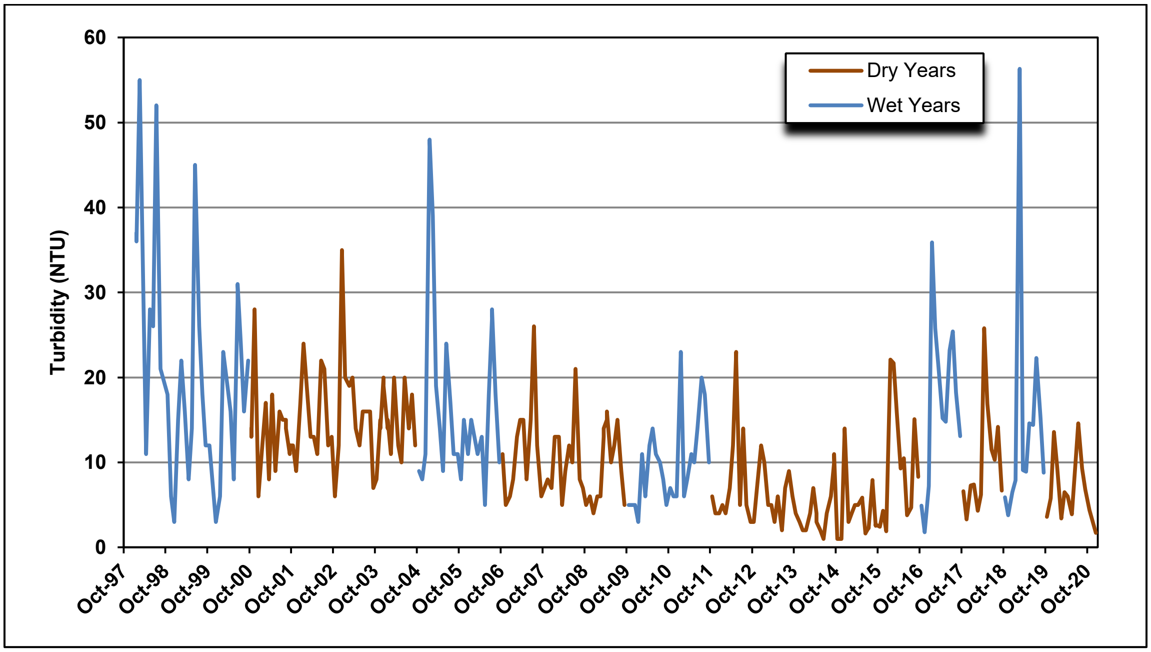
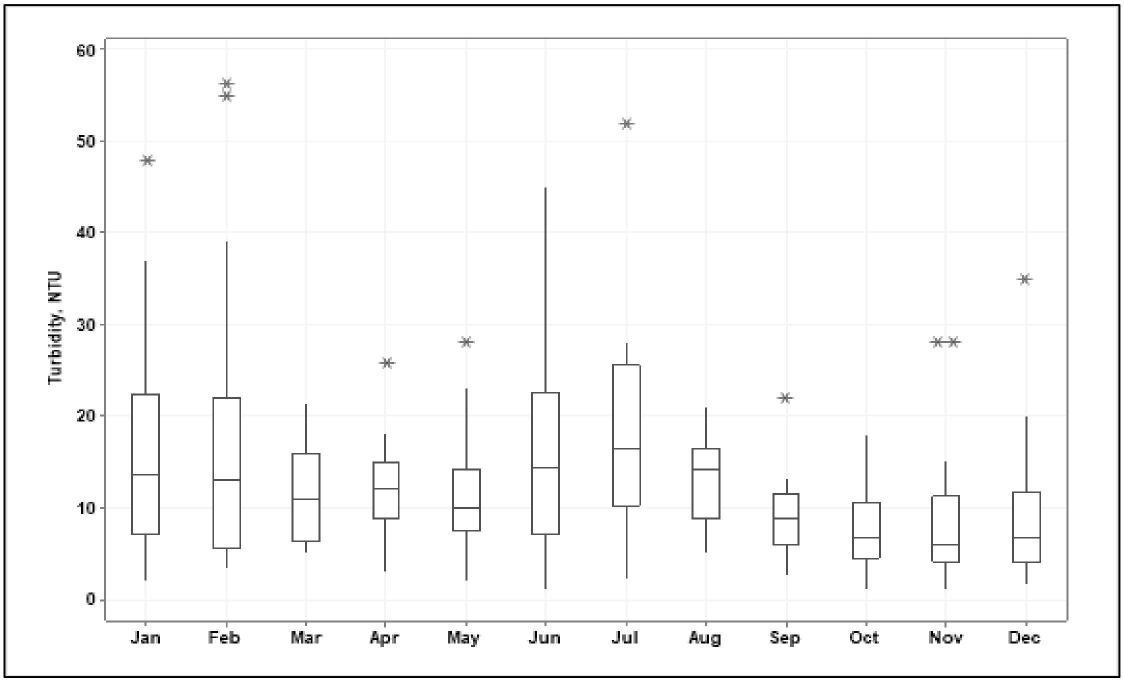


Figure 8-31. Monthly Variability in Turbidity at McCabe, 1997 to 2020



San Luis Reservoir – Grab sample turbidity data have been collected at Pacheco since 2000 and real-time data have been collected since 1989. **Figure 8-32** presents all of the available lab grab or field sample turbidity data for Pacheco. Field data was used during the 2016 to 2020 time period. There is much less variability in turbidity levels in the reservoir than in the aqueduct. The turbidity levels at Pacheco range from the reporting limit (<1) to 8 NTU with a median of 2 NTU.

- Comparison of Real-time and Grab Sample Data – **Figure 8-33** compares the real-time data with the field sample data at Pacheco from 2016 to 2020 and **Figure 8-34** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.4402 which is not acceptable.

- Spatial Trends – **Figure 8-29** shows all of the data at Pacheco, Gianelli, Banks, and McCabe. The median turbidity level at Pacheco (2 NTU) is statistically significantly lower than the median turbidity of 8 NTU at Banks (Mann-Whitney, p=0.0000) and the median turbidity of 11 NTU at McCabe during the 1998 to 2020 period (Mann-Whitney, p=0.0000).

- Long-Term Trends – **Figure 8-33** shows no discernible long-term trend at Pacheco.

- Wet Year/Dry Year Comparison – The median turbidity is 2 NTU during both dry and wet years.

- Seasonal Trends – **Figure 8-35** shows that turbidity levels are highest and more variable during the summer months.

Figure 8-32. Turbidity Levels at Pacheco

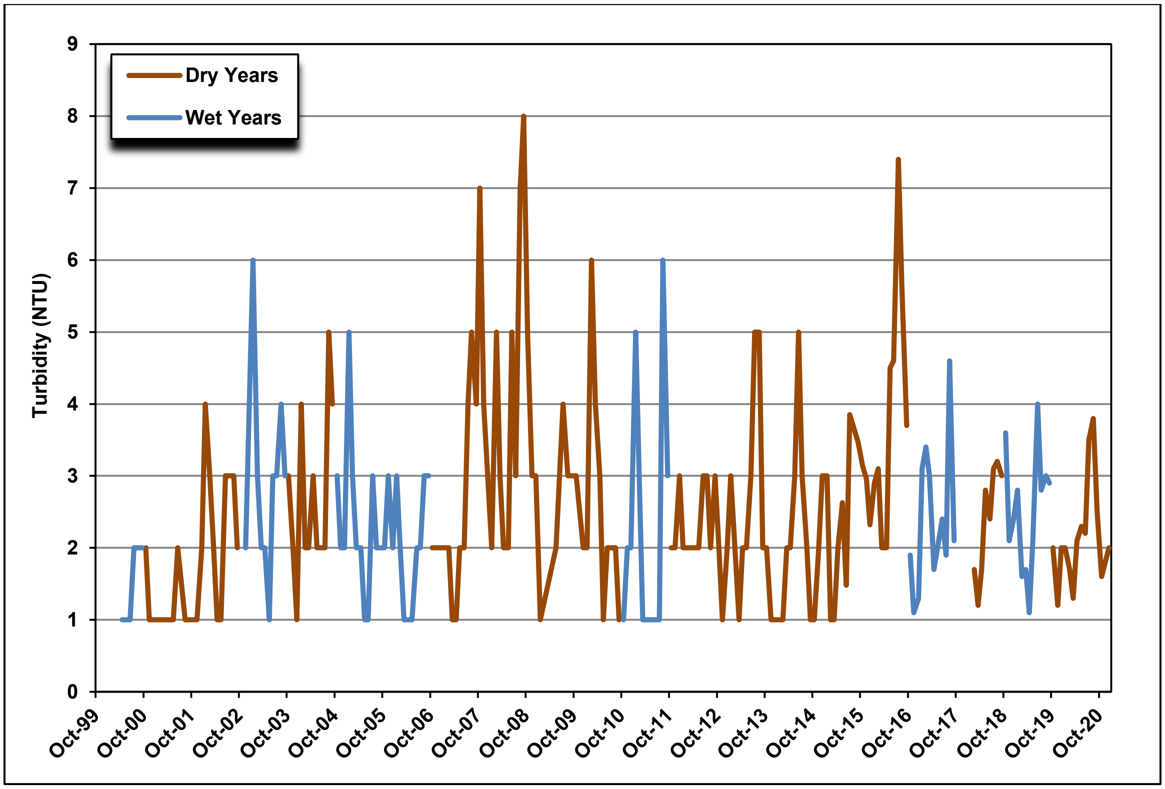


Figure 8-33. Comparison of Pacheco Real-time and Field Sample Turbidity Data, 2016 to 2020

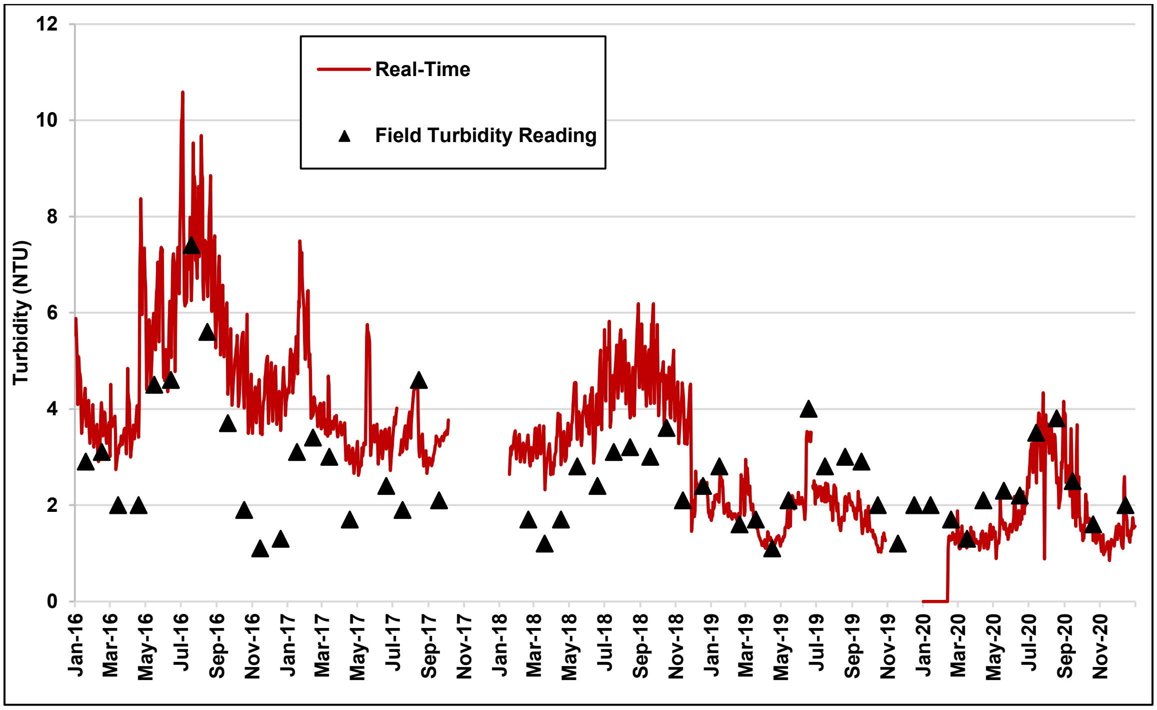


Figure 8-34. Comparison of Pacheco Real-time and Field Sample Turbidity Data, 2016 to 2020, 1:1 Graph

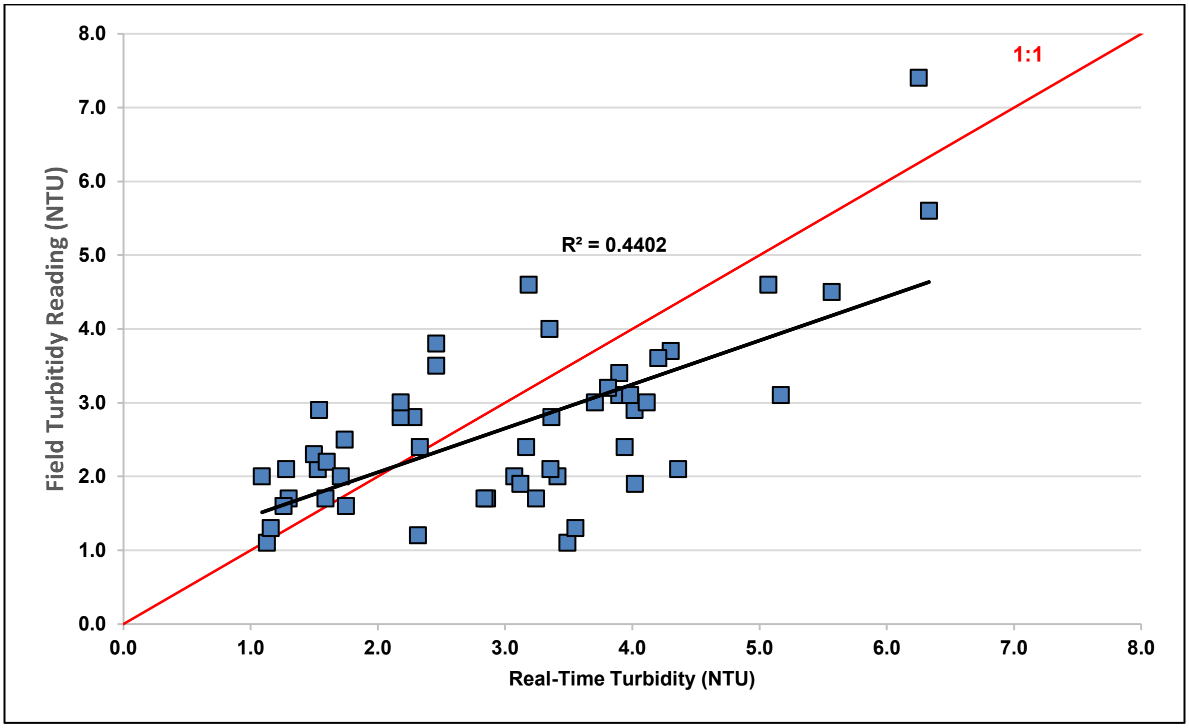
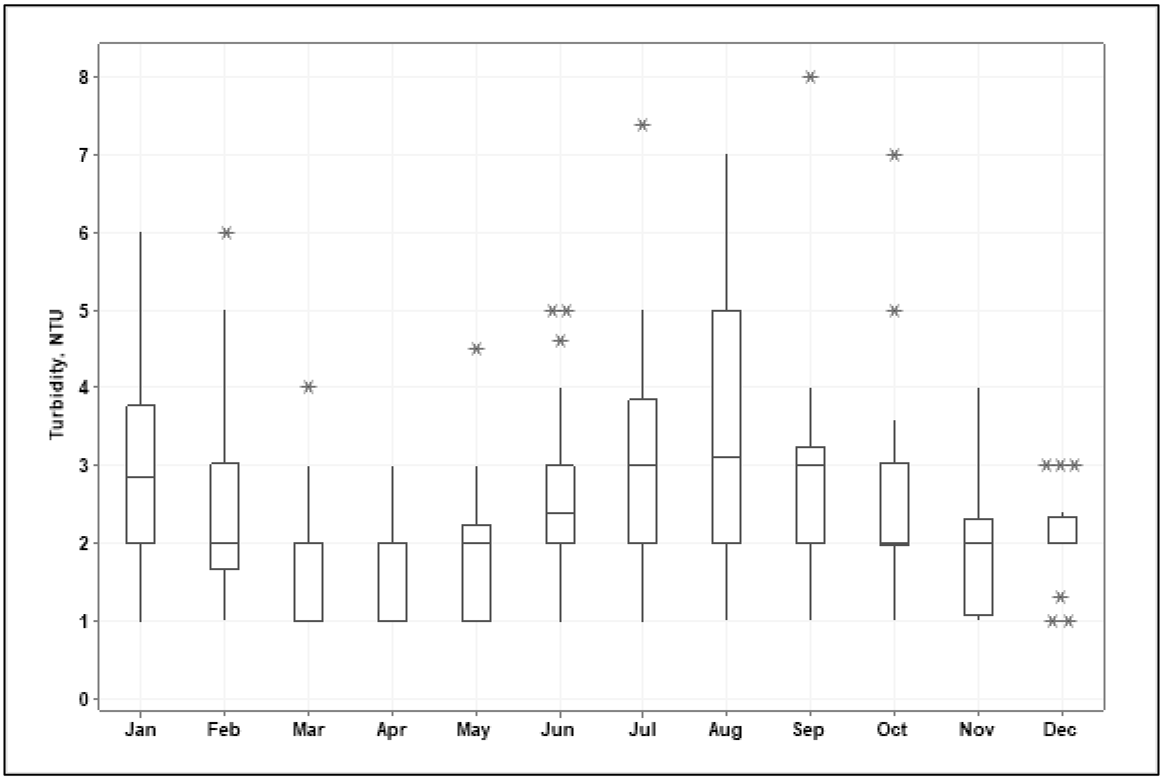


Figure 8-35. Monthly Variability in Turbidity at Pacheco, 2000 to 2020



***San Luis Reservoir (Gianelli)* – Figure 8-36** presents all of the available lab grab or field sample turbidity data for Gianelli. Field data was used during the 2016 to 2020 time period. The turbidity levels at Gianelli range from the reporting limit (<1) to 8 NTU with a median of 2 NTU.

- Comparison of Real-time and Grab Sample Data – **Figure 8-37** compares the real-time data with the field sample data at Gianelli from 2016 to 2020 and **Figure 8-38** shows that when the 2016 to 2020 data is plotted 1:1, the R squared value is 0.8054 which is acceptable.

- Spatial Trends – All available data from Gianelli and Pacheco are presented in **Figures 8-29.** The median turbidity level at Pacheco (2 NTU) is statistically significantly lower than the median turbidity of 4 NTU at Gianelli (Mann-Whitney, *p*=0.000). Gianelli may be higher than Pacheco as the water at Gianelli may be pumped from O'Neill Forebay or released from San Luis Reservoir.

- Long-Term Trends – **Figure 8-36** does not display any discernible long-term trends.

- Wet Year/Dry Year Comparison - The data were analyzed to determine if there are statistically significant differences between wet years and dry years. The median turbidity of 3.5 NTU in dry years is statistically significantly lower than the median of 5.9 NTU in wet years (Mann-Whitney, *p*=0.002).

- Seasonal Trends – Seasonal trends were not conducted as water quality is more impacted on whether or not water is being released from San Luis Reservoir or being pumped from O'Neill forebay into San Luis Reservoir. Generally pumping occurs from September to March, and releases occur from April to August.

Figure 8-36. Turbidity Levels at Gianelli

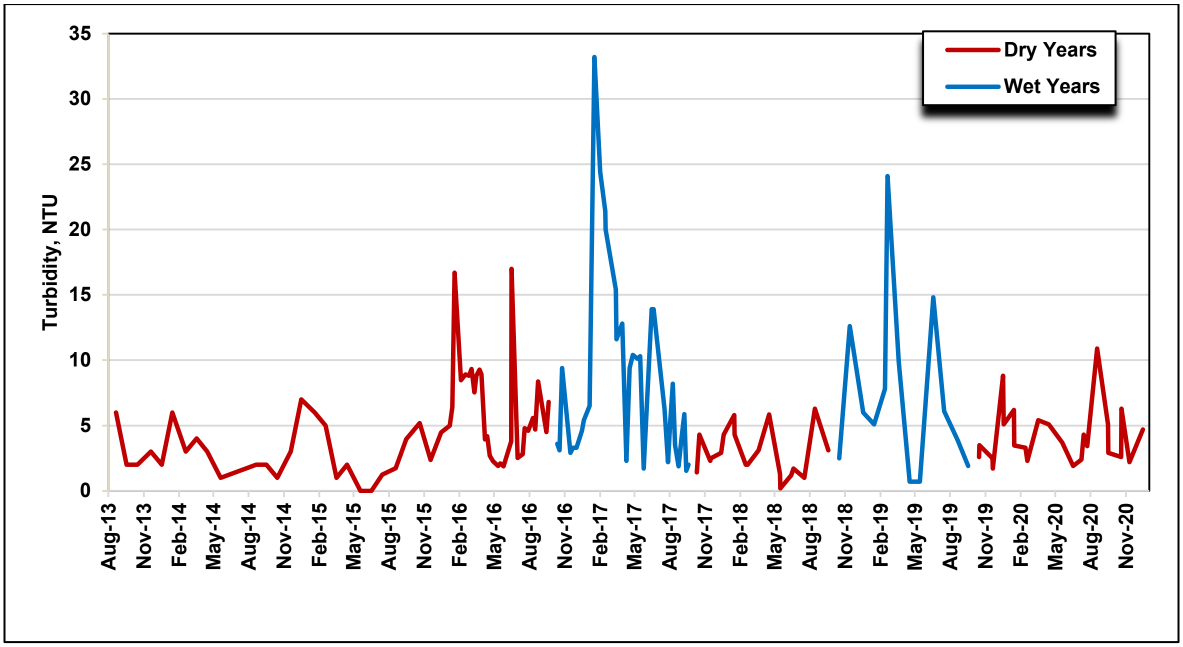


Figure 8-37. Comparison of Gianelli Real-time and Field Sample Turbidity Data, 2016 to 2020

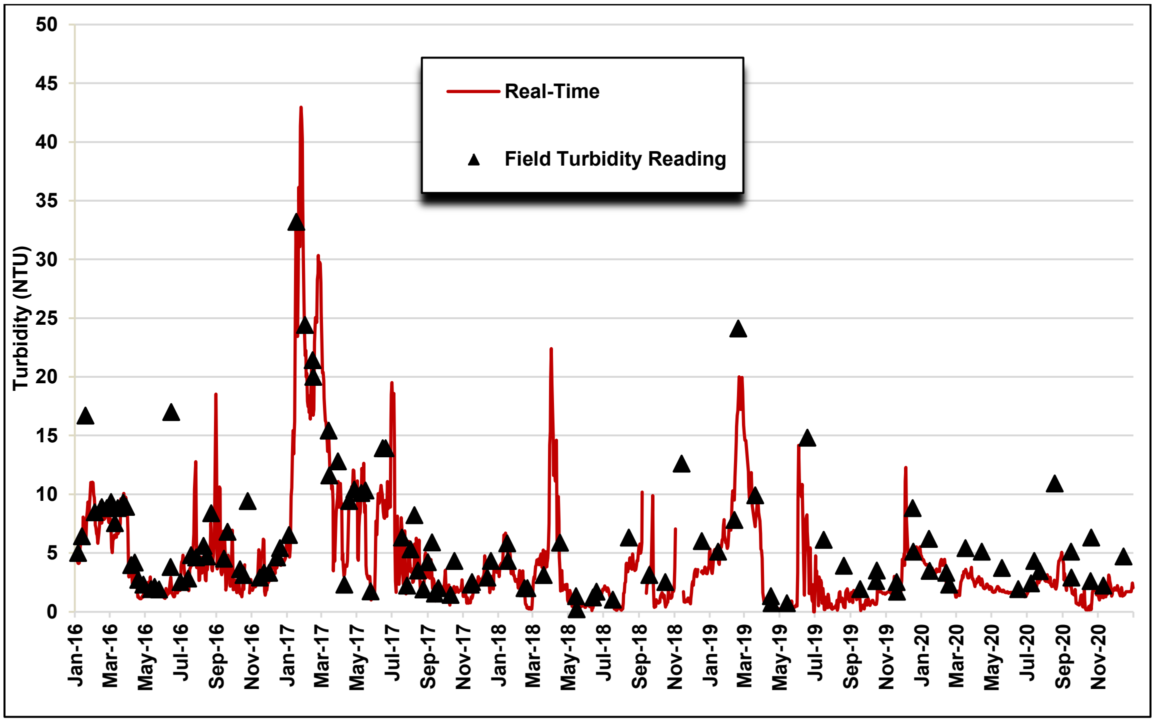
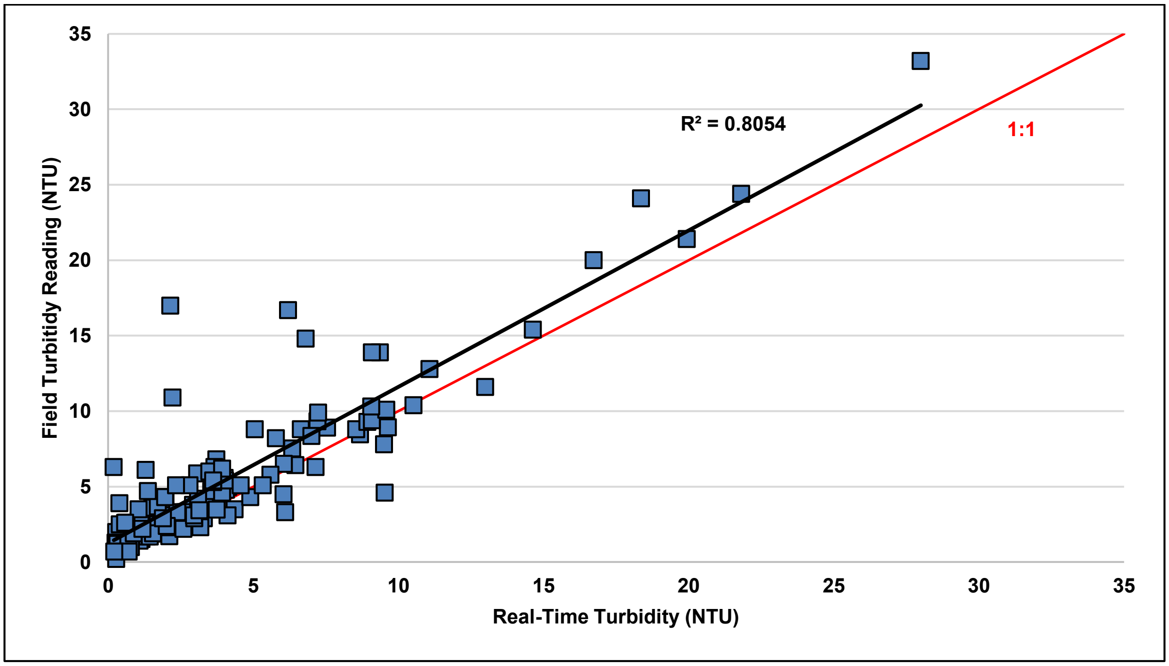


Figure 8-38. Comparison of Gianelli Real-time and Field Sample Turbidity Data, 2016 to 2020, 1:1 Graph



O'Neill Forebay Outlet/Check 13 – O'Neill Forebay Outlet on the California Aqueduct is a mixture of water from San Luis Reservoir, the California Aqueduct, and the DMC. **Figure 8-39** presents the turbidity lab grab or field sample data for O'Neill Forebay Outlet. Field data was used during the 2016 to 2020 time period. The turbidity levels at O'Neill Forebay Outlet range from <1 to 32 NTU with a median of 5 NTU.

Comparison of Real-time and Grab Sample Data – **Figure 8-40** compares the real-time data with the field sample data at Check 13 over 2016 to 2020 and **Figure 8-41** shows that when the data is plotted 1:1, the R squared value is 0.9676 which is acceptable.

- Spatial Trends – **Figure 8-29** compares the grab sample data collected between 1998 and 2020 at O'Neill Forebay Outlet to a number of other locations along the aqueduct. Turbidity decreases between Banks and O'Neill Forebay Outlet due to settling in the forebay and releases of low turbidity water from San Luis Reservoir. The O'Neill Forebay Outlet median turbidity of 5 NTU is statistically lower than the Banks median of 8 NTU (Mann-Whitney, *p*=0.000).

- Long-Term Trends – **Figure 8-39** shows a decline in turbidity levels from 1997 to 2015 but began increasing during the wet years of 2017 and 2019.

- Wet Year/Dry Year Comparison – The O'Neill Forebay Outlet dry year median turbidity of 4 NTU is statistically significantly lower than the wet year median of 7 NTU (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – **Figure 8-42** shows there is a distinct seasonal pattern with the highest turbidity levels during the winter months and lower levels in the spring. Turbidity increases again during June and July. The summer peaks at O'Neill Forebay Outlet are similar to the peaks at Banks and McCabe, although the levels at O'Neill Forebay Outlet are lower. This is likely due to low turbidity water being released from San Luis Reservoir in the summer months.

Figure 8-39. Turbidity Levels at O'Neill Forebay Outlet

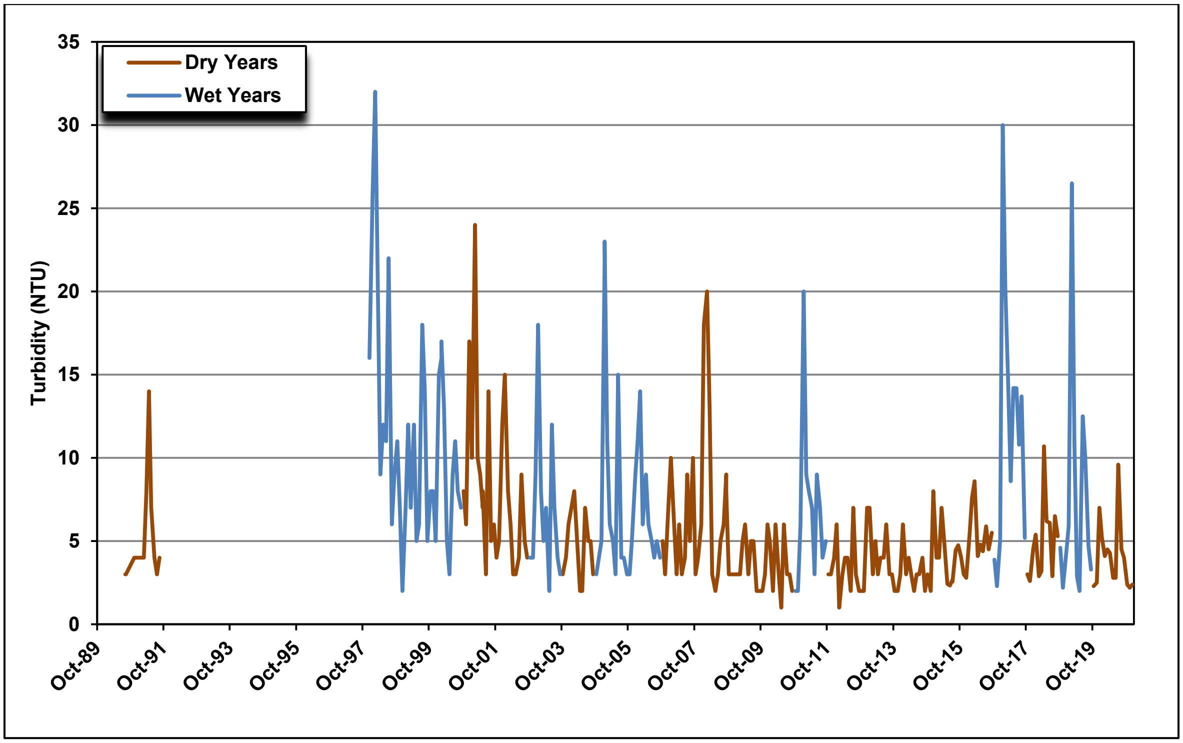


Figure 8-40. Comparison of Check 13 Real-time and Field Sample Turbidity Data, 2016 to 2020

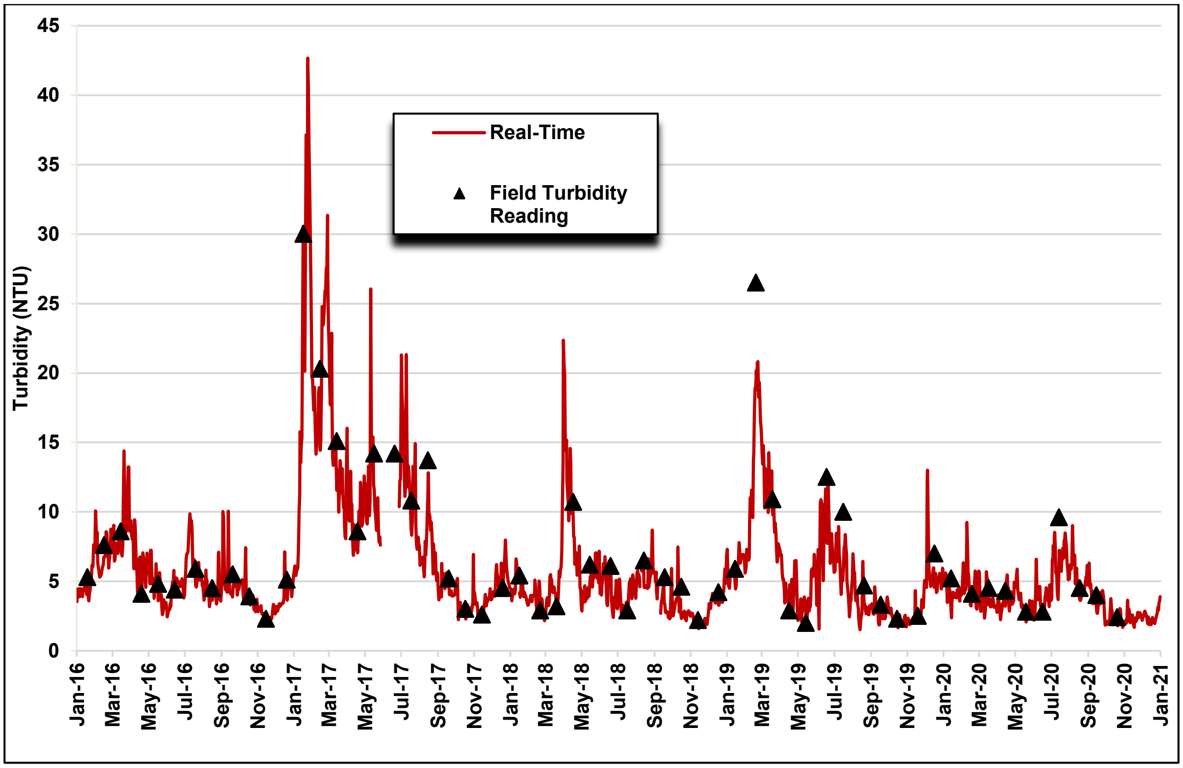


Figure 8-41. Comparison of Check 13 Real-time and Field Sample Turbidity Data, 2016 to 2020, 1:1 Graph

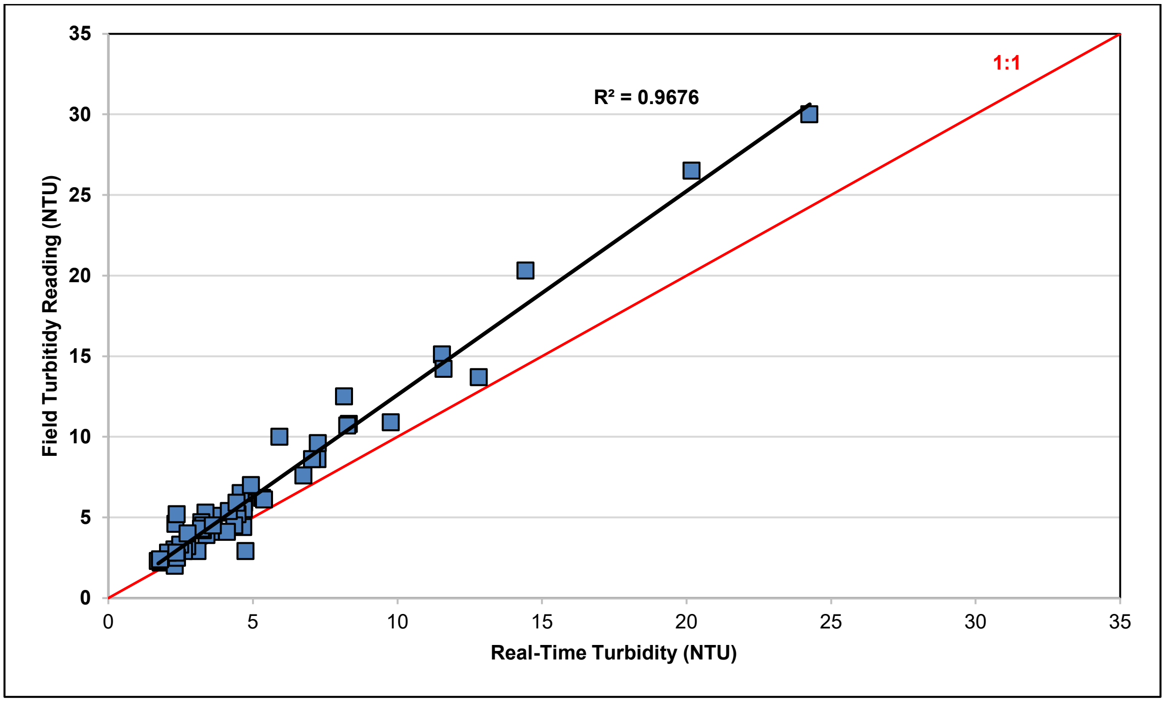
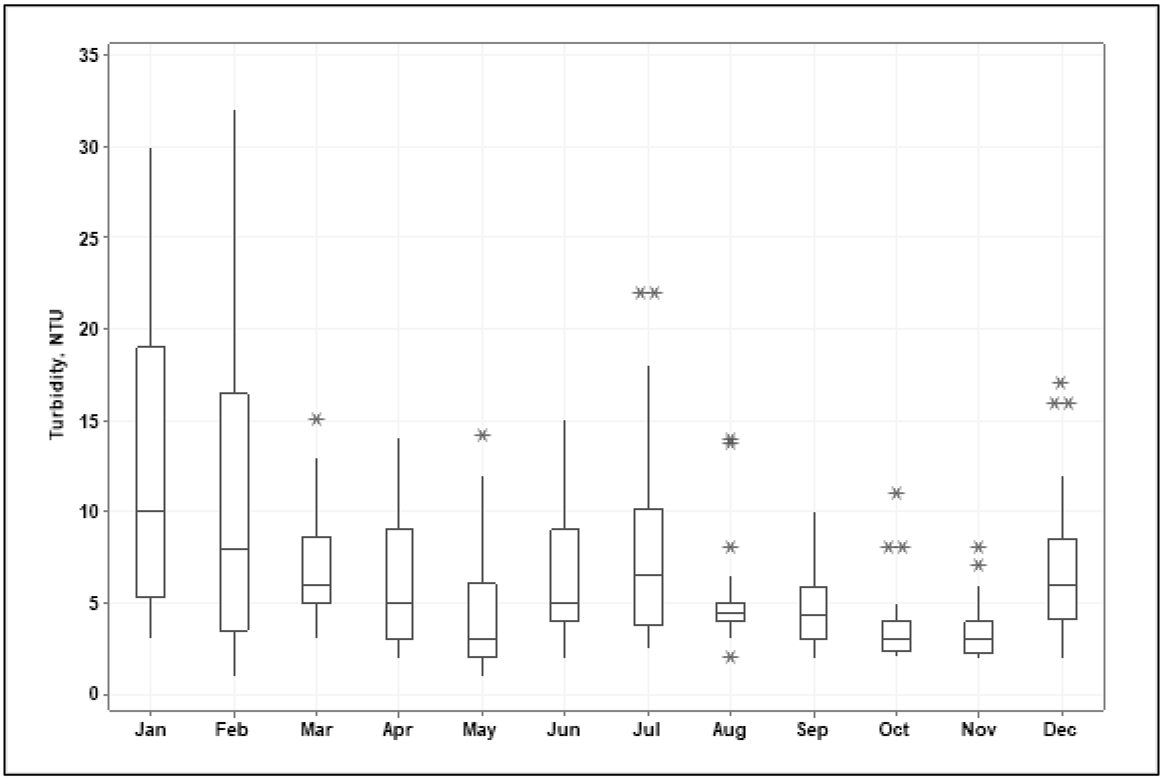


Figure 8-42. Monthly Variability in Turbidity at Check 13, 1990 to 2020



Check 21 – Check 21 represents the quality of water entering the Coastal Branch. **Figure 8-43** presents the turbidity lab grab or field sample data for Check 21. Field data was used during the 2016 to 2020 time period. The turbidity levels at Check 21 range from <1 to 71 NTU with a median of 5 NTU.

- Comparison of Real-time and Grab Sample Data – **Figure 8-44** compares the real-time data with the field sample data at Check 21 over 2016 to 2020 and **Figure 8-45** shows that when the data is plotted 1:1, the R squared value is 0.9654 which is acceptable.

- Spatial Trends – **Figure 8-29** compares the grab sample data collected between 1998 and 2020 at Check 21 to a number of other locations along the aqueduct. Although there can be flood and groundwater inflows into the aqueduct between O'Neill Forebay Outlet and Check 21, the median turbidity is 5 NTU at both locations.

- Long-Term Trends – **Figure 8-43** shows turbidity levels decline from 1997 to 2015 but began increasing during the wet years of 2017 and 2019.

- Wet Year/Dry Year Comparison – The Check 21 dry year median turbidity of 4 NTU is statistically significantly lower than the wet year median of 8 NTU (Mann-Whitney, p=0.000).

- Seasonal Trends – **Figure 8-46** shows that turbidity levels increase during the winter months, decline in the spring, and then increase again in the summer. The monthly pattern is similar to the pattern at O'Neill Forebay Outlet.

Figure 8-43. Turbidity Levels at Check 21

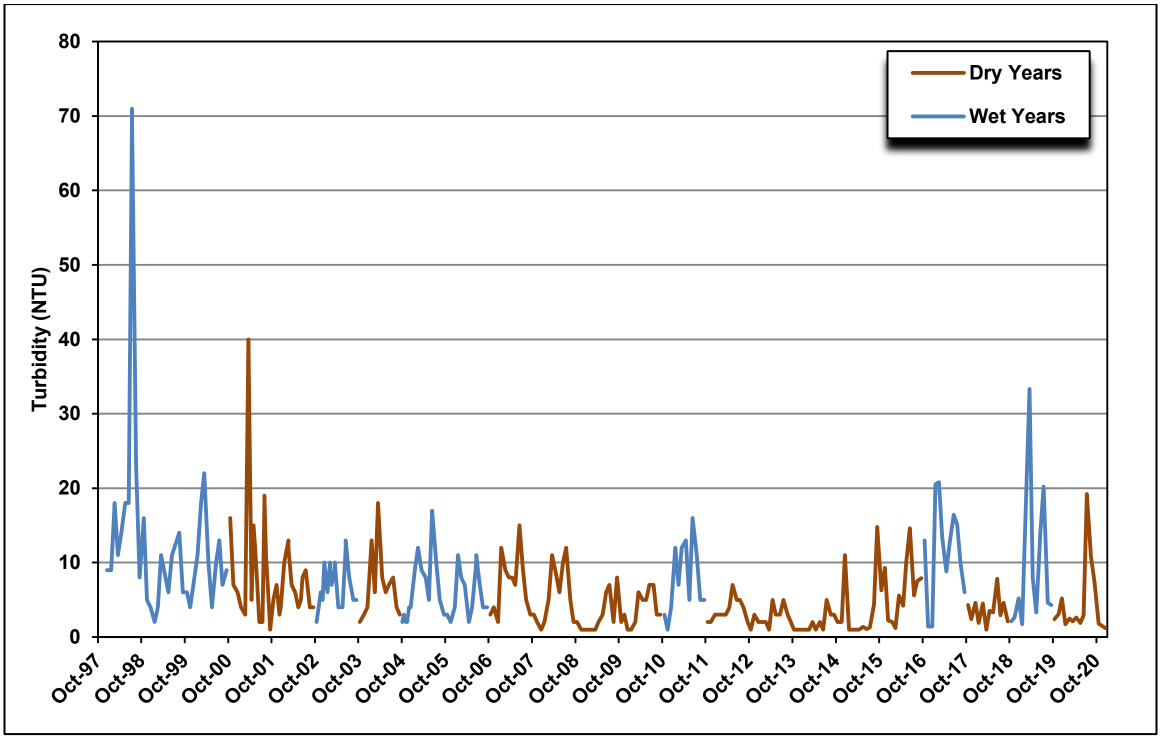


Figure 8-44. Comparison of Check 21 Real-time and Field Sample Turbidity Data, 2016 to 2020

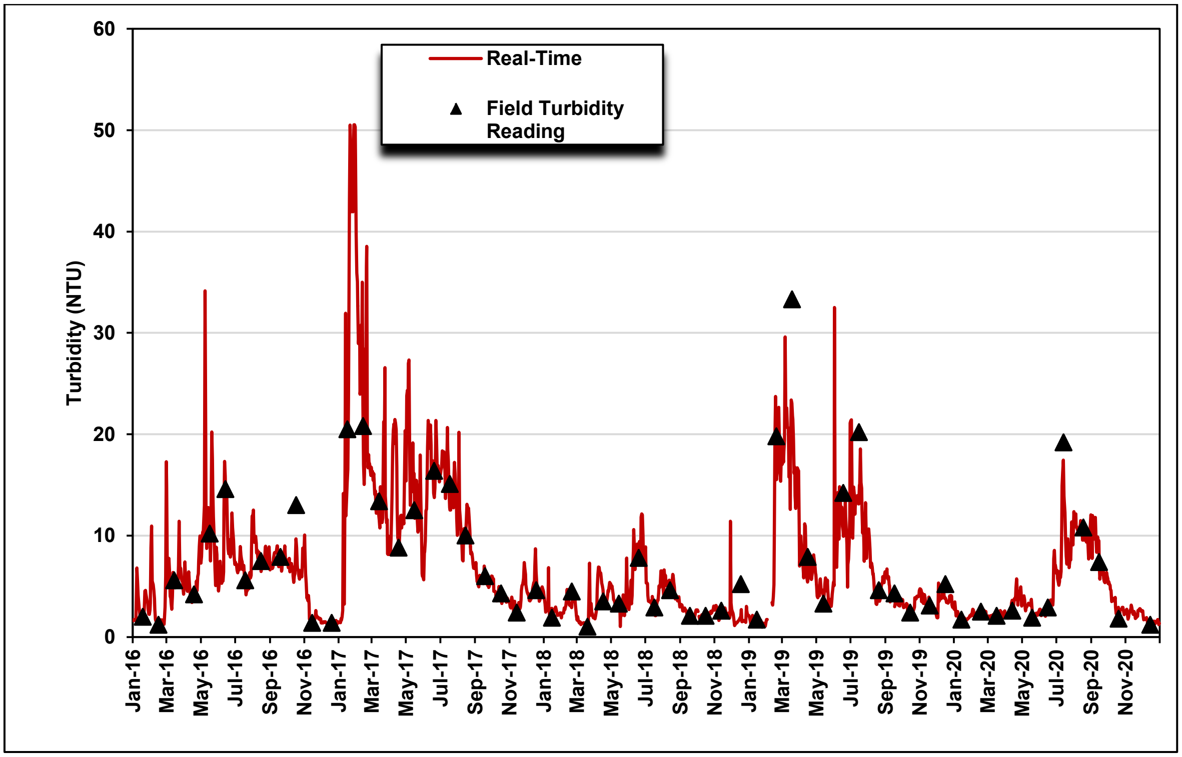


Figure 8-45. Comparison of Check 21 Real-time and Field Sample Turbidity Data, 2016 to 2020, 1:1 Graph

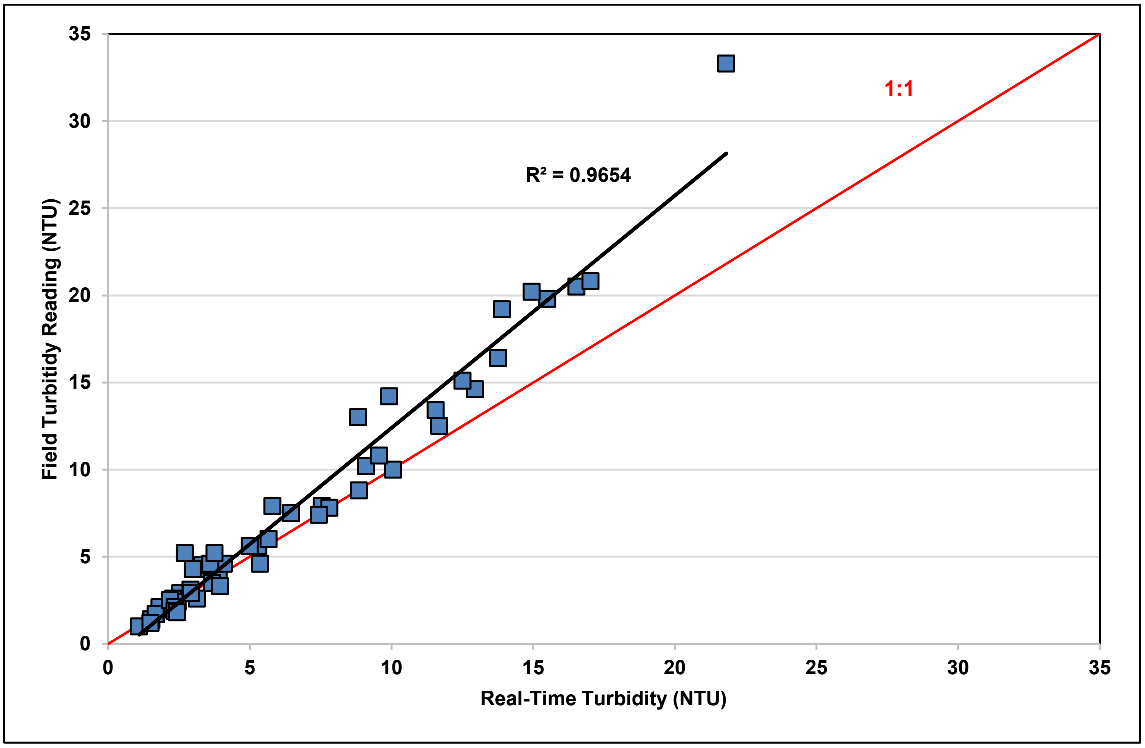
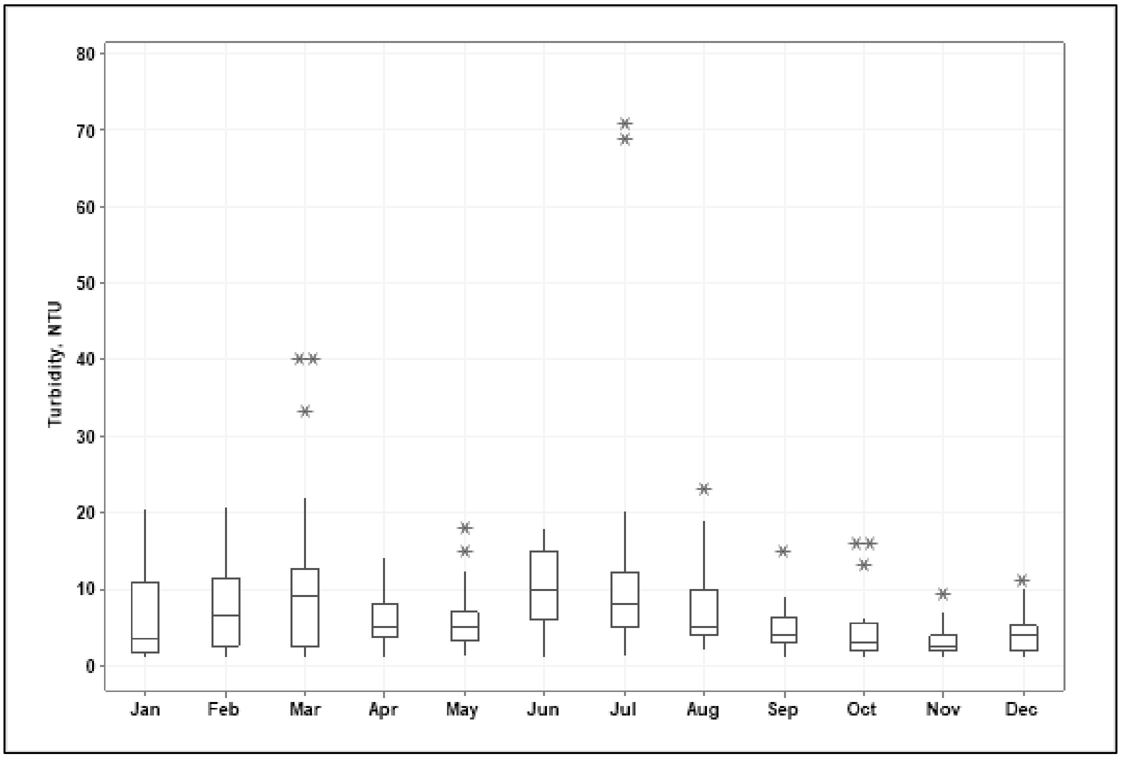


Figure 8-46. Monthly Variability in Turbidity at Check 21, 1997 to 2020



Check 41 – Check 41 is immediately upstream of the bifurcation of the aqueduct into the east and west branches. Data from this location can be used to evaluate changes along both branches of the aqueduct. **Figure 8-47** presents the lab grab or field turbidity data for Check 41. Field data was used during the 2016 to 2020 time period. Data is missing for all of 2018 and 2019. Data was kept in a log book which was damaged in a station flooding event. The turbidity levels at Check 41 range from <1 to 140 NTU with a median of 6 NTU. There was one large spike in turbidity up to 140 NTU in July 1998 and another large spike in turbidity up to 119 NTU in July 2015.

- Comparison of Real-time and Grab Sample Data – **Figure 8-48** compares the real-time and field data at Check 41 over 2016 to 2020 and **Figure 8-49** shows that when the 2016 to 2020data is plotted 1:1, the R squared value is 0.9216 which is acceptable. Real-time data has not been recording in 2020 due to a communication issue with the phone line at the station.

- Spatial Trends – **Figure 8-29** compares the grab sample data collected between 1998 and 2020 at Check 41 to a number of other locations along the aqueduct. Large volumes of groundwater and surface water can enter the aqueduct between Checks 21 and 41. The median turbidity at Check 21 is 1 NTU lower than at Check 41 and there is less variability in the data. The Check 21 median turbidity of 5 NTU is statistically lower than the Check 41 median of 6 NTU (Mann-Whitney, *p*=0.001). **Figure 8-50** shows that Check 41 generally follows the same trends as Check 21, but Check 41 may experience higher turbidity peaks.

- Long-Term Trends – **Figure 8-47** shows no discernable trend in the data.

- Wet Year/Dry Year Comparison – The Check 41 dry year median turbidity of 5 NTU is statistically significantly lower than the wet year median of 9.6 NTU (Mann-Whitney, *p*=0.000).

- Seasonal Trends – **Figure 8-51** shows that turbidity levels increase throughout the winter and spring months with the peak turbidity in July. The levels then decline during the fall months.

Figure 8-47. Turbidity Levels at Check 41

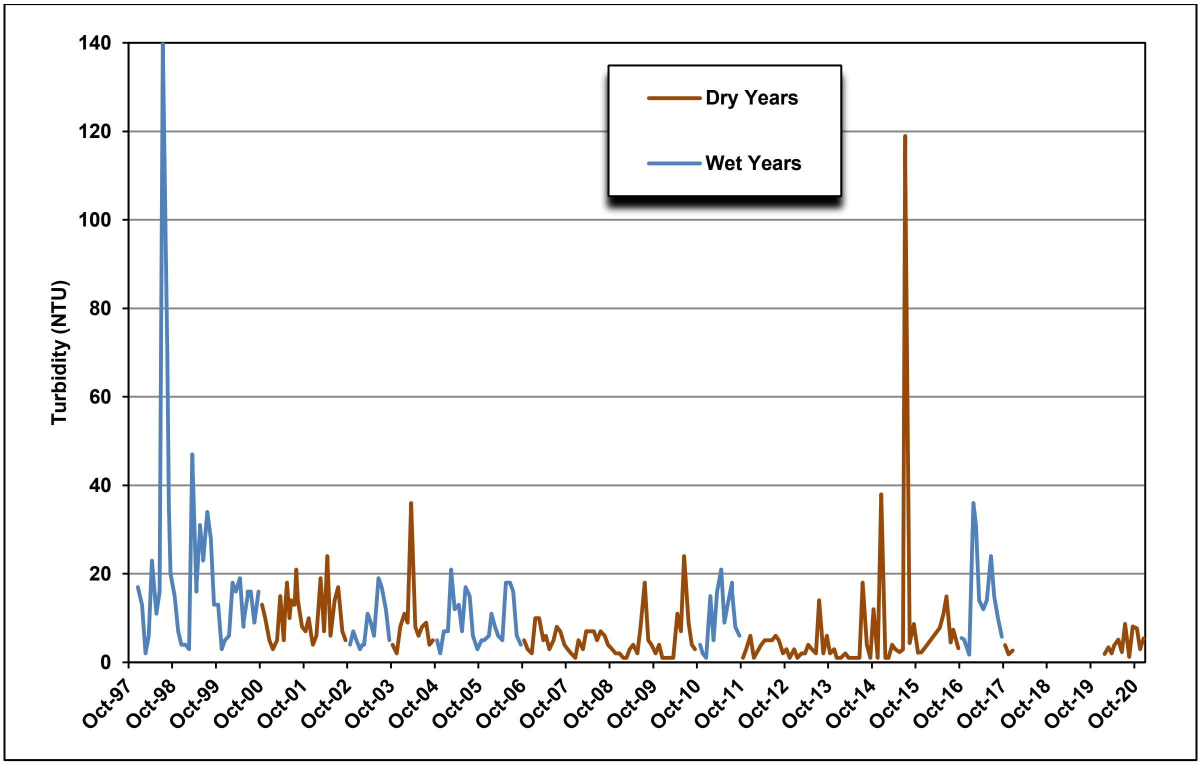


Figure 8-48. Comparison of Check 41 Real-time and Field Sample Turbidity Data, 2016 to 2020

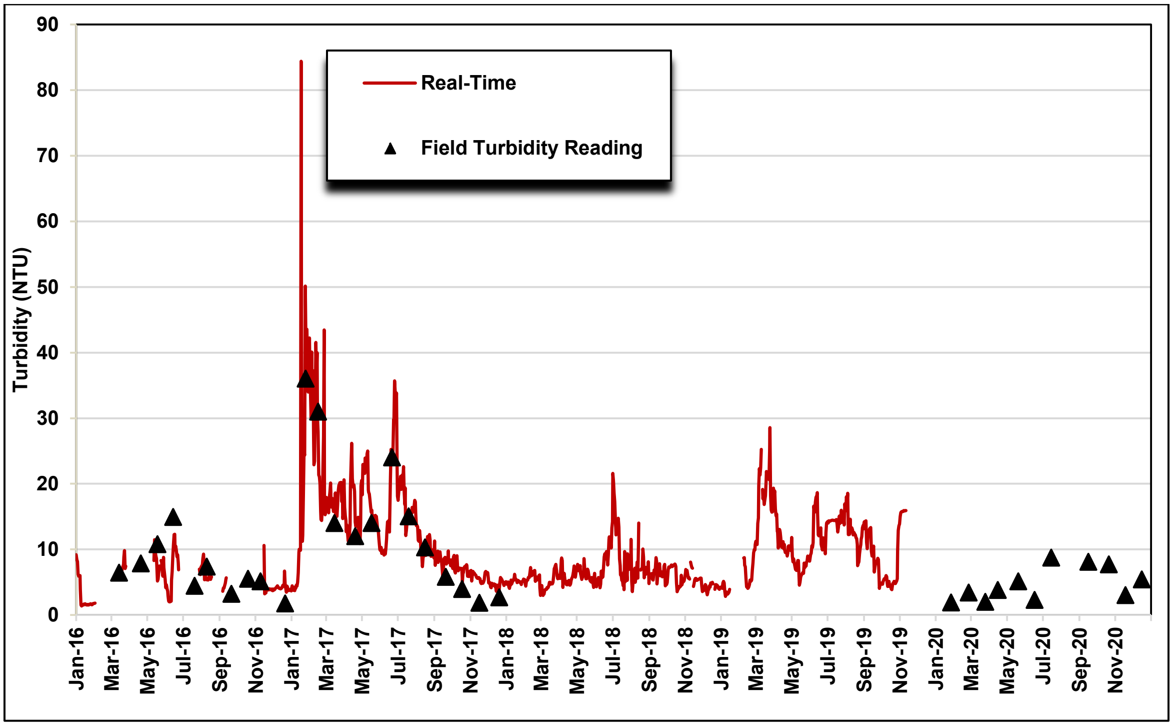


Figure 8-49. Comparison of Check 41 Real-time and Field Sample Turbidity Data, 2016 to 2020, 1:1 Graph

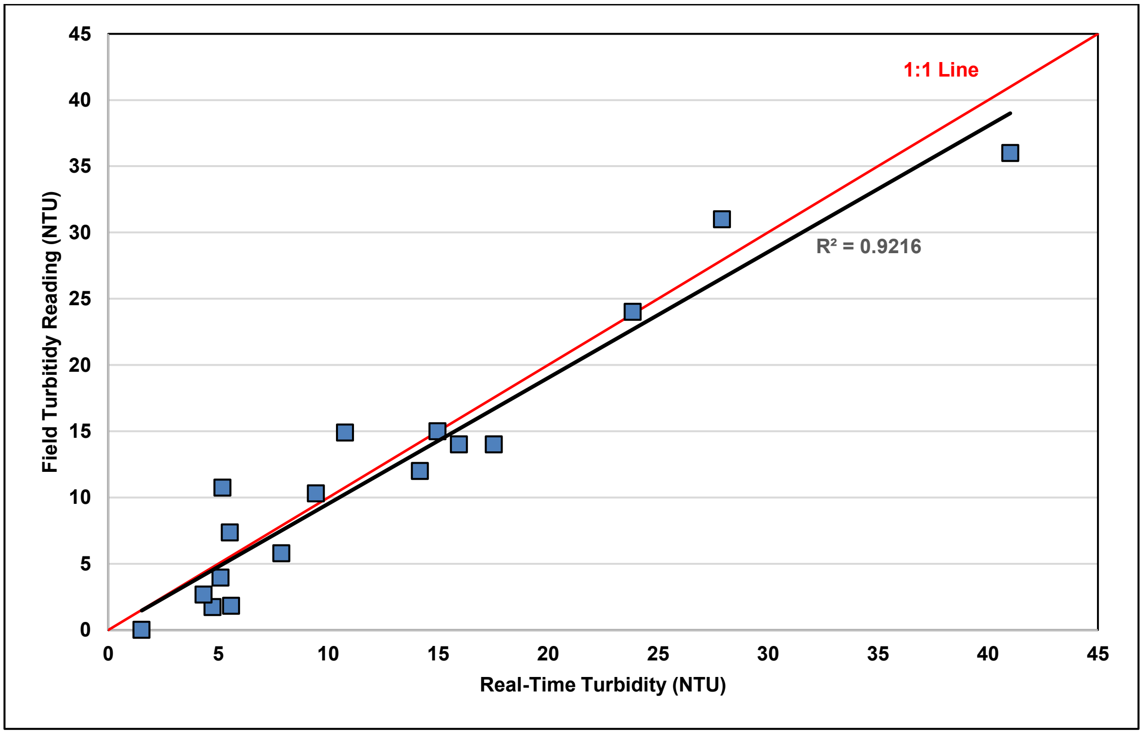
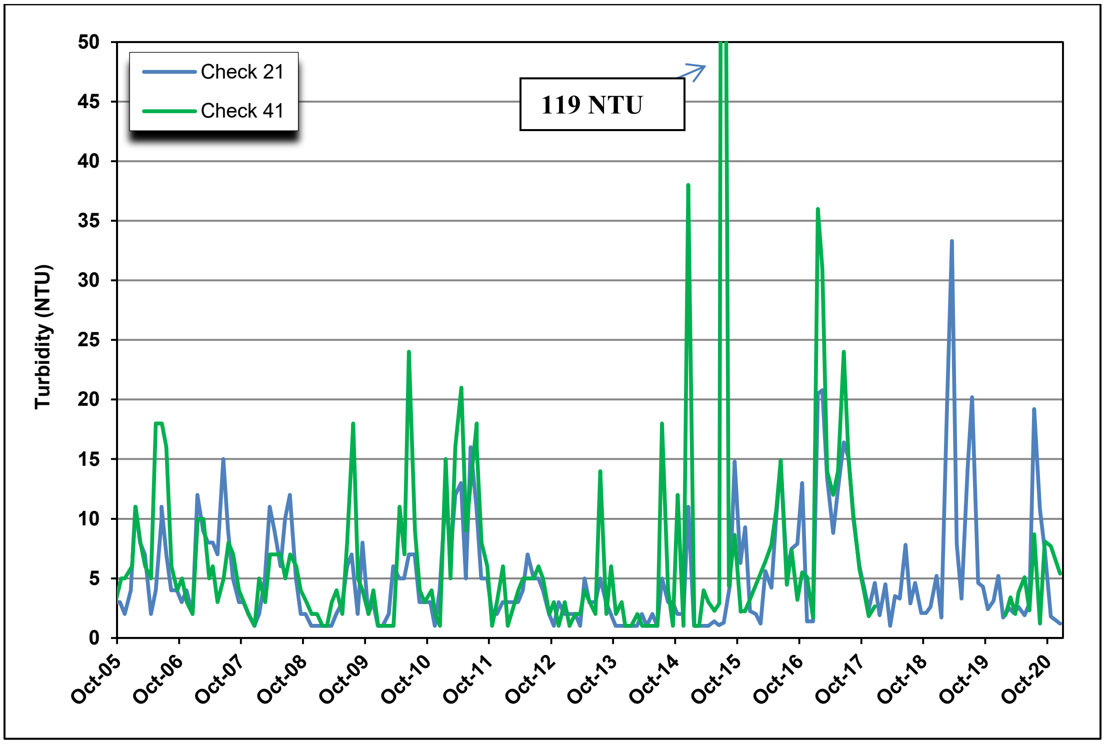
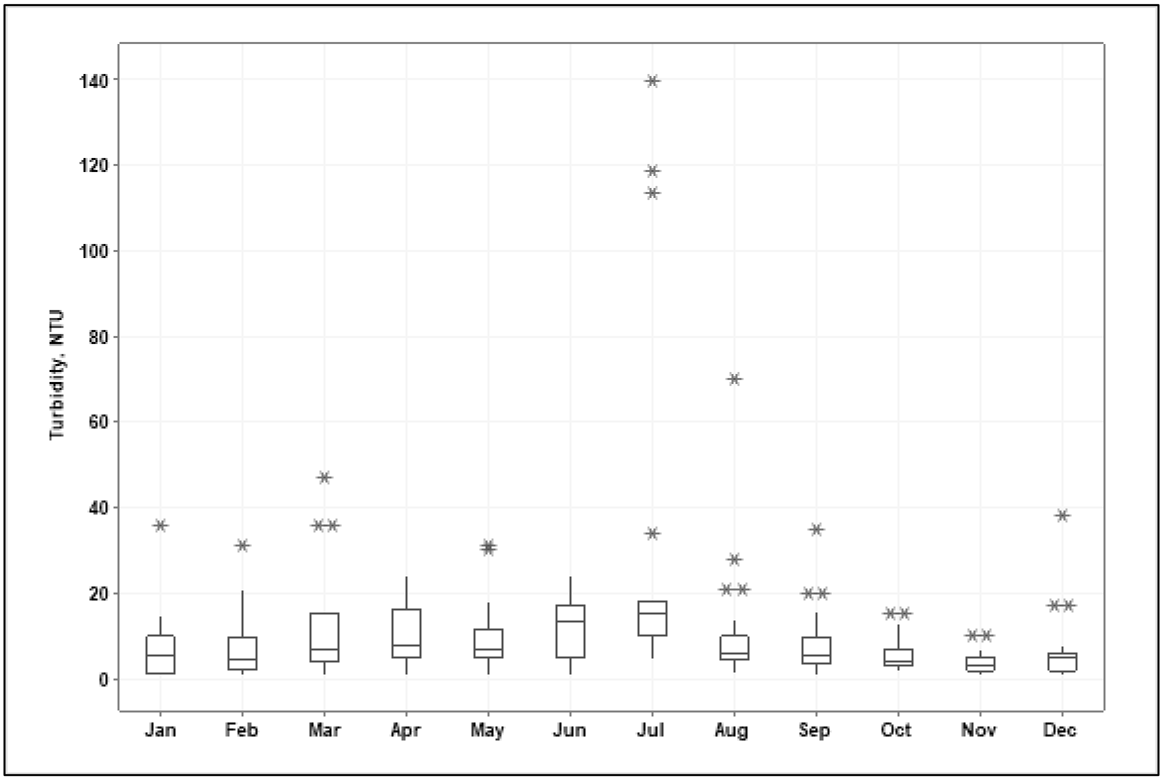


Figure 8-50. Comparison of Check 21 and Check 41 Turbidity Levels



119 NTU

Figure 8-51. Monthly Variability in Turbidity at Check 41, 1997 to 2020



Castaic Outlet – Castaic Lake is the terminus of the West Branch of the California Aqueduct. **Figure 8-52** presents the turbidity lab grab and field sample data for Castaic Outlet. Data is missing for nine months in 2017 and for all of 2018 and 2019. Data was kept in a log book which was damaged in a station flooding event. The turbidity levels at Castaic Outlet range from <1 to 17 NTU and the median turbidity is 1.3 NTU. There is much less variability in the turbidity data in the lake compared to the aqueduct. Due to the limited data, no seasonal trends will be evaluated.

- Comparison of Real-time and Grab Sample Data – **Figure 8-53** shows that the grab samples can be 1 to 2 NTU higher than the real-time measurements. However the limited amount of grab data does not allow for a reasonable comparison. **Figure 8-54** shows that when the limited 2016 to 2020 data is plotted 1:1, the R squared value is 0.0011 which is not acceptable.

- Spatial Trends – Although the sampling frequency differs between Check 41 and Castaic Outlet, **Figure 8-29** clearly shows that turbidity levels in Castaic Outlet are lower than in the Aqueduct due to settling of sediment in both Pyramid and Castaic lakes.

- Long-Term Trends –**Figure 8-52** shows that turbidity levels are low throughout the period of record with the exception of a spike in February 2005. This was a period of high rainfall with a large amount of runoff from the watershed.

- Wet Year/Dry Year Comparison – The dry year median turbidity of 2 NTU is not statistically significantly higher than the wet year median of 1 NTU (Mann-Whitney, *p*=0.113).

Figure 8-52. Turbidity Levels at Castaic Outlet

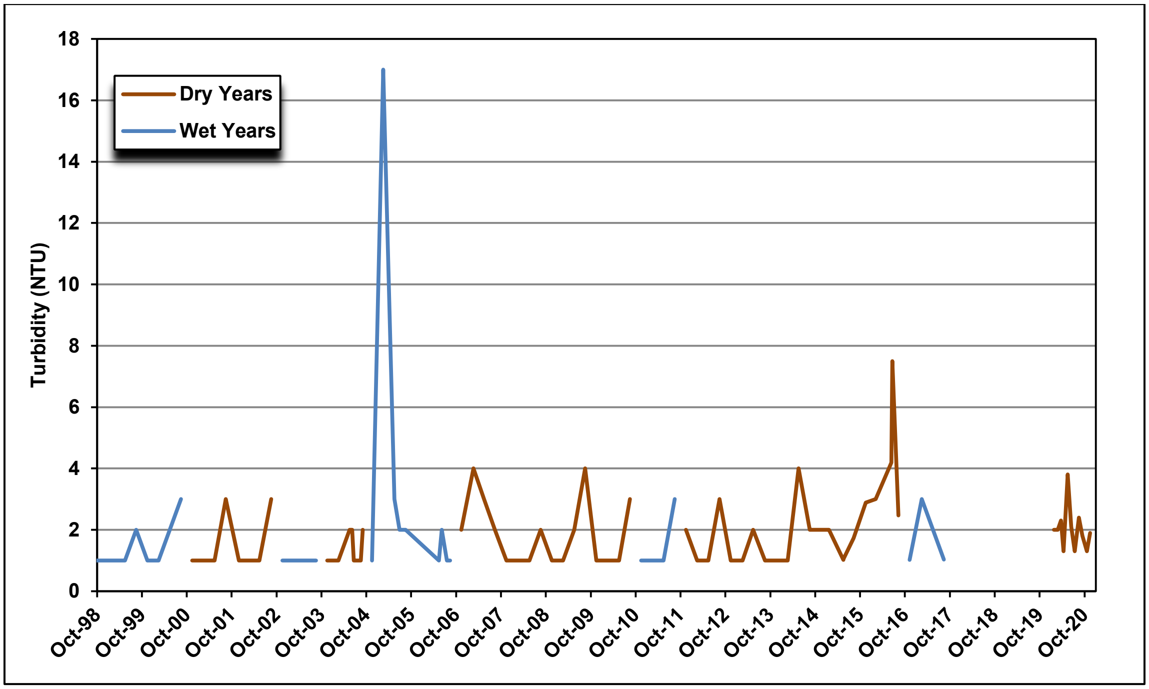


Figure 8-53. Comparison of Castaic Outlet Real-time and Field Sample Turbidity Data, 2016 to 2020

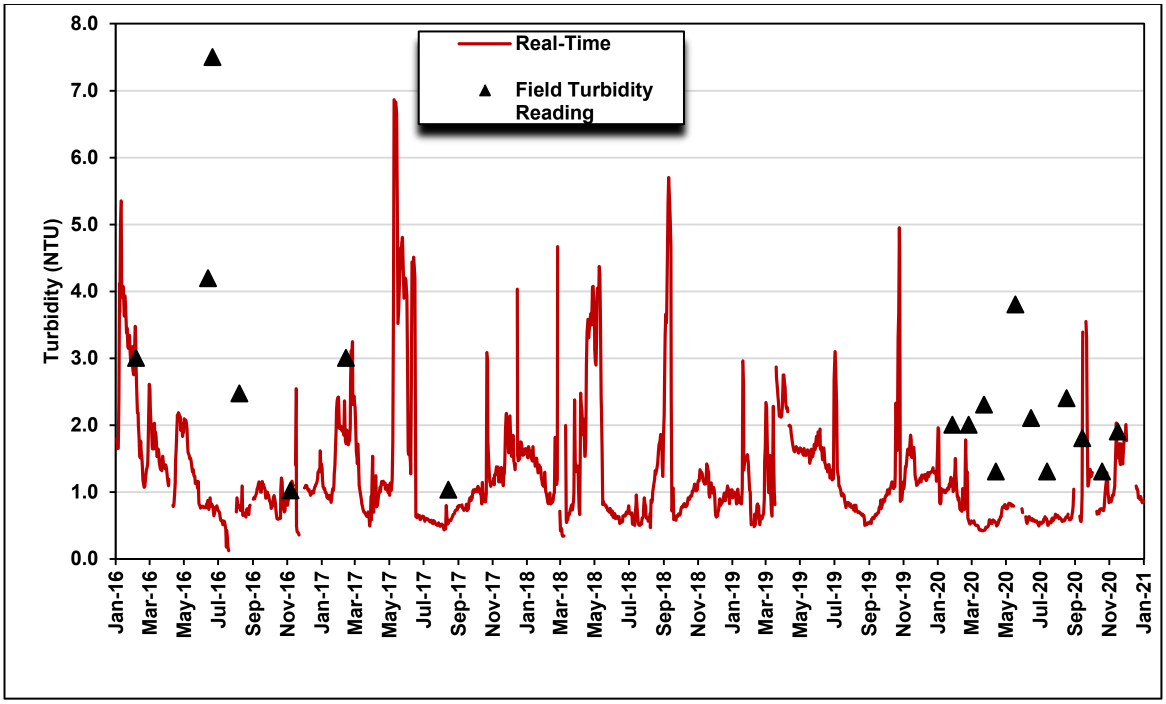
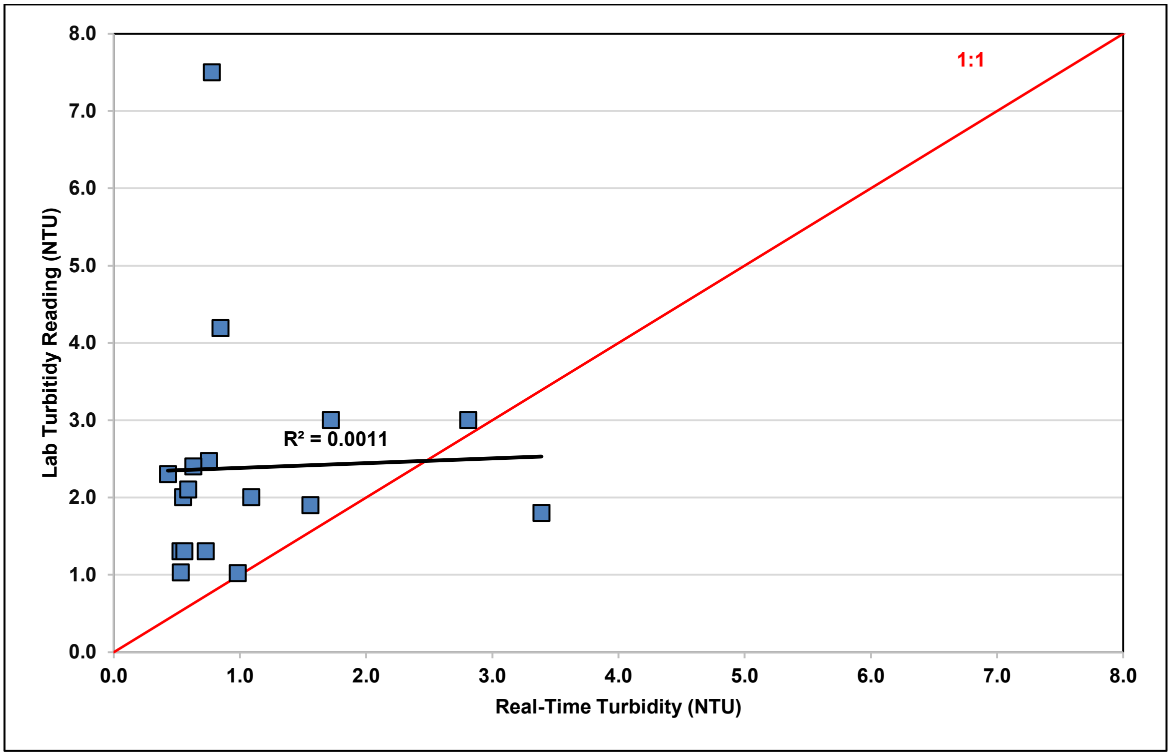


Figure 8-54. Comparison of Castaic Outlet Real-time and Field Sample Turbidity Data, 2016 to 2020, 1:1 Graph



Devil Canyon – Devil Canyon Afterbay is downstream of Silverwood Lake on the East Branch of the California Aqueduct. **Figure 8-55** presents the turbidity lab grab and field sample data for Devil Canyon. Field data was used during the 2016 to 2020 time period. The turbidity levels in the grab samples at Devil Canyon range from <1 to 18 NTU with the exception of one value of 167 NTU in October 2004. The median turbidity is 2 NTU. There was substantial rain and runoff from the Silverwood Lake watershed in the fall of 2004 and winters of 2005 and spring 2019 that resulted in high turbidity at Devil Canyon.

- Comparison of Real-time and Grab Sample Data – **Figure 8-56** compares the real-time data with the field sample data at Devil Canyon over 2016 to 2020 and **Figure 8-57** shows that when the data is plotted 1:1, the R squared value is 0.7996 which is acceptable.

- Spatial Trends – **Figure 8-29** compares Check 41 data to Devil Canyon data for the 1998 to 2020 period when data are available at both locations. The median turbidity level of 2 NTU at Devil Canyon is statistically significantly lower than the median of 6 NTU at Check 41 (Mann-Whitney, p=0.0000). The lower levels at Devil Canyon are due to settling of sediment in Silverwood Lake.

- Long-Term Trends – **Figure 8-55** does not show any discernible trend.

- Wet Year/Dry Year Comparison – The dry year median turbidity level of 1.5 NTU is statistically significantly lower than the wet year median of 3 NTU (Mann-Whitney, *p*=0.0000).

- Seasonal Trends – **Figure 8-58** shows that there is little variation in turbidity throughout the year at Devil Canyon, although the data are more variable in the fall months.

Figure 8-55. Turbidity Levels at Devil Canyon

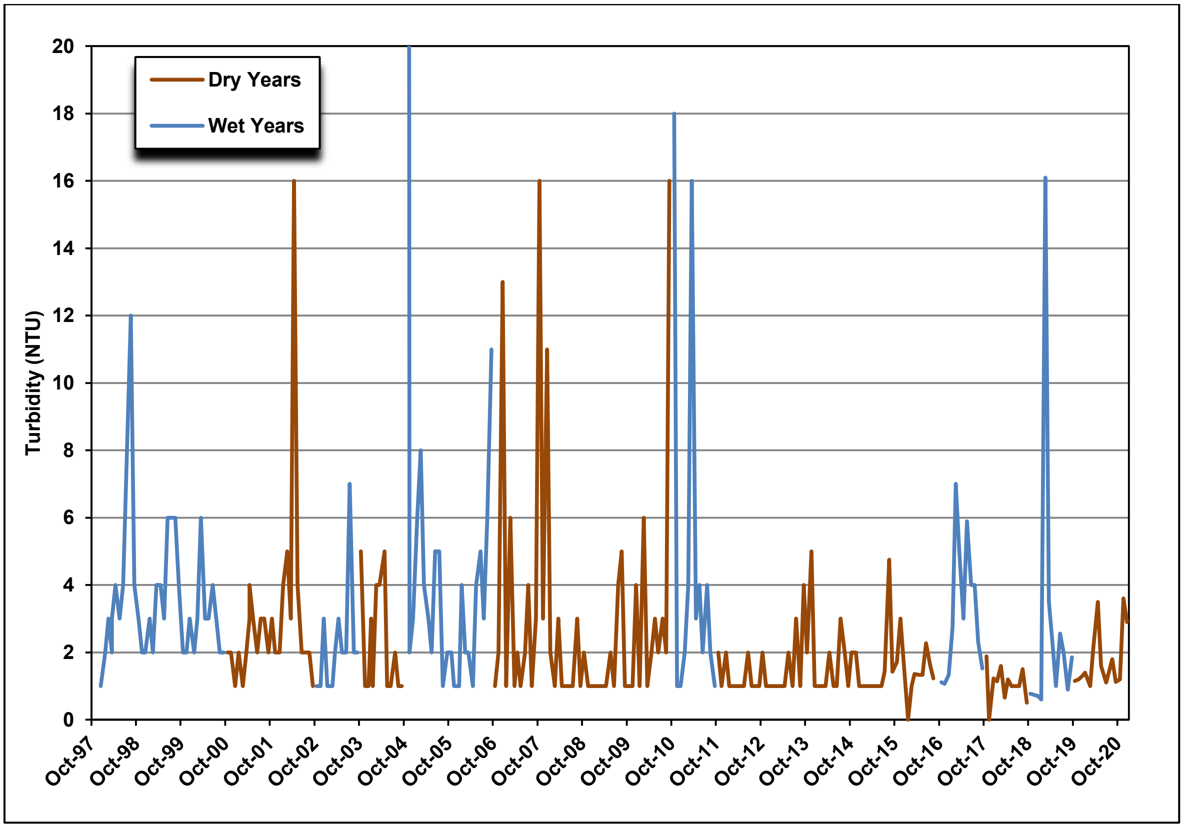


Figure 8-56. Comparison of Devil Canyon Real-time and Field Sample Turbidity Data, 2016 to 2020

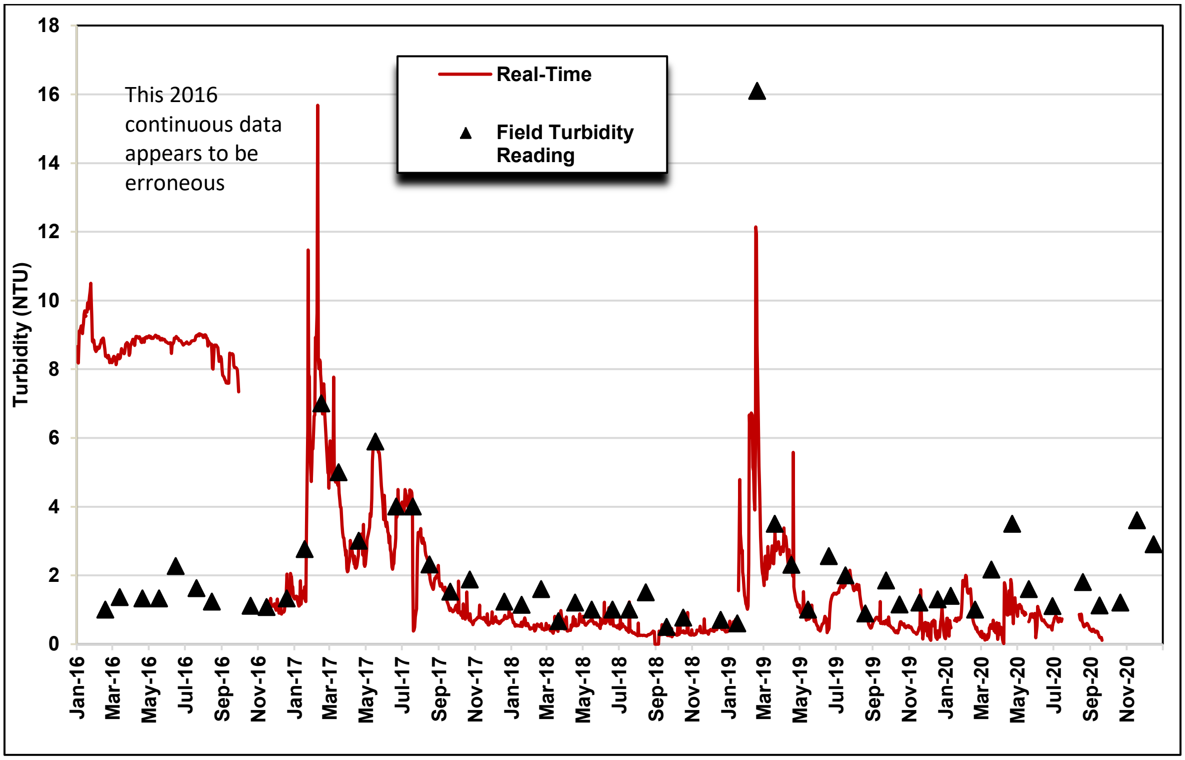


Figure 8-57. Comparison of Devil Canyon Real-time and Field Sample Turbidity Data, 2016 to 2020, 1:1 Graph

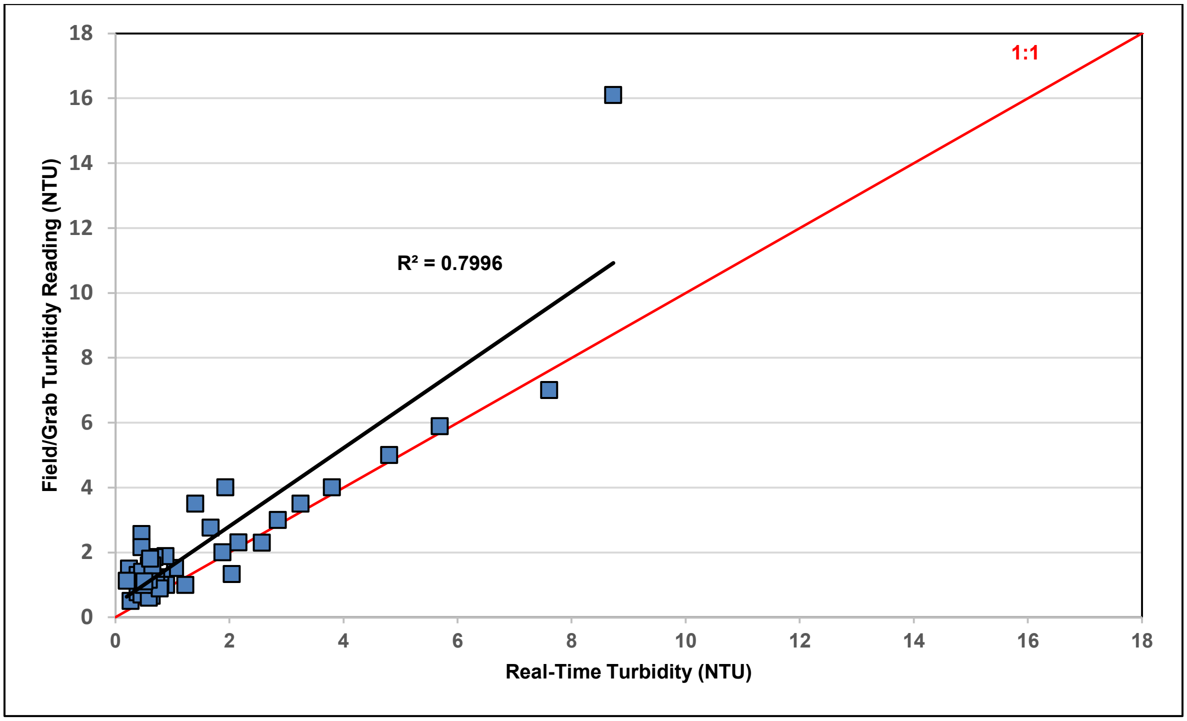
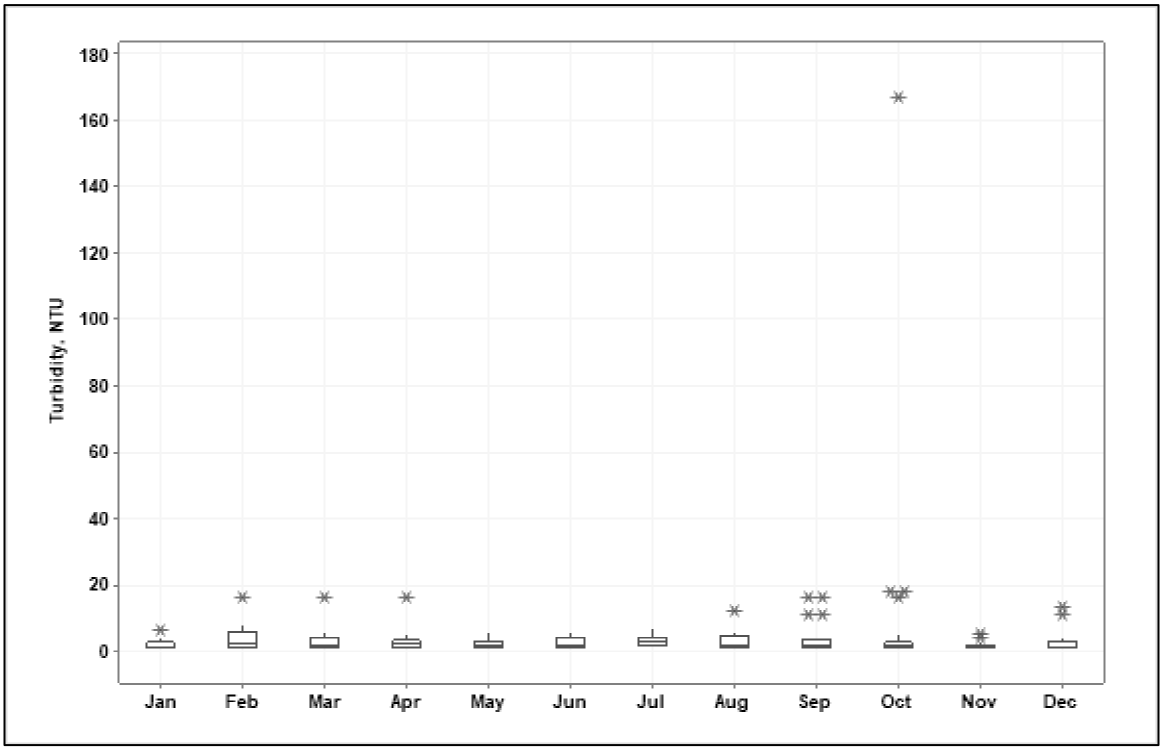


Figure 8-58. Monthly Variability in Turbidity at Devil Canyon, 1997 to 2020



SUMMARY

- Turbidity levels in the Sacramento River are related to flows, with higher turbidities associated with higher flows. The San Joaquin River shows the same pattern of rapidly increasing turbidity when flows first increase in the winter months; however during prolonged periods of high flows, turbidity drops back down. Median turbidity levels at Vernalis (17 NTU) are higher than at Hood (10 NTU).

- The turbidity levels at Barker Slough are substantially higher (median of 28 NTU) and more variable than at Hood or any other SWP monitoring location. Over the 2016 to 2020 reporting period, peak turbidity levels occurred in January. The median turbidity at Banks (8 NTU) is statistically significantly lower than in the Sacramento and San Joaquin rivers, reflecting settling in Delta channels and Clifton Court Forebay. Although the median turbidity is low, there is tremendous variability in turbidity at Banks. Turbidity decreases from a median of 8 NTU at Banks to a median of 5 NTU at O'Neill Forebay Outlet below San Luis Reservoir and then slightly increases between O'Neill Forebay Outlet and Check 41 (median value 6 NTU). The turbidity levels at DV Check 7 on the SBA are similar to those at Banks. Turbidity levels are low in the SWP reservoirs with a median of 2 NTU in Pacheco and Devil Canyon and 1 NTU at Castaic Outlet.

- There are a number of real-time instruments measuring turbidity in the SWP. Based on the 2016 to 2020 data, the real-time turbidimeters showed improved correspondence to grab sample data compared to the last (2011 to 2015) Update. For the last Update, the poorest correspondence was at Barker Slough, Check 41, Devil Canyon, and Castaic. For this Update, the poorest correspondence was at Pacheco and Castaic. It is recommended to verify the proper maintenance of these two turbidimeters.

- Turbidity levels are statistically significantly lower during dry years than wet years at most locations that were included in this analysis, as shown in **Table 8-2**. In wet years, turbidity generally increases due to erosion and watershed runoff. There was no statistically significant difference between dry and wet years for San Luis Reservoir at Pacheco and at Castaic Outlet, due to the dampening effect of the reservoirs.

- The seasonal patterns vary greatly. The Sacramento River has high turbidity during the winter months and low turbidity during the summer. The San Joaquin River shows an opposite pattern with high turbidity during the summer possibly due to agricultural inputs in the summer or algal blooms. The seasonal pattern at Banks is similar to the San Joaquin River. A 2002 DWR study concluded that summer peaks in turbidity at Banks are potentially due to the re-suspension of sediment in Clifton Court due to high winds in the Delta during the summer months. Additionally, high pumping rates in the summer create high velocities in the forebay which may re-suspend sediment and lead to higher turbidity.

- Along the aqueduct, there are peaks in the winter months and again in June or July. For all locations except for Pacheco and Devil Canyon, turbidities reach the lowest levels in the fall when flows on the rivers are lowest.

Table 8-2. Comparison of Dry Year and Wet Year Turbidity Levels

	Median Turbidity (NTU)				
Location	**Dry Years**	**Wet Years**	**Turbidity Difference (NTU)**	**Percent Difference**	**Statistical Significance**
Hood	8	12	-4	-50%	D<W
Vernalis	16	18	-2	-13%	D<W
Banks	7	10	-3	-43%	D<W
Barker Slough	24	35.5	-11.5	-48%	D<W
DV Check 7	7	8.2	-1.2	-17%	D<W
McCabe	9	14	-5	-56%	D<W
Pacheco	2	2	0	0%	No
Gianelli	3.5	5.9	-2.4	-69%	D<W
Check 13	4	7	-3	-75%	D<W
Check 21	4	8	-4	-100%	D<W
Check 41	5	9.6	-4.6	-92%	D<W
Castaic Outlet	2	1	1	50%	No
Devil Canyon	1.5	3	-1.5	-100%	D<W

RECOMMENDATION

- Due to poor correspondence between on-line turbidimeter readings and field samples at Pacheco and Castaic, it is recommended to verify the proper maintenance of these two turbidimeters.

CHAPTER 9 PATHOGENS AND INDICATOR ORGANISMS

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CHAPTER 9 PATHOGENS AND INDICATOR ORGANISMS

Source waters may be contaminated with a number of pathogenic bacteria, viruses, and protozoa, along with non-pathogenic naturally occurring microorganisms. Routine monitoring for all possible pathogens is impractical so the focus of most source water monitoring is on indicator bacteria and the regulated pathogenic protozoa, *Giardia* and *Cryptosporidium.*

Under the Surface Water Treatment Rule (SWTR), the general requirements are to provide treatment to ensure at least 3-log reduction of *Giardia* cysts and at least 4-log reduction of viruses. The California SWTR Staff Guidance Manual provides a description of source waters that require additional treatment above the minimum 3-log *Giardia* and 4-log virus reduction (California Department of Health Services, 1991). The Guidance Manual states:

> *"...in a few situations, source waters are subjected to significant sewage and recreational hazards, where it may be necessary to require higher levels of virus and cyst removals..."*

Due to the expense and uncertainties associated with pathogen monitoring, California Division of Drinking Water (DDW) staff historically relied on monthly median total coliform levels as a guide for increased treatment. When monthly medians exceeded 1,000 most probable number per 100 milliliters (MPN/100 ml), DDW staff considered requiring additional log reduction. Coliform bacteria have been used for decades to assess the microbiological quality of drinking water. These bacteria are present in the intestines of humans and other warm-blooded animals and are found in large numbers in fecal wastes. Most species occur naturally in the aquatic environment so their presence does not always indicate fecal contamination. More recently, DDW staff has started to rely upon fecal coliform and *Escherichia coli* (*E. coli)* as more specific indicators of mammalian fecal contamination. When the monthly median *E. coli* or fecal coliform density exceeds 200 MPN/100 ml, DDW staff considers requiring additional log reduction. Evaluation of pathogen reduction levels based on coliform bacterial density is not as scientifically valid as basing them on actual pathogen concentrations. The relationship between coliforms and pathogenic cysts is tenuous, but in the absence of other information, DDW uses coliform density to determine required pathogen reduction levels for individual water treatment plants (WTPs).

The Interim Enhanced Surface Water Treatment Rule (IESWTR) requires 2-log reduction of *Cryptosporidium*. Additional removal/inactivation of *Cryptosporidium* may be required based on source water monitoring for *Cryptosporidium* conducted in accordance with the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). Filtered water systems are classified in one of four bins based on their monitoring results, as shown in **Table 9-1**.

Table 9-1. LT2ESWTR Bin Classification and Action Requirements

Bin Classification	Maximum Running Annual Average (oocysts/L)	Action Required (Additional log reduction)
1	< 0.075	none
2	0.075 to < 1.0	1
3	1.0 to < 3.0	2
4	≥ 3.0	2.5

To the extent data are available, both protozoan and coliform densities are presented and discussed in this chapter for the State Water Project (SWP) Contractors treating water from the various reaches of the SWP. Data were provided by a number of SWP Contractors, the Central Valley Regional Water Quality Control Board (Regional Board), and by the Department of Water Resources (DWR) Division of Operations and Maintenance (O&M) SWP Water Quality Monitoring Program. There is considerable variability in the data that were provided including varying sampling frequencies (daily to monthly), different methods for determining indicator bacteria densities, and different periods of record. All useful, available data are included in this chapter. To calculate median densities, data results that were reported as non-detectable were set to zero and those results that were reported as greater than an upper limit were set at the specific upper limit.

DELTA

As part of the Delta RMP Pathogen Study, monthly *Giardia* and *Cryptosporidium* samples at three locations of interest in the Delta were collected; the Sacramento River at Hood, the San Joaquin River at Vernalis, and Banks Pumping Plant. This data was collected under the Delta Drinking Water Policy and serves to supplement data collected by water utilities. In addition, DWR's O&M Division collected coliform and pathogen data at the Harvey Banks O&M Center WTP (Banks WTP). The Banks WTP draws water from the California Aqueduct and provides water for DWR staff.

PROTOZOA

The Regional Board collected monthly *Giardia* and *Cryptosporidium* samples at Hood, Vernalis, and Banks from April 2015 through March 2017. There were detects of both *Giardia* and *Cryptosporidium* at Hood and Vernalis, none of either at Banks. The running annual averages (RAA) for *Giardia* and *Cryptosporidium* were calculated. **Tables 9-2** and **9-3** present summaries of the data collected at each site for *Giardia* and *Cryptosporidium*, respectively. Since all the RAAs for *Cryptosporidium* were below the trigger of 0.075 oocysts/L, the source is placed in Bin 1 under the LT2ESWTR and no additional action is required at this time. *Giardia* levels were higher than *Cryptosporidium* levels in the Sacramento River at Hood and the San Joaquin River at Vernalis, indicating that they are sources of *Giardia* to the Delta. *Giardia* was detected during all times of the year and *Cryptosporidium* was detected during the fall.

DWR collected samples for *Cryptosporidium* analysis at the Banks WTP for LT2ESWTR Round 2 monitoring from June 2019 through September 2021, approximately monthly. Twenty-eight samples were collected and all but two were non-detect, with a maximum RAA of 0.056 oocysts/L. This is below the Bin 1 threshold limit of 0.075 oocysts/L and the source is therefore placed in Bin 1 under the Round 2 LT2ESWTR. It should be noted that one sample, February 2021, had an extremely high result (0.61017 oocysts/L) that skewed the maximum RAA high.

Table 9-2. *Giardia* Detections at Hood, Vernalis, and Banks, Delta RMP Pathogen Study

Date	Number of Samples	Number of Detects	Range of Detects (cysts/L)	Range of RAA (cysts/L)
Sacramento River at Hood	24	11	ND – 0.8	0.125 – 0.233
San Joaquin River at Vernalis	24	14	ND – 0.9	0.064 – 0.15
Banks Pumping Plant	22	0	ND	ND

Table 9-3. *Cryptosporidium* Detections at Hood, Vernalis, and Banks, Delta RMP Pathogen Study

Date	Number of Samples	Number of Detects	Range of Detects (oocysts/L)	Range of RAA (oocysts/L)
Sacramento River at Hood	24	2	ND – 0.4	0.008 – 0.042
San Joaquin River at Vernalis	24	2	ND – 0.1	0.008 – 0.017
Banks Pumping Plant	22	0	ND	ND

INDICATOR ORGANISMS

The available total and fecal coliform and *E. coli* data from the DWR O&M Division Banks WTP was collected and evaluated. Samples were collected monthly from January 2016 through December 2020 for total coliform and *E. coli*. Fecal coliform samples were collected weekly from January 2016 through August 2018.

Total coliform densities ranged from 14.5 to 8,200 MPN/100 ml, with a median density of 1,119.9 MPN/100 ml. Forty-five percent of samples were less than 1,000 MPN/100 mL. **Figure 9-1** presents the total coliform data for the Banks WTP intake. Fecal coliform densities ranged from less than 4.5 to 900 MPN/100 ml, with a median density of 70 MPN/100 ml. Seventy-six percent of samples were less than 200 MPN/100 mL. **Figure 9-2** presents the fecal coliform data for the Banks WTP intake. *E. coli* densities ranged from less than 2 to 727 MPN/100 ml, with a median density of 53.8 MPN/100 ml. Eighty percent of samples were less than 200 MPN/100 mL. **Figure 9-3** presents the *E. coli* data for the Banks WTP intake. A review of **Figures 9-2** and **9-3** indicates that the highest levels of fecal coliform and *E. coli* occur during the winter months (December through February).

EVALUATION OF PATHOGEN REDUCTION/INACTIVATION REQUIREMENTS

The total coliform densities exceeded 1,000 MPN/100 ml in 55 percent of samples during the study period at the intake to the Banks WTP. Fecal coliform and *E. coli* densities can be greater than 200 MPN/100 ml, especially in the winter months. However, actual protozoa monitoring conducted at the Banks Pumping Plant resulted in no detects of either *Giardia* or *Cryptosporidium* through the Delta RMP and only two detects of *Cryptosporidium* at the Banks WTP under DWR's LT2ESWTR Round 2 monitoring. The current 2-log *Cryptosporidium* reduction requirement appears appropriate, however the 3-log *Giardia* and 4-log virus reduction requirements for the Banks WTP should be carefully considered by DDW since there is inconsistency between the coliform and protozoan data.

Figure 9-1. Total Coliforms at the Banks WTP Intake

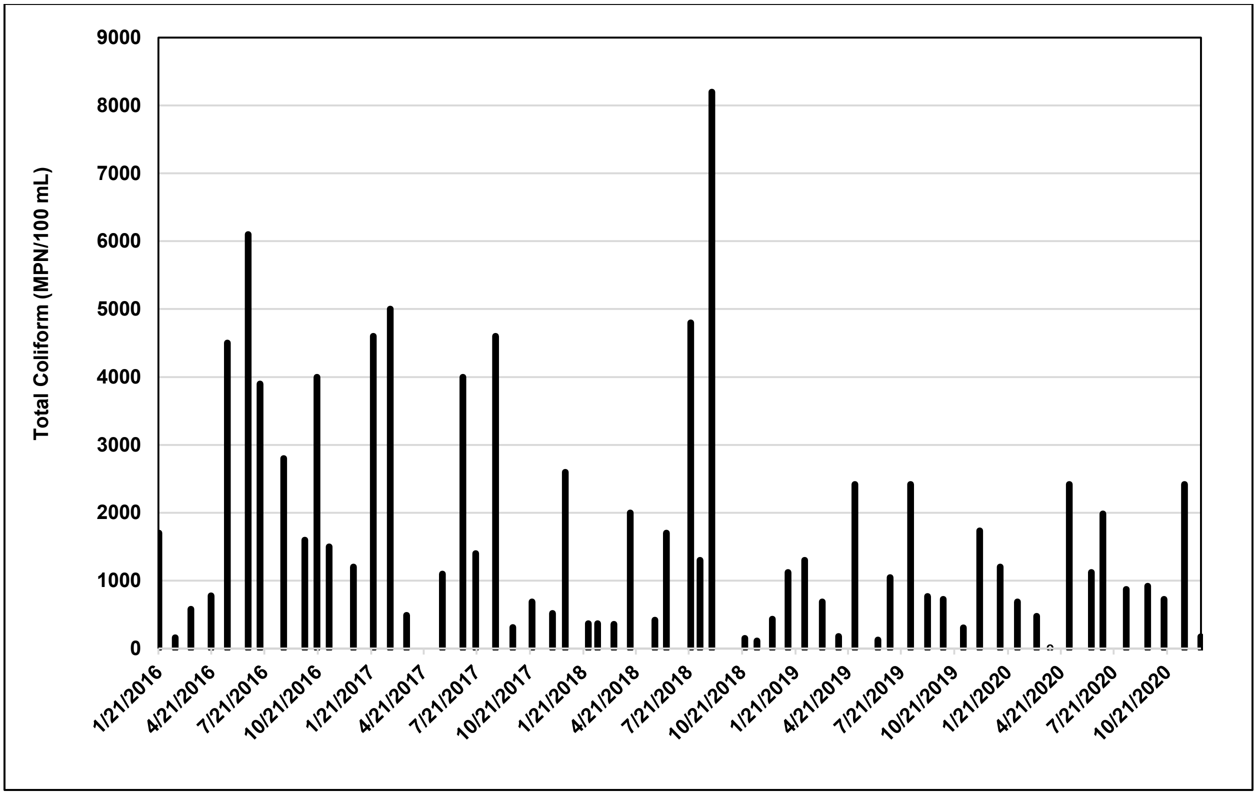


Figure 9-2. Fecal Coliforms at the Banks WTP Intake

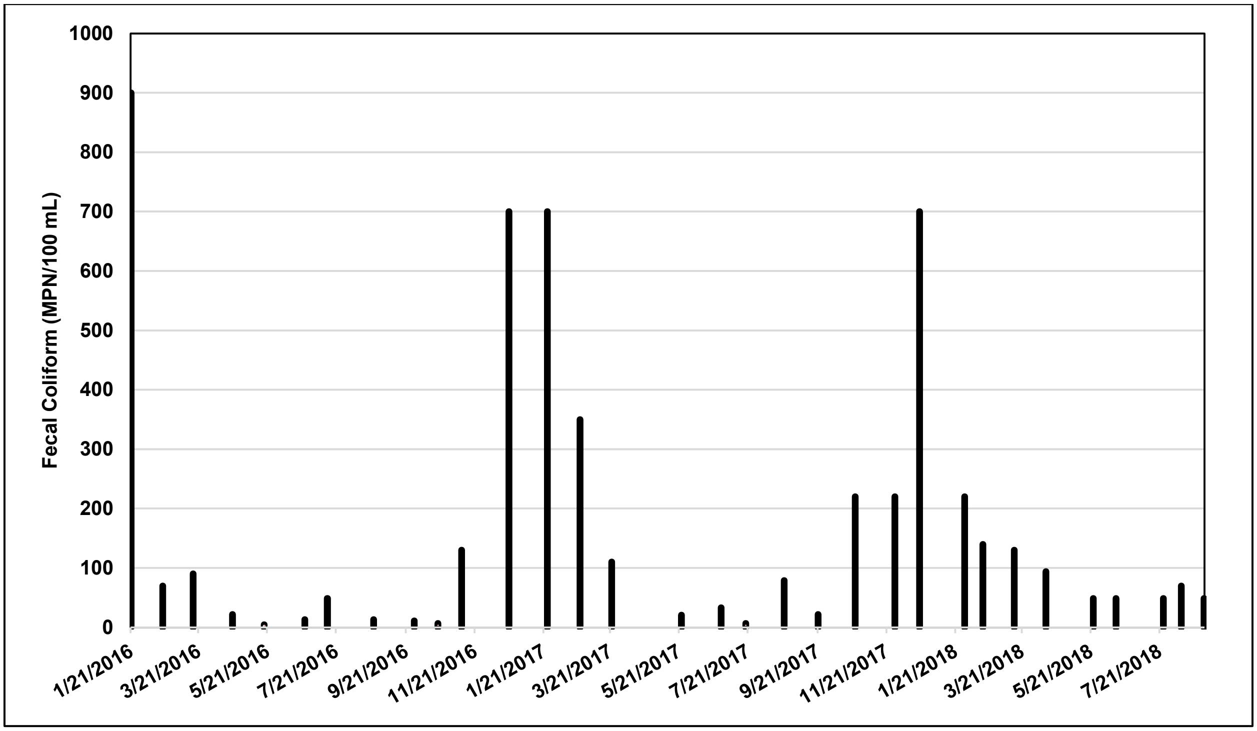
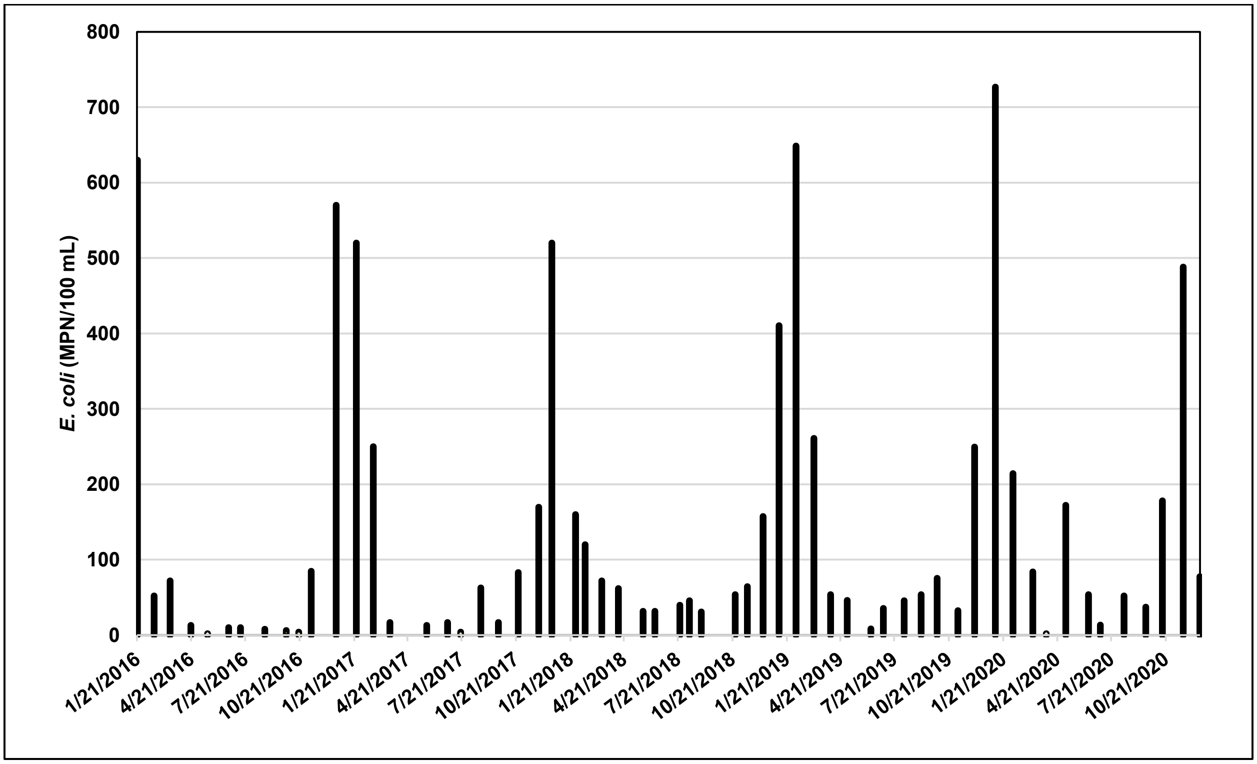


Figure 9-3. ***E. coli*** **at the Banks WTP Intake**



NORTH BAY AQUEDUCT

The Solano County Water Agency (SCWA) and Napa County Flood Control and Water Conservation District (Napa County) have contracts with DWR for North Bay Aqueduct (NBA) water. SCWA provides untreated water to Travis Air Force Base (AFB) and the cities of Benicia, Fairfield, Vacaville, and Vallejo. Fairfield and Vacaville receive treated water from the 40-million gallons per day (mgd) North Bay Regional (NBR) WTP, Benicia treats water at the 12-mgd Benicia WTP, and Vallejo treats NBA water at the 42-mgd Fleming Hill WTP, as well as the 7.5 mgd Travis AFB WTP. Napa County provides untreated water to the cities of American Canyon, Calistoga, and Napa. The City of American Canyon operates a 5.5 mgd WTP. The City of Napa treats water at the 12-mgd Jamieson Canyon WTP and provides treated water for the cities of Napa, Calistoga, and Yountville. The NBA is an enclosed pipeline, with the exception of the Cordelia Forebay (surface area of 2 acres). Collectively, the NBA provides municipal water for approximately 500,000 people in Napa and Solano counties.

While there is variability in some water quality constituents between Barker Slough and the WTP intakes, microbiological data collected at the NBR WTP intake is considered to be representative of the quality of water received by all of the cities and Travis AFB.

PROTOZOA

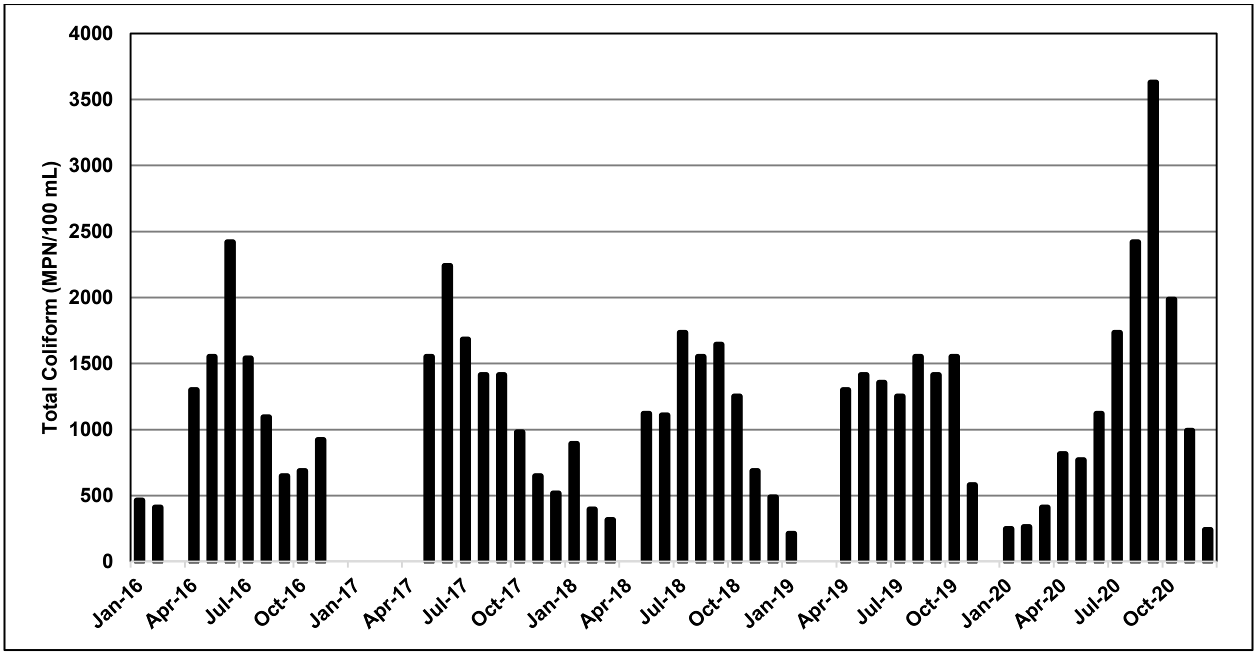
The City of Fairfield conducted *Cryptosporidium* monitoring during the study period at the Barker Slough Pumping Plant. Twenty-four samples were collected monthly between April 2015 and March 2017. Only one sample had detectable *Cryptosporidium* (May 2015 at 0.2 oocysts/L). The maximum RAA was 0.017 oocysts/L, below the Bin 1 threshold limit of 0.075 oocysts/L.

INDICATOR ORGANISMS

The available total coliform and *E. coli* data were also analyzed to provide more information on the microbial quality of the NBA. The most comprehensive data are collected at the NBR WTP intake. NBA water is treated at the NBR WTP primarily from March or April through November or December and Solano Project water from Lake Berryessa is treated during the wet season. During the periods when NBA water is treated, samples are collected almost every day from the NBR WTP intake. Data presented below was for periods when using NBA water from January 2016 through December 2020.

Total coliform densities ranged from non-detect (ND) to 38,875.5 MPN/100 ml, with a median density of 1,119.9 MPN/100 ml. The peak total coliform density measured at the NBR WTP intake was 38,875.5 MPN/100 ml, which occurred on September 10, 2020. The entire month of September 2020 was elevated with a monthly median of 3,629.4 MPN/100 mL. A number of samples collected were not diluted sufficiently during analysis so results were reported as greater than 2,419 MPN/100 ml or 4,838 MPN/100 mL, so the actual peak levels cannot be confirmed. **Figure 9-4** presents the monthly median total coliform data for the NBR WTP intake. The monthly median total coliform densities ranged from 213 to 3,629.4 MPN/100 ml. The median densities in 57 percent of months exceed 1,000 MPN/100 ml. The monthly median peak values are higher than those presented in the 2016 Update.

Figure 9-4. Monthly Median Total Coliforms at the NBR WTP Intake



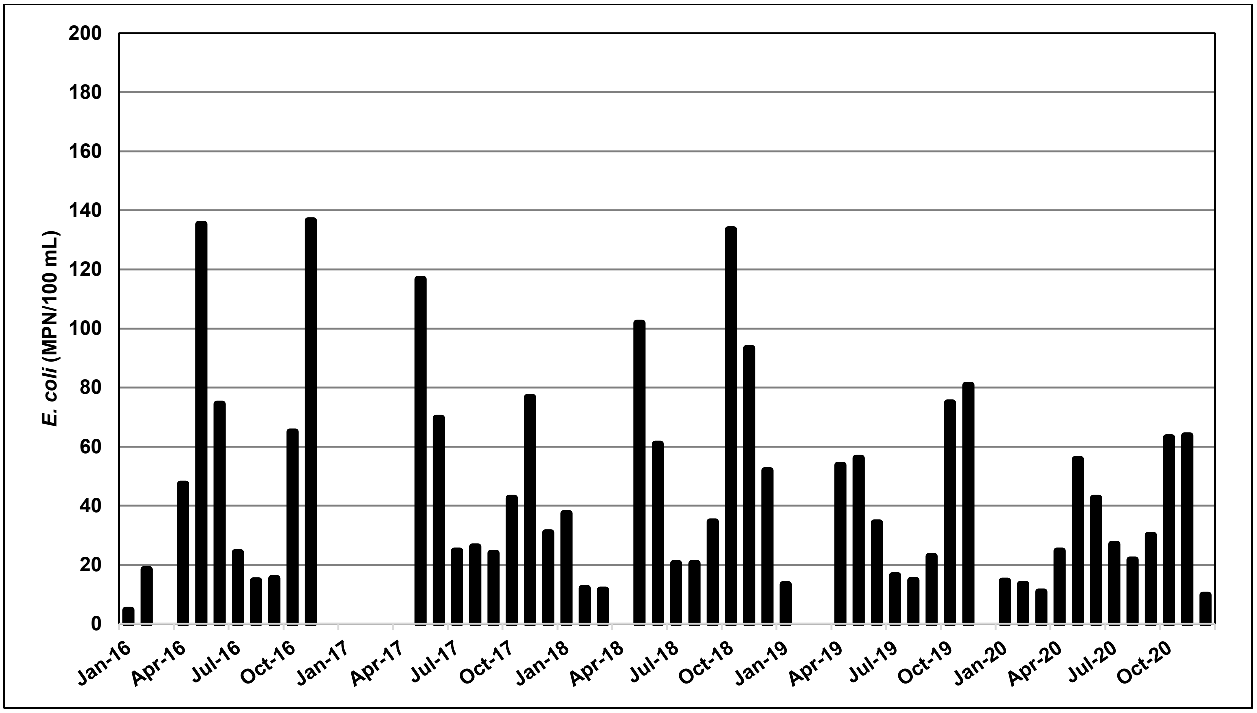
E. coli densities ranged from ND to 5,163 MPN/100 ml, with a median density of 33.6 MPN/100 ml. The peak *E. coli* density measured at the NBR WTP intake was 5,163 MPN/100 ml, which occurred on August 28, 2020. **Figure 9-5** presents the *E. coli* monthly median data. The monthly median *E. coli* densities ranged from 4.65 to 136.6 MPN/100 ml. No monthly median *E. coli* densities were above 200 MPN/100 ml. The monthly median peak values were lower than those presented in the 2016 Update.

EVALUATION OF PATHOGEN REDUCTION/INACTIVATION REQUIREMENTS

Although the monthly median total coliform densities exceed 1,000 MPN/100 ml during the majority of months of the year at the intake to the NBR WTP, median *E. coli* densities are always less than 200 MPN/100 ml during the months that the NBR WTP treats NBA water. Sufficient data were not available during the wet season to fully evaluate median coliform levels.

The monthly *Cryptosporidium* monitoring that has been conducted by the City of Fairfield indicates that *Cryptosporidium* was generally not detected and an LT2ESWTR Bin 1 classification continues to be appropriate. Although the Barker Slough watershed does not contain significant sources of human wastes, a large amount of the watershed is devoted to cattle and sheep grazing. The *Cryptosporidium* and *E. coli* monitoring confirm that the current 2-log *Cryptosporidium*, 3-log *Giardia*, and 4-log virus reduction requirements are adequate for the WTPs that treat NBA water.

Figure 9-5. Monthly Median *E. coli* at the NBR WTP Intake



SOUTH BAY AQUEDUCT

Three water agencies have contracts with DWR to receive water from the South Bay Aqueduct (SBA): Zone 7 Water Agency of the Alameda County Flood Control and Water Conservation District (Zone 7 Water Agency), Alameda County Water District (ACWD), and Santa Clara Valley Water District (Valley Water). Together, the SBA Contractors provide treated drinking water to nearly two million people in the San Francisco Bay Area.

Zone 7 Water Agency provides drinking water from two water treatment plants (12-mgd Patterson Pass and 40-mgd Del Valle) to four retail water systems in the Livermore Valley (cities of Pleasanton and Livermore, Dublin San Ramon Services District, and Cal Water Service Company – Livermore). In May 2021, the Patterson Pass WTP capacity will increase to 24 mgd after an extensive upgrade and addition of ozone treatment. Zone 7 Water Agency also provides drinking water to 12 direct users, including a local vineyard, hospital, and park. The Patterson Pass WTP intake is upstream of the point where Lake Del Valle enters the SBA so it treats 100 percent SBA water, whereas the Del Valle WTP treats varying blends of SBA and Del Valle water.

ACWD provides drinking water to customers in Fremont, Newark, and Union City. ACWD operates one surface water treatment plant, the 28-mgd WTP2. The intake to WTP2 is downstream of the point where Lake Del Valle enters the SBA so it treats varying blends of SBA and Del Valle water. The Mission San Jose WTP has been out of service since 2015.

Valley Water provides treated water from the 40-mgd Penitencia, 80-mgd Rinconada, and 100-mgd Santa Teresa WTPs (primarily uses San Luis Reservoir water) to seven retailers in Santa Clara County. The Penitencia WTP primarily treats varying blends of SBA and Lake Del Valle water but at times water from San Luis Reservoir and Anderson Reservoir (a local Valley Water reservoir) is treated at the Penitencia WTP. Although the Penitencia WTP occasionally treats water that comes from San Luis Reservoir and the local reservoirs that are not part of the SWP, the analysis of the protozoan and bacteria data was conducted on all of the data that was provided by Valley Water. This is appropriate because the analysis is specific to a water treatment plant and the data are not being used to compare different locations along the SWP. Since the SBA is an enclosed pipeline after water from Lake Del Valle enters it, the microbial quality of Del Valle, WTP2, Penitencia, and Rinconada WTPs should be similar.

PROTOZOA

Valley Water continued to monitor *Giardia* and *Cryptosporidium* at the Penitencia and Rinconada WTPs between 2016 and 2020 on a monthly basis. As shown in **Table 9-4**, *Cryptosporidium* and *Giardia* were rarely detected at either WTP. All detects were at 0.1 cyst/L, and the maximum RAA of *Cryptosporidium* at both WTPs is very low, below the Bin 1 threshold limit of 0.075 oocysts/L.

Table 9-4. Protozoan Detections at Penitencia and Rinconada WTPs, Valley Water Monitoring Program

WTP	Monitoring Period	No. of Samples	***Cryptosporidium*** **(oocysts/L)**		***Giardia*** **(cysts/L)**	
			No. of Detects	**Maximum RAA**	**No. of Detects**	**Maximum RAA**
Penitencia	1/12/16 – 12/8/20	49	3	0.02	3	0.029
Rinconada	11/15/16 – 2/11/20	17	1	0.014	0	0

Zone 7 Water Agency also sampled the Patterson Pass WTP for *Cryptosporidium* during the study period. Nineteen monthly samples were collected between January 2015 and December 2016. All but one sample were non-detect. The August 2016 resulted in a *Cryptosporidium* concentration of 0.07 oocysts/L, with a maximum RAA of 0.007 oocysts/L. This is well below the Bin 1 threshold limit of 0.075 oocysts/L.

INDICATOR ORGANISMS

Coliform data were available for varying periods of time for each of the treatment plants that treat water from the SBA. The total coliform and *E. coli* data for each WTP was compiled and evaluated. **Table 9-5** provides a summary of the statistics for the individual samples at each WTP. The data show a wide range in both total coliform and *E. coli* densities at each of the WTPs. The overall median density of total coliforms is at or below 1,000 MPN/100 ml and *E. coli* is at or below 30 MPN/100 at all of the WTPs. The peak monthly median values for total coliforms occurred during the summer months, while the peak monthly median values for *E. coli* occurred during the winter months.

Table 9-5. SBA Coliform Data Summary, 2016 - 2020

WTP	Total Coliform (MPN/100 ml)		*E. coli* (MPN/100 ml)	
	Range	Median	Range	Median
Patterson Pass	1 – >4,010	542	<2 – 165.2	16.4
Del Valle	7.5 – >4,010	768	<2 – 222	11.1
WTP2	<1 – >24,196	635	<1 – 573	10
Penitencia	9.8 – 2,830	980	<1 – 1,120	30
Rinconada	6.3 – >2,420	144	<1 – 1,410	5.2

The monthly median total coliform and *E. coli* densities are presented in **Figures 9-6 to 9-15**. The WTPs have monthly median total coliform densities greater than 1,000 MPN/100 ml, typically during the summer months. All of the WTPs had no monthly median *E. coli* greater than 200 MPN/100 mL. The total coliform and *E. coli* peak monthly median densities at the all the WTPs were similar during the last five years compared with the data presented in the 2016 Update. As an example, the 2011 to 2015 Patterson Pass WTP range for *E. coli* was < 2 to 324 MPN/100mL and the median was 11.1 MPN/100mL.

A more detailed evaluation of *E. coli* levels at Penitencia WTP was conducted to determine if there were any impacts caused by use of Dyer Reservoir. Dyer Reservoir is an off stream reservoir located off the SBA downstream of Check 1. Inspection of the data revealed that there were only three samples that exceeded 200 MPN/100 mL during the study period. Those occurred on December 19, 2017 (2,420 MPN/100 mL, with Dyer Reservoir contributing 30 percent to the influent blend), January 23, 2018 (238 MPN/100 mL, with Dyer Reservoir contributing 93 percent to the influent blend), and January 9, 2018 (236 MPN/100 mL, with Dyer Reservoir contributing 92 percent to the influent blend). The overall median *E. coli* level during the study period was 30 MPN/100 mL, with a median use of 35 percent Dyer Reservoir in the influent blend. When Dyer Reservoir use was lower (less than 35 percent blend) the median *E. coli* level was slightly lower at 26.5 MPN/100 mL (approximately 11 percent lower). When Dyer Reservoir use was higher (more than 35 percent blend) the median *E. coli* level was slightly higher at 31.7 MPN/100 mL (approximately 6 percent higher). The data indicates that Dyer Reservoir appears to have a small influence on the Penitencia WTP influent *E. coli* concentration, with *E. coli* levels slightly higher when using higher proportions of Dyer Reservoir supply.

EVALUATION OF PATHOGEN REDUCTION/INACTIVATION REQUIREMENTS

The monthly median *E. coli* data and the protozoa monitoring indicate that 2-log *Cryptosporidium*, 3-log *Giardia*, and 4-log virus reduction continues to be appropriate for the Patterson Pass, Del Valle, WTP2, Penitencia, and Rinconada WTPs. This is consistent with the previous LT2ESWTR Bin 1 classifications by DDW.

Figure 9-6. Monthly Median Total Coliforms at the Patterson Pass WTP Intake

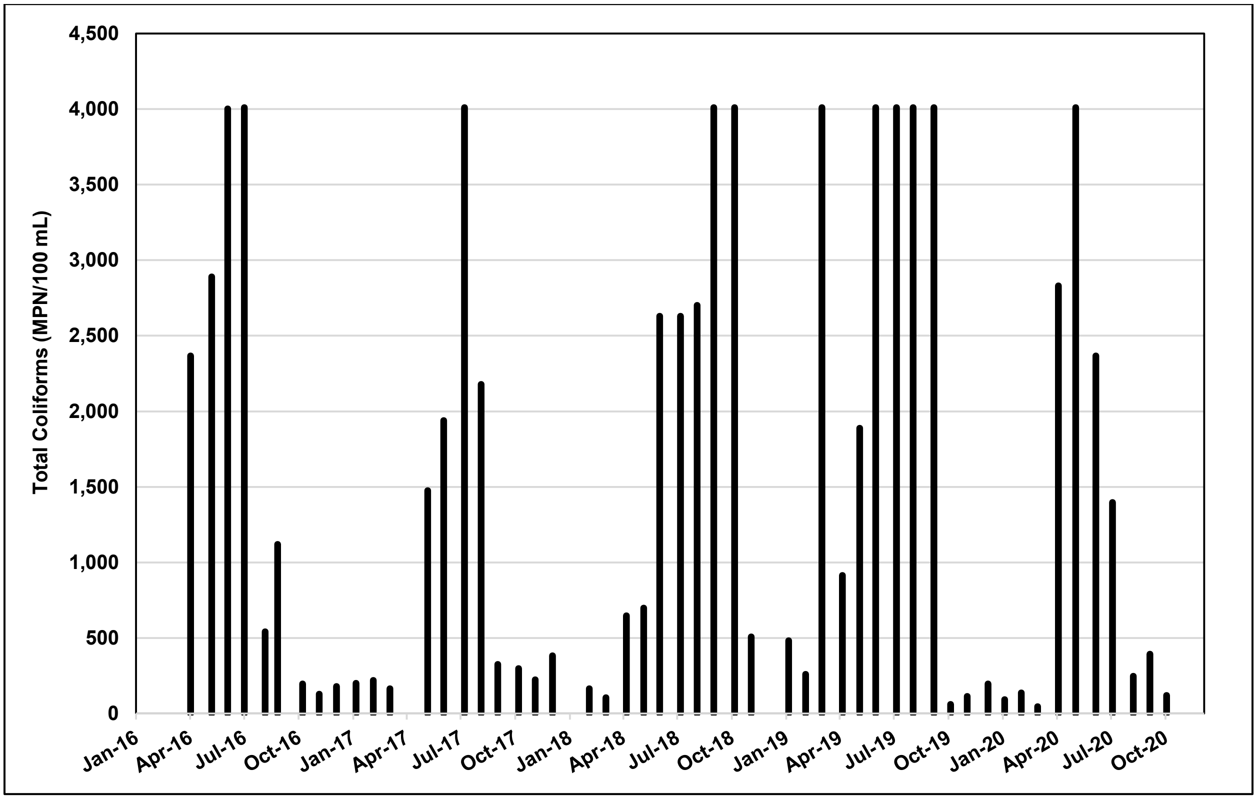


Figure 9-7. Monthly Median *E. coli* at the Patterson Pass WTP Intake

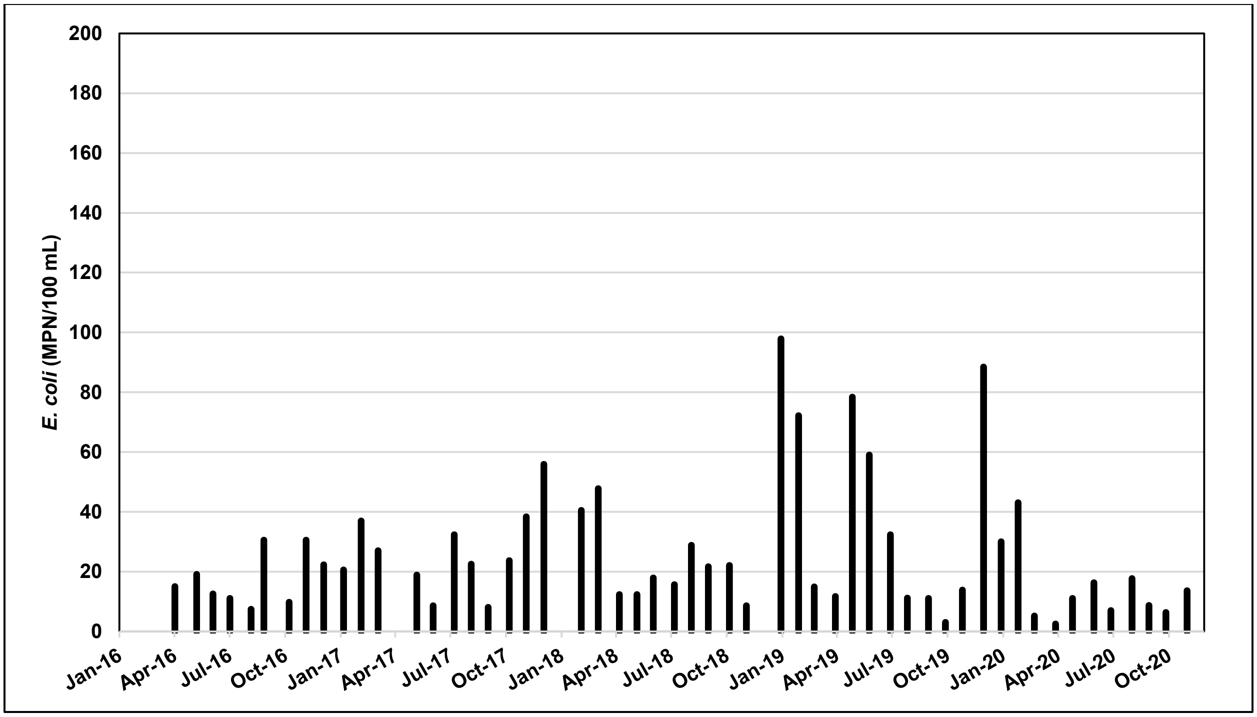


Figure 9-8. Monthly Median Total Coliforms at the Del Valle WTP Intake

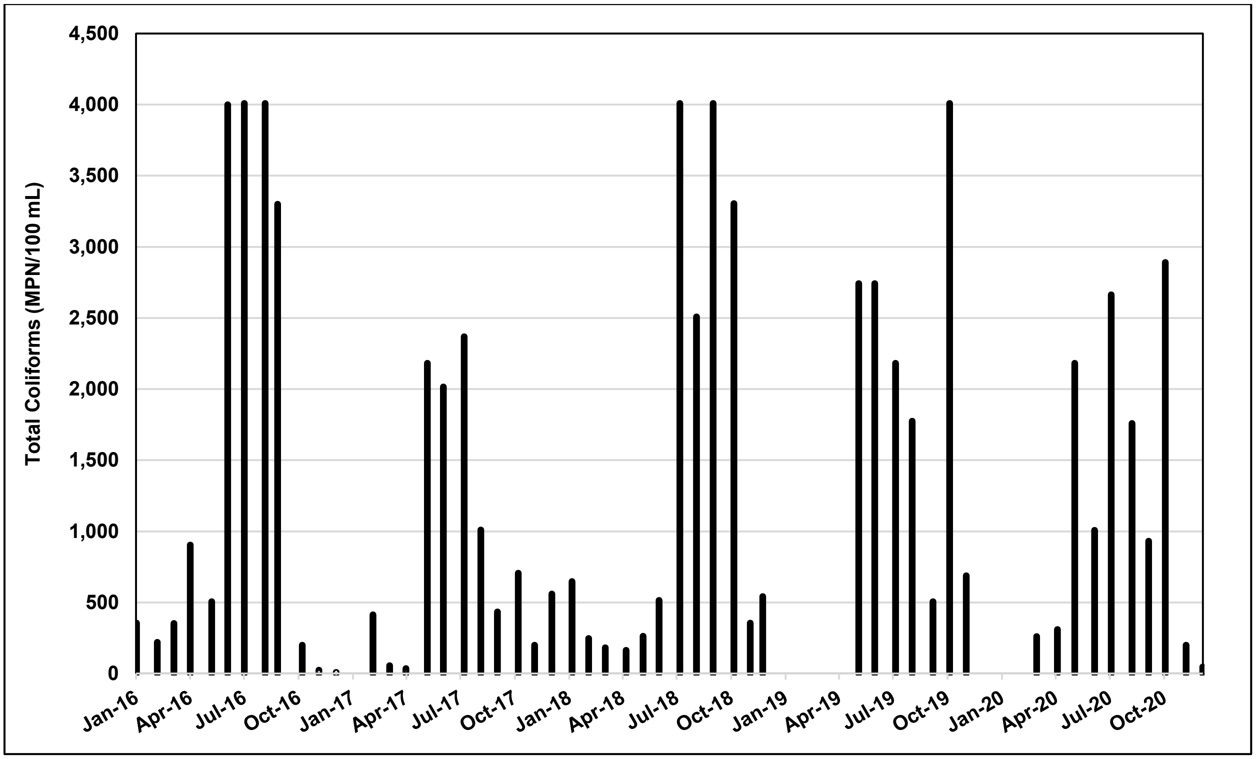


Figure 9-9. Monthly Median *E. coli* at the Del Valle WTP Intake

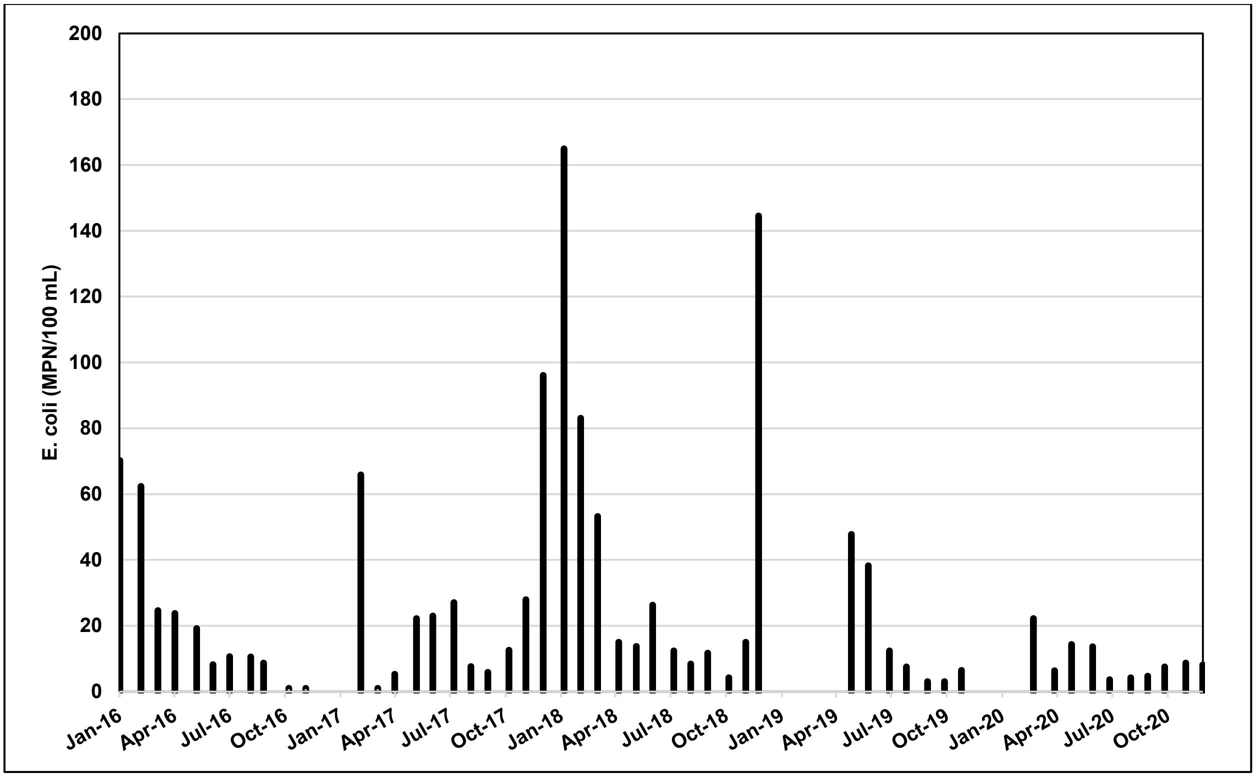


Figure 9-10. Monthly Median Total Coliforms at the WTP2 Intake

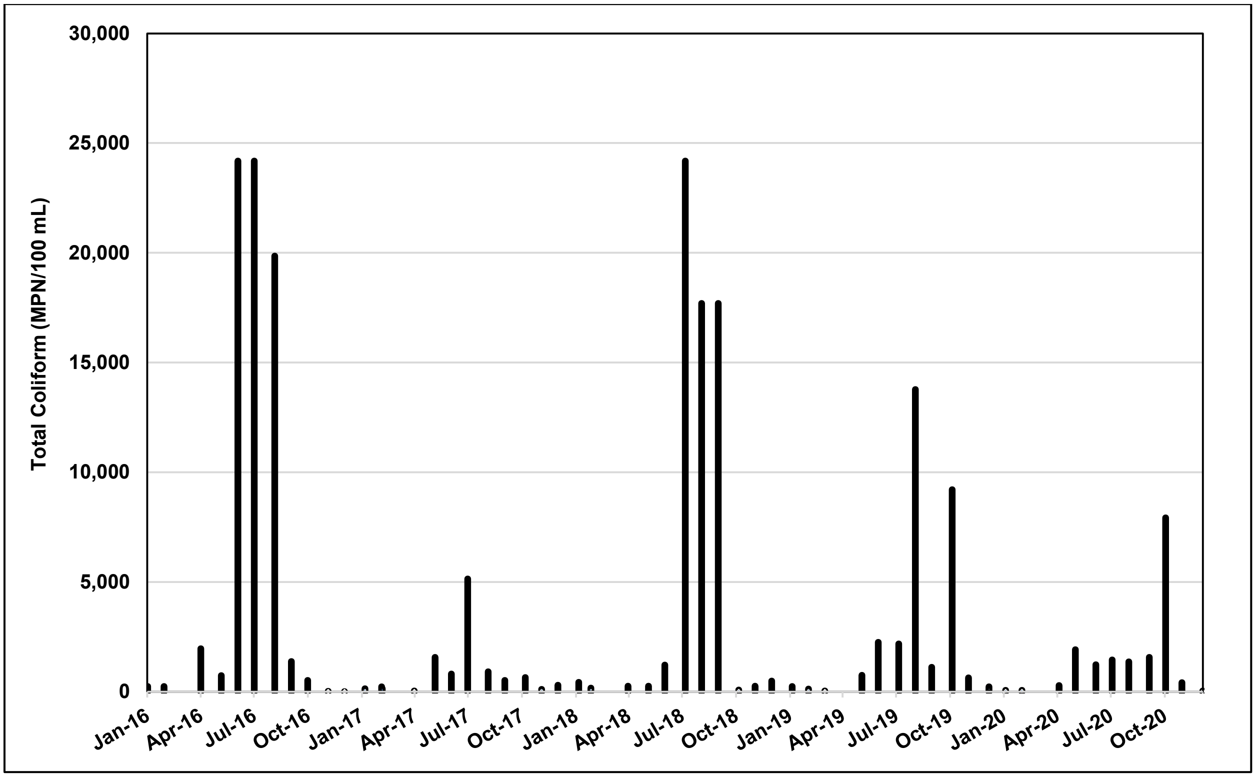


Figure 9-11 Monthly Median *E. coli* at the WTP2 Intake

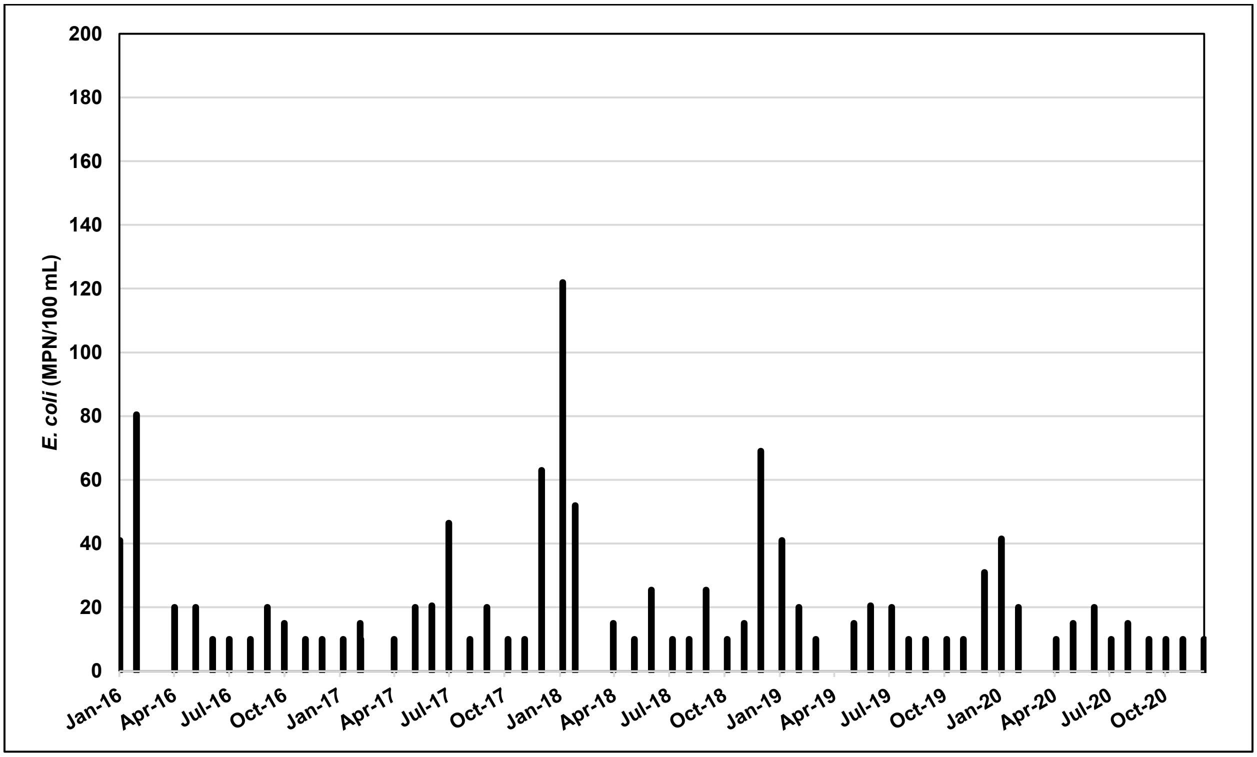


Figure 9-12. Monthly Median Total Coliforms at the Penitencia WTP Intake

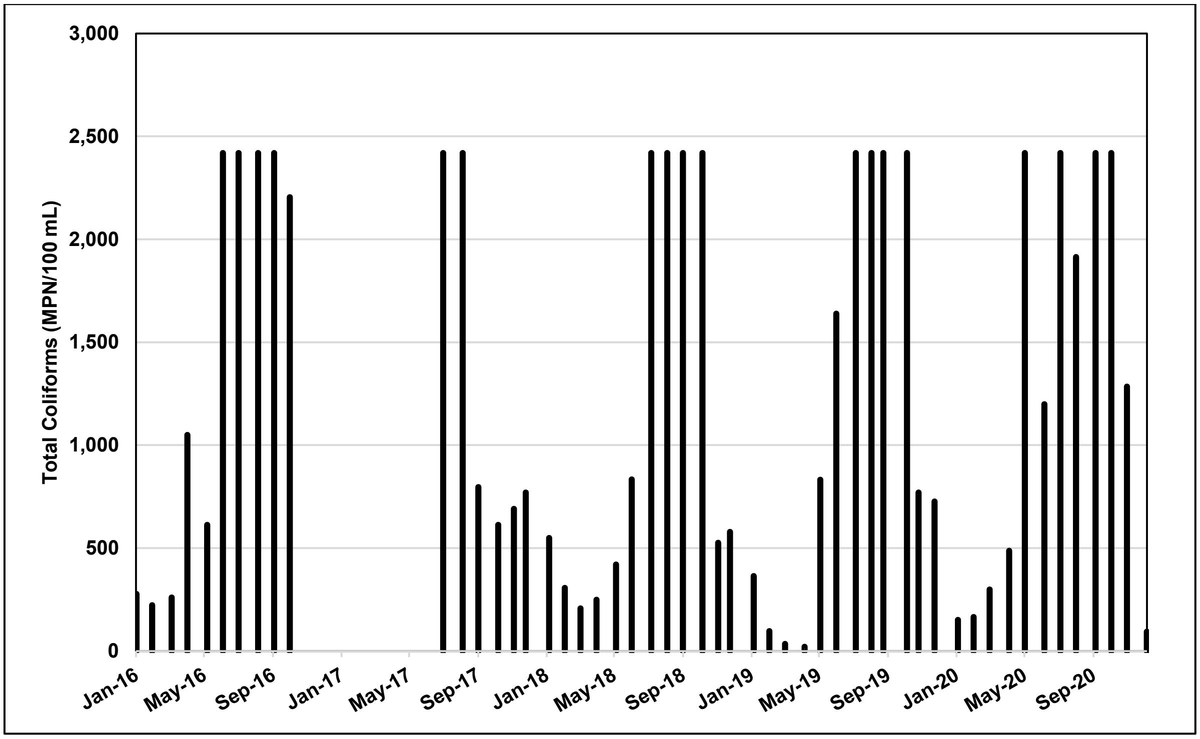


Figure 9-13. Monthly Median *E. coli* at the Penitencia WTP Intake

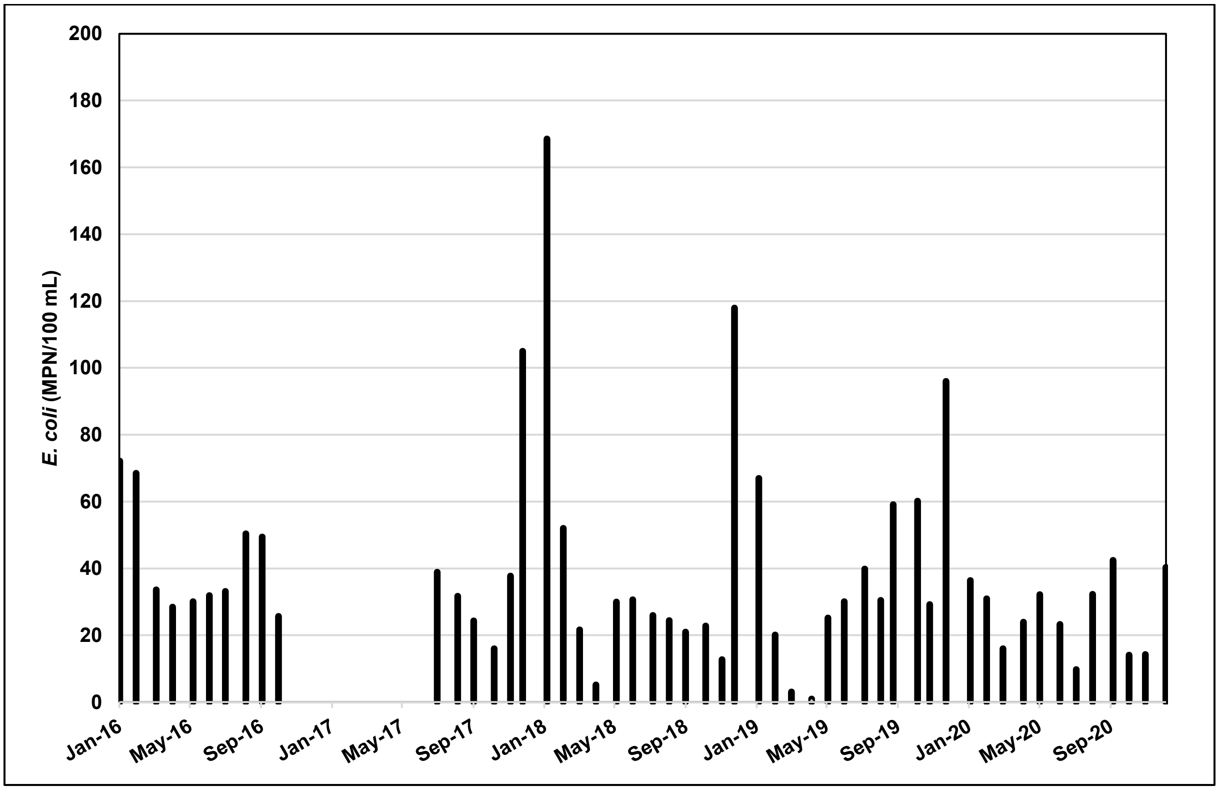


Figure 9-14. Monthly Median Total Coliforms at the Rinconada WTP Intake

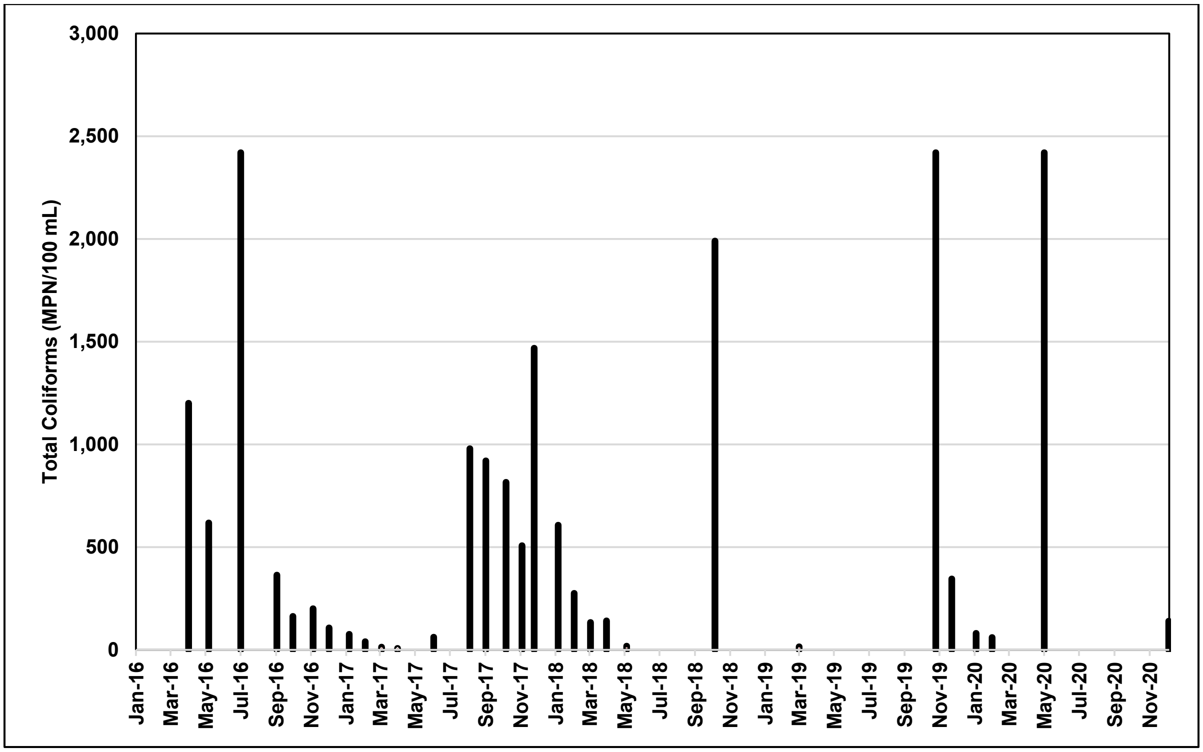
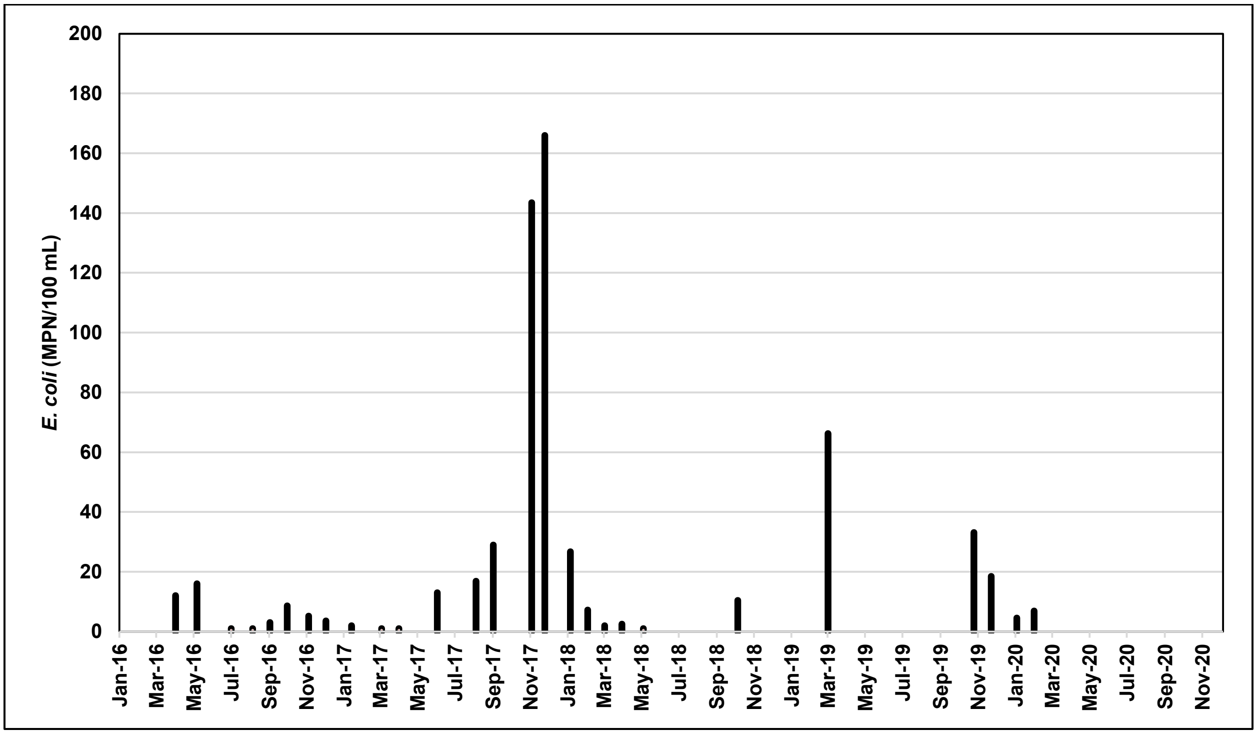


Figure 9-15. Monthly Median *E. coli* at the Rinconada WTP Intake



SAN LUIS RESERVOIR

Valley Water is the only Contractor who diverts municipal and industrial (M&I) water from San Luis Reservoir. Water is diverted from the western side of the reservoir at the Pacheco Pumping Plant (Pacheco) and flows through the Santa Clara Tunnel to Valley Water's service area. Although San Luis Reservoir water can be treated at all of Valley Water's WTPs, the Santa Teresa WTP treats primarily San Luis Reservoir water. The Santa Teresa WTP occasionally treats water from the Valley Water's local reservoirs. All data provided for the Santa Teresa WTP were included in the evaluation so local source water is also represented.

DWR operates the San Luis O&M Center WTP (San Luis WTP). In 2021, this WTP treated 11.3 million gallons per year and provides water for DWR employees, as well as the Romero Visitor Center and the California Department Parks and Recreation. The WTP draws water from penstocks 1 and 4 of the William R. Gianelli Pumping-Generating Plant (Gianelli). When water is being pumped from O'Neill Forebay into San Luis Reservoir, the source of water to the WTP is O'Neill Forebay. When power is being generated, the source of water is San Luis Reservoir.

PROTOZOA

Valley Water periodically monitored *Giardia* and *Cryptosporidium* at the Santa Teresa WTP between 2016 and 2020. As shown in **Table 9-6**, neither *Cryptosporidium* nor *Giardia* was detected.

**Table 9-6. Protozoan Detections at Santa Teresa WTP,
Valley Water Monitoring Program**

WTP	Monitoring Period	No. of Samples	***Cryptosporidium*** **(oocysts/L)**		***Giardia*** **(cysts/L)**	
			No. of Detects	**Maximum RAA**	**No. of Detects**	**Maximum RAA**
Santa Teresa	1/12/16 – 12/8/20	37	0	0	0	0

INDICATOR ORGANISMS

Figures 9-16 and 9-17 present the coliform data for the Santa Teresa WTP intake. Total coliform densities ranged from ND to greater than 2,420 MPN/100 ml, with a median density of 57.9 MPN/100 ml. Ninety percent of total coliform monthly medians were less than or equal to 1,000 MPN/100 ml. Peak monthly median values generally occur in the summer months. The total coliform densities between 2016 and 2020 were similar to those presented in the 2016 Update.

E. coli densities ranged from ND to 9.8 MPN/100 ml, with a median density of non-detect. All *E. coli* monthly medians were less than or equal to 10 MPN/100 ml. The peak values typically occur during the winter months. The peak values are lower than those presented in the 2016 Update, but median data are consistent with the historic data.

Figure 9-16. Monthly Median Total Coliforms at the Santa Teresa WTP Intake

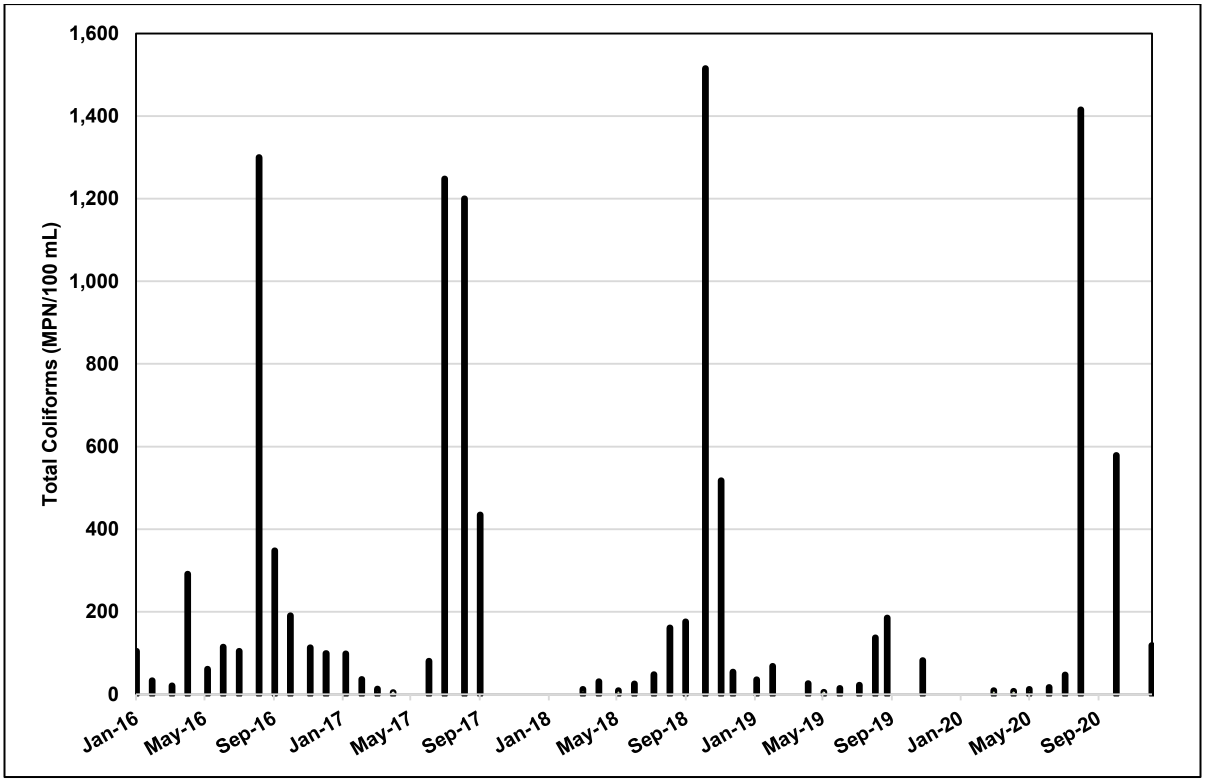
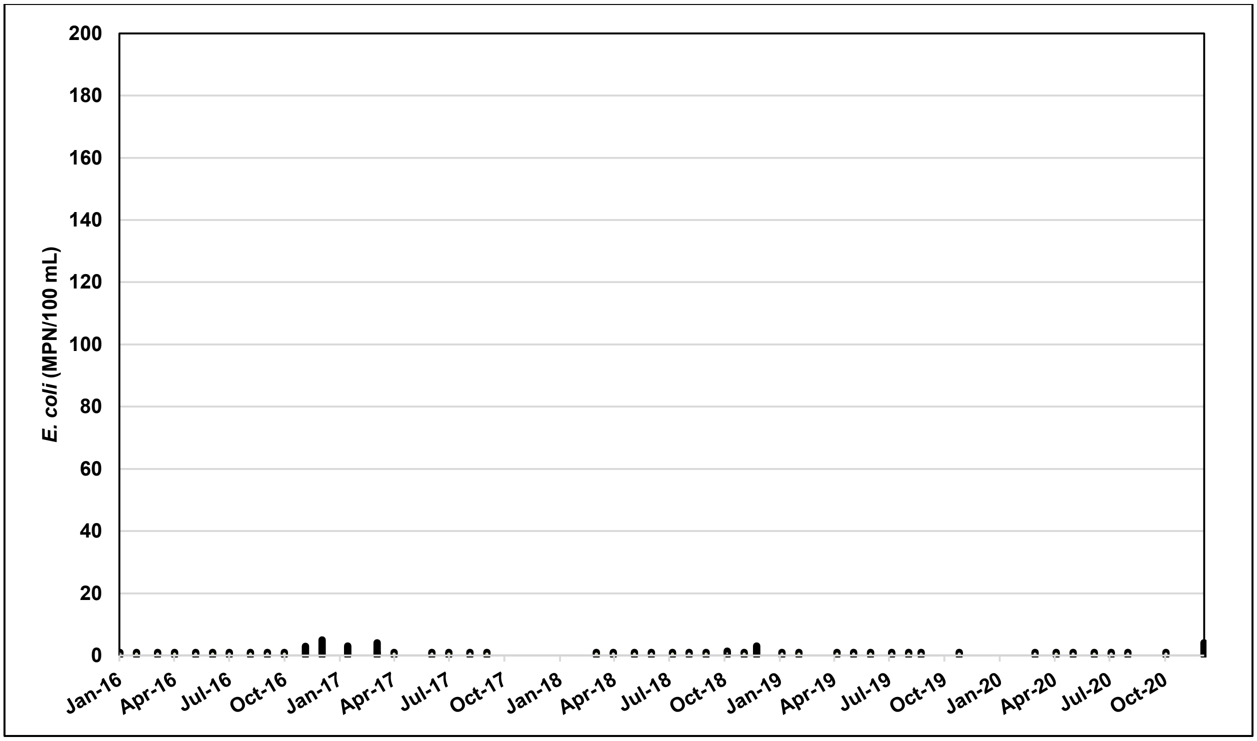


Figure 9-17. Monthly Median *E. coli* at the Santa Teresa WTP Intake



DWR collected *E. coli* data monthly at the San Luis WTP during the study period. **Figures 9-18 and 9-19** presents the coliform data for the San Luis WTP. Generally, only one sample is collected per month, therefore the monthly medians most often represent a single sample. Four months had total coliform monthly median densities greater than 1,000 MPN/100 ml (August 2018, April 2020, September 2020, and October 2020). Only one *E. coli* monthly median density was greater than 100 MPN/100ml. Due to the complex operations of O'Neill Forebay and San Luis Reservoir, it is difficult to determine the source of the higher total coliforms. In addition, DWR collected biweekly samples between October 2017 and September 2018 in compliance with LT2ESWTR Round 2 monitoring requirements. The annual average was 7.1 MPN/100 mL, well below the Bin 1 threshold limit of 100 MPN/100 mL.

EVALUATION OF PATHOGEN REDUCTION/INACTIVATION REQUIREMENTS

The pathogen and indicator organism data demonstrate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia* and 4-log reduction of viruses continue to be appropriate for the Santa Teresa WTP and the DWR San Luis WTP.

Figure 9-18. Total Coliforms at the San Luis WTP Intake

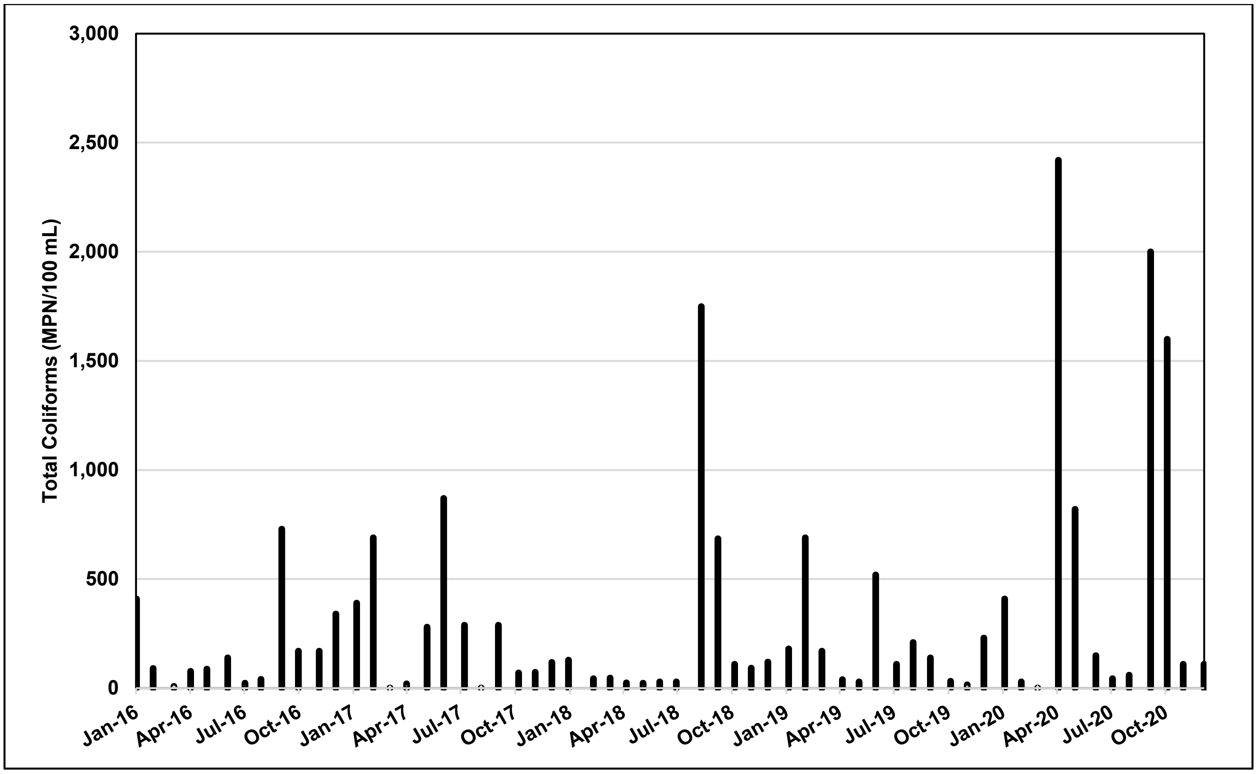
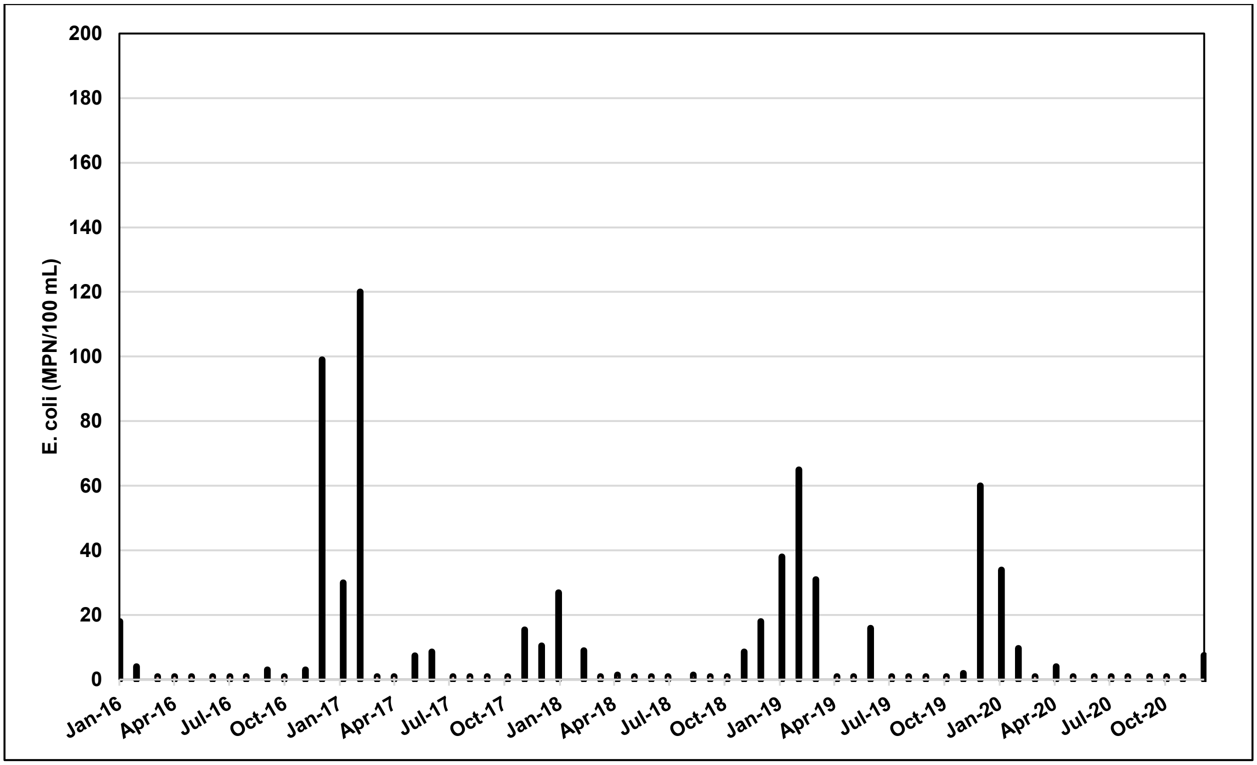


Figure 9-19. Monthly Median *E. coli* at the San Luis WTP Intake



COASTAL BRANCH OF THE CALIFORNIA AQUEDUCT

Central Coast Water Authority (CCWA) treats water at the 43-mgd Polonio Pass WTP. Treated water is delivered via pipeline from Polonio Pass WTP to a number of communities in San Luis Obispo and Santa Barbara counties. The source water quality data evaluated in this chapter is applicable to all of the communities that receive the treated water.

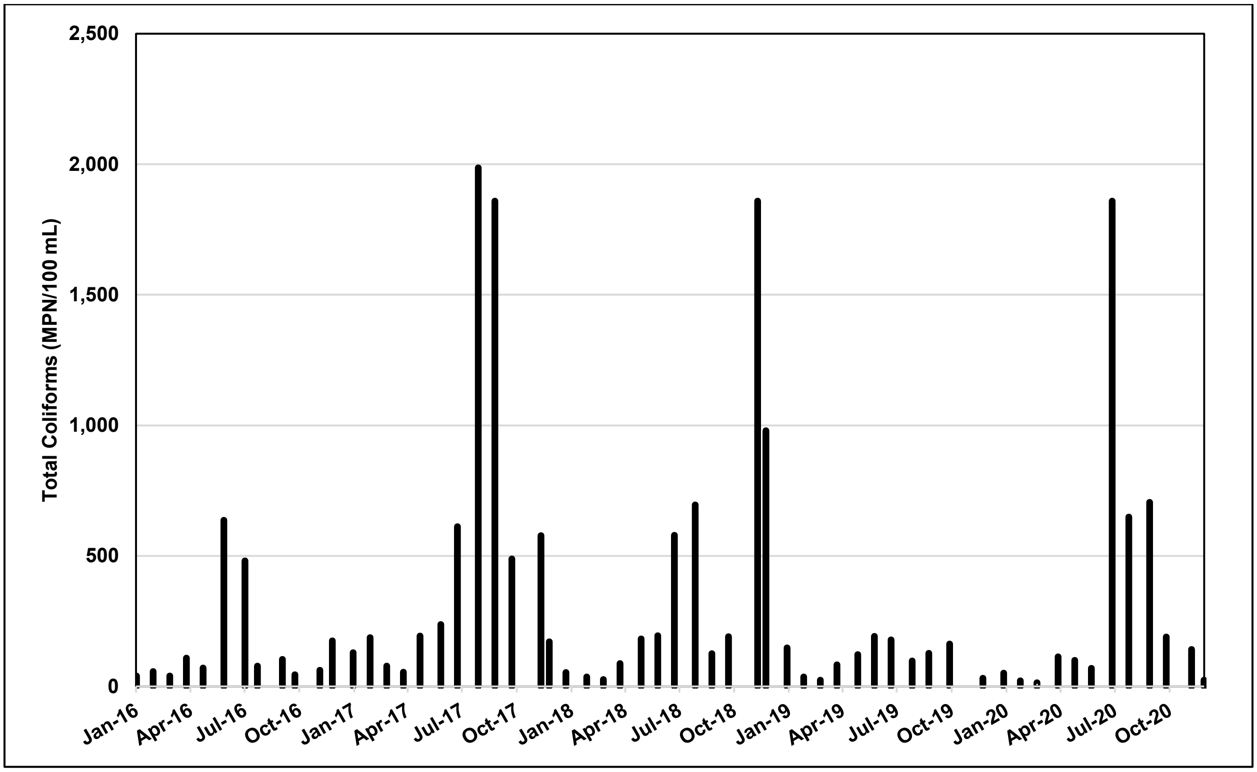
PROTOZOA

CCWA was assigned a Bin 1 classification by DDW for the Round 1 LT2ESWTR. Between March 2015 and February 2017 CCWA conducted Round 2 LT2ESWTR monthly monitoring for *Giardia* and *Cryptosporidium*. Twenty-four samples were collected and there were no detects of either protozoa, confirming a continued Bin 1 classification. CCWA continued quarterly monitoring through November 2019, with an additional 11 samples collected. There were no detects of either protozoan.

INDICATOR ORGANISMS

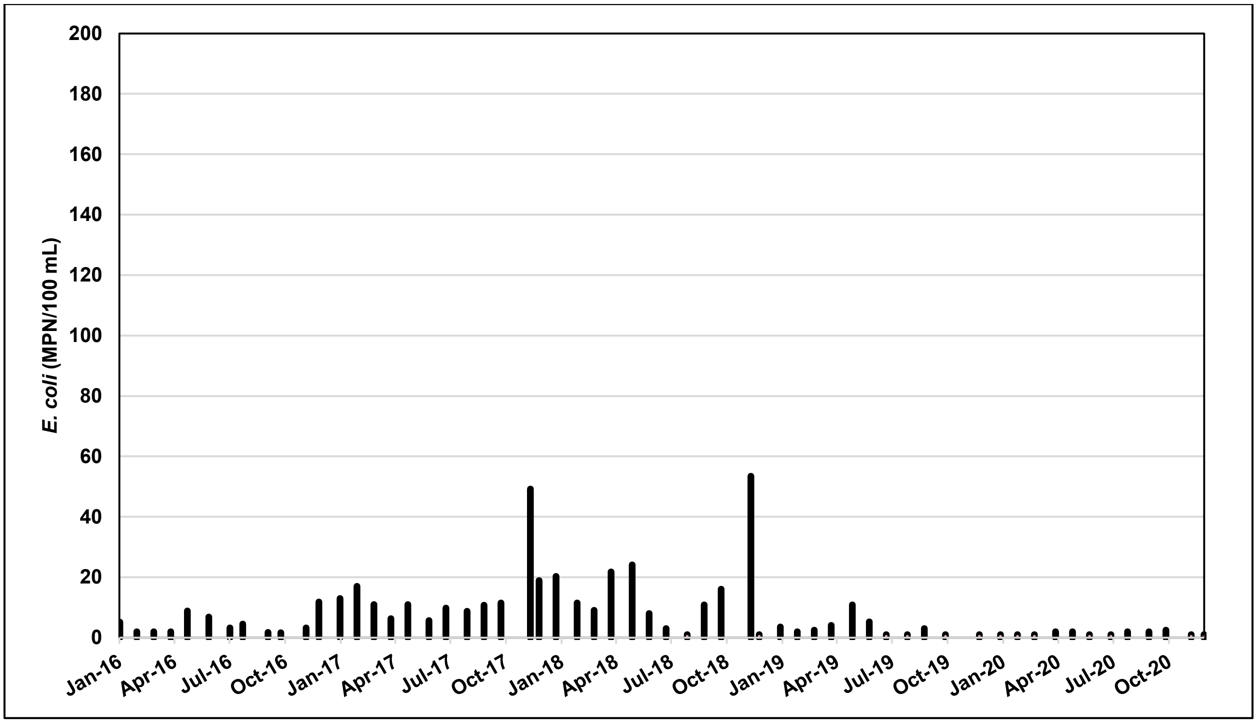
CCWA provided coliform data (total coliform and *E. coli*), collected between two and four times per month, from January 2016 through December 2020 from the intake to the Polonio Pass WTP. The total coliform densities ranged from ND to greater than 2,419 MPN/100 ml, with a median density of 127.4 MPN/100 ml. As shown in **Figure 9-20**, the monthly median total coliform densities were less than 1,000 MPN/100 ml in all but four months (August 2017, September 2017, November 2018, and July 2020) and were below 700 MPN/100 ml in 90 percent of samples. The peak monthly medians were higher than those presented in the 2016 Update.

Figure 9-20. Monthly Median Total Coliforms at the Polonio Pass WTP Intake



The *E. coli* densities ranged from ND to 123.6 MPN/100 ml, with a median density of 4.1 MPN/100 ml. As shown in **Figure 9-21**, the monthly median *E. coli* densities were less than 50 MPN/100 ml in all but one month (November 2018) and were below 20 MPN/100 ml in 92 percent of samples.

Figure 9-21. Monthly Median *E. coli* at the Polonio Pass WTP Intake



EVALUATION OF PATHOGEN REDUCTION/INACTIVATION REQUIREMENTS

CCWA's LT2ESWTR Round 2 monitoring placed the Polonio Pass WTP in Bin 1 and no additional action beyond 2-log reduction is required. The recent pathogen and indicator organism data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses continue to be appropriate for the Polonio Pass WTP.

CALIFORNIA AQUEDUCT, SAN JOAQUIN FIELD DIVISION

Kern County Water Agency (KCWA) diverts M&I water from this reach of the California Aqueduct. Water is diverted from the California Aqueduct and conveyed in the 22-mile-long Cross Valley Canal to the 72-mgd Henry C. Garnett Water Purification Plant. Treated water is sold to several retail agencies that provide drinking water for the metropolitan Bakersfield area. SWP water is exchanged whenever possible for Kern River water due to the higher quality of the Kern River. Therefore, Kern River water is used more frequently than SWP water as the source water for the Henry C. Garnett Water Purification Plant. DWR operated the Edmonston WTP at the Edmonston Pumping Plant, at the south end of the California Aqueduct and has been inactive since June 2016. The WTP took water from the California Aqueduct. This system only had one connection, so was not permitted as a public water system.

PROTOZOA

Twenty-four samples were analyzed for *Giardia* and *Cryptosporidium* by KCWA between April 2015 and March 2017, in compliance with the LT2ESWTR Round 2 monitoring requirement. These samples were collected from the California Aqueduct near the Cross Valley Canal turnout. Neither of these protozoa was detected in any of the samples, therefore the California Aqueduct at this location will continue to be classified as Bin 1.

INDICATOR ORGANISMS

Total coliforms and *E. coli* were collected by KCWA at the Cross Valley Canal turnout on a monthly basis between January 2016 and April 2017 and then quarterly from May 2017 through October 2020. Total coliform densities ranged from 29.9 to 4,184.4 MPN/100 mL, with a median density of 569.7 MPN/100 mL. *E. coli* densities ranged from ND to 99 MPN/100 mL, with a median density of 5.75 MPN/100 mL. These data are shown in **Figures 9-22 and 9-23**. The data show that while the total coliform densities exceed 1,000 MPN/100 ml in nearly half of samples, *E. coli* densities were always less than 200 MPN/100 mL and less than 50 MPN/100 ml in 96 percent of samples. Total coliform peak densities were lower than those presented in the 2016 Update.

The available total and fecal coliform data from the Edmonston WTP were collected and evaluated. Samples were collected monthly from January 2016 through May 2016, and it was decommissioned in June 2016. Total coliform densities ranged from ND to 13 MPN/100 ml, with a median density of 4.5 MPN/100 mL. Fecal coliform densities ranged from less than ND to 2 MPN/100 ml, with a median density of non-detect.

Figure 9-22. Total Coliforms in the California Aqueduct near the KCWA Turnout

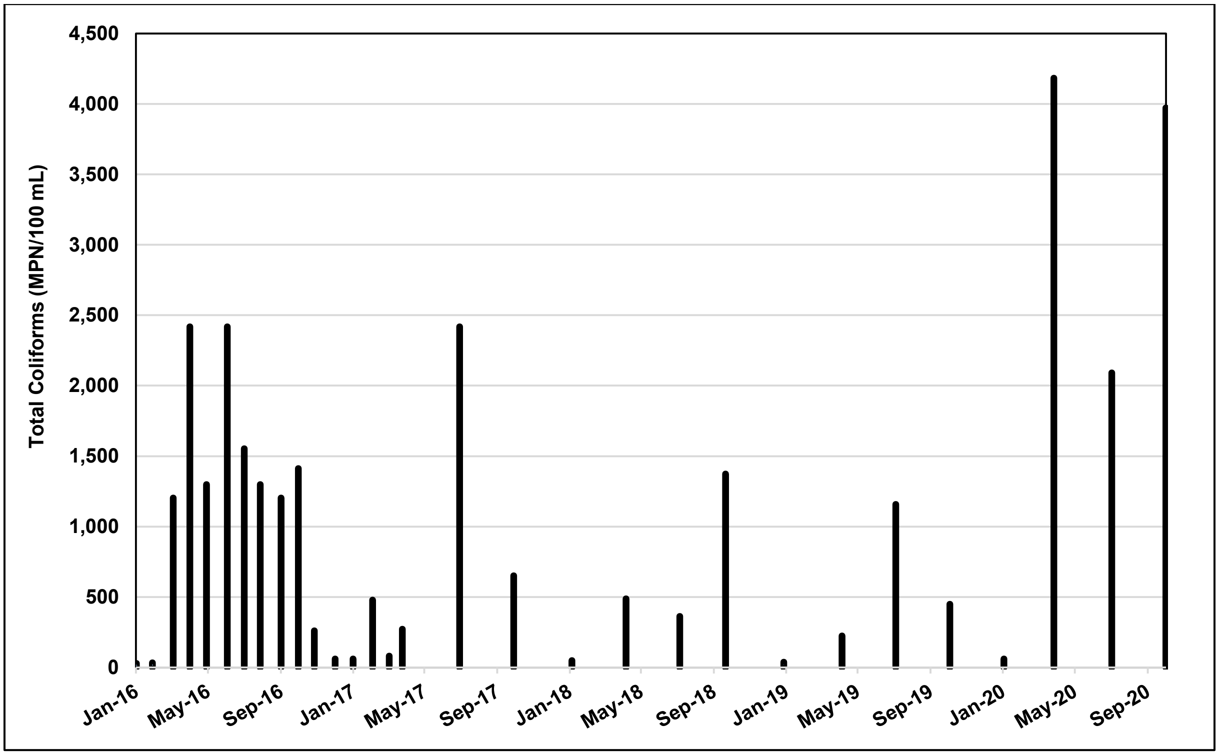
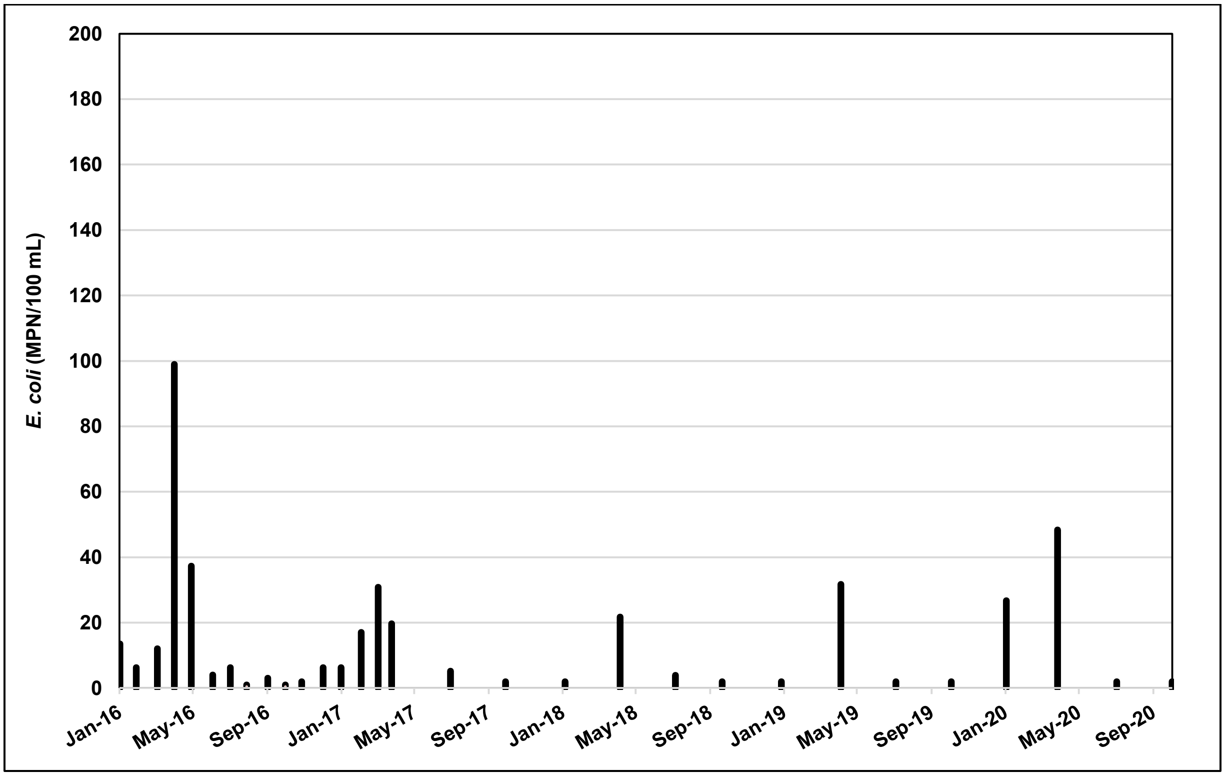


Figure 9-23. *E.coli* in the California Aqueduct near the KCWA Turnout



EVALUATION OF PATHOGEN REDUCTION/INACTIVATION REQUIREMENTS

Since the Kern River is the primary source of water for the Henry C. Garnett Water Purification Plant, log reductions are based primarily on Kern River water quality rather than the microbial quality of the California Aqueduct. When using the California Aqueduct source, protozoan results place the source in Bin 1 under the LT2ESWTR and no additional action beyond 2-log reduction is required for *Cryptosporidium*. The indicator organism data for KCWA indicates that 3-log reduction of *Giardia* and 4-log reduction of viruses continue to be appropriate. DWR's Edmonston WTP primarily uses the California Aqueduct for supply, however no treatment requirements apply since it has been decommissioned.

WEST BRANCH OF THE CALIFORNIA AQUEDUCT

The Metropolitan Water District of Southern California (MWDSC), DWR O&M Division, and Santa Clarita Valley Water Agency (SCV Water) take water from either Pyramid Lake or Castaic Lake on the West Branch. Water is diverted directly from Pyramid Lake to supply DWR's Vista del Lago WTP and Emigrant Landing WTP. Both WTPs supply treated water for recreational sites at Pyramid Lake. The maximum design flow capacity of the Vista del Lago WTP is 40-gallon per minute (gpm) and Emigrant Landing WTP is 92-gpm (Email communication, Calvin Yang, February 2022). Water is diverted from Castaic Lake and travels through the Foothill Feeder to the 750-mgd Joseph Jensen (Jensen) WTP, which serves the San Fernando Valley, Ventura County, west Los Angeles, Santa Monica, and the Palos Verdes Peninsula. SCV Water provides water service to approximately 75,000 business and residential customers as well as wholesale water to Los Angeles County Waterworks District #36. SCV Water was formed on January 1, 2018 when local water suppliers combined into one integrated, regional water provider. SCV Water treats water from Castaic Lake at the 56-mgd Earl Schmidt Filtration Plant and the 66-mgd Rio Vista Treatment Plant. Data from the Jensen WTP intake, Vista del Lago WTP, Emigrant Landing WTP, and Castaic Lake are evaluated in this chapter.

PROTOZOA

MWDSC's Jensen WTP was classified as Bin 1 based on results obtained during Round 2 LT2ESWTR monitoring conducted from April 2015 through March 2017. MWDSC collected monthly samples for *Giardia* and *Cryptosporidium* at the Jensen WTP influent from January 2016 through December 2020. Neither *Giardia* cysts nor *Cryptosporidium* oocysts were detected in any of the 60 treatment plant influent samples.

SCV Water initiated its Round 2 LT2ESWTR monitoring at the Rio Vista WTP in October 2015. Fifteen monthly samples were collected and analyzed for *Giardia* and *Cryptosporidium* through September 2017. There were no detections of either protozoa, therefore the source is classified as Bin 1 again.

INDICATOR ORGANISMS

DWR submitted *E. coli* data collected at the Vista Del Lago WTP for LT2ESWTR Round 1 monitoring and received a Bin 1 classification. The available total and fecal coliform and *E. coli* data from the DWR O&M Division Vista del Lago WTP was collected and evaluated. Samples were collected weekly from January 2016 through December 2020. Total coliform densities ranged from ND to 130 MPN/100 ml, with a median density of 4 MPN/100 ml. **Figure 9-24** presents the total coliform monthly median data for the Vista del Lago WTP intake. Fecal coliform densities ranged from ND to 30 MPN/100 ml, with a median density of non-detect. **Figure 9-25** presents the fecal coliform monthly median data for the Vista del Lago WTP intake. *E. coli* densities ranged from ND to 30 MPN/100 ml, with a median density of non-detect. **Figure 9-26** presents the *E. coli* monthly median data for the Vista del Lago WTP intake. A review of **Figures 9-25 and 9-26** indicates that the detectable levels of fecal coliform and *E. coli* occur during the fall months.

DWR submitted *E. coli* data collected at the Emigrant Landing WTP for LT2ESWTR Round 1 monitoring and received a Bin 1 classification. The available total and fecal coliform and *E. coli* data from the DWR O&M Division Emigrant Landing WTP (at Pyramid Lake) was collected and evaluated. Samples were collected monthly from January 2016 through December 2020. Total coliform densities ranged from ND to 70 MPN/100 ml, with a median density of 4 MPN/100 ml. **Figure 9-27** presents the total coliform monthly median data for the Emigrant Landing WTP intake. Fecal coliform densities ranged from ND to 30 MPN/100 ml, with a median density of non-detect. **Figure 9-28** presents the fecal coliform monthly median data for the Emigrant Landing WTP intake. *E. coli* densities ranged from ND to 30 MPN/100 ml, with a median density of non-detect. **Figure 9-29** presents the *E. coli* monthly median data for the Emigrant Landing WTP intake. A review of **Figures 9-28 and 9-29** indicates that the detectable levels of fecal coliform and *E. coli* occur during the fall and winter months.

MWDSC provided monthly median indicator organism data for the period of January 2016 through December 2020. Total coliform weekly samples range from 1 to 20,000 MPN/100 mL. The monthly medians for total coliforms and *E. coli* are shown in **Figures 9-30 and 9-31.** These data indicate that about 25 percent of monthly median total coliform densities exceed 1,000 MPN/100 ml, with peaks generally occurring during the summer months. The highest monthly total coliform median occurred in August 2018. The peak total coliform monthly medians are lower than those presented in the 2016 Update. *E. coli* weekly samples range from ND to 6 MPN/100 mL. The monthly median *E. coli* densities were at or below 2 MPN/100 ml for all months.

SCV Water collects weekly total and fecal coliform and *E. coli* samples from Castaic Lake. Data from January 2016 through December 2020 were evaluated for this study. Total coliform densities ranged from ND to 780 MPN/100 ml, with a median density of 4 MPN/100 ml. **Figure 9-32** shows that the monthly median total coliform densities do not exceed 20 MPN/100 ml. The fecal coliform densities range from ND to 8 MPN/100 ml, with a non-detectable median density. **Figure 9-33** shows the monthly median fecal coliform densities, with none exceeding 2 MPN/100 ml. *E. coli* densities range from ND to 8 MPN/100 ml, with a non-detectable median density. **Figure 9-34** shows the monthly median *E. coli* densities, with none exceeding 2 MPN/100 ml. Coliform densities can peak throughout the year in Castaic Lake.

Figure 9-24. Total Coliforms in Pyramid Lake at the Vista del Lago WTP Intake

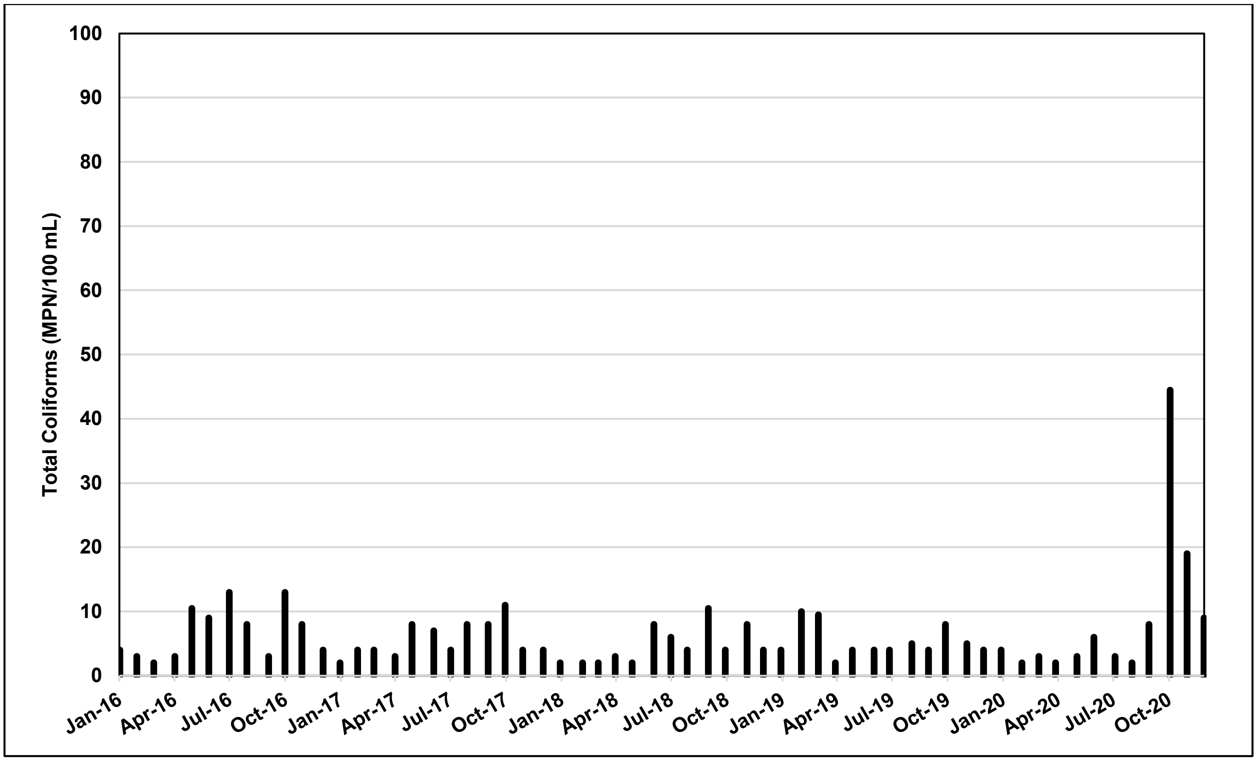


Figure 9-25. Fecal Coliforms in Pyramid Lake at the Vista del Lago WTP Intake

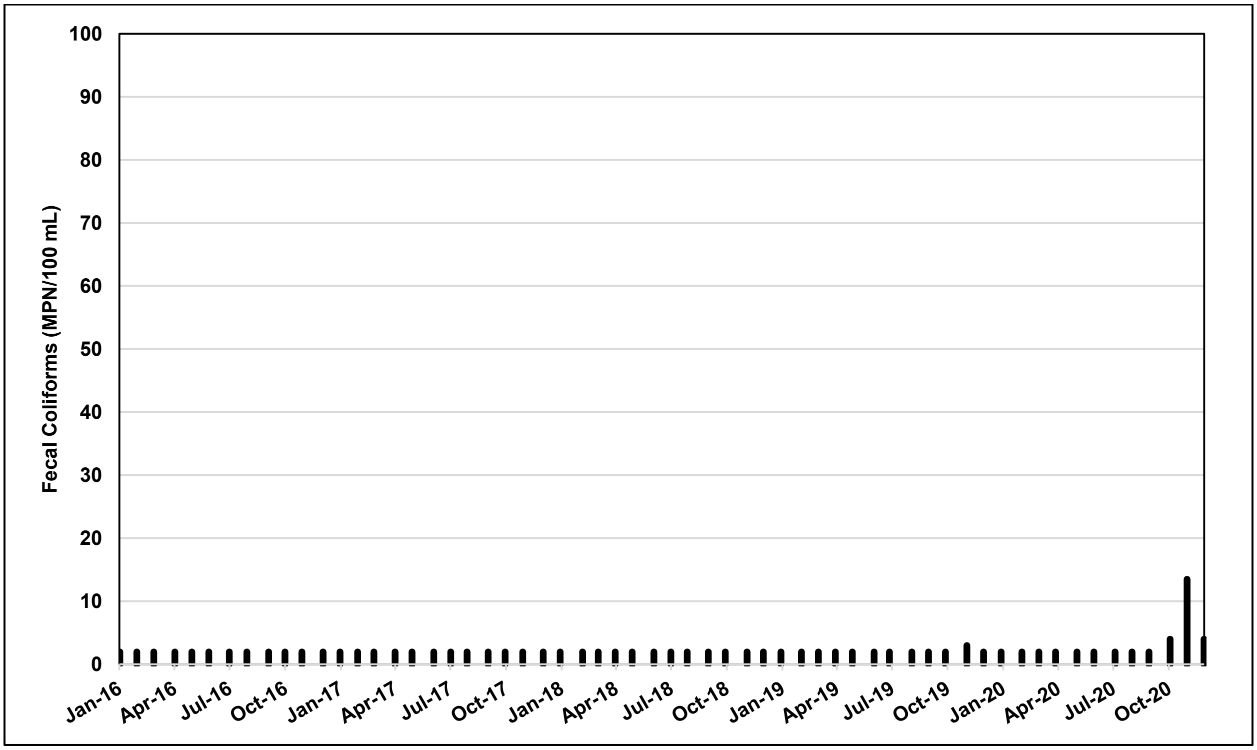


Figure 9-26. *E. coli* in Pyramid Lake at the Vista del Lago WTP Intake

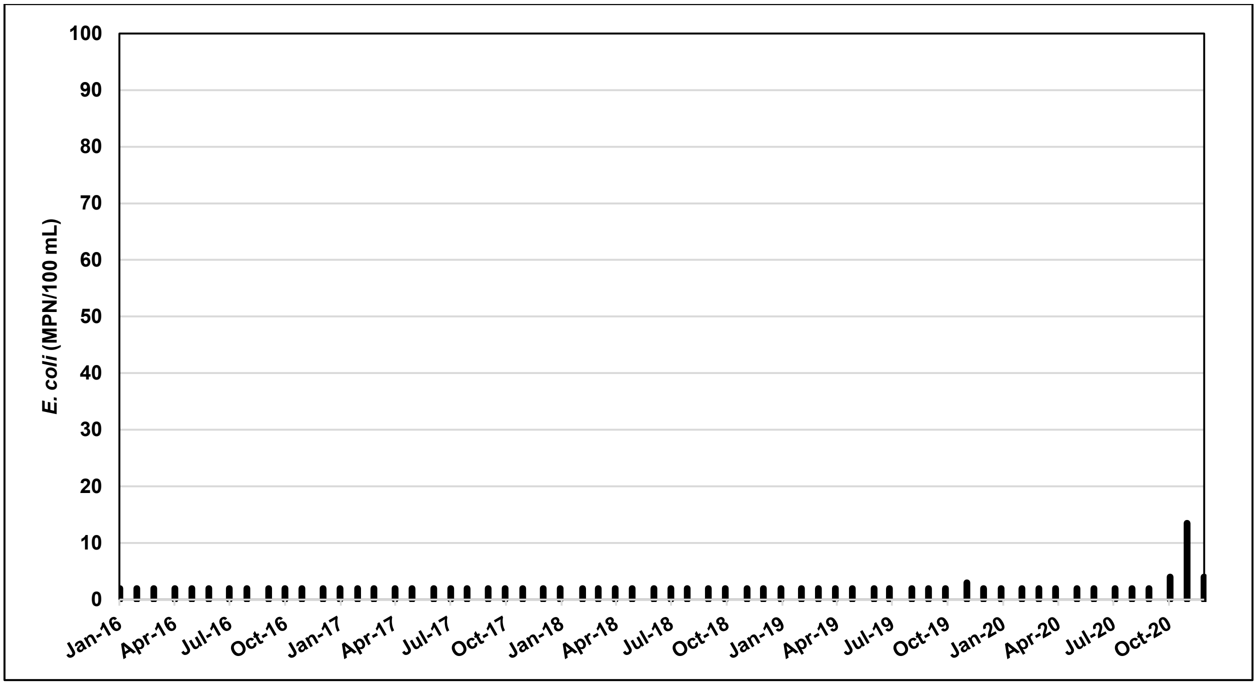


Figure 9-27. Total Coliforms in Pyramid Lake at the Emigrant Landing WTP Intake

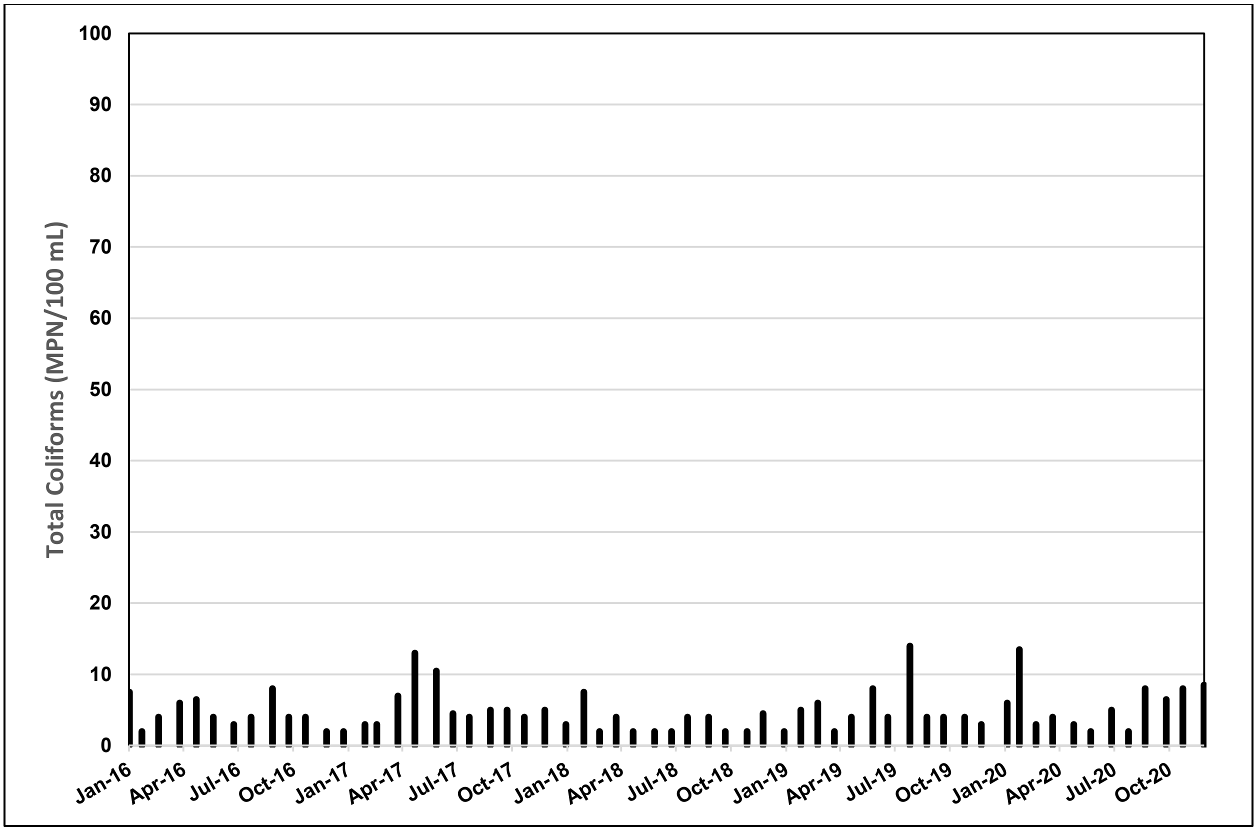


Figure 9-28. Fecal Coliforms in Pyramid Lake at the Emigrant Landing WTP Intake

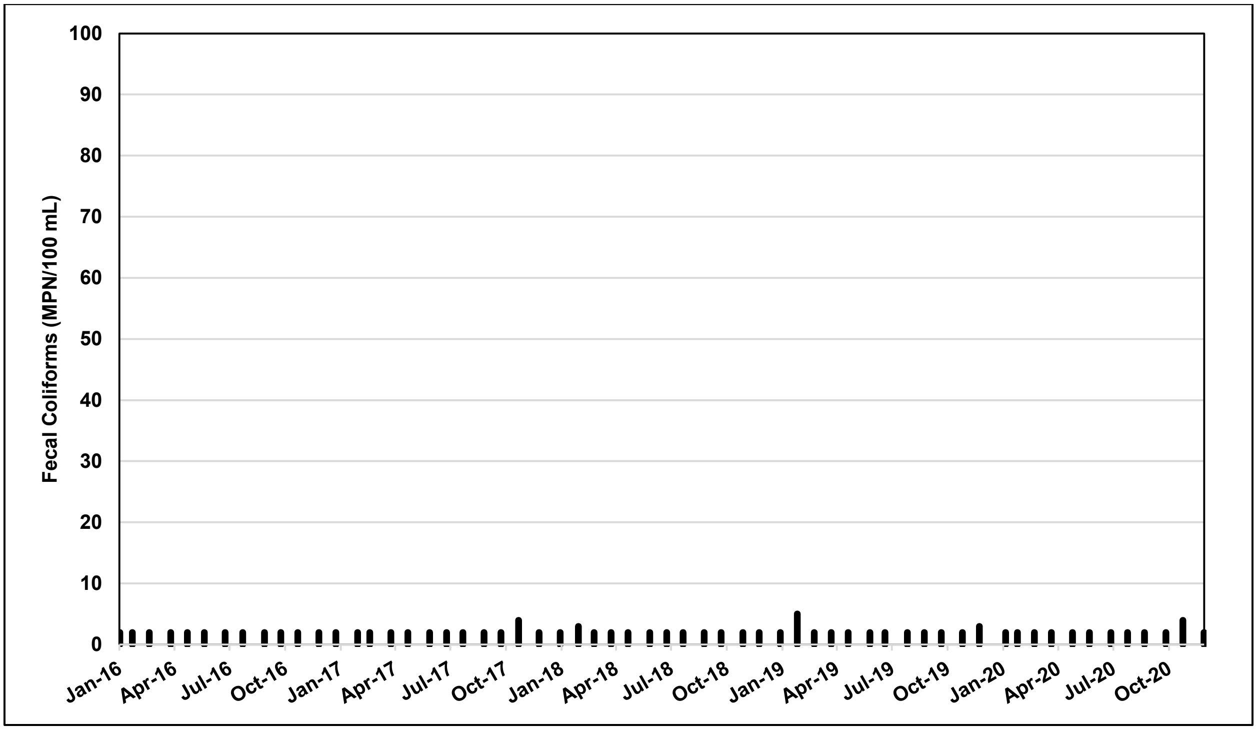


Figure 9-29. ***E. coli*** **in Pyramid Lake at the Emigrant Landing WTP Intake**

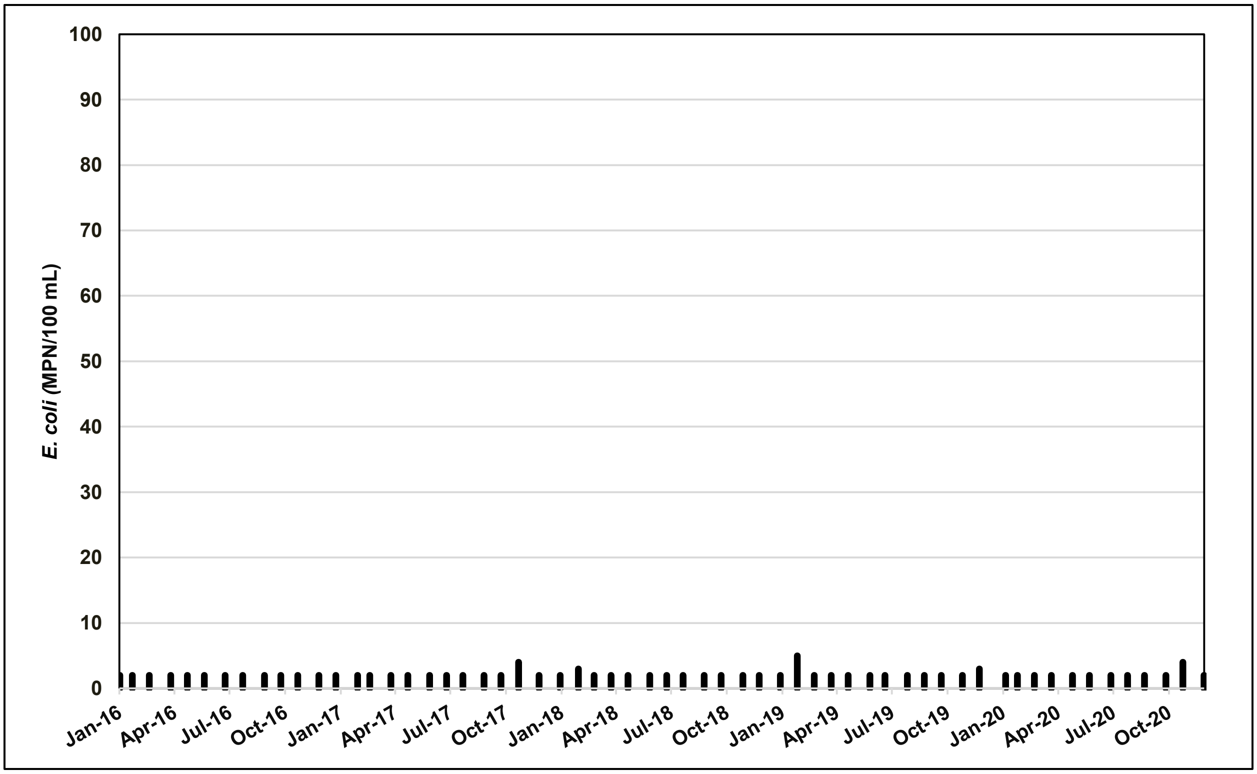


Figure 9-30. Monthly Median Total Coliforms at the Jensen WTP Intake

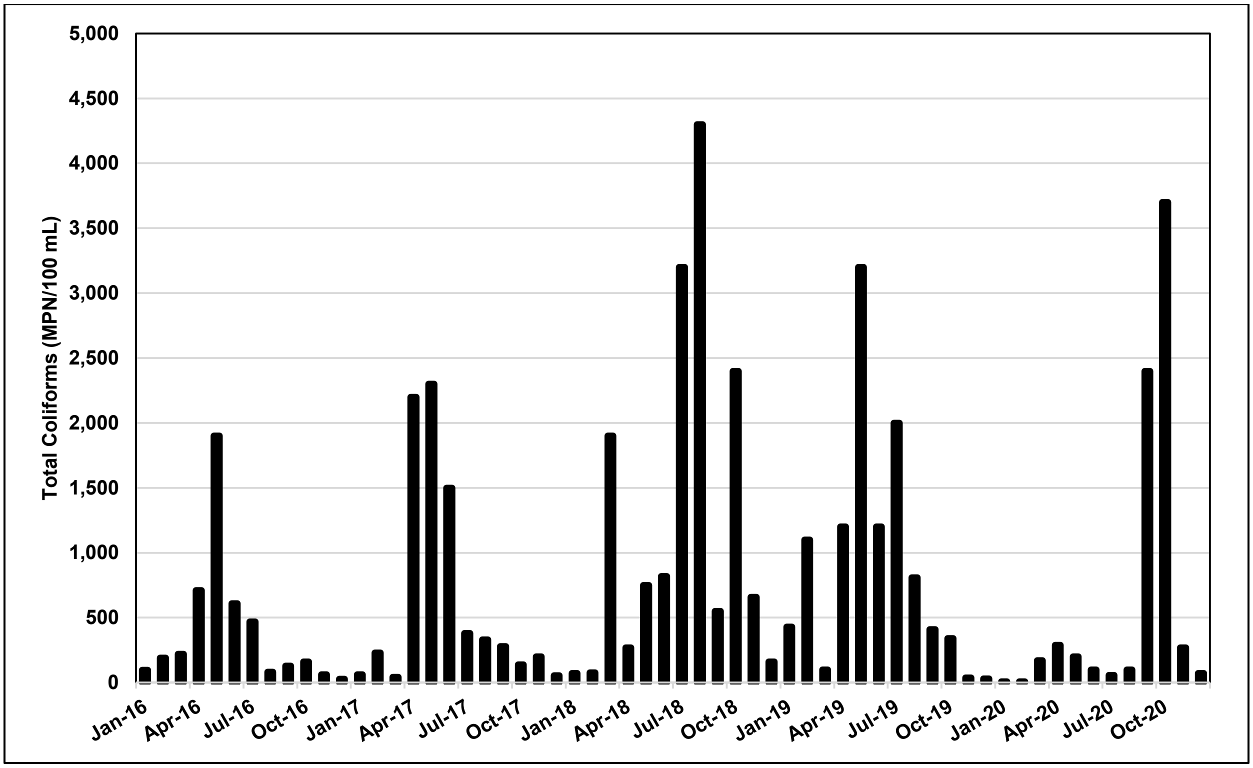


Figure 9-31. Monthly Median *E. coli* at the Jensen WTP Intake

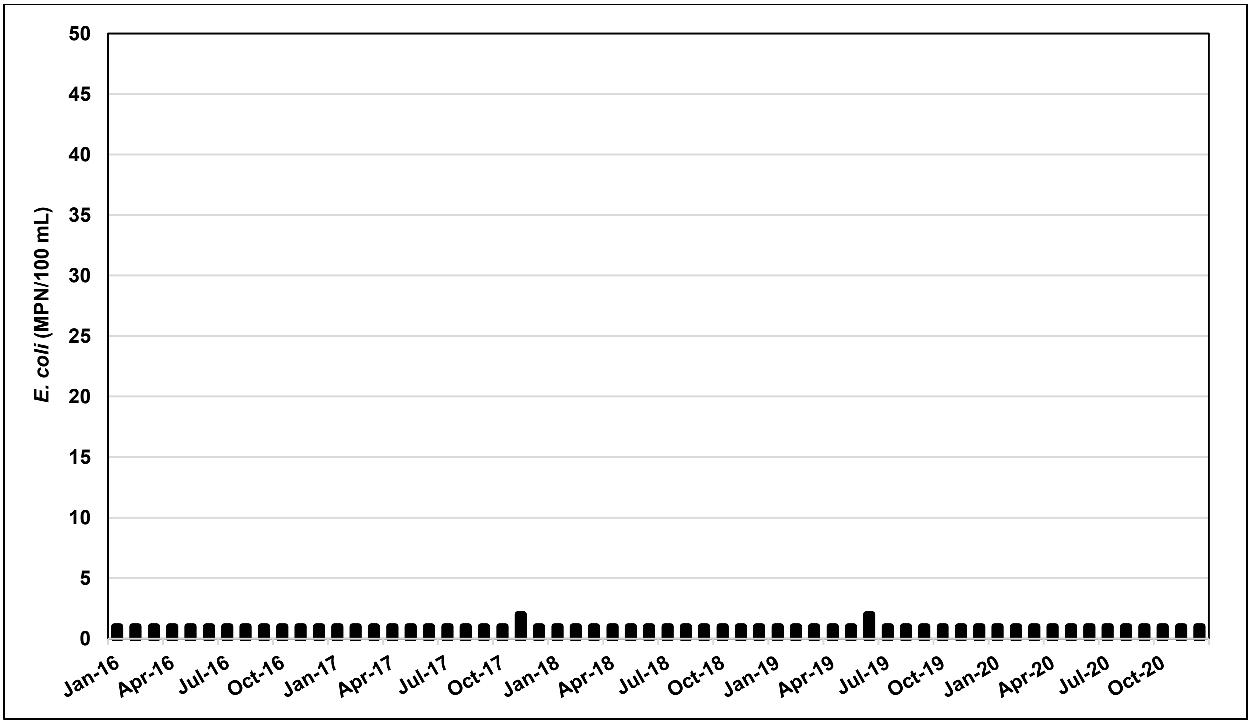


Figure 9-32. Monthly Median Total Coliforms in Castaic Lake

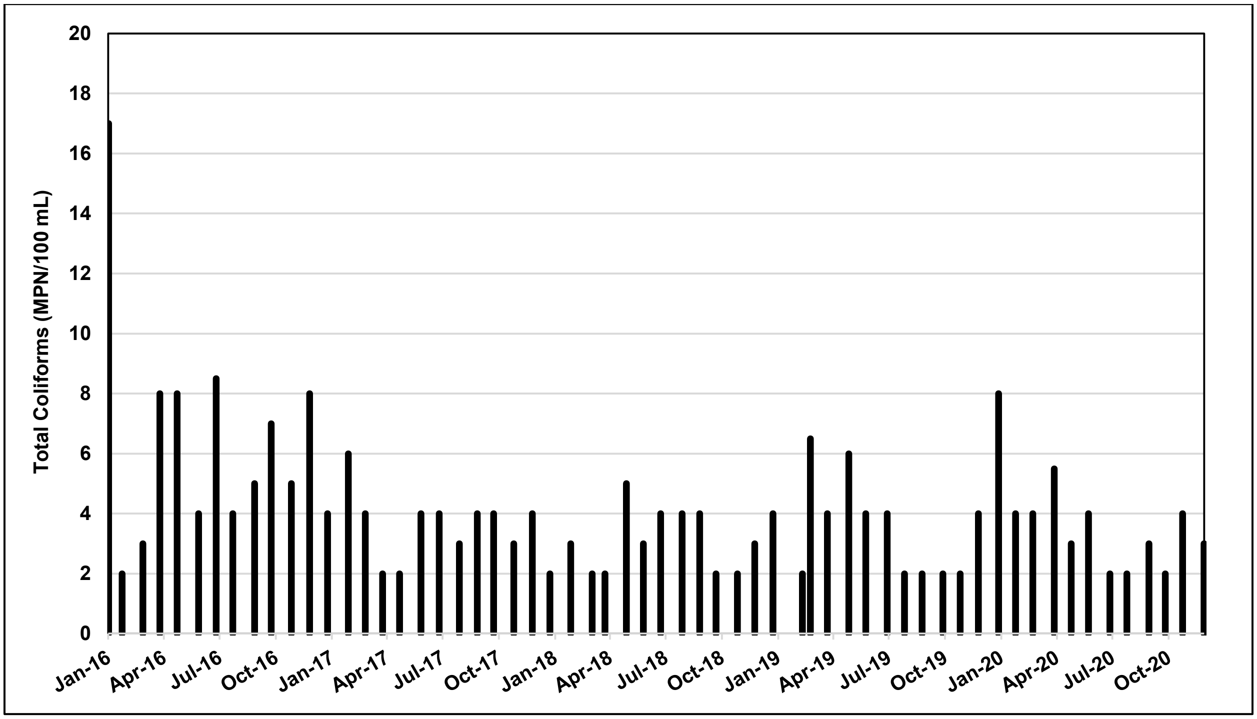


Figure 9-33. Monthly Median Fecal Coliforms in Castaic Lake

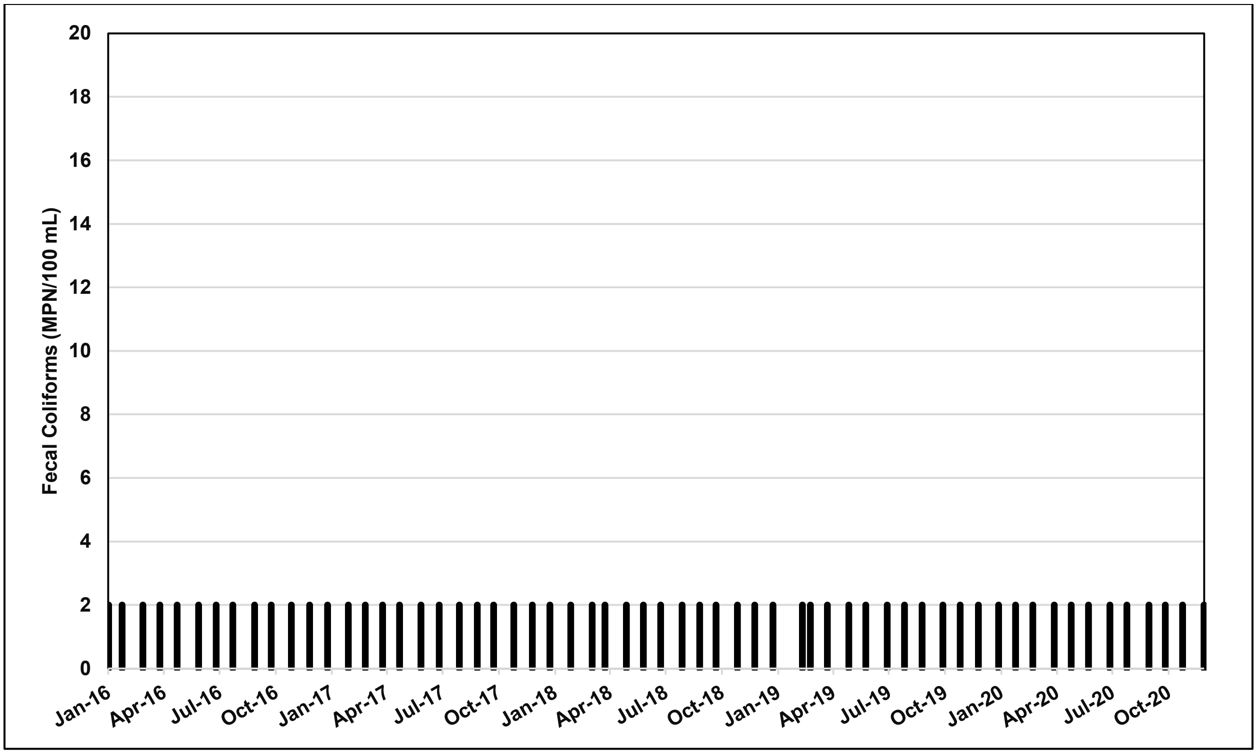
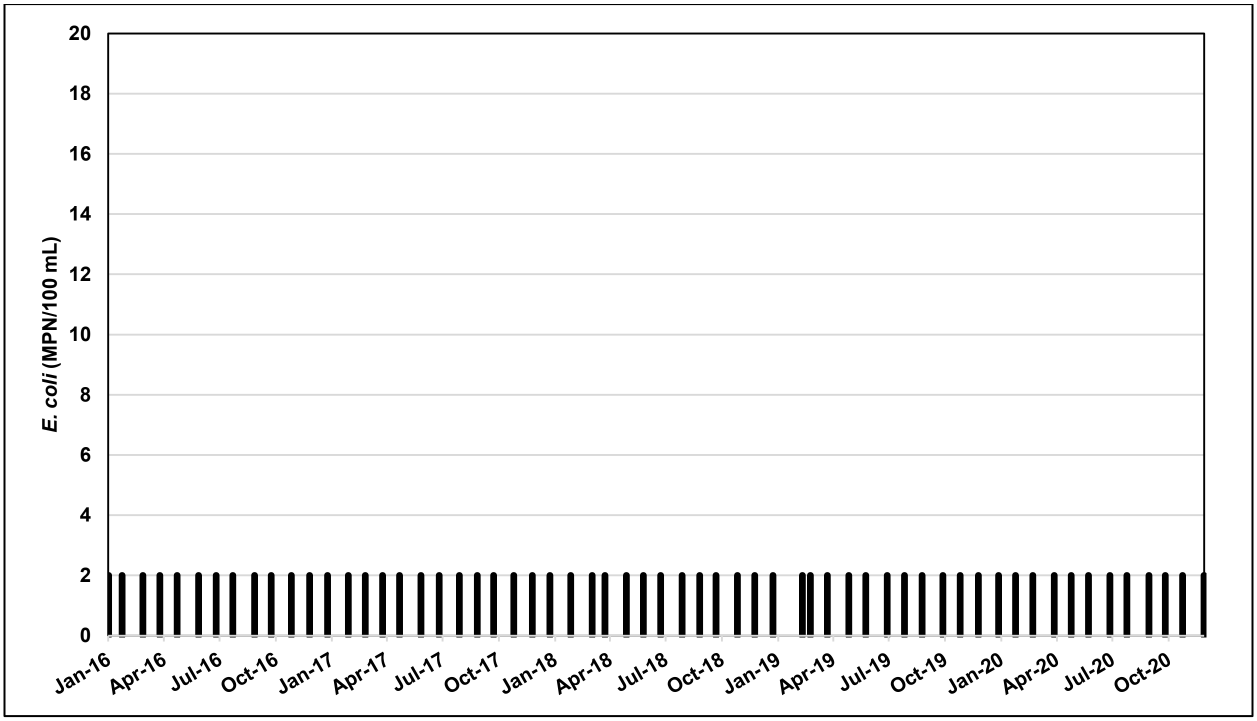


Figure 9-34. Monthly Median *E. coli* in Castaic Lake



EVALUATION OF PATHOGEN REDUCTION/INACTIVATION REQUIREMENTS

Both the indicator organism data and the *Giardia* and *Cryptosporidium* data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia*, and 4-log reduction of viruses continue to be appropriate for all the treatment plants treating water from the West Branch.

EAST BRANCH OF THE CALIFORNIA AQUEDUCT (CHECK 42 TO CHECK 66)

The Antelope Valley-East Kern Water Agency (AVEK) and Palmdale Water District (Palmdale) divert water from this reach of the East Branch and provide drinking water to customers in the Mojave Desert. AVEK diverts M&I water at four locations and treats it at the 4-mgd Acton WTP (decommissioned in 2016), 10-mgd Eastside WTP, 65-mgd Quartz Hill WTP, and the 14-mgd Rosamond WTP. Quartz Hill WTP treats 100 percent East Branch water, Eastside WTP treats a mixture of banked groundwater and East Branch water, and Rosamond WTP treats 100 percent groundwater. Palmdale treats water at the 30-mgd Palmdale Water District WTP.

PROTOZOA

AVEK initiated its LT2ESWTR Round 2 monitoring in January 2016 at the Acton, Eastside, and Quartz Hill, and Rosamond WTPs. Twenty-four bi-weekly samples were collected for both *Giardia* and *Cryptosporidium* analysis at the Acton, Eastside, and Quartz Hill WTPs through December 2016. There were no detections of *Giardia* or *Cryptosporidium*. The Rosamond WTP was sampled bi-weekly between June and October 2016. Nine results for *Giardia* and *Cryptosporidium* were all non-detect.

The City of Palmdale initiated its LT2ESWTR Round 2 monitoring in April 2015 at the Palmdale WTP. Twenty-four monthly samples were collected through April 2017. All were non-detect for both *Giardia* and *Cryptosporidium* and LT2ESWTR Bin 1 classification continues to be appropriate.

INDICATOR ORGANISMS

AVEK provided coliform data from January 2016 to December 2020 at their three operating WTPs. The data are summarized in **Table 9-7**. These data indicate that the monthly median total coliform densities are generally below 1,000 MPN/100 ml and the *E. coli* monthly medians are generally below 30 MPN/100 ml. The total coliform levels were higher than those presented in the 2016 Update, while the *E. coli* levels were at or below those presented in the 2016 Update.

Table 9-7. Summary of AVEK Coliform Data

WTP	Total Coliforms (MPN/100ml)		*E. coli* (MPN/100ml)	
	Maximum, Median Detected	Monthly Median Range	Maximum, Median Detected	Monthly Median Range
Eastside	>2,419.6, 30	ND – >2,419.6	50, 5.2	ND – 18
Quartz Hill	>2,419.6, 30	ND – >2,419.6	80, ND	ND – 26.2
Rosamond	>2,419.6, 23.1	ND – 1,732.9	34.1, ND	ND – 9.25

Palmdale collects weekly coliform data at their WTP as well. The monthly median densities for total coliform and *E. coli* were provided and are shown in **Figures 9-35 and 9-36**. Total coliform monthly median densities ranged from 20 to greater than 2,420 MPN/100 mL. Sixty-five percent of the monthly medians were less than 1,000 MPN/100 mL. *E. coli* monthly median densities ranged from ND to 73 MPN/100 mL. Ninety-six percent of the *E. coli* monthly median densities were less than 50 MPN/100 ml. Most peak *E. coli* levels occur during the winter months.

EVALUATION OF PATHOGEN REDUCTION/INACTIVATION REQUIREMENTS

The protozoa and indicator organism data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia*, and 4-log reduction of viruses continue to be appropriate for the treatment plants treating water from this reach of the East Branch.

Figure 9-35. Monthly Median Total Coliforms at the Palmdale WTP

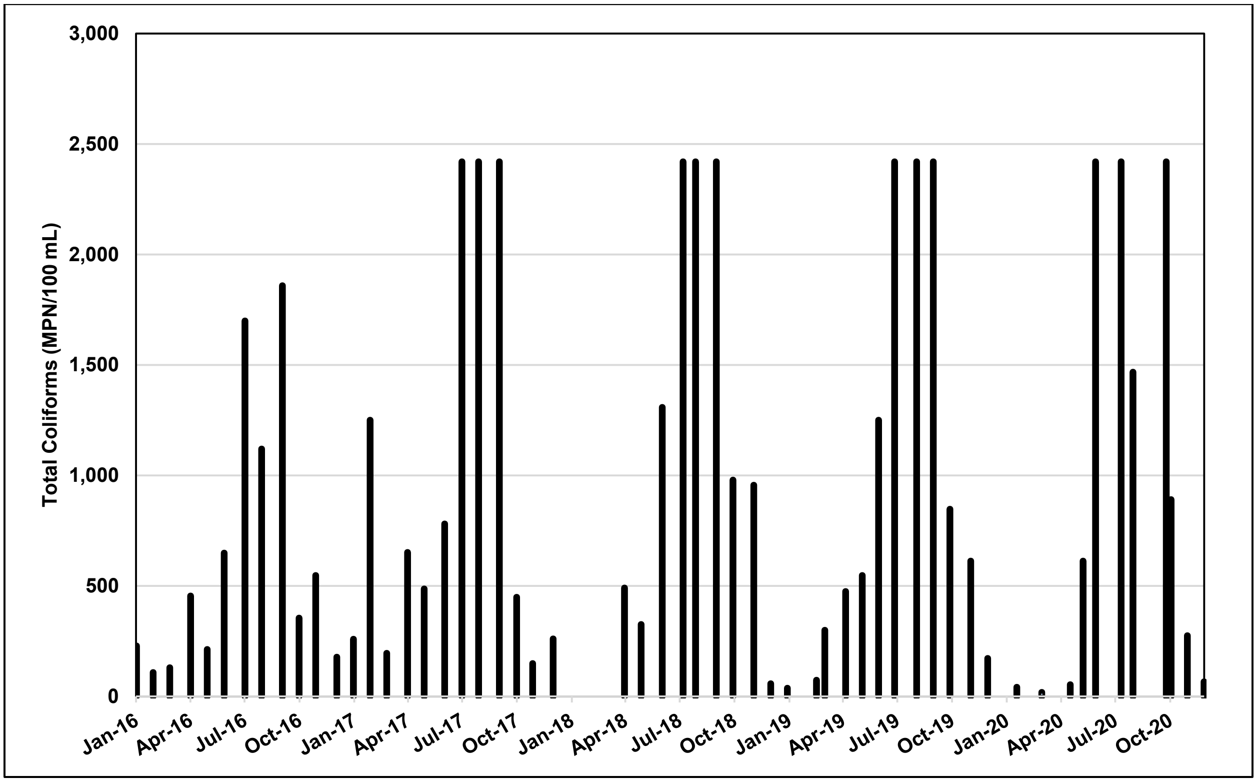
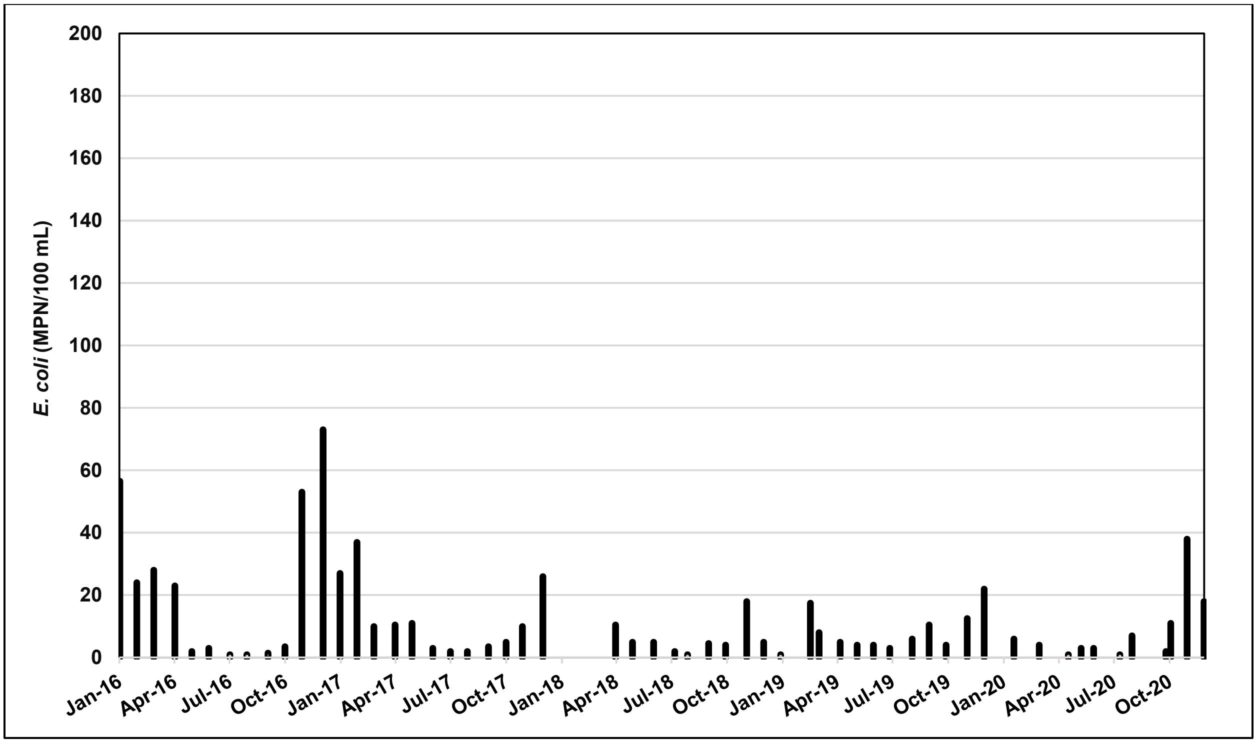


Figure 9-36. Monthly Median *E. coli* at the Palmdale WTP



EAST BRANCH OF THE CALIFORNIA AQUEDUCT (SILVERWOOD LAKE TO LAKE PERRIS)

MWDSC and Crestline Lake Arrowhead Water Agency (CLAWA) are the only two agencies that divert water from this reach of the East Branch for direct use. San Bernardino Valley Municipal Water District is a wholesale agency that diverts water from the East Branch. Other agencies use East Branch water for groundwater recharge. MWDSC diverts water from Devil Canyon Afterbay, downstream of Silverwood Lake and treats it at the 326-mgd Henry J. Mills (Mills) WTP. MWDSC routinely takes water from Lake Perris. When water is taken from Lake Perris it is typically blended with Colorado River water and treated at the 520-mgd Robert A. Skinner WTP, but it can also be treated at the Mills WTP. CLAWA diverts water directly from the south side of Silverwood Lake and treats it at the 5-mgd CLAWA WTP. CLAWA delivers water to wholesale and residential customers in the San Bernardino Mountains. Data from the Mills WTP and the CLAWA Silverwood intake are evaluated in this section.

PROTOZOA

MWDSC's Mills WTP was classified as Bin 1 based on results obtained during Round 2 LT2ESWTR monitoring conducted from April 2015 through March 2017. MWDSC collected monthly samples for *Giardia* and *Cryptosporidium* at the Mills WTP influent from January 2016 through December 2020. Neither *Giardia* cysts nor *Cryptosporidium* oocysts were detected in any of the 60 treatment plant influent samples.

CLAWA monitored for *Giardia* and *Cryptosporidium* approximately quarterly between February 2016 and November 2020. A total of 17 samples were collected. There were no detects of *Cryptosporidium* or *Giardia*. In compliance with LT2ESWTR Round 2 monitoring requirements, CLAWA monitored for *E. coli* biweekly between January 2016 and December 2020, with a maximum RAA of 3.26 MPN/100 mL, well below the Bin 1 classification threshold of 100 MPN/100 mL.

INDICATOR ORGANISMS

MWDSC provided monthly median coliform data for the period of January 2016 through December 2020. Total coliform weekly samples ranged from 3 to 11,000 MPN/100 mL. The monthly medians for total coliforms and *E. coli* are shown in **Figures 9-37 through 9-38.** These data indicate that about 80 percent of monthly median total coliform densities are below 1,000 MPN/100 ml, with peaks generally occurring during the summer months. The peak total coliform monthly medians are lower than those presented in the 2016 Update. *E. coli* weekly samples ranged from ND to 86 MPN/100 mL. The monthly median *E. coli* densities were at or below 20 MPN/100 ml for all months, with peaks generally occurring during the winter months.

CLAWA collects weekly total and fecal coliform and *E. coli* samples from the Silverwood intake. Data from January 2016 through December 2020 were evaluated for this study. Total coliform densities ranged from ND to 540 MPN/100 ml, with a median density of 9.3 MPN/100 ml. **Figure 9-39** shows that the monthly median total coliform densities do not exceed 60 MPN/100 ml. The fecal coliform densities range from ND to 79 MPN/100 ml, with a median density of 1.9 MPN/100 mL. **Figure 9-40** shows the monthly median fecal coliform densities, with none exceeding 20 MPN/100 ml. *E. coli* densities range from ND to 21 MPN/100 ml, with a non-detectable median density. **Figure 9-41** shows the monthly median *E. coli* densities, with none exceeding 15 MPN/100 ml. Total coliform densities peak in the summer months, while fecal coliform and *E. coli* peak in the winter months.

EVALUATION OF PATHOGEN REDUCTION/INACTIVATION REQUIREMENTS

Both the indicator organism data and the *Giardia* and *Cryptosporidium* data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia*, and 4-log reduction of viruses continue to be appropriate for the treatment plants treating water from this reach of the East Branch.

Figure 9-37. Monthly Median Total Coliforms at the Mills WTP

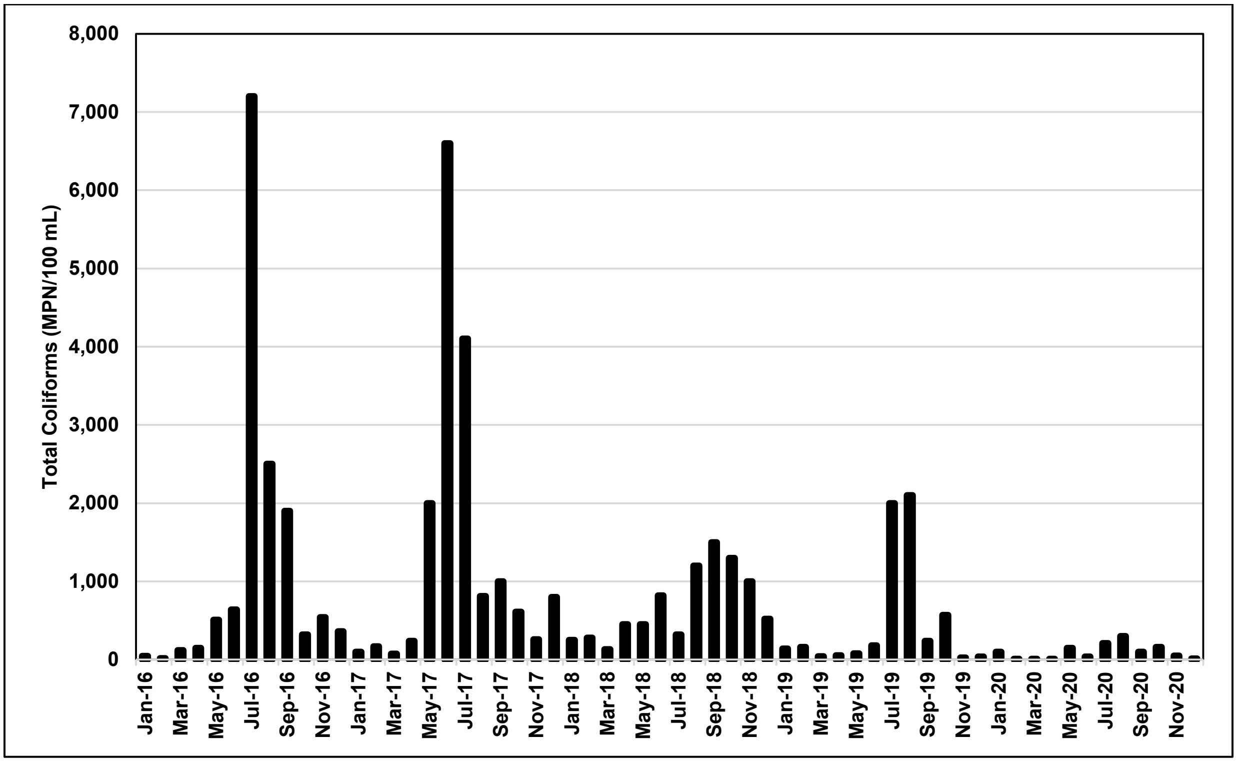


Figure 9-38. Monthly Median *E. coli* at the Mills WTP

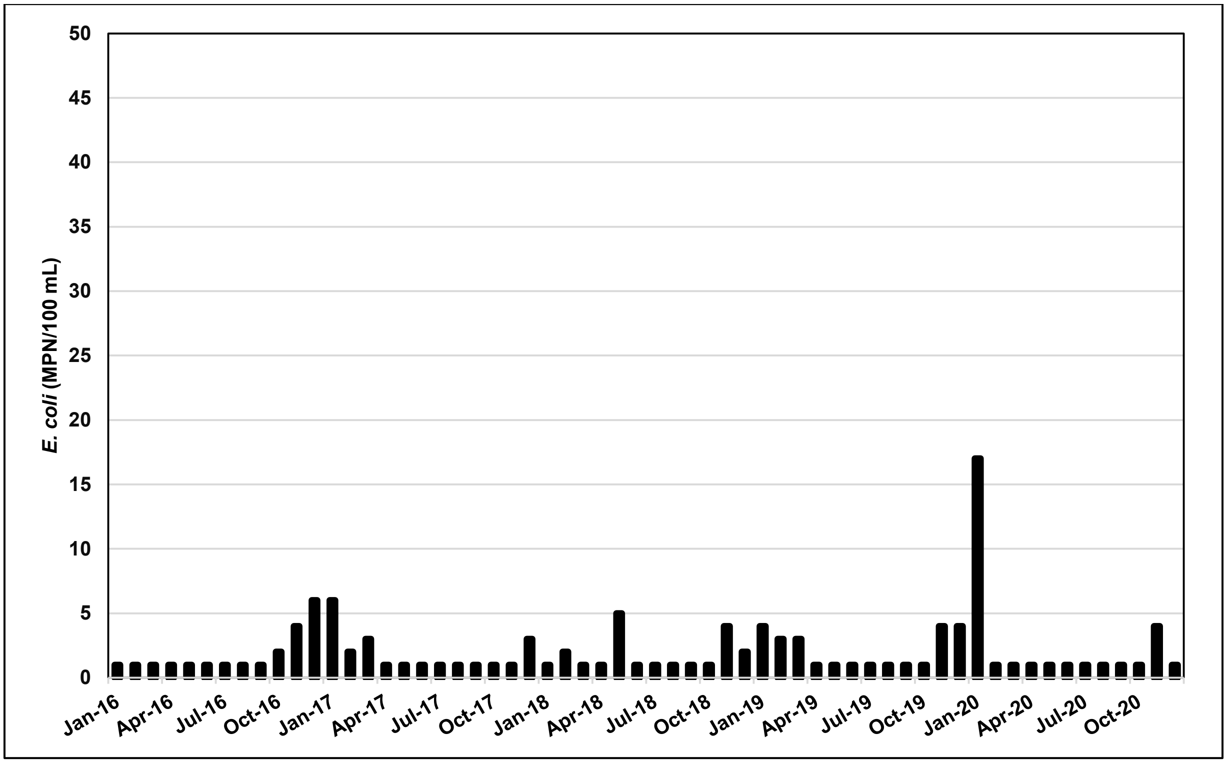


Figure 9-39. Monthly Median Total Coliforms at the CLAWA WTP

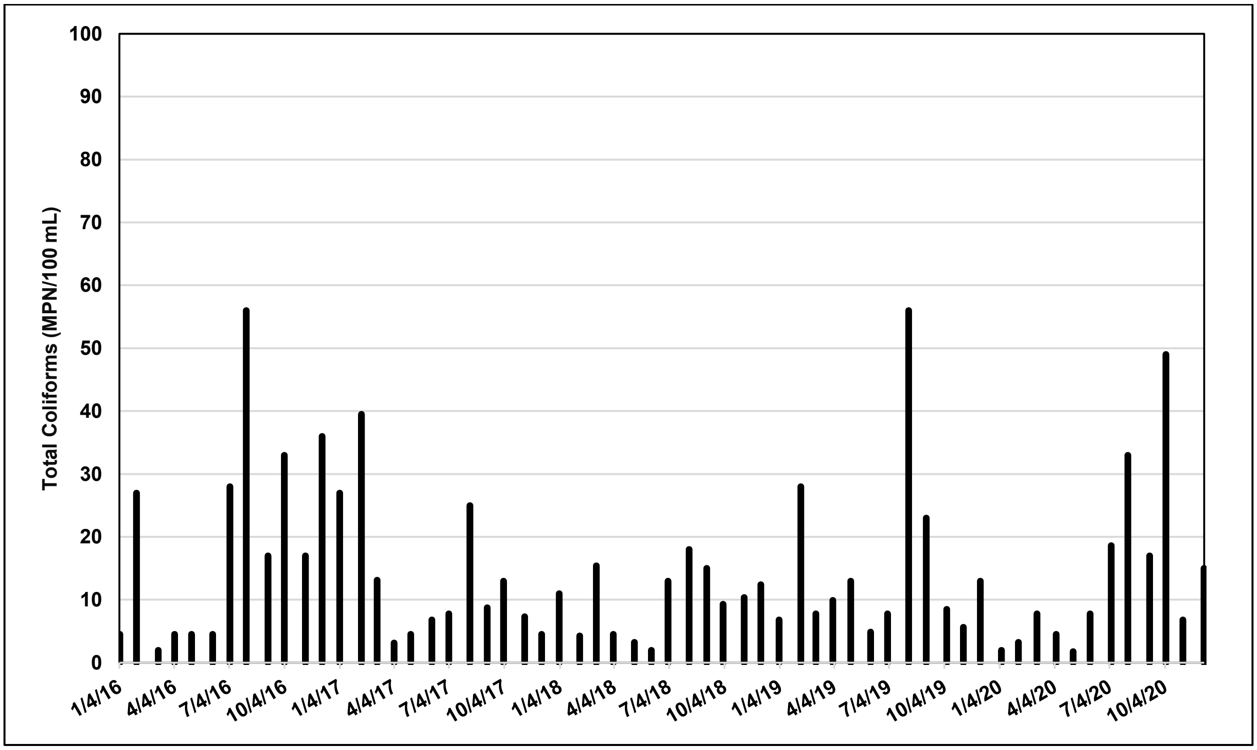


Figure 9-40. Monthly Median Fecal Coliforms at the CLAWA WTP

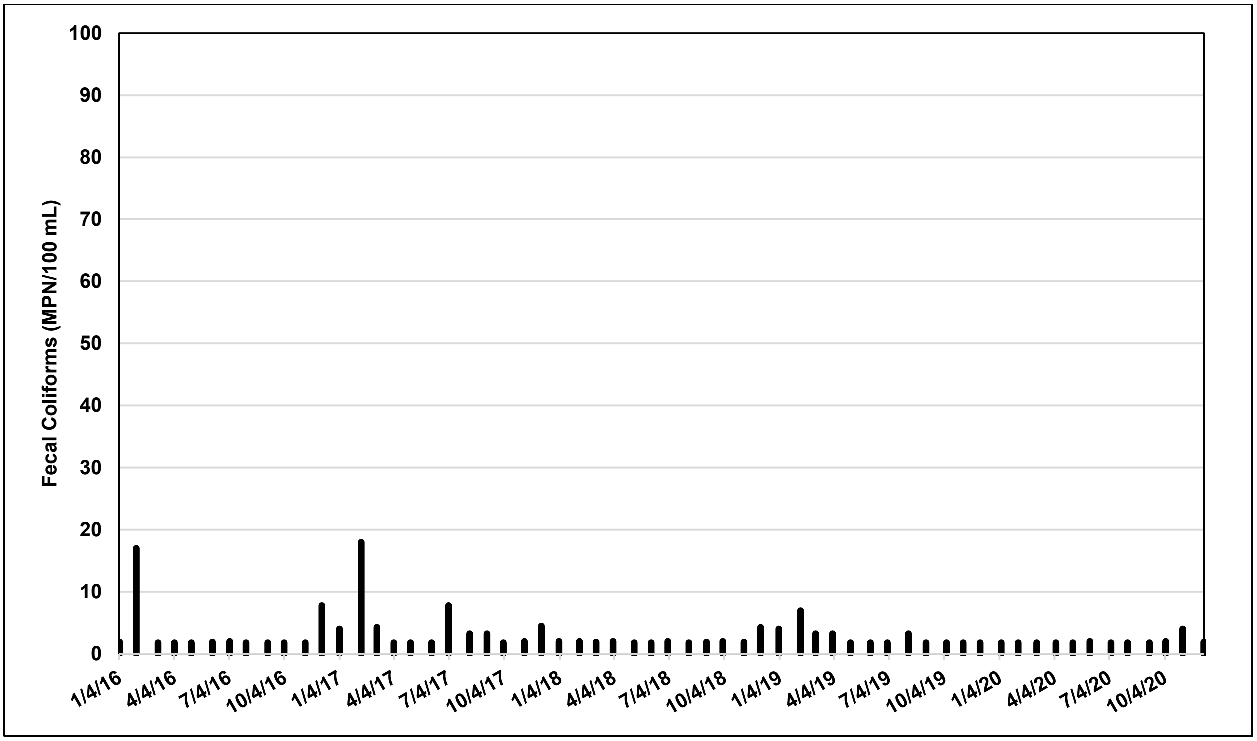
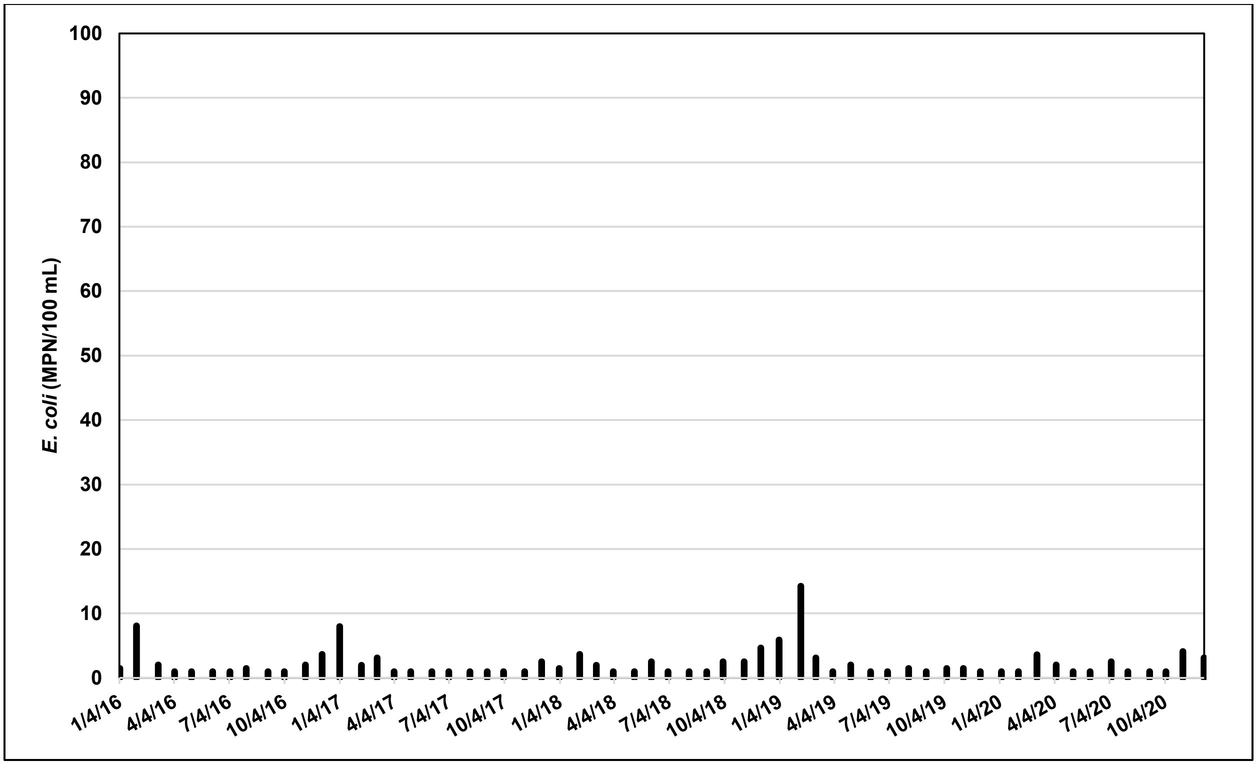


Figure 9-41. Monthly Median *E. coli* at the CLAWA WTP



SUMMARY

- The Regional Board collected monthly *Giardia* and *Cryptosporidium* samples at Hood, Vernalis, and Banks from April 2015 through March 2017 as part of the Delta RMP Pathogen Study. There were detects of both *Giardia* and *Cryptosporidium* at Hood and Vernalis, none of either at Banks. All the RAAs for *Cryptosporidium* were below the trigger of 0.075 oocysts/L and the sources are placed in Bin 1 under the LT2ESWTR. *Giardia* levels were higher than *Cryptosporidium* levels in the Sacramento River at Hood and the San Joaquin River at Vernalis, indicating that they are sources of *Giardia* to the Delta. *Giardia* was detected during all times of the year and *Cryptosporidium* was detected during the fall.

- The DWR diversion at the Banks WTP in the Delta was sampled for both indicator organisms and protozoa. Total coliform monthly median densities generally exceeded 1,000 MPN/100 mL and were among the highest in the SWP sources evaluated. Fecal coliform and *E. coli* densities were often greater than 200 MPN/100 mL, especially in the winter months. There were two detects of *Cryptosporidium* at the Banks Pumping Plant, resulting in a continued LT2ESWTR Bin 1 classification for the source. However, the coliform data suggests that the 3-log *Giardia* and 4-log virus reduction requirements may not be adequate for the Banks WTP and should be carefully considered by DDW.

- The NBA Contractors previously completed LT2ESWTR monitoring, resulting in Bin 1 classifications. *Cryptosporidium* monitoring conducted during this study period continued to support Bin 1 classification. Total coliform monthly medians were similar to historical values, often exceeding 1,000 MPN/100 ml and were among the highest in the SWP sources evaluated. However, *E. coli* monthly medians remained stable and were below the 200 MPN/100 ml advanced treatment threshold in all months. The current 2-log *Cryptosporidium*, 3-log *Giardia*, and 4-log virus reduction requirements continue to be appropriate for the WTPs that treat NBA water.

- The SBA Contractors previously completed LT2ESWTR monitoring, resulting in Bin 1 classifications. Valley Water and Zone 7 Water Agency conducted additional protozoan monitoring and the results are consistent with the previous Bin 1 classification. All of the *E. coli* monthly medians for SBA Contractor data were less than the 200 MPN/100 ml advanced treatment threshold. Peak total coliform densities occurred in the summer months while peak *E. coli* densities occurred in the winter months. The current 2-log *Cryptosporidium*, 3-log *Giardia*, and 4-log virus reduction requirements continue to be appropriate for the WTPs that treat SBA water.

- Valley Water and DWR use San Luis Reservoir to supply the Santa Teresa and San Luis WTPs, respectively. Valley Water previously completed LT2ESWTR monitoring, resulting in a Bin 1 classification at the Santa Teresa WTP. Valley Water recently conducted additional protozoan monitoring for the Santa Teresa WTP and the results were consistent with the previous Bin 1 classification. Total coliform monthly medians were similar to historic values, and *E. coli* monthly medians were lower than historic values and well below the 200 MPN/100 ml advanced treatment threshold. Peak *E. coli* densities occurred during wet weather months. The current 2-log *Cryptosporidium*, 3-log *Giardia*, and 4-log virus reduction requirements continue to be appropriate for the Santa Teresa and San Luis WTPs.

- CCWA completed LT2ESWTR Round 2 monitoring, confirming a Bin 1 classification. CCWA continued quarterly monitoring through November 2019, with an additional 11 samples collected and there were no detects of either protozoa. The coliform data continued to show generally low overall densities. Total coliform monthly medians were less than 1,000 MPN/100 mL in all but four months, and *E. coli* monthly medians were well below the 200 MPN/100 ml advanced treatment threshold. The data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses continue to be appropriate for the Polonio Pass WTP.

- KCWA conducted coliform and protozoa monitoring near its turnout on the California Aqueduct. The source was previously classified as Bin 1 under the LT2ESWTR and no additional action was required. *Giardia* and *Cryptosporidium* monitoring during this study period confirmed Bin 1 classification. KCWA's total coliform densities can exceed 1,000 MPN/100 ml with peak monthly medians lower than those presented in the 2016 Update. *E. coli* densities remained stable and below the 200 MPN/100 ml advanced treatment threshold in all months. The protozoan, fecal coliform, and *E. coli* data indicate that the California Aqueduct in this reach should be provided 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses. Prior to its decommission in 2016, DWR monitoring at the Edmonston WTP showed total coliform monthly medians always less than 1,000 MPN/100 mL and fecal coliform monthly medians always less than 200 MPN/100 mL, however no treatment requirements apply.

- MWDSC and SCV Water previously completed LT2ESWTR monitoring for their WTPs taking water from Castaic Lake, resulting in Bin 1 classifications. MWDSC and SCV Water both conducted monthly *Giardia* and *Cryptosporidium* monitoring during the study period, with no detections of either protozoa, resulting in a continued Bin 1 classification. DWR previously completed LT2ESWTR *E. coli* monitoring for their WTPs taking water from Pyramid Lake, resulting in Bin 1 classifications, and data from this study period continues to support a Bin 1 classification. Total coliform monthly medians at MWDSC's Jensen WTP intake can exceed 1,000 MPN/100 ml during the summer months and peak densities were lower than those presented in the 2016 Update. *E. coli* remained stable and well below the 200 MPN/100 ml advanced treatment threshold. Coliform densities in Castaic Lake are lower and stable throughout the year. Coliform densities in Pyramid Lake are also lower throughout the year. The fecal coliform, *E. coli* and protozoan data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses continue to be appropriate for the treatment plants treating water from the West Branch.

- AVEK and Palmdale previously completed LT2ESWTR monitoring, resulting in Bin 1 classifications. AVEK and Palmdale both conducted *Giardia* and *Cryptosporidium* monitoring during the study period, with no detects of either *Giardia* or *Cryptosporidium*, resulting in a continued Bin 1 classification. The AVEK total coliform monthly medians were generally less than 1,000 MPN/100 ml and the fecal coliform and *E. coli* monthly medians were well below the 200 MPN/100 ml advanced treatment threshold. The Palmdale total coliform monthly medians were often above 1,000 MPN/100 ml. The *E. coli* monthly medians were always below the 200 MPN/100 ml threshold. The fecal coliform, *E. coli*, and protozoan data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses continue to be appropriate for the treatment plants treating water from the East Branch.

- MWDSC and CLAWA previously completed LT2ESWR monitoring at their WTPs, resulting in Bin 1 classifications for both agencies. MWDSC conducted monthly *Giardia* and *Cryptosporidium* monitoring during the study period, with no detects of either protozoa resulting in a continued Bin 1 classification. CLAWA also conducted *Giardia* and *Cryptosporidium* monitoring during the study period with no detects and conducted LT2ESWTR Round 2 *E. coli* monitoring which resulted in continued Bin 1 classification. MWDSC's data show that total coliform monthly medians can exceed 1,000 MPN/100 ml, especially during the summer months, and median densities are lower than those presented in the 2016 Update. *E. coli* remained stable and well below the 200 MPN/100 ml advanced treatment threshold, with peaks occurring during the winter months. CLAWA's data show that total coliform monthly medians are well below 1,000 MPN/100 ml, with peaks also occurring during the summer months. Fecal coliform and *E. coli* monthly medians were well below the 200 MPN/100 ml advanced treatment threshold, with peaks also occurring during the winter months. The *E. coli* and protozoan data indicate that 2-log reduction of *Cryptosporidium*, 3-log reduction of *Giardia,* and 4-log reduction of viruses continue to be appropriate for the treatment plants treating water from the East Branch lakes.

RECOMMENDATION

- The 3-log *Giardia* and 4-log virus reduction requirements for DWR's Banks Water Treatment Plant (WTP) should be carefully reviewed by DDW since there is inconsistency between the coliform and protozoan data.

REFERENCES

Delta Regional Monitoring Program Pathogen Study Final Report, October 2018. Prepared by Larry Walker Associates

CHAPTER 10 ARSENIC AND CHROMIUM

CONTENTS

FIGURES

TABLES

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CHAPTER 10 ARSENIC AND CHROMIUM

The impact of the non-Project turn-in program to Aqueduct water quality varies from year to year, as the turn-in volumes and sources vary. As an example, 2016 was a year with high volumes of groundwater turned into the Aqueduct, as 2016 was the fourth year of consecutive dry years from 2013 to 2016. In comparison, 2017 and 2019 were wet years, and the source of turn-ins was flood surface water and the overall turn-in volumes were lower.

Generally, groundwater turn-ins increase arsenic, nitrate, and sulfate levels in downstream water quality (due to higher concentrations of these constituents in the turn-in groundwater compared to the Aqueduct), and decrease salinity, bromide and chloride (due to lower concentrations of these constituents in the turn-in groundwater compared to the Aqueduct).

As the volume of non-Project inflows are generally much lower in wet years, arsenic concentrations in the Aqueduct during the wet years of 2017 and 2019 were not impacted by non-Project inflows to the extent as during the dry years of 2013 to 2016. The results for chromium during this reporting period (2016 to 2020) have shown both increases and decreases in downstream water quality. More information on non-project turn-ins to the California Aqueduct can be found in Chapter 13D. This section evaluates the potential impacts of non-Project inflows to arsenic and chromium concentrations in the California Aqueduct.

ARSENIC

Arsenic has historically been detected in in SWP supplies at low levels (0.001 – 0.004 milligrams per liter [mg/L]), however, due to the introduction of non-Project groundwater, higher levels may be detected when pump-in programs are operating (up to approximately 0.009 mg/L). Arsenic has a primary Maximum Contaminant Level (MCL) of 0.010 mg/L. The primary source of the higher levels of arsenic in the SWP is groundwater that is allowed into the aqueduct between Check 23 and Check 39.

During the study period (2016 through 2020) total and dissolved arsenic were monitored monthly at both Check 21 and Check 41. The total arsenic levels at Check 21 ranged from 0.001 mg/L to 0.003 mg/L, with a median of 0.002 mg/L. The dissolved arsenic levels at Check 21 were very similar, ranging from non-detect (less than 0.001 mg/L) to 0.003 mg/L, with a median of 0.002 mg/L. The total arsenic levels at Check 41 ranged from 0.001 mg/L to 0.008 mg/L, with a median of 0.002 mg/L. The dissolved arsenic levels at Check 41 were very similar, ranging from non-detect (less than 0.001 mg/L) to 0.008 mg/L, with a median of 0.002 mg/L. No data exceeded the primary MCL at either site and these levels were lower than during the last study period. There is a distinct increase in peak values between Check 21 and Check 41, due to the non-Project groundwater inflows.

Figure 10-1 shows the total arsenic concentrations at Check 21, which is upstream of most of the groundwater inflows, and Check 41, which is downstream of most of the inflows, between 2012 and 2020. All values were below the primary MCL for arsenic of 0.010 mg/L. **Figure 10-1** also includes the monthly volumes of non-Project flows. Non-Project inflows are variable throughout the year and between years. Additionally, although the source of non-project inflows is typically groundwater, turn-ins for the wet years of 2017 and 2019 were comprised of entirely of flood surface waters from creeks such as Cantua and Salt Creeks in the San Luis Field Division, or excess Kern River water turned in at Kern County Water Agency's Cross Valley Canal (CVC) or the Kern Water Bank Canal (KWBC) inflows near Check 28, as well as Friant Kern Canal water turned in at the Arvin Edison Water Storage District (AEWSD). These surface water sources have lower arsenic concentrations compared to groundwater and this data is presented below. Although some non-Project flows occurred in 2012, flows became more consistent and higher between 2013 and 2016. Flows were less consistent during this most recent study period, 2016 through 2020.

Figure 10-1. Total Arsenic Concentrations in the California Aqueduct

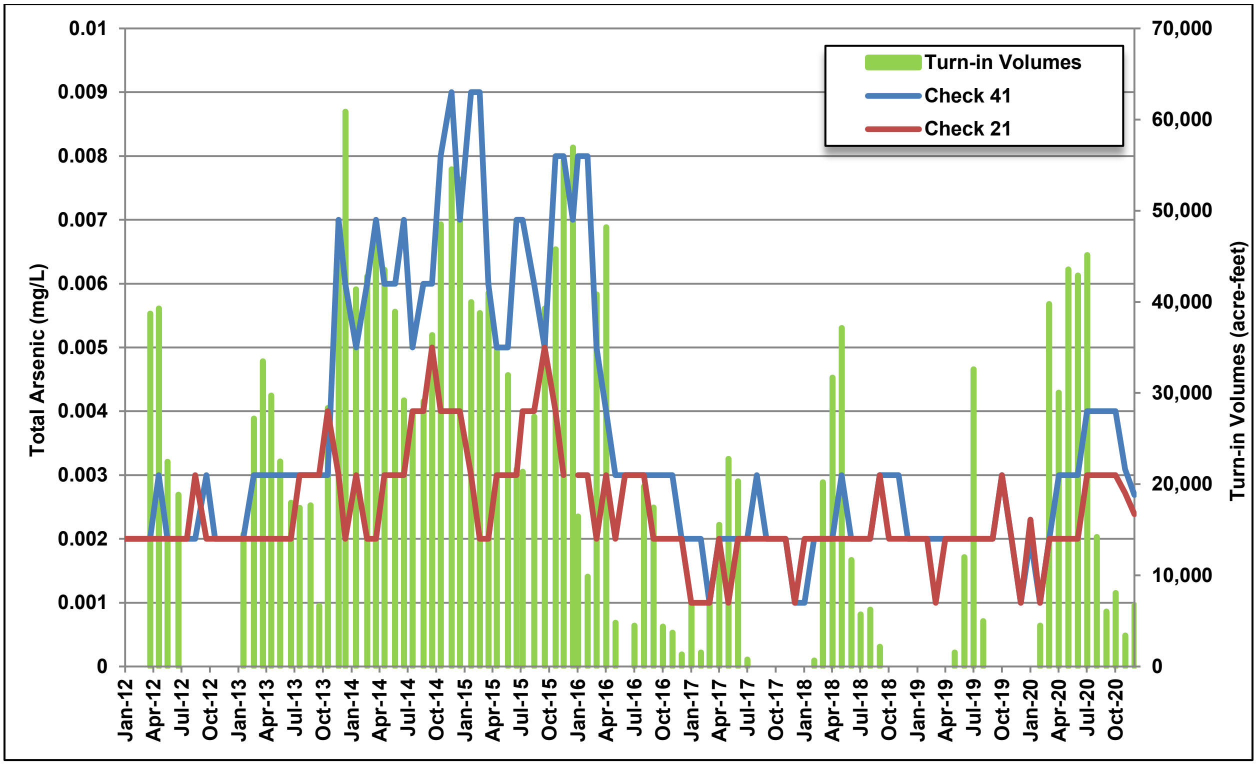
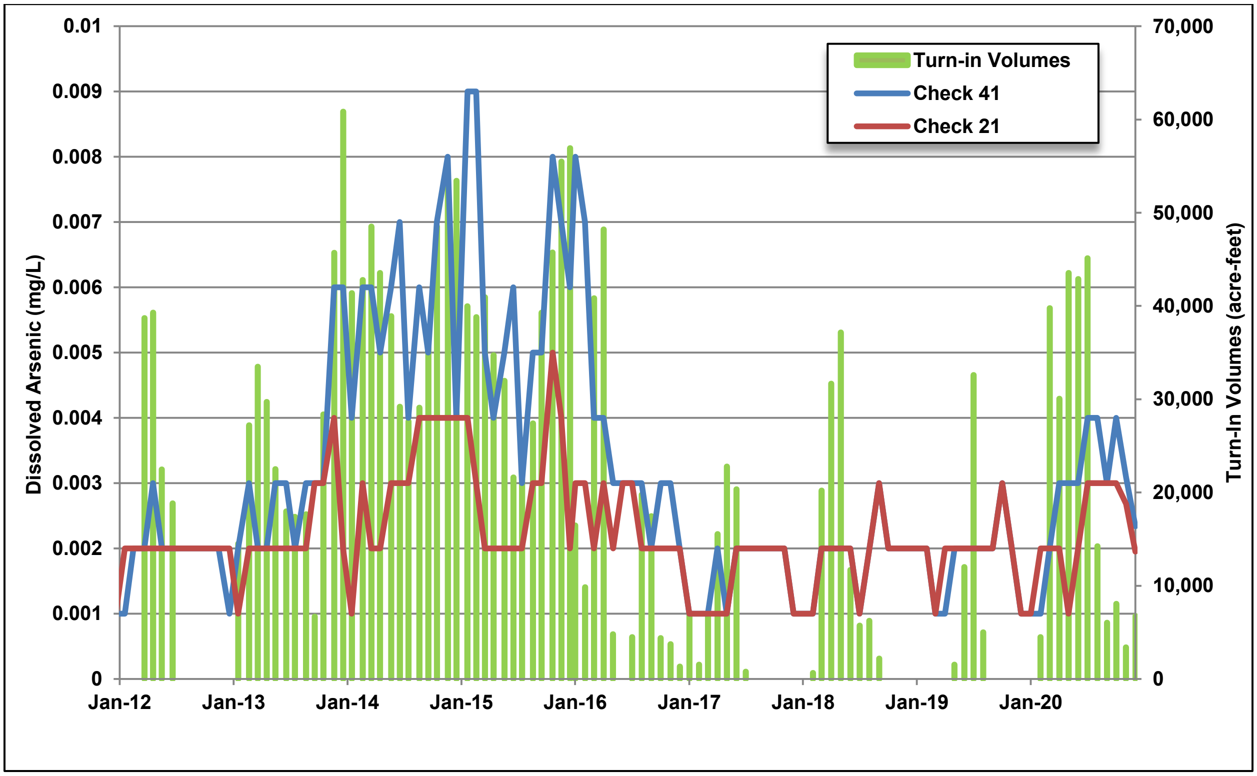


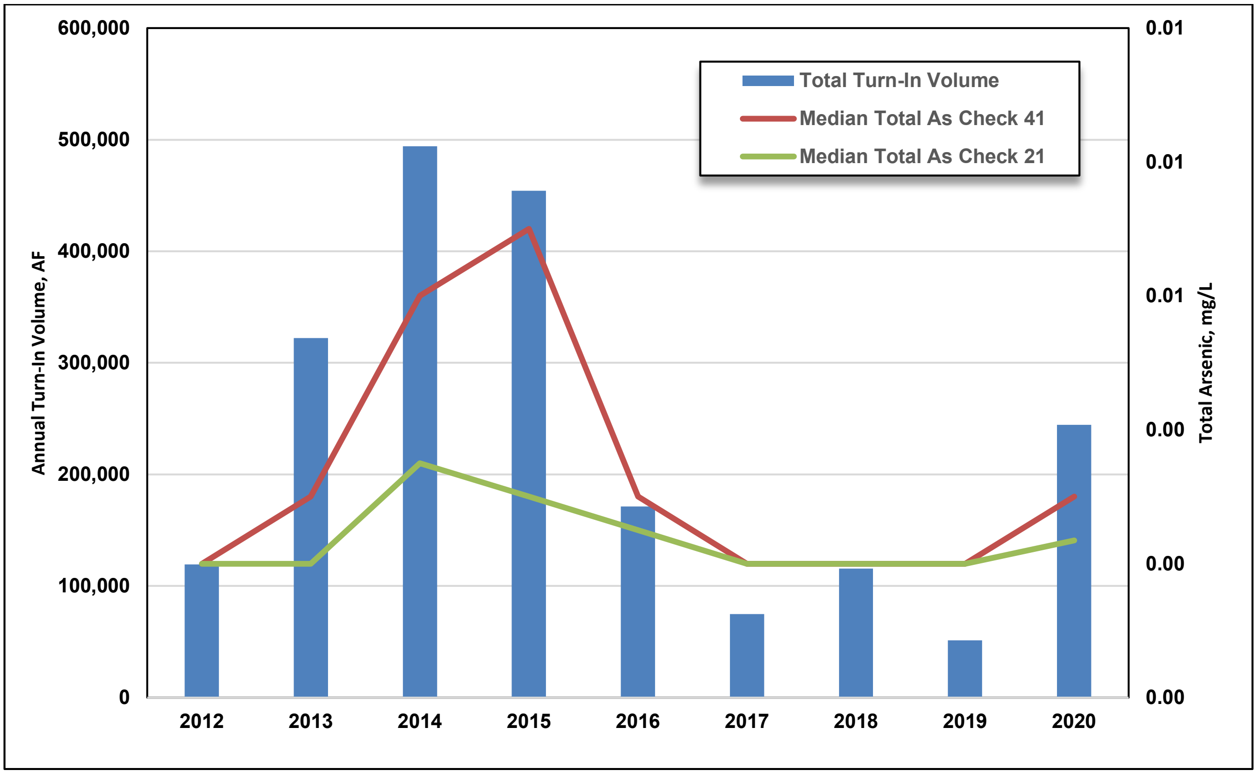
Figure 10-2 shows the dissolved arsenic concentrations at Check 21 and Check 41, along with non-Project flows. The dissolved arsenic concentrations are similar to the total arsenic concentrations and also have never exceeded the MCL of 0.010 mg/L. The dissolved concentration equals the total concentration at both Check 21 and Check 41 in almost all samples, indicating that arsenic is almost entirely present in the source water as dissolved.

Figure 10-2. Dissolved Arsenic Concentrations in the California Aqueduct



In order to assess the impact of overall non-Project flow input, a comparison of annual turn-in volume and median total arsenic at both Check 21 and Check 41 was conducted. **Figure 10-3** presents a summary of this data. The chart shows that at Check 21 there was a slight increase in median annual total arsenic during the peak drought period (2014 through 2016), but this was still significantly below the primary MCL. The graph also shows that as the annual turn-in volume increases, so does the median annual total arsenic levels at Check 41, downstream of the non-Project inflows. Generally, when the annual turn-in volume was limited to less than 150,000 acre-feet there was no increase in total arsenic between Check 21 and Check 41. There was a small increase (less than 30 percent) with non-Project flows up to 250,000 acre-feet annually. The most significant increase in annual median total arsenic between Check 21 and Check 41 occurred in years with more than 300,000 acre-feet of turn-in volume.

Figure 10-3. Median Annual Total Arsenic Concentration and Annual Turn-In Volume in the California Aqueduct



A review of the available total arsenic data for six groundwater inflows between Check 21 and Check 41 was conducted. Data was provided for Semitropic Water Storage District (SWSD) #3 inflow near Check 24, the Kern County Water Agency's CVC inflows near Check 28, the KWBC inflows near Check 28, the West Kern Water District (WKWD) inflow upstream of Check 29, Wheeler Ridge-Maricopa Water Storage District (WRWSD) inflows between Check 33 and 36, and AEWSD inflows near Check 35. The range, average, and median concentrations of the various inflows are presented in **Table 10-1**. The highest values are from SWSD #3 and KWBC inflows. The average and median values of the inflows are greater than those in the Aqueduct at Check 21, showing that these groundwater inflows contribute to increases in arsenic at Check 41.

Table 10-2 shows total arsenic data for surface water inflow occurring in years 2017 and 2019, which occurred only at CVC, KWBC and AEWSD inflows. No data was available for AEWSD as their inflows occurred over a short time period in January 2017 and June/July 2019. Arsenic in the surface water inflows were lower than groundwater inflows, which further explains the smaller impact at Check 41 in 2017 and 2019, compared to 2016 and 2020.

Table 10-1. Summary of Total Arsenic in Groundwater Inflows Between Check 21 and Check 41 (mg/L), 2016 - 2020

Inflow	Years	Number of Samples	Range	Average	Median
SWSD #3	2016 and 2020	42	0.002-0.011	0.0076	0.0081
CVC	2016 and 2018 and 2020	23	<0.002 - 0.0098	0.0044	0.0041
KWBC	2016 and 2018 and 2020	10	<0.0007 - 0.012	0.0038	0.0028
WKWD	2016 and 2018 and 2020	8	<0.002 - 0.007	0.0024	0.0022
WRMWSD	2016 and 2018 and 2020	59	<0.002 - 0.0083	0.0042	0.0045
AEWSD	2016 and 2018	5	0.001 - 0.007	0.0044	0.004

Table 10-2. Summary of Total Arsenic in Surface Water Inflows Between Check 21 and Check 41 (mg/L), 2016 - 2020

Inflow	Years	Number of Samples	Range	Average	Median
CVC	2017 and 2019	5	0.0018 - 0.0037	0.0028	0.0028
KWBC	2017 and 2019	9	0.0019 - 0.0044	0.0035	0.0035

CHROMIUM

Chromium is currently regulated by both USEPA and DDW. The federal primary MCL is 0.1 mg/L and the California primary MCL is 0.05 mg/L. Both standards include the two primary forms of chromium, trivalent and hexavalent, as chromium can be used as an indicator for hexavalent chromium. Total chromium levels in the SWP have not historically been at levels of concern, but an evaluation of both chromium is included in this 2022 Update to address the potential adoption of a hexavalent chromium specific standard.

During the study period (2016 through 2020) total and dissolved chromium were monitored monthly at both Check 21 and Check 41. The total chromium levels at Check 21 ranged from non-detect (less than 0.001 mg/L) to 0.003 mg/L, with a median of 0.001 mg/L. The dissolved chromium levels at Check 21 were very similar, ranging from non-detect (less than 0.001 mg/L) to 0.003 mg/L, with a median of non-detect (less than 0.001 mg/L). The total chromium levels at Check 41 ranged from non-detect (less than 0.001 mg/L) to 0.005 mg/L, with a median of 0.001 mg/L. The dissolved chromium levels at Check 41 were very similar, ranging from non-detect (less than 0.001 mg/L) to 0.004 mg/L, with a median of 0.001 mg/L. No data exceeded the primary MCL at either site and these levels were lower than during the last study period. There is an increase in peak values between Check 21 and Check 41 similar to arsenic, likely due to the non-Project groundwater inflows.

Figure 10-4 shows the total chromium concentrations at Check 21, which is upstream of most of the groundwater inflows, and Check 41, which is downstream of most of the inflows, between 2012 and 2020. All values were below the primary MCL for chromium of 0.05 mg/L. **Figure 10-1** also includes the monthly volumes of non-Project flows. Non-Project inflows are variable throughout the year and between years. As mentioned earlier, the source of non-project inflows is typically groundwater, however turn-ins for the wet years of 2017 and 2019 were comprised of entirely of flood surface waters from creeks such as Cantua and Salt Creeks in the San Luis Field Division, or excess Kern River water turned in at Kern County Water Agency's CVC or the KWBC inflows near Check 28, as well as Friant Kern Canal water turned in at the AEWSD. These surface water sources have lower hexavalent chromium concentrations compared to groundwater and this data is presented below. Although some non-Project flows occurred in 2012, flows became more consistent and higher between 2013 and 2016. Flows were less consistent during this most recent study period, 2016 through 2020.

Figure 10-4. Total Chromium Concentrations in the California Aqueduct

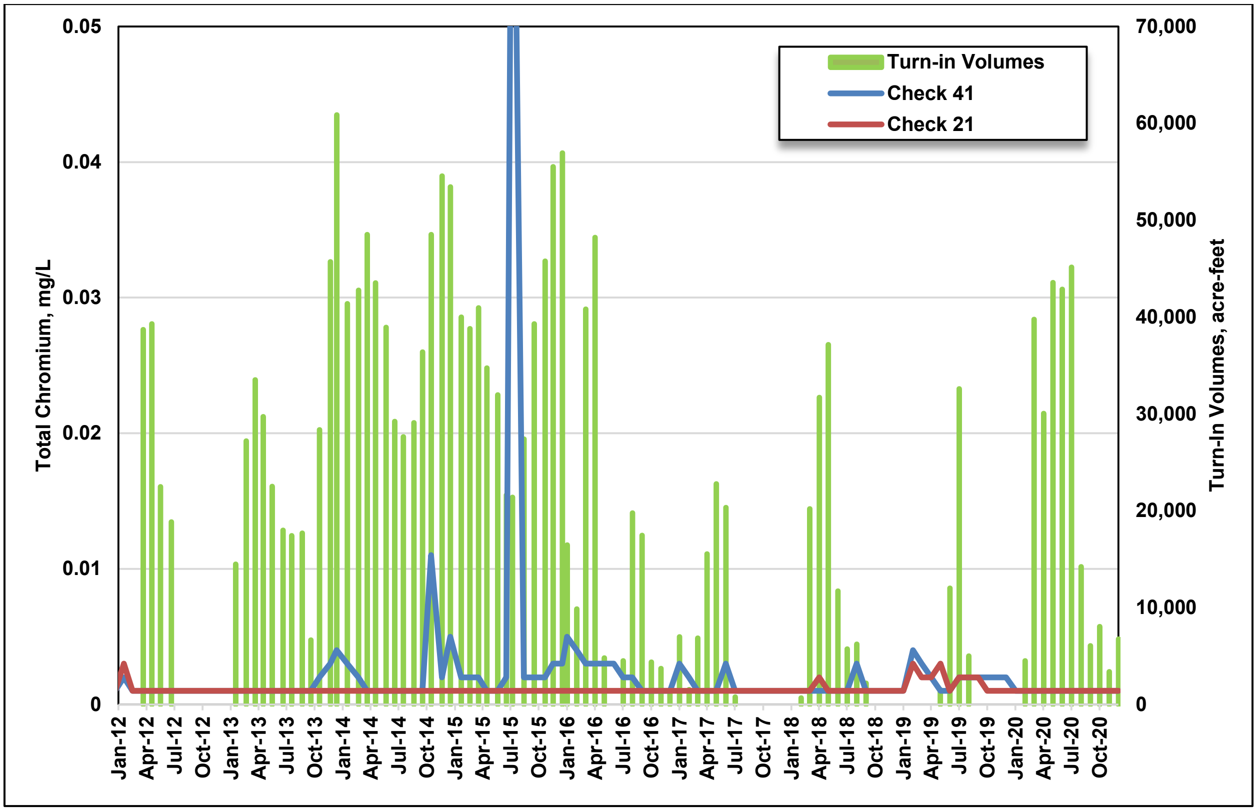
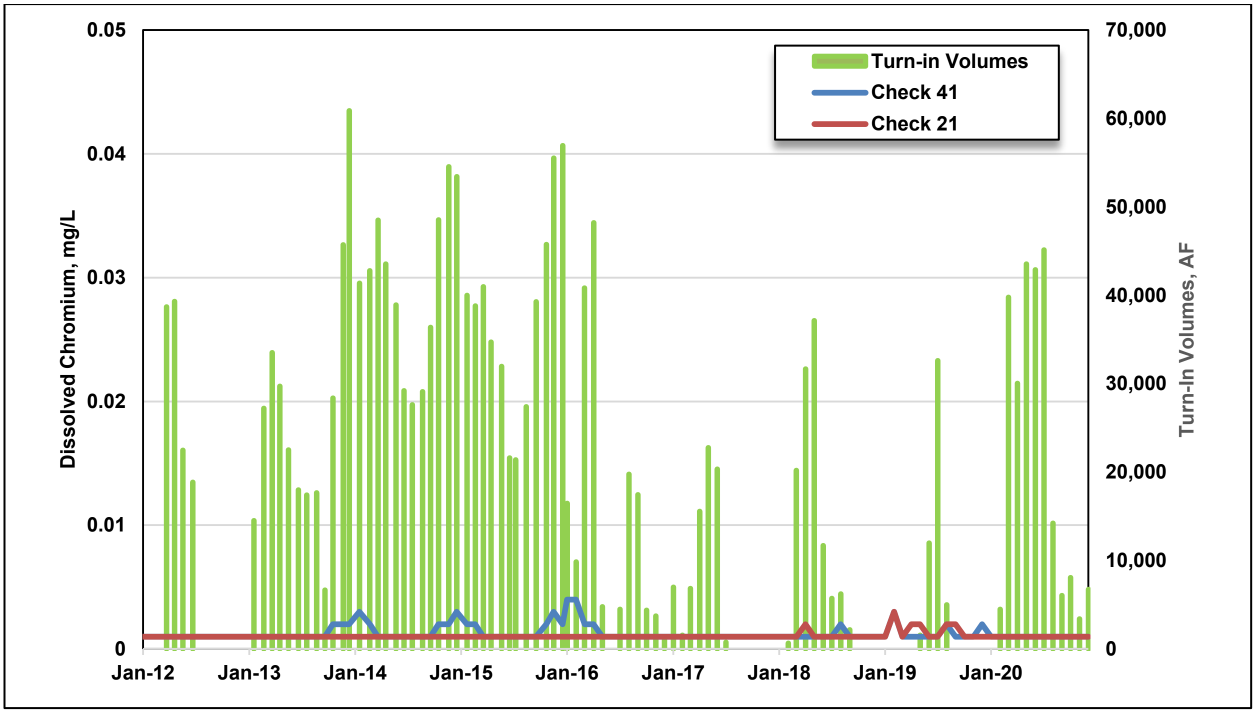


Figure 10-5 shows the dissolved chromium concentrations at Check 21 and Check 41, along with non-Project flows. The dissolved chromium concentrations are similar to the total chromium concentrations and also have never exceeded the MCL of 0.05 mg/L. The dissolved concentration equals the total concentration at both Check 21 and Check 41 in almost all samples, indicating that chromium is almost entirely present in the source water as dissolved.

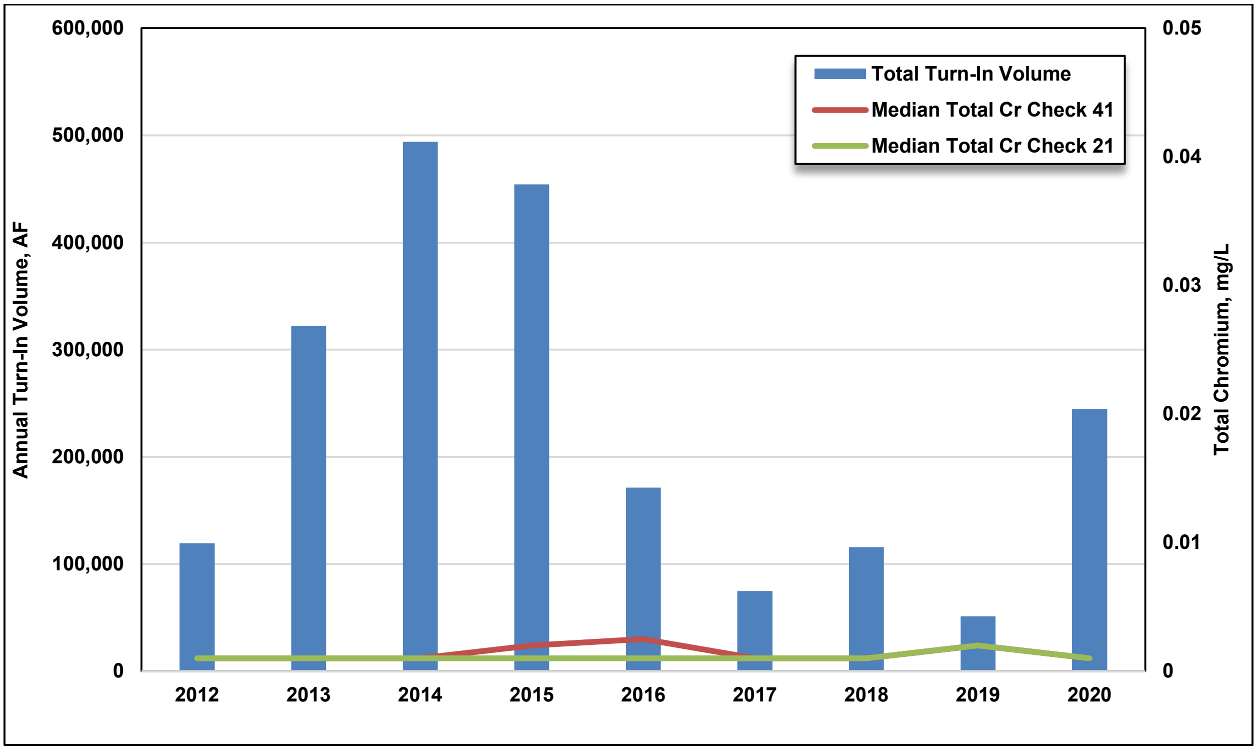
Figure 10-5. Dissolved Chromium Concentrations in the California Aqueduct



In order to assess the impact of overall non-Project flow input, a comparison of annual turn-in volume and median total chromium at both Check 21 and Check 41 was conducted. **Figure 10-6** presents a summary of this data. The chart shows that Check 21 and 41 generally have the same annual median total chromium level, with only a slight increase in 2015 and 2016 (peak drought period). All values are well below the primary MCL.

Unlike arsenic, the graph does not show a significant increase in total chromium as the annual turn-in volume increases downstream of the non-Project inflows. It appears that chromium levels in the California Aqueduct are less impacted by the non-Project inflows than arsenic.

Figure 10-6. Median Annual Total Chromium Concentration and Annual Turn-In Volume in the California Aqueduct



A review of the available total and hexavalent chromium data for six groundwater inflows between Check 21 and Check 41 was conducted. Data was provided for SWSD #3 inflow near Check 24, the CVC inflows near Check 28, the KWBC inflows near Check 28, the WKWD inflow near Check 29, WRMWSD inflows between Check 33 and 36, and AEWSD inflows near Check 35. The range, average, and median concentrations of the various inflows are presented in **Table 10-3,** and similarly for hexavalent chromium in **Table 10-4**.

The highest total chromium and hexavalent chromium in groundwater inflows were in the SWSD #3 inflow, with a maximum of 11 µg/L and 9.5 µg/L, respectively. As these inflow concentrations are greater than those in the Aqueduct at Check 21, chromium will increase in the Aqueduct after the SWSD #3 inflow location, but subsequent downstream inflows such as at CVC and KWBC will dilute the chromium in Aqueduct, so no significant increase is generally observed at Check 41.

Table 10-5 shows hexavalent chromium data for surface water inflow occurring in years 2017 and 2019, which occurred only at CVC, KWBC, and AEWSD inflows. No data was available for AEWSD as their inflows occurred over a short time period in January 2017 and June/July 2019. Hexavalent chromium in the surface water inflows were lower than groundwater inflows.

Table 10-3. Summary of Total Chromium in Groundwater Inflows Between Check 21 and Check 41 (mg/L), 2016 to 2020

Inflow	Years	Number of Samples	Range	Average	Median
SWSD #3	2016 and 2020	42	0.01 - 0.011	0.01	0.01
CVC	2016 and 2018 and 2020	23	<0.002 - 0.0012	0.00065	0.00058
KWBC	2016 and 2018 and 2020	no data			
WKWD	2016 and 2018 and 2020	no data			
WRMWSD	2016 and 2018 and 2020	52	<0.003 - 0.0075	0.000027	0
AEWSD	2016 and 2018	5	<0.001 - 0.005	0.0016	0.001

Table 10-4. Summary of Hexavalent Chromium in Groundwater Inflows Between Check 21 and Check 41 (mg/L), 2016 to 2020

Inflow	Years	Number of Samples	Range	Average	Median
SWSD #3	2016 and 2020	42	0.000071 - 0.0095	0.0054	0.0059
CVC	2016 and 2018 and 2020		0.00034 - 0.0015	0.00093	0.00095
KWBC	2016 and 2018 and 2020	10	<0.000031 - 0.0014	0.0087	0.00085
WKWD	2016 and 2018 and 2020	8	0.0009 - 0.0012	0.00102	0.001
WRMWSD	2016 and 2018 and 2020	81	<0.00005 - 0.00069	0	0
AEWSD	2016 and 2018	5	<0.0001 - 0.0043	0.0011	0

Table 10-5. Summary of Hexavalent Chromium in Surface Water Inflows Between Check 21 and Check 41 (mg/L), 2016 - 2020

Inflow	Years	Number of Samples	Range	Average	Median
CVC	2017 and 2019	5	<0.000031- 0.000042	0.000026	0.000033
KWBC	2017 and 2019	9	<0.000031- 0.000042	0.000024	0.000034

SUMMARY

- The introduction of non-Project inflows to the California Aqueduct between Checks 23 and 39 can cause an increase in the concentration of total and dissolved arsenic in the SWP water. All values in the SWP during the study period are less than the MCL of 10 µg/L. Check 41 saw the greatest increases in total and dissolved arsenic during the years with greater than 300,000 acre-feet of turn-in volume, 2014 and 2015. Increases in arsenic levels were generally seen in years with greater than 150,000 acre-feet of turn-in volume, but at lower levels, such as 2016 and 2020. The turn-in water can be either groundwater or surface water. The arsenic level of the turn-in surface water is similar to that already in the Aqueduct, causing little impact. The arsenic levels of the turn-in groundwater can vary significantly, with median total arsenic values ranging from less than 2 to 12 µg/L. The highest levels were seen in the SWSD #3 turn-ins near Check 24.

- The introduction of non-Project inflows to the California Aqueduct between Checks 23 and 39 does not appear to cause a significant increase in the concentration of total and dissolved chromium in the SWP water. All of the samples along the California Aqueduct during the study were well below the total chromium MCL of 50 ug/L. The impact of turn-in volumes on chromium levels in the Aqueduct appears to be less important than on arsenic levels, and increased chromium levels may be more related to the type of inflow. The hexavalent chromium levels of the turn-in surface water is similar to or lower than that already in the Aqueduct, causing little impact. The total and hexavalent chromium levels of the turn-in groundwater can vary significantly, with median hexavalent chromium values ranging from 0.85 to 5.9 µg/L. The highest levels were seen in the SWSD #3 turn-in near Check 24.

- Overall, the impact of the non-Project turn-in program to Aqueduct water quality varies from year to year, as the turn-in volumes and sources vary. As an example, 2016 was a year with high volumes of groundwater turned into the Aqueduct, as 2016 was the fourth year of consecutive dry years from 2013 to 2016. In comparison, 2017 and 2019 were wet years, and the source of turn-ins was flood surface water and the overall turn-in volumes were lower.

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Constituents of Emerging Concern (CECs) are defined by the USEPA as “chemicals being discovered in water that previously had not been detected or are being detected at levels that may be significantly different than expected that may cause a risk to human health and the environment.” CECs can be broadly defined as a substance that is in place where it doesn’t belong. CECs are substances that have been released to, found in, or have the potential to enter surface water (or groundwater) and they do not currently have human health-based regulation in drinking water. CECs also have new or changing health exposure information and they pose a real or perceived health threat.

Studies have shown that pharmaceuticals and personal care products (PPCPs) such as antibiotics, synthetic hormones, and other endocrine disrupting compounds are present in our nation's waterbodies. Other classes of emerging contaminants include polybrominated diphenyl ethers (PDBEs), pesticides, alkylphenols, disinfection byproducts such as nitrosamines, per- and polyfluoroalkyl substances (PFAS), and other industrial and commercial chemicals. Further research suggests that certain drugs may cause ecological harm. The USEPA has historically investigated this topic and developed strategies to help protect the health of both the environment and the public.

The 1996 Safe Drinking Water Act Amendments provided a list of chemical and microbial contaminants for possible future regulation, this program is known as the Contaminant Candidate List (CCL) and Regulatory Determination. Every five years the USEPA is required to update the list, select at least five constituents for evaluation, and determine whether to regulate. The regulations are determined based on risk assessment and cost-benefit considerations and on minimizing overall risk. The CCL includes a wide universe of contaminants that are not currently regulated by the USEPA, however some of these are already regulated in California, either with Maximum Contaminant Levels (MCL), Notification Levels (NL), or Archived Advisory Levels (AAL). Many of the constituents on this list have a USEPA Health Advisory (HA) or a USEPA Human Health Benchmark for Pesticides (HHBP), which are non-enforceable human health thresholds.

The Regulatory Determinations are supported by the Unregulated Contaminant Monitoring Rule (UCMR) Program that requires public water systems to monitor for unregulated contaminants. To date, there have been four CCLs and UCMRs, along with four finalized Regulatory Determinations. The fifth CCL (CCL5) is currently in draft form and will be supported by monitoring data from the fifth UCMR (UCMR5).

This section will focus on CECs with available data related to PFAS monitoring throughout the Central Valley, pesticide, PPCP, and PFAS monitoring through the USEPA Unregulated Contaminant Monitoring Rule (UCMR) program, and the Delta Regional Monitoring Program’s CEC and pesticides efforts.

PER- AND POLYFLUOROALKYL SUBSTANCES

BACKGROUND

Per- and polyfluoroalkyl substances (PFAS) are a large group of human-made substances that do not occur naturally in the environment and are resistant to heat, water, and oil. PFAS have been used extensively in surface coating and protectant formulations due to their unique ability to reduce the surface tension of liquids. Perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) are two types of PFAS that are no longer manufactured or imported into the United States. However, manufacturers are developing replacement technologies in the PFAS family by substituting longer-chain substances with shorter-chain substances.

Exposure to PFOA and PFOS can cause adverse health effects, including harm to a developing fetus or infant, immune system and liver effects, and cancer. While consumer products are a large source of exposure to these chemicals, drinking water has become an increasing concern due to their persistence in the environment and their tendency to accumulate in groundwater.

REGULATORY INFORMATION

In May 2016, the USEPA issued a lifetime HA (LHA) for PFOA and PFOS in drinking water, advising municipalities that they should notify their customers of the presence of levels over 70 nanograms per liter (or parts per trillion [ppt]) in community water supplies. The LHA is the level, or amount, calculated to offer a margin of protection against adverse health effects to the most sensitive populations. The LHA level is 70 ppt for PFOA and PFOS individually or combined. Currently, the USEPA has not set HA levels for the other PFAS chemicals.

In January 2021, the USEPA published its final Fourth Regulatory Determination under the CCL Program. As part of that, USEPA determined that PFOS and PFOA warrant regulation, and potentially other PFAS too. A draft regulation for PFOS and PFOA is expected in late 2022 and a final in 2023. Six PFAS were included in the third Unregulated Contaminant Monitoring Rule (UCMR3), including PFOS and PFOA, with monitoring conducted between 2013 and 2015. As part of the fifth Unregulated Contaminant Monitoring Rule (UCMR5), USEPA will require many public water systems to monitor for 29 PFAS between 2023 and 2025.

Additionally, the USEPA published a PFAS Action Plan in February 2019 that identified a strategy for moving forward with management of PFAS in drinking water. In February 2020 and October 2021, the USEPA published Updates to the PFAS Action Plan that now make it a Strategic Roadmap for PFAS. It includes the following commitments; development of MCLs for PFOA/PFOS, inclusion of PFAS on the UCMR5, analytical method development, developing Clean Water Act water quality criteria for PFAS, and including PFAS at Federal Cleanup Sites.

Notification Levels (NLs) are a non-regulatory, precautionary health-based measure set by California’s State Water Board Division of Drinking Water (DDW) for concentrations of unregulated contaminants in drinking water that warrant public notification and further monitoring and assessment. Public water systems are encouraged to test their water for contaminants with Notification Levels. In August 2019, DDW established NLs at concentrations of 6.5 ppt for PFOS and 5.1 ppt for PFOA, consistent with California's Office of Environmental Health Hazard Assessment (OEHHA) recommendations. In February 2020, DDW asked OEHHA to develop recommended NLs for seven PFAS that have been detected in California drinking water supplies. Subsequently, in March 2021 OEHHA published a final NL for perfluorobutane sulfonic acid (PFBS) at 0.5 micrograms per liter (or parts per billion [ppb]). In March 2022, OEHHA published a recommended NL for perfluorohexane sulfonic acid (PFHxS) at 2 ppt. The remaining PFAS with an impending NL include:

- perfluorohexanoic acid (PFHxA)
- perfluoroheptanoic acid (PFHpA)
- perfluorononanoic acid (PFNA)
- perfluorodecanoic acid (PFDA)
- 4,8-dioxia-3H-perflourononanoic acid (ADONA)

Every constituent that has an NL has a companion Response Level (RL), which if exceeded triggers responses by a local water system. Under California law (Assembly Bill 756), if a water system receives a State Water Board order for testing and finds that the PFOA or PFOS concentration exceeds their RL, the system is required to take the water source out of service, provide treatment, or notify their customers in writing. On February 6, 2020, DDW set revised RLs at 10 ppt for PFOA and 40 ppt for PFOS based on a running four quarter average. The RL for PFBS is set at 5 ppb.

In October 2019, OEHHA announced the initiation of Public Health Goal (PHG) assessments for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). These were published in July 2021 with proposed PHGs of 0.007 ppt for PFOA and 1 ppt for PFOS, based on the one in a million cancer risk estimate. Non-cancer risks concentrations would be 3 ppt for PFOA and 2 ppt for PFOS. DDW expects that MCLs will be ready by 2024 for both PFOA and PFOS.

MONITORING DATA

DWR – Analysis for PFAS compounds was added to the State Water Project (SWP) triannual samples and turn-in related sampling in 2020 in response to increasing DDW regulations for two PFAS compounds (PFOA and PFOS) and increasing interest from SWP Contractors. Samples were collected on the North Bay Aqueduct (at Barker Slough Pumping Plant (PP)) and Aqueduct (at Banks PP, Check 13, and Teerink PP). A total of 13 sampling events occurred in 2020 resulting in 320 analytical results. Barker Slough PP and Banks PP were sampled in June and September, Check 13 (O'Neill Forebay) was sampled in March, June, and September, and Teerink PP was sampled between March and August during months with high groundwater turn-ins.

There were detections and reportable values at all four sites sampled, as shown in **Table 11-1**. Check 13 saw the lowest frequency of PFAS detections, at 26 percent, while the other three sites all saw about 35 percent detection of PFAS. However, it is important to note that most of the detections were above the Method Detection Limit (MDL), but below the Method Reporting Limit (MRL). This means that the PFAS was detected, but only as an estimated concentration.

Overall, five to ten percent of samples had detectable results greater than the MRL. DWR uses DoD modified EPA 537 method. Since DWR does not have any statutory requirements for these samples they do not have detection limits for reporting. The MDL is the minimum reporting limit for DWR's contract lab and method capabilities. It should be noted that the DL and MRL varied between PFAS, sample site, and sample event. Please refer to **Appendix 11-1** which shows the varying DLs and MRLs for the dataset used for **Table 11-1 and 11-2**.

Table 11-1. Summary of DWR PFAS Monitoring By SWP Site, 2020 Data

Final Site Name	Total Samples	# (and %) of Non-detects	# (and %) of Detections < MRL	# (and %) of Detections > MRL
Barker Slough PP	48	31 (65%)	13 (27%)	4 (8%)
Banks PP	48	31 (65%)	13 (27%)	4 (8%)
Check 13	80	59 (74%)	13 (16%)	8 (10%)
Teerink PP	144	90 (63%)	47 (33%)	7 (5%)

A summary of the data results is presented in **Table 11-2**. The most frequently detected PFAS were PFHxA, perfluoropentanoic acid (PFPeA), PFBS, PFHpA, perfluorobutanoic acid (PFBA), PFHxS, PFOA, and PFOS. The only three with existing drinking water standards are PFBS, PFOA, and PFOS, all of which have DDW NLs. PFHxS has a recommended NL, but it is not yet finalized. None were detected above their respective DDW NLs. DDW has requested NLs for PFHxA, PFHpA, and PFNA, so these may be of interest in the future.

Table 11-2. Overall Summary of DWR PFAS Monitoring at Selected SWP Sites, 2020 Data

Compound	# Samples	# (and %) of Non-Detects	# (and %) of Detections < MRL	# (and %) of Detections > MRL	Max Result (ng/L)
PFHxA	13	0	2 (15%)	11 (85%)	4.2
PFPeA	13	0	8 (62%)	5 (38%)	2.1
PFBS	13	1 (8%)	12 (92%)	0	0.67J
PFHpA	13	1 (8%)	12 (92%)	0	0.82J
PFBA	13	2 (15%)	6 (46%)	5 (38%)	2.6
PFHxS	13	2 (15%)	11 (85%)	0	0.73J
PFOA	13	2 (15%)	11 (85%)	0	1.6J
PFOS	13	2 (15%)	11 (85%)	0	1.7J
FOSA	13	5 (38%)	6 (46%)	2 (15%)	2.4
PFNA	13	6 (46%)	7 (54%)	0	0.39J
NEtFOSAA	13	13 (100%)	0	0	<1.8
NMeFOSAA	13	13 (100%)	0	0	<2.9
PFDA	13	13 (100%)	0	0	<1
PFDoA	13	13 (100%)	0	0	<1
PFDS	13	13 (100%)	0	0	<1
PFHpS	13	13 (100%)	0	0	<1

Compound	# Samples	# (and %) of Non-Detects	# (and %) of Detections < MRL	# (and %) of Detections > MRL	Max Result (ng/L)
PFNS	13	13 (100%)	0	0	<1
PFPeS	13	13 (100%)	0	0	<1
PFTeA	13	13 (100%)	0	0	<1
PFTriA	13	13 (100%)	0	0	<1.2
PFUnA	13	13 (100%)	0	0	<1
4:2 FTS	13	13 (100%)	0	0	<4.8
6:2 FTS	13	13 (100%)	0	0	<2.3
8:2 FTS	13	13 (100%)	0	0	<1.8
11Cl-PF3OUdS	1	1 (100%)	0	0	<1
9Cl-PF3ONS	1	1 (100%)	0	0	<1
ADONA	1	1 (100%)	0	0	<1
EtFOSA	1	1 (100%)	0	0	<1
EtFOSE	1	1 (100%)	0	0	<1
HFPO-DA	1	1 (100%)	0	0	<1
MeFOSA	1	1 (100%)	0	0	<1
MeFOSE	1	1 (100%)	0	0	<1

J = estimated value

SWP Contractors - Data for four SWP contractors was found for the UCMR3 monitoring in 2013 through 2015 that included PFOA, PFOS, PFBS, PFHpA, PFHxS, and PFNA. Alameda County Water District (ACWD) monitored the treated water at its Water Treatment Plant (WTP) #2 on the South Bay Aqueduct, the City of Fairfield monitored the treated water at its North Bay Regional (NBR) WTP on the North Bay Aqueduct, Metropolitan Water District of Southern California (MWDSC) monitored the raw water at the Jensen WTP on the West Branch of the California Aqueduct and Lake Silverwood on the East Branch of the California Aqueduct, and the City of Palmdale monitored the treated water at its Filtration Plant on the East Branch of the California Aqueduct. Each site was monitored quarterly for one year. All samples were non-detect. It is cautioned that the six PFAS monitored for UCMR3 had significantly higher method detection limits that were also higher than the respective NLs for PFOS and PFOA.

ACWD collected a raw water sample in June 2020 for PFOA and PFOS analysis, both of which were non-detectable. Antelope Valley-East Kern Water Agency collected two raw water samples, September and November 2019, for analysis of 18 PFAS. All were non-detect, except for PFHxA and that was detected in both samples at 2.3 and 3.5 ppt. Valley Water collected three raw water samples at Penitencia WTP (treating South Bay Aqueduct), August 2018, November 2020, and December 2020, for analysis of 18 PFAS. All analytes including PFOA and PFOS were non-detectable in all samples. They also collected two raw water samples from Santa Teresa WTP (treating San Luis reservoir), August 2018 and November 2020, for analysis of 18 PFAS. PFOA and PFOS were non-detectable in both samples. Only PFHxA was detected at 3 ppt in the raw water. MWDSC collected additional samples for the Jensen WTP and Lake Silverwood raw water for expanded PFAS analysis. In 2017 MWD analyzed samples for 12 PFAS, all were non-detectable. In 2019 MWD analyzed samples for 45 PFAS and degradates, all were non-detectable except PFHxA. This was found at both source waters, with an average of 2.5 ppt at Jensen WTP influent and 2.95 ppt at Lake Silverwood. Santa Clarita Valley Water Agency (SCVWA) collected a raw and treated water sample from Castaic Lake in August 2019 for analysis of 112 PFAS. All were non-detectable except for PFHxA, which was found in the raw water only at 2.4 ppt.

POTW Effluent - The Central Valley Regional Water Quality Control Board (Central Valley Board) has required publicly-owned treatment works (POTWs) to analyze treated effluent for PFAS since October 2020. Data was collected quarterly between October 2020 and September 2021 and nine POTWs have been identified to include in this evaluation because they have significant flow and discharge in close proximity to the SWP pumping facilities. This includes; the City of Manteca Wastewater Quality Control Facility (WQCF), City of Modesto WQCF, City of Vacaville Easterly Wastewater Treatment Plant (WWTP), City of Merced Wastewater Treatment Facility (WWTF), Sacramento Regional WWTP, Stockton Regional Wastewater Control Facility (RWCF), City of Tracy WWTP, City of Lodi White Slough Water Pollution Control Facility (WPCF), and City of Turlock Regional Water Quality Control Facility (RWQCF). In total, 18 PFAS have been detected in wastewater effluent in the selected POTWs, as shown in **Table 11-3**. The summary includes all detects that were above the Detection Limit (DL), either as confirmed detects if the concentrations were above the MRL or as estimated values if the concentrations were below the MRL. The most commonly detected PFAS, with more than 50 percent of samples detectable, include: PFHxA, PFPeA, PFOA, PFOS, PFBA, and perfluorohexadecanoic acid (PFHxDA). Additionally, two more PFAS were found in more than 30 percent of samples; PFHxS and PFBS. It should be noted that the DL and MRL varied between PFAS, sample event, and POTW so further inspection of the top detected compounds was conducted. Please refer to **Appendix 11-2** which shows the varying DLs and MRLs for the dataset used for **Table 11-3**.

The most frequently detected PFAS was PFHxA at 93 percent of samples positive, with all of those detect results above the MRL. It was only monitored at four of the POTWs, with all of them finding detectable values. There was only one non-detectable result, but the DL for that sample was significantly higher than all the other samples (21 ppt vs 3.8 ppt). It appears that PFHxA is quite ubiquitous at POTW effluents. There is currently no drinking water threshold for PFHxA, but DDW has requested preparation of a NL.

The next most commonly detected PFAS was PFPeA at 82% of samples positive, with 42 percent of the detects above the MRL and 58 percent of the detects below the MRL. It was monitored and detected at all nine POTWs. There is currently no drinking water threshold for PFPeA and it has not yet been listed for development of a regulatory standard.

Similarly, PFOA and PFOS were detected in 63 and 58 percent of samples, respectively. PFOA was slightly more ubiquitous than PFOS, but both were present in the effluent of almost all of the POTWs. The majority of PFOA samples, 25 out of 38, had DLs higher than the DDW NL of 5.1 ppt. PFOS had only five samples out of 38 with a DL greater than the DDW NL of 6.5 ppt. When the DL is higher than the DDW NL, this is problematic as a result could be reported as non-detectable, but still be present at a level of interest. PFOA was detected in 24 samples and all results were greater than the DDW NL of 5.1 ppt, and though it was non-detectable in 14 samples, all of these had a DL greater than the DDW NL of 5.1 ppt. The majority of detectable PFOS, 59 percent, was lower than the DDW NL of 6.5 ppt. Of the 16 non-detectable results only five had a DL higher than the DDW NL while the other 11 had a DL lower than the DDW NL of 6.5 ppt. Therefore, the data results are clearer for PFOS compared to PFOA. PFOA appears to be present at higher levels of concern than PFOS, but both are frequently detected in POTW effluent at levels of interest.

PFHxDA was also detected in a majority of samples, at 61 percent. Almost all of the detects (94 percent) were estimated values below the MRL. It was monitored at seven POTWs and detected at five of those. There is currently no drinking water threshold for PFHxDA and it has not yet been listed for development of a regulatory standard.

The last PFAS detected in a majority of samples is PFBA, at 58 percent. Sixty-four percent of the detects were estimated values below the MRL. It was monitored and detected at eight of nine POTWs. There is currently no drinking water threshold for PFBA and it has not yet been listed for development of a regulatory standard.

Table 11-3. Summary of PFAS Effluent Monitoring at Selected POTWs

Compound	Total # Samples	% Detects	% Detects < MRL	% Detects > MRL	% POTWs Detectable	Max Detect (ng/L) and POTW
PFHxA	14	93%	-	100.0%	100%	75 - Manteca
PFPeA	38	82%	58%	42%	100%	52 - Sac Regional
PFOA	38	63%	46%	54%	100%	17 - Modesto
PFOS	38	58%	50%	50%	89%	47 - Stockton
PFHxDA	28	61%	94%	6%	71%	55 - Merced
PFBA	38	58%	64%	36%	89%	37 - Tracy
PFHxS	38	37%	64%	36%	56%	14 - Stockton
PFBS	38	34%	15%	85%	67%	320 - Merced
PFDA	38	29%	45%	55%	44%	4 - Manteca
PFHpA	38	24%	22%	78%	33%	5.3 - Modesto
PFNA	38	24%	100%	-	33%	5.3 - Stockton
6:2 FTS	38	13%	60%	40%	33%	170 - Tracy
NEtFOSAA	38	8%	100%	-	22%	9.4 - Stockton
NMeFOSAA	38	8%	100%	-	11%	1.2 - Easterly
8:2 FTS	38	5%	100%	-	11%	0.96 - Sac Regional
PFPeS	38	3%	100%	-	11%	0.57 - Easterly
9Cl-PF3ONS	38	3%	100.0%	-	11%	1.1 - Manteca
11Cl-PF3OUdS	38	0%	-	-	-	-
4:2 FTS	38	0%	-	-	-	-
ADONA	38	0%	-	-	-	-
EtFOSA	38	0%	-	-	-	-

Compound	Total # Samples	% Detects	% Detects < MRL	% Detects > MRL	% POTWs Detectable	Max Detect (ng/L) and POTW
EtFOSE	38	0%	-	-	-	-
FOSA	38	0%	-	-	-	—-
HFPO-DA	38	0%	-	-	-	-
MeFOSA	38	0%	-	-	-	-
MeFOSE	38	0%	-	-	-	-
PFDoA	38	0%	-	-	-	-
PFDS	38	0%	-	-	-	-
PFHpS	38	0%	-	-	-	-
PFNS	28	0%	-	-	-	-
PFTeA	38	0%	-	-	-	-
PFTriA	38	0%	-	-	-	-
PFUnA	38	0%	-	-	-	-

There are two additional PFAS that were detected in just below a majority of samples, but still quite frequently and at a majority of POTWs. PFHxS was detected in 37 percent of samples, and 64 percent of the detects were concentrations below the MRL. There is a new DDW NL of 2 ppt for PFHxS. The DL was greater than the DDW NL of 2 ppt in 25 out of 38 samples. Twenty out of 24 non-detects had DLs greater than DDW NL. The majority of detected PFHxS samples, 10 out of 14, were detected above the DDW NL of 2 ppt. PFBS was detected in 34 percent of samples, and nearly all (85 percent) were concentrations above the MRL. There is a DDW NL of 0.5 ppb, or 500 ppt, for PFBS. No samples exceeded this value.

Delta Regional Monitoring Program – The Central Valley Regional Water Quality Control Board (Central Valley Board) developed the Delta Regional Monitoring Program (RMP) to allow for centralized data collection related to the Sacramento-San Joaquin Delta. As part of this program, there is a CEC Pilot Study that will conduct monitoring for a variety of CECs, including PFOA and PFOS. The Work Plan for the Pilot Study was based on the State Water Board's 2016 CEC Statewide Pilot Study Monitoring Plan.

The study will be conducted over a three-year period, allowing for adaptive change each year. The target of the study will be to assess overall levels of CECs coming into the Delta and the potential impacts from POTWs and urban runoff. For Year 1, samples were collected quarterly at four locations in the Sacramento River watershed (American River at Discovery Park, Sacramento River at Elkhorn Boat Ramp, Sacramento River at Freeport, and Sacramento River at Hood) and at two locations in the San Joaquin River watershed (San Joaquin River at Vernalis and San Joaquin River at Buckley Cove). These sites are shown on **Figure 11-1**. For Year 2, the Year 1 sampling will continue on a quarterly basis, and POTW effluent from two WWTPs will also be sampled on a quarterly basis.

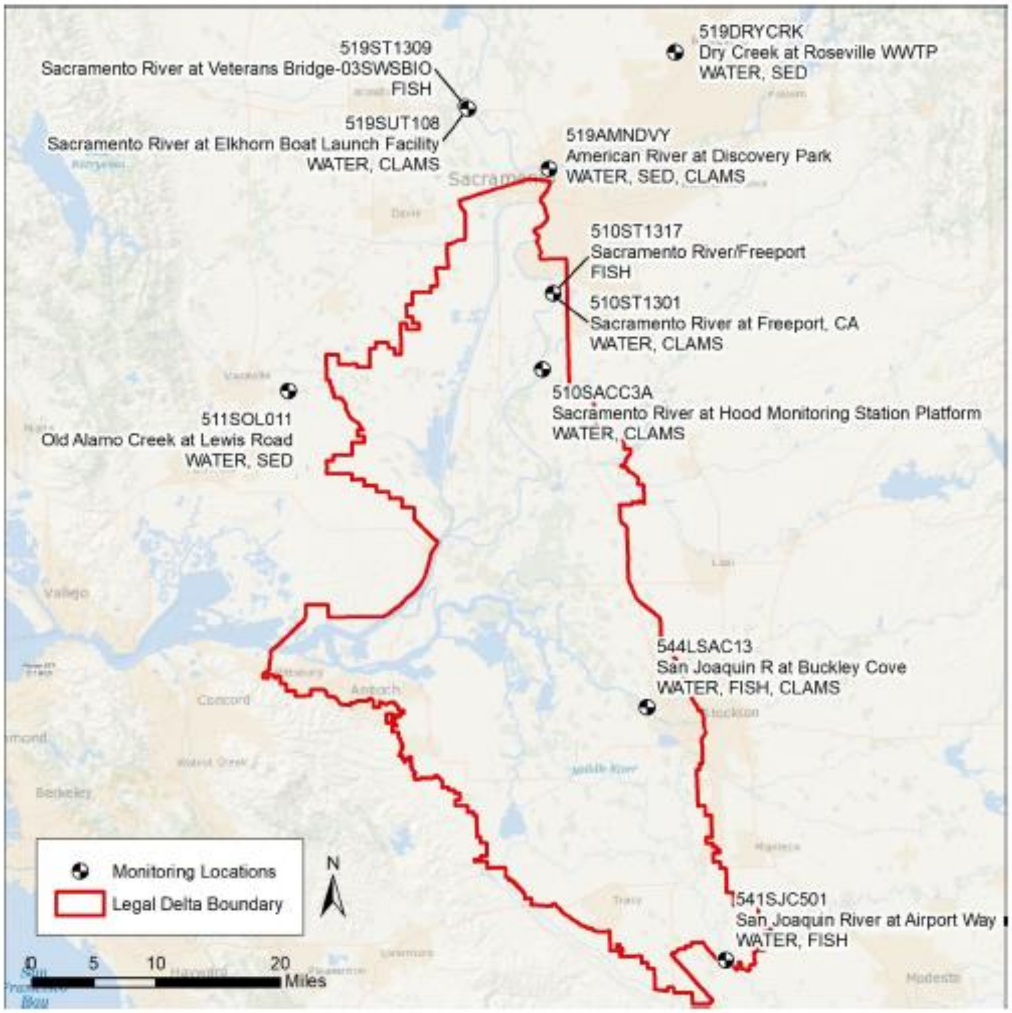
Year 1 data from September 2020 through June 2021 shows that all samples in the Sacramento River watershed were non-detectable for both PFOS and PFOA (with a maximum DL of 2.11 ppt). Both PFOS and PFOA were detectable at both sites in the San Joaquin River, with increased frequency and concentration at Buckley Cove (downstream of the Stockton RWCF). The average PFOS concentration at Buckley Cove was 2.53 ppt and was estimated at 1.61 ppt for PFOA.

PHARMACEUTICALS

BACKGROUND

Many PPCPs have probably been present in water and the environment for as long as humans have been using them. The medications that we take are not entirely absorbed by our bodies, or animals that we provide them to, and are excreted and passed into wastewater and subsequently into surface water and groundwater. Per USEPA, scientists have found no evidence of adverse human health effects from PPCPs in the environment to date. However, it should be noted that the effects of mixtures of CECs at low concentrations are poorly understood, and a range of mixture effects are possible even when each individual chemical is present in a mixture at low concentrations determined not to have individual effects.

Figure 11-1. Delta RMP Sample Site Locations



REGULATORY INFORMATION

Currently, there are no drinking water standards or specific advisories for any pharmaceutical compounds. Four pharmaceutical compounds have been included in the CCL5, as shown in **Table 11-4**. USEPA has created CCL Screening Levels (SL) or Health Reference Levels (HRL) for each of these compounds.

Table 11-4. Pharmaceuticals Included on the CCL5

CCL5 Pharmaceutical	Drinking Water Threshold Type	Category
17-alpha ethynyl estradiol	CCL SL	Pharmaceutical - hormone
Desvenlafaxine	CCL SL	Pharmaceutical – antidepressant
Fluconazole	CCL SL	Pharmaceutical – antifungal
Quinoline	CCL HRL	Pharmaceutical - antimalarial

USEPA has made no Regulatory Determinations for any pharmaceutical compounds.

MONITORING DATA

Delta Regional Monitoring Program – As described earlier, the Delta RMP CEC Pilot Study conducted Year 1 monitoring for selected PPCP CECs on a quarterly basis from September 2020 to June 2021, as shown in **Table 11-5**. Year 2 monitoring began in October 2021, however at the time of report writing, these results are not available for public review. Triclocarban was added to Year 2 monitoring.

Table 11-5. PPCP CECs Included in the Delta RMP Pilot Study

Constituent	Category
17-alpha ethynyl estradiol	Pharmaceutical - hormone
17-beta-estradiol	Pharmaceutical - hormone
Diclofenac	Pharmaceutical - analgesic
Estrone	Pharmaceutical - hormone
Galaxolide	Personal Care - fragrance
Gemfibrozil	Pharmaceutical - antilipidemic
Ibuprofen	Pharmaceutical - analgesic
Iopromide	Pharmaceutical - Xray contrast agent
Naproxen	Pharmaceutical - analgesic
Progesterone	Pharmaceutical - hormone
Salicylic Acid	Pharmaceutical - antibacterial
Testosterone	Pharmaceutical - hormone
Triclosan	Pharmaceutical - antibacterial

Only four of these PPCP CECs (galaxolide, gemfibrozil, naproxen, ibuprofen) were detected in the Sacramento River watershed. Ibuprofen was only detected at the Sacramento River at Hood site, in two of three samples, with a maximum value of 80 ppb. Gemfibrozil was only detected once at the Sacramento River at Hood site, in one of three samples. Naproxen was detected at the Sacramento River at Hood site, in two of three samples, with a maximum value of 66 ppb. Galaxolide was found in all samples at all sites. The levels were lowest on the American River at Discovery Park (average 136.6 ppb), higher on the Sacramento River at Elkhorn Boat Launch (average 247.25 ppb), blended at the Sacramento River at Freeport (average 170.8 ppb), and significantly higher at the Sacramento River at Hood (average 1,958.3 ppb) which is downstream of the Sacramento Regional WWTP. Only galaxolide was detected in the San Joaquin River watershed. Galaxolide was detected in all samples at both sites. The levels were lowest at Vernalis (average 119.8 ppb) and higher at Buckley Cove (average 571.3 ppb) which is downstream of the Stockton RWCF.

SWP Contractors - Data for three SWP contractors and DWR was found for the UCMR3 monitoring in 2013 through 2015 that included 17-alpha-ethylnylestradiol, 17-beta-estradiol, 4-androstene-3,17-dione, equilin, estriol, estrone, and testosterone. Alameda County Water District (ACWD) monitored the treated water at its Water Treatment Plant (WTP) #2 on the South Bay Aqueduct, the City of Fairfield monitored the treated water at its North Bay Regional (NBR) WTP on the North Bay Aqueduct, the City of Palmdale monitored the treated water at its Filtration Plant on the East Branch of the California Aqueduct, and DWR monitored the Jones Pumping Plant. Each site was monitored quarterly for one year. All samples were non-detect, except one sample for 4-androstene-3,17-dione at NBR WTP (July 2013 at 0.00092 ppb). This is a week androgen steroid hormone and has not been listed on the CCL.

As a supplement to the Delta RMP CEC Pilot Study, the SWP Contractors conducted companion monitoring for a wider suite of PPCPs, as shown in **Table 11-6**. It should be noted that the companion monitoring discussed below covers Year 1 monitoring from September 2020 to June 2021, as well as October 2021 monitoring for Year 2.

Table 11-6. PPCP CECs Included in the SWP Contractor Supplement to the Delta RMP Pilot Study

Constituent	Category
Acetaminophen	Pharmaceutical - analgesic
Amoxicillin	Pharmaceutical - antibiotic
Atenolol	Pharmaceutical - hypertension
Atorvastatin	Pharmaceutical - Antihyperlipidemic
Azithromycin	Pharmaceutical - antibiotic
Caffeine	Pharmaceutical - CNS stimulant
Carbamazepine	Pharmaceutical - anticonvulsant
Ciprofloxacin	Pharmaceutical - antibiotic
Cotinine	Personal Care - nicotine derivative
DEET	Personal Care - insect repellent
Diazepam	Pharmaceutical - antianxiety

Constituent	**Category**
Fluoxetine	Pharmaceutical - antidepressant
Meprobamate	Pharmaceutical - tranquilizer
Methadone	Pharmaceutical - analgesic/drug detox
Phenytoin (Dilantin)	Pharmaceutical - anticonvulsant
Primidone	Pharmaceutical - anticonvulsant
Sucralose	Personal Care - sweetener
Sulfamethoxazole	Pharmaceutical - antibiotic
Trimethoprim	Pharmaceutical - antibiotic

Eight of these CECs were detected in the Sacramento River watershed (atenolol, caffeine, ciprofloxacin, cotinine, DEET, sucralose, sulfamethoxazole, and trimethoprim). Most were infrequently and inconsistently detected. The only CEC to be found at all sites in all samples in the Sacramento River watershed was sucralose. The levels were lowest on the American River at Discovery Park (average 43 ppb), higher on the Sacramento River at Elkhorn Boat Launch (average 290 ppb), blended at the Sacramento River at Freeport (average 264 ppb), and significantly higher at the Sacramento River at Hood (average 1,246 ppb), which is downstream of the Sacramento Regional WWTP.

Ten of these CECs were detected in the San Joaquin River watershed (amoxicillin, caffeine, carbamazepine, ciprofloxacin, DEET, meprobamate, phenytoin, primidone, sucralose, and sulfamethoxazole). Most were infrequently and inconsistently detected, however there were consistently more PPCPs detected at the Buckley Cove site downstream of the Stockton RWCF. Carbamazepine, caffeine, meprobamate, and sulfamethoxazole were detected in all samples at Buckley Cove. Only two CECs were to be found at both sites in all samples; DEET and sucralose. DEET levels were highest at the San Joaquin at Vernalis site (average 33.4 ppb) and decreased slightly at Buckley Cove (average 28.8 ppb). Sucralose levels were lowest at the Vernalis site (average 61.4 ppb) and significantly higher at the Buckley Cove site (average 4,640 ppb), which is downstream of the Stockton RWCF.

PESTICIDES

BACKGROUND

The Central Valley boasts millions of acres of agriculture and associated with that is millions of pounds of pesticides applied. Agricultural practices need to be adaptive to address varying pests. This often involves rotational pesticide application and the use of newly developed pesticides. There is no requirement for drinking water standards to be considered for new use pesticides, so many current use pesticides have no regulation in drinking water. However, the potential for impact to human health exists.

REGULATORY INFORMATION

Emerging, or new use pesticides, generally do not have drinking water standards set for them. A review of the CCL5 shows that the list includes 44 current use pesticides, as shown in **Table 11-**

7. Each of these pesticides has a human health threshold in drinking water that has been established, including one USEPA National Recommended Water Quality Criteria (NRWQC), two DDW NLs, four DDW Archived Advisory Levels (AALs), seven USEPA HAs, 26 USEPA HHBPs, and four CCL Health Reference Levels (HRL). NRWQCs are Clean Water Act human health regulatory values that are designed for protection of humans consuming both surface water and organisms that live within surface waters. DDW AALs are the same as DDW NLs, but for constituents that were of interest in the early 1980s and have since been archived. CCL HRLs are concentrations of chemicals in drinking water not expected to result in adverse health outcomes over a lifetime of exposure. There is available monitoring data for 18 of these pesticides during the study period in the SWP, which is discussed further below.

In California, there may be many more site-specific pesticides used that have not been identified as a national priority and added to the CCL process. If these are detected at levels of interest or concern in water supplies, DDW will often set a NL.

Table 11-7. Pesticides Included on the CCL5

CCL5 Pesticide	Drinking Water Threshold Type
2-Hydroxyatrazine	HHBP
2,4-Dinitrophenol	CCL HRL
6-Chloro-1,3,5-triazine-2,4-diamine	HHBP
Acephate	HHBP
Acrolein	USEPA NRWQC
alpha-Hexachlorocyclohexane (alpha-HCH)	BHC AAL
Bensulide	HHBP
Bromoxynil	HHBP
Carbaryl	HA
Carbendazim (MBC)	HHBP
Chlordecone (Kepone)	*CCL HRL
Chlorpyrifos	HA
Deethylatrazine	*CCL HRL
Desisopropyl atrazine	*CCL HRL
Diazinon	NL, HA
Dicrotophos	HHBP
Dieldrin	AAL, HA
Dimethoate	AAL
Diuron	HA
Ethalfluralin	HHBP
Ethoprop	HHBP
Fipronil	HHBP
Flufenacet	HHBP
Fluometuron	HA
Iprodione	HHBP
Malathion	AAL, HA
Methomyl	HA
Norflurazon	HHBP
Oxyfluorfen	HHBP
Permethrin	HHBP
Phorate	HHBP
Phosmet	HHBP
Phostebupirim	HHBP
Profenofos	HHBP
Propachlor	NL, HA
Propanil	HHBP
Propargite	HHBP
Propazine	HA
Propoxur	HHBP
Tebuconazole	HHBP
Terbufos	HA
Thiamethoxam	HHBP
Tri-allate	HHBP
Tribufos	HHBP

USEPA has previously determined not to regulate 15 emerging pesticides through the Regulatory Determination process; CCL1 – aldrin, dieldrin, metribuzin, CCL2 - dacthal mono and di-acid degradates, 1,1-dichloro-2,2-bis(p-chlorophenyl) ethylene (DDE), s-ethyl propylthiocarbamate (EPTC), fonofos, terbacil, CCL3 – dimethoate, terbufos, terbufos sulfone, and CCL4 – acetochlor, methyl bromide, metolachlor. It should be noted that dieldrin, dimethoate, and terbufos have been added to the CCL5 for reconsideration.

MONITORING DATA

Delta Regional Monitoring Program – The Delta RMP worked in cooperation with the US Geologic Survey (USGS) to complete a two-year study of pesticide inputs to the Delta. This involved monthly sampling of five inputs to the Delta between July 2015 and June 2017. The five sites monitored were; the Sacramento River at Hood, Ulatis Creek at Brown Road, the Mokelumne River at New Hope Road, the San Joaquin River at Vernalis, and the San Joaquin River at Buckley Cove. The study monitored for current use pesticides, including seven currently regulated pesticides and 147 unregulated pesticides in drinking water.

The unregulated pesticides included in the data set are of interest as CECs and were evaluated as part of this study. There were a total of 17,520 sample results to evaluate from the five sites over the 24 months. Of the 147 unregulated pesticides with analytical results, 89 were never detected at any time at any site. These are listed in **Table 11-8**. Of the 89 pesticides with no detects, only eight are included on the CCL5 as indicated on the table.

The remaining 58 pesticides were detected at least once at one site. A summary of the number of each detects and the average over the two-year monitoring period is provided for each site in **Table 11-9**. Of the 58 pesticides with detects, only 10 are included on the CCL5 as indicated on the table.

Most of the detected pesticides have either a USEPA HA, DDW NL, DDW AAL, or USEPA HHBP available to assess the significance of the data results, those are shown in **Table 11-9**. It can be seen that generally speaking, the data results are orders of magnitude below the respective human health threshold values. This indicates that the detected pesticides are not expected to pose significant health threat in the drinking water supply. There were nine pesticides that had human health thresholds less than 3,000 ppt (greater than the maximum detected pesticide value). These pesticides were evaluated further. Chlorothalonil has a HA of 1,500 ppt and the maximum detected value was 7.8 ppt at the Sacramento River at Hood. Chlorpyrifos has a HA of 2,000 ppt and the maximum detected value was 4.3 ppt at the San Joaquin River at Vernalis. Diazinon has a NL of 1,200 ppt and a HA of 1,000 ppt and the maximum detected value was 89.1 ppt at the Mokelumne River. Diuron has a HA of 2,000 ppt and the maximum detected value was 450.8 ppt, which is just under 25 percent of the HA. Fipronil has a HHBP of 1,000 ppt and the maximum value was 25 ppt at the Sacramento River at Hood. Imazalil has a HHBP of 484 ppt and the maximum value was 118.9 ppt, which is just under 25 percent of the HHBP. Iprodione has a HHBP of 674 ppt and the maximum value was 201.4 at the San Joaquin River at Vernalis, which is just under 30 percent of the HHBP. Oxadiazon has a HHBP at 416 ppt and the maximum value was 79.4 ppt at Ulatis Creek, which is just under 20 percent of the HHBP. Oxyfluorfen has a HHBP of 404 ppt and the maximum value was 210.9 ppt at the San Joaquin

River at Buckley Cove, which is just over 50 percent of the HHBP. When looking at the frequency of detection, the spatial variability of detections, and peak levels relative to human health thresholds it appears that the top detected pesticides of interest are; oxyfluorfen, diuron, iprodione, imazalil, and oxadiazon. Three of these, oxyfluorfen, diuron, and iprodione, are also on the CCL5.

Table 11-8. Delta RMP Pesticide Study – Unregulated Pesticides with No Detects

Acetamiprid	Ethofenprox	Permethrin, Total*
Alachlor	Famoxadone	Phenothrin
Allethrin	Fenamidone	Phosmet*
Azinphos Methyl	Fenarimol	Picoxystrobin
Benfluralin	Fenbuconazole	Prometon
Butralin	Fenpropathrin	Propargite*
Butylate	Fenpyroximate	Propyzamide
Captan	Fenthion	Pyraclostrobin
Chlorpyrifos Oxon	Fluazinam	Pyridaben
Coumaphos	Fludioxonil	Resmethrin
Cyantraniliprole	Flufenacet*	Sedaxane
Cyazofamid	Flumetralin	Tebuconazole*
Cycloate	Fluopicolide	Tebupirimfos oxon
Cyfluthrin, total	Fluoxastrobin	Tebupirimfos
Cyhalofop-butyl	Flutolanil	Tefluthrin
Cymoxanil	Flutriafol	Tetradifon
Cypermethrin, Total	Ipconazole	Tetramethrin
Cyproconazole	Kresoxim-methyl	T-Fluvalinate
Dacthal	Malaoxon	Thiacloprid
DDD(p,p')	Malathion*	Thiazopyr
DDE(p,p')	Mandipropamid	Tolfenpyrad
DDT(p,p')	Metconazole	Triadimefon
Deltamethrin	Methidathion	Triadimenol
Desthio-prothioconazole	Methoprene	Triallate*
Diazoxon	Novaluron	Tributyl Phosphorotrithioate, S,S,S-
Dichloroaniline, 3,5-	Paclobutrazol	Triflumizole
Dimethomorph	Parathion, Methyl	Trifluralin
Esfenvalerate	Pebulate	Triticonazole
Ethaboxam	Pentachloroanisole	Zoxamide
Ethalfluralin*	Pentachloronitrobenzene	

*Pesticide included on the CCL5

Table 11-9. Delta RMP Pesticide Study – Unregulated Pesticides with Detects

Pesticide or Degradate	MDL, ng/L	Sacramento River	Delta		San Joaquin River		Human Health Threshold (ppt)
		Hood	Mokelumne River	Ulatis Creek	Vernalis	Buckley Cove	
		# Detects, Average[1]	# Detects, Average[1]	# Detects, Average[1]	# Detects, Average[1]	# Detects, Average[1]	
Acibenzolar-S-methyl	3	-	-	-	1, <3	1, 3.7	HHBP - 460,000
Azoxystrobin	3.1	20, 53.6	6, 12.9	16, 28.6	16, 12.1	22, 39	HHBP - 1,070,000
Bifenthrin	0.7	1, <0.7	-	6, 3.1	-	-	HHBP - 210,000
Boscalid	2.8	9, 3.2	18, 10.1	24, 45.6	22, 16.4	22, 35.7	HHBP - 1,300,000
Carbaryl[2]	6.5	2, <6.5	-	1, <6.5	-	-	HA - 40,000; AAL - 700,000
Carbendazim[2]	4.2	14, 11	4, <4.2	7, 16.3	8, 11.1	19, 29.3	HHBP - 12,400
Chlorantraniliprole	4	1, <4	-	17, 102.1	9, <4	12, 4.9	HHBP - 9,350,000
Chlorothalonil	4.1	2, <4.1	1, <4.1	-	-	-	HA - 1,500
Chlorpyrifos[2]	2.1	-	-	-	1, <2.1	-	HA - 2,000
Clomazone	2.5	7, 16.6	1, <2.5	-	-	4, 2.9	HHBP – 5,000,000
Clothianidin	3.9	-	-	2, <3.9	-	-	HHBP - 580,000
Cyhalothrin	0.5	-	-	1, <0.5	-	-	HHBP - 6,200
Cyprodinil	7.4	1, <7.4	1, <7.4	1, <7.4	1, <7.4	-	HHBP - 160,000
Diazinon[2]	0.9	-	1, 3.7	2, 2.4	3, <0.9	2, <0.9	NL 1,200; HA 1,000
Dichlorobenzenamine, 3,4-	3.2	20, 24.1	4, <3.2	16, <3.2	3, <3.2	15, 6.6	(propanil degradate)
Dichlorophenyl Urea, 3,4-	3.4	1, <3.4	-	5, <3.4	4, <3.4	11, 4	(diuron degradate)
Dichlorophenyl-3-methyl Urea, 3,4-	3.5	3, 4.5	-	17, 4.8	7, 4.8	19, 15.4	(diuron degradate)
Difenoconazole	10.5	-	-	1, <10.5	-	-	HHBP - 60,000
Dinotefuran	4.5	-	-	2, <4.5	-	1, <4.5	HHBP - 6,000,000
Dithiopyr	1.6	7, 2.5	8, 2.9	19, 28.4	15, 7.5	14, 7	HHBP - 21,000
Diuron[2]	3.2	11, 22.4	3, 9.25	21, 16.1	17, 36	23, 66	HA - 2,000
EPTC	1.5	-	-	1, <1.5	1, <1.5	2, 1.71	HHBP - 300,000
Fenhexamid	7.6	2, <7.6	1, <7.6	2, <7.6	1, <7.6	-	HHBP - 1,000,000
Fipronil Desulfinyl Amide	3.2	1, <3.2	-	1, <3.2	-	-	(fipronil degradate)
Fipronil Desulfinyl	1.6	2, <1.6	2, <1.6	4, <1.6	-	8, 1.6	(fipronil degradate)
Fipronil Sulfide	1.8	1, <1.8	-	-	-	4, <1.8	(fipronil degradate)
Fipronil Sulfone	3.5	2, <3.5	-	4, <3.5	-	3, <3.5	(fipronil degradate)
Fipronil[2]	2.9	10, 3.1	1, <2.9	6, <2.9	-	4, <2.9	HHBP - 1,000
Flonicamid	3.4	-	-	1, <3.4	-	-	HHBP - 200,000
Fluridone	3.7	1, <3.7	2, <3.7	12, 8.2	4, <3.7	21, 110.5	HHBP - 890,000
Flusilazole	4.5	1, <4.5	-	-	1, <4.5	-	HHBP - 10,000
Fluxapyroxad	4.8	1, <4.8	5, <4.8	12, 12.8	9, 5	14, 12.9	HHBP - 120,000
Hexazinone	8.4	19, 19	16, 12.8	21, 135.4	19, 16.1	21, 29.9	HA - 400,000

Table 11-9 Continued. Delta RMP Pesticide Study – Unregulated Pesticides with Detects

Pesticide or Degradate	**MDL, ng/L**	**Sacramento River**	**Delta**		**San Joaquin River**		
		Hood	**Mokelumne River**	**Ulatis Creek**	**Vernalis**	**Buckley Cove**	**Human Health Threshold (ppt)**
		# Detects, Average [1]	**# Detects, Average [1]**	**# Detects, Average [1]**	**# Detects, Average [1]**	**# Detects, Average [1]**	
Imazalil	10.5	1, <10.5	1, <10.5	-	-	-	HHBP - 484
Imidacloprid	3.8	3, <3.8	1, <3.8	23, 13.1	6, <3.8	13, 7.3	HHBP - 500,000
Indoxacarb	4.9	-	-	1, <4.9	-	-	HHBP - 100,000
Iprodione [2]	4.4	1, <4.4	2, <4.4	5, 17.5	-	5, 6.9	HHBP - 674
Metalaxyl	5.1	-	-	1, <5.1	-	1, <5.1	HHBP - 3,000,000
Methoxyfenozide	2.7	8, 3.9	11, 3.5	12, 11.6	24, 21.3	24, 53.4	HHBP - 600,000
Metolachlor	1.5	12, 4.1	5, 1.5	21, 201.3	19, 12.4	24, 37.1	HA - 700,000
Myclobutanil	6	-	1, <6	-	-	1, <6	HHBP - 150,000
Napropamide	8.2	-	-	2, 9.1	1, <8.2	-	HHBP - 710,000
Oryzalin	5	1, <5	-	5, 21.6	3, <5	4, 12.7	HHBP - 3,800
Oxadiazon	2.1	-	-	5, 7.7	-	3, <2.1	HHBP - 416
Oxyfluorfen [2]	3.1	2, <3.1	4, <3.1	8, 10.7	2, <3.1	4, 14.5	HHBP - 404
Pendimethalin	2.3	-	1, <2.3	6, 39.6	4, 5.9	4, 7.6	HHBP - 2,000,000
Penoxsulam	3.5	1, <3.5	-	-	-	-	HHBP - 870,000
Piperonyl Butoxide	2.3	14, 8	4, <2.3	-	2, <2.3	9, 5.4	HHBP - 950,000
Prodiamine	5.2	-	-	2, <5.2	-	-	HHBP - 830,000
Prometryn	1.8	-	-	-	1, <1.8	-	HHBP - 200,000
Propanil [2]	10.1	2, <10.1	-	-	-	-	HHBP - 200,000
Propiconazole	5	2, <5	-	7, 24.4	4, <5	1, <5	HHBP - 600,000
Pyrimethanil	4.1	-	1, <4.1	1, <4.1	-	-	HHBP - 1,000,000
Quinoxyfen	3.3	-	2, <3.3	-	-	-	HHBP - 1,000,000
Tetraconazole	5.6	-	1, <5.6	1, <5.6	1, <5.6	-	HHBP - 43,000
Thiabendazole	3.6	-	-	3, <3.6	-	3, <3.6	HHBP - 600,000
Thiamethoxam [2]	3.4	-	-	3, <3.4	1, <3.4	1, <3.4	HHBP - 71,000
Trifloxystrobin	4.7	-	1, <4.7	1, <4.7	-	-	HHBP - 220,000

[1] Each site had 24 samples for each pesticide, average units are ppt (ng/L)

[2] Pesticide included on the CCL5

The Sacramento River at Hood site detected 35 pesticides, or about 24 percent of the total pesticides monitored. The Mokelumne River site detected 29 pesticides, or about 20 percent of total pesticides monitored. Ulatis Creek detected 45 pesticides, or about 31 percent of the total pesticides monitored. The San Joaquin River at Vernalis site detected 31 pesticides (21 percent), while the downstream Buckley Cove site detected of 35 pesticides (24 percent). Pesticides were found at all sites, most commonly detected in Ulatis Creek. There was seasonal variability likely caused by agricultural practices.

OTHER CHEMICALS

BACKGROUND

CECs include a wide universe of constituents and there are many synthetic chemicals that are used in human products that have the potential to enter drinking water supplies and impact human health. This can include commercial and industrial chemicals, such as plastics and flame retardants.

REGULATORY INFORMATION

A review of the CCL5 shows that the list includes 10 synthetical chemicals, as shown in **Table 11-10**. Each of these chemicals has a human health threshold in drinking water that has been established, including two DDW MCLs, two DDW NLs, two USEPA HAs, four USGS Health Based Screening Levels (HBSL), one CCL HRL, and one CCL Screening Level (SL). HBSLs are non-enforceable water-quality benchmarks that can be used to supplement MCLs and HHBPs. CCL SLs are a calculated concentration of a chemical in drinking water derived from chronic toxicity values identified from primary data sources, such as an oral reference dose. There is available monitoring data for two of these chemicals during the study period in the SWP, which is discussed further below. MTBE and 1,2,3-trichloropropane are already regulated in California with primary MCLs, so they are not included in this CEC evaluation.

Table 11-10. Chemicals Included on the CCL5

CCL Chemical	Drinking Water Threshold	Use
1,2,3-Trichloropropane	DDW MCL, HA	Paint ingredient
2-Aminotoluene (o-Toluidine)	CCL HRL	Manufacturing intermediary
4-Nonylphenol (all isomers)	CCL SL	Chemical preparation
Anthraquinone	HBSL	Dye production
Bisphenol A	HBSL	Resin production
Methyl tert-butyl ether (MTBE)	DDW MCL	Gasoline additive
Tributyl phosphate	HBSL	Flame retardant
Trimethylbenzene (1,2,4-)	NL	Chemical intermediate
Tris (2-chloroethyl) phosphate (TCEP)	HBSL	Flame retardant, plasticizer
1,4-Dioxane	NL, HA	Solvent, stabilizer

MONITORING DATA

Delta Regional Monitoring Program – The Delta RMP CEC Pilot Study conducted monitoring for CECs and included Bisphenol A, which is a chemical used in plastic and resin production and is included on the CCL5. Bisphenol A was found at all sites. Data presented herein is for Year 1 monitoring only.

For the Sacramento River watershed, the highest levels were found at the Sacramento River at Elkhorn Boat Launch (average 28.8 ppt). It is unclear why this site had the highest levels and could be a localized impact. The levels were about the same at the American River at Discovery Park (average 11.7 ppt) and the Sacramento River at Freeport (average 11 ppt) and slightly higher downstream at the Sacramento River at Hood (average 20 ppt), which is downstream of the Sacramento Regional WWTP.

For the San Joaquin River watershed, the levels were lowest at Vernalis (average 4.3 ppt) and higher at Buckley Cove (average 25.7 ppt), which is downstream of the Stockton RWCF.

All of these values are well below the Bisphenol A USGS HBSL of 300 ppb (or 300,000 ppt).

SWP Contractors - As a supplement to the Delta RMP CEC Pilot Study, the SWP Contractors conducted companion monitoring for some other chemical CECs, as shown in **Table 11-11**. Data evaluated herein is for Year 1 monitoring from September 2020 to June 2021, as well as October 2021 monitoring for Year 2.

These are emerging contaminants with little available human health information. There are no standards, and only one has a USGS HBSL. All three have USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. These are only intended to determine if a contaminant should be considered for evaluation as part of a Superfund Site analysis of tap water.

Table 11-11. Other Chemical CECs Included in the SWP Contractor Supplement to the Delta RMP Pilot Study

Constituent	Drinking Water Threshold	Use
Tris (1,3-dichloro-2-propyl) phosphate (TDCPP)	RSL	Flame retardant
Tris (1-chloro-2-propyl) phosphate (TCPP)	RSL	Flame retardant
Tris (2-chloroethyl) phosphate (TCEP)*	HBSL, RSL	Flame retardant, plasticizer

*Chemical included on the CCL5

For the Sacramento River watershed these three chemicals were infrequently and inconsistently detected. TDCPP was detected once at the American River at Discovery Park site during a fall storm sample (71 ppt) and it was detected once at the Sacramento River at Hood (29 ppt). The RSL for TDCPP is 35.7 ppb (or 35,700 ppt), so these results are well below any level of interest. TCPP was detected once at the American River at Discovery Park site during a fall storm sample (220 ppt) and it was detected twice at the Sacramento River at Hood (68 and 53 ppt). The RSL for TCPP is 19 ppb (or 19,000 ppt), so these results are well below any level of interest. TCEP was detected once at the American River at Discovery Park site during a fall storm sample (24 ppt). The RSL for TCEP is 3.85 ppb (or 3,850 ppt) and the HBSL is 40 ppb (or 40,000 ppt), so these results are well below any level of interest.

For the San Joaquin River watershed these three chemicals were infrequently and inconsistently detected. TDCPP was detected once at the San Joaquin River at Vernalis site (10 ppt) and it was detected twice at the San Joaquin River at Buckley Cove (75 and 51 ppt). The RSL for TDCPP is 35.7 ppb (or 35,700 ppt), so these results are well below any level of interest. TCPP was detected in all five samples at the San Joaquin River at Buckley Cove (average 184 ppt), downstream of the Stockton RWCF. The RSL for TCPP is 19 ppb (or 19,000 ppt), so these results are well below any level of interest. TCEP was also detected in all five samples at the San Joaquin River at Buckley Cove (average 19.8 ppt), downstream of the Stockton RWCF. The RSL for TCEP is 3.85 ppb (or 3,850 ppt) and the HBSL is 40 ppb (or 40,000 ppt), so these results are well below any level of interest.

SUMMARY

- Monitoring data within the SWP shows that PFAS are detectable in the source water. The most frequently detected PFAS include: PFHxA, PFPeA, PFBS, PFHpA, PFBA, PFHxS, PFOA, and PFOS. Four of the most frequently detected PFAS have DDW NLs, while two more have an impending DDW NL. The four PFAS with DDW NLs include PFOA, PFOS, PFBS, and PFHxS (recommended NL). There were no detects in the SWP above the respective DDW NLs for PFOA, PFOS, PFBS, and PFHxS. Looking at individual SWP Contractor data, there is very little detectability of PFAS downstream in the SWP, except for PFHxA. PFHxA appears to be the most ubiquitous and long-lasting PFAS in the SWP, and DDW is preparing a NL.

- POTW effluent monitoring indicates that they are a source of PFAS in the Sacramento River, San Joaquin River, and Delta, sometimes at levels above the DDW NLs. The most frequently detected PFAS was PFHxA at 93 percent of samples positive, with all of those detect results above the MRL. It appears that PFHxA is quite ubiquitous at POTW effluents. The majority of PFHxS detects were above its DDW NL.

- Monitoring data in the SWP shows that PPCPs are infrequently detected in the source water, but do appear to have an upstream to downstream increasing trend. The most prevalent PPCPs were galaxolide, DEET, and sucralose. Bisphenol A was also detected at all sites. Galaxolide and sucralose both increased significantly downstream of POTWs. The San Joaquin River system had significantly higher levels of sucralose, while the Sacramento River system had significantly higher levels of galaxolide. Overall, the San Joaquin River at Buckley Cove had the most detections of CECs; caffeine, carbamazepine, DEET, meprobamate, sucralose, sulfamethoxazole, TCPP, and TCEP were detected in all samples.

- Monitoring data in the sources to the Delta show that unregulated pesticides are commonly detected in the source water, but are generally not present at levels of concern based on currently available human health threshold information. The Sacramento, Mokelumne, and San Joaquin Rivers are all potential sources of unregulated pesticides to the Delta, and Ulatis Creek is a slightly more significant source. The top detected pesticides of interest are; oxyfluorfen, diuron, iprodione, imazalil, and oxadiazon. Three of these, oxyfluorfen, diuron, and iprodione, are also on the USEPA CCL5.

- Monitoring data in the sources to the Delta show that other chemicals of potential interest can be detected in the source water, but are not present at levels of concern based on currently available human health threshold information. Two of these, Bisphenol A and TCEP, are on the USEPA CCL5.

RECOMMENDATIONS

- Continue to track results for Year 2 and 3 for the Delta RMP CEC Study.

- Continue to track DWR monitoring for PFAS in the SWP System.

- Continue to assess PFAS collected by the SWP Contractors as part of UCMR5.

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USGS. Pesticide Inputs to the Sacramento–San Joaquin Delta, 2015–16: Results from the Delta Regional Monitoring Program. Data Series 1089. 2018.

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https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/NotificationLevels.html

CHAPTER 12 ARTICLE 19 CONSTITUENTS AND ALKALINITY

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FIGURES

TABLES

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CHAPTER 12 ARTICLE 19 CONSTITUENTS AND ALKALINITY

WATER QUALITY CONCERN – ARTICLE 19 CONSTITUENTS

Table 12-1 contains a table of Article 19 water quality objectives that the State "shall take all reasonable measures to make available at all delivery structures for delivery of project water". This evaluation will focus on total dissolved solids, total hardness, chloride, sulfate, and boron. The locations selected for evaluation are Barker Slough, Banks, Del Valle Check 7, Pacheco, and Check 13. Additional constituents and locations may be considered for future evaluations.

It should be noted that the analytical method for chloride changed from USEPA Method 325.2 to USEPA Method 300.0 (DWR modified 28 day hold) in November 2000, and was revised in August 2020 to adhere to a 48 hour hold time. Similarly, the analytical method for sulfate changed from USEPA Method 375.2 to USEPA Method 300.0 (DWR modified 28 day hold) in November 2000, and was revised in August 2020 to adhere to a 48 hour hold time. For this evaluation, datasets for sulfate and chloride were combined.

Table 12-1. Article 19 Water Quality Objectives

Constituent	Monthly Average	Average for any 10-year period	Maximum
Total Dissolved Solids	440	220	-
Total Hardness	180	110	-
Chloride	110	55	-
Sulfate	110	20	-
Boron	0.6	-	-
Sodium Percentage	50	40	-
Fluoride	-	-	1.5
Lead	-	-	0.1
Selenium	-	-	0.05
Hexavalent Chromium	-	-	0.05
Arsenic	-	-	0.05
Iron and Manganese together	-	-	0.3
Magnesium	-	-	125
Copper	-	-	3
Zinc	-	-	15
Phenol	-	-	0.001

WATER QUALITY EVALUATION

***Barker Slough*– Figures 12-1 through Figure 12-3** shows grab sample data at Barker Slough. **Figure 12-1** shows that sulfate and chloride never exceeded the monthly average water quality objective of 110 mg/L. However, hardness exceeded the monthly average objective of 180 mg/L in April 2008, March 2017, and April 2018. **Figure 12-2** shows that TDS exceeded the monthly average objective of 440 mg/L in March 2017 and April 2018. **Figure 12-3** shows that boron never exceeded the monthly average objective of 0.6 mg/L.

The ten year averages (January 2011 to December 2020) were 192.6 mg/L for TDS, 24.9 mg/L for chloride, 26.7 mg/L for sulfate, and 98.9 mg/L for hardness, respectively. The ten-year average of 20 mg/L for sulfate was exceeded.

Figure 12-1. Chloride, Sulfate and Hardness at Barker Slough

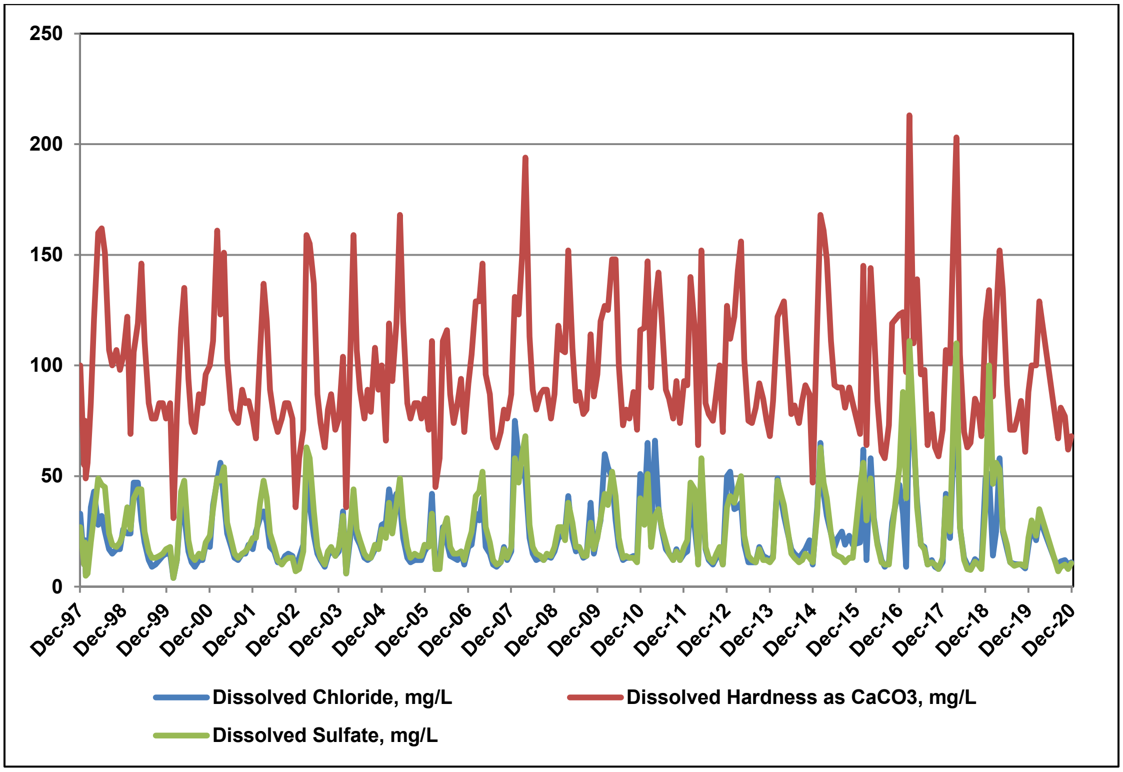


Figure 12-2. Total Dissolved Solids at Barker Slough

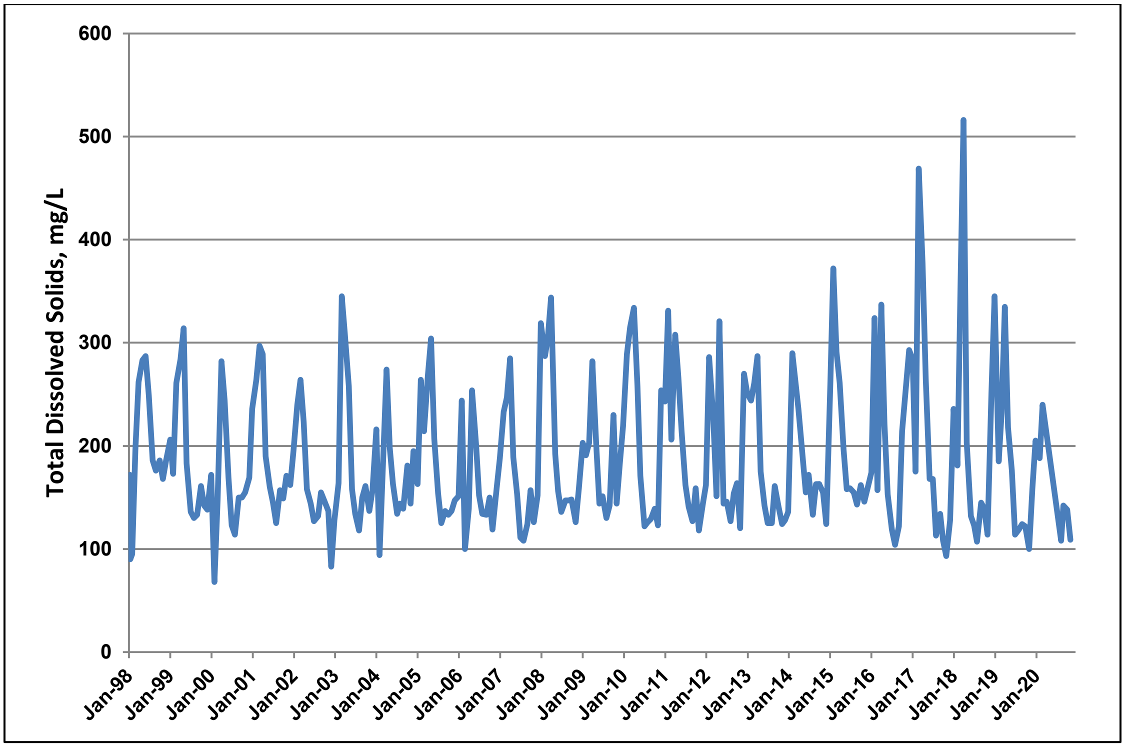
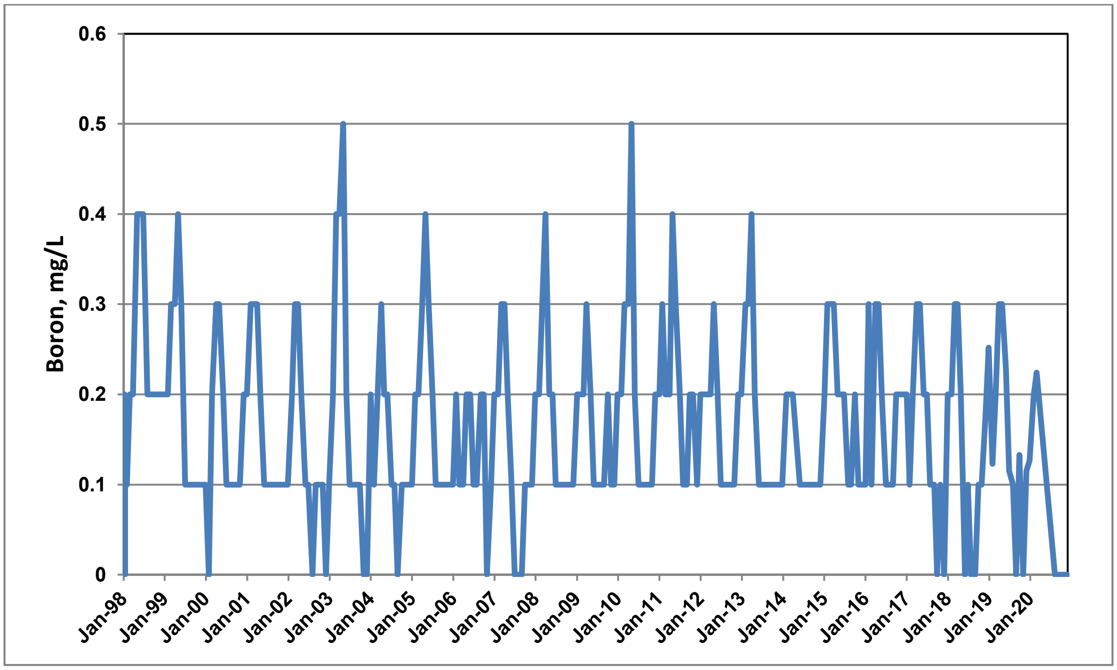


Figure 12-3. Boron at Barker Slough



Banks – **Figures 12-4 through Figure 12-7** shows grab sample data at Banks. **Figure 12-4** shows that sulfate never exceeded the monthly average water quality objective of 110 mg/L.

However, chloride exceeded the monthly average objective of 110 mg/L in many months. **Figure 12-5** shows that TDS exceeded the monthly average objective of 440 mg/L in February 2014 as well as from June to August 2015. **Figure 12-6** shows that boron never exceeded the monthly average objective of 0.6 mg/L, except for April 1998 when boron was measured at 1.2 mg/L. **Figure 12-7** shows that hardness never exceeded the monthly average objective of 180 mg/L.

The ten year averages (January 2011 to December 2020) were 236.9 mg/L for TDS, 75.4 mg/L for chloride, 30.7 mg/L for sulfate, and 90.1 mg/L for hardness, respectively. The ten-year average of 20 mg/L for sulfate was exceeded, as well as the ten-year averages for TDS and chloride.

Figure 12-4. Chloride and Sulfate at Banks

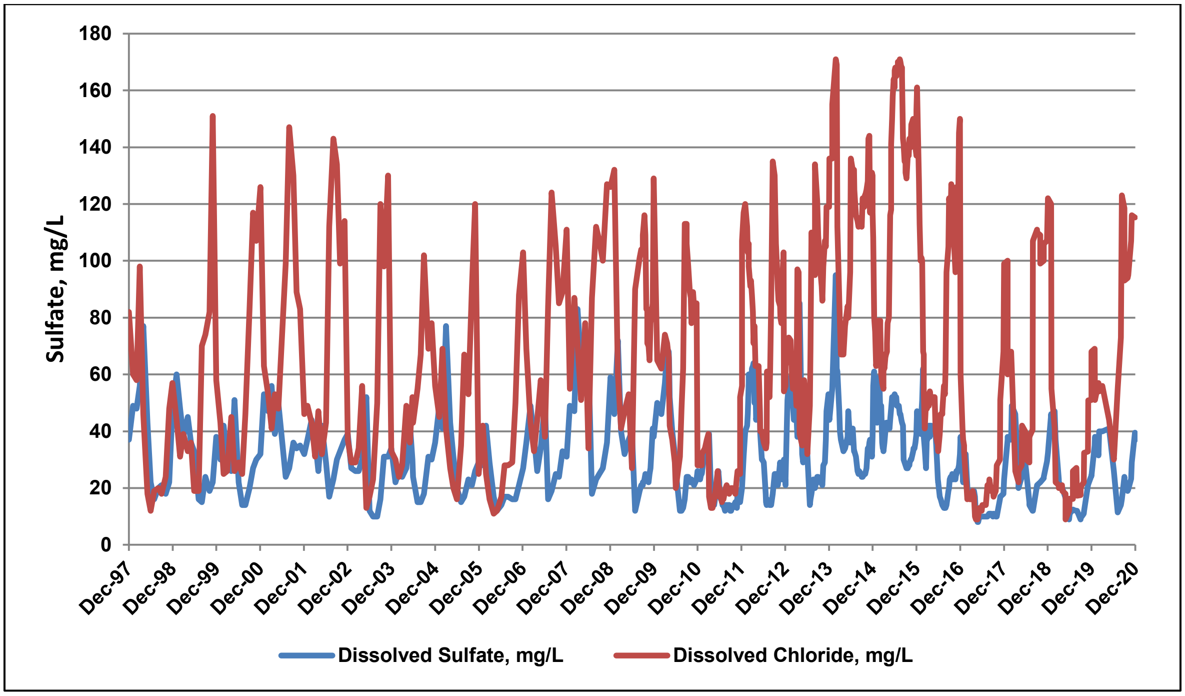


Figure 12-5. Total Dissolved Solids at Banks

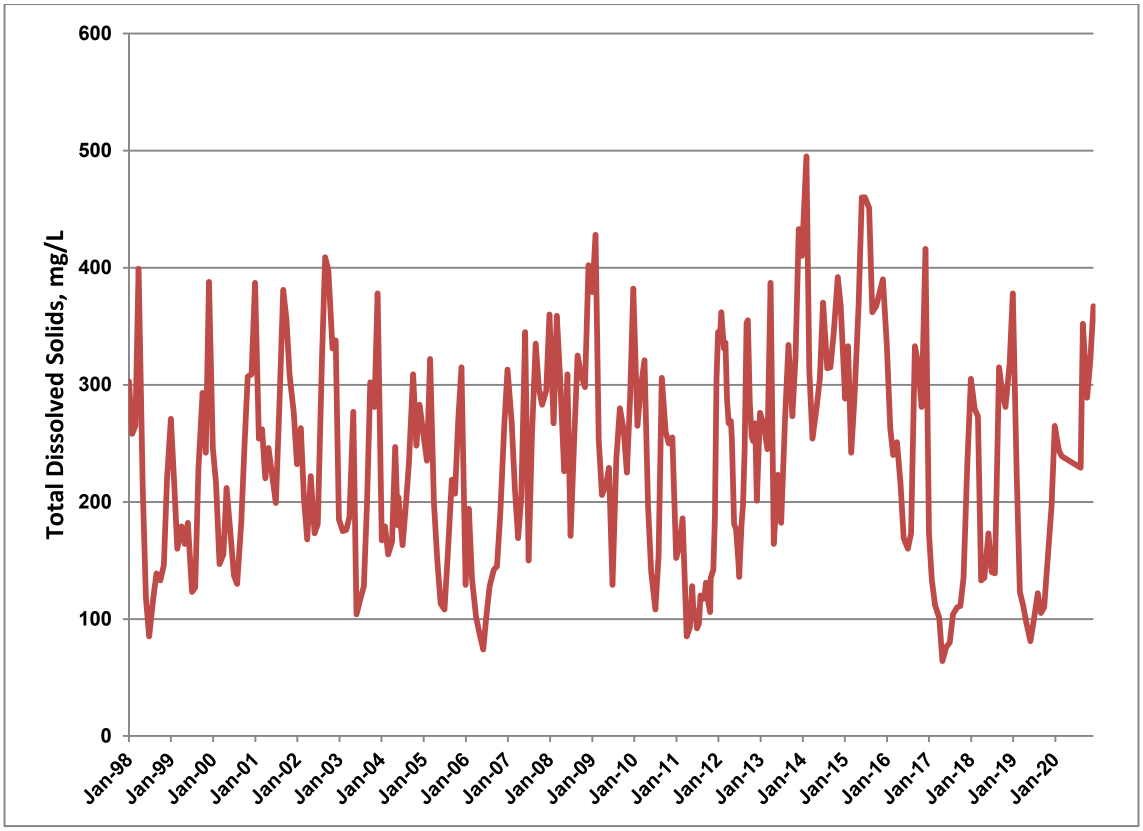


Figure 12-6. Boron at Banks

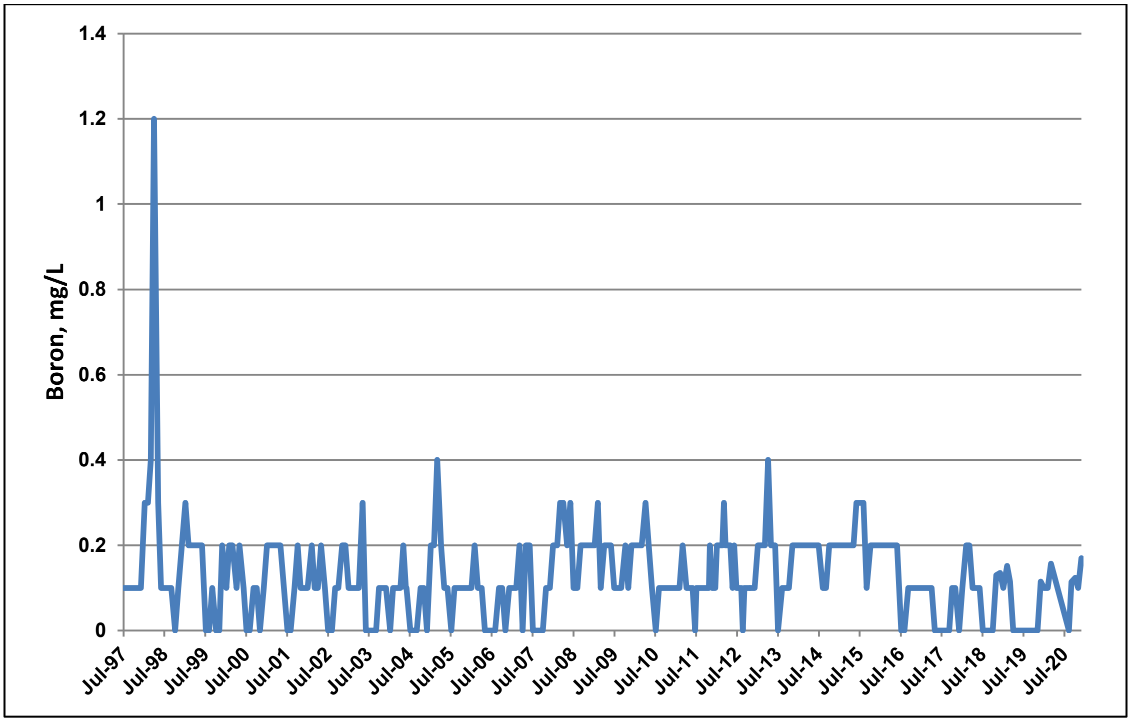
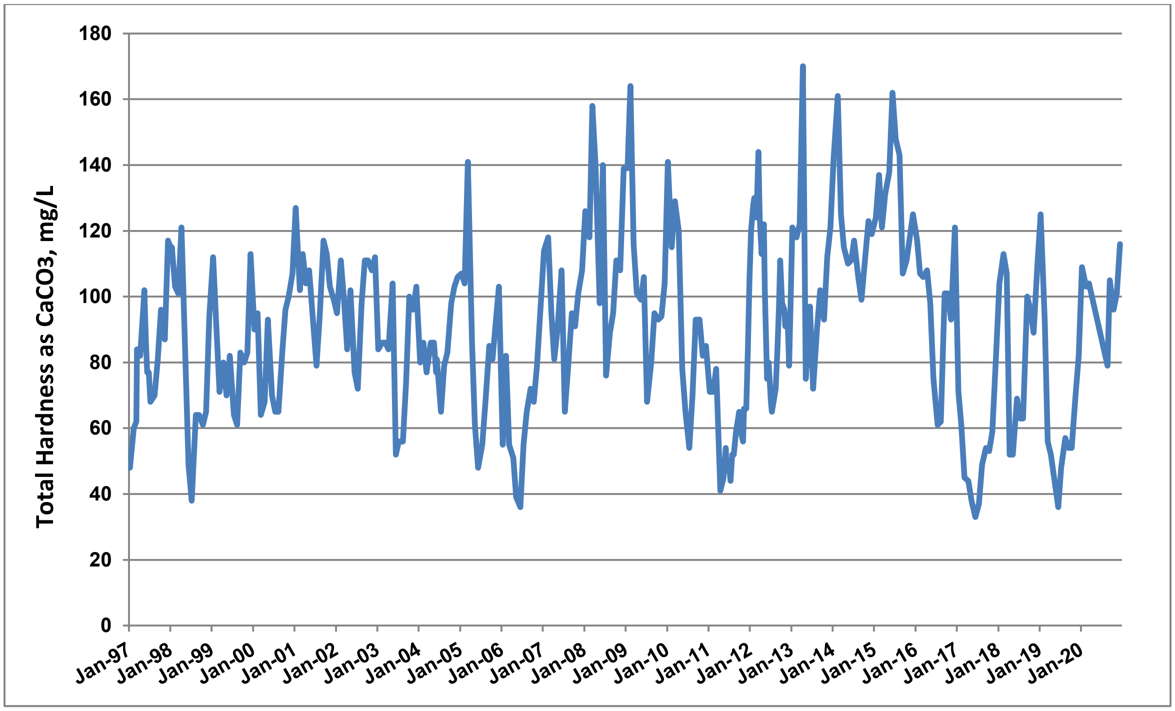


Figure 12-7. Hardness at Banks



***Del Valle Check** 7*– **Figures 12-8 through Figure 10-** shows grab sample data at Del Valle Check 7. **Figure 12-8** shows that sulfate never exceeded the monthly average water quality objective of 110 mg/L. However, hardness exceeded the monthly average objective of 180 mg/L in April 2013 and chloride exceeded the monthly average objective in many months. **Figure 12-9** shows that TDS exceeded the monthly average objective of 440 mg/L in February 2009, February 2014, as well as from June to August 2015. **Figure 12-10** shows that boron never exceeded the monthly average objective of 0.6 mg/L.

The ten year averages (January 2011 to December 2020) were 244.8 mg/L for TDS, 71.1 mg/L for chloride, 29.1 mg/L for sulfate, and 91.6 mg/L for hardness, respectively. The ten-year average of 20 mg/L for sulfate was exceeded, as well as the ten-year averages for TDS and chloride.

Figure 12-8. Chloride, Sulfate and Hardness at Del Valle Check 7

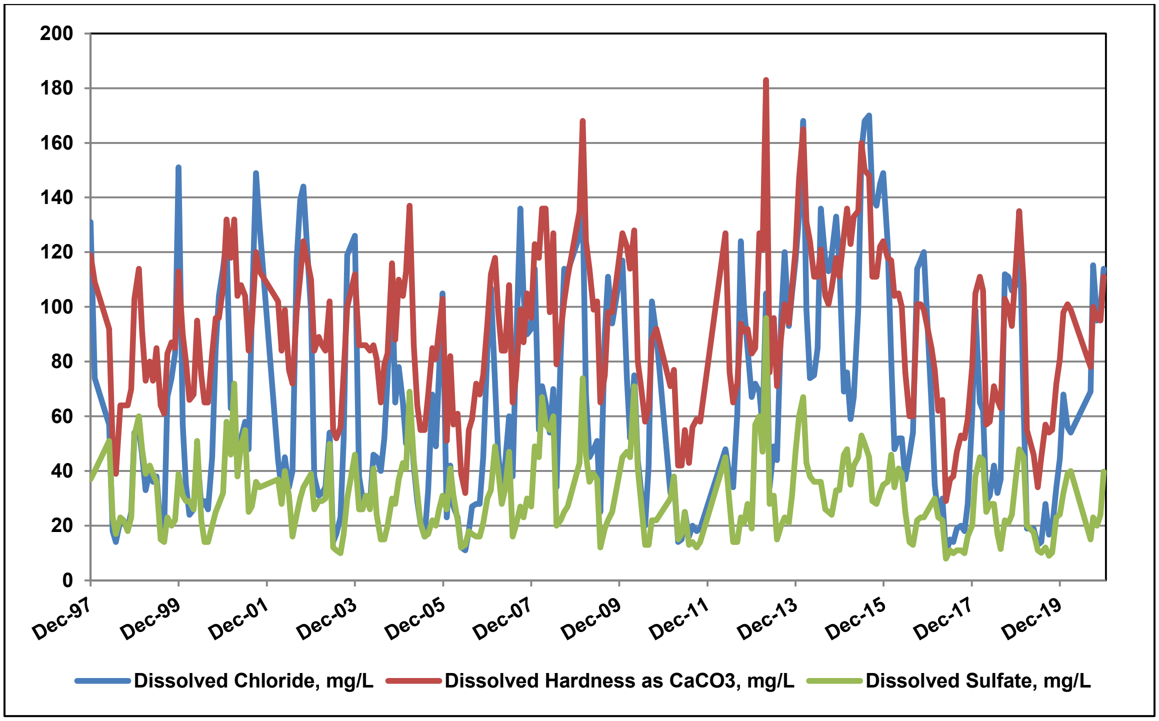


Figure 12-9. Total Dissolved Solids at Del Valle Check 7

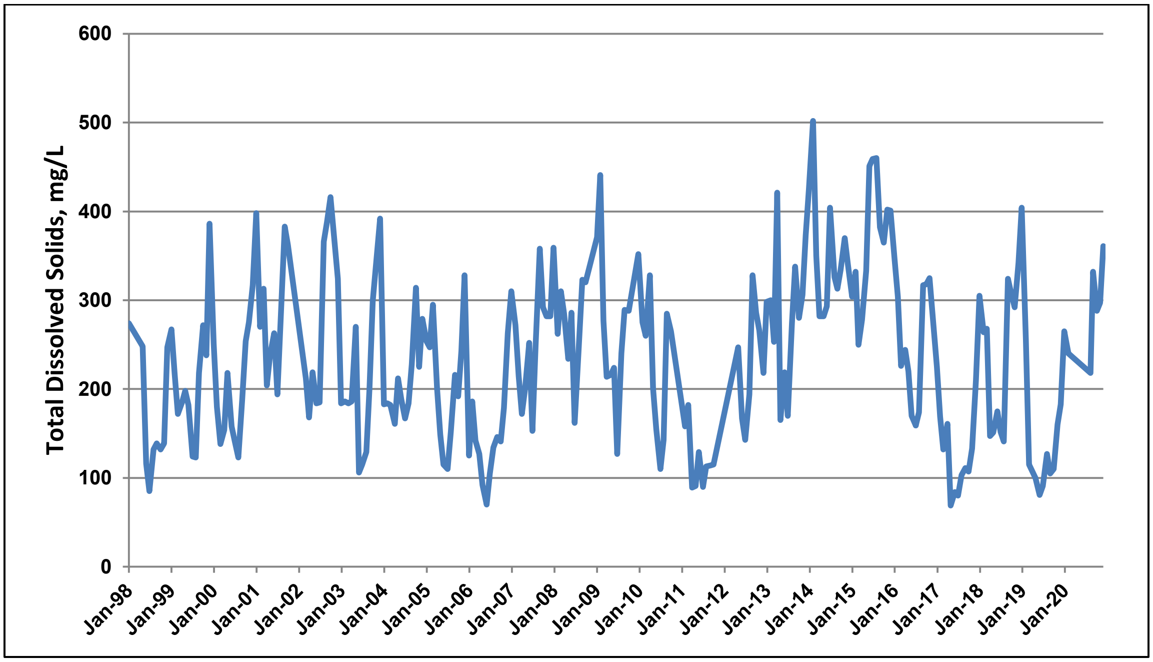
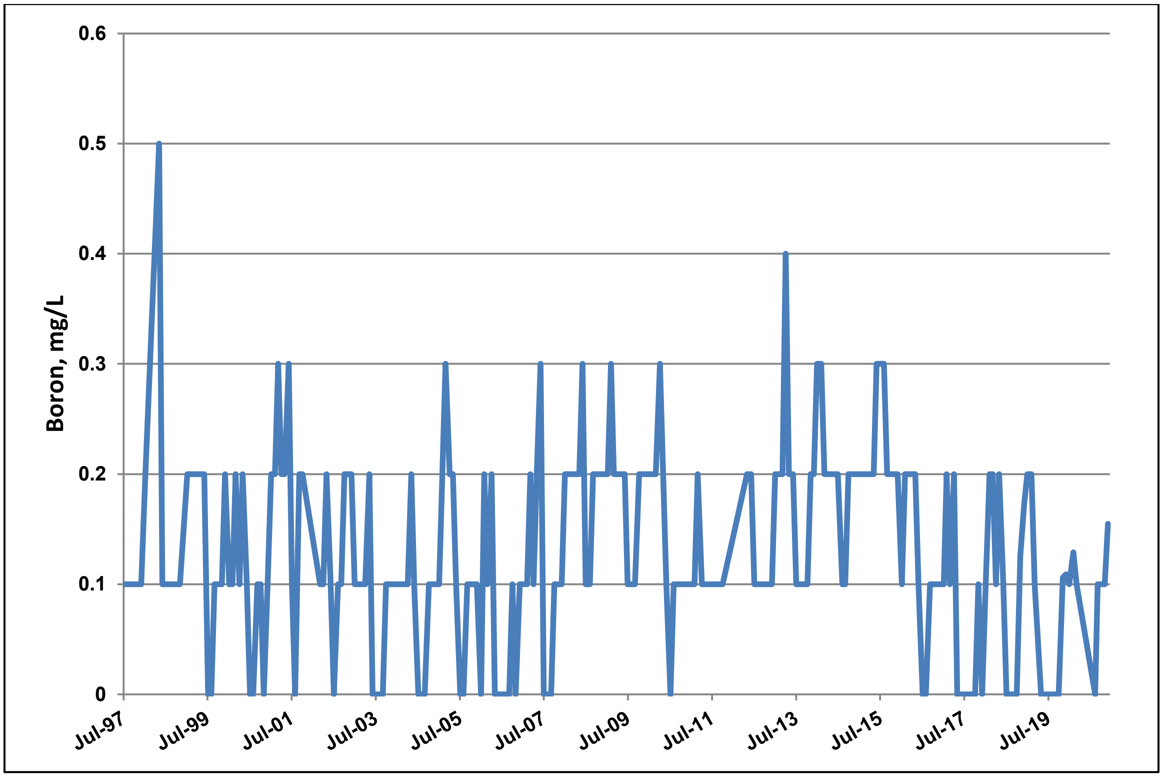


Figure 12-10. Boron at Del Valle Check 7



Pacheco– **Figures 12-11 through Figure 13-** shows grab sample data at Pacheco. **Figure 12-11** shows that sulfate and hardness never exceeded the monthly average water quality objective of 110 mg/L and 180 mg/L, respectively. However, chloride exceeded the monthly average objective in December 2014 and from October 2015 to March 2016. **Figure 12-12** shows that TDS never exceeded the monthly average objective of 440 mg/L and **Figure 12-13** shows that boron never exceeded the monthly average objective of 0.6 mg/L.

The ten year averages (January 2011 to December 2020) were 290.9 mg/L for TDS, 85.2 mg/L for chloride, 38.4 mg/L for sulfate, and 110.1 mg/L for hardness, respectively. The ten-year average of 20 mg/L for sulfate was exceeded, as well as the ten-year averages for TDS and chloride.

Figure 12-11. Chloride, Sulfate and Hardness at Pacheco

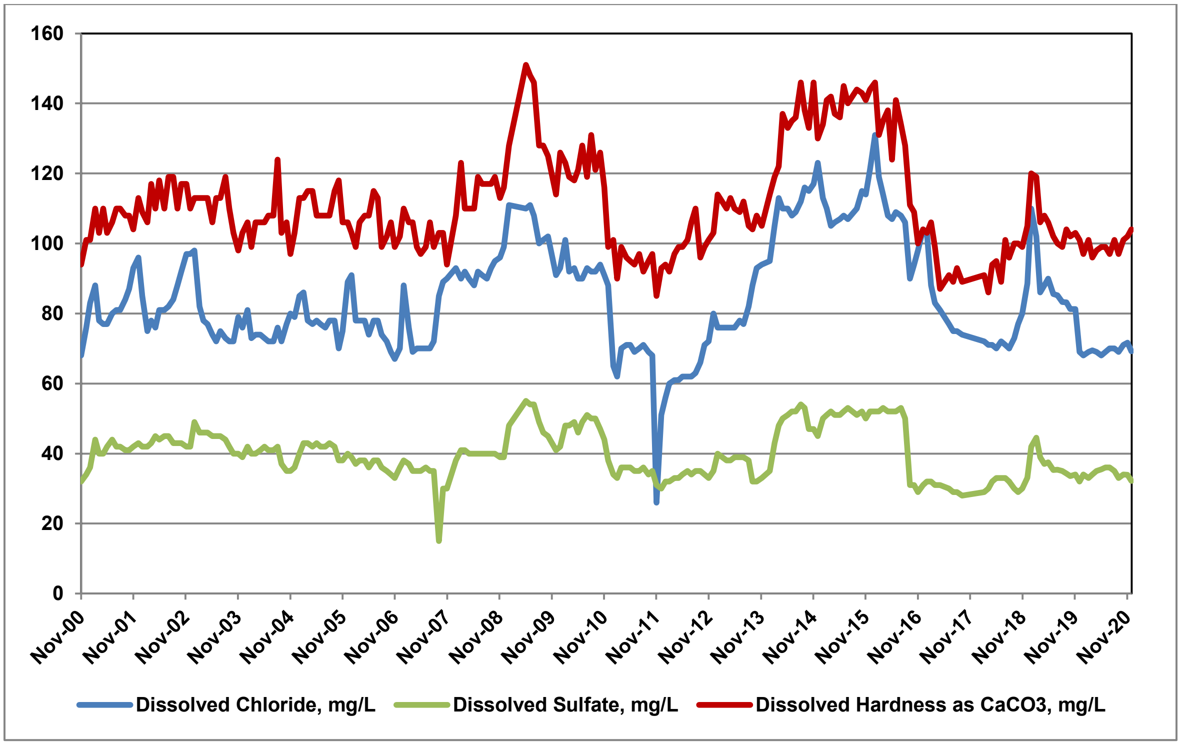


Figure 12-12. Total Dissolved Solids at Pacheco

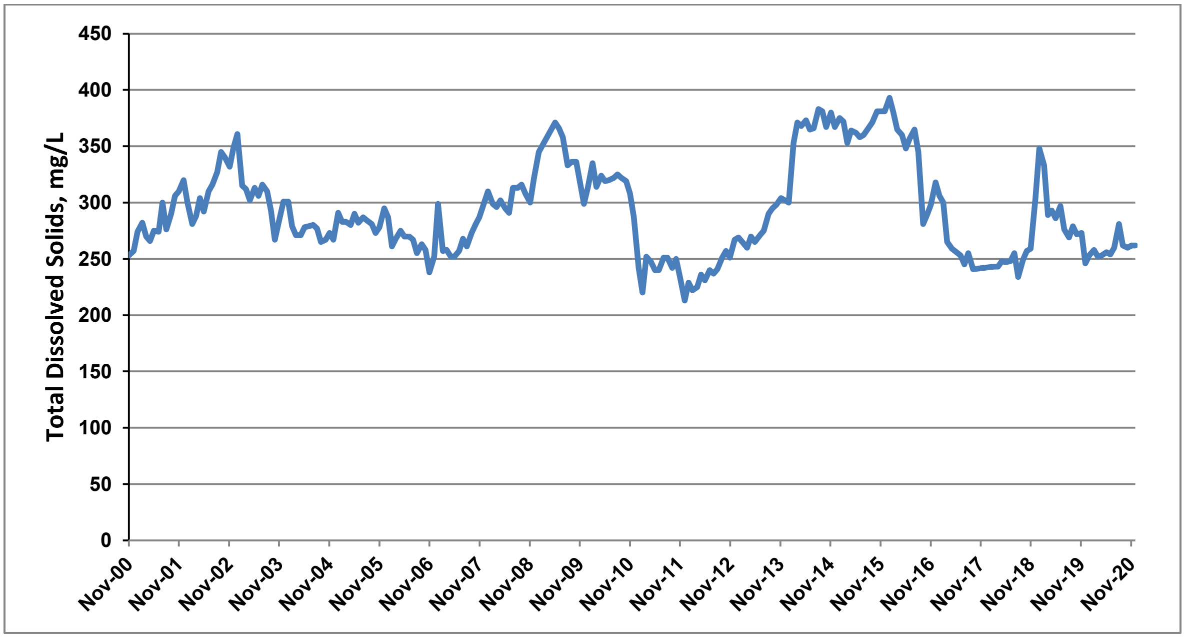
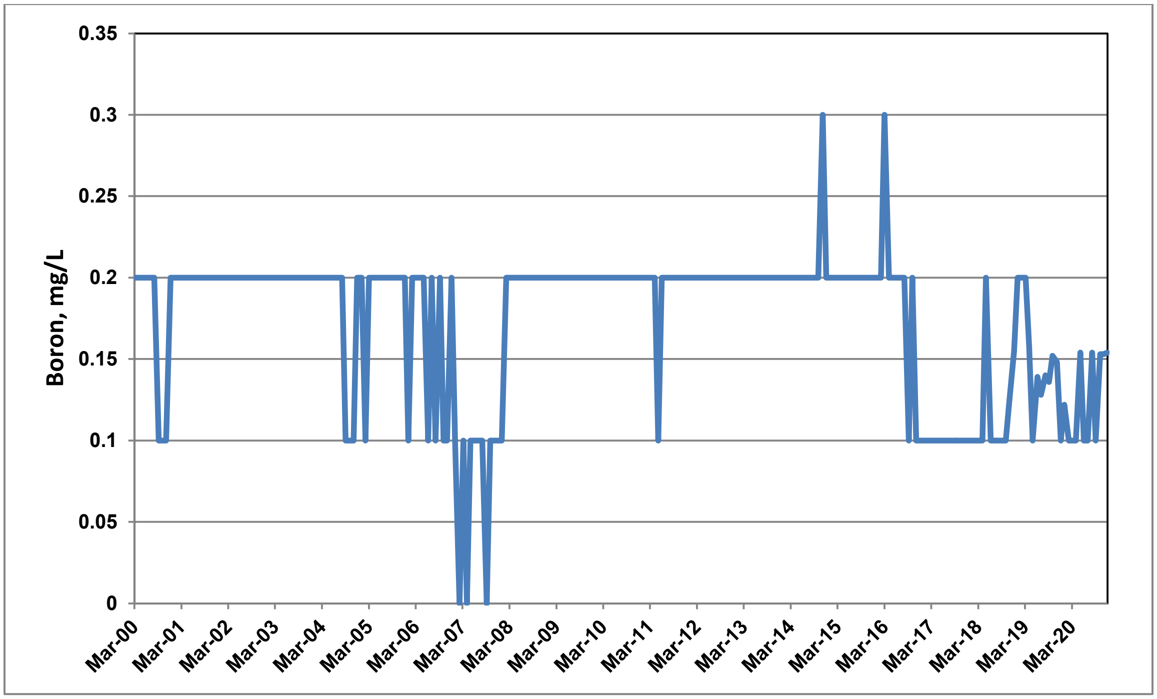


Figure 12-13. Boron at Pacheco



Check 13– **Figures 12-14 through Figure 16-** shows grab sample data at Check 13. **Figure 12-14** shows that sulfate and hardness never exceeded the monthly average water quality objective of 110 mg/L and 180 mg/L, respectively. However, chloride exceeded the monthly average objective of 110 mg/L for many months. **Figure 12-15** shows that TDS exceeded the monthly average objective of 440 mg/L in February 2014 and **Figure 12-16** shows that boron never exceeded the monthly average objective of 0.6 mg/L.

The ten year averages (January 2011 to December 2020) were 264.6 mg/L for TDS, 75.4 mg/L for chloride, 35.4 mg/L for sulfate, and 100.7 mg/L for hardness, respectively. The ten-year average of 20 mg/L for sulfate was exceeded, as well as the ten-year averages for TDS and chloride.

Figure 12-14. Chloride, Sulfate and Hardness at Check 13

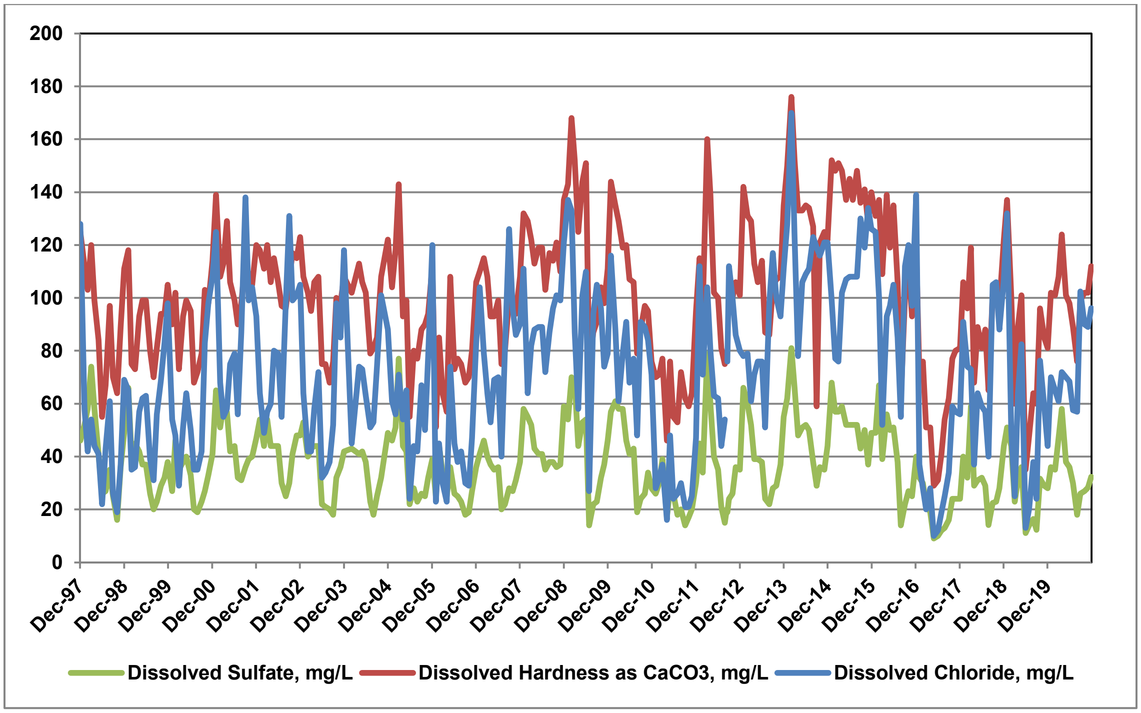


Figure 12-15. Total Dissolved Solids at Check 13

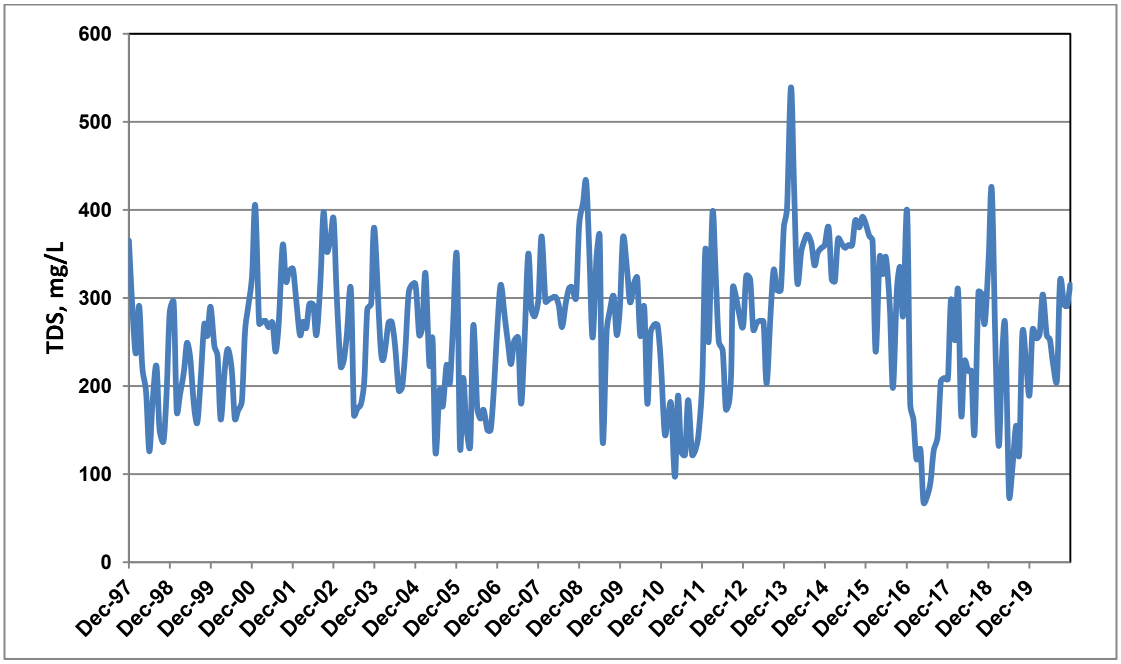
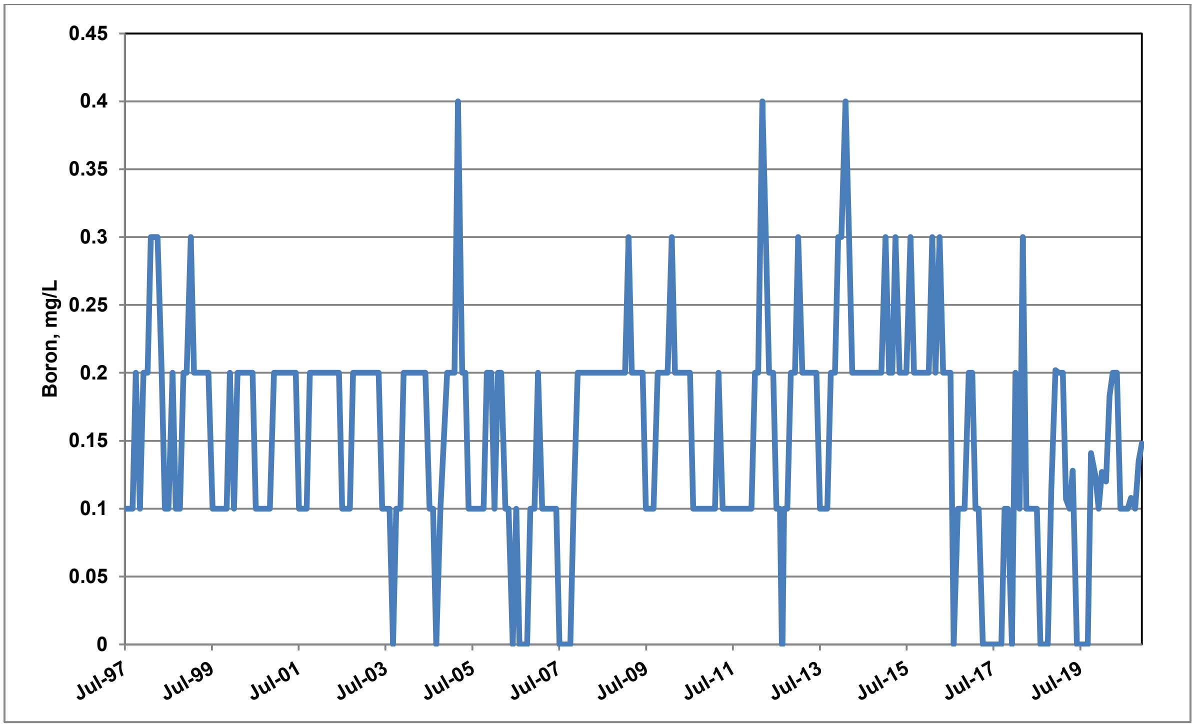


Figure 12-16. Boron at Check 13



SUMMARY FOR ARTICLE 19 CONSTITUENTS

- Monthly average water quality objectives for sulfate and boron were never exceeded during the past twenty years at Barker Slough, Banks, Del Valle Check 7, Pacheco and Check 13.
- In contrast, water quality objectives for chloride were exceeded in many months, with the exception of Barker Slough which had no exceedances.
- Over the past twenty years, monthly average water quality objectives for hardness were exceeded at Barker Slough three times, once at Del Valle Check 7 and never at Banks, Pacheco, and Check 13.
- Over the past twenty years, monthly average water quality objectives for TDS were exceeded at Barker Slough twice, four times at Banks, five times at Del Valle Check 7, once at Check 13 and never at Pacheco. Except for Barker Slough, the TDS exceedances occurred in the drought years of 2014 and 2015. Water at Barker Slough is influenced by the local watershed, which contains saline soils, and therefore high TDS occurred in wet years of 2017 or spring runoff.
- The ten year average (January 2011 to December 2020) water quality objectives were exceeded for TDS, sulfate and chloride at Banks, Del Valle Check 7, Pacheco and Check 13.
- Pacheco had the highest 10-year averages for TDS, sulfate, chloride and hardness.

WATER QUALITY CONCERN – ALKALINITY

The Stage 1 Disinfection/Disinfection By-Product (D/DBP) Rule sets a treatment technology for DBP precursor removal (enhanced coagulation) based on source water total organic carbon (TOC) levels and source water alkalinity levels as shown in **Table 12-2.** For sources with TOC between 2 mg/L and 4 mg/L and alkalinity above 60 mg/L, 25 percent TOC removal is required. For sources with TOC between 2 mg/L and 4 mg/L and alkalinity below 60 mg/L, 35 percent TOC removal is required. For sources with TOC between 4 and 8 mg/L and alkalinity below 60 mg/L, 45 percent TOC removal is required. Due to the increased amount of TOC removal required with source water alkalinity levels below 60 mg/L, many contractors have an internal trigger when total alkalinity is below 60 mg/L. The focus of this discussion is to highlight the occurrence of low alkalinity in SWP waters, and the resultant impact on the water treatment plants.

Table 12-2. TOC Enhanced Coagulation Removal Requirements (Percent)

	Alkalinity, mg/L as $CaCO_3$		
TOC, mg/L	0 – 60	> 60 – 120	> 120
> 2.0 - 4.0	35	25	15
> 4.0 - 8.0	45	35	25
> 8.0	50	40	30

WATER QUALITY EVALUATION

Figures 12-17 through **12-22** provide alkalinity data for the complete period of record for the following locations: Barker Slough, Banks, DV Check 7, Pacheco, Check 13 and Devil Canyon. As shown in the figures, alkalinity is greatly influenced by hydrology, as low alkalinities in SWP source waters occurred in the wet years such as 2017 and 2019. The exception to this is the Barker Slough location, as the local soils in the watershed are highly mineralized and cause alkalinity to increase in wet years.

Banks, Del Valle Check 7 and Check 13 follow the same general trends over time. However, the median and average at Check 13 are slightly higher compared to Banks and DV Check 7. This could be because Check 13 water quality is impacted from releases from San Luis Reservoir and flows from the Delta Mendota Canal.

As expected, reservoir locations such Pacheco at San Luis Reservoir have more buffering capacity and therefore alkalinity levels are more stable. Although Lake Silverwood and Devil Canyon are located at the terminus reservoir of the East Branch, it is much smaller in volume compared to San Luis Reservoir and more closely reflects current hydrologic conditions.

Table 12-3. Average, Median and 95th percentiles for Total Alkalinity, 2016 to 2020

Location	**Average, mg/L**	**Median, mg/L**	**95th Percentile, mg/L**
Barker Slough	97.7	87	156.3
Banks	59.1	60	81.3

Location	Average, mg/L	Median, mg/L	95th Percentile, mg/L
DV Check 7	61	62.5	81
Pacheco	74.7	74	89.6
Check 13	66.3	69	86
Devil Canyon	66.9	6.95	82.3

Figure 12-17. Total Alkalinity at Barker Slough

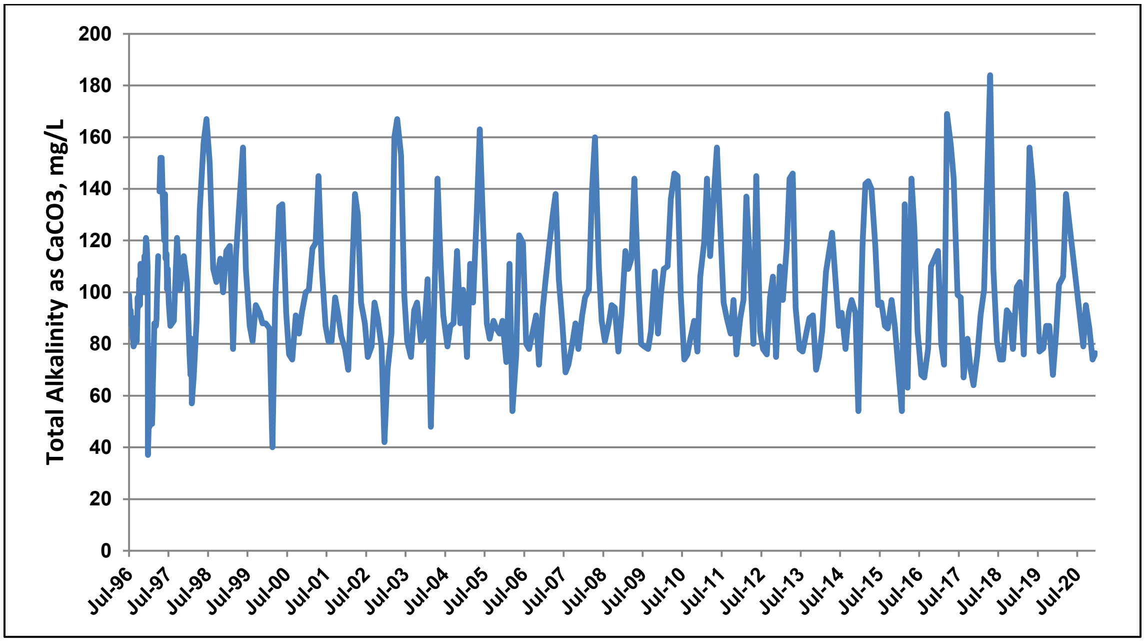


Figure 12-18. Total Alkalinity at Banks

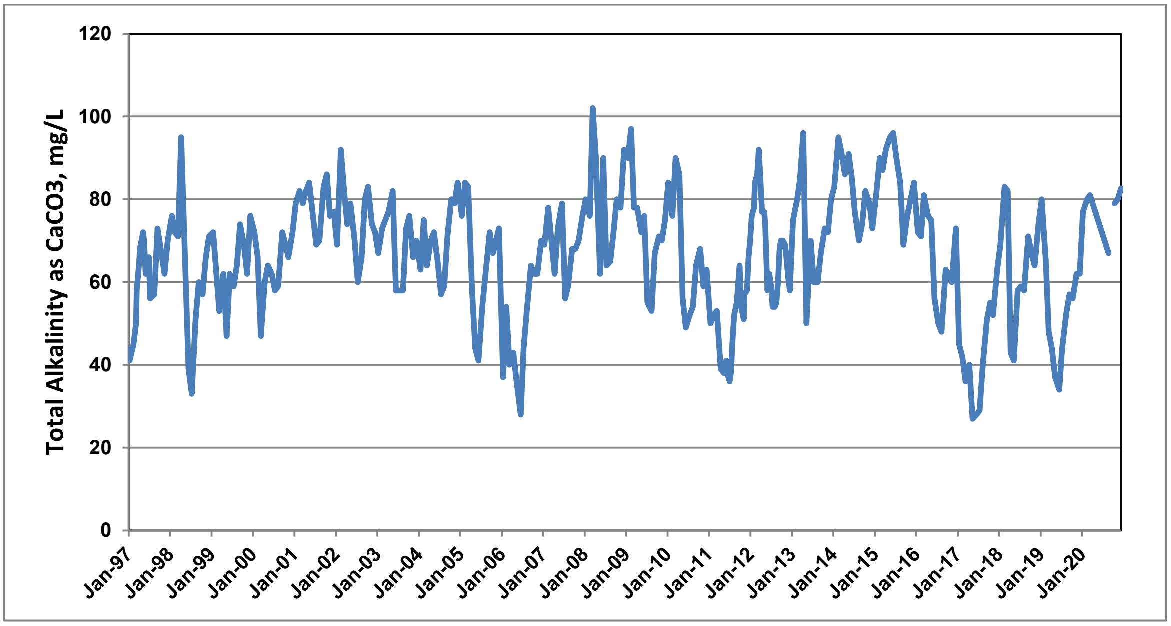


Figure 12-19. Total Alkalinity at Del Valle Check 7

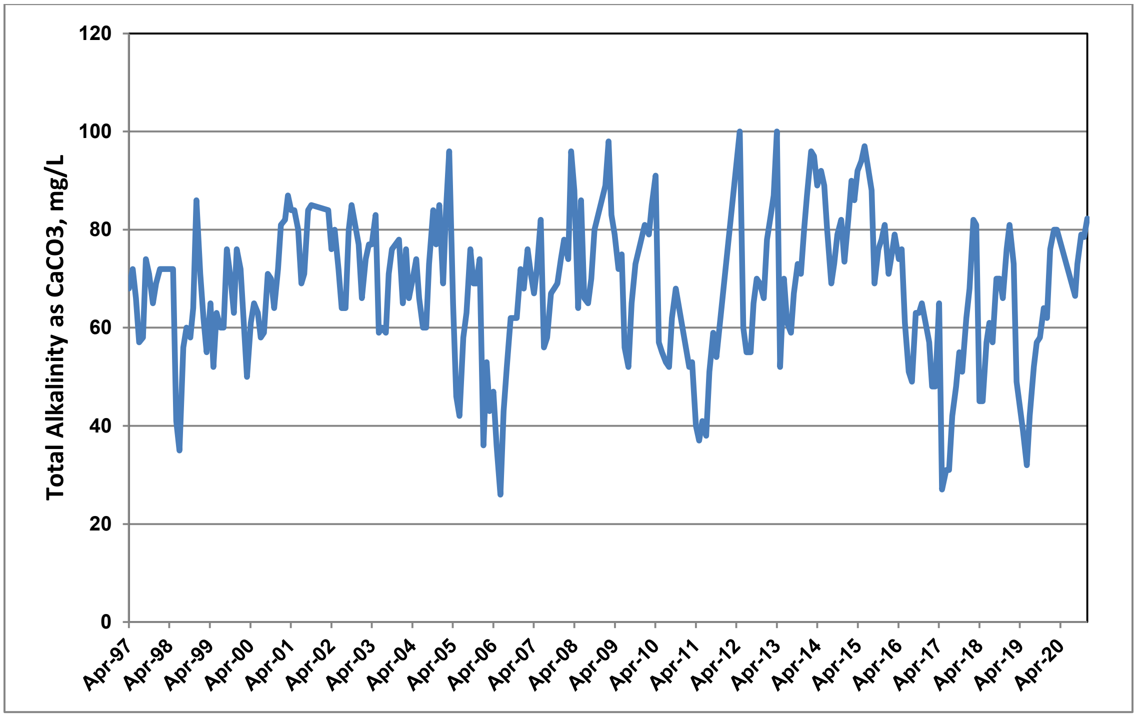


Figure 12-20. Total Alkalinity at Pacheco

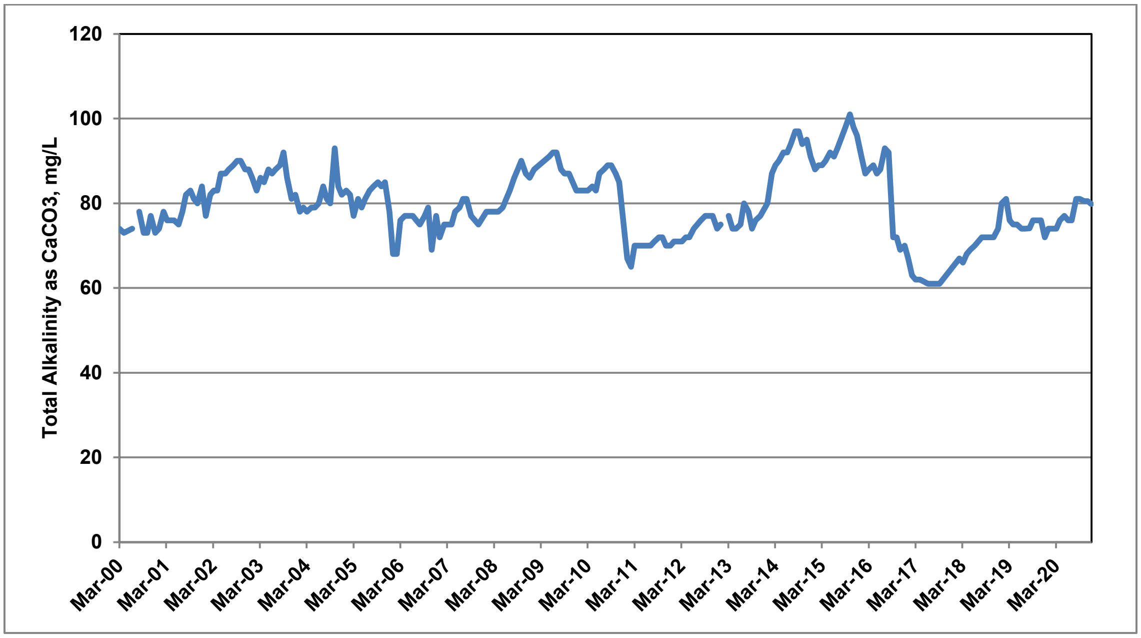


Figure 12-21. Total Alkalinity at Check 13

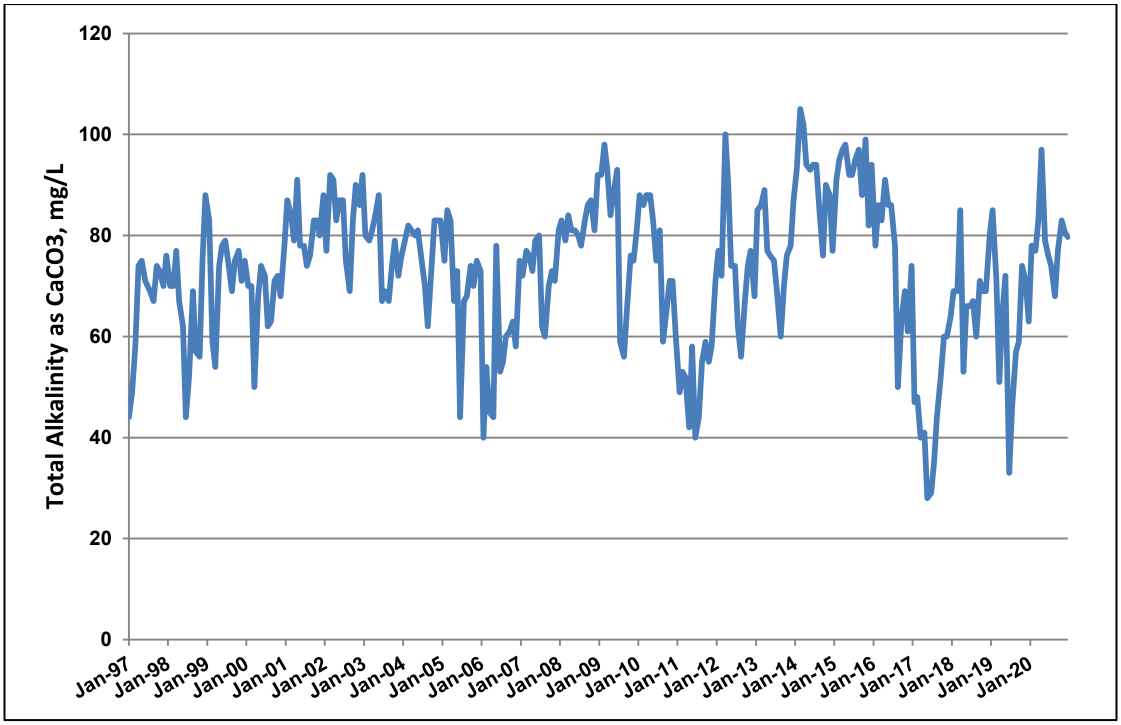
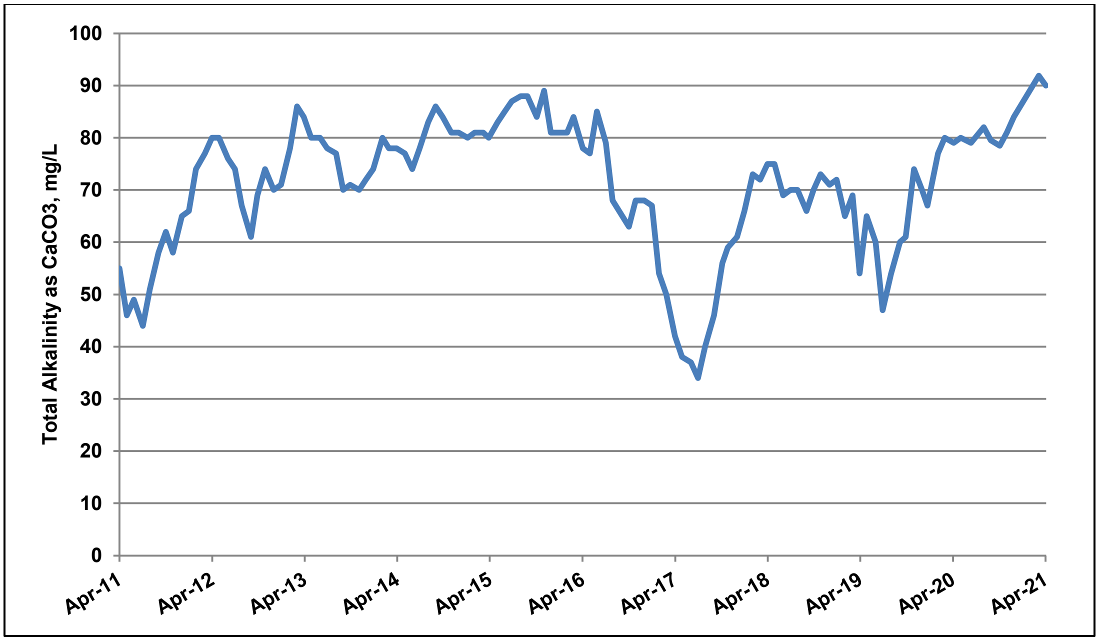


Figure 12-22. Total Alkalinity at Devil Canyon



Note: Samples collected at Second Afterbay location since 2011

As stated earlier, many contractors have an internal trigger when total alkalinity is either below 60 mg/L or above 120 mg/L, as this changes the percent TOC removal required for enhanced coagulation under the Stage 1 D/DBP Rule. Low alkalinity also impacts the effectiveness of the coagulation process during water treatment. The following discussion focuses on alkalinity during the 2016 to 2020 time period.

- From 2016 to 2020, alkalinity was never lower than 60 mg/L at Pacheco and only during the month of January 2016 at Barker Slough. However, alkalinity was above 120 mg/L at Barker Slough 20% of the time from 2016 to 2020.

- From 2016 to 2020, 51% of the time total alkalinity was 60 mg/L or less at Banks.

- From 2016 to 2020, 44% of the time total alkalinity was 60 mg/L or less at DV Check 7. Low alkalinities were particularly challenging as total alkalinity was less than 60 mg/L for seven consecutive months in 2017 (May through November) and six consecutive months in 2019 (March through October). Valley Water had challenges with respect to coagulation and TOC removal during low alkalinity periods. Zone 7 Water Agency had to limit the coagulant dosage at both water treatment plants, and although TOC removal was met, filter performance was negatively impacted and more filter backwashes were required. During these periods of low alkalinity, the SBA contractors had to coordinate unplanned releases with DWR from Lake Del Valle to increase source water alkalinity.

- From 2016 to 2020, 31% of the time total alkalinity was 60 mg/L or less at Check 13. In 2017, there were nine consecutive months, from January to September, when alkalinity was 60 mg/L or less.

- From 2016 to 2020, 25% of the time total alkalinity was 60 mg/L or less at Devil Canyon, however low alkalinities were particularly challenging as there were six consecutive months of low alkalinity from April to September 2017. Downstream users raised the pH to ensure the finished water was stabilized or non-corrosive due to the low alkalinity. Additionally, the low alkalinity water also raised the regulatory requirement for total organic carbon removal, which resulted in higher coagulant dosages than usual.

SUMMARY FOR ALKALINITY

- Alkalinity is greatly influenced by hydrology, as low alkalinities in SWP source waters occurred in the wet years such as 2017 and 2019. The exception to this is the Barker Slough location, as the local soils in the watershed are highly mineralized and cause alkalinity to increase in wet years.

- Low alkalinities present treatment challenges for contractors treating SWP.

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CHAPTER 13A WILDFIRES IN SWP WATERSHEDS

CONTENTS

FIGURES

TABLES

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CHAPTER 13A WILDFIRES IN SWP WATERSHEDS

BACKGROUND/WATER QUALITY CONCERN

Wildfires can cause drastic changes to landscape and vegetation, which may alter the water quality of surrounding streams, rivers, and lakes within a burned watershed, and potentially cause changes to influent water quality for drinking water providers. Increased erosion due to the destabilization of hillslopes following wildfire can result in higher particulate matter mobilized to streams. Subsequent precipitation events can also lead to the transport of ash, charred biomass and sediments. High particulate loads in source waters can cause an assortment of drinking water treatment (e.g. coagulation, disinfection) and infrastructure problems (e.g. pipeline clogging, reservoir dredging).

Since erosion is the key concern associated with wildfires, turbidity, organic carbon, nutrients, and total dissolved solids are the key constituents of concern. In addition to these, it is possible that the increased soil erosion in the Sacramento River watershed could also increase the levels of metals (such as aluminum, iron, and manganese) and possibly organic compounds (such as pesticides) in the source water. A recent study shows that in burn areas that runoff has higher rates of dissolved organic carbon due to transformation of carbon compounds[1]. Results from Water Research Foundation study (4590) found that the heating of soil and litter can alter the organic matter, resulting in a lower molecular weight dissolved organic matter (DOM) composition, which is harder to coagulate. The study concluded that higher coagulant doses would need to be applied to achieve desired finished water turbidity and total organic carbon (TOC) removal. The study also concluded that the utilities will likely experience the greatest treatment challenges immediately following a wildfire and subsequent flow events.

Depending on their use and proximity to water bodies, retardants may result in water quality impacts since they contain active ingredients. As the wildland/urban interface continues to expand there is increased potential for wildfires to involve residential and commercial facilities as well. This would increase the exposure to a wider array of potential contaminants.

2020 WILDFIRES - SCU COMPLEX FIRE

The Santa Clara Unit (SCU) Lighting Complex Fire began on August 18, 2020 and was contained on October 1, 2020. Approximately 396,624 acres were burned, portions of which occurred in the Lake Del Valle watershed as shown in **Figure 13A-1.** The SCU Complex fire was comprised of approximately 20 separate fires that burned across multiple locations of the Diablo Mountain Range in Alameda, Contra Costa, San Joaquin, Santa Clara and Stanislaus counties.

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[1] Hohner, Summers, Rosario-Ortiz. Laboratory simulation of postfire effects on conventional drinking water treatment and disinfection byproduct formation. AWWA WaterScience. 2019, e1155.

Figure 13A-1. SCU Fire Perimeter and SWP Water Bodies Affected

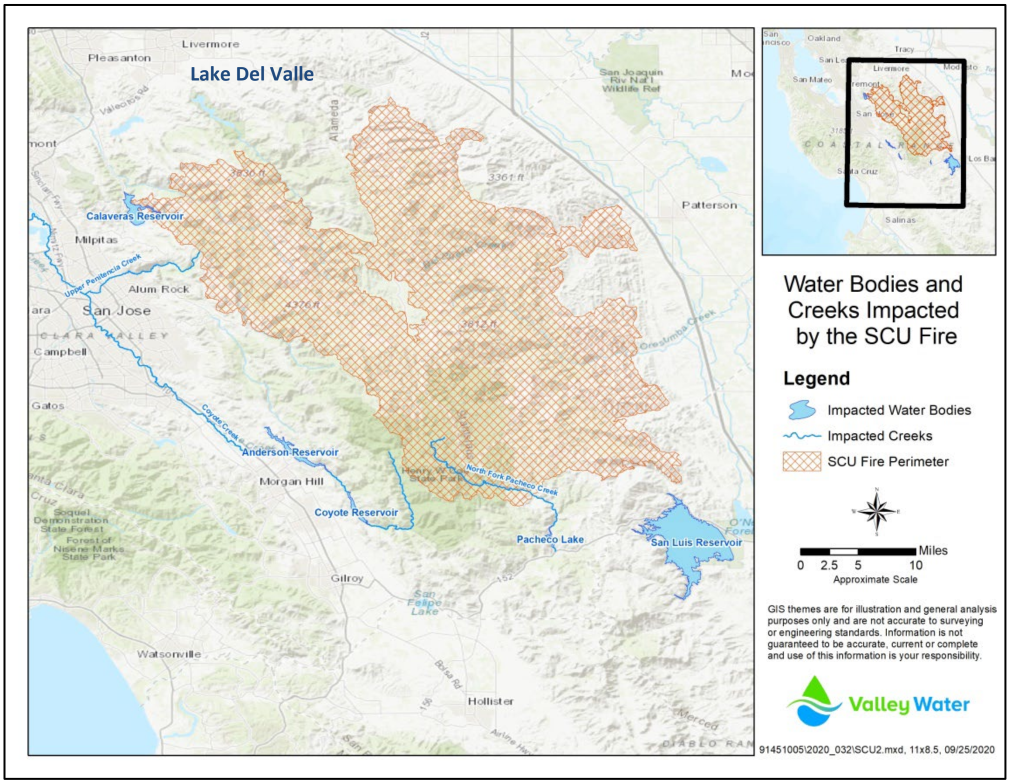


Figure 13A-2 shows that fifty-eight percent of the Arroyo Valle watershed upstream of Lake Del Valle was impacted by the SCU Fire. The SCU Fire also burned in the San Luis Reservoir watershed, but this subwatershed drains east and away from the San Luis Reservoir and therefore has no impact.

For the Arroyo Valle watershed, post-fire water quality monitoring focused on impacts to the South Bay Water Contractors and Lake Del Valle. Impacts to the South Bay Water Contractors will be assessed by collecting monthly samples at the Del Valle Conservation Outlet Works during periods when water is being released from the lake.

Impacts to Lake Del Valle were assessed by sampling inflows to the lake (Arroyo Valle) during storms or periods of significant runoff. As shown in **Figure 13A-3**, although samples were collected on January 29, March 10 and April 29, 2021, flow was lower in March and April and these samples likely do not represent post-fire runoff. However the first inflow sample on January 29, 2021 was collected near the peak flow for the first flush of the year, and is likely a better representation of post-fire first flush impacts to Lake Del Valle. Samples were collected for nutrients, metals, cations, anions, solids, polyaromatic hydrocarbons (PAHs) and sediment. **Table 13A-1** shows a summary of selected analytes which showed higher levels in the post-fire runoff sample collected on January 29. There were also low levels of benzaldehyde, benzoic acid, and benzyl alcohol (less than 1 μg/L) in the January 29 sample.

Figure 13A-2. SCU Fire Perimeter Within Arroyo Valle (Lake Del Valle) Watershed

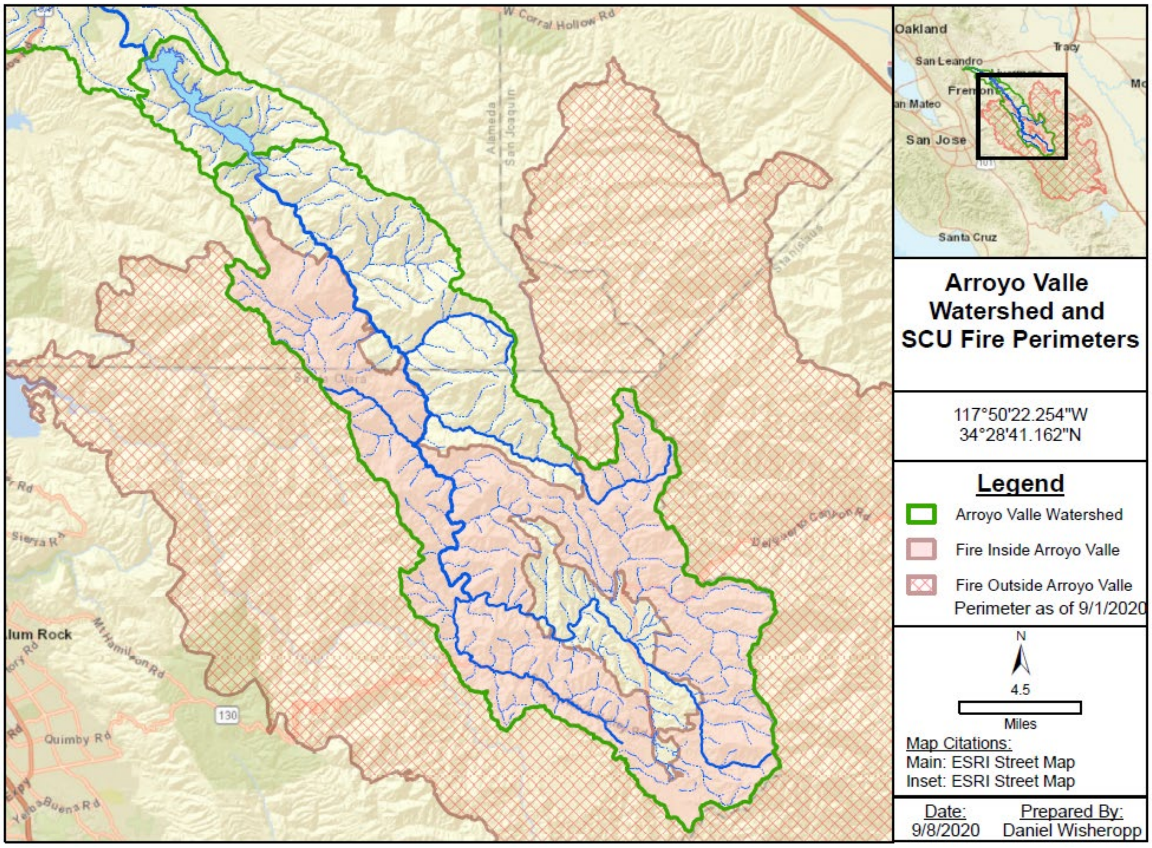
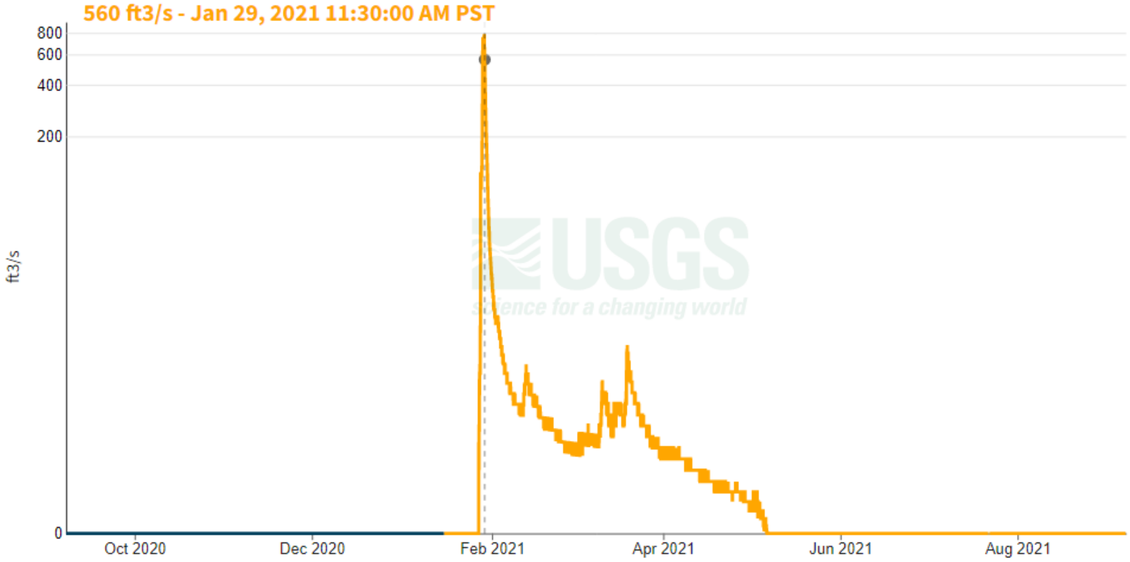


Figure 13A-3. Streamflow at USGS Gauge (11176400) Arroyo Valle, cfs



Source:https://waterdata.usgs.gov/monitoring-location/11176400/#parameterCode=00065&period=P365D

Table 13A-1. 2021 Post-fire monitoring at Arroyo Valle, µg/L

	1/29/2021	3/10/2021	4/29/2021
Aluminum, total	4,700	12.9	20.4
Arsenic, total	2.4	<1	<1
Chromium, total	17	1.35	1.62
Iron, total	4,200	19.1	49.5
Manganese, total	140	<5	10.7
TOC	11	2.8	2.7
Strontium, µg/L	510	Not collected	Not collected
Turbidity, NTU	116.5	0.6	0.5
Phosphorus, mg/L	0.34	0.014	0.057

2020 WILDFIRES - NORTH COMPLEX FIRE

The North Complex Fire began by lightning on August 17, 2020 and was contained on December 3, 2020. Approximately 327,859 acres were burned, which represents 14 percent of the Lake Oroville watershed, as shown in **Figure 13A-4.**

Impacts to Lake Oroville will be assessed by DWR by collecting samples at four sites: dam site (main body of lake) and the three arms which are the North Fork, Middle Fork and South Fork, shown in **Figure 13A-4** as DWR sampling sites. Samples were collected monthly from November 2020 to spring 2021 and will continue for the foreseeable future. Samples were tested for nutrients, metals, cations, anions, TOC, DOC, total suspended solids, and volatile suspended solids. Additionally, continuous water quality data (turbidity, temperature, EC, DO, pH) were collected using YSI EXO sondes at three sites: dam site, Thermalito Diversion Pool downstream from Emergency Spillway, Thermalito Diversion Dam.

The Central Valley Regional Water Quality Control Board also conducted post-fire watershed monitoring at six locations within the Lake Oroville watershed, shown in **Figure 13A-4** as NC1 through NC6.

Samples were collected by the Central Valley Regional Water Quality Control Board on November 19 and December 16 2020, as well as January 19, February 17, March 16 and April 22, 2021. Samples were collected for nutrients, minerals, bacteria, TOC, metals and polyaromatic hydrocarbons (PAHs), which are a byproduct of combustion. A full set of data collected for each sampling date is included in **Appendix 13A-1.**

Overall, minerals and nutrients were low. Metals had the highest concentrations, particularly at the Berry Creek (NC 2) location. As shown in **Figure 13A-5**, the primary drinking water maximum contaminant level (MCL) for aluminum was exceeded in the post-fire runoff at Berry Creek. Secondary MCLs were also exceeded for iron and manganese. There is no MCL for

TOC, but TOC is of concern as a disinfection-byproduct precursor, and TOC was included for evaluation. **Figure 13A-5** also shows the gradual decline in concentrations over time.

Although elevated levels for aluminum, iron and manganese were present at Berry Creek, levels in water leaving Lake Oroville at Thermolito Diversion did not exceed any primary or secondary MCLs, as shown in **Figure 13A-6**. Although DWR collected water samples at the North Fork, Middle Fork, and South Fork, the water quality leaving Lake Oroville is best represented by data collected at the Thermolito Diversion **(Figure 13A-6).**

Figure 13A-5. Elevated Constituents in Berry Creek after North Complex Fire

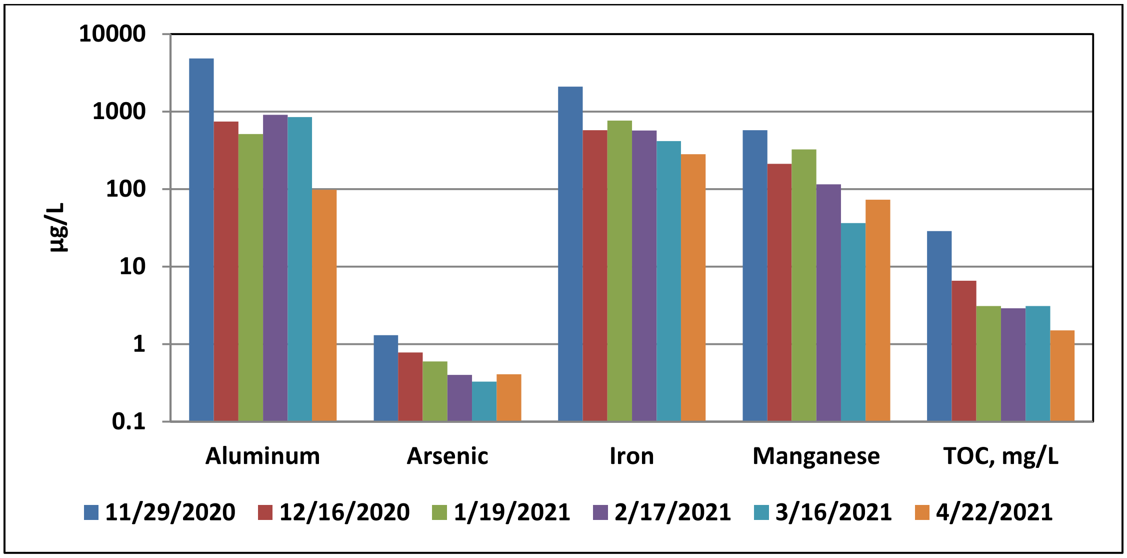


Figure 13A-6. Selected Constituents at Thermolito Diversion after North Complex Fire

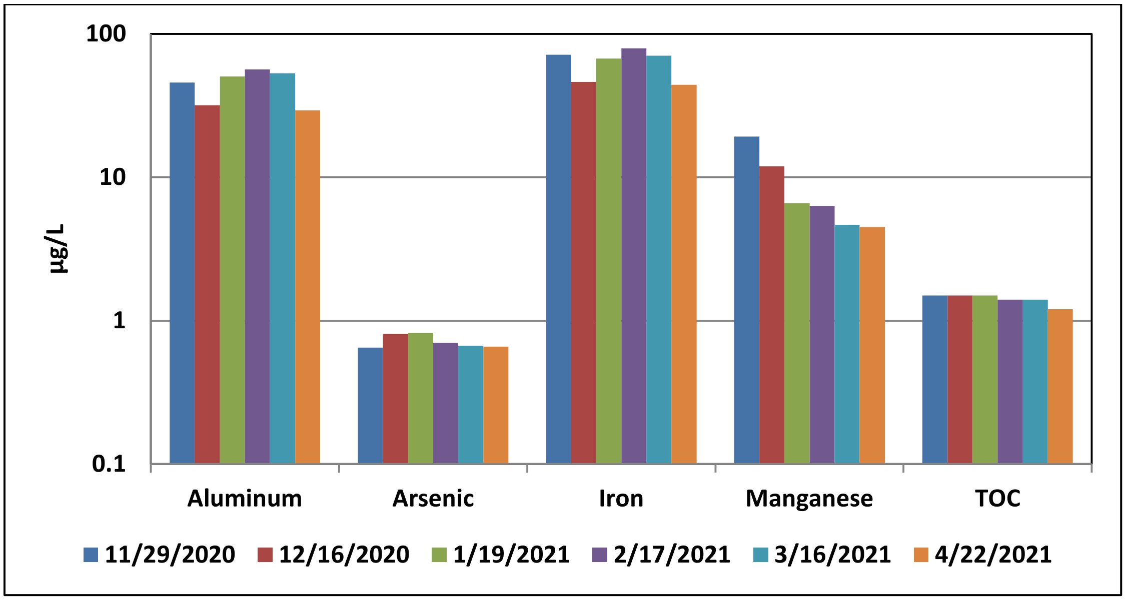
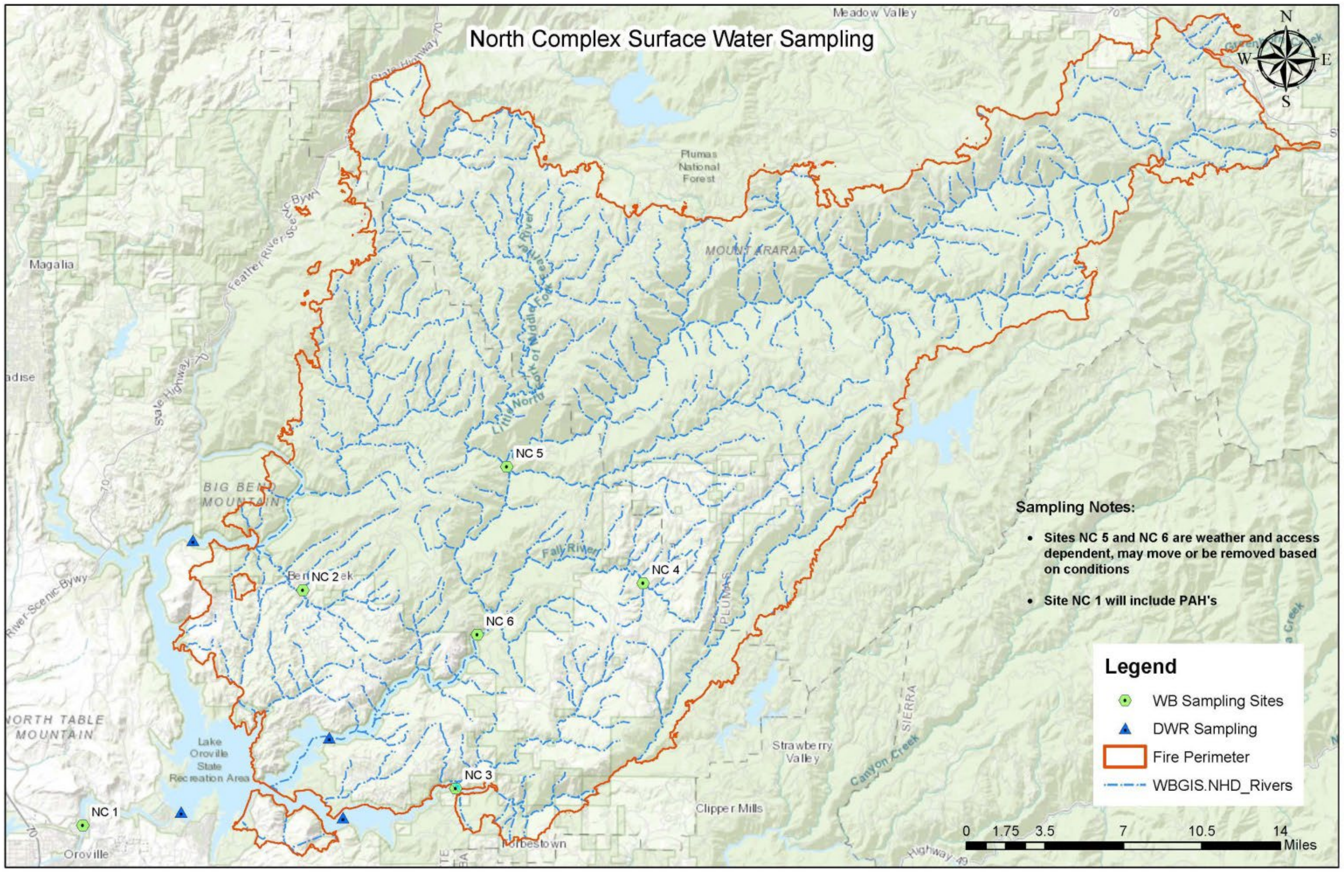


Figure 13A-4. North Complex Lightning Fire



Sampling Notes:

- **Sites NC 5 and NC 6 are weather and access dependent, may move or be removed based on conditions**
- **Site NC 1 will include PAH's**

DWR North Complex and Potter's Fire Sampling Plan

Page **10** of **10**

2018 CARR, HIRZ AND DELTA FIRES

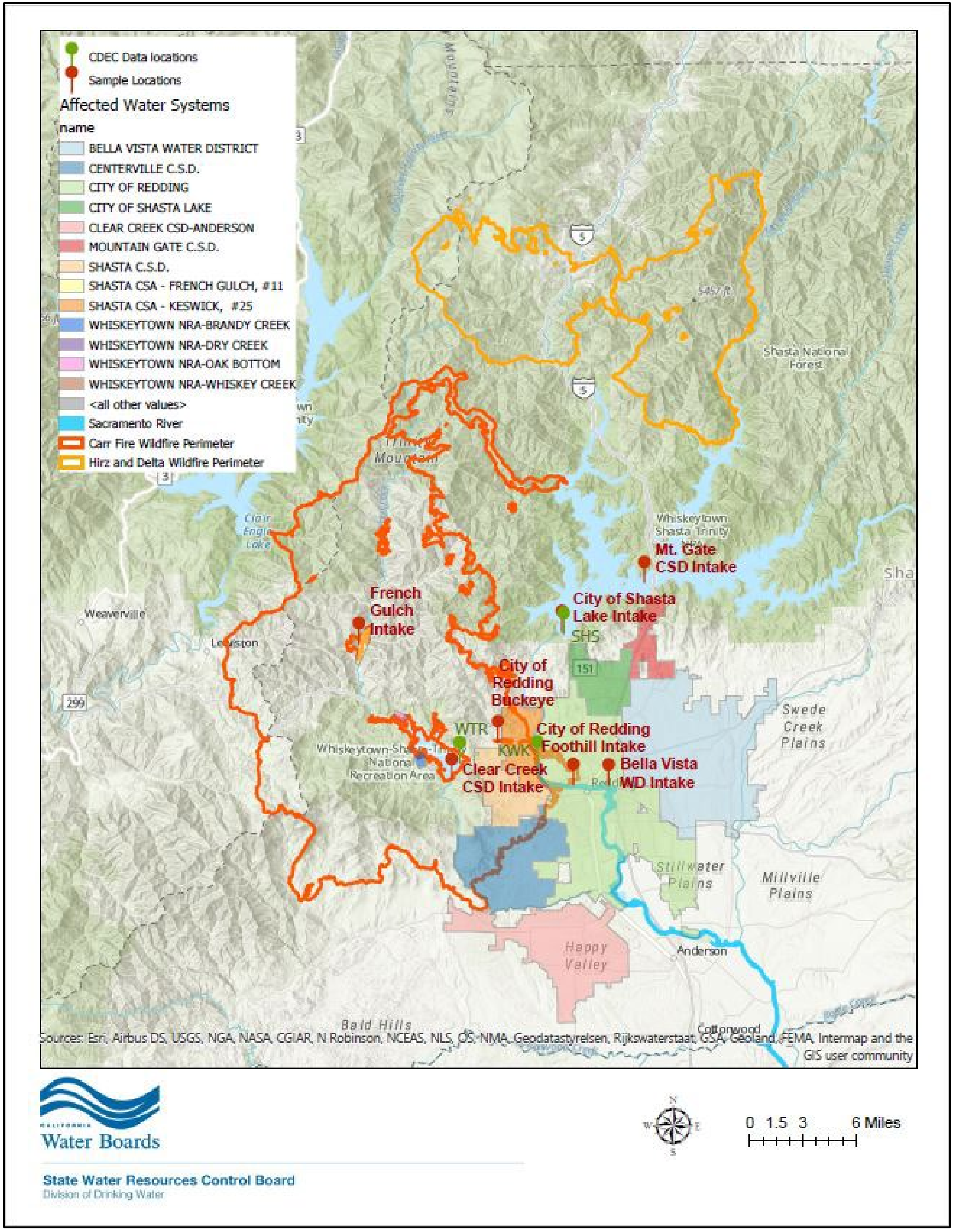
The Carr Fire burned 229,651 acres and destroyed 1,077 homes and 277 other structures. The fire lasted from July 23 to August 30, 2018 and affected watersheds along Upper Clear Creek, Whiskeytown Lake, the Sacramento River, and areas of Shasta Lake. The Hirz fire began on August 9, 2018 and was contained on September 12, 2018. The Delta fire began on September 5, 2018 and merged with the Hirz fire, but was contained on October 7, 2018. The Hirz and Delta Fire affected the watershed along the Upper Sacramento River and portions of Lake Shasta. **Figure 13A-7** shows the burn area for each of the fires, and the affected water systems.

DDW and the affected water systems collected samples for pH, temperature, turbidity, nitrate, TOC and alkalinity every two weeks from October 2018 to April 2019 from seven surface water intake locations on Upper Clear Creek, Whiskeytown Lake, Sacramento River, and Shasta Lake.

Water Quality Data/Studies

As discussed in the DDW report, water quality impacts to the affected water systems were not as severe as anticipated as the burn areas did not experience mass wasting or significant debris flow. Although water quality decreased for brief periods after significant rain events, the water systems voluntarily ceased operation during these short times, and were able to generally operate continuously during the post-fire winter. As an example, TOC never exceeded 3.5 mg/L at any sampling location and the highest turbidity was 220 NTU which dropped to 10 NTU by the next day. Nitrate was never detected from October 2018 to January 2019.

Figure 13A-7. Carr, Delta, and Hirz Fire Burn Area and Drinking Water System Intakes



A separate sampling effort was conducted by the Central Valley Regional Board, which monitored portions of the Trinity River, Whiskeytown Lake, and Sacramento River watersheds as shown in **Figure 13A-8.** Data for this effort can be found in **Appendix 13A-2.** Samples were collected from September 2018 to March 2019, with a final sample in January 2020. The first sample was collected to characterize baseline water quality, the second sample was for the first storm event, and then four subsequent samples were collected. Samples were collected for general chemistry, nutrients, TOC, metals and PAHs. All PAHs were nondetectable, except for a single detection of chrysene at 0.011 µg/L at Clear Creek Peltier Valley Road Bridge.

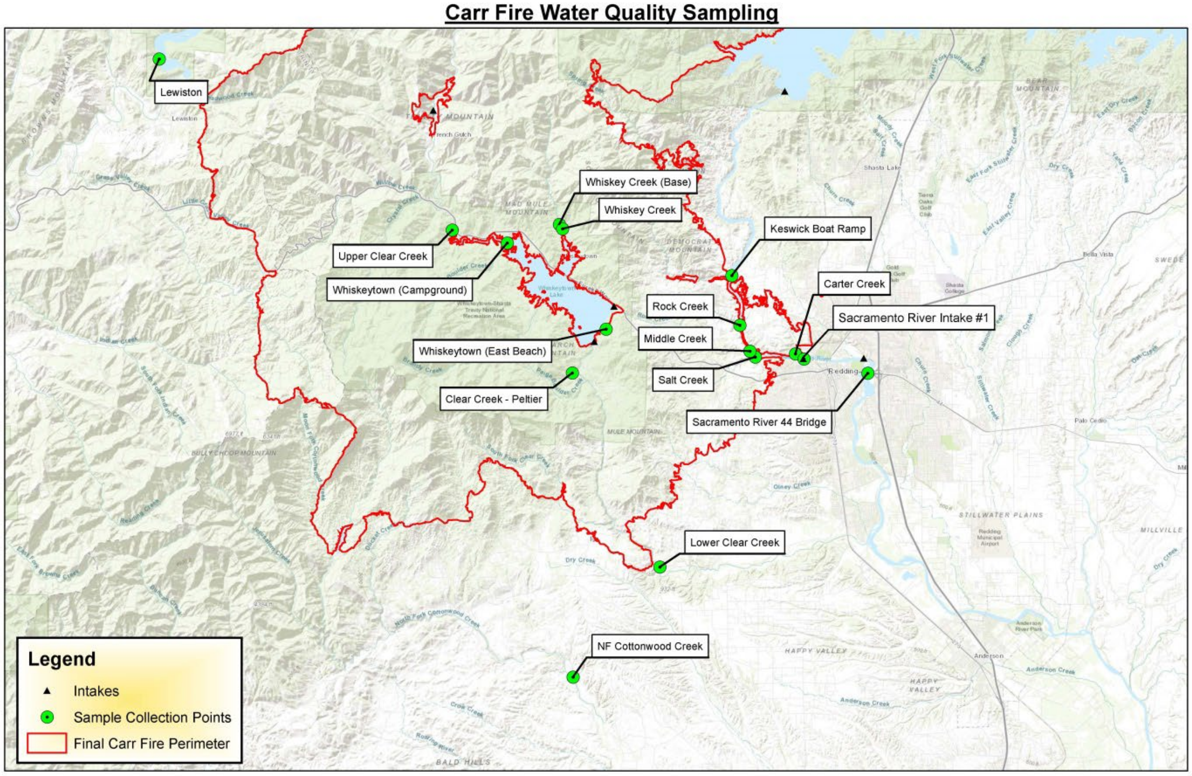
Eight samples were above the primary MCL of 1,000 µg/L for aluminum, with concentrations ranging from 1,210 to 6,300 µg/L; Three samples at Upper Clear Creek (December 2018, January 2019, January 2020), one sample at Whiskey Creek (January 2019), one sample at Rock Creek (January 2020), one sample at Middle Creek (January 2020), one sample at Salt Creek (January 2020), and one sample at Carter Creek (January 2020). However, the concentrations of total aluminum in the mainstem of the Sacramento River at 44 Bridge in January 2020 was 103 µg/L, and 193 µg/L at Sacramento River Intake #1, which are both below the secondary MCL for aluminum. These locations are shown on **Figure 13A-8**.

Eight samples were above the secondary MCL of 50 µg/L for manganese, with concentrations ranging from 59.6 to 415 µg/L; Two samples at Upper Clear Creek (January 2019, January 2020), one sample at Whiskeytown Lake Oak Bottom Campground (January 2020), one sample at Whiskey Creek (January 2019), one sample at Rock Creek (January 2020), one sample at Middle Creek (January 2020), one sample at Salt Creek (January 2020), and one sample at Carter Creek (January 2020). However, the concentrations of total manganese in the mainstem of the Sacramento River at 44 Bridge in January 2020 was 4.77 µg/L, and 11.4 µg/L at Sacramento River Intake #1, which are both way below the secondary MCL for manganese.

There were numerous detections of total iron above the secondary MCL of 300 µg/L at various sampling locations. Peak concentrations were as follows: 6,030 µg/L at Upper Clear creek in January 2019, 7,370 µg/L at Whiskey Creek in January 2019, 2,040 µg/L at Rock Creek in January 2020, 5,030 µg/L at Middle Creek in January 2020, 4,100 µg/L at Salt Creek in January 2020, and 5,330 µg/L at Carter Creek in January 2020. However, the concentrations of total iron in the mainstem of the Sacramento River at 44 Bridge in January 2020 was 103 µg/L, and 259 µg/L at Sacramento River Intake #1, which are both below the secondary MCL for iron.

According to the Central Valley Regional Board, iron and aluminum occur naturally in soils in the watershed. The elevated levels of iron and aluminum are indicative of soil transport from stormwater runoff, caused by the burn severity and lack of vegetation to control sediment and erosion.

Figure 13A-8. Carr Post-Fire Watershed Sampling



Source: Central Valley Regional Water Quality Control Board

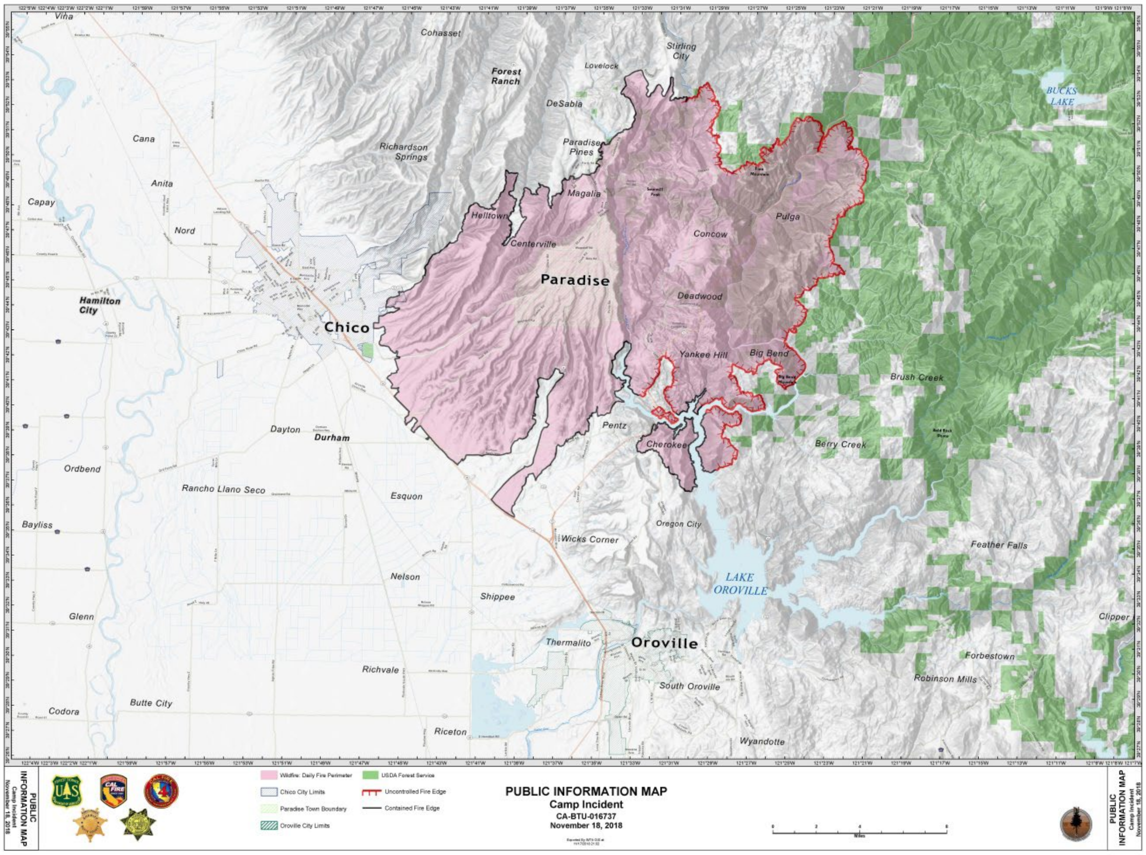
2018 CAMP FIRE

The Camp Fire started on November 8, 2018 on Pulga Road and Camp Creek Road near Jarbo Gap and burned a total of 153,336 acres (about 240 square miles). The fire was fully contained on November 25, 2018. A total of 13,972 single, multiple and mixed commercial residences, 528 commercial and 4,293 other buildings were destroyed.

As a result of the Camp Fire, the burned area was evaluated by an interagency Watershed Emergency Response Team (WERT). The WERT evaluated post-fire watershed conditions, identified potential values-at-risk related to human life-safety and property, and evaluated the potential for increased post-fire flooding and debris flows. The team also recommended potential emergency protection measures to help reduce the risks to those values.

The burn area is shown in **Figure 13A-9**. The burn area drains from northeast to southwest; the portion east of Paradise drains to the Feather River and Lake Oroville, and the western portion drains to Butte Creek, Little Chico Creek, and tributaries of Butte Valley (Dry Creek, and Clear Creek). Approximately 19 percent of the fire area was unburned/very low soil burn severity, 63 percent of the fire area was low soil burn severity, 16 percent of the fire area was moderate soil burn severity, and 2 percent of the fire area was high soil burn severity.

Figure 13A-9. Camp Fire Burn Area



Debris flows are among the most hazardous consequences of rainfall on burned hillslopes. Debris flows pose a hazard distinct from other sediment-laden flows because of their unique destructive power. According to the WERT report, the majority of the basins which have a 60 percent or greater probability of debris flows are located along steep slopes that flank the North Fork Feather River and the West Branch of the Feather River upstream of Lake Oroville.

In addition to debris flow, erosion potential was also evaluated in the WERT report. Areas that showed elevated increased erosion potential (between 20 to 25 tons per acre) included very steep soils along the upper reaches of Butte Creek, Dry Creek, Clear Creek, and other smaller drainages to Butte Valley and along the West Branch Feather River.

General recommendations to mitigate fire-related impacts to water quality included:

The burned debris from structures and vehicles should either be properly disposed of, or mitigations put in place to prevent runoff from burned sites from entering watercourse. Areas with the highest density of burned structures near watercourses or with storm drainage systems that drain directly to watercourses should be the priority.

Water Quality Data/Studies

According to the WERT report, "naturally occurring asbestos, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, silver and zinc are known metals found in metamorphic rocks of the Sierra Nevadas. These rocks mostly underlay most of the eastern half of the burn area. Contributions of metals to the North Fork and West Branch Feather River within the burn area can be anticipated."

Additionally, the burn area contains numerous historic mines with associated mine tailings and mine waste that may contain potentially harmful concentrations of heavy minerals. Additionally, as many as 30,000 cars and numerous mobile home parks burned (SF Estuary, Sept. 2019). As these mobile homes sit on slabs, the runoff drained directly to the storm drain and creeks.

It is expected that runoff from the burn area will contain chemical contaminants in addition to ash and fire-related sediment and debris that may pose adverse impacts to the water supply. As discussed in the following sections, post-fire runoff was monitored by the Regional Board and CalTrans in the Butte Creek watershed, and by DWR in the Lake Oroville watershed.

Post fire Water Quality Monitoring Conducted by Regional Board and CalTrans

Post fire monitoring was conducted at ten sites by various agencies as shown in **Figure 13A-10.** The orange dots are the sample sites monitored by CalTrans, the yellow dots are the sites monitored by "CVWB SWAMP Rancho" which is the Central Valley Regional Board, and the red dots are the sites monitored by CDFW/DWR.

Samples were collected on January 9, January 17, February 26, March 27, May 15, November 13, and December 19, 2019. Samples were also taken in February 6, 2020 and the last sample was taken in March 12, 2020. Samples were collected for nutrients, minerals, bacteria, TOC, metals and polyaromatic hydrocarbons (PAHs), which are a byproduct of combustion. A full set of data collected for each sampling date is included in **Appendix 13A-3.**

It is important to note that all sites except for site 10 (West Branch of the Feather River in Lake Oroville) are in the Butte Creek watershed and do not flow to Lake Oroville, but flow through the Sutter Bypass eventually draining into the Sacramento River above Knights Landing. As flows continue down the Sacramento River, the post-fire flow will be again diluted by the American River, prior to reaching the Hood Station.

Overall, the data showed that there were times where the primary drinking water MCLs were exceeded in the post-fire runoff for aluminum, antimony, arsenic, and lead. Secondary MCLs were also exceeded for sulfate, iron and manganese. There is no MCL for TOC, but TOC is of concern as a disinfection-byproduct precursor, and TOC was included for evaluation. Individual graphs for each constituent are shown in **Figures 13A-11** through **18.**

Overall, metals increased in the post-fire runoff. Interestingly, the peak varied by constituent. For example, aluminum, iron and manganese peaked at the end of February, while lead, arsenic, and antimony peaked at the end of March. On February 26, 2019, aluminum had a peak concentration of 9,660 µg/L at Camp 6, iron peaked at 9,140 µg/L at Camp 3, and manganese peaked at 837 µg/L also at Camp 3. On March 27, 2020, antimony had a peak concentration of 300 µg/L at Camp 7, arsenic peaked at 42.1 µg/L at Camp 8, and lead peaked at 107 µg/L at Camp 9.

Additional information on rainfall is provided in the discussion of data collected by DWR in the following section. It is important to note that the largest recorded 24-hour rainfall total during the period of study (December 2018 to June 2020) was 6.1 inches on February 26, 2019, coinciding with the highest concentrations of aluminum, iron and manganese in the post-fire runoff.

Aluminum showed a second peak in December 2019 and March 2020, but levels did not return to levels seen in February 2019. Iron also showed a second peak in March 2020, across all sites. Arsenic and manganese also showed a second peak in March 2020, but only at one site. Both aluminum and iron occurs naturally in this watershed. According to the Regional Board, it is difficult to discern what is present due to burned debris and what is natural.

Lead, antimony and sulfate levels decreased over time, with no second peaks after the initial peak.

The sampling results for PAHs were very sporadic. The highest number of detections across all sites occurred during the March 2019 sampling. The most common PAH detections were for benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene and benz(a)anthracene. The highest concentration detected was 1.15 µg/L of benzo(k)fluoranthene on January 9, 2019.

As shown in **Figure 13A-18**, TOC levels in the post-fire runoff were generally above 2 mg/L for most locations from January to March 2019, with a decrease by May 2019, and a second peak in December 2019.

Figure 13A-10. Camp Fire Monitoring

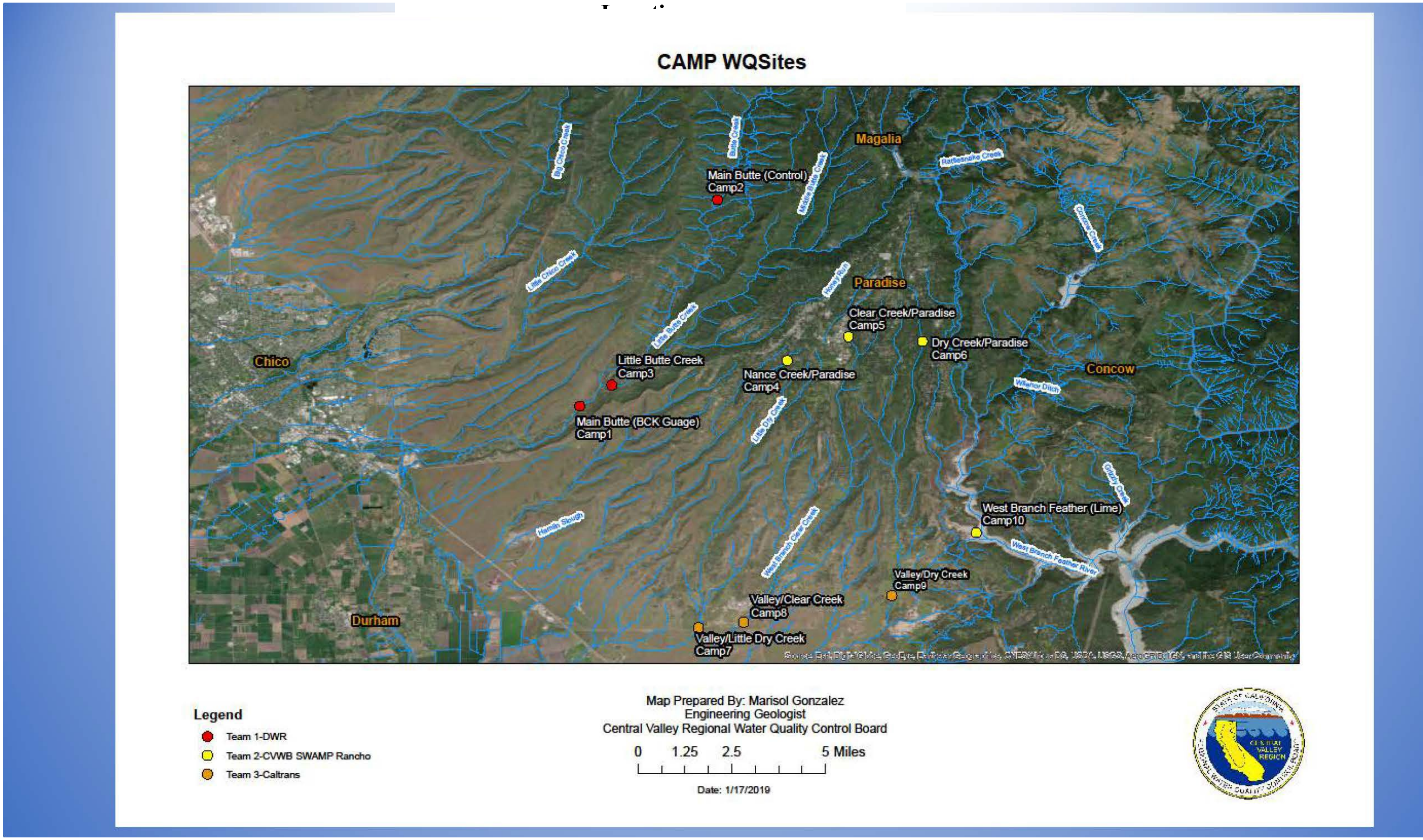


Figure 13A-11. Aluminum Levels in Post-Camp Fire Monitoring

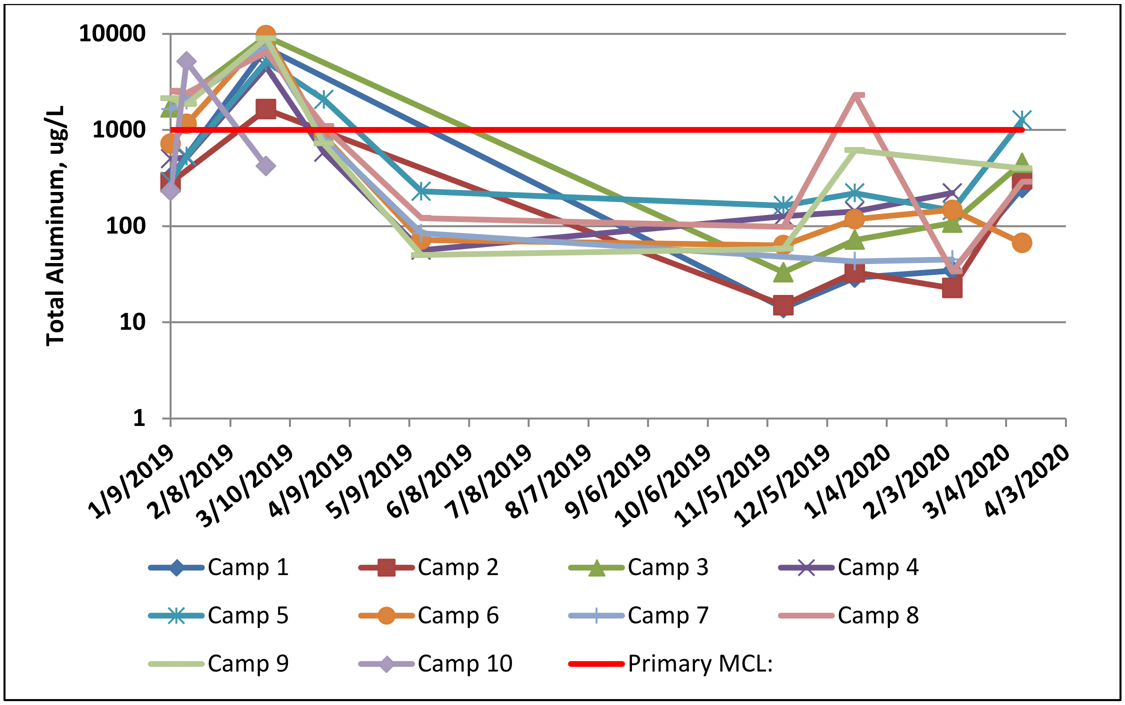


Figure 13A-12. Antimony Levels in Post-Camp Fire Monitoring

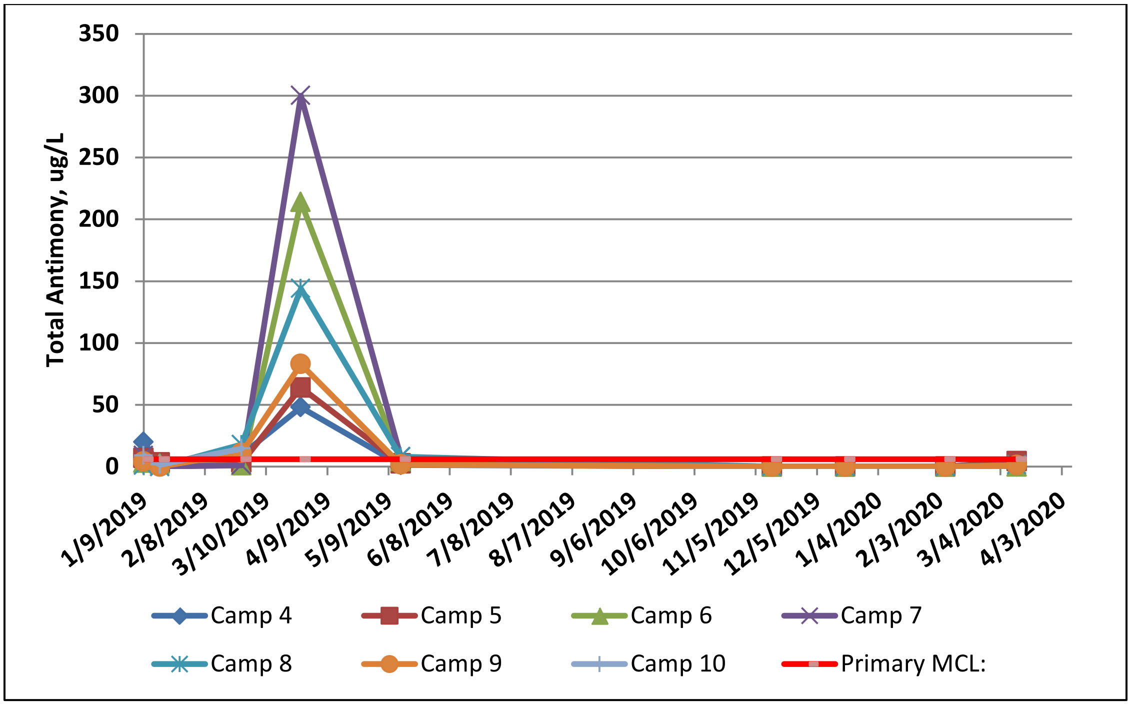


Figure 13A-13. Arsenic Levels in Post-Camp Fire Monitoring

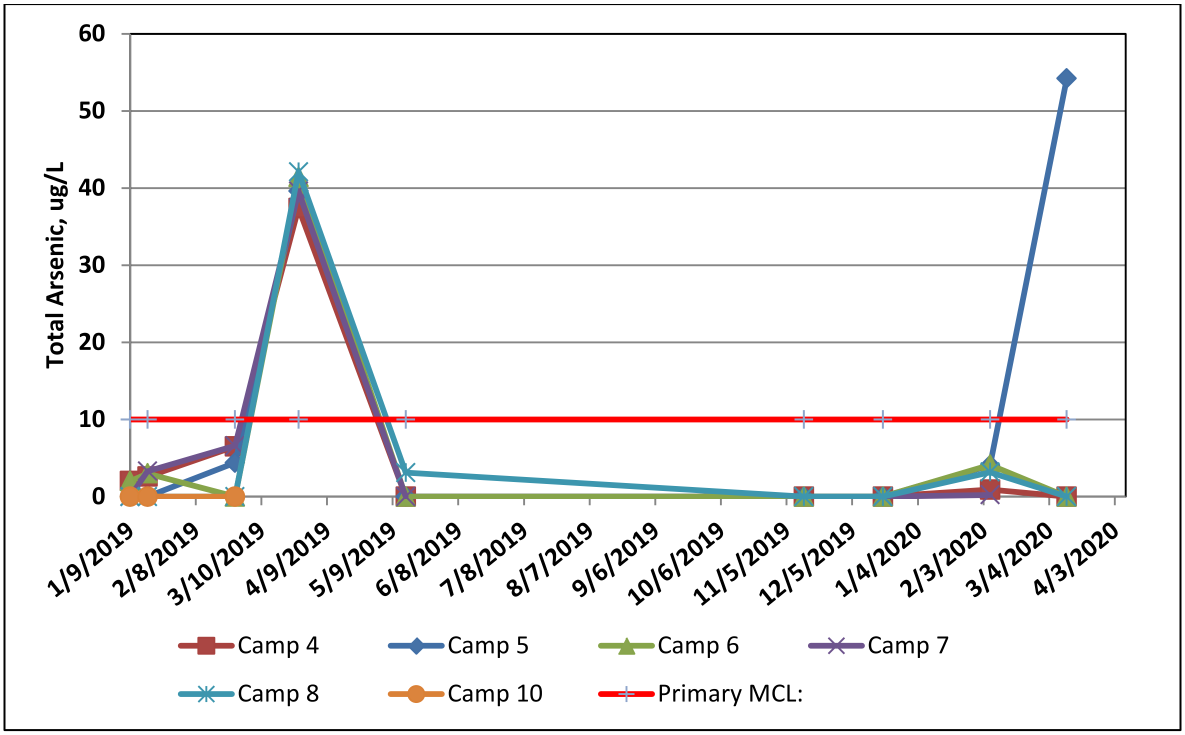


Figure 13A-14. Lead Levels in Post-Camp Fire Monitoring

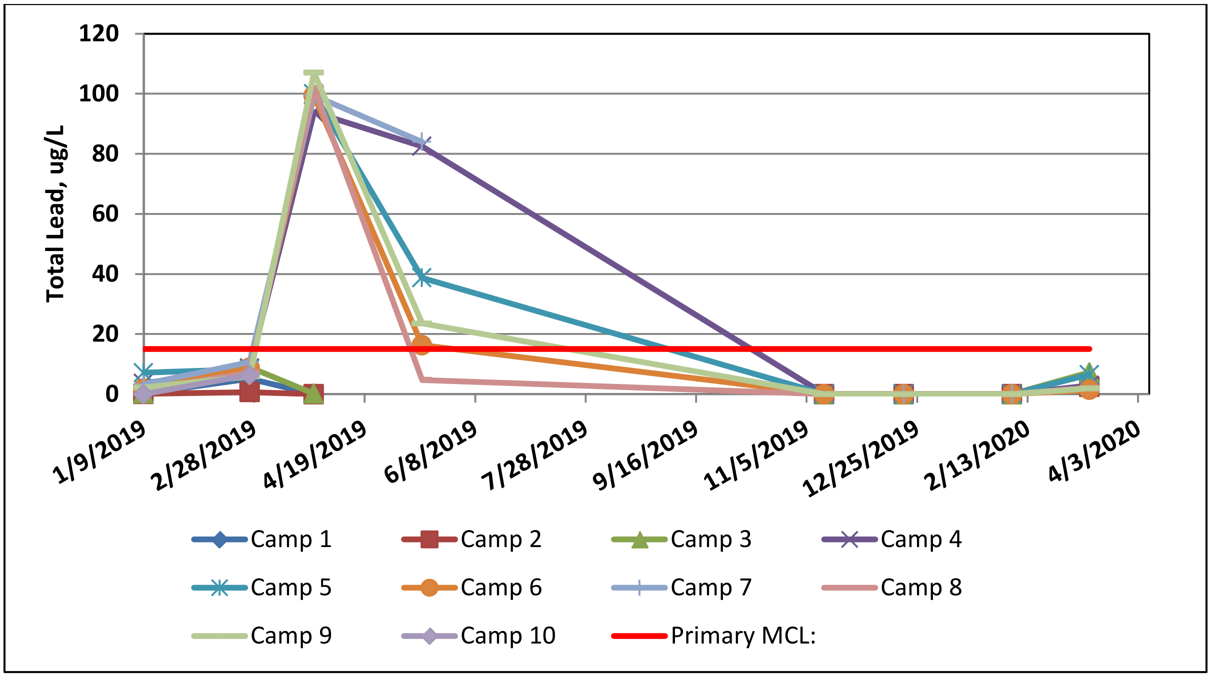


Figure 13A-15. Sulfate Levels in Post-Camp Fire Monitoring

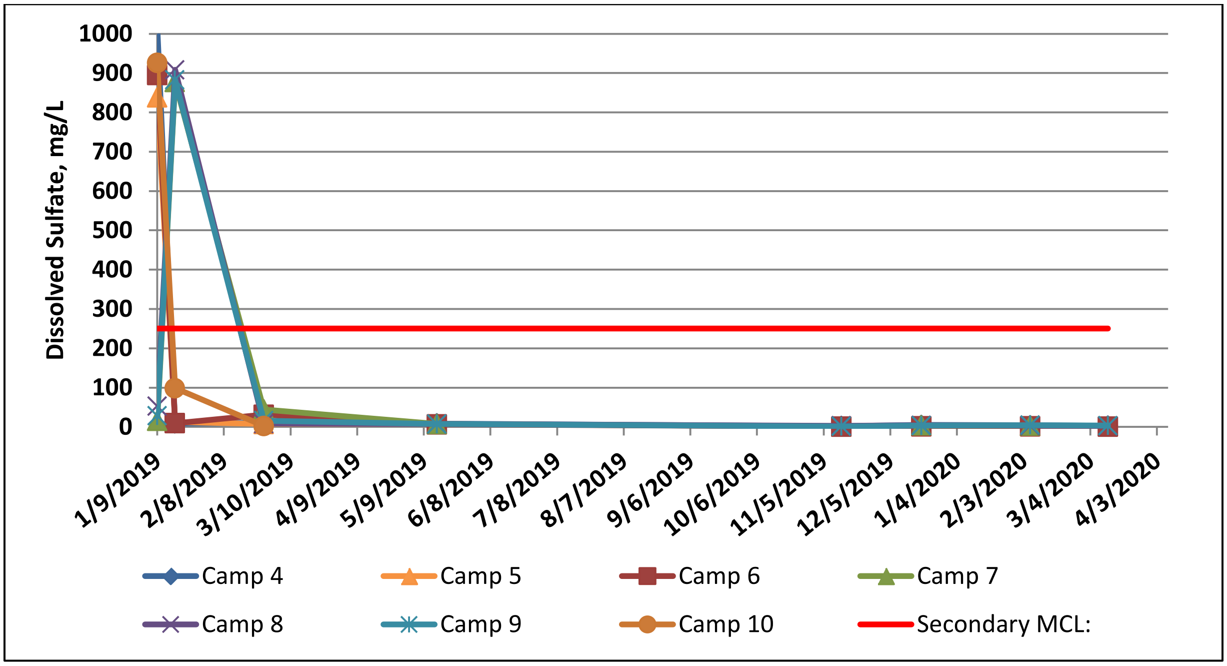


Figure 13A-16. Iron Levels in Post-Camp Fire Monitoring

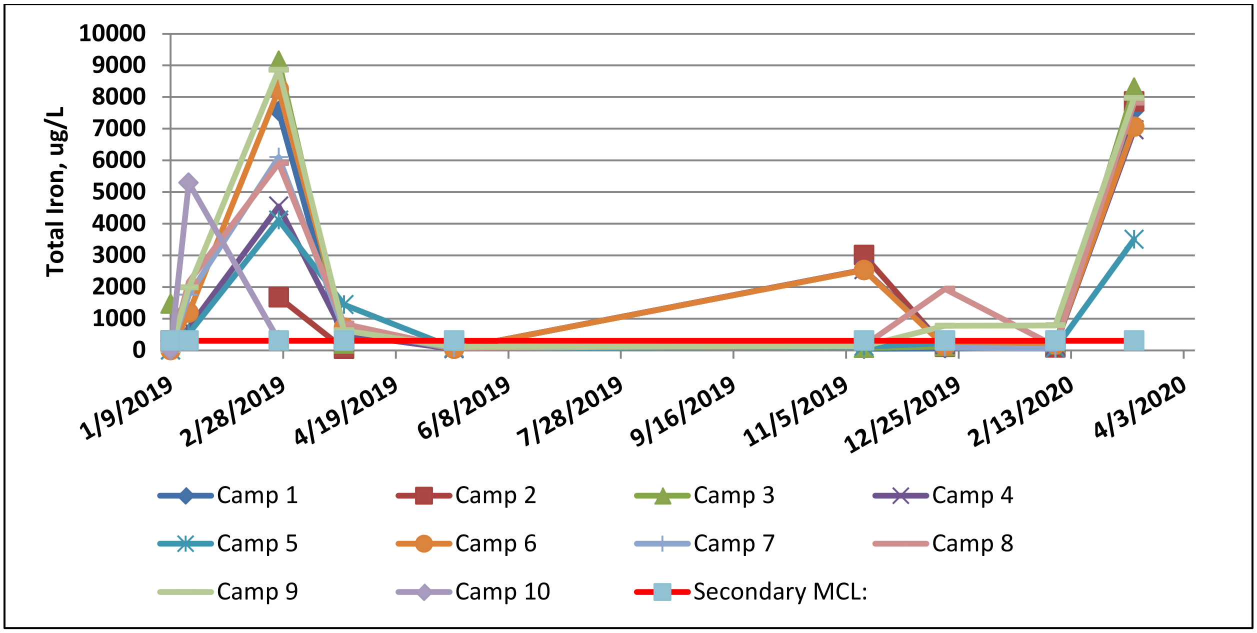


Figure 13A-17. Manganese Levels in Post-Camp Fire Monitoring

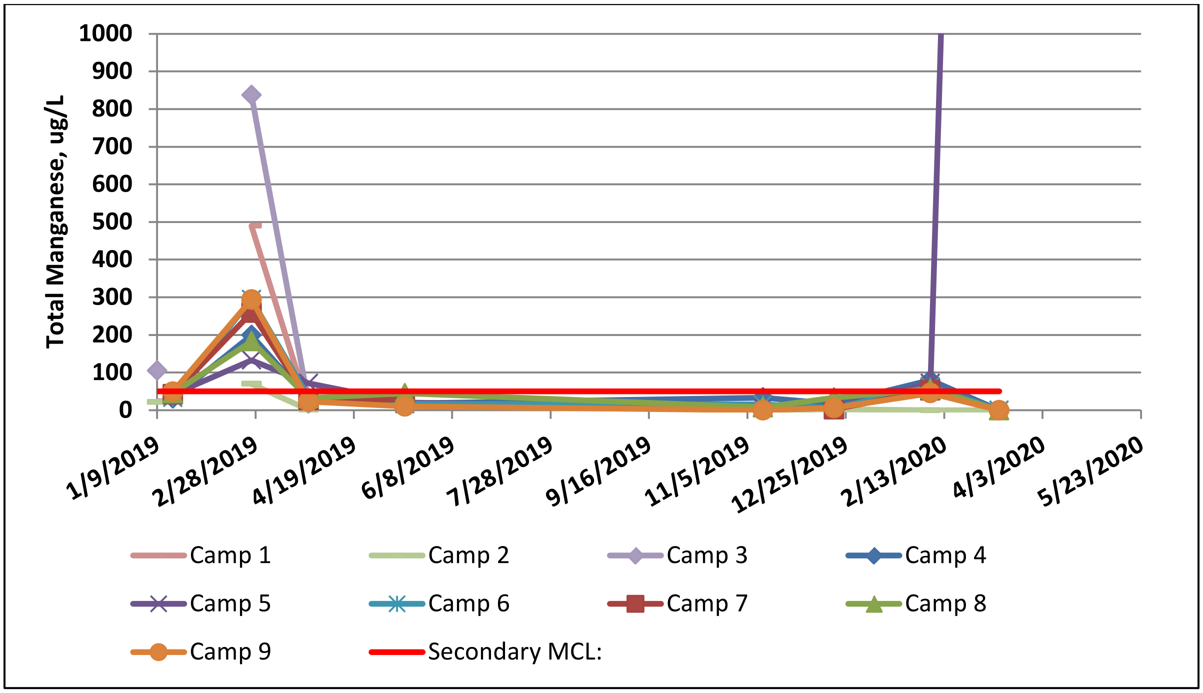
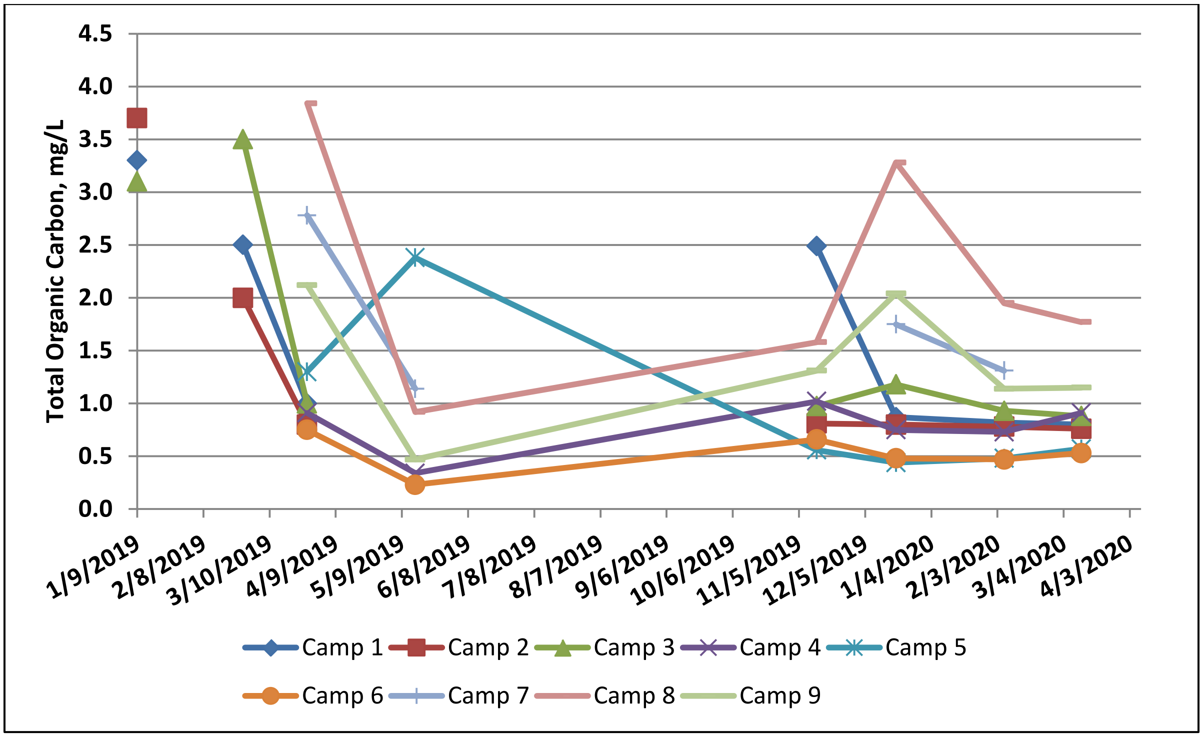


Figure 13A-18. Total Organic Carbon Levels in Post-Camp Fire Monitoring



Post fire Water Quality Monitoring Conducted by DWR

As discussed earlier, DWR collected samples of post-fire runoff in the Butte Creek watershed which drains to Lake Oroville **(Figure 13A-19).** DWR collected upstream samples in the relatively unburned area of Hwy 70 near Arch Rock tunnel, as well as at Poe Powerhouse Rd, which is downstream of Hwy 70 and within the burn area. In-lake samples were collected in the North Fork and West Branch of Lake Oroville. If the boat was not available, or boating conditions unsafe, back up sampling sites was conducted at Lime Saddle Marina. The goal was to sample one storm per month. **Table 2** shows the sampling dates and rainfall amounts for the previous 24-hours.

Table 13A-2. Sampling Dates and Conditions

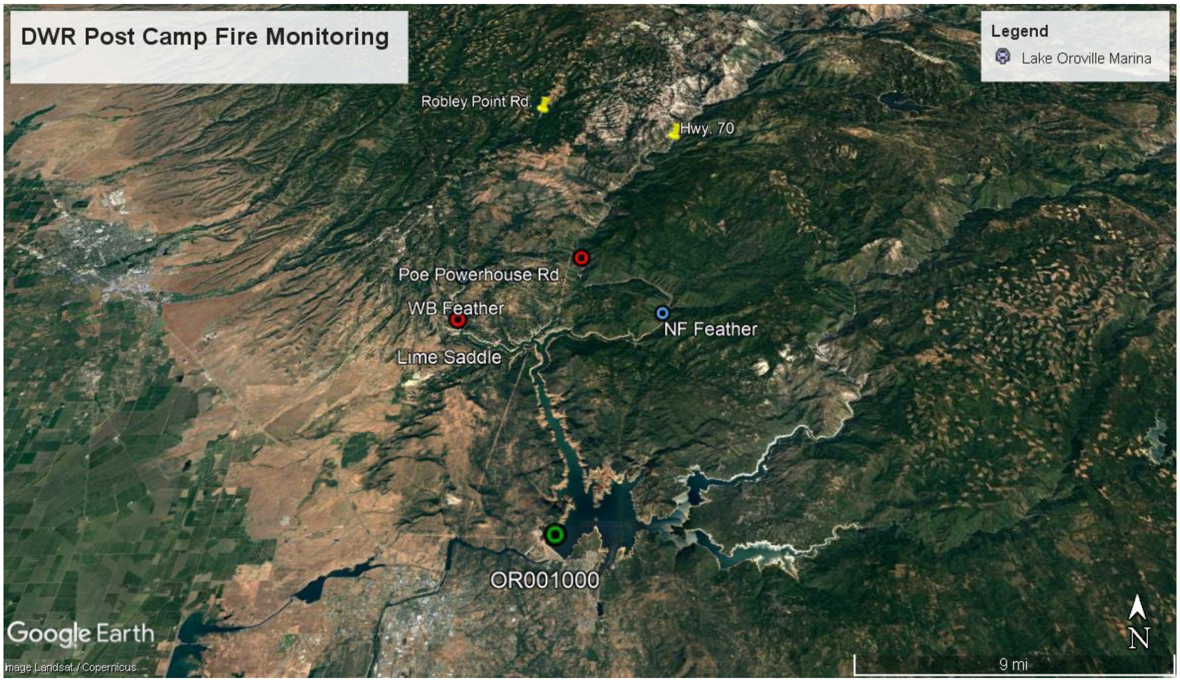
Sample Date	Sample Types	Trip Purpose	24-hour Rainfall Total (inches)	Total Accumulated Rain (inches)	Reservoir Elevation (feet)
12/7/2018	Boat & Land	Background samples	0.05	9.3	666
12/18/2018	Boat & Land	Storm water samples	0.01	11.8	666
1/9/2019	Boat & Land	Storm water samples	2.15	20.5	673
2/14/2019	Boat & Land	Storm water samples	5.40	45.3	754
3/27/2019	Boat & Land	Storm water samples	1.17	70.8	847
5/16/2019	Land	Storm water samples	2.72	79.2	890
6/20/2019	Boat & Land	Dry-weather samples	0.00	85.8	896
12/2/2019	Land	Storm water samples	2.11	4.5	776
3/15/2020	Land	Storm water samples	1.10	22.2	806

Notes:
24-Hour rainfall total for each date is the 24-hour average calculated at noon for each date.
Total accumulated rain is the summation from October 1 to September 30 each year.
Site IDs for boat sample types = NF Arm, WB Arm, & Lime Saddle.
Site IDs for land sample types = Arch Rock, Poe PH, Lime Saddle, Concow Res, and Rock Creek

Samples collected at Hwy 70 and Poe Powerhouse were to assess the direct effects of burn-area runoff on the water draining to Lake Oroville, and samples collected at North Fork and West Branch were to assess the impact to Lake Oroville itself. Samples collected at the North Fork and West Branch were collected from each respective arm as close to the river inflow as possible, in order to limit the influence of water already in Lake Oroville. (However, it is important to note that the location of these sample sites changed as water level in the lake rose and the location of the river inflow moved upstream. Due to the complexities of monitoring the lake sites, this report refers the reader to the DWR report for more information on the lake sites.)

Lastly, the routine water quality sampling continued near the Lake Oroville Dam. Samples are normally collected from April to November. Due to the fire, samples were collected during December 2018 through March 2019 and also during December 2019 to March 2020.

Figure 13A-19. DWR Water Quality Monitoring Locations, Post Camp Fire Monitoring



Similar to the data collected by the Regional Board for the Butte watershed, aluminum, iron and manganese were above their respective primary or secondary drinking water MCLs in the post-fire runoff, as shown in **Figures 13A-20 through 22.** Similar to the data collected by the Regional Board, a second peak was also seen in the second winter samples which illustrates that post-fire contaminants continue to be released from the watershed from consecutive winters when it rains. PAHs were not detected in any samples for the post-fire runoff. Lead and arsenic did not exceed their MCLs in post-fire runoff samples collected by DWR, compared to runoff samples collected by the Regional Board. Antimony was not analyzed in DWR samples.

Figure 13A-20. Aluminum Levels in Post-Camp Fire Monitoring, DWR

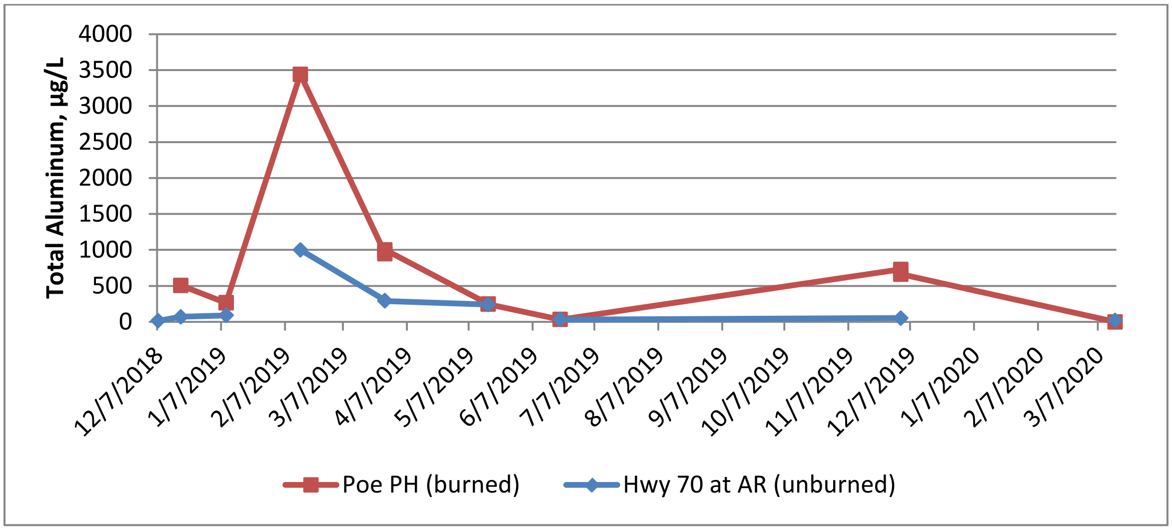


Figure 13A-21. Iron Levels in Post-Camp Fire Monitoring, DWR

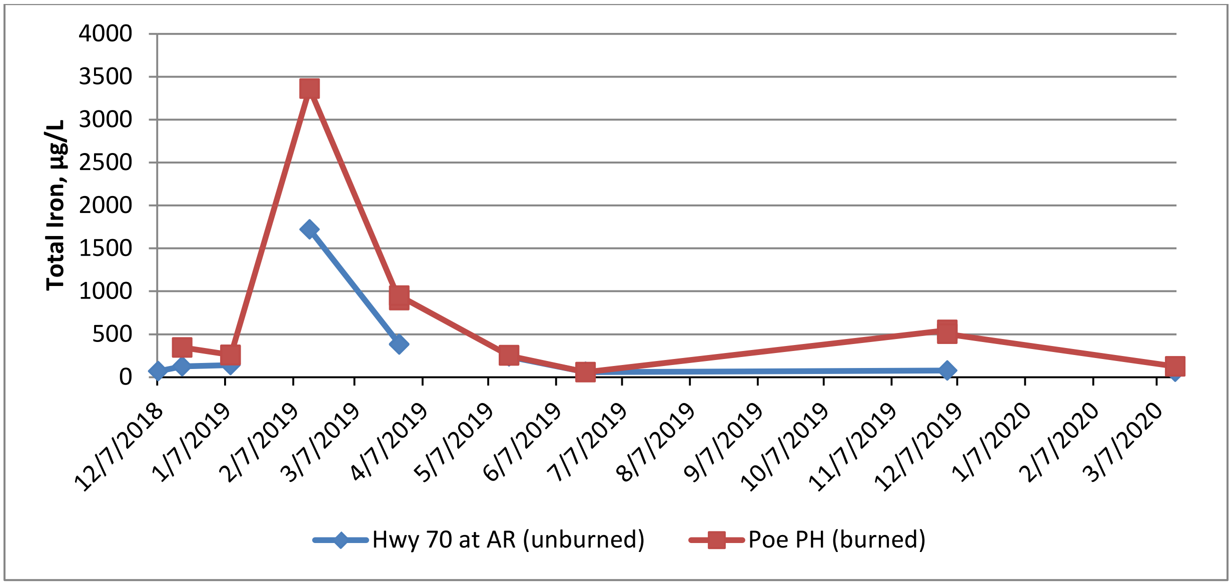
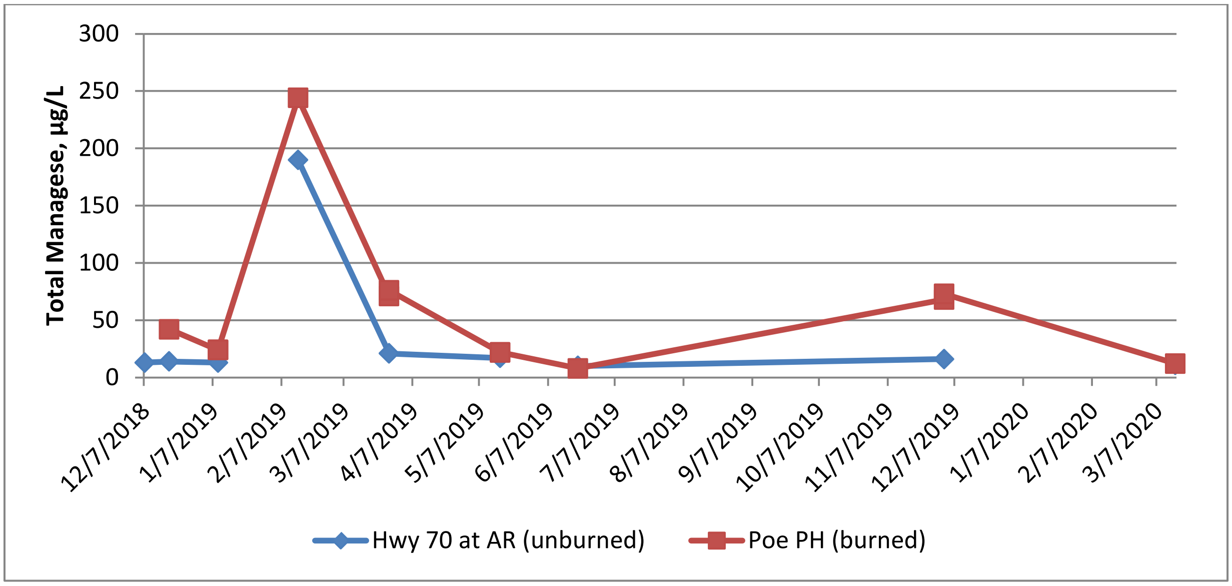


Figure 13A-22. Manganese Levels in Post-Camp Fire Monitoring, DWR



In addition to monitoring post-fire runoff from burn areas, DWR monitoring also collected runoff from unburned areas and compared the two samples. Samples collected at Hwy 70 generally represent runoff coming from an unburned area, while samples collected at Poe Powerhouse represents runoff coming from a burned area and entering the North Fork. DWR calculated a relative percent change (RPC) between the two sites, calculated as the downstream result minus the upstream result divided by the upstream result. Although many sample sets did not show any change in RPC, there were some notable trends as shown in **Table 13A-3.**

Generally, increases from unburned areas to burned areas were observed for total aluminum, total iron, total manganese, total nickel, dissolved nitrate +nitrite, turbidity and total suspended solids. Increases were seen in both the first and second winter after the fire. Please refer to DWR report for additional information.

Table 13A-3. North Fork Upstream/Downstream Relative Percent Change Calculations for Analyte Concentrations

Sample Date	**12/18/18**	**1/9/2019**	**2/14/2019**	**3/27/2019**	**3/27/2019***	**5/16/2019**	**6/20/2019**	**12/2/2019**	**12/2/2019***	**3/15/2020**
24-hr Total Rain (in.)	**0.01**	**2.14**	**5.41**	**1.24**	**1.24**	**2.35**	**0.00**	**2.11**	**2.11**	**1.10**
Accum. Rain (in.)	**11.8**	**20.5**	**45.3**	**70.8**	**70.8**	**79.2**	**85.8**	**4.5**	**4.5**	**22.2**
24-hr US Flow (cfs)	**2,254**	**2,603**	**5,213**	**4,781**	**4,781**	**4,454**	**699**	**619**	**619**	**205**
Alkalinity	3	63	0	6	9	4	10	26	23	8
Aluminum (D)	**281**	-50	-24	8	13	-14	-7	32	26	0
Aluminum (T)	**614**	**194**	**244**	**222**	**240**	7	0	**1,252**	**1,128**	-76
Arsenic (D)	-50	0	0	0	0	0	0	0	0	0
Arsenic (T)	-50	0	0	0	0	0	0	0	0	0
Calcium (D)	NS	NS	NS	0	0	4	0	16	18	1
Chloride (D)	-21	-4	0	0	0	0	0	**112**	**110**	0
Chromium (D)	100	0	0	0	0	0	0	-50	-50	0
Chromium (T)	100	100	75	**200**	**200**	0	0	100	100	0
Conductance	0	66	0	7	9	2	9	27	28	8
Copper (D)	-50	0	-50	0	0	0	0	0	0	0
Copper (T)	100	100	100	100	100	0	0	100	**200**	0
Field Conductance	2	70	1	8	NS	2	9	22	NS	7
Field DO	-8	-9	-3	-3	NS	-3	-1	1	NS	-2
Field pH	0	2	3	0	NS	0	-1	2	NS	-1
Field Turbidity	**623**	**221**	33	**432**	NS	4	-13	**1,055**	NS	**113**
Field Water Temp.	39	59	16	12	NS	14	6	14	NS	21
Hardness (D)	11	90	-7	3	3	0	13	25	29	7
Iron (D)	12	-62	-8	8	15	-35	8	71	71	5
Iron (T)	**177**	84	95	**136**	**149**	6	-3	**612**	**553**	**108**
Lead (T)	0	0	**300**	0	0	0	0	0	0	0
Magnesium (D)	NS	NS	NS	0	0	0	26	35	36	32
Manganese (D)	**660**	0	**138**	100	100	0	0	**420**	**500**	-64
Manganese (T)	**200**	85	28	**238**	**262**	29	-20	**325**	**356**	10
Nickel (D)	0	100	-67	0	0	-50	0	0	100	100
Nickel (T)	100	**300**	6	**167**	**167**	0	0	**200**	**200**	40
Nitrate (D)	**416**	**300**	-19	0	0	0	-90	**486**	**2620**	0
Nitrate + Nitrite (D)	**132**	**300**	-45	0	**628**	0	-82	**192**	**172**	**140**
Organic Carbon (D)	0	-32	-11	-5	-5	-5	0	-17	-13	100

Sample Date	**12/18/18**	**1/9/2019**	**2/14/2019**	**3/27/2019**	**3/27/2019***	**5/16/2019**	**6/20/2019**	**12/2/2019**	**12/2/2019***	**3/15/2020**
24-hr Total Rain (in.)	**0.01**	**2.14**	**5.41**	**1.24**	**1.24**	**2.35**	**0.00**	**2.11**	**2.11**	**1.10**
Accum. Rain (in.)	**11.8**	**20.5**	**45.3**	**70.8**	**70.8**	**79.2**	**85.8**	**4.5**	**4.5**	**22.2**
24-hr US Flow (cfs)	**2,254**	**2,603**	**5,213**	**4,781**	**4,781**	**4,454**	**699**	**619**	**619**	**205**
Organic Carbon (T)	4	-28	7	-14	36	-13	0	-10	-6	**142**
Phosphorus (T)	**377**	**200**	**131**	33	100	-89	-20	-29	-26	14
Potassium (D)	19	22	-7	29	7	-50	14	7	9	13
Potassium (T)	14	13	NS	NS	NS	NS	NS	NS	NS	NS
Settleable Solids	0	0	33	0	0	0	0	0	0	0
Sulfate (D)	-18	99	11	29	29	0	-21	26	18	24
TDS	0	48	0	6	6	3	7	10	10	9
TKN	-13	57	67	52	100	-75	-50	74	95	**900**
TSS	**600**	0	9	**275**	**856**	0	0	**1,500**	**1,750**	100
Zinc (D)	0	-58	0	0	0	0	0	0	0	**220**
Zinc (T)	**140**	-69	83	0	0	**140**	0	0	0	**220**

Notes:
(D) = dissolved, (T) = total, Accum. = accumulated, DO = dissolved oxygen, NS = no sample,
TDS = total dissolved solids, TKN = total kjeldahl nitrogen, TSS = total suspended solids,
US = upstream, as measured at the Arch Rock site
* Field replicate sample at Poe PH, sample at Arch Rock was the same for both comparisons
All results are percentages.
Table does not include analytes

Impacts to Distribution System

Another water quality issue emerged from the Camp Fire, which was volatile organic compounds (VOC) contamination. Due to depressurization of water lines after the fire, it was found that back-siphonage of smoke and combustion materials into the water lines could lead to adsorption/deposition of chemicals in the smoke onto water lines. An investigation conducted after the 2017 Tubbs Fire found that benzene contamination in the treated water was caused by thermal degradation of plastic pipe and other water system components as well as back-siphonage of smoke, ash, soot and other debris when the system lost pressure and service connections to homes were left open (Macler et al 2020). After the Camp and Tubbs fire, DDW and the involved utilities analyzed the water systems, configurations, and materials. It was found that water lines made of more porous material (like polyethylene) appeared to allow more contamination to absorb into the pipe. Additionally, gaskets, valves and other rubber materials were also shown to be susceptible to VOC contamination (Macler at el 2020). Another study by Proctor et al 2020, outlined that certain plastics in the distribution system may serve as a "primary VOC source through in situ plastic pyrolysis."

DDW advised the drinking water systems to immediately begin unidirectional flushing and issued water quality advisories. DDW continued testing for VOCs around the distribution systems and found that benzene was found over the MCL in 30 percent of samples collected in the service lines to burned structures (Macler et al, 2020). (Due to the do-not-drink/do-not-use advisories, few people, if any, ever consumed contaminated water in Paradise)

A separate paper by Proctor et al 2020, indicated that benzene was detected even 8 months after the fire. The maximum detection of benzene occurred in early February, (approximately 3 months post-fire) at a concentration greater than 2,217 µg/L. Other VOCs detected at high concentrations in this same sample were naphthalene (693 µg/L), toluene (676 µg/L), styrene (378 µg/L), ethyl benzene (76 µg/L) and xylenes (66 µg/L).

Downstream Impacts

Due to the elevated levels of certain metals found in the watersheds near the Camp and Carr fires, it was desired to conduct an examination of metal data in the mainstem of the Sacramento River at locations further downstream.

The Sacramento Watershed Coordinated Monitoring Program has been collecting metal data on a quarterly basis along the Sacramento River at Knights Landing and at Verona since 2008. Knights Landing is on the Sacramento River just before the confluence of the Sacramento River and Feather River, and Verona is on the Sacramento River just after the confluence of the Sacramento River and Feather River. Unfortunately, the program did not collect samples from March 2018 to December 2019 due to contracting issues, with a restart in February 2020. Therefore, there is no downstream data in the mainstem Sacramento River to correlate the peaks shown in **Figures 13A-11 through 18,** and **Figures 13A-20 through 22**. Additionally, sampling for metals at the Hood location was discontinued in spring of 2018 by DWR, in an effort to increase discrete sampling efficiency. Due to the fires in summer/fall of 2018 and 2020, metals will be reinstated at Hood in fall of 2020.

When the Sacramento Watershed Coordinated Monitoring Program was restarted in February 2020, limited metals were collected. Data for arsenic was available, but no data was available for lead, antimony, aluminum, iron, or manganese until August 2020. Data collected on February 19, 2020 at Knights Landing had an arsenic concentration of 3 µg/L and was 2 µg/L at Verona. **Tables 13A-4 and 5** show metal data from sampling conducted in August and November 2020 as well as the historical median from 2015 to 2017 for comparison.

Iron and aluminum levels at both locations were higher in the August 2020 sample compared to historical median (2015-2017), which may indicate impacts after the Camp and North Complex Fires.

Table 13A-4. Selected Metals Data at Sacramento River below Knights Landing

	2015-2017 Median	8/11/2020	11/10/2020
Aluminum, µg/L	124	370	206
Antimony,µg/L	no historical data	<1	<1
Arsenic, µg/L	2	2	2.39
Iron, µg/L	192	467	242
Lead, µg/L	0.17	<1	<1
Manganese, µg/L	21.8	23.5	10.1

Note: Data extracted from DWR Water Data Library for Sacramento R BL Knights Landing A0219501

Table 13A-5. Selected Metals Data at Sacramento River at Verona

	2015-2017 Median	8/11/2020	11/10/2020
Aluminum, µg/L	94.1	140	171
Antimony,µg/L	no historical data	<1	<1
Arsenic, µg/L	1.2	<1	1.73
Iron, µg/L	191.5	217	259
Lead, µg/L	0.16	<1	<1
Manganese, µg/L	26.7	16	18.3

Note: Data extracted from WDL for Sac A Verona A0215000

SUMMARY

Post-fire monitoring in the North Complex, Carr and Camp fire burn areas showed elevated levels (above primary and secondary drinking water MCLs) for aluminum, iron, and manganese in smaller watershed tributaries in samples collected by the Regional Board and DWR. According to the Central Valley Regional Board, iron and aluminum occur naturally in soils in both watersheds. The elevated levels of iron and aluminum are indicative of soil transport from stormwater runoff, caused by the burn severity and lack of vegetation to control sediment and erosion. For the Camp Fire, levels of aluminum, iron and manganese were lower in the post-fire runoff samples collected by DWR in the Lake Oroville watershed, compared to the post-fire runoff samples collected by the Regional Board in the Butte watershed.

Lead, antimony, and arsenic were also detected above their respective primary MCLs in post-fire monitoring of watershed tributaries in the Butte watershed following the Camp Fire, but were not above MCLs in the Lake Oroville watershed. Additionally, arsenic and lead were not detected above their respective primary MCLs in post-fire monitoring for the Carr Fire. No samples were collected for antimony in the Carr fire watershed after the fire.

Overall, the highest concentrations of metals in post-fire runoff were after the Camp Fire, compared to the Carr and North Complex fires. Post-fire monitoring showed that water quality impacts from wildfires may continue after the first post-fire winter. Quite often, there was a second peak which occurred in the second winter after the wildfire.

In addition to monitoring post-fire runoff from burn areas, DWR also collected runoff from unburned areas and compared the two samples. Generally, increases from unburned areas to burned areas were observed for total aluminum, total iron, total manganese, total nickel, dissolved nitrate +nitrite, turbidity and total suspended solids.

It is important to note that the impact to the State Water Contractors will diminish as water moves further downstream the Sacramento River. These wildfires occurred in the upper Sacramento River watershed. Sacramento River water is mixed with the American River prior to the Delta, and additionally mixed with water from the San Joaquin River and tidal waters within the Delta, prior to the export pumps.

RECOMMENDATION

Continue post-fire water quality monitoring when needed for SWP watersheds. Data collected by other monitoring programs such as Sacramento Watershed Coordinated Monitoring Program may assist in monitoring impacts further downstream on the mainstem of the Sacramento River. (The Sacramento Watershed Coordinated Monitoring Program collects metal data on a quarterly basis on the mainstem of the Sacramento River at Knights Landing and at Verona. These locations may be useful to monitor post-fire water quality impacts due to wildfires in Upper Sacramento River watershed areas and Lake Oroville.)

REFERENCES

CAMP Fire Watershed Emergency Response Team Final Report CA-BTU-016737, dated November 29, 2018.

“Tire Melt in Salmon Stream?” San Francisco Estuary, September 2019, Vol. 28, No.3, pp7-8.

Water Research Foundation. 2018. Project 4590. Wildfire Impacts on Drinking Water Treatment Process Performance: Development of Evaluation Protocols and Management Practices.

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Proctor, C.R. et al. “Wildfire caused widespread drinking water distribution network contamination”, AWWA Water Science 2020;e1183.

Post Fire Water Quality Impacts and Sampling Results at Public Water System Intakes on the Sacramento River, Whiskeytown Lake, Shasta Lake, and Upper Clear Creek, prepared by SWRCB Division of Drinking Water Lassen District Field Office, August 2019.

CHAPTER 13B. AQUATIC VEGETATION IN THE DELTA

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CHAPTER 13B. AQUATIC VEGETATION IN THE DELTA

BACKGROUND

The aquatic vegetation community in the Delta is composed of submersed, floating, and emergent species, with each form represented by both native and non-native species. Submersed aquatic vegetation (SAV) roots in the sediments in waterways and maintains its lifecycle below the water surface. Floating aquatic vegetation (FAV) floats on the water surface, and emergent aquatic vegetation (EAV) is generally rooted below the water surface, but the foliage is almost entirely above the water surface.

Among the FAV community, two aggressive non-native freshwater species have established in recent decades: Water hyacinth (*Eichhornia crassipes*) and water primrose (*Ludwigia* spp.). In 2015, 83% of all floating vegetation in the Delta was comprised of these two species (Ustin et al. 2016). Furthermore, SAV species such as watermilfoil (*Myriophyllum spicatum*), curly leaf pondweed (*Potamogeton crispus*) and Brazilian waterweed (*Egeria densa*) have also continued to spread or be persistent in the Delta (Santos et al. 2011).

Aquatic invasive plants can rapidly displace native species, clog water conveyance systems, form dense mats that restrict water movement, trap sediment, and interfere with recreation uses and navigation. Aquatic plants also change shoreline habitat by slowing water velocities, which increases water clarity. Native fish species like Delta smelt who prefer open water become more vulnerable to predatory fishes, with increasing aquatic vegetation.

Trends in Aquatic Vegetation Coverage

To date, aquatic vegetation monitoring campaigns in the Delta have been sporadic at best. From 2004 to 2008, California Department of Parks and Recreation, Division of Boating and Waterways (DBW) funded the annual collection of hyperspectral airborne imagery in early summer. However, these records were for the central Delta and the Liberty Island Cache Slough complex region only. From 2009 to 2013, there was no imagery collected over the Delta. In 2014 and 2015, imagery of the Delta was captured using the Airborne Visible-InfraRed Imaging Spectrometer-Next Generation (AVIRIS-NG) imagery funded through California Department of Fish and Wildlife to determine the impact of drought on aquatic invasive species. Similar efforts were conducted again in 2016 and 2017, but only for the northwest (Cache Slough Complex) and central Delta regions.

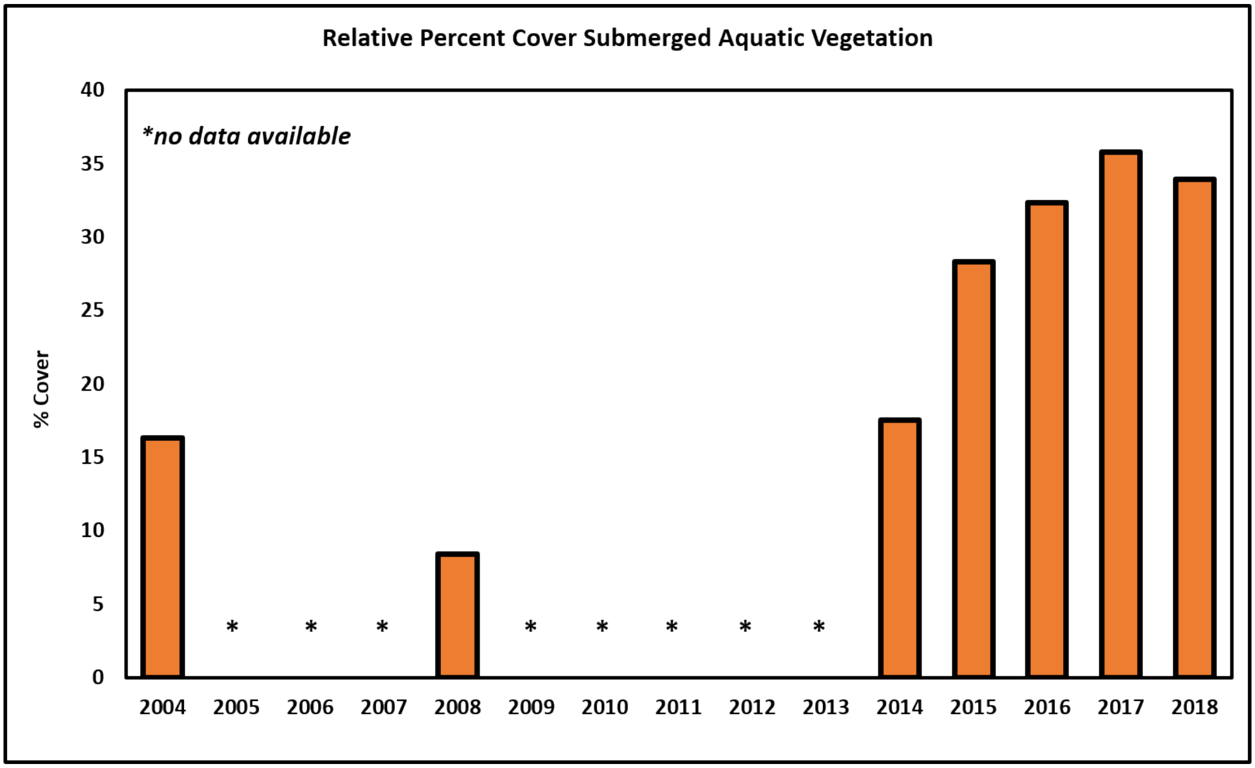
Based on the information above, data for SAV coverage for the entire Delta exists for years 2014, 2015 and 2019 only, as shown in **Table 13B-1.** Acres invaded by FAV are typically much less compared to SAV; for example, FAV coverage was 2,300 acres in 2019 (Personal communication, Shruti Khanna, 2020). Data for FAV coverage over the entire Delta is not available for 2014 and 2015.

Table 13B-1. SAV coverage over entire Legal Delta

Year	Acres invaded by SAV
2014	8,390
2015	12,600
2019	15,000

As more information exists for the North and Central Delta, Ustin et al. 2019 estimated that the percent cover of SAV in these more consistently monitored region have more than doubled between 2014 and 2018, as shown in **Figure 13B-1.**

Figure 13B-1. Percent Cover of SAV in the North and Central Delta



It is hypothesized that the aquatic vegetation has flourished due to favorable conditions during the drought. With less water flowing, reduced water velocity may result in decreased sediment re-suspension and subsequent increased water clarity. Increased water clarity furthers the survival and persistence of submersed plants due to increased penetration of sunlight into the water column. Increased water clarity has been coincident with declines in Delta Smelt and other native, pelagic fishes in the Delta as these native species rely on turbid environments to avoid predators (Ferrari et al. 2014).

Division of Boating and Waterways

According to Section 64 of the Harbors and Navigation Code, the DBW is designated as the lead agency of the state for the purpose of cooperating with agencies of the United States and other public agencies in identifying, detecting, controlling, and administering programs to manage invasive aquatic plants in the Sacramento-San Joaquin Delta, its tributaries, and the Suisun Marsh.

DBW's Aquatic Invasive Plant Control Program (AIPCP) is currently authorized to treat the following species as listed in **Table 13B-2.**

Table 13B-2. Target Species for DBW's Aquatic Invasive Plant Control Program

Common Name	Scientific Name
Alligatorweed	*Alternanthera philoxeroides*
Brazillian waterweed or Brazilian elodea	*Egeria densa*
Coontail (or hornwort)	*Ceratophyllum demersum*
Curlyleaf pondweed	*Potamogeton crispus*
Eurasian watermilfoil	*Myriophyllum spicatum*
Fanwort	*Cabomba caroliniana*
South American spongeplant	*Limnobium laevigatum*
Uruguay water primrose	*Ludwigia hexapetala*
Water hyacinth	*Eichhornia crassipes*

The program also operates under a number of regulations:

- **State Water Resources Control Board (SWRCB)**
  - Statewide General National Pollutant Discharge Elimination System (NPDES) Permit (CAG990005)
- **United States Fish and Wildlife Service (USFWS) Biological Opinions**
  - Service File No. 81410-2013-F-0005, effective March 13, 2013
  - Service File No. 08FBDT00-2014-F-0029, effective August 11, 2014
  - Service File No. 08FBDT00-2018-F-0029, effective April 3, 2019
- **Extensions on the Biological Opinions for:**
  - Service File No. 08FBDT00-2013-F-0015
  - Service File No. 81410-2013-F-0005
  - Service File No.08FBDT00-2014-F-0029
- **National Marine Fisheries Service (NMFS) Letters of Concurrence**
  - 2013/9443, effective February 27, 2013
  - 2014-394, effective May 28, 2014
  - 2017-8268, effective May 15, 2018

DBW must follow the terms and conditions specified in the NPDES permit, biological opinions and concurrence letters. The herbicide application season typically runs from March through

November. During the season, fish monitoring data must be continuously reviewed to avoid treating in sites where listed fish species are likely to be present. For example, during the March to June time period when delta smelt, winter-run Chinook, spring-run Chinook, and/or steelhead juveniles were entering and/or present in the Delta, selection of application sites depended on available Interagency Ecological Program (IEP) monitoring data showing the absence of special status fish species in treatment sites. Both the USFWS Biological Opinion and NMFS Letter of Concurrence require an annual report to be submitted January 31, following the application season.

Coverage under the Statewide General NPDES Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States was obtained in December 2013 and requires monitoring of herbicide residues in receiving waters (to be discussed later), temperature, electrical conductivity, salinity, dissolved oxygen, pH and turbidity. The permit is referenced as the Statewide General NPDES Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States (Permit No. CAG990005, Water Quality Order 2013-0002-DWQ). The NPDES Statewide General Permit for Aquatic Pesticide Use requires DBW to submit an annual reporton March 1, following the application season.

SUBMERSED AQUATIC VEGETATION

The DBW produces a SAV and FAV annual report on chemical usage, areas treated, and overall effectiveness. SAV treatments will be discussed first.

Herbicides to Control SAV

To date, Sonar is the primary chemical used by DBW to control SAV. Fluridone (1-methyl-3phenyl-5(trifluromethyl-phenyl)-4 (1H)-pyridone is the active ingredient in Sonar. Fluridone was approved by the USEPA in 1986. There are a variety of different formulations of the herbicide, including liquid and pellets. The SAV Control Program utilizes fluridone formulations such as SonarPR (granular), and two pellet formulations, SonarOne and SonarQ. Fluridone is a selective systemic herbicide that inhibits the formation of carotene, an action that results in the photo-degradation of chlorophyll exposed to sunlight. Plants are unable to produce carbohydrates and starve to death over time. Fluridone not absorbed by the plants is broken down into naturally occurring elements mostly through exposure to sunlight or binding to substrate. (California Dept. of Boating and Waterways Annual SAV report)

The effectiveness of fluridone depends on the degree to which the herbicide maintains contact with the target plant. Fluridone treatment programs will typically last from 8 to 16 weeks and need to be completed within the March 1 to November 30 timeframe. Fluridone formulations are applied at rates of 5 to 20 ppb per application, lower than the 10 to 40 ppb listed on Sonar labels. It is DBW's intent to maintain a fluridone concentration in the water column at the treatment site between the 2 and 5 ppb range.

Depending on water conditions, the half-life for fluridone ranges from 4 to 97 days. (Wisconsin Dept. of Natural Resources Fact Sheet). Two major degradation products from fluridone are n-methyl formamide (NMF) and 3-trifluoromethyl benzoic acid.

At the start of each treatment season, a baseline treatment plan is established per site by United States Department of Agriculture Research Service and DBW (with consultative support from SePRO Aquatic Specialists). The protocol is to specify weekly fluridone applications at a specific parts per billion (ppb) level, by quantity and formulation, based on the size and depth of the treatment area, infestation level, presence of nearby irrigation or potable water intakes, and extent of tidal influent at the site (2019 Annual DBW Report). The baseline treatment plan is adjusted on a weekly basis, if necessary, based on results from water samples taken at treatment sites throughout the treatment season. The SAV Control Program receives fluridone results within 24 hours of sampling and uses these results, if necessary, to maintain the desired fluridone concentration of 2 to 5 ppb.

Unfortunately, the efficacy of using fluridone to control SAV in the Delta has been limited. In 2018, DBW began testing of diquat and endothall for SAV control and are currently testing to demonstrate that these chemicals are safe and effective. Both diquat and endothall are fast-acting contact herbicides. Diquat controls weeds by causing rapid disruption of cellular membranes resulting in rapid kill. Endothall has been classified as a contact herbicide, but it may function as a systemic herbicide in some plants.

Limited information on DBW's usage of these chemicals is provided in the SAV annual reports. In 2018, 5 sites in the Delta were treated with diquat. In 2019, 11 sites were treated with diquat and 2 sites were treated with endothall. As of the writing of this report (April 2022), information on 2020 treatments were not available as the 2020 Annual DBW Report was not finalized.

The USDA Aquatic Research Laboratory (Madsen et al, 2021) conducted field demonstration evaluations for diquat in 2018 at Indian Slough and Cabrillo Bay (Discovery Bay). The main purpose for the evaluation was for removal of *Egeria*. Cabrillo Bay had been treated for 16 weeks with fluridone without effect, and was subsequently treated once with diquat. Indian Slough was treated once with diquat. Both treatments targeted the label rate of 370 µg/L. Results showed that when diquat was used as a follow-up to a fluridone treatment, diquat provided 98 percent control. When used alone in Indian Slough, diquat provided 80 percent control.

The USDA also treated a plot on the Middle River with endothall, in response to an urgent request from an irrigation district in 2018. Treatments occurred on October 25 and November 1, 2018 at 5 mg/L. The plant community was a mix of species including Egeria, coontail, Eurasian milfoil and fanwort. After one treatment, 43 percent control was achieved.

Health Impacts

Health impacts are not expected from exposure to fluridone through drinking water at concentrations that are used to control aquatic plants. There is no drinking water maximum contaminant level (MCL) for fluridone. The USEPA Human Health Benchmark for Pesticides (HHBP), has an acute (one-day) HHBP of 34,500 ppb and a chronic (long-term) HHBP of 960 ppb. The chronic HHBP is set at a level that is not expected to result in health effects from long-term daily consumption in drinking water. The HHBP for a number of pesticides can be found here:

https://www.epa.gov/pesticides/updated-list-human-health-benchmarks-pesticides-drinking-water-available

Diquat is an herbicide of moderate acute toxicity causing acute dermal toxicity and primary eye irritation (Toxicity Category II). It is classified as a Group E carcinogen, indicating that it poses no known cancer risk for humans. Diquat currently has a primary drinking water MCL of 20 ppb and a Public Health Goal (PHG) of 6 ppb.

Endothall is a contact herbicide that prevents certain plants from making the proteins they need. Factors such as density and size of the plants present, water movement, and water temperature determine how quickly endothall works. Under favorable conditions, plants begin to weaken and die within a few days after application. Endothall currently has a primary drinking water MCL of 100 ppb and a PHG of 94 ppb. Field studies show that low concentrations of endothall persist in water for several days to several weeks depending on environmental conditions. The half-life (the time it takes for half of the active ingredient to degrade) averages five to ten days (Wisconsin Department of Natural Resources Fact Sheet).

Herbicide Usage to Control SAV

Figure 13B-2 shows the chemical usage from 2014 to 2019 for SAV, which shows a significant increase in Sonar usage in 2017, compared to previous years. Additionally, diquat and endothall were used in 2018 and 2019. The data in **Figure 13B-2** is in pounds applied for Sonar and in gallons applied for diquat and endothall. **Table 13B-3** shows the acreage treated and number of sites treated from 2010 to 2019. As an example, **Figure 13B-3** shows the 71 sites where treatment occurred in 2018.

Figure 13B-2. Herbicide Usage for SAV by year for 2014 to 2019

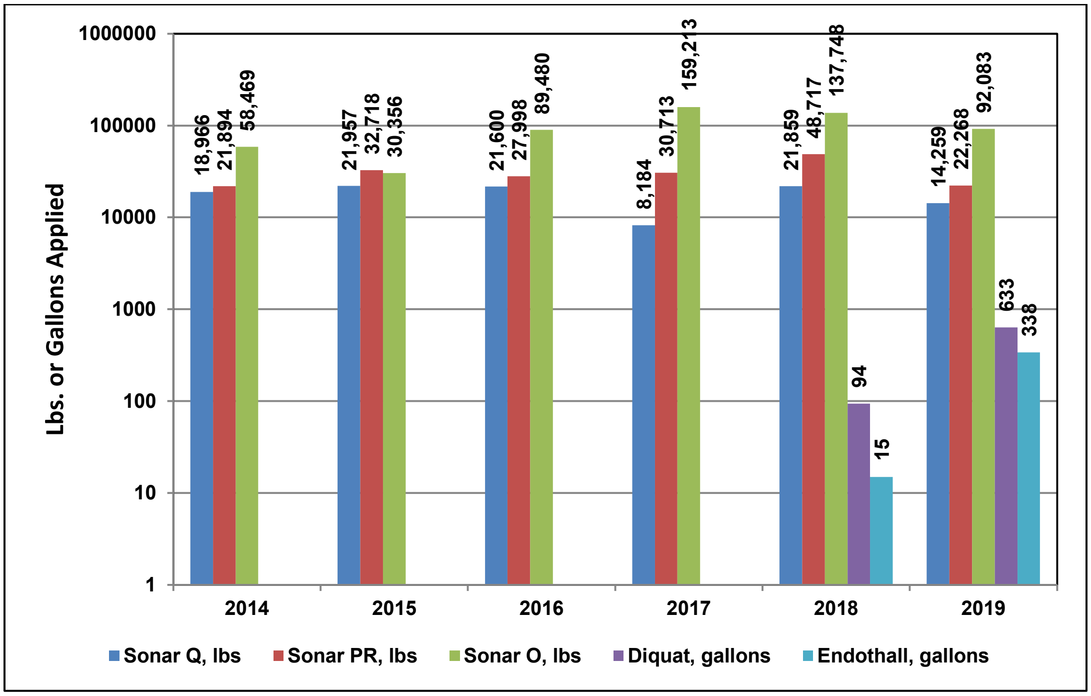
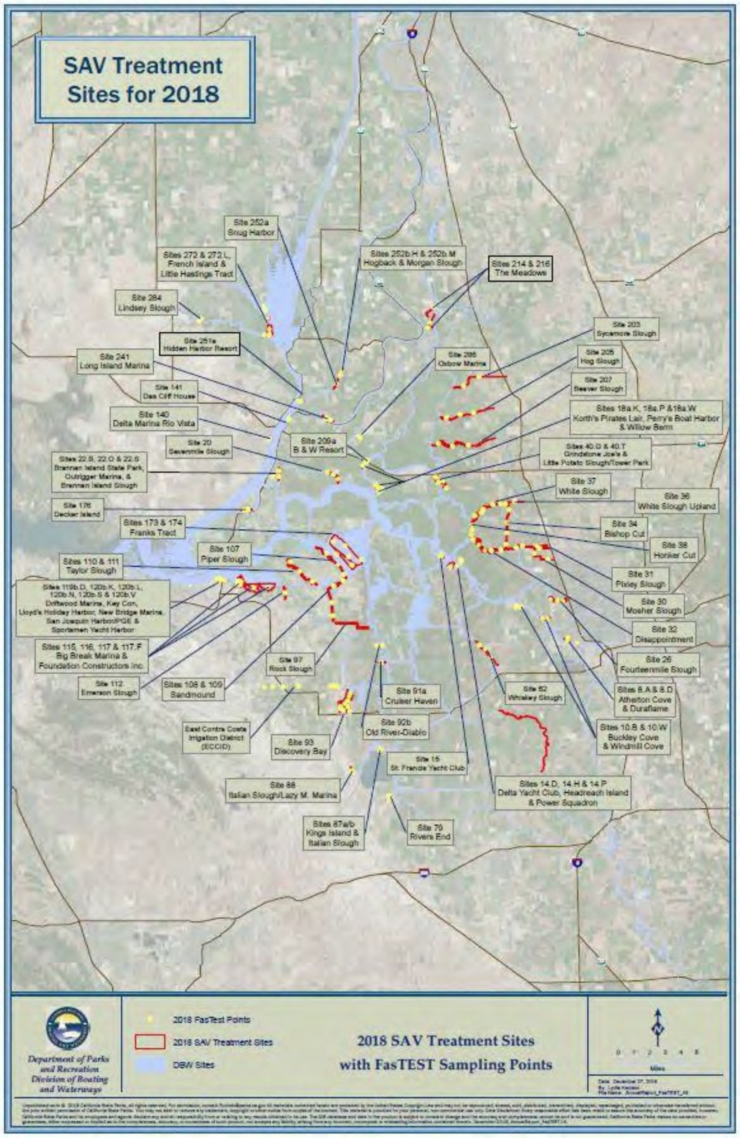


Table 13B-3. Number of Acres and number of sites treated from 2010 to 2019 for SAV

Year	Number of Sites Treated	Acreage Treated
2010	**3**	**641**
2011	**5**	**3,195**
2012	**15**	**2,663**
2013	**18**	**1,560**
2014	**17**	**2,144**
2015	**25**	**1,529**
2016	**26**	**2,443**
2017	**47**	**2,967**
2018	**71**	**4,360**
2019	**77**	**2,439**

Figure 13B-3. Map of 2018 SAV Treatment Sites



Herbicide Residual Concentrations After Treatment

DBW is required to document herbicide residues in receiving waters, specifically through the Aquatic Pesticide Application Plan (APAP), which is required by and approved by the State Water Resources Control Board. For liquid and pellet herbicides, water sampling occurs pretreatment, immediately post-treatment on the same day of application, and seven days after treatment. Additionally samples must be taken at 3 locations (upstream control site, treatment site, and receiving water immediately downstream of treatment area). According to the NPDES permit, the number of sufficient monitoring sites varies by project (Email communication, Gurgagn Chand, April 2021).

In 2017, although 47 sites were treated with fluridone, only two sites (White Slough and B&W Marina) were required to be monitored for fluridone in receiving waters. All of the samples collected in 2017 were below the receiving water limit of 560 µg/L for fluridone, and the maximum concentration was 0.87 µg/L at B&W Marina. Herbicide residue shall not exceed the following concentrations in receiving waters as shown in **Table 13B-4.** Maximum residue limits are equivalent to USEPA municipal drinking water standards, or MCLs. Since the monitoring required by the APAP is fairly limited, it is difficult to make conclusions about residual fluridone concentrations after treatment.

Table 13B-4. Receiving Water Limits for Herbicides used for SAV Control

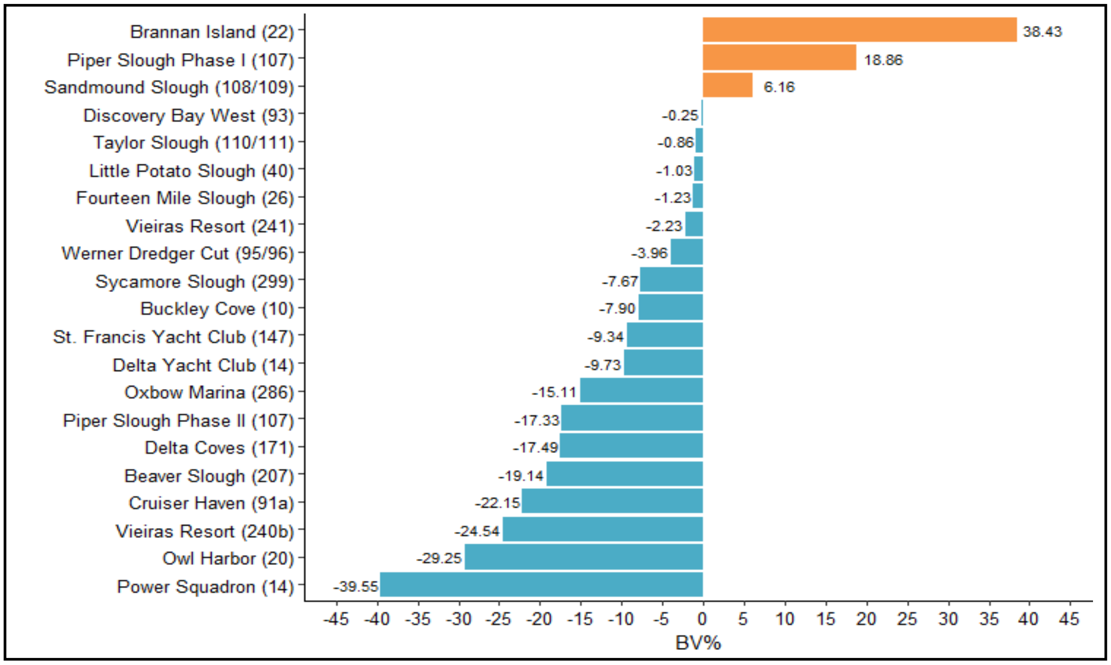
Herbicide Active Ingredient	Maximum Concentration, µg/L
Diquat	20
Endothall	100
Fluridone	560

According to the annual reports from 2016 to 2019, all herbicide residue concentrations at receiving water stations were either not detected or were below receiving water limits. As of the writing of this report (April 2022), information on 2020 treatments were not available as the 2020 Annual DBW Report was not finalized.

Effectiveness of SAV Treatments

Beginning in 2016, hydroacoustic biomonitoring has been employed to provide a detailed, quantitative metrics of the change in bio-volume and percent cover in treated sites. Biovolume value is the proportion of the plant height to water depth, and is ranged from zero to one. Vegetation cover is any sort of aquatic plants present in a water body which has a biovolume greater than 0.05 percent. A percent cover of this vegetation is calculated as vegetation cover divided by the total area surveyed.

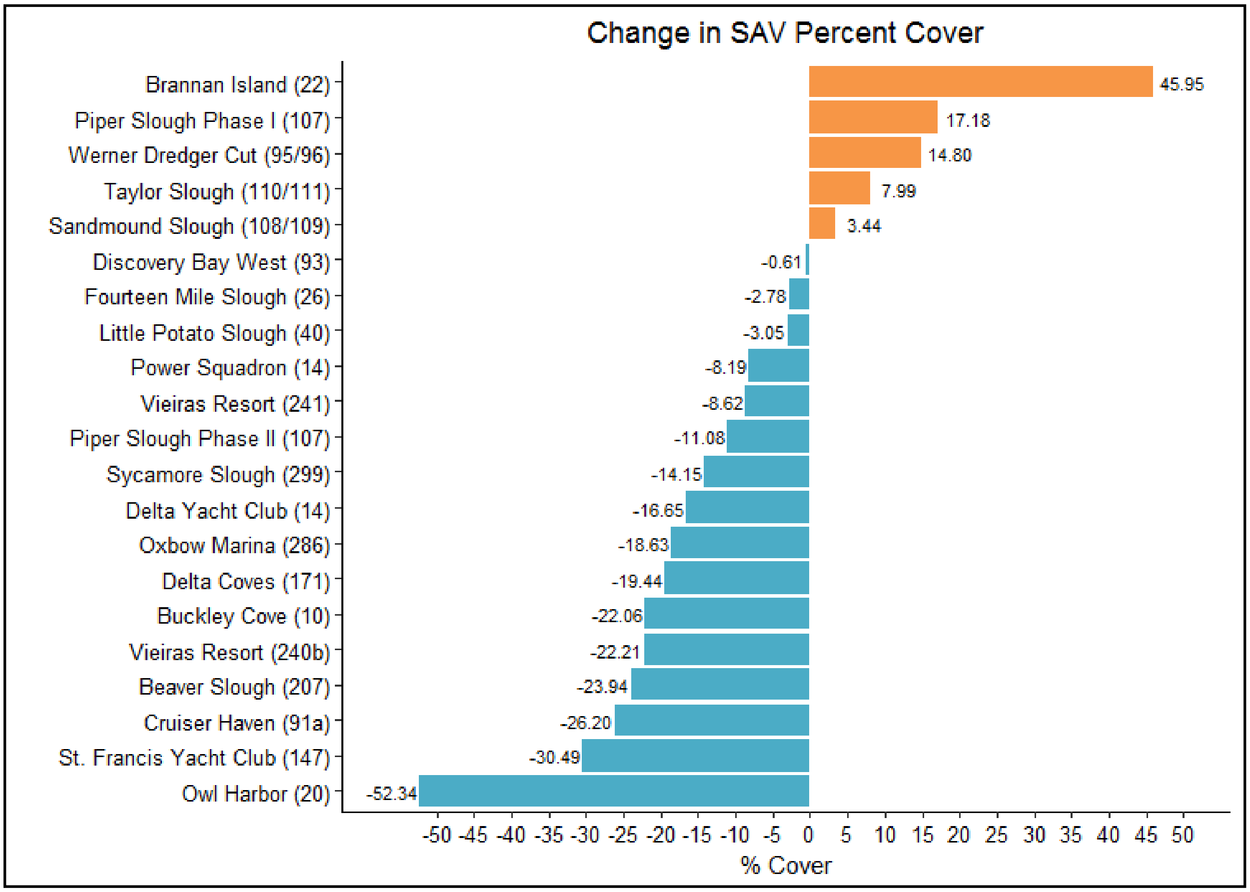
Figure 13B-4. Mean percent change in biovolume between 2016 pre- and post- treatment



Note: (*) Number inside parentheses is site number

As seen in **Figure 13B-4**, only eight out of the 21 sites treated in 2016 had equal to or greater than 10 reduction of biovolume. Out of the remaining 13 sites, 10 sites showed minimal reduction, and 3 sites showed an increase in biovolume. As seen in **Figure 13B-5**, 11 out of the 21 sites had equal to or greater than 10 percent reduction of percent cover. Out of the remaining 10 sites, 5 sites showed minimal reduction of percent cover, and five sites showed an increase in percent cover. Based on the 2016 data, the effectiveness of the use of fluridone to control SAV is mixed, with only 38 to 52 percent of the sites having at least 10 percent reduction of biovolume or percent cover, respectively.

Figure 13B-5. Mean percent change in SAV cover between 2016 pre- and post- treatment



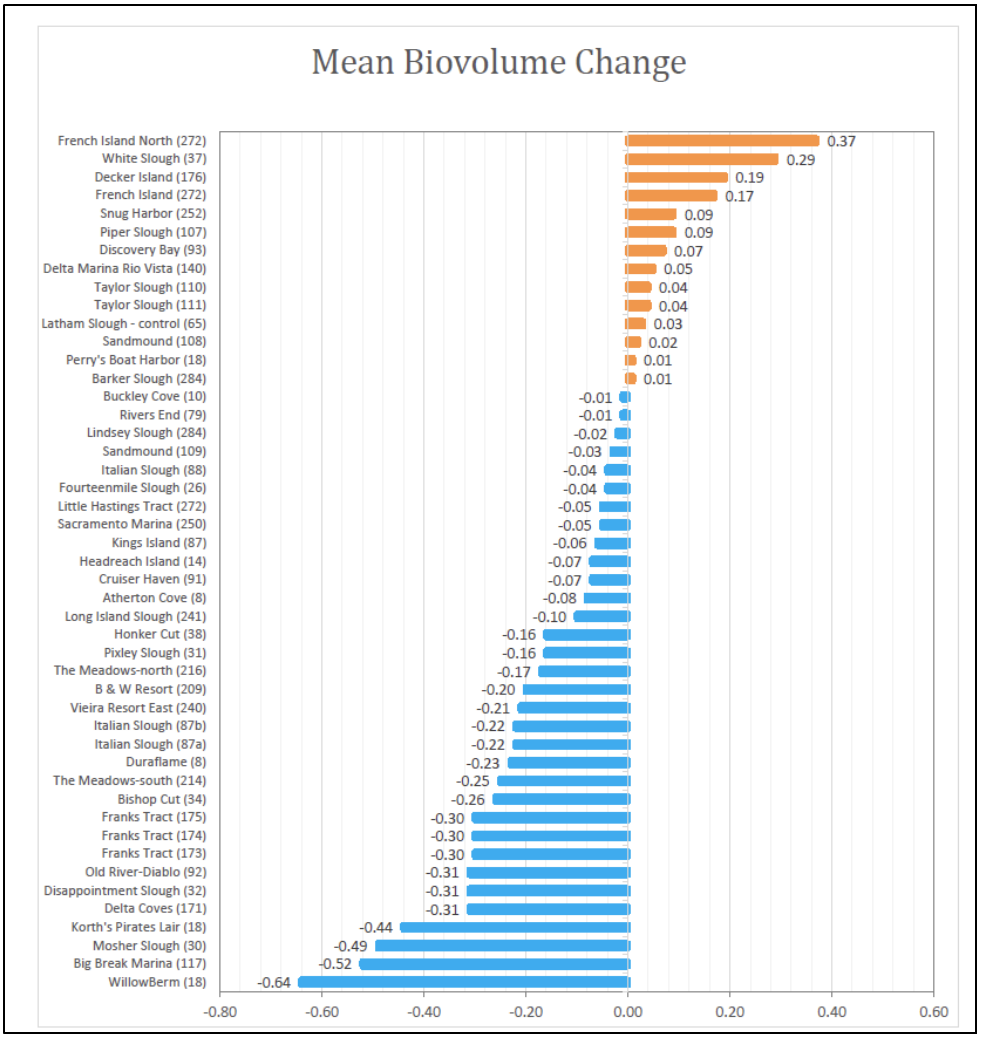
Note: (*) Number inside parentheses is site number

As seen in **Figure 13B-6**, 21 out of the 47 sites treated in 2017 had equal to or greater than 10 percent reduction of biovolume. Out of the remaining 26 sites, 12 sites showed minimal biovolume reduction, and 14 sites showed an increase in biovolume. As seen in **Figure 13B-7**, 24 out of 47 sites treated in 2017 had equal to or greater than 10 percent reduction of percent cover. Out of the remaining 23 sites, 13 sites showed minimal reduction of percent cover and 10 sites showed an increase in percent cover.

Based on the 2017 data, the effectiveness of the use of fluridone to control SAV is mixed, with only 44 to 50 percent of the sites having at least 10 percent reduction of biovolume or percent cover, respectively.

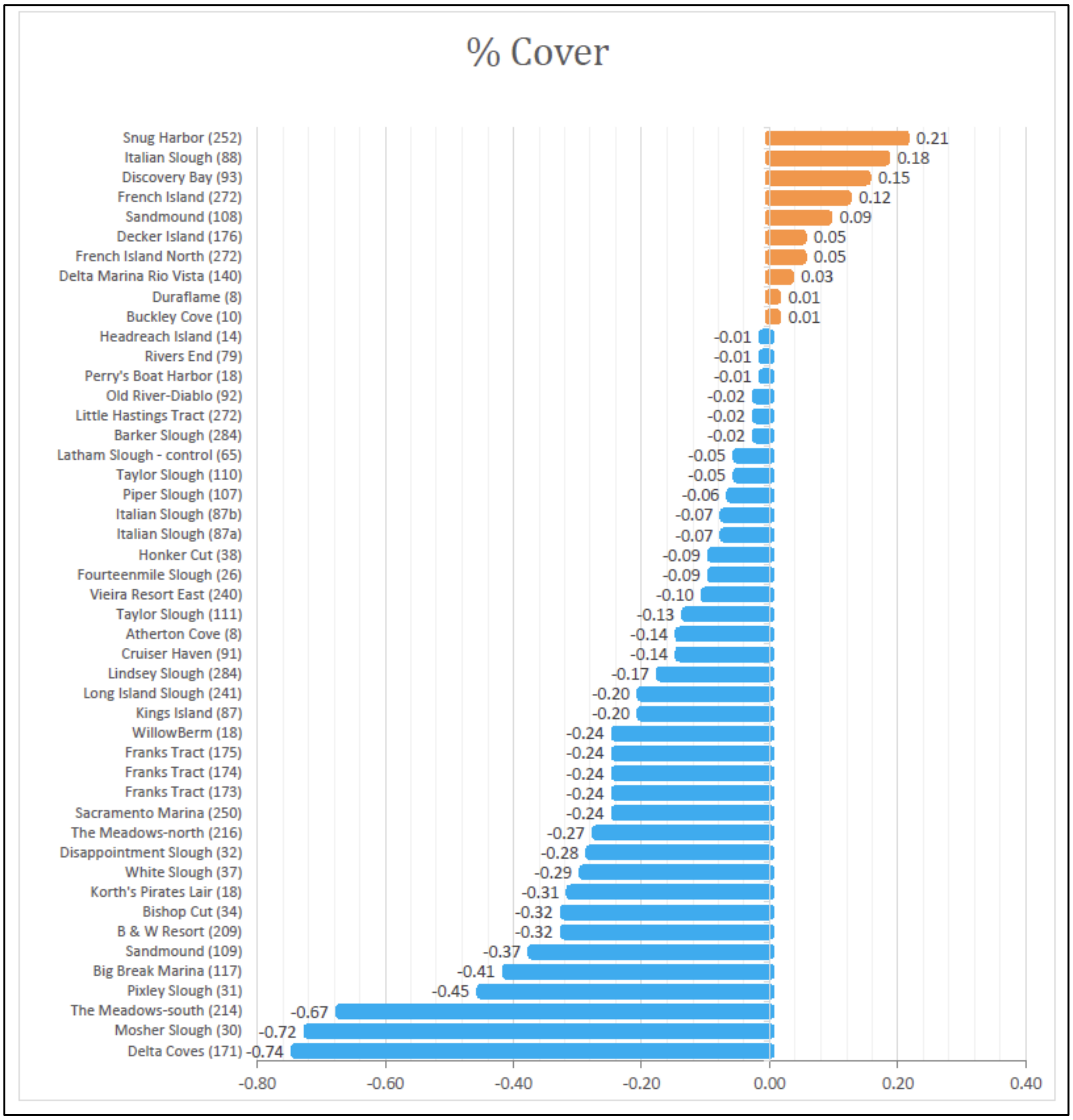
The 2018 annual SAV report did not include data on biovolume or percent cover reduction.

Figure 13B-6. Mean percent change in biovolume between 2017 pre- and post- treatment



Note: (*) Number inside parentheses is site number

Figure 13B-7. Mean percent change in SAV cover between 2017 pre- and post- treatment

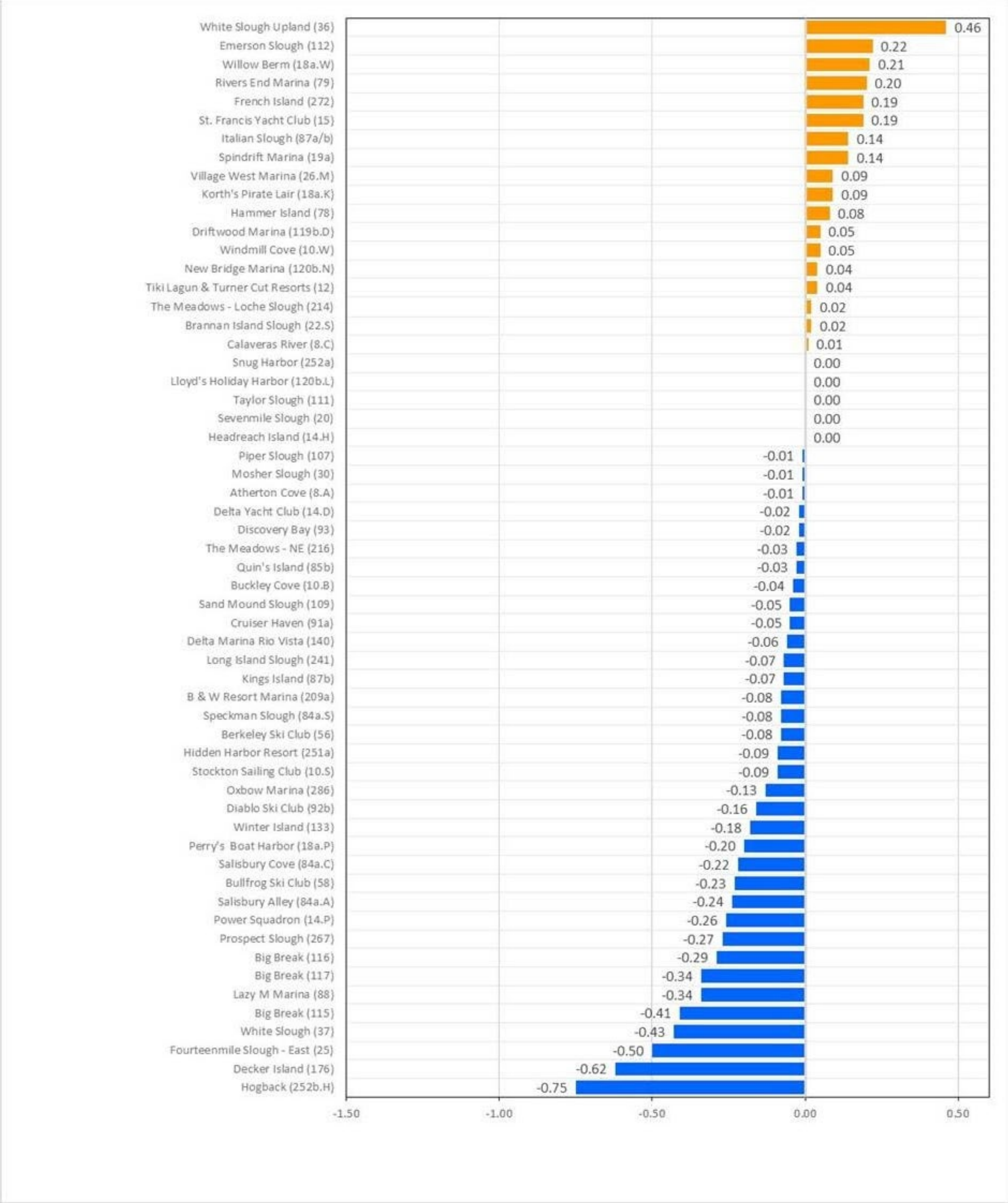


Note: (*) Number inside parentheses is site number

As seen in **Figure 13B-8**, 17 out of the 58 sites treated in 2019 had equal to or greater than 10 percent reduction of biovolume. Out of the remaining 41 sites, 18 sites showed minimal biovolume reduction, and 23 sites showed either not change or an increase in biovolume. As seen in **Figure 9**, 21 out of 62 sites treated in 2019 had equal to or greater than 10 percent reduction of percent cover. Out of the remaining 41 sites, 11 sites showed minimal reduction of percent cover and 30 sites showed either no change or an increase in percent cover.

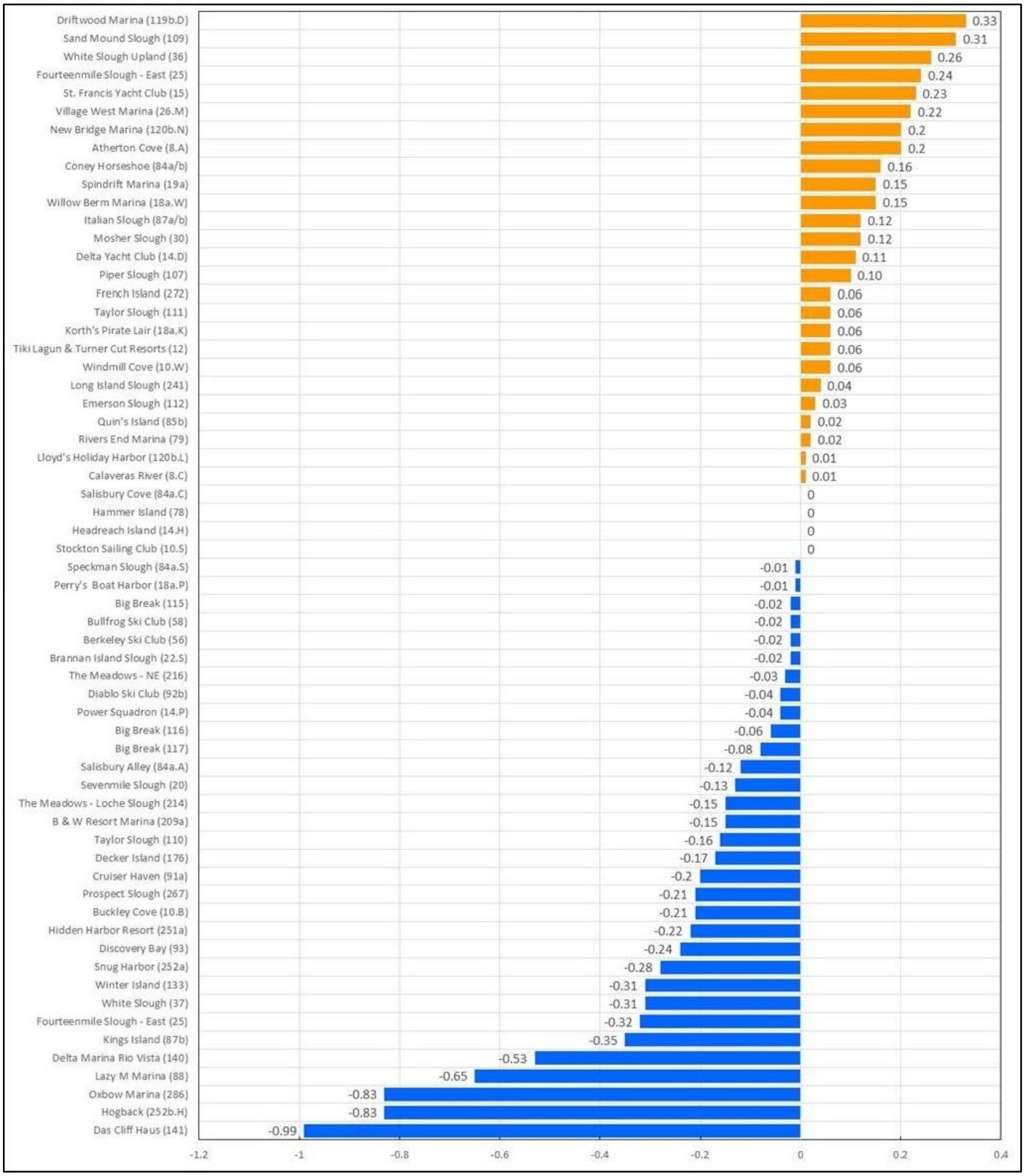
Based on the 2019 data, the effectiveness of the use of fluridone to control SAV is limited, with only 29 to 33 percent of the sites having at least 10 percent reduction of biovolume or percent cover, respectively. Therefore, the overall effectiveness in 2019 was less than in 2016 and 2017.

Figure 13B-8. Mean percent change in biovolume between 2019 pre- and post- treatment



Note: (*) Number inside parentheses is site number

Figure 13B-9. Mean percent change in SAV cover between 2019 pre- and post- treatment



Note: (*) Number inside parentheses is site number

Additional Studies on Effectiveness of SAV Treatments

Related studies on the effectiveness of fluridone to reduce SAV in the Delta were also conducted under the Delta Smelt Resiliency Strategy. Locations of good fish habitat such as Liberty Island have seen major weed encroachment in recent years (Delta Smelt Resiliency Strategy Aquatic Weed Control Action, January 2019). The goal was to remove SAV and restore habitat for Delta Smelt. This study compared two herbicide treatment sites using pelleted fluridone to nearby untreated sites. It was found that over the course of 18 months in both 2017 and 2018, SAV biomass was not reduced by the use of fluridone. It was found that the target fluridone concentrations of 2 to 5 ppb were difficult to maintain in the water, despite high application rates (up to 20 ppb) and frequent applications (weekly). Autosampler data showed that fluridone concentrations in the water decreased with increasing tide gauge height, "suggesting that incoming tides diluted fluridone and outgoing tides likely transported it away from sites."(Rasmussen, 2021). The study concluded that "in the absence of sustained effective concentrations in the water, this slow-acting systemic herbicide is unlikely to damage photosynthetic tissues sufficiently to reduce SAV abundance."

To further support these findings on the ineffectiveness of fluridone, a study was conducted by California Dept. of Fish and Game (Khanna et al, 2021). Efficacy under this study by Khanna was a comparison of treated sites to untreated sites, rather than percent reduction of cover or biovolume. Studies by Khanna et al 2021 show that the fluridone treatments provide only a 10 percent reduction compared to untreated sites, the effect of treatments do not last longer than a year, and consecutive years of treatment were not more effective than single year treatments.

Furthermore, a 2021 report called "Critical Needs of Invasive Aquatic Vegetation in the Sacramento-San Joaquin Delta" concluded that "recent science demonstrates that current treatment methods and monitoring for SAV are not sufficient for reducing coverage, particularly in habitats like those targeted for restoration." Due to the limited efficacy of fluridone, the report proposes the exploration of new tools for SAV control. The most promising tools identified in the current AIPCP Biological Opinions are benthic mats, bubble curtains, and new herbicides.

Benthic mats are thick material laid over the bottom of a water body to prevent growth of submerged vegetation. Following installation, this method is likely to be minimally invasive, but would require maintenance if mats are left in place to avoid sediment accumulation and subsequent plant growth. This method is likely to be cost and time intensive in the short-term but may have lasting impacts on SAV cover. An air bubble curtain, which produces a wall of bubbles from a series of closely spaced release points forms a "curtain" of bubbles in the water column. Bubble curtains could be used in tandem with herbicides to increase water holding time in the treatment areas, thereby holding herbicide concentrations for maximum efficacy. Other herbicides, such as endothall, may also be tested for improving SAV control. The report proposes a collaborative effort in 2021 between the DWR/California Department of Fish and Wildlife Fish Restoration Program and the DBW AIPCP to rapidly investigate the effectiveness at two pilot sites, Decker Island and Prospect Island.

FLOATING AQUATIC VEGETATION

Herbicides to Control FAV

There are four herbicides used for the FAV control program: glyphosate, 2,4-D, imazamox, and penoxsulam. Glyphosate is most frequently used of the four chemicals. The FAV Control Program sprays herbicide directly onto water hyacinth, spongeplant, and/or water primrose and does not inject herbicides into the water column to treat submersed plants.

The time to symptom development in FAV treated with glyphosate ranged from one to three weeks. Visible effects are gradual wilting and yellowing of the plants which eventually advanced to complete browning. For FAV treated with 2,4-D, the time to symptom development is faster, with wilting and chlorosis of the plants being observed as early as two days after treatment. In some cases, treated plants remained floating for a significant amount of time, but most decomposing plants eventually sank into the water column. (2017 Annual FAV report, June 2018).

Health Impacts

Glyphosate is a broad-spectrum systemic herbicide used to kill weeds, especially perennials. Glyphosate currently has a primary drinking water MCL of 700 ppb and a public health goal of 900 ppb. The USEPA classification for glyphosate is “not likely” to be carcinogenic to humans, based on evidence from animals and humans.

2,4-D is a widely used herbicide that controls broadleaf weeds. 2,4-D generally has low toxicity for humans, except certain acid and salt forms can cause eye irritation. Swimming is restricted for 24 hours after application of certain 2,4-D products applied to control aquatic weeds to avoid eye irritation. 2,4-D currently has a primary drinking water MCL of 70 ppb and a public health goal of 20 ppb.

Imazamox is a systemic herbicide that moves throughout the plant tissue and prevents plants from producing a necessary enzyme, acetolactate synthase, which is not found in animals. Susceptible plants will stop growing soon after treatment, but plant death and decomposition will occur over several weeks. Dissipation studies in lakes indicate a halflife ranging from 4 to 49 days with an average of 17 days. There are no drinking water MCL for imazamox and no USEPA Human Health Benchmark for Pesticides (HHBP).

Penoxsulam is also a systemic herbicide that moves throughout the plant tissue and prevents plants from producing ALS. Susceptible plants will stop growing soon after treatment and become reddish at the tips of the plant. Plant death and decomposition will occur gradually over several weeks to months. There is no drinking water MCL for penoxsulam and no acute USEPA HHBP. It has a chronic (long-term) HHBP of 941 ppb. Penoxsulam must remain in contact with plants for around 60 days. (Wisconsin Dept. of Natural Resources Fact Sheet). Because of this long contact period, penoxsulam is likely to be used for larger-scale or whole-lake treatments and should not be used where rapid dilution can occur such as spot treatments or moving water.

Herbicide Usage to Control FAV

Figure 13B-10 shows the chemical usage (mainly glyphosate and 2,4-D) from 2010 to 2019 for FAV, and **Figure 13B-11** shows the acreage treated from 1990 to 2019. **Figure 13B-12** shows the 210 sites where treatment occurred in 2017. In addition, FAV was mechanically harvested from October 2015 to May 2019 from waterways of the Delta that were identified as being a nursery site or having high infestations of water hyacinth, spongeplant and/or water primose.

Figure 13B-10. Herbicide Usage for FAV by year for 2010 to 2019

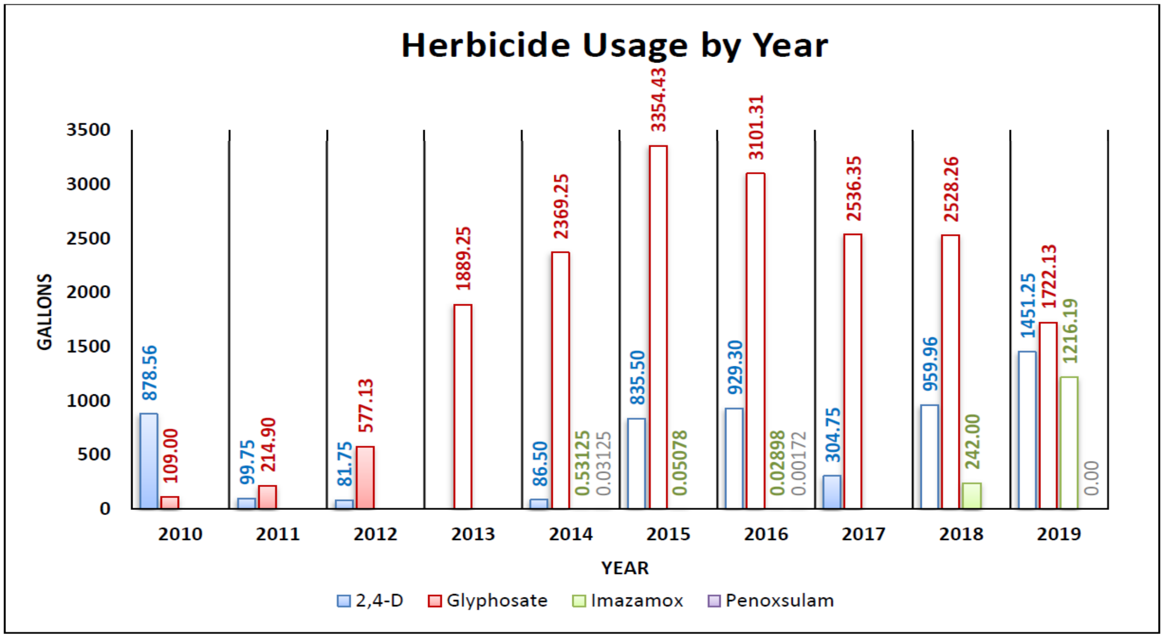


Figure 13B-11. Number of Acres Treated from 1990 to 2019 for FAV

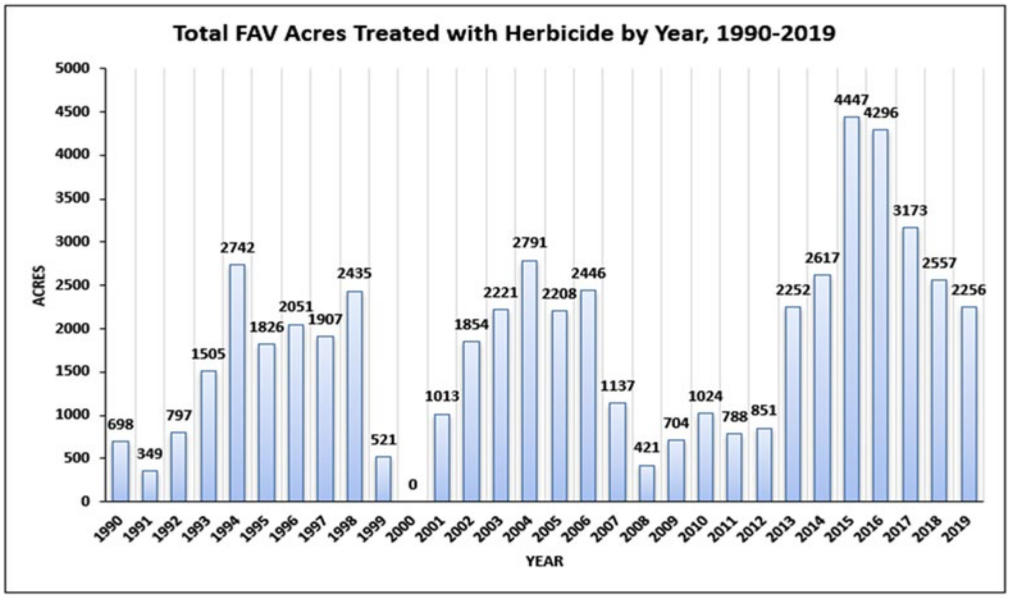
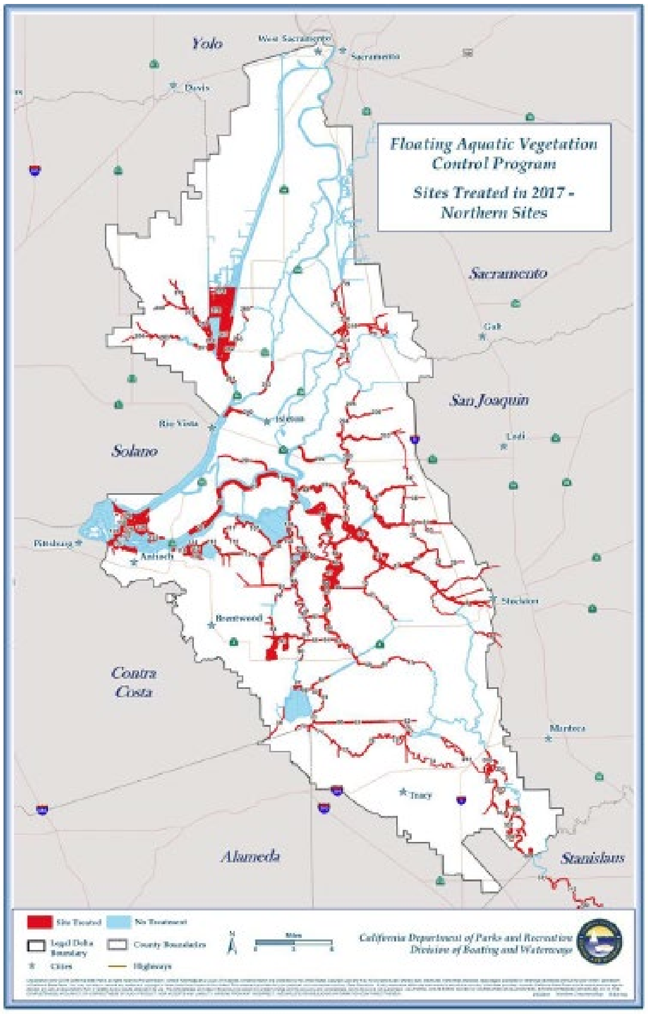


Figure 13B-12. Map of 2017 Northern FAV Treatment Sites



Herbicide Residual Concentrations After Treatment

DBW is required to document herbicide residues in receiving waters, specifically through the Aquatic Pesticide Application Plan (APAP), which is required by and approved by the State Water Resources Control Board. According to the NPDES permit, the number of sufficient monitoring sites varies by project (Email communication, Gurgagn Chand, April 2021). Since the monitoring required by the APAP is fairly limited, it is difficult to make conclusions about residual herbicide concentrations after treatment.

Although 210 sites were treated, only a total of four sites were monitored in 2017 (Two sites for 2,4-D and two sites for glyphosate). Samples are required to be taken upstream of the treatment area, inside the treatment area, and downstream of the treatment area. Samples are to be taken at three times; pre-treatment (usually day before), immediately after treatment, and one week after treatment. All of the samples were well below the MCL of 70 ppb for 2,4-D and 700 ppb for glyphosate. The maximum glyphosate sample was 1.03 ppb and the maximum 2,4-D sample was 1.59 ppb. Maximum residue limits are equivalent to USEPA municipal drinking water standards, or MCLs. Herbicide residue shall not exceed the following concentrations in receiving waters as shown in **Table 13B-5.**

Table 13B-5. Receiving Water Limits for Herbicides Used for FAV Control

Herbicide Active Ingredient	**Maximum Concentration, µg/L**
2,4-D	70
Glyphosate	700
Imazamox	No receiving water limit
Penoxsulam	No receiving water limit

According to the annual reports from 2016 to 2019, all herbicide residue concentrations at receiving water stations were either not detected or were below receiving water limits.

Effectiveness of FAV Treatments

Unlike the SAV treatments, there are no hydroacoustic biomonitoring to provide detailed, quantitative metrics of the change in bio-volume and percent cover in treated sites. Based on surveys by DBW staff, FAV was better controlled in 2017 as there were observed decreases in the amount of FAV biomass present in Delta waterways, primarily water hyacinth. During the 2016 to 2017 winter, an increase in precipitation and water flows flushed large concentrations of water hyacinth out of the Delta and towards marine waters (CDBW, 2019 annual report)

In 2019, photo point monitoring for FAV was implemented into the control program to monitor floating aquatic vegetation changes over a period of time. This process consists of taking repeated pictures with the same field of view of the same location (site) at multiple pre-selected locations (sites). In 2018, the FAV team took pictures twice a year, but in 2019 the team decided to take pictures three times a year. This included taking pictures in the spring (pre-growth season), mid-summer (during peak growth season of floating aquatic plants) and during the winter (when plants start their dormancy period).

SUMMARY

- Invasive Aquatic Vegetation is a problem that appears to be worsening, resulting in the need for increased chemical usage in recent years (2017 to 2019) compared to 2013 to 2016.
- Currently, fluridone is used for SAV control, at concentrations far below levels of concern to human health. However, fluridone has not shown to be effective in controlling SAV. Therefore, different chemicals may be used more in the future, such as diquat and endothall, and both have a drinking water MCL.
- Based on the annual DBW reports, reductions in SAV biovolume and percent cover after treatment with fluridone have mixed results. Reductions for SAV biovolume and percent cover were worse in 2019 (compared to 2016 and 2017), as only 29 to 33 percent of sites had at least a 10 percent reduction of biovolume or percent cover.

- Studies by Khanna et al 2021 show that the treatments provide only a 10 percent reduction compared to treated sites, the effect of treatments do not last longer than a year, and consecutive years of treatment were not more effective than single year treatments.
- Studies by Rasmussen et al 2021 also confirm that SAV was not reduced in the Delta after fluridone application, likely due to the tidal environment.
- New tools such as benthic mats, bubble curtains, or new herbicides are proposed to be deployed at Decker Island and Prospect Island in 2021. As of September 2021, benthic mats and bubble curtains have not been deployed, as they require approval by the Army Core of Engineers.
- For control of Egeria, the most effective results with a 98 percent of control were demonstrated in Indian Slough, when diquat (contact herbicide) was used as a follow-up to a fluridone (systemic herbicide) treatment.

RECOMMENDATION

- As mentioned earlier, a collaborative effort in 2021 between the DWR/California Department of Fish and Wildlife Fish Restoration Program and the DBW AIPCP was proposed to rapidly investigate new control methods at two pilot sites, Decker Island and Prospect Island. Contractors should continue to track this effort as chemicals may change, or new tools such as benthic mats or bubble curtains may provide new solutions to control aquatic vegetation.

- Contractors may wish to sample more frequently for endothall and diquat if being used in the Delta more frequently.

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CHAPTER 13C ENDOTHALL TREATMENTS

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ENDOTHALL TREATMENTS AT CLIFTON COURT

BACKGROUND

From 1995 until 2006, Clifton Court forebay (CCF) was treated with copper-based herbicides (mainly Komeen) to control aquatic weeds, predominantly Brazilian waterweed, or *Egeria densa* (National Marine Fisheries Services letter to DWR, August 25, 2015). Herbicide treatments ceased in 2006 when the southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris)* was listed as a threatened species. From 2006 to 2015, DWR mechanically removed weeds in CCF using boat harvesters. However, this method had limited effectiveness, which resulted in reduced pumping rates at Banks Pumping Plant. Over this time period, the aquatic vegetation in Clifton Court Forebay changed from predominantly *Egeria densa* to one dominated by curly-leaf pondweed, sago pondweed, and southern naiad.

In April 2015, DWR proposed to begin using Aquathol K in both CCF and O'Neill Forebay. The active ingredient in Aquathol K is endothall. In August 2015, DWR received a letter from the National Oceanic and Atmospheric Administration (NOAA)'s National Marine Fisheries Services (NMFS) which approved the use of Aquathol K in CCF. The approval letter stated that "due to the low toxicity of the Aquathol K at the proposed application concentration and the proposed application methods, the use of Aquathol K in CCF is unlikely to impact listed salmonids and is preferred over the currently use copper-based herbicides." Subsequent approval letters from NMFS, along with concurrence from the United States Fish and Wildlife Service (USFWS) and California Department of Fish and Wildlife (CDFW), in 2016 and 2017 addressed DWR's request to apply Aquathol K and copper sulfate from June 29 through August 31, which was previously July 1 through August 31.

All operational procedures for aquatic herbicide application in CCF as described in the 2008 USFWS biological assessment and the modified 2011 USFWS biological assessment for delta smelt were in place for treatments which occurred prior to 2020. Herbicide applications in 2020 followed modified operational procedures in the 2019 NMFS and USFWS Biological Opinions and 2020 Incidental Take Permit (ITP). The modified treatment procedures allow for herbicide treatments outside of the June 29 to August 31 window under special conditions and with approval from NMFS, CDFW and USFWS.

WATER QUALITY CONCERN

The active ingredient in Aquathol K is 40.3 percent dipotassium salt of endothall. The targeted application rates for endothall are 2 to 3 mg/L, which is 20 to 30 times the primary drinking water maximum contaminant level (MCL) of 0.1 mg/L. As the first downstream drinking water intake (Zone 7 Water Agency) is located within approximately 8 hours of CCF, the downstream water agencies are greatly concerned in regards to the residual concentration of endothall remaining after treatment. During the 2018 endothall treatment, a special study was conducted to obtain information about the reduction of endothall levels in the CCF and transport downstream through the South Bay Aqueduct (SBA). The study was also repeated in 2019 and 2020. Special study results are presented below. It should be noted that in 2020, the target endothall dose was 1.25 mg/L since it was used in conjunction with copper sulfate.

Description of Special Study at Clifton Court Forebay

As mentioned above, endothall sampling was conducted during a one-time annual treatment in 2018 and 2019. There were two treatments in 2020, which occurred on June 29 and November 3. According to DWR staff, the November treatment in 2020 occurred due to regrowth of vegetation in the CCF, and there was an opportunity to schedule a treatment as the Banks and South Bay PP were scheduled for a planned maintenance outage. In 2018 and 2019, grab samples were collected at 2-hour time intervals in CCF, and once water was released from CCF, downstream sampling at Banks Pumping Plant (Banks) and South Bay Pumping Plant (SBPP) occurred every 4 hours for approximately six to seven days, using autosamplers. These locations are shown in **Figure 13-C1**. **Figure 13C-2** shows the 2020 treatment area, which is normally the southeast portion of the forebay.

In June 2020, grab samples were collected at 2-hour time intervals in CCF, and downstream sampling using autosamplers at Banks and SBA Check 2 occurred every 4 hours for approximately six to seven days. Daily grab samples were also collected at Dyer Reservoir in 2020. SBA Check 2 and Dyer Reservoir are shown in **Figure 13C-3.** In November 2020, no samples were collected in CCF, but autosamplers at Banks and SBA Check 2 collected downstream samples every 4 hours for two to three days.

DWR contracts with Clean Lakes Inc. (CLI), Inc. to apply aquatic herbicides to control aquatic vegetation. All treatments were performed by CLI staff in possession of current qualified applicator licenses and certificates in the Aquatics category issued by the California Department of Pesticide Regulation. Aquathol K was applied from a boat, with hosing injecting the chemical about 3 to 4 feet below the water surface. Generally, the treatment areas within CCF have been in shallow water, ranging from three to 4.5 feet.

Figure 13C-1. Sampling Locations at CCF, Banks and South Bay Pumping Plant

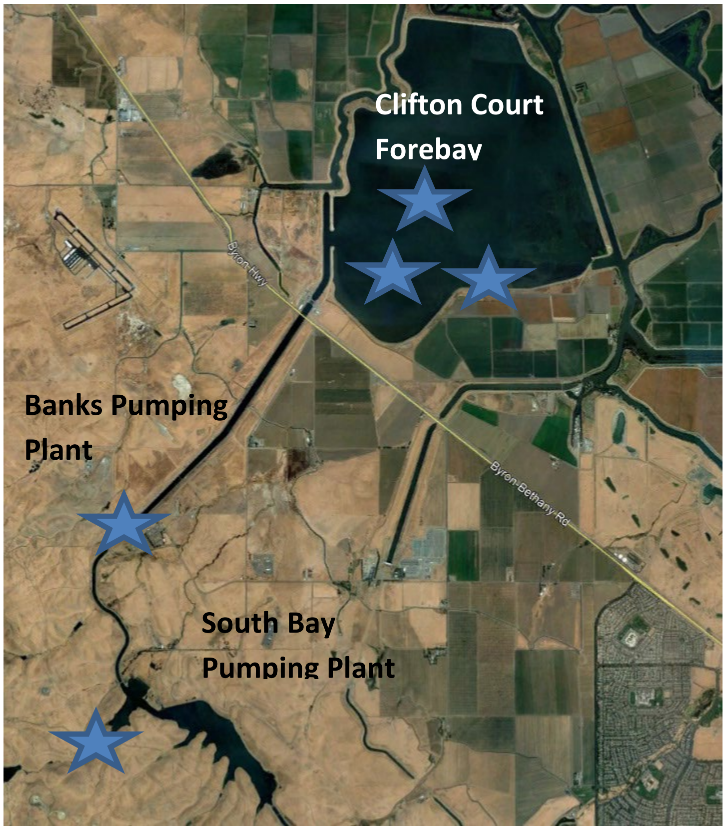


Figure 13C-2. Typical treatment area in Clifton Court Forebay

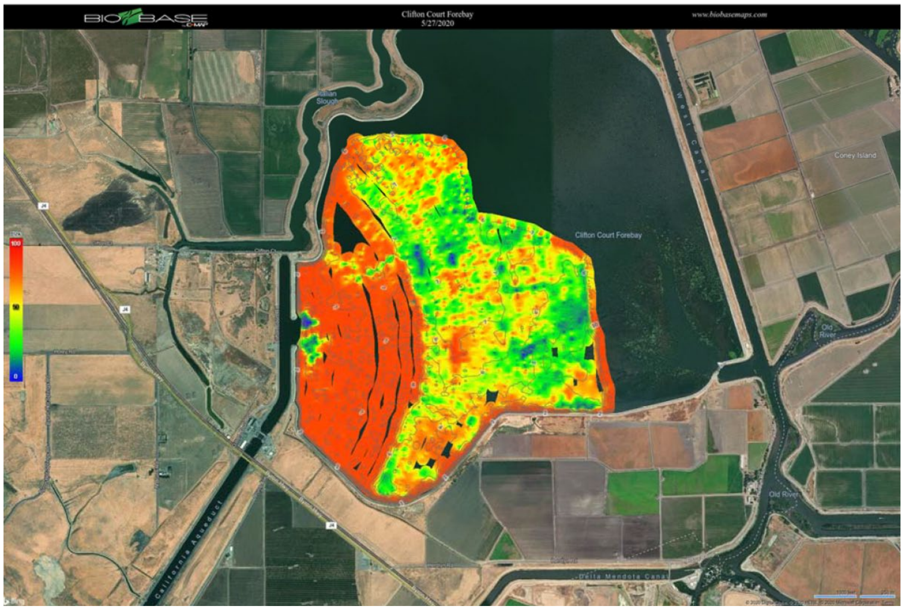
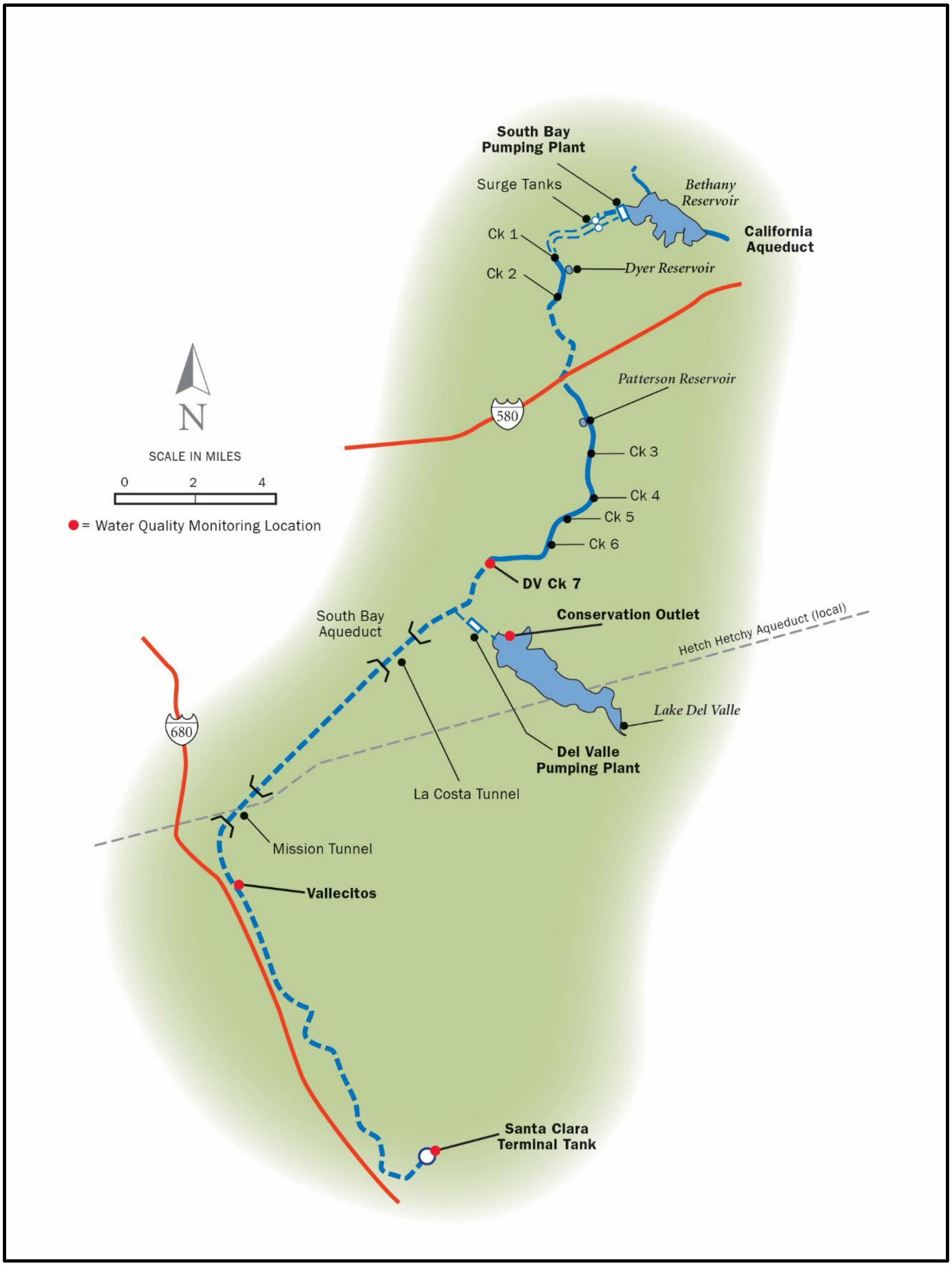


Figure 13C-3. Sampling Locations at Bethany, Dyer and SBA water agencies



Endothall Application

As shown in **Table 13C-1**, endothall treatments have occurred on a yearly basis since 2016. The surface area and volume treated in CCF do not vary much from year to year, with approximately 38.2 to 43.0 percent of the surface area and 22.7 to 24.6 percent of the volume of CCF needing treatment. The applied dosage has been 2 mg/L, with the exception of 1.25 mg/L being applied in 2020. A lower dosage of 1.25 mg/L of endothall was applied in 2020 as Komeen (copper) was also applied at a dosage of 0.75 mg/L. CLI felt that the application of two chemicals would have a synergistic effect, and the endothall concentration could be lowered.

Table 13C-1. Summary of Aquathol K Treatments in CCF

Date	Treatment Surface Area (acres)	Forebay Surface Area (acres)	Percent of Forebay Surface Area	Treatment Volume (AF)	Average Forebay Volume (AF)	Percent of Forebay Volume	Application Rate (mg/L)	Aquathol K Volume (gallons)
6/29/2016	937	2,180	43.0%	3,760	16,540	22.7%	2	4,812
7/7/2017	937	2,180	43.0%	3,749	16,540	22.7%	2	4,812
6/29/2018	915	2,180	42.0%	3,879	16,540	23.5%	2	4,903
6/29/2019	915	2,180	42.0%	3,812	16,540	23.0%	2	4,903
6/29/2020	910	2,180	41.7%	3,924	16,540	23.7%	1.25	3,143
11/3/2020	833	2,180	38.2%	4,061	16,540	24.6%	1.25	3,250

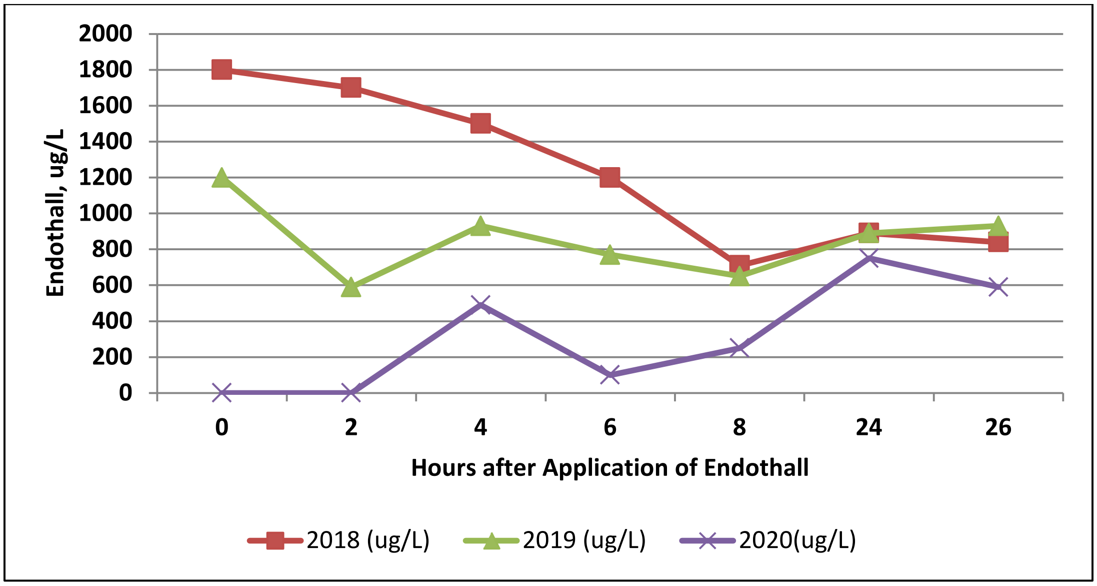
SPECIAL STUDY RESULTS

The study results will be presented by location, from upstream to downstream location. Combined endothall results collected at the CCF will be presented for 2018, 2019 and 2020 as these results are not dependent on operational pumping rates (which change from year to year), compared to downstream locations. Results at Banks and SBPP will be presented by year. It should be noted that the SBPP sampling location was replaced with the SBA Check 2 location in 2020.

The biological opinions require the closure of the Clifton Court Intake Radial gates 24 hours prior to endothall treatment. During this time, water in Clifton Court is allowed to "draw-down" to allow fish to move out of proposed treatment areas. After 24 hours, the endothall treatment begins and Banks Pumping Plant is also shutoff at the start of herbicide treatment, thereby keeping endothall inside the forebay. Endothall is applied by boat in various treatment zones within the CCF. Endothall applications generally do not conclude until the late afternoon. Since a minimum 24-hour hold period is required for contact time between the herbicide and the vegetation, Banks Pumping Plant will not resume until the late afternoon of the following day. **Figure 13C-4** shows the endothall concentrations at a given location in the CCF over the 24 to 26 hour hold period for treatments conducted in 2018, 2019, and 2020. It should be noted that no samples were collected after the 8 hour period until the 24 hour period, as this was the evening and nighttime period and no samples could be collected from the boat. The percent reduction of endothall from time zero to 8 hours was 60 percent in 2018 and 45 percent in 2019. The 2020 results did not have detectable concentration at the zero or two hour time sample, but if it was assumed that the starting concentration was 1,250 µg/L (application dose), this would have resulted in a 80 percent reduction.

Interestingly, in all years, endothall concentrations increased from the 8 hour sample to the 26 hour sample. This could be because endothall is not taken up by plant material when there is no sunlight. Concentrations may increase due to the mixing of CCF water during the nighttime hours. It is important to note that endothall concentrations at the 26 hour sample were still higher than the MCL of 100 µg/L; for example, resultant concentrations at the 26 hour time were 840 µg/L in 2018, 930 µg/L in 2019, and 590 µg/L in 2020.

Figure 13C-4. Endothall concentrations during 24 hour-hold time in CCF



2018 Operation and Special Study Results

As mentioned above, when the minimum 24-hour hold time at CCF is completed, pumping at Banks may resume. Water then flows through the Banks Inlet Channel to Bethany Reservoir. If the South Bay Pumping plant is on, then water is pumped from Bethany Reservoir into the SBA Aqueduct. Water also continuously flows by gravity and exits Bethany, moving downstream into the California Aqueduct.

In 2018, when the 24-hour hold time at CCF was completed, Banks resumed pumping at a low rate, about 375 cfs, as shown in **Figure 13C-5.** The SBPP resumed pumping about 10 hours after Banks resumed pumping. As shown in **Figure 13C-5**, endothall concentrations at Banks peaked at 100 µg/L (on 7/1 at 5am) and remained at this level for about 16 hours. This peak occurred 9 hours after Banks resumed pumping. There was a second peak of endothall at Banks which measured 97 µg/L, and lasted for 4 hours. This second peak occurred 65 hours after Banks resumed pumping.

Although the endothall concentration at Banks reached the MCL of 100 µg/L, no endothall was detected at the SBPP for any samples collected over the 7 day period, as shown in **Figure 13C-6.**

Figure 13C-5. Endothall Concentrations at Banks Pumping Plant, 2018 Application

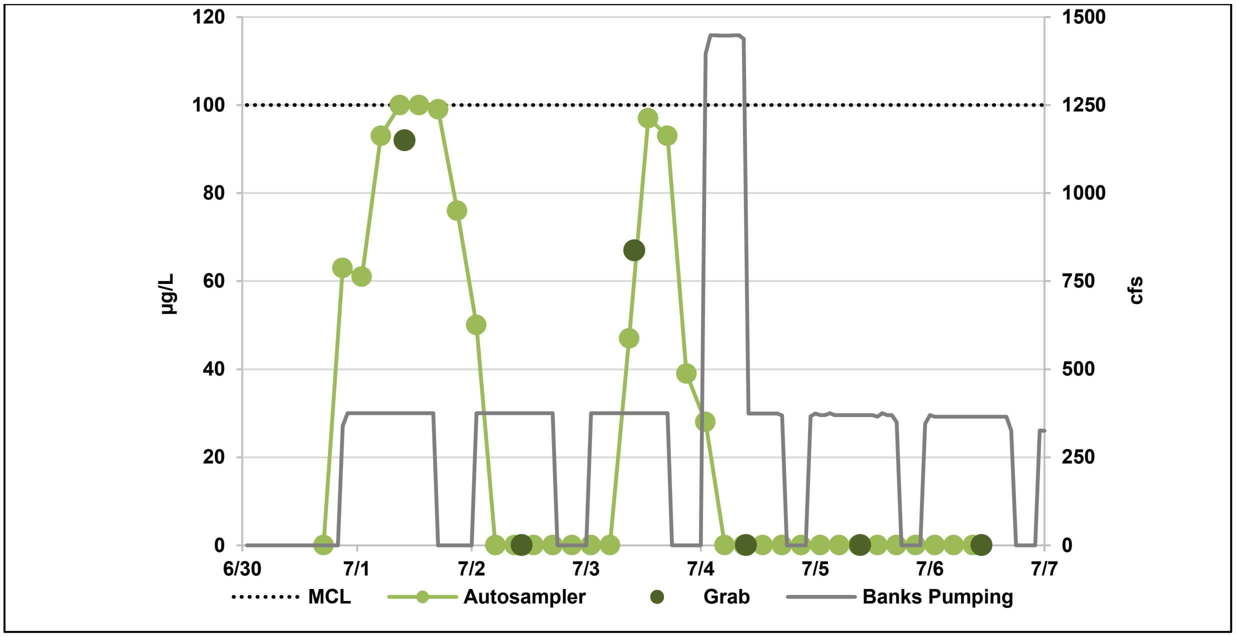
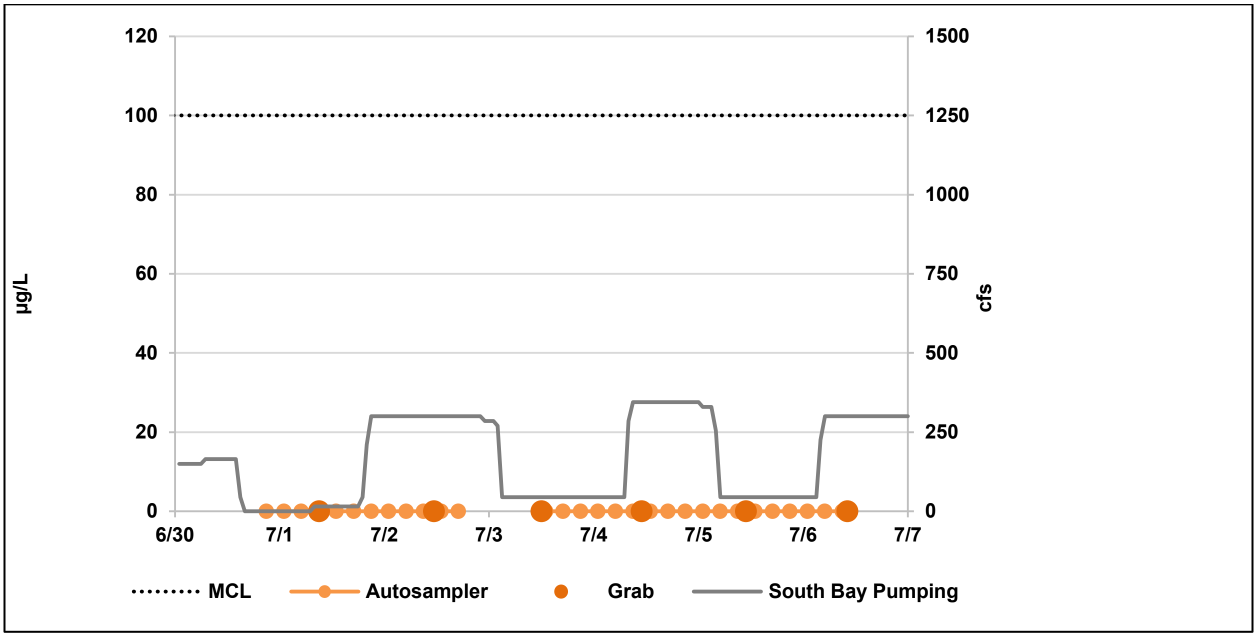


Figure 13C-6. Endothall Concentrations at South Bay Pumping Plant, 2018 Application



2019 Operation and Special Study Results

In 2019, when the 24-hour hold time at CCF was completed, Banks resumed pumping at a high rate, about 7,000 cfs, as shown in **Figure 13C-7.** The SBPP resumed pumping at the same time Banks resumed pumping. As shown in **Figure 13C-7**, endothall concentrations at Banks peaked at 590 µg/L (on 7/1 at 1am) and remained above the MCL of 100 µg/L for about 24 hours. This peak occurred 5 hours after Banks resumed pumping. Unlike the 2018 results, there was not a second peak of endothall at Banks.

Also, unlike the 2018 results, endothall was detected at the SBPP, as shown in **Figure 13C-8.** Endothall was detected above the MCL of 100 µg/L for about 28 hours, with a peak of 360 µg/L, 28 hours after pumping resumed (on 7/2/2019 at 1am). (Two samples were missed on 7/2/2019 due to autosampler programming error).

Zone 7 Water Agency, Alameda County Water District (ACWD), and Valley Water also collected samples at their respective treatment plants. Zone 7 Water Agency collected both raw and treated water samples on 7/1/2019 and 7/5/2019 and all samples were non-detectable. ACWD collected a raw and treated water sample on 7/2/2019; the raw water sample was non-detectable (ND) and the treated water sample was 30 µg/L. It should be noted that the ACWD samples did not meet the temperature and hold time requirements, and serve for informational purposes only. Valley Water collected raw and treated water samples on 7/1/2019 and 7/2/2019 and results were non-detectable. Raw and treated water samples were also collected by Valley Water on 7/3/2019; the raw water sample was 19 µg/L and the treated water sample was not analyzed due to not meeting sampling requirements.

Figure 13C-7. Endothall Concentrations at Banks Pumping Plant, 2019 Application

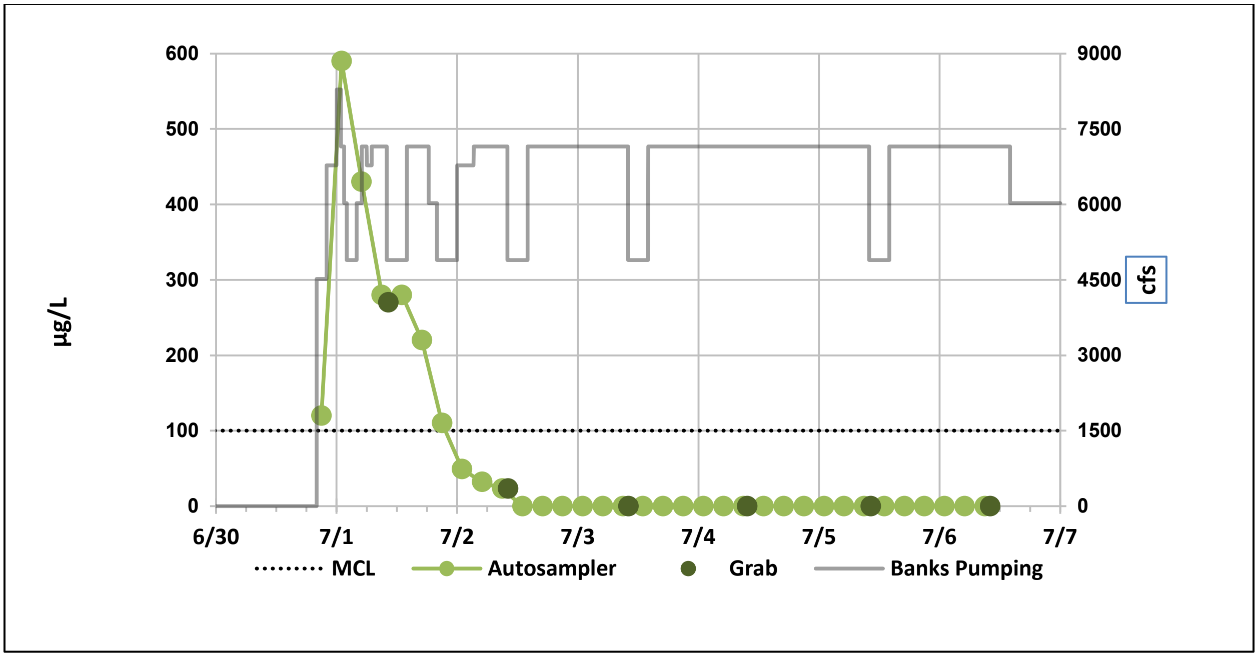
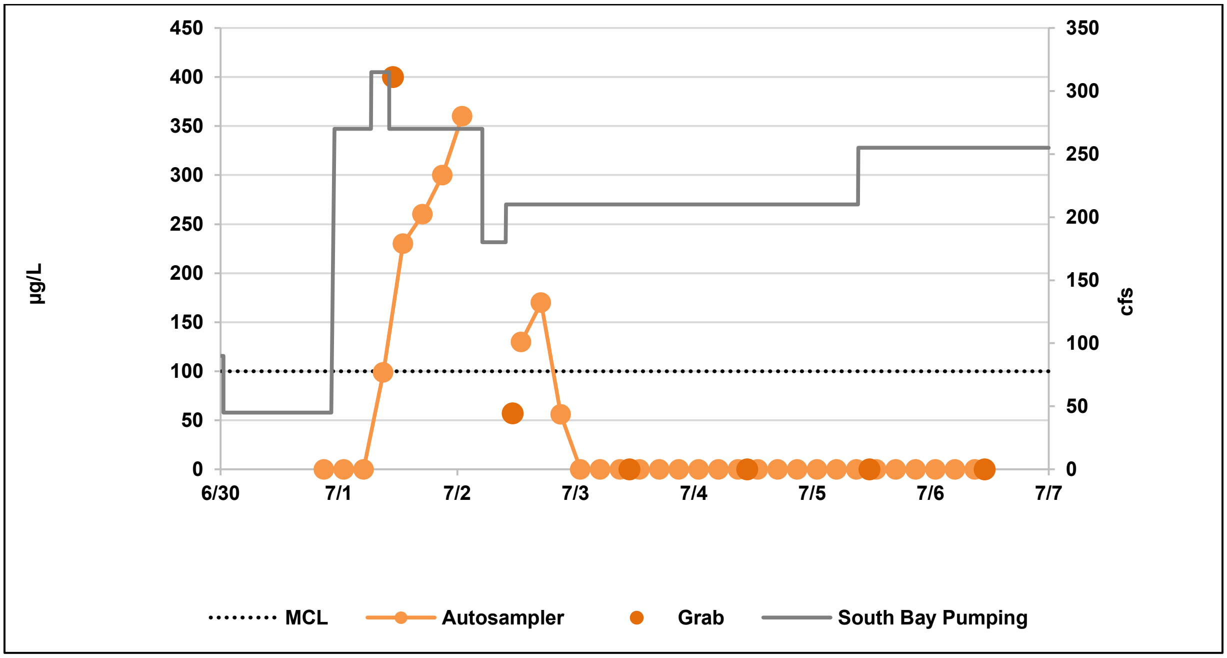


Figure 13C-8. Endothall Concentrations at South Bay Pumping Plant, 2019 Application



June 2020 Operation and Special Study Results

In early 2020, alternative operational plans were made to accommodate for potentially high pumping rates at Banks, which was shown to quickly move endothall into the SBA in 2019. In order to reduce the impact of high pumping at Banks, SBA contractors agreed to limit their demand to 200 cfs for a 48 hour period, which would allow the SBPP to be off for a 48 hours (in addition to the 24 hour hold time in CCF). In other words, pumping start times at Banks and SBPP would be staggered by 48 hours. This would be different compared to 2019, when SBPP was pumping when Banks resumed pumping. DWR O&M staff determined that the 200 cfs demand could be meet by using releases from Lake Del Valle and Dyer Reservoir. Once the 48 period had ended, and South Bay Pumping Plant would need to resume pumping, it was hoped that endothall concentrations would be below the MCL.

In 2020, when the 24-hour hold time at CCF was completed, Banks resumed pumping at 3,390 cfs the evening of 6/30, then decreased to 2,260 cfs the morning of 7/1, and another decrease to 1,130 cfs the afternoon of 7/1 as shown in **Figure 13C-9**. As shown in **Figure 13C-9**, endothall concentrations at Banks peaked at 610 µg/L (on 7/1 at 5am) and remained above the MCL of 100 µg/L for about 28 hours. This peak occurred 12 hours after Banks resumed pumping. It is important to note that by the time SBPP resumed pumping on the afternoon of 7/2, endothall concentrations were non-detectable at Banks.

SBPP resumed pumping 48 hours after pumping at Banks resumed. As shown in **Figure 13C-10**, endothall concentrations at SBA Check 2 peaked at 78 µg/L (on 7/3 at 1am) and dropped to non-detectable levels 8 hours later (on 7/3 at 9am). **This study showed that the operational changes made in 2020 to keep South Bay Pumping Plant off for 48 hours, kept endothall**

concentrations lower than the MCL in the SBA. Another major change was that the dosage concentration of endothall was 1.25 mg/L, compared to 2 mg/L which was applied in all previous annual CCF treatments.

Zone 7 Water Agency, ACWD, and Valley Water also collected samples to analyze for endothall at their treatment plants. Zone 7 collected two treated water samples on July 6, 2020 and both samples were non-detectable. ACWD collected raw and treated water samples (twice a day) from July 2 to July 5, and all results were non-detectable. Valley Water collected raw and treated water at the Penitencia Water Treatment Plant from July 4 to July 7, and all results were non-detectable.

Figure 13C-9. Endothall Concentrations at Banks, June 2020 Application

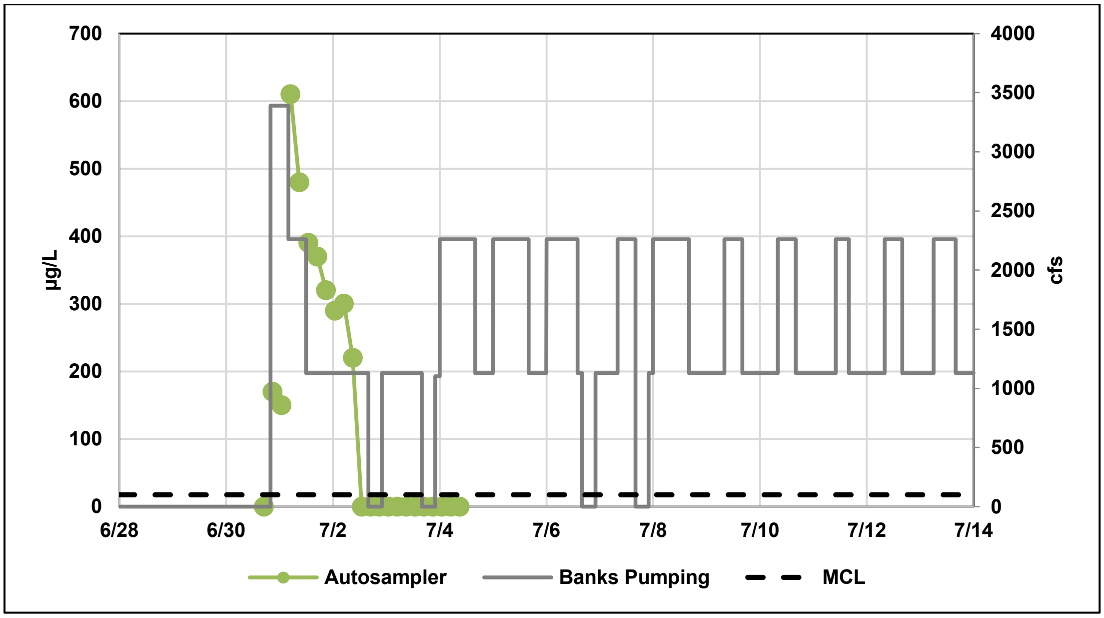
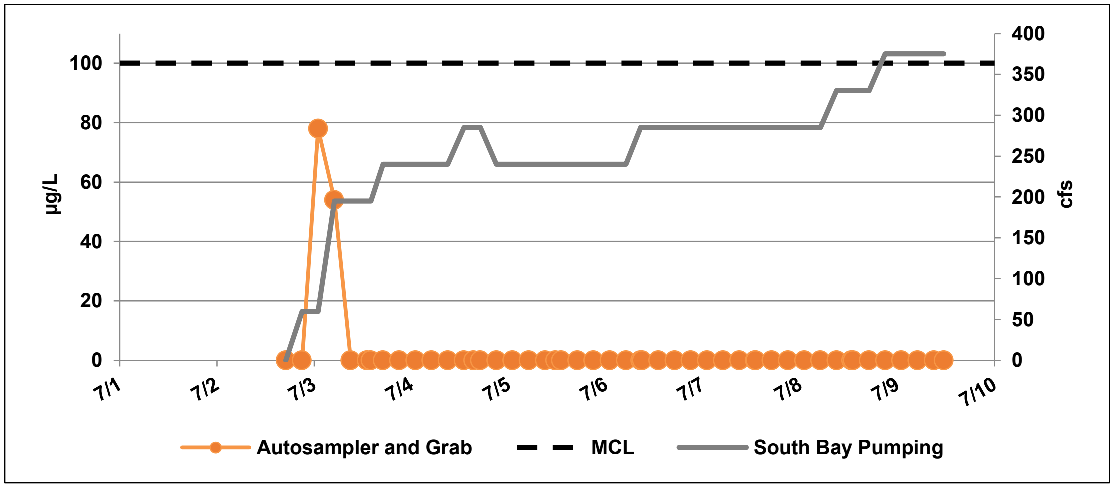


Figure 13C-10. Endothall Concentrations at SBA Check 2, June 2020 Application



November 2020 Operation and Special Study Results

Due to vegetation regrowth in the CCF after the June treatment, and the planned maintenance outage at Banks Pumping Plant, a second endothall treatment occurred on November 3, 2020. Overall, this treatment had much longer hold times in both CCF and Bethany, compared to past treatments. For example, the endothall treatment occurred on November 3, and Banks did not resume pumping until November 7th at 14:00, which is approximately 96 hours, or four days of hold time. Once water was pumped into Bethany, the SBPP did not resume pumping until the morning of November 9 at 9:00, which added an additional 43 hours that water was not pumped from Bethany into the SBA.

Detectable levels were seen at Banks (**Figure 13C-11)** when pumping resumed on November 7th; as levels were above the 100 µg/L MCL for a 24 hour period, however SBPP was not pumping at this time. It should be noted that although above the MCL, these concentrations at Banks were much lower compared to 2019 and June 2020 results. The long hold times were effective in reducing endothall residual, as all samples collected at SBA Check 2 were non-detectable as shown in **Figure 13C-12**.

Figure 13C-11. Endothall Concentrations at Banks, November 2020 Application

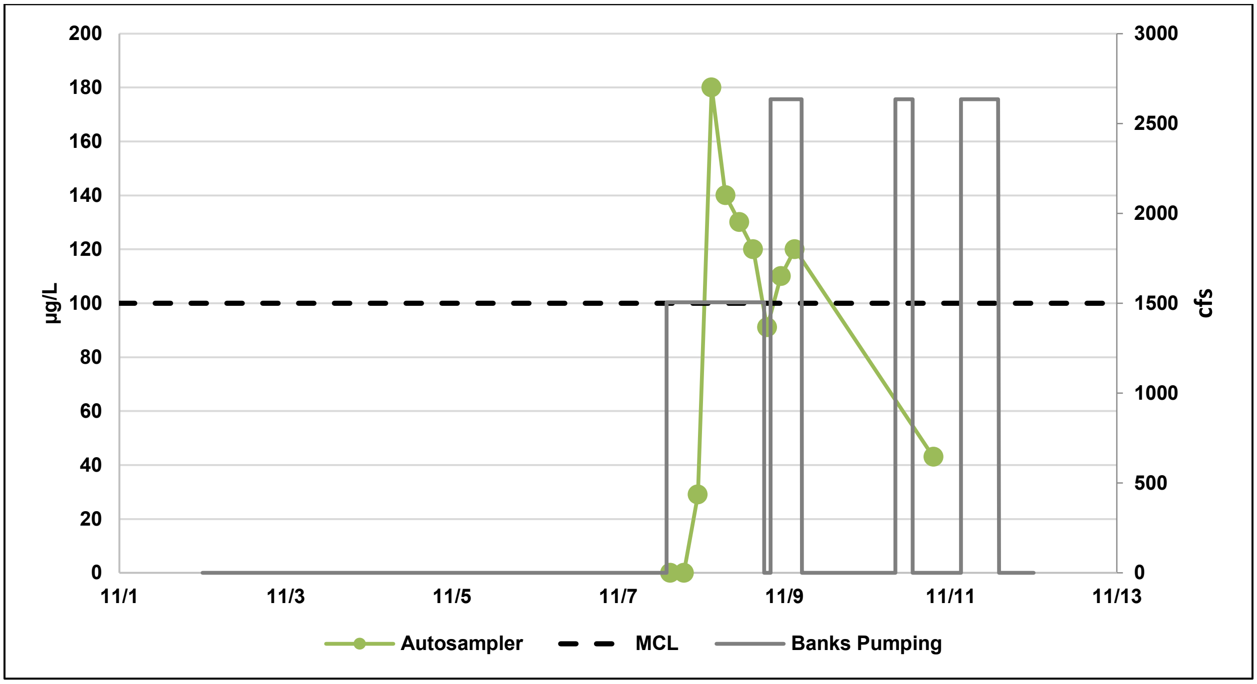
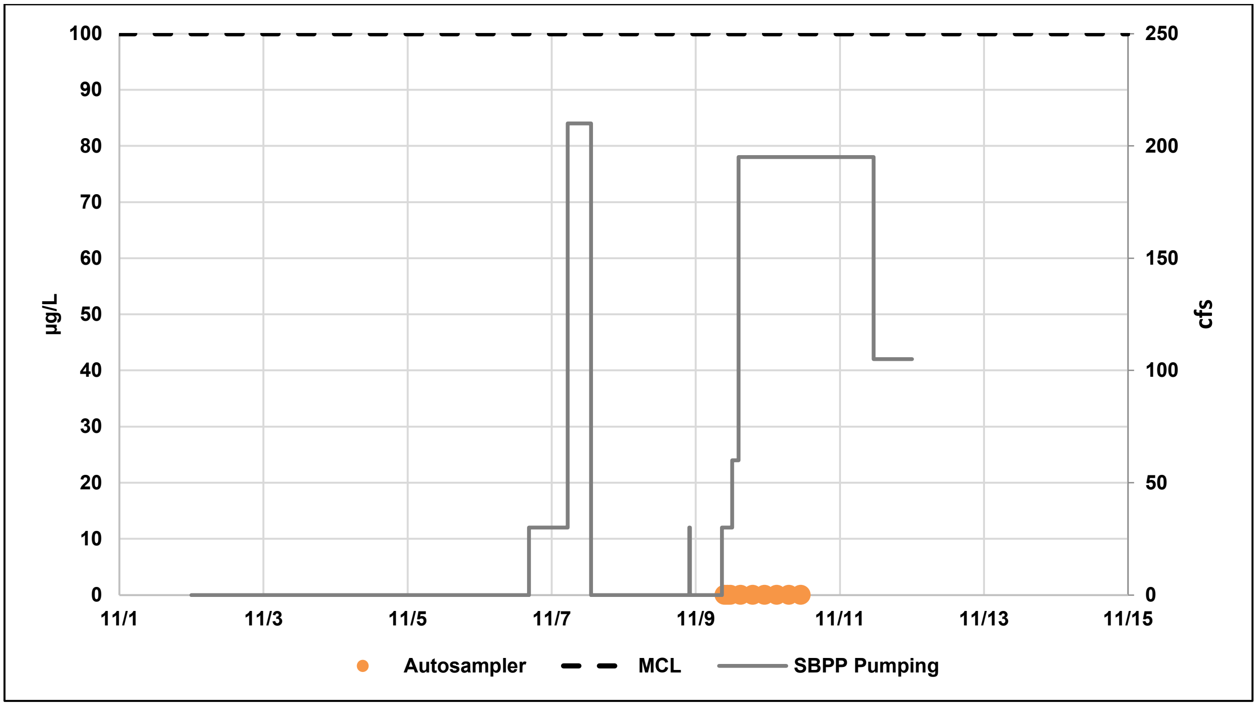


Figure 13C-12 . Endothall Concentrations at SBA Check 2, November 2020 Application



ACWD and Valley Water also collected samples to analyze for endothall at their treatment plants. ACWD collected raw and treated water samples (twice a day) on November 9 and 10, and all results were non-detectable. Valley Water collected raw and treated water at the Penitencia Water Treatment Plant from November 10 to November 11, and all results were non-detectable.

EFFICACY

DWR's contractor, CLI performs a pre-treatment inspection and survey of the system to ensure an accurate assessment of the aquatic vegetation growth. CLI utilizes Submersed Aquatic Vegetation (SAV) mapping technology (BioBase System) to record SAV characteristics in the treatment areas. Data is collected to evaluate aquatic weed coverage, height in the water column, and bio-volume. A post-treatment inspection is then conducted about 30 days after the treatment to support Post-Treatment efficacy evaluations.

Based on the information provided in **Table 13C-2**, the efficacy of endothall has been decreasing since 2016 when endothall replaced copper as the main chemical to reduce aquatic vegetation. Notably, the efficacy in 2018 and 2019 was less compared to the 2016 and 2017 treatments. CLI could not provide a reason for the lack of efficacy in 2018. For 2019, the SAV increased as *Egeria* (and *Cladophora*) grew in after the pondweed was treated, as endothall is not effective for *Egeria*. In June 2020, copper was used in conjunction with endothall and this showed a dramatic improvement in the decrease of biovolume, which was a decrease of 73.2 percent. It is unclear why the area did not also follow the same trend with a marked decrease. CLI suspects that it is related to the measurement of surface area using the mapping technology software (email from Tom McNabb to Daniel Wisheropp, October 2020).

The variability in efficacy demonstrates the need to reevaluate the herbicides to be used for every treatment, based on the plant species present.

Table 13C-2. Treatment Efficacy at Clifton Court Forebay

Pre-Veg Survey Date	Post-Veg Survey Date	Treatment Date	Percent Increase or Decrease in SAV Area	Percent Increase or Decrease in Bio-Volume
6/14 and 6/20/16	7/28/2016	6/29/2016	-91.04%	-70.42%
5/30/2017	8/9/2017	7/7/2017	-35.80%	-52.90%
6/7/2018	7/31/2018	6/29/2018*	-29.80%	41.60%
6/17/2019	8/2/2019	6/29/2019	-9.40%	-27.40%
5/27/2020	7/31/2020	6/29/2020	-16.5%	-73.2%
10/20/2020	12/2/2020	11/3/2020	-21.9%	-79.5%

CONSTRAINTS

There are operational constraints which must be accommodated for an application to be "approved". Endothall applications at CCF can only occur from June 28th to August 31 of each year (without special approval from NMFS, USFWS, and CDFW). As environmental restrictions are lifted and downstream water demands usually increase on July 1 and dictate pumping rates, DWR prefers to have the herbicide application take place on June 28 to 29 to allow for the 24 hour hold time in CCF. As the pumping rate at Banks is driven by downstream demand, the pumping rate at Banks cannot be predetermined, and Banks must resume pumping within 24 hours.

Similarly, South Bay Pumping Plant must resume pumping within 24 to 48 hours to address demand from SBA contractors.

SUMMARY

As demonstrated in 2018, the low pumping rate at Banks reduced the downstream peak of endothall, keeping endothall concentrations at or below the MCL at Banks and non-detectable at SBPP. This was in contrast to 2019, when the pumping rate was high at Banks, and the SBPP resumed pumping at the same time as Banks. As a result, endothall concentrations at the SBPP remained above the MCL of 100 µg/L for about 28 hours in 2019. For the June 2020 treatment, it was decided to keep SBPP off for 48 hours, in addition to the 24 hours hold time in CCF, and additionally, the applied endothall dosage was reduced to 1.25 mg/L. In June 2020, endothall concentrations at SBA Check 2 never reached above the MCL, although endothall was detectable below the MCL for 8 hours. In November 2020, water was held in CCF for approximately 96 hours (before Banks started pumping), and there was an additional 43 hours before SBPP started pumping. This resulted in no detectable endothall at SBA Check 2 after CCF treatment.

These studies have provided a better understanding of the fate and transport of endothall from CCF and through the SBA. For example, it has been shown that the 24 hour hold time in the CCF reduces the endothall concentration by 45 to 60 percent. However, this still results in endothall residual concentrations higher than the MCL, with applied dosages ranging from 1.25 to 2 mg/L. Longer hold times in the CCF result in lower endothall concentrations at Banks, as demonstrated in November 2020. Staggering the pump start times at Banks and South Bay Pumping Plant also proved to be beneficial in keeping the endothall concentrations below the MCL at SBA Check 2 for both the June and November 2020 treatments, as this provided for additional time before SBPP started pumping water into the SBA. Lower pumping rates at Banks Pumping Plant results in lower endothall concentrations at Banks as shown in 2018. If pumping rates at Banks and SBPP are not staggered and are high, detectable concentrations of endothall can move through the SBA. Therefore, there are a number of factors which influence the amount of residual endothall reaching the downstream intakes:

- Application or Dosage concentration of endothall
- Pumping rates at Banks and South Bay Pumping Plant, and ability to stagger pump start times
- Amount of contact time or "hold" time in CCF and Bethany
- Availability of releases from Lake Del Valle and Dyer Reservoir which can be used to prolong South Bay PP outages, or possible use as a source to blend endothall concentrations down in the SBA.

The contractors will continue to work closely with DWR to optimize all of the conditions above, to the extent possible, in order to keep endothall concentrations below the MCL in the source water. It should be noted that endothall was never detected in any valid treated water samples collected by the water agencies.

REFERENCES

2016 Aquatic Pesticide Application Report (APAR) Application Dates: June 29, 2016, Clifton Court Forebay and Banks Pumping Plant Channel. Prepared by Clean Lakes Inc. Prepared for DWR Delta Field Division.

2017 Aquatic Pesticide Application Report (APAR) Application Dates: July 7, 2017, Clifton Court Forebay and Banks Pumping Plant Channel. Prepared by Clean Lakes Inc. Prepared for DWR Delta Field Division, August 2017.

2018 Aquatic Pesticide Application Report (APAR) Application Dates: June 29, 2018, Clifton Court Forebay and Banks Pumping Plant Channel. Prepared by Clean Lakes Inc. Prepared for DWR Delta Field Division, October 2018.

2019 Aquatic Pesticide Application Report (APAR) Application Dates: June 29, 2019, Clifton Court Forebay and Banks Pumping Plant Channel. Prepared by Clean Lakes Inc. Prepared for DWR Delta Field Division, September 2019.

2020 Aquatic Pesticide Application Report (APAR) Application Dates: June 29, 2020, Clifton Court Forebay and Banks Pumping Plant Channel. Prepared by Clean Lakes Inc. Prepared for DWR Delta Field Division, September 2020.

ENDOTHALL TREATMENTS AT O'NEILL FOREBAY

BACKGROUND

According to DWR staff, the predominant vegetation present in O'Neill Forebay in the last ten to twenty years has been various pondweed species and *Egeria densa* to a lesser extent. (Email communication, Tanya Veldhuizen, March 2021). In April 2015, DWR proposed to begin using Aquathol K in both CCF and O'Neill Forebay (ONF). There are no restrictions placed on the timing of aquatic pesticides at O'Neill Forebay. However, since O'Neill Forebay is part of the San Luis Joint-Use complex, the scheduling of treatments must be coordinated with the Bureau of Reclamation. The San Luis Joint-Use complex includes O'Neill Dam and Forebay, Sisk Dam, San Luis Reservoir, Gianelli Pumping-Generating Plant, Dos Amigos Pumping Plant and a 103-mile portion of the California Aqueduct.

WATER QUALITY CONCERN

The active ingredient in Aquathol K is 40.3 percent dipotassium salt of endothall. As the targeted application rates for endothall at O'Neill Forebay is 3 mg/L, this is 30 times the primary drinking water MCL of 0.1 mg/L. CLI has indicated that a higher dosage is needed at ONF compared to CCF, due to the smaller width and size of the plots. The first downstream State Water Project drinking water intake (Central Coast Water Authority) is approximately 4.5 days downstream from O'Neill Forebay. Similar to the SBA, a special study was initiated in 2018 to obtain information about the reduction of endothall levels in the ONF and transport downstream through the California Aqueduct. The study was also continued in 2019 and 2020.

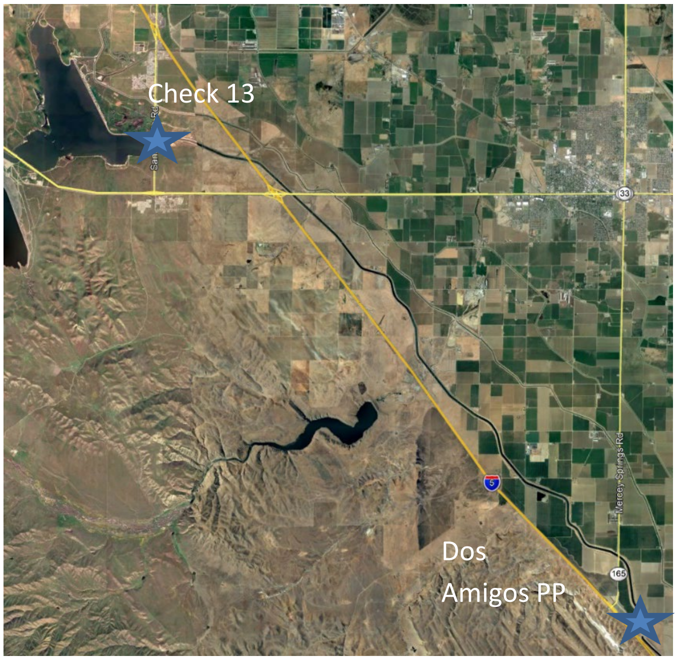
Description of Special Study at O'Neill Forebay

As mentioned above, endothall sampling was conducted in coordination with the one-time annual treatments in 2018 and 2020. In 2019, two smaller endothall treatments were conducted in August and September, but sampling was conducted only for the first treatment in August 2019. Unfortunately, the contract lab used for the 2018 study reported possible chemical interference with organic matter in the raw water, which may have affected the endothall data. (The lab indicated that they typically analyze for endothall in treated drinking water). Therefore, only endothall data from the 2019 and 2020 studies will be discussed.

In 2019, four sites were sampled within the O'Neill Forebay on the day of treatment every two hours for six hours, as shown in **Figure 13C-13.** Daily sampling was conducted at two downstream locations for four days after treatment: Check 13 and Dos Amigos Pumping Plant, as shown in **Figure 13C-14**. In 2020, daily samples at Check 13 and Dos Amigos Pumping plant were conducted for three days after treatment; no forebay sampling was conducted. Although water can be pumped from O'Neill Forebay to the San Luis Reservoir via the Gianelli pumping plant, it was not necessary to sample San Luis Reservoir since the Gianelli pumping plant was generating power, and therefore, releases were occurring from San Luis Reservoir into the O'Neill Forebay. It is also important to note that even if water was pumped from the O'Neill Forebay into the San Luis Reservoir, the San Luis Reservoir has a much larger volume compared to the O’Neill Forebay, and any introduced endothall pumped from the O’Neill Forebay would be greatly diluted in the San Luis Reservoir.

Figure 13C-13. Endothall Sampling Locations at O’Neill Forebay

Figure 13C-14. Endothall Sampling Locations at Check 13 and Dos Amigos Pumping Plant



SPECIAL STUDIES

DWR contracts with CLI to apply Aquathol K to control aquatic vegetation. All treatments are performed by CLI staff in possession of current qualified applicator licenses and certificates in the Aquatics category issued by the California Department of Pesticide Regulation. Endothall is applied from a boat, and according to the aquatic pesticide application report prepared by CLI "herbicide applications were made to the lower portion of the water column." Generally, the treatment areas within O'Neill Forebay have been in shallow water, ranging from three to six feet.

As shown in **Table 13C-3**, endothall treatments have occurred on a yearly basis since 2015, except for 2017 when no endothall was applied. The surface area and volume treated in ONF do not vary much from year to year, with approximately 1 to 6 percent of the surface area and 0.3 to 2 percent of the volume of ONF needing treatment. It should be noted that the surface area and volume being treated at O'Neill Forebay is much less compared to CCF. The applied endothall dosage at O'Neill Forebay has been held at 3 mg/L for all treatments.

Table 13C-3. Summary of Aquathol K Treatments in ONF

Date	Treatment Surface Area (acres)	Forebay Surface Area (acres)	Percent of Forebay Surface Area	Treatment Volume (AF)	Average Forebay Volume (AF)	Percent of Forebay Volume	Application Rate (mg/L)	Aquathol K Volume (gallons)
8/14/2015	170	2,700	6%	937.5	47,804	2%	3	1,800
8/3/2016	170	2,700	6%	911.5	47,804	2%	3	1,750
6/12/2018	159	2,700	6%	911.5	47,804	2%	3	1,640
8/7/2019	25	2,700	0.9%	135	47,804	0.3%	3	259
9/24/2019	99.9	2,700	3.7%	521	47,804	1.1%	3	1,000
6/30/2020	130.6	2,700	4.4%	698.3	47,804	1.3%	3	1,341

2019 Special Study Results

As discussed earlier, endothall samples were collected at four locations in the O'Neill forebay on the day of treatment. For each site, samples were collected every two hours for 6 hours. Samples were also collected at Check 13 and the Dos Amigos Pumping Plant from August 8 (day after treatment) to August 11 (four days after treatment). All samples were non-detectable for endothall, with a reporting limit of 20 µg/L. The Central Coast Water Authority (CCWA) did not collect samples at their intake due to the non-detectable levels at Check 13 and Dos Amigos Pumping Plant.

2020 Special Study Results

In contrast to the 2019 results, endothall was detected in downstream samples as shown in **Table 13C-4**. It is notable that levels were detectable at the Dos Amigos Pumping Plant, which is approximately 18 miles downstream of Check 13. 2020 results may have been higher than the 2019 results as the area treated was about 4 times greater than in 2020, compared to 2019. The Dos Amigos Pumping Plant was pumping higher after the 2019 treatment, compared to the 2020 treatment, suggesting that the larger area treated in 2020 was the determining factor in detectable levels of endothall downstream.

The CCWA estimated the travel time to reach their intake along the Coastal Aqueduct based on flows, and collected a raw and treated water sample on July 8, and both samples were non-detectable.

Table 13C-4. Endothall Results After 2020 Endothall Treatment at O'Neill Forebay (µg/L)

Location	6/30/2020 13:00	7/1/2020 12:55	7/2/2020 12:05	7/2/2020 13:02	7/3/2020 9:40	7/4/2020 10:15
Check 13	<20	<20	52			
Dos Amigos PP				<20	61	33

For the June 2018 treatment, Check 13 radial gates remained open, Dos Amigos was off from 6:00 to 16:00, then one unit running (1250 cfs) for 16:00 to 19:00, then two units (2500 cfs) for 19:00 to 21:00, then three units (5000 cfs) for 22:00 into the next day. Gianelli P/G and O'Neill P/G had zero flow until midnight on the day of treatment.

For the August 2019 treatment, Check 13 radial gates remained open, Dos Amigos pumped at its normal rate (7,200 to 9,500 cfs), and Gianelli P/G plant had zero flow during the treatment.

For the 2020 treatment, Check 13 radial gates remain opened and Dos Amigos also remained pumping at 2 units (3,700 to 4,200 cfs), and Gianelli P/G and O'Neill P/G had zero flow until midnight on the day of treatment.

EFFICACY

DWR's contractor, CLI performs a pre-treatment inspection and survey of the system to ensure an accurate assessment of the aquatic vegetation growth. CLI utilizes Submersed Aquatic Vegetation (SAV) mapping technology (BioBase System) to record SAV characteristics in the treatment areas. Data is collected to evaluate aquatic weed coverage, height in the water column, and bio-volume. A post-treatment inspection is then conducted about 30 days after the treatment to support Post-Treatment efficacy evaluations.

Table 13C-5 shows the treatment efficacy of endothall at O'Neill Forebay. Control efficacy was higher in years 2015 and 2016 when the aquatic herbicide applications were performed later in the season (August) compared to the June 2018 applications. (O'Neill Forebay 2018 APAR, page 4). In the 2018 post-vegetation survey, Naiad (*Najas spp.*), various Pondweed spp, and Coontail (*Ceratophyllum demersum*) were found growing in portions of the treatment area on August 3, 2018. (O'Neill Forebay 2018 APAR, page 4). The Naiad (*Najas spp.*) growth cycle occurs later in the season, and this species contributed to an increase in post Treatment SAV percent cover and bio-volume.

With the exception of the 2018 treatment, all other treatments conducted from 2015 to 2020 were effective in reducing the SAV cover and bio-volume.

Table 13C-5. Treatment Efficacy at O'Neill Forebay

Pre-Veg Survey Date	Post-Veg Survey Date	Treatment Date	Percent Increase or Decrease in SAV Area	Percent Increase or Decrease in Bio-Volume
8/3/2015	9/11/2015	8/14/2015	-59.60%	-77.43%
6/9/2016 and 8/3/2016	8/31/2016	8/3/2016	-41%	-62%
6/1/2018	8/3/2018	6/12/2018	13%	31%
8/7/2019	9/4/2019	8/7/2019	-7%	-51%
9/24/2019	10/22/2019	9/24/2019	-52%	-72%
5/27/2020	8/11/2020	6/30/2020	-4%	-53%

SUMMARY

The endothall studies have provided a better understanding of the fate and transport of endothall from O'Neill Forebay and downstream the California Aqueduct. Unlike the CCF treatments, there is no requirement to hold water in the O'Neill Forebay and it is more difficult to close the Check 13 radial gates since the facility is part of the San Luis Joint-Use complex. Fortunately, the shoreline areas needing treatment in O'Neill Forebay are a small percentage of the total area and volume of O'Neill Forebay. There are a few factors which influence the amount of residual endothall reaching the downstream intakes and may be controlled/adjusted:

- Application or Dosage concentration of endothall
- Percent area or volume to be treated
- Pumping rates at Dos Amigos Pumping Plant

The contractors will continue to work closely with DWR to optimize all of the conditions above, to the extent possible, in order to keep endothall concentrations below the MCL in the source water.

REFERENCES

O'Neill Forebay Aquatic Herbicide and Application Services, Aquatic Pesticide Application Report (APAR), Application Date August 14, 2015. Prepared by Clean Lakes Inc. Prepared for DWR San Luis Field Division, September 2015.

O'Neill Forebay Aquatic Herbicide and Application Services, Aquatic Pesticide Application Report (APAR), Application Date August 3, 2016. Prepared by Clean Lakes Inc. Prepared for DWR San Luis Field Division, September 2016.

O'Neill Forebay Aquatic Herbicide and Application Services, Aquatic Pesticide Application Report (APAR), Application Date June 12, 2018. Prepared by Clean Lakes Inc. Prepared for DWR San Luis Field Division, October 2018.

O'Neill Forebay Aquatic Herbicide and Application Services, Aquatic Pesticide Application Report (APAR), Application Date August 7, 2019 and September 24, 2019. Prepared by Clean Lakes Inc. Prepared for DWR San Luis Field Division, November 2019.

2020 Aquatic Pesticide Application Plan (APAP) O'Neill Forebay. Prepared by Clean Lakes Inc. Prepared for DWR San Luis Field Division, June 2020.

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CHAPTER 13D NON-PROJECT TURN-INS TO THE CALIFORNIA AQUEDUCT

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FIGURES

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CHAPTER 13D NON-PROJECT TURN-INS TO THE CALIFORNIA AQUEDUCT

BACKGROUND

In addition to conveying SWP waters, the California Aqueduct is also used as a conveyance system for water agencies to transfer water within their service area, or to another agency entirely. A turn-in encompasses "both water pumped directly into the Aqueduct (pump-ins) and water passively conveyed into the Aqueduct via bidirectional turn-in/turn-out structures." Non-Project water is defined as water not diverted directly from the Sacramento-San Joaquin Delta Typically, higher turn-in volumes occur during dry years, when supplemental supplies are most needed.

Although typically groundwater, turn-ins to the California Aqueduct may also be surface water sources or flood flows.

The 2012 SWP WSS provided an initial examination of turn-in water quality and evaluated the impact to downstream water users. A recommendation from the 2012 SWP WSS was for DWR to provide an annual water quality report on the turn-ins. DWR has been providing annual reports since 2013 and distributing the reports to the State Water Contractors.

For this discussion, the participants, volumes turned-in and the downstream water quality impacts will be summarized. The primary source of information for this report section are the annual reports on "Water Quality Assessment of Non-Project Turn-ins to the California Aqueduct" produced by DWR.

Overall, the impacts of turn-ins to downstream Aqueduct water quality during the 2016 to 2020 time period is considerably less in comparison to the drought years of 2014 and 2015. This is because the total volume of turn-ins has been much less in recent years compared to 2014 and 2015, as shown in **Table 13D-2**. Additionally, all turn-in water in 2017 and 2019 was surface water, and surface water turn-ins (such as Kings River, Kern River, and Friant-Kern Canal) are generally lower in arsenic compared to groundwater turn-ins.

DWR has developed a Water Quality Policy and Implementation Process for Acceptance of Non-Project Water into the State Water Project, dated October 2012 (**Appendix 13D**). Please refer to this policy for information on how participants are screened and approved for turn-ins. Constituents of concern (COC) in the 2012 policy are arsenic, bromide, chloride, nitrate, sulfate, organic carbon and total dissolved solids. A recent review of pump-in proposal monitoring programs indicate that for some participants, additional constituents such as chromium, hexavalent chromium, uranium, and 1,2,3-trichloropropane (1,2,3-TCP) have been incorporated into routine monitoring of pump-ins. Participants have also been requested by DWR to conduct sampling for PFAS in 2020 and 2021. Although the focus of this report is on the constituents of concern as specified in the 2012 policy, a separate discussion on PFAS and 1,2,3 TCP has been added at the end of this section. In addition to COC, participating agencies are also required to complete Title 22 monitoring for all participating wells or representative wells (group of manifolded wells) prior to start up. The specific requirements for each agency are explained in their respective Pump-in Proposals. In some situations, an existing Title 22 test may be substituted for any well near a similar well with a Title 22 test of record. A well must be re-tested for Title 22 constituents every three years, or every nine years depending on the PIP.

Turn-in Participants

The participants will be discussed by DWR Field Division, and from upstream to downstream. Please note that not all participants participate every year. **Figure 13D-1** shows the participants' turn-in location along the California Aqueduct and **Table 13D-1** provides the milepost for each turn-in, along with selected check structures and pumping plants.

Figure 13-D1. Turn-in Sites along California Aqueduct

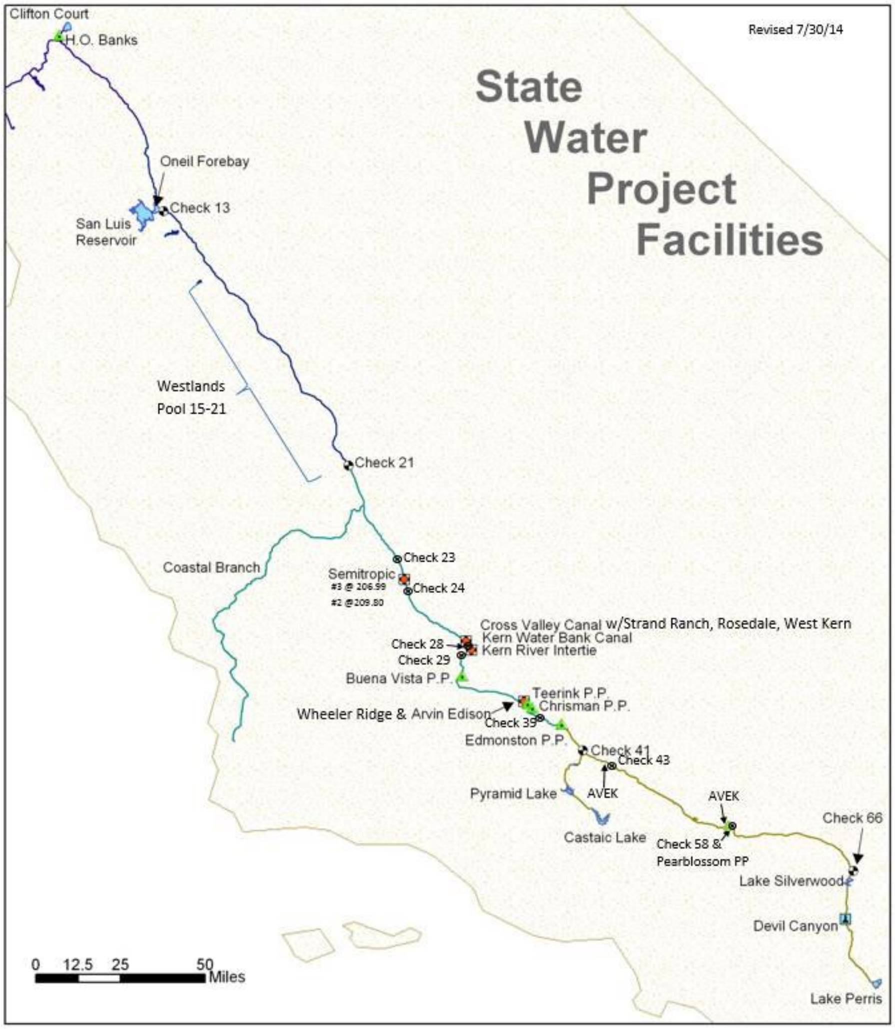


Table 13-D1. Milepost Information for Turn-in Location and Aqueduct Features

Check Structure or Turn-in Location	Milepost
Westlands	Various locations within Pool 15-21
Check 21	172.26
Coastal Aqueduct	184.63
Check 23	197.05
Semitropic 3	207.00
Semitropic 2	209.80
Check 27	231.73
Tupman Rd. Bridge	236.43
Cross Valley Canal	238.04
Kern Water Bank Canal	238.19
Cole’s Levee Bridge	240.14
West Kern #1	240.20
Highway 119 Bridge	241.06
Check 29	244.54
Buena Vista PP	250.99
Wheeler Ridge (7G3W)	269.66
Wheeler Ridge (7P6W)	269.66
Wheeler Ridge (7P5W)	270.24
Wheeler Ridge (8G2W)	272.10
Wheeler Ridge (8P1W)	272.31
Wheeler Ridge (8P2W)	272.53
Wheeler Ridge (8P3W)	272.80
Wheeler Ridge (9G4W)	276.09
Wheeler Ridge (9G1W)	277.28
Arvin Edison	277.30
Teerink PP	278.13
Wheeler Ridge (10P1X)	280.14
Chrisman PP	280.36
Check 39	290.21
Edmonston PP	293.45
Check 41	303.41

San Luis Field Division

In the San Luis Field Division, the single entity is the Westlands Water District (WWD). WWD can convey water to the California Aqueduct directly from individual wells, or from WWD’s Lateral 7 facility. The Lateral 7 facility pumps water from the Mendota Pool into the Aqueduct. The Mendota Pool may contain groundwater from nearby WWD wells (as in 2016), or may receive surplus storm waters from the San Joaquin River and Kings River which WWD is allowed to take (as in 2017 and 2019). The water quality in the Mendota Pool was noticeably different in 2016 compared to 2017 due to this change in source water. In addition to WWD, flood flows may enter through drain inlets on the west side of the Aqueduct during heavy storms. As stated in DWR's 2017 report, the largest inflows came from Cantua Creek, Salt Creek and smaller creeks which pond alongside the Aqueduct and eventually enter the Aqueduct through drain inlets.

San Joaquin Field Division

In the San Joaquin Field Division, there are potentially six different agencies or districts participating in the turn-in program.

- The Semitropic Water Storage District (SWSD) can operate two turn-in structures – Semitropic 3 (SWSD 3) and Semitropic 2 (SWSD 2), which are capable of conveying groundwater from more than 430 wells in their service area.
- The Kern County Water Agency (KCWA) operates the Cross Valley Canal (CVC), which conveys groundwater and surface water to the Aqueduct from a number of entities and sources. The entities include KCWA-member units and nonmembers that operate groundwater recharge basins around the Kern Fan area. Participants include the Irvine Ranch Water District's (IRWD's) Strand Ranch Integrated Banking Project (SRIBP) and the Rosedale-Rio Bravo Water Storage District (Rosedale). Rosedale, a KCWA-member unit, operates 10 wells and IRWD operates seven wells. West Kern Water District (WKWD), also a KCWA-member unit, can deliver groundwater from at least five wells directly to CVC. Note that WKWD can also bypass the CVC and pump from these five wells directly into the Aqueduct using the turn-in structure identified as West Kern #1. Cawelo Water District delivers groundwater and surface water to Friant-Kern Canal from Cawelo's conveyance channels then to CVC .
- The Kern Water Bank Authority (KWBA) operates the Kern Water Bank Canal (KWBC) which conveys groundwater to the Aqueduct from up to 96 recovery wells located around the Kern Fan. Other entities such as the Pioneer Property, the Berrenda Mesa Project and the City of Bakersfield 2800 Acres pump groundwater to the KWBC. (The CVC can also convey KWBA water to the Aqueduct.)
- The WKWD can operate one turn-in structure – West Kern #1 which is capable of conveying groundwater from 13 wells.
- The Wheeler Ridge-Maricopa Water Storage District (WRMWSD) can operate 11 turn-in structures, where each structure conveys groundwater from individual wells or from several wells manifolded into a single pipeline.
- The Arvin-Edison Water Storage District (AEWSD) can operate one turn-in structure, the AEWSD Canal, with numerous wells in AEWSD's service area available for participation. Other potential sources of water to the AEWSD Canal include water from the CVC, Kern River, Friant-Kern Canal, and AEWSD farm wells.

Southern Field Division

In the Southern Field Division, the Antelope Valley-East Kern Water Agency (AVEK) can pump groundwater into the Aqueduct from four wells connected to a shared turn-in/turn-out facility at Aqueduct MP 357.72, located nearly three miles upstream of Pearblossom Pumping Plant.

Turn-In Volumes

As summarized in **Table 13D-2**, from 2016 to 2020, 2020 had the greatest volume of Non-Project turn-ins, with 244,412 acre-feet. **Table 13D-2** also confirms that typically, higher turn-in volumes occur during dry years, when supplemental supplies are most needed. **Table 13D-3** shows by field division, the participating agencies, the location of the turn-in, and the volumes turned-in by month. Overall, the highest volumes of non-Project turn-in water occurred through the CVC and the KWBC. If the total volume of turn-in water from CVC and KWBC were combined, they accounted for 48%, 70%, 75.5%, 81.7% and 89.1% of the total flow for years 2016 to 2020, respectively.

Table 13D-2. Turn-In Volumes by Year

Year	Water Year Type (Sacramento Valley)	Turn-In Volume (AF)
2013	Dry	336,857
2014	Critical	518,062
2015	Critical	482,825
2016	Below Normal	214,467
2017	Wet	94,518
2018	Below Normal	115,595
2019	Wet	55,356
2020	Dry	244,412

The California Department of Water Resources adopts five water year types: wet, above normal, below normal, dry, and critical. The classification is based on a water year index that is derived from full natural flow measurements. For the Sacramento River region, the water year index is called the Sacramento Valley Index (SVI) (also known as the “4 River Index” and the “40-30-30 Index”) and uses the sum of calculated monthly unimpaired runoff from the following gauges: Sacramento River above Bend Bridge, Feather River at Oroville, Yuba River at Smartsville, and American River below Folsom Dam. The SVI is calculated based on the following equation:

SVI = (0.4 X current April-July runoff) + (0.3 X current October-March runoff) + (0.3 X previous year’s index)

The current April-July runoff is for the sum of the runoff for the four rivers in the current water year from April to July, in million acre-feet. If the previous year’s index exceeds 10 MAF, then 10 MAF is applied instead. Once the SVI is calculated, the year type classification is based on the thresholds in **Table 13-D4.**

Table 13D-3. Non-Project Turn-ins to the California Aqueduct, 2016 to 2020, Acre-feet

San Luis Field Division - Check 13 to Check 21				San Joaquin Field Division - Check 21 to Check 41							Southern Field Division	SUM
	Westlands	**Westlands Lat 7**	**Flood waters***	**SWSD 3**	**SWSD 2**	**CVC**	**KWBC**	**WKWD**	**WRMWSD**	**AEWSD**	**AVEK**	
	Various	MP 115.43	Various	MP 207	MP 209.8	MP 238.04	MP 238.19	MP 240.2	MP 269.66-280.14	MP 277.3	MP 357.72	
Jan-16	0	0	0	1,781	1,257	492	989	0	2,288	9,506	168	16,481
Feb-16	0	0	0	0	0	178	300	0	2,435	6,787	152	9,852
Mar-16	0	0	0	6,159	0	13,048	12,681	660	2,516	5,626	145	40,835
Apr-16	7,819	4,033	0	4,762	0	21,230	11,341	855	2,150	7,804	74	60,068
May-16	8,233	4,146	0	553	0	1,693	550	657	1,251	96	0	17,179
Jun-16	5,227	2,225	0	0	0	0	0	0	0	0	0	7,452
Jul-16	5,860	2,601	0	0	0	4,320	0	0	174	0	13	12,968
Aug-16	1,482	1,482	0	0	0	18,585	0	0	1,028	0	169	22,746
Sep-16	0	0	0	0	0	15,960	0	0	1,269	0	226	17,455
Oct-16	0	0	0	0	0	2,666	0	0	1,605	0	109	4,380
Nov-16	0	0	0	0	0	2,048	0	0	1,679	0	0	3,727
Dec-16	0	0	0	0	0	855	0	0	469	0	0	1,324
2016 total	28,621	14,487	0	13,255	1,257	81,075	25,861	2,172	16,864	29,819	1,056	214,467
Jan-17	0	1,029	1,128	0	0	0	0	0	0	5,863	0	8,020
Feb-17	0	2,717	1,556	0	0	0	0	0	0	0	0	4,273
Mar-17	0	4,319	2	0	0	0	6,841	0	0	0	0	11,162
Apr-17	0	4,883	0	0	0	0	15,559	0	0	0	0	20,442
May-17	0	3,533	0	0	0	2,533	20,257	0	0	0	0	26,323
Jun-17	0	2,694	0	0	0	3,542	16,802	0	0	0	0	23,038

	Westlands	Westlands Lat 7	Flood waters*	SWSD 3	SWSD 2	CVC	KWBC	WKWD	WRMWSD	AEWSD	AVEK	SUM
Jul-17	0	479	0	0	0	0	781	0	0	0	0	1,260
Aug-17	0	0	0	0	0	0	0	0	0	0	0	0
Sep-17	0	0	0	0	0	0	0	0	0	0	0	0
Oct-17	0	0	0	0	0	0	0	0	0	0	0	0
Nov-17	0	0	0	0	0	0	0	0	0	0	0	0
Dec-17	0	0	0	0	0	0	0	0	0	0	0	0
2017 total	0	19,654	2,686	0	0	6,075	60,240	0	0	5,863	0	94,518
Jan-18	0	0	0	0	0	0	0	0	0	0	0	0
Feb-18	0	0	0	0	0	668	0	0	0	0	0	668
Mar-18	0	0	453	0	0	7,037	6,835	748	858	4,277	0	20,208
Apr-18	0	0	0	0	0	8,793	14,858	0	2,228	5,813	0	31,692
May-18	0	0	0	0	0	14,574	16,743	0	2,037	3,803	0	37,157
Jun-18	0	0	0	0	0	827	8,667	0	2,214	0	0	11,708
Jul-18	0	0	0	0	0	0	3,556	0	2,170	0	0	5,726
Aug-18	0	0	0	0	0	0	3,606	0	2,637	0	0	6,243
Sep-18	0	0	0	0	0	0	1,427	0	766	0	0	2,193
Oct-18	0	0	0	0	0	0	0	0	0	0	0	0
Nov-18	0	0	0	0	0	0	0	0	0	0	0	0
Dec-18	0	0	0	0	0	0	0	0	0	0	0	0
2018 total	0	0	453	0	0	31,899	55,692	748	12,910	13,893	0	115,595
Jan-19	0	0	107	0	0	0	0	0	0	0	0	107
Feb-19	0	0	417	0	0	0	0	0	0	0	0	417
Mar-19	0	0	74	0	0	0	0	0	0	0	0	74
Apr-19	0	0	0	0	0	0	1,552	0	0	0	0	1,552
May-19	0	888	0	0	0	0	12,006	0	0	0	0	12,894

	Westlands	Westlands Lat 7	Flood waters*	SWSD 3	SWSD 2	CVC	KWBC	WKWD	WRMWSD	AEWSD	AVEK	SUM
Jun-19	0	2,714	0	0	0	4,745	22,705	0	0	5,150	0	35,314
Jul-19	0	0	0	0	0	369	3,918	0	0	711	0	4,998
Aug-19	0	0	0	0	0	0	0	0	0	0	0	0
Sep-19	0	0	0	0	0	0	0	0	0	0	0	0
Oct-19	0	0	0	0	0	0	0	0	0	0	0	0
Nov-19	0	0	0	0	0	0	0	0	0	0	0	0
Dec-19	0	0	0	0	0	0	0	0	0	0	0	0
2019 total	0	3,602	598	0	0	5,114	40,181	0	0	5,861	0	55,356
Jan-20	0	0	0	0	0	0	0	0	0	0	0	0
Feb-20	0	0	0	0	0	1,990	2,517	0	0	0	0	4,507
Mar-20	0	0	0	0	0	18,647	17,525	1,108	2,489	0	0	39,769
Apr-20	0	0	0	0	0	11,746	16,163	985	1,159	0	0	30,053
May-20	0	0	0	0	0	16,816	23,646	518	2,579	0	0	43,559
Jun-20	0	0	0	0	0	13,815	26,344	0	2,726	0	0	42,885
Jul-20	0	0	0	0	0	17,171	25,811	0	2,153	0	0	45,135
Aug-20	0	0	0	0	0	10,808	1,550	0	1,877	0	0	14,235
Sep-20	0	0	0	95	0	4,147	0	0	1,814	0	0	6,056
Oct-20	0	0	0	3,077	0	4,850	0	0	137	0	0	8,064
Nov-20	0	0	0	1,992	0	1,405	0	0	0	0	0	3,397
Dec-20	0	0	0	3,289	0	3,463	0	0	0	0	0	6,752
2020 total	0	0	0	8,453	0	104,858	113,556	2,611	14,934	0	0	244,412

* Floodwaters which pond along San Luis Canal from Check 13 to Check 21 may enter Aqueduct through drain inlets. The largest are Cantua Creek and Salt Creek. Each has two to three points of entry, either a drain inlet or a pump-in.

Table 13D-4. Sacramento Valley Index Year Type Classification in MAF

Water Year Type	**Sacramento Valley Index (MAF)**
Wet	Equal to or greater than 9.2
Above Normal	Greater than 7.8, and less than 9.2
Below Normal	Greater than 6.5, and equal to or less than 7.8
Dry	Greater than 5.4, and equal to or less than 6.5
Critical	Equal to or less than 5.4

DOWNSTREAM WATER QUALITY ASSESSMENTS

As the number of participants and turn-in volumes change from year to year, assessments will be summarized separately for each year below. Generally, water quality is assessed in the DWR annual reports in three ways: 1) comparing the concentration of the turn-in water to the upstream Aqueduct water quality, 2) comparing the upstream and downstream Aqueduct water quality for a particular turn-in location and 3) calculating the percentage of Aqueduct (POA), which is the percentage of turn-in volume to the Aqueduct volume at the same location. In order to simplify the evaluation, this report will focus on option #2. The reader is referred to the annual DWR reports for detailed information and analysis.

2016

The impact of turn-ins occurring within the San Luis Field Division can be assessed by comparing the water quality at the upstream location (Check 13) to the downstream location (Check 21). The 2016 annual DWR report states that for the San Luis Field Division, "results for the upstream (Check 13) /downstream (Check 21) analysis showed no consistent increases for any constituents downstream of the WWD turn-ins "(Page 101, 2016 report).

The impact of turn-ins occurring within the San Joaquin Field Division can be assessed by comparing the water quality at the upstream location (Check 21) to the downstream location (Check 41). As stated in the 2016 annual DWR report "overall, constituents of concern (COCs) that routinely increased in the Aqueduct after turn-ins from the San Joaquin Field Division included arsenic, chromium, hexavalent chromium, and sulfate. COCs that routinely decreased in the Aqueduct included bromide, chloride, DOC, and salinity (conductivity and TDS)" (Page 106, 2016 report). A more detailed evaluation was conducted for the constituents that routinely increase (arsenic, total chromium, nitrate as NO_3 and sulfate), as shown in **Table 13D-5** through **Table 8.** These data tables illustrate the variability in increases, with some months showing decreases. For arsenic, the months of January and February 2016 showed the greatest increase of 5 µg/L from Check 21 to Check 41. Arsenic concentrations increased to 8 µg/L at Check 41 in January and February 2016 due to repair work in Pool 30. Due to the closure of check structure 29, Aqueduct flow stopped downstream of Pool 30, but AEWSD and WRMWSD continued to operate. POA reached as high as 48 percent in January 2016 and 46 percent in February 2016. Arsenic concentrations in AEWSD and WRMWSD were 7 µg/L, which resulted in arsenic concentrations at 8 µg/L at Check 41. Similarly, nitrate, sulfate, and total chromium had the greatest increases from Check 21 to Check 41 in January and February. Nitrate as NO_3 increased by 14.4 mg/L in January and increased by 12.3 mg/L in February. Sulfate increased by 39 mg/L in January and 60 mg/L in February. Total chromium increased by 5 µg/L in January and by 4 µg/L in February.

Resultant downstream water quality is reflective of the sources being turned in, volumes being turned in, and flow in the Aqueduct. No Aqueduct samples exceeded the drinking water MCL for any COC. The highest arsenic concentration over the 2016 to 2020 reporting period was 8 µg/L measured at Check 41 in January and February 2016. Additional information on arsenic and chromium concentrations in the Aqueduct will be provided in **Chapter 10.** For the Southern Field Division, the AVEK turn-in had very little influence on Aqueduct water quality because of its small relative inflow volume and good water quality. There were no impacts to downstream water quality.

Table 13D-5. Arsenic Concentrations at Check 21 and Check 41 during months of turn-ins for San Joaquin Field Division, mg/L

Check 21		Check 41			
Sample Date	Total Arsenic mg/L EPA 200.8 (T) [1]*	Sample Date	Total Arsenic mg/L EPA 200.8 (T) [1]*	Net Increase or Decrease, mg/L	% Increase or Decrease
1/19/2016	0.003	1/20/2016	0.008	0.005	166.7%
02/16/16	0.003	2/17/2016	0.008	0.005	166.7%
03/15/16	0.002	3/14/2016	0.005	0.003	150.0%
04/19/16	0.003	4/20/2016	0.004	0.001	33.3%
05/17/16	0.002	5/18/2016	0.003	0.001	50.0%
07/19/16	0.003	7/20/2016	0.003	0	0.0%
08/16/16	0.003	8/10/2016	0.003	0	0.0%
09/20/16	0.002	9/21/2016	0.003	0.001	50.0%
10/18/16	0.002	10/19/2016	0.003	0.001	50.0%
11/15/16	0.002	11/9/2016	0.003	0.001	50.0%
12/20/16	0.002	12/21/2016	0.002	0	0.0%
01/17/17	0.001	1/25/2017	0.002	0.001	100.0%
03/14/17	0.001	3/15/2017	0.001	0	0.0%
04/18/17	0.002	4/19/2017	0.002	0	0.0%
05/16/17	0.001	5/17/2017	0.002	0.001	100.0%
06/20/17	0.002	6/21/2017	0.002	0	0.0%
07/18/17	0.002	7/19/2017	0.002	0	0.0%

Check 21		Check 41			
Sample Date	Total Arsenic mg/L EPA 200.8 (T) [1]*	Sample Date	Total Arsenic mg/L EPA 200.8 (T) [1]*	Net Increase or Decrease, mg/L	% Increase or Decrease
02/20/18	0.002	2/21/2018	0.002	0	0.0%
03/20/18	0.002	3/28/2018	0.002	0	0.0%
04/17/18	0.002	4/18/2018	0.002	0	0.0%
05/15/18	0.002	5/16/2018	0.003	0.001	50.0%
06/19/18	0.002	6/20/2018	0.002	0	0.0%
07/17/18	0.002	7/18/2018	0.002	0	0.0%
08/14/18	0.002	8/16/2018	0.002	0	0.0%
09/18/18	0.003	9/19/2018	0.003	0	0.0%
04/16/19	0.002	4/17/2019	0.002	0	0.0%
05/14/19	0.002	5/22/2019	0.002	0	0.0%
06/18/19	0.002	6/19/2019	0.002	0	0.0%
07/16/19	0.002	7/17/2019	0.002	0	0.0%
02/18/20	0.001	2/26/2020	0.001	0	0.0%
03/17/20	0.002	3/25/2020	0.002	0	0.0%
04/14/20	0.002	4/15/2020	0.003	0.001	50.0%
05/19/20	0.002	5/20/2020	0.003	0.001	50.0%
06/16/20	0.002	6/17/2020	0.003	0.001	50.0%
07/14/20	0.003	7/15/2020	0.004	0.001	33.3%
08/18/20	0.003	8/19/2020	0.004	0.001	33.3%
09/15/20	0.003	9/16/2020	0.004	0.001	33.3%
10/20/20	0.003	10/21/2020	0.004	0.001	33.3%
11/17/20	2.68	11/18/2020	3.09	0.41	15.3%
12/15/20	1.95	12/16/2020	2.33	0.38	19.5%

Table 13D-6. Nitrate as NO_3 Concentrations at Check 21 and Check 41 during months of turn-ins for San Joaquin Field Division, mg/L

Check 21		Check 41			
Sample Date	Dissolved Nitrate mg/L EPA 300.0 28d Hold [1]*	Sample Date	Dissolved Nitrate mg/L EPA 300.0 28d Hold [1]*	Net Increase or Decrease, mg/L	% Increase or Decrease
1/19/2016	<0.1	1/20/2016	14.4	14.4	>14300%
2/16/2016	<0.1	2/17/2016	12.3	12.3	>12200%
3/15/2016	4.3	3/14/2016	6.4	2.1	48.8%
4/19/2016	3.4	4/20/2016	3.5	0.1	2.9%

Check 21		Check 41			
Sample Date	Dissolved Nitrate mg/L EPA 300.0 28d Hold [1]*	Sample Date	Dissolved Nitrate mg/L EPA 300.0 28d Hold [1]*	Net Increase or Decrease, mg/L	% Increase or Decrease
5/17/2016	3	5/18/2016	2.6	-0.4	-13.3%
7/19/2016	0.6	7/20/2016	<0.1	-0.6	-83.3%
8/16/2016	<0.1	8/10/2016	<0.1	0	0.0%
9/20/2016	<0.1	9/21/2016	<0.1	0	0.0%
10/18/2016	0.3	10/19/2016	<0.1	-0.3	-66.7%
11/15/2016	2	11/9/2016	<0.1	-2	-95.0%
12/20/2016	2.5	12/21/2016	2	-0.5	-20.0%
1/17/2017	3.1	1/25/2017	5.2	2.1	67.7%
3/14/2017	2.2	3/15/2017	2.5	0.3	13.6%
4/18/2017	2	4/19/2017	2	0	0.0%
5/16/2017	0.7	5/17/2017	0.4	-0.3	-42.9%
6/20/2017	1.2	6/21/2017	1.2	0	0.0%
7/18/2017	1.3	7/19/2017	1.1	-0.2	-15.4%
2/20/2018	3.1	2/21/2018	4	0.9	29.0%
3/20/2018	1.1	3/28/2018	1.1	0	0.0%
4/17/2018	3	4/18/2018	4.2	1.2	40.0%
5/15/2018	1	5/16/2018	1.2	0.2	20.0%
6/19/2018	1.3	6/20/2018	1.1	-0.2	-15.4%
7/17/2018	1	7/18/2018	0.2	-0.8	-80.0%
8/14/2018	0.4	8/16/2018	0.22	-0.18	-45.0%
9/18/2018	0.6	9/19/2018	0.2	-0.4	-66.7%
4/16/2019	2.1	4/17/2019	1.3	-0.8	-38.1%
5/14/2019	2.2	5/22/2019	2	-0.2	-9.1%
6/18/2019	1.02	6/19/2019	0.8	-0.22	-21.6%
7/16/2019	0.713	7/17/2019	0.85	0.137	19.2%
2/18/2020	3.4	2/26/2020	2.71	-0.69	-20.3%
3/17/2020	1.9	3/25/2020	3	1.1	57.9%
4/14/2020	2.4	4/15/2020	4.3	1.9	79.2%
5/19/2020	1.4	5/20/2020	3.4	2	142.9%
6/16/2020	0.7	6/17/2020	2.1	1.4	200.0%
7/14/2020	<0.1	7/15/2020	0.5	0.5	400.0%
8/18/2020	<0.1	8/19/2020	<0.1	0	0.0%
9/15/2020	0.2	9/16/2020	<0.1	-0.2	-50.0%
10/20/2020	0.8	10/21/2020	<0.1	-0.8	-87.5%
11/17/2020	1.206	11/18/2020	0.1704	-1.0356	-85.9%
12/15/2020	1.8	12/16/2020	1.5085	-0.2915	-16.2%

Table 13D-7. Total Chromium Concentrations at Check 21 and Check 41 during months of turn-ins for San Joaquin Field Division, mg/L

Check 21		Check 41			
Sample Date	Total Chromium mg/L EPA 200.8 (T) [1]*	Sample Date	Total Chromium mg/L EPA 200.8 (T) [1]*	Net Increase or Decrease, mg/L	% Increase or Decrease
1/19/2016	<0.001	1/20/16	0.005	0.005	>400%
2/16/2016	<0.001	2/17/16	0.004	0.004	>300%
3/15/2016	0.001	3/14/16	0.003	0.002	200.0%
4/19/2016	0.001	4/20/16	0.003	0.002	200.0%
5/17/2016	0.001	5/18/16	0.003	0.002	200.0%
7/19/2016	<0.001	7/20/16	0.002	0.002	>100%
8/16/2016	0.001	8/10/16	0.002	0.001	100.0%
9/20/2016	0.001	9/21/16	<0.001	-0.001	0.0%
10/18/2016	0.001	10/19/16	<0.001	-0.001	0.0%
11/15/2016	<0.001	11/9/16	0.001	0.001	0.0%
12/20/2016	<0.001	12/21/16	0.001	0.001	0.0%
1/17/2017	0.001	1/25/2017	0.003	0.002	200.0%
3/14/2017	0.001	3/15/2017	0.001	0	0.0%
4/18/2017	0.001	4/19/2017	0.001	0	0.0%
5/16/2017	0.001	5/17/2017	0.001	0	0.0%
6/20/2017	0.001	6/21/2017	0.003	0.002	200.0%
7/18/2017	<0.001	7/19/2017	0.001	0.001	0.0%
2/20/2018	<0.001	2/21/2018	0.001	0.001	0.0%
3/20/2018	<0.001	3/28/2018	0.001	0.001	0.0%
4/17/2018	0.002	4/18/2018	0.001	-0.001	-50.0%
5/15/2018	0.001	5/16/2018	0.001	0	0.0%
6/19/2018	0.001	6/20/2018	0.001	0	0.0%
7/17/2018	0.001	7/18/2018	0.001	0	0.0%
8/14/2018	0.001	8/16/2018	0.003	0.002	200.0%
9/18/2018	0.001	9/19/2018	0.001	0	0.0%
4/16/2019	0.002	4/17/2019	0.002	0	0.0%
5/14/2019	0.003	5/22/2019	0.001	-0.002	-66.7%
6/18/2019	0.001	6/19/2019	0.001	0	0.0%
7/16/2019	0.002	7/17/2019	0.002	0	0.0%
2/18/2020	<0.001	2/26/2020	<0.001	0	0.0%
3/17/2020	<0.001	3/25/2020	<0.001	0	0.0%
4/14/2020	<0.001	4/15/2020	0.001	0.001	0.0%

Check 21		Check 41			
Sample Date	Total Chromium mg/L EPA 200.8 (T) [1]*	Sample Date	Total Chromium mg/L EPA 200.8 (T) [1]*	Net Increase or Decrease, mg/L	% Increase or Decrease
05/19/20	<0.001	5/20/2020	<0.001	0	0.0%
6/16/2020	<0.001	6/17/2020	<0.001	0	0.0%
7/14/2020	0.001	7/15/2020	0.001	0	0.0%
8/18/2020	0.001	8/19/2020	<0.001	-0.001	0.0%
9/15/2020	<0.001	9/16/2020	0.001	0.001	0.0%
10/20/2020	<0.001	10/21/2020	0.001	0.001	0.0%
11/17/2020	<0.001	11/18/2020	<0.001	0	0.0%
12/15/2020	<0.001	12/16/2020	0.001	0.001	0.0%

Table `13D-8. Total Sulfate Concentrations at Check 21 and Check 41 during months of turn-ins for San Joaquin Field Division, mg/L

Check 21		Check 41			
Sample Date	Dissolved Sulfate mg/L EPA 300.0 28d Hold [1]*	Sample Date	Dissolved Sulfate mg/L EPA 300.0 28d Hold [1]*	Net Increase or Decrease, mg/L	% Increase or Decrease
1/19/2016	48	1/20/2016	87	39	81.3%
2/16/2016	49	2/17/2016	109	60	122.4%
3/15/2016	45	3/14/2016	66	21	46.7%
4/19/2016	84	4/20/2016	52	-32	-38.1%
5/17/2016	59	5/18/2016	66	7	11.9%
7/19/2016	30	7/20/2016	32	2	6.7%
8/16/2016	16	8/10/2016	21	5	31.3%
9/20/2016	20	9/21/2016	21	1	5.0%
10/18/2016	26	10/19/2016	28	2	7.7%
11/15/2016	26	11/9/2016	33	7	26.9%
12/20/2016	34	12/21/2016	24	-10	-29.4%
1/17/2017	27	1/25/2017	31	4	14.8%
3/14/2017	22	3/15/2017	23	1	4.5%
4/18/2017	24	4/19/2017	21	-3	-12.5%
5/16/2017	8	5/17/2017	9	1	12.5%
6/20/2017	11	6/21/2017	11	0	0.0%
7/18/2017	14	7/19/2017	12	-2	-14.3%

Check 21		Check 41			
Sample Date	Dissolved Sulfate mg/L EPA 300.0 28d Hold [1]*	Sample Date	Dissolved Sulfate mg/L EPA 300.0 28d Hold [1]*	Net Increase or Decrease, mg/L	% Increase or Decrease
2/20/2018	37	2/21/2018	42	5	13.5%
3/20/2018	30	3/28/2018	31	1	3.3%
4/17/2018	37	4/18/2018	49	12	32.4%
5/15/2018	33	5/16/2018	31	-2	-6.1%
6/19/2018	33	6/20/2018	43	10	30.3%
7/17/2018	32	7/18/2018	37	5	15.6%
8/14/2018	14	8/16/2018	25	11	78.6%
9/18/2018	22	9/19/2018	20	-2	-9.1%
4/16/2019	32	4/17/2019	27	-5	-15.6%
5/14/2019	37	5/22/2019	31	-6	-16.2%
6/18/2019	11.1	6/19/2019	7.4	-3.7	-33.3%
7/16/2019	13	7/17/2019	15.3	2.3	17.7%
2/18/2020	40	2/26/2020	41	1	2.5%
3/17/2020	36	3/25/2020	47	11	30.6%
4/14/2020	47	4/15/2020	37	-10	-21.3%
5/19/2020	39	5/20/2020	48	9	23.1%
6/16/2020	36	6/17/2020	41	5	13.9%
7/14/2020	34.5	7/15/2020	39	4.5	13.0%
8/18/2020	21	8/19/2020	26.5	5.5	26.2%
9/15/2020	21	9/16/2020	21	0	0.0%
10/20/2020	25	10/21/2020	28.14	3.14	12.6%
11/17/2020	29.01	11/18/2020	30	0.99	3.4%
12/15/2020	30.35	12/16/2020	29.05	-1.3	-4.3%

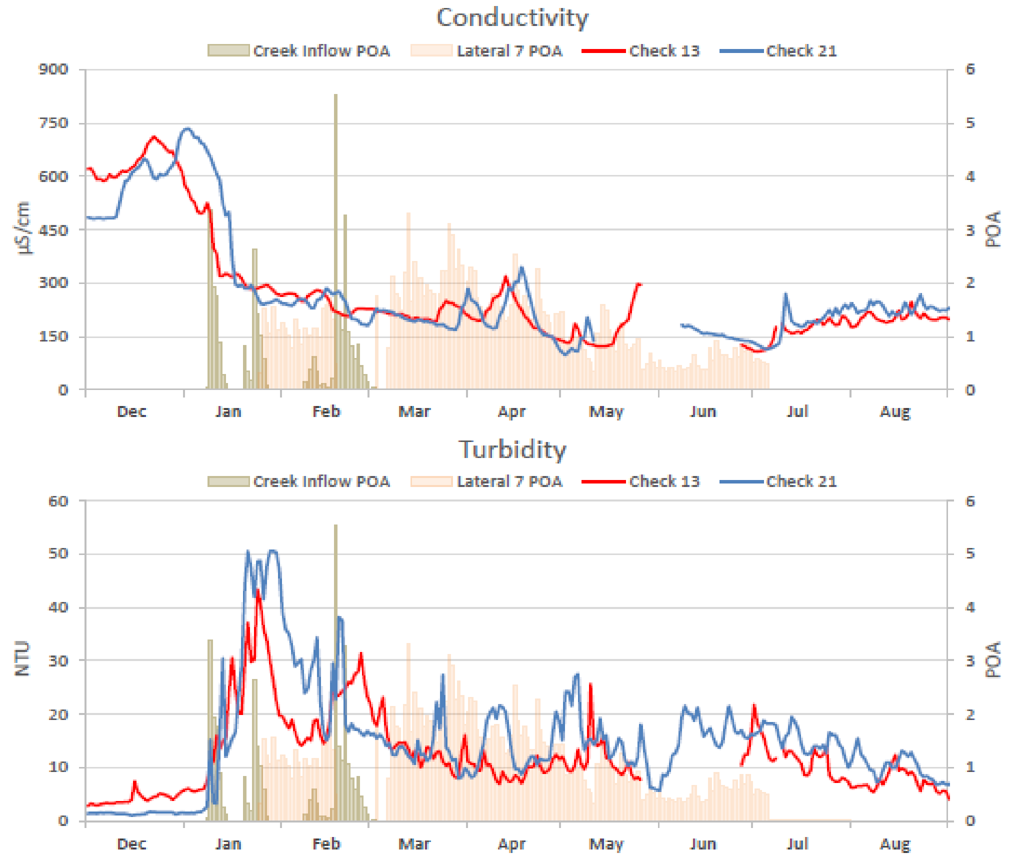
2017

2017 was a very uncharacteristic year for turn-ins, as all turn-in water was surface water. In the past, the majority of non-Project Water has been groundwater pumped into the Aqueduct. However, heavy precipitation in 2017 resulted in excess surface water from the San Joaquin River, Kings River, Kern River, and Coastal Range floodwaters (from Salt Creek and Cantua Creek) that were pumped or flowed into the Aqueduct.

For the San Luis Field Division, as shown in **Table 13D-3,** turn-ins comprised of flood flows (Salt Creek and Cantua Creek) entering at multiple locations from Check 13 and Check 21, as well as excess Kings River and San Joaquin River, entering through the Mendota Pool, and then to the Aqueduct via Lateral 7. As stated in the 2017 DWR report, TSS and turbidity in the flood flows were much higher compared to the upstream Aqueduct water. For TSS, the flood water ranged from 127 to 3,768 mg/L compared with 4 mg/L in the upstream Aqueduct water. For turbidity, the flood water ranged from 82 to 1,702 NTU, compared with 13 NTU in the upstream Aqueduct water. Flood waters also had higher concentrations for most metals, compared to the upstream Aqueduct water, especially for aluminum, arsenic, chromium, iron, lead, manganese and nickel. However, only small increases in most constituents were observed downstream of the flood flows. This is because the period of creek inflows coincided with relatively large Aqueduct flows. Pumping at Dos Amigos, located upstream of the creek inlet structures, totaled 563,194 AF during the 53 day period of creek inflows. Therefore, during the 53-day period of flood flows in January and February, the flood flows only constituted a total POA of 0.47 percent (2684/563,194). If the POA was calculated on a daily basis over the 53 day period, the POA ranged from <0.1 percent to 5.5 percent.

Figure 13D-2 shows real-time turbidity and conductivity data at Check 13 and Check 21, which are upstream and downstream of the creek flows, respectively. Elevated levels of conductivity are present at both Check 13 and Check 21, due to high Aqueduct flows and flood flows.

Figure 13D-2. Real-Time Measurements for Conductivity and Turbidity with Creek Inflows Percentage-of-Aqueduct Values, 2017



Notes:
POA = percentage-of-Aqueduct, NTU = nephelometric turbidity units, µS/cm = microsiemens per centimeter.
Raw data is posted on the California Data Exchange Center for Check 13 (Station ID: C13) and Check 21 (Station ID: C21).

Turn-ins from Lateral 7 also constituted a very low total POA over the January through July time period, at 0.84 percent (2017 report). As most constituents sampled in the Lateral 7 flows were lower in concentration than the upstream Aqueduct, there was "very little influence attributable to Lateral 7."

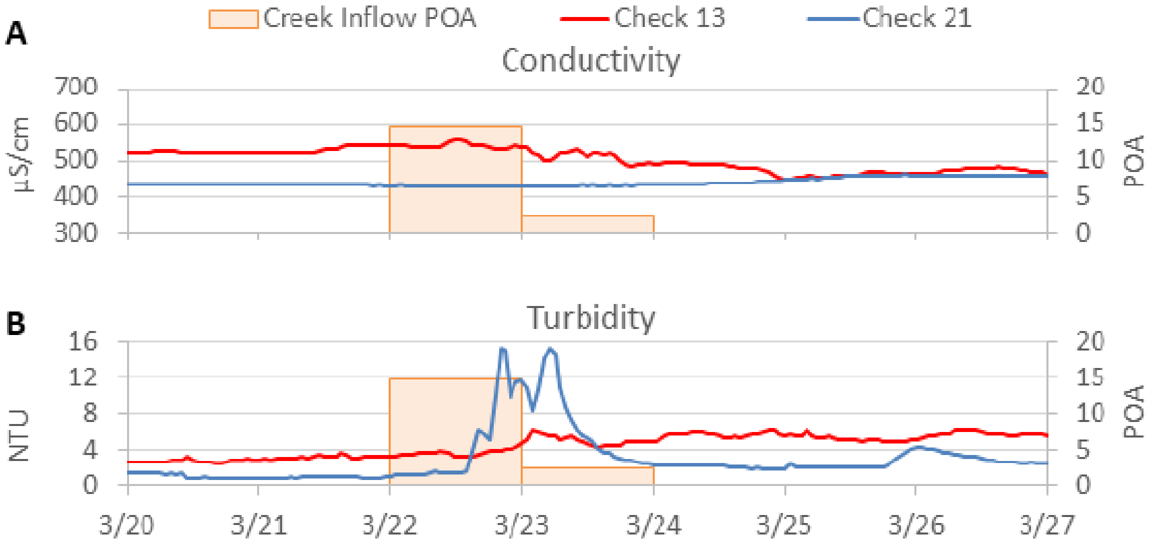
For the San Joaquin Field Division, the Kern Water Bank Canal and the Cross Valley Canal conveyed excess Kern River flows, and AEWSD conveyed Friant-Kern Canal water. Inflows from CVC and KWBC were sampled, and grab samples were collected upstream and downstream of the turn-ins themselves. Samples collected from the CVC and the KWBC were close to or lower than the Aqueduct for almost all constituents (2017 report). The Friant-Kern Canal was also sampled, and concentrations were less than or close in value to Aqueduct concentrations. Similarly, there was little to no influence from the AEWSD turn-in to downstream water quality. Slight decreases were observed for most COCs. For arsenic, **Table 4** shows the greatest increase from Check 21 to Check 41 was 1 µg/L in January and May, with no change in all other months. For nitrate as NO_3, the highest increase was 2.1 mg/L in January 2017, for sulfate the highest increase was 4 mg/L in January, and for total chromium the highest increase was 2 µg/L in January and June.

2018

For the San Luis Field Division, flood flows from Cantua Creek and a drain inlet at MP 166.04 made up the inflows of 453 AF which occurred over two days, March 22 and 23. Cantua Creek inflow was 354 AF on March 22 and 89 AF on March 23. Dos Amigos was pumping 2,118 AF on March 22 and 3,707 AF on March 23, which equated to a POA of 14.7 percent on March 22 and a POA of 2.3 percent on March 23. Due to the short duration of the 2018 creek inflows, no water quality samples were collected. **Figure 13D-3** shows real-time turbidity and conductivity data at Check 13 and Check 21, which are upstream and downstream of the creek flows, respectively. Turbidity at Check 21 shows a sharp increase to 15 NTU, but the peak is short-lived.

In comparison to the high creek and high Aqueduct flows in 2017, where high creek flows lasted for 53 days, the impact in 2018 was short-lived.

Figure 13D-3. Real-Time Measurements for Conductivity and Turbidity with Creek Inflows Percentage-of-Aqueduct Values, 2018



Notes:
POA = percentage-of-Aqueduct, NTU = nephelometric turbidity units,
µS/cm = microsiemens per centimeter.
Raw data is posted on the California Data Exchange Center for Check 13 (Station ID: C13) and Check 21 (Station ID: C21).

Source: 2020 DWR Report "Water Quality Assessment of Non-project Turn-ins to the California Aqueduct, 2018"

The impact of turn-ins occurring within the San Joaquin Field Division can be assessed by comparing the water quality at the upstream location (Check 21) to the downstream location (Check 41) during the months when turn-ins occurred from February to September. For arsenic, **Table 13D-5** shows the greatest increase from Check 21 to Check 41 was 1 µg/L in May, with no change in all other months. For nitrate as NO_3, the highest increase was 1.2 mg/L in April, for sulfate the highest increase was 12 mg/L in April, and for total chromium the highest increase was 2 µg/L in August. Results for total chromium were variable, with three months showing an increase, one month showing a decrease, and four months showing no change. Dissolved organic carbon, bromide, and chloride decreased at Check 41.

2019

Overall, 2019 was a wet year and therefore the turn-in volumes were the lowest during the 2016 to 2020 time period. As in 2017, all turn-in water was surface water. Participating turn-in entities operated for a few months in the first half of 2019 only; there were no turn-ins from August to December. During the months of January, February and March, only the San Luis Field Division had turn-ins. For the San Luis Field Division**,** turn-ins comprised of flood flows from Salt Creek and Cantua Creek. During these months, arsenic did not increase from Check 13 to Check 21, and sulfate and nitrate as NO_3 had modest increases of 5 mg/L and 0.3 mg/L, respectively. During the months of April through July, there were turn-ins within the San Joaquin Field Division. For the San Joaquin Field Division, the Kern Water Bank Canal and the Cross Valley Canal conveyed excess Kern River flows, and AEWSD conveyed Friant-Kern Canal water. However, arsenic and total chromium showed no change from Check 21 to Check 41, and both sulfate and nitrate as NO_3 decreased from Check 21 to Check 41 during these months (except for July which had a minimal increase of 2.3 mg/L for sulfate and 0.14 mg/L for nitrate). Similarly, bromide, chloride, TDS, and DOC decreased from Check 21 to Check 41 during the months of April to June, with minimal increases of 0.01 mg/L, 4 mg/L, 13 mg/L, and 0.1 mg/L, respectively in July.

2020

In 2020, there were no turn-ins within the San Luis Field Division and the Southern Field Division. Therefore, only turn-ins occurring within the San Joaquin Field Division require a water quality assessment, by comparing Check 21 to Check 41. Arsenic, sulfate, and nitrate as NO_3 increased downstream at Check 41 due to turn-ins. Arsenic was higher by 1 µg/L during all of the months from April through October. For nitrate as NO_3, the highest increase was 2 mg/L in May, for sulfate the highest increase was 9 mg/L in May, and the highest increase for total chromium was 1 µg/L. Results for total chromium were variable, with four months showing an increase, one month showing a decrease, and six months showing no change. Dissolved organic carbon, TDS, specific conductance, bromide, and chloride decreased at Check 41.

PFAS and 1,2,3-TCP

As mentioned earlier, 1,2,3-TCP was added in 2018 as a constituent of concern and DWR requested PFAS monitoring of turn-ins to the participants. Please refer to **Tables 13D-9** and **10** for 1,2,3-TCP and PFAS data, respectively.

Samples for 1,2,3-TCP have been collected at turn-in locations for all participants except for Westlands and AVEK, as these agencies did not operate pump-ins after the primary drinking water MCL for 1,2,3-TCP was finalized in December 2017. As shown in **Table 13D-9** and shaded in yellow, there have been a few detections of 1,2,3-TCP above its respective MCL of 0.005 µg/L in the Cross Valley Canal, turn-in 10P1X for WRMWSD, and in the Arvin Edison canal.

As of May 2021, sampling for PFAS began in 2020 and have been collected at CVC, KWBC, and WRMWSD turn-ins. Low level detections of PFAS are shaded in yellow in **Table 13D-10,** with no results above the notification levels of 5.1 ng/L for PFOA, 6.5 ng/L for PFOS and 500 ng/L for PFBS.

Table 13D-9. Turn-in Monitoring Results for 1,2,3-TCP as of April 2021, µg/L

Date	Turn-in Site	Milepost	Collector	Concentration, µg/L
9/28/2020	SWSD 3	207	SWSD	<0.0007
9/29/2020	SWSD 3	207	SWSD	<0.0007
9/30/2020	SWSD 3	207	SWSD	<0.0007
10/1/2020	SWSD 3	207	SWSD	<0.0007
10/2/2020	SWSD 3	207	SWSD	<0.0007
10/5/2020	SWSD 3	207	SWSD	<0.0007
10/6/2020	SWSD 3	207	SWSD	0.00078
10/7/2020	SWSD 3	207	SWSD	0.0007
10/8/2020	SWSD 3	207	SWSD	<0.0007
10/9/2020	SWSD 3	207	SWSD	<0.0007
10/12/2020	SWSD 3	207	SWSD	0.0011
10/13/2020	SWSD 3	207	SWSD	<0.0007
10/14/2020	SWSD 3	207	SWSD	0.00074
10/15/2020	SWSD 3	207	SWSD	0.00087
10/16/2020	SWSD 3	207	SWSD	0.00083
10/19/2020	SWSD 3	207	SWSD	0.00074
10/20/2020	SWSD 3	207	SWSD	0.00074
10/21/2020	SWSD 3	207	SWSD	<0.0007
10/22/2020	SWSD 3	207	SWSD	<0.0007
10/23/2020	SWSD 3	207	SWSD	0.00079
10/26/2020	SWSD 3	207	SWSD	0.00075
10/27/2020	SWSD 3	207	SWSD	<0.0007
10/28/2020	SWSD 3	207	SWSD	0.00073
10/29/2020	SWSD 3	207	SWSD	0.00071
10/30/2020	SWSD 3	207	SWSD	<0.0007
3/2/2021	SWSD 3	207	SWSD	<0.0007
3/3/2021	SWSD 3	207	SWSD	<0.0007
3/4/2021	SWSD 3	207	SWSD	<0.0007
3/5/2021	SWSD 3	207	SWSD	<0.0007
3/8/2021	SWSD 3	207	SWSD	<0.0007
3/9/2021	SWSD 3	207	SWSD	<0.0007
3/10/2021	SWSD 3	207	SWSD	<0.0007
3/11/2021	SWSD 3	207	SWSD	<0.0007
3/12/2021	SWSD 3	207	SWSD	<0.0007
3/15/2021	SWSD 3	207	SWSD	<0.0007
3/16/2021	SWSD 3	207	SWSD	<0.0007
3/17/2021	SWSD 3	207	SWSD	<0.0007

Date	Turn-in Site	Milepost	Collector	Concentration, µg/L
3/18/2021	SWSD 3	207	SWSD	<0.0007
3/19/2021	SWSD 3	207	SWSD	<0.0007
3/22/2021	SWSD 3	207	SWSD	<0.0007
3/23/2021	SWSD 3	207	SWSD	<0.0007
3/24/2021	SWSD 3	207	SWSD	<0.0007
3/29/2021	SWSD 3	207	SWSD	<0.0007
3/30/2021	SWSD 3	207	SWSD	<0.0007
3/31/2021	SWSD 3	207	SWSD	<0.0007
4/1/2021	SWSD 3	207	SWSD	<0.0007
4/2/2021	SWSD 3	207	SWSD	<0.0007
4/5/2021	SWSD 3	207	SWSD	<0.0007
4/6/2021	SWSD 3	207	SWSD	<0.0007
4/7/2021	SWSD 3	207	SWSD	<0.0007
4/9/2021	SWSD 3	207	SWSD	<0.0007
4/12/2021	SWSD 3	207	SWSD	<0.0007
4/13/2021	SWSD 3	207	SWSD	<0.0007
4/14/2021	SWSD 3	207	SWSD	<0.0007
4/16/2021	SWSD 3	207	SWSD	<0.0007
4/19/2021	SWSD 3	207	SWSD	<0.0007
4/20/2021	SWSD 3	207	SWSD	<0.0007
4/21/2021	SWSD 3	207	SWSD	<0.0007
4/23/2021	SWSD 3	207	SWSD	<0.0007
4/26/2021	SWSD 3	207	SWSD	<0.0007
3/6/2018	CVC	238.04	KCWA	<0.0015
3/13/2018	CVC	238.04	KWCA	0.0024
3/20/2018	CVC	238.04	KCWA	0.003
4/16/2018	CVC	238.04	KCWA	<0.0015
6/1/2018	CVC	238.04	KCWA	0.0071
6/20/2019	CVC	238.04	KCWA	<0.0016
2/18/2020	CVC	238.04	KCWA	< 0.00053
3/2/2020	CVC	238.04	WKWD	ND
3/2/2020	CVC	238.04	RRB	<0.00053
3/9/2020	CVC	238.04	WKWD	ND
3/9/2020	CVC	238.04	RRB	0.0045
3/16/2020	CVC	238.04	WKWD	ND
3/17/2020	CVC	238.04	RRB	<0.00053
3/23/2020	CVC	238.04	WKWD	ND
5/14/2020	CVC	238.04	KCWA	< 0.00053
5/22/2020	CVC	238.04	RRB	<0.00053

Date	Turn-in Site	Milepost	Collector	Concentration, µg/L
7/30/2020	CVC	238.04	KCWA	< 0.00053
1/14/2021	CVC	238.04	KCWA	0.0082
4/7/2021	CVC	238.04	KCWA	<0.0006
2/4/2021	CVC	238.04	RRB	<0.0006
3/10/2021	CVC	238.04	RRB	<0.0006
3/6/2018	KWBC	238.19	KCWA	<0.0015
3/13/2018	KWBC	238.19	KCWA	<0.0015
3/20/2018	KWBC	238.19	KCWA	<0.0015
4/16/2018	KWBC	238.19	KCWA	<0.0015
6/1/2018	KWBC	238.19	KCWA	<0.0015
8/16/2018	KWBC	238.19	KCWA	<0.0015
4/26/2019	KWBC	238.19	KCWA	<0.0016
5/28/2019	KWBC	238.19	KCWA	<0.0016
6/20/2019	KWBC	238.19	KCWA	<0.0016
3/2/2020	KWBC	238.19	KCWA	< 0.00053
5/14/2020	KWBC	238.19	KCWA	< 0.00053
7/30/2020	KWBC	238.19	KCWA	< 0.00053
2/5/2021	KWBC	238.19	KCWA	<0.0006
4/7/2021	KWBC	238.19	KCWA	<0.0006
3/2/2020	WKWD #1	240.2	WKWD	ND
3/9/2020	WKWD #1	240.2	WKWD	ND
3/16/2020	WKWD #1	240.2	WKWD	ND
3/23/2020	WKWD #1	240.2	WKWD	ND
4/10/2018	7G3W	269.66	WRMWSD	<0.0050
6/19/2018	7G3W	269.66	WRMWSD	<0.0050
8/14/2018	7G3W	269.66	WRMWSD	<0.0050
4/1/2020	7G3W	269.66	WRMWSD	<0.00070
7/1/2020	7G3W	269.66	WRMWSD	<0.00070
2/11/2021	7G3W	269.66	WRMWSD	<0.0006
4/15/2021	7G3W	269.66	WRMWSD	<0.0006
4/10/2018	7P6W	269.66	WRMWSD	<0.0050
6/19/2018	7P6W	269.66	WRMWSD	<0.0050
8/14/2018	7P6W	269.66	WRMWSD	<0.0050
4/1/2020	7P6W	269.66	WRMWSD	<0.00070
7/1/2020	7P6W	269.66	WRMWSD	<0.00070
2/11/2021	7P6W	269.66	WRMWSD	<0.0006
4/15/2021	7P6W	269.66	WRMWSD	<0.0006
4/10/2018	7P5W	270.24	WRMWSD	<0.0050

Date	Turn-in Site	Milepost	Collector	Concentration, µg/L
6/19/2018	7P5W	270.24	WRMWSD	<0.0050
8/14/2018	7P5W	270.24	WRMWSD	<0.0050
4/1/2020	7P5W	270.24	WRMWSD	<0.00070
7/1/2020	7P5W	270.24	WRMWSD	<0.00070
2/11/2021	7P5W	270.24	WRMWSD	<0.0006
4/15/2021	7P5W	270.24	WRMWSD	<0.0006
4/11/2018	8G3W	272.1	WRMWSD	<0.0050
6/19/2018	8G3W	272.1	WRMWSD	<0.0050
8/14/2018	8G3W	272.1	WRMWSD	<0.0050
4/1/2020	8G3W	272.1	WRMWSD	<0.00070
7/1/2020	8G3W	272.1	WRMWSD	<0.0007
4/10/2018	8P1W	272.31	WRMWSD	<0.0050
6/19/2018	8P1W	272.31	WRMWSD	<0.0050
8/14/2018	8P1W	272.31	WRMWSD	<0.0050
4/1/2020	8P1W	272.31	WRMWSD	<0.00070
7/1/2020	8P1W	272.31	WRMWSD	<0.00070
2/11/2021	8P1W	272.31	WRMWSD	<0.0006
4/15/2021	8P1W	272.31	WRMWSD	<0.0006
6/19/2018	8P2W	272.53	WRMWSD	<0.0050
8/15/2018	8P2W	272.53	WRMWSD	<0.0050
4/1/2020	8P2W	272.53	WRMWSD	<0.00070
7/1/2020	8P2W	272.53	WRMWSD	<0.00070
2/11/2021	8P2W	272.53	WRMWSD	<0.0006
4/15/2021	8P2W	272.53	WRMWSD	<0.0006
6/19/2018	8P3W	272.8	WRMWSD	<0.0050
8/15/2018	8P3W	272.8	WRMWSD	<0.0050
4/1/2020	8P3W	272.8	WRMWSD	<0.00070
7/1/2020	8P3W	272.8	WRMWSD	<0.00070
2/11/2021	8P3W	272.8	WRMWSD	<0.0006
4/15/2021	8P3W	272.8	WRMWSD	<0.0006
4/10/2018	8P4W	273.75	WRMWSD	<0.0050
6/19/2018	8P4W	273.75	WRMWSD	<0.0050
8/14/2018	8P4W	273.75	WRMWSD	<0.0050
4/1/2020	8P4W	273.75	WRMWSD	<0.00070
7/1/2020	8P4W	273.75	WRMWSD	<0.00070
2/11/2021	8G3W	273.75	WRMWSD	<0.0006
4/15/2021	8G3W	273.75	WRMWSD	<0.0006
4/10/2018	9G4W	276.09	WRMWSD	<0.0050

Date	Turn-in Site	Milepost	Collector	Concentration, µg/L
8/15/2018	9G4W	276.09	WRMWSD	<0.0050
4/1/2020	9G4W	276.09	WRMWSD	<0.00070
7/1/2020	9G4W	276.09	WRMWSD	<0.00070
2/11/2021	9G4W	276.09	WRMWSD	<0.0006
4/15/2021	9G4W	276.09	WRMWSD	<0.0006
4/10/2018	9G1W	277.28	WRMWSD	<0.0050
8/15/2018	9G1W	277.28	WRMWSD	<0.0050
4/1/2020	9G1W	277.28	WRMWSD	<0.00070
7/1/2020	9G1W	277.28	WRMWSD	<0.00070
2/11/2021	9G1W	277.28	WRMWSD	<0.0006
4/15/2021	9G1W	277.28	WRMWSD	<0.0006
4/11/2018	10P1X	280.14	WRMWSD	0.042
5/14/2018	10P1X	280.14	WRMWSD	<0.0050
7/2/2018	10P1X	280.14	WRMWSD	<0.0050
8/20/2018	10P1X	280.14	WRMWSD	<0.0050
4/1/2020	10P1X	280.14	WRMWSD	<0.0050
7/1/2020	10P1X	280.14	WRMWSD	<0.00070
2/11/2021	10P1X	280.14	WRMWSD	0.037
4/26/2021	10P1X	280.14	WRMWSD	<0.0014
3/12/2018	AEWSD	277.3	AEWSD	0.023
4/24/2018	AEWSD	277.3	AEWSD	<0.005

Table 13D-10. Turn-in Monitoring Results for PFAS as of April 2021, ng/L

Date	Site	MP	Collector	Analyte		Concentration, ng/L
3/2/2020	CVC	238.04	KCWA	4:2 FTS	--	<0.45
3/2/2020	CVC	238.04	KCWA	6:2 FTS	--	<1.8
3/2/2020	CVC	238.04	KCWA	8:2 FTS	--	<0.91
3/2/2020	CVC	238.04	KCWA	NetFOSAA	--	<0.45
3/2/2020	CVC	238.04	KCWA	NMeFOSAA	--	<0.54
3/2/2020	CVC	238.04	KCWA	Perfluorobutanesulfonic Acid	PFBS	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluorobutanoic Acid	PFBA	<1.8
3/2/2020	CVC	238.04	KCWA	Perfluorodecanesulfonic Acid	PFDS	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluorodecanoic Acid	PFDA	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluorododecanoic Acid	PFDoA	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluoroheptanesulfonic Acid	PFHpS	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluoroheptanoic Acid	PFHpA	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluorohexanesulfonic Acid	PFHxS	<0.45

Date	Site	MP	Collector	Analyte		Concentration, ng/L
3/2/2020	CVC	238.04	KCWA	Perfluorohexanoic Acid	PFHxA	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluorononanesulfonic Acid	PFNS	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluorononanoic Acid	PFNA	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluorooctanesulfonamide	PFOSA	0.53
3/2/2020	CVC	238.04	KCWA	Perfluorooctanesulfonic Acid	PFOS	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluorooctanoic Acid	PFOA	0.48
3/2/2020	CVC	238.04	KCWA	Perfluoropentanesulfonic Acid	PFPeS	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluoropentanoic Acid	PFPeA	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluorotetradecanoic Acid	PFTeDA	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluorotridecanoic Acid	PFTrDA	<0.45
3/2/2020	CVC	238.04	KCWA	Perfluoroundecanoic Acid	PFUdA	<0.45
5/14/2020	CVC	238.04	KCWA	4:2 FTS	--	<0.43
5/14/2020	CVC	238.04	KCWA	6:2 FTS	--	<1.7
5/14/2020	CVC	238.04	KCWA	8:2 FTS	--	<0.85
5/14/2020	CVC	238.04	KCWA	NetFOSAA	--	<0.43
5/14/2020	CVC	238.04	KCWA	NMeFOSAA	--	**1.2**
5/14/2020	CVC	238.04	KCWA	Perfluorobutanesulfonic Acid	PFBS	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluorobutanoic Acid	PFBA	<1.7
5/14/2020	CVC	238.04	KCWA	Perfluorodecanesulfonic Acid	PFDS	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluorodecanoic Acid	PFDA	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluorododecanoic Acid	PFDoA	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluoroheptanesulfonic Acid	PFHpS	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluoroheptanoic Acid	PFHpA	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluorohexanesulfonic Acid	PFHxS	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluorohexanoic Acid	PFHxA	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluorononanesulfonic Acid	PFNS	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluorononanoic Acid	PFNA	<0.45
5/14/2020	CVC	238.04	KCWA	Perfluorooctanesulfonamide	PFOSA	**0.55**
5/14/2020	CVC	238.04	KCWA	Perfluorooctanesulfonic Acid	PFOS	**0.43**
5/14/2020	CVC	238.04	KCWA	Perfluorooctanoic Acid	PFOA	**0.58**
5/14/2020	CVC	238.04	KCWA	Perfluoropentanesulfonic Acid	PFPeS	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluoropentanoic Acid	PFPeA	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluorotetradecanoic Acid	PFTeDA	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluorotridecanoic Acid	PFTrDA	<0.43
5/14/2020	CVC	238.04	KCWA	Perfluoroundecanoic Acid	PFUdA	<0.43
7/30/2020	CVC	238.04	KCWA	4:2 FTS	--	<0.54
7/30/2020	CVC	238.04	KCWA	6:2 FTS	--	<0.45
7/30/2020	CVC	238.04	KCWA	8:2 FTS	--	<1.01
7/30/2020	CVC	238.04	KCWA	NetFOSAA	--	<0.25

Date	Site	MP	Collector	Analyte		Concentration, ng/L
7/30/2020	CVC	238.04	KCWA	NMeFOSAA	--	<0.36
7/30/2020	CVC	238.04	KCWA	Perfluorobutanesulfonic Acid	PFBS	<0.25
7/30/2020	CVC	238.04	KCWA	Perfluorobutanoic Acid	PFBA	<0.25
7/30/2020	CVC	238.04	KCWA	Perfluorodecanesulfonic Acid	PFDS	<0.32
7/30/2020	CVC	238.04	KCWA	Perfluorodecanoic Acid	PFDA	<0.25
7/30/2020	CVC	238.04	KCWA	Perfluorododecanoic Acid	PFDoA	<0.25
7/30/2020	CVC	238.04	KCWA	Perfluoroheptanesulfonic Acid	PFHpS	<0.28
7/30/2020	CVC	238.04	KCWA	Perfluoroheptanoic Acid	PFHpA	<0.25
7/30/2020	CVC	238.04	KCWA	Perfluorohexanesulfonic Acid	PFHxS	<0.25
7/30/2020	CVC	238.04	KCWA	Perfluorohexanoic Acid	PFHxA	<0.32
7/30/2020	CVC	238.04	KCWA	Perfluorononanesulfonic Acid	PFNS	<0.40
7/30/2020	CVC	238.04	KCWA	Perfluorononanoic Acid	PFNA	<0.25
7/30/2020	CVC	238.04	KCWA	Perfluorooctanesulfonamide	PFOSA	<0.25
7/30/2020	CVC	238.04	KCWA	Perfluorooctanesulfonic Acid	PFOS	**0.45**
7/30/2020	CVC	238.04	KCWA	Perfluorooctanoic Acid	PFOA	<0.41
7/30/2020	CVC	238.04	KCWA	Perfluoropentanesulfonic Acid	PFPeS	<0.29
7/30/2020	CVC	238.04	KCWA	Perfluoropentanoic Acid	PFPeA	<0.31
7/30/2020	CVC	238.04	KCWA	Perfluorotetradecanoic Acid	PFTeDA	<0.43
7/30/2020	CVC	238.04	KCWA	Perfluorotridecanoic Acid	PFTrDA	<0.29
7/30/2020	CVC	238.04	KCWA	Perfluoroundecanoic Acid	PFUdA	<0.40
1/14/2021	CVC	238.04	KCWA	4:2 FTS	--	<0.54
1/14/2021	CVC	238.04	KCWA	6:2 FTS	--	<0.45
1/14/2021	CVC	238.04	KCWA	8:2 FTS	--	<1.01
1/14/2021	CVC	238.04	KCWA	NetFOSAA	--	<0.25
1/14/2021	CVC	238.04	KCWA	NMeFOSAA	--	<0.36
1/14/2021	CVC	238.04	KCWA	Perfluorobutanesulfonic Acid	PFBS	<0.25
1/14/2021	CVC	238.04	KCWA	Perfluorobutanoic Acid	PFBA	**0.66**
1/14/2021	CVC	238.04	KCWA	Perfluorodecanesulfonic Acid	PFDS	<0.32
1/14/2021	CVC	238.04	KCWA	Perfluorodecanoic Acid	PFDA	<0.25
1/14/2021	CVC	238.04	KCWA	Perfluorododecanoic Acid	PFDoA	<0.25
1/14/2021	CVC	238.04	KCWA	Perfluoroheptanesulfonic Acid	PFHpS	<0.28
1/14/2021	CVC	238.04	KCWA	Perfluoroheptanoic Acid	PFHpA	<0.25
1/14/2021	CVC	238.04	KCWA	Perfluorohexanesulfonic Acid	PFHxS	<0.25
1/14/2021	CVC	238.04	KCWA	Perfluorohexanoic Acid	PFHxA	<0.32
1/14/2021	CVC	238.04	KCWA	Perfluorononanesulfonic Acid	PFNS	<0.4
1/14/2021	CVC	238.04	KCWA	Perfluorononanoic Acid	PFNA	<0.25
1/14/2021	CVC	238.04	KCWA	Perfluorooctanesulfonamide	PFOSA	<0.25
1/14/2021	CVC	238.04	KCWA	Perfluorooctanesulfonic Acid	PFOS	<0.25
1/14/2021	CVC	238.04	KCWA	Perfluorooctanoic Acid	PFOA	<0.41

Date	Site	MP	Collector	Analyte		Concentration, ng/L
1/14/2021	CVC	238.04	KCWA	Perfluoropentanesulfonic Acid	PFPeS	<0.29
1/14/2021	CVC	238.04	KCWA	Perfluoropentanoic Acid	PFPeA	<0.31
1/14/2021	CVC	238.04	KCWA	Perfluorotetradecanoic Acid	PFTeDA	<0.43
1/14/2021	CVC	238.04	KCWA	Perfluorotridecanoic Acid	PFTrDA	<0.29
1/14/2021	CVC	238.04	KCWA	Perfluoroundecanoic Acid	PFUdA	<0.4
3/2/2020	KWBC	238.19	KCWA	4:2 FTS	--	<0.45
3/2/2020	KWBC	238.19	KCWA	6:2 FTS	--	<1.8
3/2/2020	KWBC	238.19	KCWA	8:2 FTS	--	<0.89
3/2/2020	KWBC	238.19	KCWA	NetFOSAA	--	<0.45
3/2/2020	KWBC	238.19	KCWA	NMeFOSAA	--	<0.53
3/2/2020	KWBC	238.19	KCWA	Perfluorobutanesulfonic Acid	PFBS	**0.9**
3/2/2020	KWBC	238.19	KCWA	Perfluorobutanoic Acid	PFBA	<1.8
3/2/2020	KWBC	238.19	KCWA	Perfluorodecanesulfonic Acid	PFDS	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluorodecanoic Acid	PFDA	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluorododecanoic Acid	PFDoA	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluoroheptanesulfonic Acid	PFHpS	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluoroheptanoic Acid	PFHpA	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluorohexanesulfonic Acid	PFHxS	**0.6**
3/2/2020	KWBC	238.19	KCWA	Perfluorohexanoic Acid	PFHxA	**0.47**
3/2/2020	KWBC	238.19	KCWA	Perfluorononanesulfonic Acid	PFNS	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluorononanoic Acid	PFNA	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluorooctanesulfonamide	PFOSA	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluorooctanesulfonic Acid	PFOS	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluorooctanoic Acid	PFOA	**0.52**
3/2/2020	KWBC	238.19	KCWA	Perfluoropentanesulfonic Acid	PFPeS	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluoropentanoic Acid	PFPeA	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluorotetradecanoic Acid	PFTeDA	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluorotridecanoic Acid	PFTrDA	<0.45
3/2/2020	KWBC	238.19	KCWA	Perfluoroundecanoic Acid	PFUdA	<0.45
5/14/2020	KWBC	238.19	KCWA	4:2 FTS	--	<0.43
5/14/2020	KWBC	238.19	KCWA	6:2 FTS	--	<1.7
5/14/2020	KWBC	238.19	KCWA	8:2 FTS	--	<0.86
5/14/2020	KWBC	238.19	KCWA	NetFOSAA	--	<0.43
5/14/2020	KWBC	238.19	KCWA	NMeFOSAA	--	<0.52
5/14/2020	KWBC	238.19	KCWA	Perfluorobutanesulfonic Acid	PFBS	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorobutanoic Acid	PFBA	<1.7
5/14/2020	KWBC	238.19	KCWA	Perfluorodecanesulfonic Acid	PFDS	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorodecanoic Acid	PFDA	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorododecanoic Acid	PFDoA	<0.43

Date	Site	MP	Collector	Analyte		Concentration, ng/L
5/14/2020	KWBC	238.19	KCWA	Perfluoroheptanesulfonic Acid	PFHpS	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluoroheptanoic Acid	PFHpA	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorohexanesulfonic Acid	PFHxS	**0.45**
5/14/2020	KWBC	238.19	KCWA	Perfluorohexanoic Acid	PFHxA	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorononanesulfonic Acid	PFNS	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorononanoic Acid	PFNA	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorooctanesulfonamide	PFOSA	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorooctanesulfonic Acid	PFOS	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorooctanoic Acid	PFOA	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluoropentanesulfonic Acid	PFPeS	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluoropentanoic Acid	PFPeA	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorotetradecanoic Acid	PFTeDA	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluorotridecanoic Acid	PFTrDA	<0.43
5/14/2020	KWBC	238.19	KCWA	Perfluoroundecanoic Acid	PFUdA	<0.43
7/30/2020	KWBC	238.19	KCWA	4:2 FTS	--	<0.54
7/30/2020	KWBC	238.19	KCWA	6:2 FTS	--	**1.1***
7/30/2020	KWBC	238.19	KCWA	8:2 FTS	--	<1.01
7/30/2020	KWBC	238.19	KCWA	NetFOSAA	--	<0.25
7/30/2020	KWBC	238.19	KCWA	NMeFOSAA	--	<0.36
7/30/2020	KWBC	238.19	KCWA	Perfluorobutanesulfonic Acid	PFBS	<0.25
7/30/2020	KWBC	238.19	KCWA	Perfluorobutanoic Acid	PFBA	**0.65**
7/30/2020	KWBC	238.19	KCWA	Perfluorodecanesulfonic Acid	PFDS	<0.32
7/30/2020	KWBC	238.19	KCWA	Perfluorodecanoic Acid	PFDA	<0.25
7/30/2020	KWBC	238.19	KCWA	Perfluorododecanoic Acid	PFDoA	<0.25
7/30/2020	KWBC	238.19	KCWA	Perfluoroheptanesulfonic Acid	PFHpS	<0.28
7/30/2020	KWBC	238.19	KCWA	Perfluoroheptanoic Acid	PFHpA	**0.31**
7/30/2020	KWBC	238.19	KCWA	Perfluorohexanesulfonic Acid	PFHxS	**0.52**
7/30/2020	KWBC	238.19	KCWA	Perfluorohexanoic Acid	PFHxA	**1.0***
7/30/2020	KWBC	238.19	KCWA	Perfluorononanesulfonic Acid	PFNS	<0.40
7/30/2020	KWBC	238.19	KCWA	Perfluorononanoic Acid	PFNA	<0.25
7/30/2020	KWBC	238.19	KCWA	Perfluorooctanesulfonamide	PFOSA	<0.25
7/30/2020	KWBC	238.19	KCWA	Perfluorooctanesulfonic Acid	PFOS	**0.33**
7/30/2020	KWBC	238.19	KCWA	Perfluorooctanoic Acid	PFOA	<0.41
7/30/2020	KWBC	238.19	KCWA	Perfluoropentanesulfonic Acid	PFPeS	<0.29
7/30/2020	KWBC	238.19	KCWA	Perfluoropentanoic Acid	PFPeA	<0.31
7/30/2020	KWBC	238.19	KCWA	Perfluorotetradecanoic Acid	PFTeDA	<0.43
7/30/2020	KWBC	238.19	KCWA	Perfluorotridecanoic Acid	PFTrDA	<0.29
7/30/2020	KWBC	238.19	KCWA	Perfluoroundecanoic Acid	PFUdA	<0.40
2/5/2021	KWBC	238.19	KCWA	4:2 FTS	--	<0.54

Date	Site	MP	Collector	Analyte		Concentration, ng/L
2/5/2021	KWBC	238.19	KCWA	6:2 FTS	--	<0.45
2/5/2021	KWBC	238.19	KCWA	8:2 FTS	--	<1.01
2/5/2021	KWBC	238.19	KCWA	NetFOSAA	--	<0.25
2/5/2021	KWBC	238.19	KCWA	NMeFOSAA	--	<0.36
2/5/2021	KWBC	238.19	KCWA	Perfluorobutanesulfonic Acid	PFBS	**0.3**
2/5/2021	KWBC	238.19	KCWA	Perfluorobutanoic Acid	PFBA	**0.51**
2/5/2021	KWBC	238.19	KCWA	Perfluorodecanesulfonic Acid	PFDS	<0.32
2/5/2021	KWBC	238.19	KCWA	Perfluorodecanoic Acid	PFDA	<0.25
2/5/2021	KWBC	238.19	KCWA	Perfluorododecanoic Acid	PFDoA	<0.25
2/5/2021	KWBC	238.19	KCWA	Perfluoroheptanesulfonic Acid	PFHpS	<0.28
2/5/2021	KWBC	238.19	KCWA	Perfluoroheptanoic Acid	PFHpA	<0.25
2/5/2021	KWBC	238.19	KCWA	Perfluorohexanesulfonic Acid	PFHxS	<0.25
2/5/2021	KWBC	238.19	KCWA	Perfluorohexanoic Acid	PFHxA	<0.32
2/5/2021	KWBC	238.19	KCWA	Perfluorononanesulfonic Acid	PFNS	<0.4
2/5/2021	KWBC	238.19	KCWA	Perfluorononanoic Acid	PFNA	<0.25
2/5/2021	KWBC	238.19	KCWA	Perfluorooctanesulfonamide	PFOSA	<0.25
2/5/2021	KWBC	238.19	KCWA	Perfluorooctanesulfonic Acid	PFOS	<0.25
2/5/2021	KWBC	238.19	KCWA	Perfluorooctanoic Acid	PFOA	**0.45**
2/5/2021	KWBC	238.19	KCWA	Perfluoropentanesulfonic Acid	PFPeS	<0.29
2/5/2021	KWBC	238.19	KCWA	Perfluoropentanoic Acid	PFPeA	<0.31
2/5/2021	KWBC	238.19	KCWA	Perfluorotetradecanoic Acid	PFTeDA	<0.43
2/5/2021	KWBC	238.19	KCWA	Perfluorotridecanoic Acid	PFTrDA	<0.29
2/5/2021	KWBC	238.19	KCWA	Perfluoroundecanoic Acid	PFUdA	<0.4
2/11/2021	10P1X	280.14	WRMWSD	10:2 FTS	--	<0.85
2/11/2021	10P1X	280.14	WRMWSD	4:2 FTS	--	<0.42
2/11/2021	10P1X	280.14	WRMWSD	6:2 FTS	--	<1.7
2/11/2021	10P1X	280.14	WRMWSD	8:2 FTS	--	<0.85
2/11/2021	10P1X	280.14	WRMWSD	NetFOSAA	--	<0.42
2/11/2021	10P1X	280.14	WRMWSD	NMeFOSAA	--	<0.51
2/11/2021	10P1X	280.14	WRMWSD	Perfluorobutanesulfonic Acid	PFBS	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorobutanoic Acid	PFBA	<1.7
2/11/2021	10P1X	280.14	WRMWSD	Perfluorodecanesulfonic Acid	PFDS	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorodecanoic Acid	PFDA	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorododecanesulfonic acid	--	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorododecanoic Acid	PFDoA	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluoroheptanesulfonic Acid	PFHpS	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluoroheptanoic Acid	PFHpA	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorohexadecanoic acid	--	<0.85

Date	Site	MP	Collector	Analyte		Concentration, ng/L
2/11/2021	10P1X	280.14	WRMWSD	Perfluorohexanesulfonic Acid	PFHxS	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorohexanoic Acid	PFHxA	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorononanesulfonic Acid	PFNS	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorononanoic Acid	PFNA	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorooctadecanoic acid	--	<0.85
2/11/2021	10P1X	280.14	WRMWSD	Perfluorooctanesulfonamide	PFOSA	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorooctanesulfonic Acid	PFOS	**0.55**
2/11/2021	10P1X	280.14	WRMWSD	Perfluorooctanoic Acid	PFOA	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluoropentanesulfonic Acid	PFPeS	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluoropentanoic Acid	PFPeA	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorotetradecanoic Acid	PFTeDA	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluorotridecanoic Acid	PFTrDA	<0.42
2/11/2021	10P1X	280.14	WRMWSD	Perfluoroundecanoic Acid	PFUdA	<0.42
2/11/2021	7G3W	269.66	WRMWSD	10:2 FTS	--	<0.85
2/11/2021	7G3W	269.66	WRMWSD	4:2 FTS	--	<0.42
2/11/2021	7G3W	269.66	WRMWSD	6:2 FTS	--	<1.7
2/11/2021	7G3W	269.66	WRMWSD	8:2 FTS	--	<0.85
2/11/2021	7G3W	269.66	WRMWSD	NetFOSAA	--	<0.42
2/11/2021	7G3W	269.66	WRMWSD	NMeFOSAA	--	<0.51
2/11/2021	7G3W	269.66	WRMWSD	Perfluorobutanesulfonic Acid	PFBS	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorobutanoic Acid	PFBA	<1.7
2/11/2021	7G3W	269.66	WRMWSD	Perfluorodecanesulfonic Acid	PFDS	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorodecanoic Acid	PFDA	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorododecanesulfonic acid	--	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorododecanoic Acid	PFDoA	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluoroheptanesulfonic Acid	PFHpS	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluoroheptanoic Acid	PFHpA	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorohexadecanoic acid	--	<0.85
2/11/2021	7G3W	269.66	WRMWSD	Perfluorohexanesulfonic Acid	PFHxS	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorohexanoic Acid	PFHxA	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorononanesulfonic Acid	PFNS	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorononanoic Acid	PFNA	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorooctadecanoic acid	--	<0.85
2/11/2021	7G3W	269.66	WRMWSD	Perfluorooctanesulfonamide	PFOSA	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorooctanesulfonic Acid	PFOS	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorooctanoic Acid	PFOA	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluoropentanesulfonic Acid	PFPeS	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluoropentanoic Acid	PFPeA	<0.42

Date	Site	MP	Collector	Analyte		Concentration, ng/L
2/11/2021	7G3W	269.66	WRMWSD	Perfluorotetradecanoic Acid	PFTeDA	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluorotridecanoic Acid	PFTrDA	<0.42
2/11/2021	7G3W	269.66	WRMWSD	Perfluoroundecanoic Acid	PFUdA	<0.42
2/11/2021	7P5W	270.24	WRMWSD	10:2 FTS	--	<0.82
2/11/2021	7P5W	270.24	WRMWSD	4:2 FTS	--	<0.41
2/11/2021	7P5W	270.24	WRMWSD	6:2 FTS	--	<1.6
2/11/2021	7P5W	270.24	WRMWSD	8:2 FTS	--	<0.82
2/11/2021	7P5W	270.24	WRMWSD	NetFOSAA	--	<0.41
2/11/2021	7P5W	270.24	WRMWSD	NMeFOSAA	--	<0.49
2/11/2021	7P5W	270.24	WRMWSD	Perfluorobutanesulfonic Acid	PFBS	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorobutanoic Acid	PFBA	<1.6
2/11/2021	7P5W	270.24	WRMWSD	Perfluorodecanesulfonic Acid	PFDS	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorodecanoic Acid	PFDA	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorododecanesulfonic acid	--	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorododecanoic Acid	PFDoA	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluoroheptanesulfonic Acid	PFHpS	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluoroheptanoic Acid	PFHpA	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorohexadecanoic acid	--	<0.82
2/11/2021	7P5W	270.24	WRMWSD	Perfluorohexanesulfonic Acid	PFHxS	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorohexanoic Acid	PFHxA	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorononanesulfonic Acid	PFNS	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorononanoic Acid	PFNA	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorooctadecanoic acid	--	<0.82
2/11/2021	7P5W	270.24	WRMWSD	Perfluorooctanesulfonamide	PFOSA	**0.55**
2/11/2021	7P5W	270.24	WRMWSD	Perfluorooctanesulfonic Acid	PFOS	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorooctanoic Acid	PFOA	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluoropentanesulfonic Acid	PFPeS	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluoropentanoic Acid	PFPeA	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorotetradecanoic Acid	PFTeDA	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluorotridecanoic Acid	PFTrDA	<0.41
2/11/2021	7P5W	270.24	WRMWSD	Perfluoroundecanoic Acid	PFUdA	<0.41
2/11/2021	7P6W	269.66	WRMWSD	10:2 FTS	--	<0.91
2/11/2021	7P6W	269.66	WRMWSD	4:2 FTS	--	<0.45
2/11/2021	7P6W	269.66	WRMWSD	6:2 FTS	--	<1.8
2/11/2021	7P6W	269.66	WRMWSD	8:2 FTS	--	<0.91
2/11/2021	7P6W	269.66	WRMWSD	NetFOSAA	--	<0.45
2/11/2021	7P6W	269.66	WRMWSD	NMeFOSAA	--	<0.55
2/11/2021	7P6W	269.66	WRMWSD	Perfluorobutanesulfonic Acid	PFBS	<0.45

Date	Site	MP	Collector	Analyte		Concentration, ng/L
2/11/2021	7P6W	269.66	WRMWSD	Perfluorobutanoic Acid	PFBA	<1.8
2/11/2021	7P6W	269.66	WRMWSD	Perfluorodecanesulfonic Acid	PFDS	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorodecanoic Acid	PFDA	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorododecanesulfonic acid	--	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorododecanoic Acid	PFDoA	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluoroheptanesulfonic Acid	PFHpS	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluoroheptanoic Acid	PFHpA	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorohexadecanoic acid	--	<0.91
2/11/2021	7P6W	269.66	WRMWSD	Perfluorohexanesulfonic Acid	PFHxS	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorohexanoic Acid	PFHxA	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorononanesulfonic Acid	PFNS	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorononanoic Acid	PFNA	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorooctadecanoic acid	--	<0.91
2/11/2021	7P6W	269.66	WRMWSD	Perfluorooctanesulfonamide	PFOSA	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorooctanesulfonic Acid	PFOS	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorooctanoic Acid	PFOA	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluoropentanesulfonic Acid	PFPeS	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluoropentanoic Acid	PFPeA	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorotetradecanoic Acid	PFTeDA	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluorotridecanoic Acid	PFTrDA	<0.45
2/11/2021	7P6W	269.66	WRMWSD	Perfluoroundecanoic Acid	PFUdA	<0.45
2/11/2021	8G3W	273.75	WRMWSD	10:2 FTS	--	<0.88
2/11/2021	8G3W	273.75	WRMWSD	4:2 FTS	--	<0.44
2/11/2021	8G3W	273.75	WRMWSD	6:2 FTS	--	<1.8
2/11/2021	8G3W	273.75	WRMWSD	8:2 FTS	--	<0.88
2/11/2021	8G3W	273.75	WRMWSD	NetFOSAA	--	<0.44
2/11/2021	8G3W	273.75	WRMWSD	NMeFOSAA	--	<0.53
2/11/2021	8G3W	273.75	WRMWSD	Perfluorobutanesulfonic Acid	PFBS	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorobutanoic Acid	PFBA	<1.8
2/11/2021	8G3W	273.75	WRMWSD	Perfluorodecanesulfonic Acid	PFDS	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorodecanoic Acid	PFDA	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorododecanesulfonic acid	--	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorododecanoic Acid	PFDoA	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluoroheptanesulfonic Acid	PFHpS	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluoroheptanoic Acid	PFHpA	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorohexadecanoic acid	--	<0.88
2/11/2021	8G3W	273.75	WRMWSD	Perfluorohexanesulfonic Acid	PFHxS	<0.44

Date	Site	MP	Collector	Analyte		Concentration, ng/L
2/11/2021	8G3W	273.75	WRMWSD	Perfluorohexanoic Acid	PFHxA	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorononanesulfonic Acid	PFNS	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorononanoic Acid	PFNA	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorooctadecanoic acid	--	<0.88
2/11/2021	8G3W	273.75	WRMWSD	Perfluorooctanesulfonamide	PFOSA	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorooctanesulfonic Acid	PFOS	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorooctanoic Acid	PFOA	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluoropentanesulfonic Acid	PFPeS	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluoropentanoic Acid	PFPeA	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorotetradecanoic Acid	PFTeDA	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluorotridecanoic Acid	PFTrDA	<0.44
2/11/2021	8G3W	273.75	WRMWSD	Perfluoroundecanoic Acid	PFUdA	<0.44
2/11/2021	8P1W	272.31	WRMWSD	10:2 FTS	--	<0.9
2/11/2021	8P1W	272.31	WRMWSD	4:2 FTS	--	<0.45
2/11/2021	8P1W	272.31	WRMWSD	6:2 FTS	--	<1.8
2/11/2021	8P1W	272.31	WRMWSD	8:2 FTS	--	<0.9
2/11/2021	8P1W	272.31	WRMWSD	NetFOSAA	--	<0.45
2/11/2021	8P1W	272.31	WRMWSD	NMeFOSAA	--	<0.54
2/11/2021	8P1W	272.31	WRMWSD	Perfluorobutanesulfonic Acid	PFBS	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorobutanoic Acid	PFBA	<1.8
2/11/2021	8P1W	272.31	WRMWSD	Perfluorodecanesulfonic Acid	PFDS	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorodecanoic Acid	PFDA	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorododecanesulfonic acid	--	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorododecanoic Acid	PFDoA	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluoroheptanesulfonic Acid	PFHpS	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluoroheptanoic Acid	PFHpA	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorohexadecanoic acid	--	<0.9
2/11/2021	8P1W	272.31	WRMWSD	Perfluorohexanesulfonic Acid	PFHxS	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorohexanoic Acid	PFHxA	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorononanesulfonic Acid	PFNS	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorononanoic Acid	PFNA	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorooctadecanoic acid	--	<0.9
2/11/2021	8P1W	272.31	WRMWSD	Perfluorooctanesulfonamide	PFOSA	**0.56**
2/11/2021	8P1W	272.31	WRMWSD	Perfluorooctanesulfonic Acid	PFOS	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorooctanoic Acid	PFOA	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluoropentanesulfonic Acid	PFPeS	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluoropentanoic Acid	PFPeA	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluorotetradecanoic Acid	PFTeDA	<0.45

Date	Site	MP	Collector	Analyte		Concentration, ng/L
2/11/2021	8P1W	272.31	WRMWSD	Perfluorotridecanoic Acid	PFTrDA	<0.45
2/11/2021	8P1W	272.31	WRMWSD	Perfluoroundecanoic Acid	PFUdA	<0.45
2/11/2021	8P2W	272.53	WRMWSD	10:2 FTS	--	<0.82
2/11/2021	8P2W	272.53	WRMWSD	4:2 FTS	--	<0.41
2/11/2021	8P2W	272.53	WRMWSD	6:2 FTS	--	<1.6
2/11/2021	8P2W	272.53	WRMWSD	8:2 FTS	--	<0.82
2/11/2021	8P2W	272.53	WRMWSD	NetFOSAA	--	<0.41
2/11/2021	8P2W	272.53	WRMWSD	NMeFOSAA	--	<0.49
2/11/2021	8P2W	272.53	WRMWSD	Perfluorobutanesulfonic Acid	PFBS	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorobutanoic Acid	PFBA	<1.6
2/11/2021	8P2W	272.53	WRMWSD	Perfluorodecanesulfonic Acid	PFDS	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorodecanoic Acid	PFDA	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorododecanesulfonic acid	--	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorododecanoic Acid	PFDoA	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluoroheptanesulfonic Acid	PFHpS	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluoroheptanoic Acid	PFHpA	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorohexadecanoic acid	--	<0.82
2/11/2021	8P2W	272.53	WRMWSD	Perfluorohexanesulfonic Acid	PFHxS	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorohexanoic Acid	PFHxA	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorononanesulfonic Acid	PFNS	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorononanoic Acid	PFNA	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorooctadecanoic acid	--	<0.82
2/11/2021	8P2W	272.53	WRMWSD	Perfluorooctanesulfonamide	PFOSA	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorooctanesulfonic Acid	PFOS	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorooctanoic Acid	PFOA	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluoropentanesulfonic Acid	PFPeS	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluoropentanoic Acid	PFPeA	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorotetradecanoic Acid	PFTeDA	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluorotridecanoic Acid	PFTrDA	<0.41
2/11/2021	8P2W	272.53	WRMWSD	Perfluoroundecanoic Acid	PFUdA	<0.41
2/11/2021	8P3W	272.8	WRMWSD	10:2 FTS	--	<0.88
2/11/2021	8P3W	272.8	WRMWSD	4:2 FTS	--	<0.44
2/11/2021	8P3W	272.8	WRMWSD	6:2 FTS	--	<1.8
2/11/2021	8P3W	272.8	WRMWSD	8:2 FTS	--	<0.88
2/11/2021	8P3W	272.8	WRMWSD	NetFOSAA	--	<0.44
2/11/2021	8P3W	272.8	WRMWSD	NMeFOSAA	--	<0.53
2/11/2021	8P3W	272.8	WRMWSD	Perfluorobutanesulfonic Acid	PFBS	<0.44

Date	Site	MP	Collector	Analyte		Concentration, ng/L
2/11/2021	8P3W	272.8	WRMWSD	Perfluorobutanoic Acid	PFBA	<1.8
2/11/2021	8P3W	272.8	WRMWSD	Perfluorodecanesulfonic Acid	PFDS	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorodecanoic Acid	PFDA	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorododecanesulfonic acid	--	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorododecanoic Acid	PFDoA	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluoroheptanesulfonic Acid	PFHpS	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluoroheptanoic Acid	PFHpA	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorohexadecanoic acid	--	<0.88
2/11/2021	8P3W	272.8	WRMWSD	Perfluorohexanesulfonic Acid	PFHxS	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorohexanoic Acid	PFHxA	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorononanesulfonic Acid	PFNS	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorononanoic Acid	PFNA	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorooctadecanoic acid	--	<0.88
2/11/2021	8P3W	272.8	WRMWSD	Perfluorooctanesulfonamide	PFOSA	**0.45**
2/11/2021	8P3W	272.8	WRMWSD	Perfluorooctanesulfonic Acid	PFOS	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorooctanoic Acid	PFOA	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluoropentanesulfonic Acid	PFPeS	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluoropentanoic Acid	PFPeA	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorotetradecanoic Acid	PFTeDA	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluorotridecanoic Acid	PFTrDA	<0.44
2/11/2021	8P3W	272.8	WRMWSD	Perfluoroundecanoic Acid	PFUdA	<0.44
2/11/2021	9G4W	276.09	WRMWSD	10:2 FTS	--	<0.87
2/11/2021	9G4W	276.09	WRMWSD	4:2 FTS	--	<0.43
2/11/2021	9G4W	276.09	WRMWSD	6:2 FTS	--	<1.7
2/11/2021	9G4W	276.09	WRMWSD	8:2 FTS	--	<0.87
2/11/2021	9G4W	276.09	WRMWSD	NetFOSAA	--	<0.43
2/11/2021	9G4W	276.09	WRMWSD	NMeFOSAA	--	<0.52
2/11/2021	9G4W	276.09	WRMWSD	Perfluorobutanesulfonic Acid	PFBS	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorobutanoic Acid	PFBA	<1.7
2/11/2021	9G4W	276.09	WRMWSD	Perfluorodecanesulfonic Acid	PFDS	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorodecanoic Acid	PFDA	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorododecanesulfonic acid	--	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorododecanoic Acid	PFDoA	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluoroheptanesulfonic Acid	PFHpS	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluoroheptanoic Acid	PFHpA	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorohexadecanoic acid	--	<0.87
2/11/2021	9G4W	276.09	WRMWSD	Perfluorohexanesulfonic Acid	PFHxS	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorohexanoic Acid	PFHxA	<0.43

Date	Site	MP	Collector	Analyte		Concentration, ng/L
2/11/2021	9G4W	276.09	WRMWSD	Perfluorononanesulfonic Acid	PFNS	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorononanoic Acid	PFNA	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorooctadecanoic acid	--	<0.87
2/11/2021	9G4W	276.09	WRMWSD	Perfluorooctanesulfonamide	PFOSA	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorooctanesulfonic Acid	PFOS	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorooctanoic Acid	PFOA	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluoropentanesulfonic Acid	PFPeS	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluoropentanoic Acid	PFPeA	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorotetradecanoic Acid	PFTeDA	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluorotridecanoic Acid	PFTrDA	<0.43
2/11/2021	9G4W	276.09	WRMWSD	Perfluoroundecanoic Acid	PFUdA	<0.43

Arsenic

Due to elevated arsenic concentrations close to the MCL at Check 41 in 2014 and 2015, additional information on SWSD monitoring will be presented here. The SWSD pump-in proposal dated May 20, 2020 states on page 10 that "the flow weighted average of the two physical pump-in locations should not exceed the applicable MCL and the calculated ambient constituent of concern concentrations in the aqueduct at that time should not exceed an additional 10 percent of the applicable MCL after blending." Both of these compliance points will be examined below.

Over the reporting period, SWSD was active from January to May 2016 and also from October to December 2020. As shown in **Figures 13D-4 and 5**, arsenic in the SWSD 3 turn-in exceeded the MCL of 10 µg/L once in 2016 and a number of times in 2021. Note that 2021 data is outside of the time period for this report; however this data was considered for inclusion due to its importance.

Arsenic concentrations in the Aqueduct are monitored monthly by DWR. DWR collects samples upstream at Check 23 and downstream of SWSD at Check 27. If those samples increase by greater than 10% of the MCL then SWSD is not in compliance with their agreement with DWR. Since 10% of the MCL is 1 µg/L, arsenic concentrations cannot increase by more than 1 µg/L from Check 23 to Check 27 when SWSD is operating their turn-in program. **Table 13D-11** shows monthly samples collected at Check 23 and Check 27 when SWSD was operating in March/April 2016 and March through October 2021. The increase exceeded more than 1 µg/L in June and October 2021. In November 2021, SWSD requested a temporary change to its Pump-in Policy through the end of 2021. This change would rescind the limitation on the blended SWSD turn-in water to not increase arsenic concentrations downstream by more than 10% of the MCL, as measured at Check 23 and Check 27. This limitation was proposed because of the low flow in the Aqueduct and closure of check gates, which made it difficult to calculate impacts from upstream to downstream. This temporary change was accepted by the contractors, due to the drought and resultant Aqueduct flows being low.

Samples were not collected for Check 23 and Check 27 during the months that SWSD was operating in 2020 (October, November and December) as the operation was sporadic and flows were less than 100 cfs.

Figure 13D-4. Arsenic in SWSD 3 Turn-in, (prior to Aqueduct), 2016

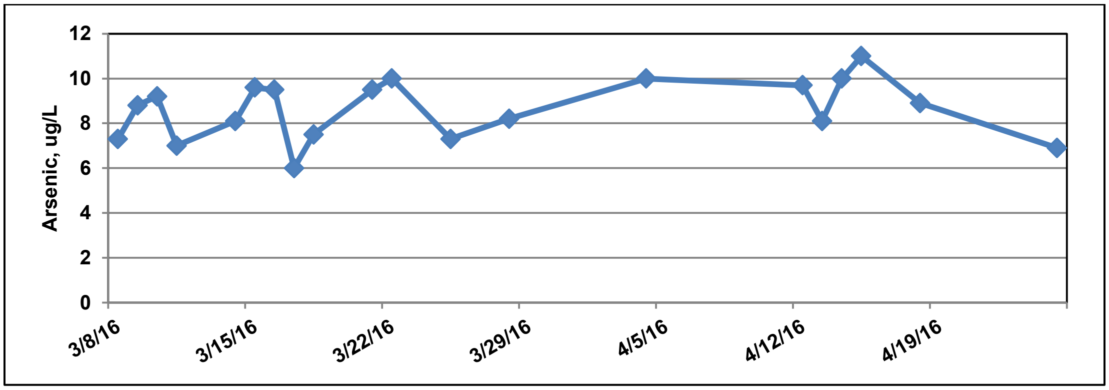


Figure 13D-5. Arsenic in SWSD 3 Turn-in, (prior to Aqueduct), 2020 and 2021

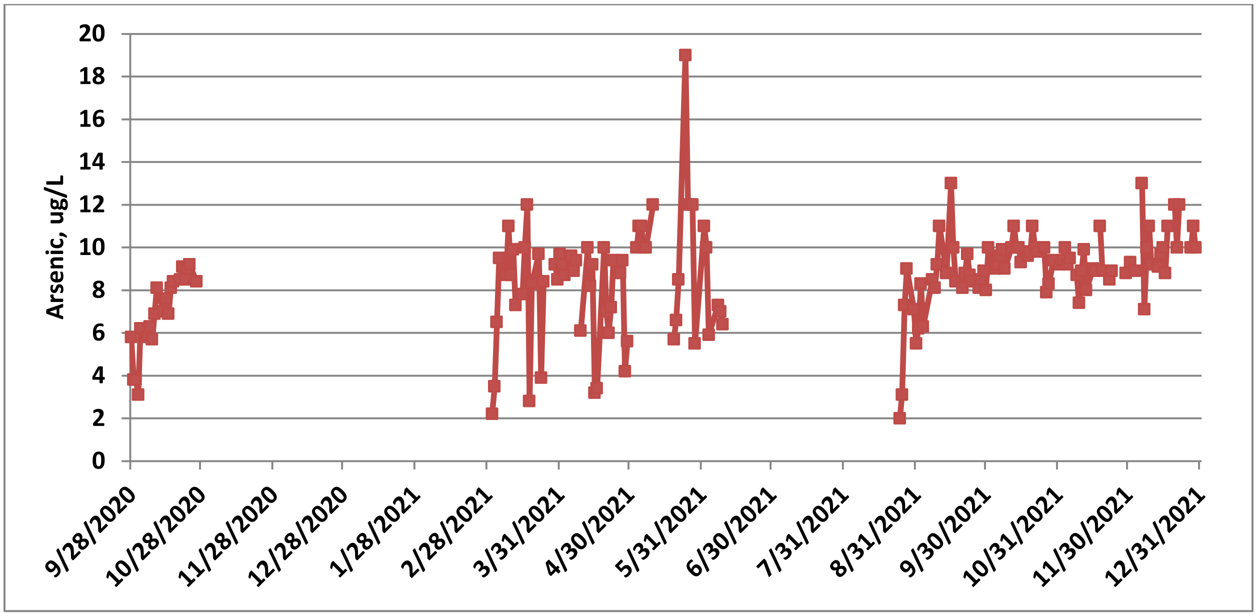


Table 13D-11. Arsenic Concentrations (mg/L) at Check 23 and Check 27 during time periods when SWSD was operating turn-ins

Date	Check 23	Check 27
3/15/2016	0.002	0.003
4/19/2016	0.003	0.003
3/16/2021	0.00229	0.00317
4/27/2021	0.00302	0.00368

Date	Check 23	Check 27
6/15/2021	**0.00272**	**0.00587**
9/21/2021	**0.0036**	**0.00439**
10/19/2021	**0.00338**	**0.00488**
11/16/2021	**0.00345**	**0.00677**
12/21/2021	**0.00333**	**0.00535**

SUMMARY

- Overall, during the reporting period, the highest volumes of non-Project turn-in water occurred in the San Joaquin Field Division, through the CVC and the KWBC.
- Typically, higher turn-in volumes occur during dry years, when supplemental supplies are most needed. If turn-ins occur during wet years, they are likely to be surface water.
- Resultant downstream water quality is reflective of the sources being turned in, volumes being turned in, and flow in the Aqueduct.
- The impact of the turn-in program to Aqueduct water quality varies from year to year, as the turn-in volumes vary greatly. Generally, groundwater turn-ins increase arsenic, nitrate and sulfate levels in downstream water quality (due to higher concentrations of these constituents in the turn-in water compared to the Aqueduct), and decrease salinity, bromide and chloride (due to lower concentrations of these constituents in the turn-in water compared to the Aqueduct). The results for total chromium during this reporting period have shown both increases and decreases in downstream water quality.
- Over the reporting period, turn-ins occurring in 2016 had the highest water quality impact, specifically in the months of January and February 2016. Arsenic concentrations increased by 5 µg/L from Check 21 to Check 41, with a resultant arsenic concentration of 8 µg/L at Check 41. Similarly, nitrate as NO_3 increased by 14.4 mg/L in January and increased by 12.3 mg/L in February. Sulfate increased by 39 mg/L in January and 60 mg/L in February. Total chromium increased by 5 µg/L in January and by 4 µg/L in February. This impact was due to repair work in Pool 30, such that Aqueduct flow stopped downstream of Pool 30, but AEWSD and WRMWSD continued to operate. POA reached as high as 48 percent in January 2016 and 46 percent in February 2016.
- No MCLs for any of the constituents of concern were exceeded in the Aqueduct over the 2016 to 2020 reporting period.
- However, recent data from 2021 indicate that arsenic above the MCL of 10 µg/L entered the Aqueduct from SWSD 3 turn-in. Greater effort or improvements are needed by SWSD to keep turn-in levels below the arsenic MCL.
- There have been a few detections of 1,2,3-TCP above its respective MCL of 0.005 µg/L in the Cross Valley Canal, turn-in 10P1X for WRMWSD, and in the Arvin Edison canal which do not comply with the DWR policy.
- There have been low level detections of PFAS in the turn-ins, with no results above the notification levels of 5.1 ng/L for PFOA, 6.5 ng/L for PFOS and 500 ng/L for PFBS. However, monitoring results will continue to be evaluated in anticipation of upcoming PFAS regulations.

RECOMMENDATIONS

- Project proponent(s) to provide monthly information on POAs during months of active turn-ins.
- When flow in Aqueduct is zero, consideration should be given to limit or stop turn-ins.
- Participating agencies should continue routine sampling as required by DWR prior to and during active turn-ins. Participating agencies should utilize the best water quality possible.
- DWR to provide timely delivery of participant water quality turn-in data as well as notification of excess surface water flows into the Aqueduct. It is recommended to use a portal such that data can be automatically uploaded by the laboratory conducting the analysis and for interested parties to access data directly. Participant proposal should include requirements for data submission to DWR, as only some proposals currently specify. (In progress with DWR).
- During active pump-ins, DWR to provide Aqueduct water quality data comparison for Check 13 and Check 21, Check 23 to Check 27, as well as Check 21 to Check 41 for COCs. This will provide timely information to verify modeled results from participants. This could be provided or displayed on the portal/website mentioned above.
- Revision of DWR's Water Quality Policy and Implementation Process for Acceptance of Non-Project Water into the State Water Project for better protection of source water quality should address/include (at a minimum):
  - Notification and response levels should be added for new constituents of concern as identified by DDW (ie. 1,2,3-trichloropropane and PFAS)
  - Surface water inflows
  - Treated wastewater flows
  - Increased water quality monitoring if warranted during specific operating conditions
  - Definition or criteria should be specified for "nearby" well used to develop water quality monitoring plan and/or allowed substitutions.

REFERENCES

Water Quality Assessment of Non-Project Turn-ins to the California Aqueduct, 2016, prepared by State of California Natural Resources Agency Department of Water Resources, November 2017.

Water Quality Assessment of Surface Water Introductions to the California Aqueduct, 2017, prepared by State of California Natural Resources Agency Department of Water Resources, December 2018.

Water Quality Assessment of Non-Project Turn-ins to the California Aqueduct, 2018, prepared by State of California Natural Resources Agency Department of Water Resources, December 2020.

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CHAPTER 13E NON-PROJECT TURN-INS TO THE DELTA MENDOTA CANAL

CONTENTS

FIGURES

TABLES

BACKGROUND

The Delta Mendota Canal (DMC) carries Central Valley Project (CVP) water to farms, communities, and wetlands between Tracy and Mendota. The 166 mile canal was built by the Bureau of Reclamation in 1952 and is currently operated and maintained by the San Luis and Delta-Mendota Water Authority. Since 1995, the San Luis and Delta- Mendota Water Authority, on behalf of eight of its member agencies (participating districts), has requested Warren contracts from the Bureau of Reclamation for the annual cumulative introduction of up to 50,000 AF of groundwater into the Delta Mendota Canal.

The addition of non-project water may further change/degrade the quality of water in the canal. The CVP contractors use surface and groundwater to supplement their contractual supply from the CVP. These supplies are called "Non-Project Water" because they have not been appropriated by the United States for the purposes of the CVP.

As stated in the Bureau of Reclamation's Final Environmental Assessment EA-18-007, there are currently 47 wells and 41 discharge points that are currently operated under the DMC

Groundwater Turn-in Program. Forty wells are located in Delta-Mendota and 7 wells are in Tracy. **Figure 13E-1** shows the participating water districts.

Figure 13E-1. Participating Districts in the DMC Groundwater Turn-in Program

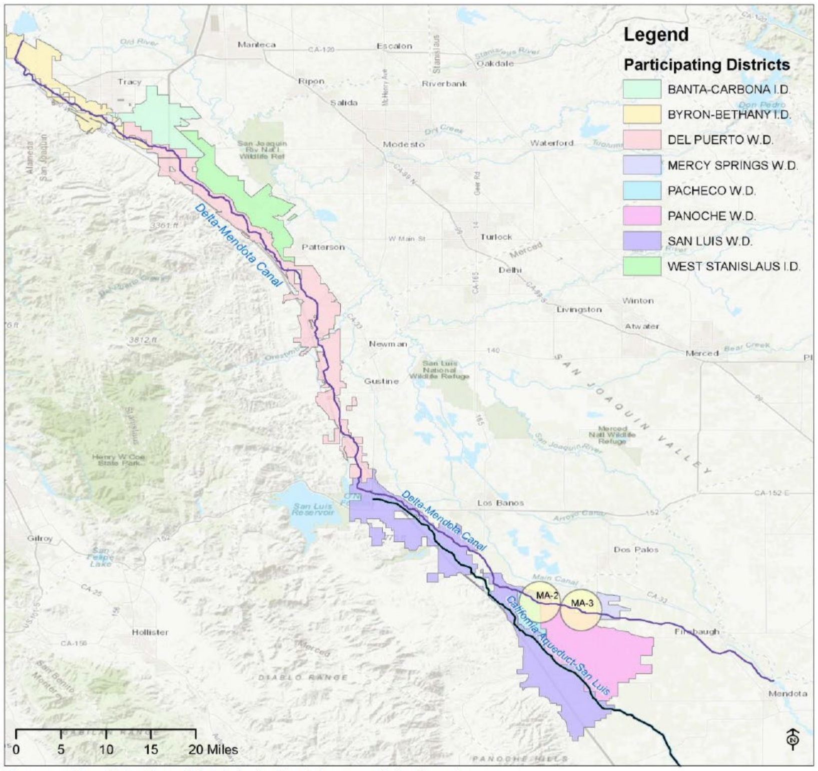


Figure 1 Participating Districts in the Proposed Action Area

It should be noted that since the DMC is completely separate from the California Aqueduct after O'Neill Forebay, the impact of groundwater turn-ins is focused on wells upstream of O'Neill Forebay. Byron- Bethany Irrigation District (BBID), Banta Carbona Irrigation District (BCID), West Stanislaus Irrigation District (WSID), San Luis Water District (SLWD), Del Puerto Water District (DPWD), and Patterson Irrigation District (PID) have wells upstream of O'Neill Forebay.

According to recent Non-Project Water Credits Reports provided by the San Luis and Delta-Mendota Water Authority, BBID has six turnouts between mileposts 3.3 and 15.11, BCID has one turn-out at milepost 20.42, WSID has one turnout at milepost 31.31, PID has two turnouts at mileposts 31.31 and 42.53, SLWD has two turnouts at mileposts 48.97 and 58.28 and DPWD has multiple turnouts as every well has its own turnout.

Table 13E-1 shows the total amount of groundwater and **Table 13E-2** shows the total amount of surface water introduced into the DMC (above Check 13) by the participating districts since 2016, per calendar year Surface water is typically water released from Millerton Lake or the Friant Dam. It should be noted that groundwater turn-in volumes are available for 2013 to 2015

(Final EA-18-007), but these older volumes could not be independently verified with water reports from the San Luis and Delta Mendota Water Authority, and therefore not included.

As discussed in the next section, a major change in the groundwater turn-in program occurred in 2018, which resulted in no groundwater pumping in 2018 and 2019. Due to a CVP allocation of 0 percent in March 2020, there were groundwater turn-ins in 2020 as shown in **Table 13E-1**.

Table 13E-1. Groundwater Turn-ins to the DMC, 2016 to 2020

District	2016	2017	2018*	2019	2020
Banta Carbona ID	2,644	0	0	0	0
Byron-Bethany ID	1,591	0	0	0	346
Del Puerto WD	8,458	430	0	0	527
West Stanislaus ID	9,085	170	0	0	1,805
Patterson ID	3,734	229	0	0	5,359
San Luis WD	2,717	322	0	0	1,588
Sum above Check 13	28,229	1,151	0	0	9,625

Source: Non-Project Water Credits Report from San Luis and Delta Mendota Water Authority

Table 13E-2. Surface Water Turn-ins to the DMC, 2016 to 2020

District	2016	2017	2018*	2019	2020
Del Puerto WD	8,540	192	0	0	0
Banta Carbona ID	17,790	8,085	13,775	10,915	11,780
West Stanislaus ID	0	0	0	0	2,391
Byron Bethany ID	0	0	0	0	1,768
Patterson ID	9,220	0	563	1,200	0
San Joaquin River Restoration Pump Back BCID*	422	4,340	8,590	4,250	7,147
San Joaquin River Restoration Pump Back PID*	410	2,294	8,576	14,511	13,104
Sum above Check 13	36,382	14,911	31,504	30,876	36,190

*Note: San Joaquin Restoration river flows are to restore the original flow of the San Joaquin River to assist salmon runs from Mendota to Patterson. Releases from Friant Dam flow to the Mendota Pool and then into the DMC. BCID and PID have contracts to pick up river water and credit it back to Friant Dam.

WARREN CONTRACTS

In 2013, in order to streamline environmental review, the Bureau of Reclamation completed an Environmental Assessment (EA-12-061) that covered the proposed execution of two 5-year Warren Act Contracts for the continued annual cumulative introduction of up to 50,000 AF of groundwater into the DMC over a 10-year period. Reclamation provided the public with an opportunity to comment on EA-12-061 between November 13, 2012 and December 13, 2012. No comments were received. Reclamation determined that the DMC Groundwater Turn-In Program would not significantly affect the quality of the human environment and a Finding of No Significant Impact (FONSI) was signed on January 10, 2013. According to EA 12-061, over the past 20 years, Reclamation has issued either annual or two-year Exchange Agreements and/or Warren Act Contracts for groundwater pumping into the DMC and storage in San Luis Reservoir. EA-12-061 was revamped in 2018 due to the issues of subsidence, and EA-12-061 was replaced with EA-18-007.

EA-18-007 now limits groundwater pumping by CVP agricultural allocation as shown in **Table 13E-3**. Since CVP allocation was greater than 50 percent for all zones in 2018 and 2019, no groundwater turn-ins were allowed in 2018 and 2019.

Table 13E-3. Amount of Groundwater Pumping Allowed by Zone

DMC Zone	CVP Allocation Start Threshold	Pumping Cap if Allocation is >40 percent	Pumping Cap is Allocation is 40-21 percent	Pumping Cap if Allocation is 20 percent or less
1 (MP 0.0 to 24.43)	≤ 50	15,000 AF	17,500 AF	20,000 AF
2 (MP 24.44 to 70.01)	≤ 40	N/A	17,500 AF	20,000 AF
3 (MP 70.02 to 99.82)	≤ 45	15,000 AF	17,500 AF	20,000 AF
4 (MP 99.83 to 116.48)	≤ 40	N/A	17,500 AF	20,000 AF

WATER QUALITY MONITORING REQUIREMENTS AS OF MAY 2018

The DMC Groundwater Pump-In Program is subject to water quality monitoring, groundwater monitoring, and reporting requirements described in “Delta-Mendota Canal Non-Project Water Pump-In Program Monitoring Plan”, dated March 2018. According to Reclamation, participating wells which apply for the program are evaluated on a year to year basis (Personal Communication, Jeff Paperdick, Reclamation). Reclamation may allow some wells which exceed secondary standards to participate in the program during periods of drought.

Prior to pumping into the DMC, each source of non-project water must be tested for a short list of constituents of concern **(Table 13E-4).** This initial test will screen out unacceptable water sources by requiring that the well meet the requirements of **Table 13E-4**. Upon review of the short list lab results and written approval from Reclamation and the Authority, the non-project water may be discharged into the DMC. Non-project water sources discharging into the DMC are required to sample the short list of constituents every week for the first four weeks, followed by monthly sampling for the duration of pumping. Once a well has been approved for the short list, the well owner should immediately schedule sampling for Title 22 constituents as listed in **Table 13E-5**. Every three years the non-project source is required to sample for the full suite of Title 22.

Any wells that do not meet water quality requirements are not allowed to introduce groundwater into the DMC. As of May 2018, all participating wells must meet the standards listed in **Table 13E-4.** In particular, the salinity of each source of turn-in water should not exceed 1,500 mg/L TDS or exceed 10 mg/L for nitrate as N.

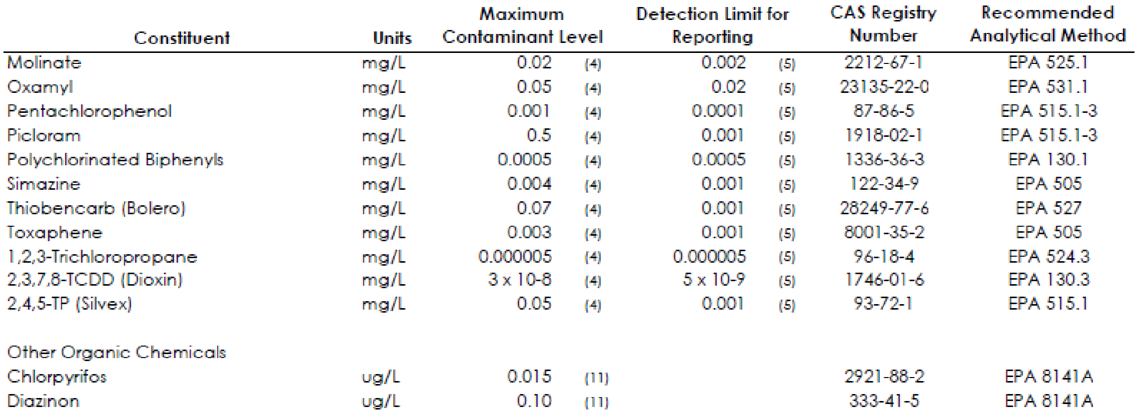
Table 13E-4. Short list of Constituents to be Monitored and Requirements, as of May 2018

Constituent	Units	Maximum Contaminant Level		Detection Limit for Reporting		CAS Registry Number	Recommended Analytical Method
Arsenic	mg/L	0.01	(1)	0.002	(2)	7440-38-2	EPA 200.8
Boron	mg/L	0.7	(13)			7440-42-8	EPA 200.7
Nitrate (as nitrogen)	mg/L	10	(1)	0.4	(2)	7727-37-9	EPA 300.1
Selenium	mg/L	0.002	(10)	0.0004	(2)	7782-49-2	EPA 200.8
Sodium	mg/L	69	(12)			7440-23-5	EPA 200.7
Specific Conductance	µS/cm	1,600	(7)				SM 2510 B
Sulfate	mg/L	500	(7)			14808-79-8	EPA 300.1
Total Dissolved Solids	mg/L	1,000	(7)				SM 2540 C

Table 13E-5. Water Quality Requirements for Participating Wells as of May 2018

Constituent	Units	Maximum Contaminant Level		Detection Limit for Reporting		CAS Registry Number	Recommended Analytical Method
Primary							
Aluminum	mg/L	1	(1)	0.05	(2)	7429-90-5	EPA 200.7
Antimony	mg/L	0.006	(1)	0.006	(2)	7440-36-0	EPA 200.8
Arsenic	mg/L	0.010	(1)	0.002	(2)	7440-38-2	EPA 200.8
Asbestos	MFL	7	(1)	0.2 MFL>10um	(2)	1332-21-4	EPA 100.2
Barium	mg/L	1	(1)	0.1	(2)	7440-39-3	EPA 200.7
Beryllium	mg/L	0.004	(1)	0.001	(2)	7440-41-7	EPA 200.7
Cadmium	mg/L	0.005	(1)	0.001	(2)	7440-43-9	EPA 200.7
Chromium, total	mg/L	0.05	(1)	0.01	(2)	7440-47-3	EPA 200.7
Cyanide	mg/L	0.15	(1)	0.1	(2)	57-12-5	EPA 335.2
Fluoride	mg/L	2.0	(1)	0.1	(2)	16984-48-8	EPA 300.1
Mercury	mg/L	0.002	(1)	0.001	(2)	7439-97-6	EPA 245.1
Nickel	mg/L	0.1	(1)	0.01	(2)	7440-02-0	EPA 200.7
Nitrate (as nitrogen)	mg/L	10	(1)	0.4	(2)	7727-37-9	EPA 300.1
Nitrate + Nitrite (sum as nitrogen)	mg/L	10	(1)			14797-55-8	EPA 353.2
Nitrite (as nitrogen)	mg/L	1	(1)	0.4	(2)	14797-65-0	EPA 300.1
Perchlorate	mg/L	0.006	(1)	0.004	(2)	14797-73-0	EPA 314/331/332
Selenium	mg/L	0.002	(10)	0.0004		7782-49-2	EPA 200.8
Thallium	mg/L	0.002	(1)	0.001	(2)	7440-28-0	EPA 200.8
Secondary							
Aluminum	mg/L	0.2	(6)			7429-90-5	EPA 200.7
Color	units	15	(6)				EPA 110
Copper	mg/L	1.0	(6)	0.05	(8)	7440-50-8	EPA 200.7
Foaming Agents (MBAS)	mg/L	0.5	(6)				
Iron	mg/L	0.3	(6)			7439-89-6	EPA 200.7
Manganese	mg/L	0.05	(6)			7439-96-5	EPA 200.7
Methyl-tert-butyl ether (MTBE)	mg/L	0.013	(4)			1634-04-4	EPA 502.2/524.2
Odor -threshold	units	3	(6)				SM 2150B
Silver	mg/L	0.1	(6)			7440-22-4	EPA 200.7
Thiobencarb	mg/L	0.001	(6)			28249-77-6	EPA 527
Turbidity	units	5	(6)				EPA 190.1/SM2130B
Zinc	mg/L	5	(6)			7440-66-6	EPA 200.7
Total Dissolved Solids	mg/L	1,000	(7)				SM 2540 C
Specific Conductance	µS/cm	1,600	(7)				SM 2510 B
Chloride	mg/L	500	(7)			16887-00-6	EPA 300.1
Sulfate	mg/L	500	(7)			14808-79-8	EPA 300.1
Other Required Analyses							
Boron	mg/L	0.7	(13)			7440-42-8	EPA 200.7
Lead	mg/L	0.015	(8)	0.005	(8)	7439-92-1	EPA 200.8
Molybdenum	mg/L	0.01	(11)			7439-98-7	EPA 200.7
Sodium	mg/L	69	(12)			7440-23-5	EPA 200.7
Radioactivity							
Gross Alpha	pCi/L	15	(3)	3	(3)		SM 7110C

Constituent	Units	Maximum Contaminant Level	Detection Limit for Reporting	CAS Registry Number	Recommended Analytical Method
Organic Chemicals					
(a) Volatile Organic Chemicals (VOCs)					
Benzene	mg/L	0.001 (4)	0.0005 (5)	71-43-2	EPA 502.2/524.2
Carbon Tetrachloride	mg/L	0.0005 (4)	0.0005 (5)	56-23-5	EPA 502.2/524.2
1,2-Dichlorobenzene	mg/L	0.6 (4)	0.0005 (5)	95-50-1	EPA 502.2/524.2
1,4-Dichlorobenzene	mg/L	0.005 (4)	0.0005 (5)	106-46-7	EPA 502.2/524.2
1,1-Dichloroethane	mg/L	0.005 (4)	0.0005 (5)	75-34-3	EPA 502.2/524.2
1,2-Dichloroethane	mg/L	0.0005 (4)	0.0005 (5)	107-06-2	EPA 502.2/524.2
1,1-Dichloroethylene	mg/L	0.006 (4)	0.0005 (5)	75-35-4	EPA 502.2/524.2
cis-1,2-Dichloroethylene	mg/L	0.006 (4)	0.0005 (5)	156-59-2	EPA 502.2/524.2
trans-1,2-Dichloroethylene	mg/L	0.01 (4)	0.0005 (5)	156-60-5	EPA 502.2/524.2
Dichloromethane.	mg/L	0.005 (4)	0.0005 (5)	75-09-2	EPA 502.2/524.2
1,2-Dichloropropane.	mg/L	0.005 (4)	0.0005 (5)	78-87-5	EPA 502.2/524.2
1,3-Dichloropropene.	mg/L	0.0005 (4)	0.0005 (5)	542-75-6	EPA 502.2/524.2
Ethylbenzene.	mg/L	0.3 (4)	0.0005 (5)	100-41-4	EPA 502.2/524.2
Methyl-tert-butyl ether	mg/L	0.013 (4)	0.003 (5)	1634-04-4	EPA 502.2/524.2
Monochlorobenzene	mg/L	0.07 (4)	0.0005 (5)	108-90-7	EPA 502.2/524.2
Styrene.	mg/L	0.1 (4)	0.0005 (5)	100-42-5	EPA 502.2/524.2
1,1,2,2-Tetrachloroethane.	mg/L	0.001 (4)	0.0005 (5)	79-34-5	EPA 502.2/524.2
Tetrachloroethylene (PCE)	mg/L	0.005 (4)	0.0005 (5)	127-18-4	EPA 502.2/524.2
Toluene	mg/L	0.15 (4)	0.0005 (5)	108-88-3	EPA 502.2/524.2
1,2,4-Trichlorobenzene	mg/L	0.005 (4)	0.0005 (5)	120-82-1	EPA 502.2/524.2
1,1,1-Trichloroethane	mg/L	0.200 (4)	0.0005 (5)	71-55-6	EPA 502.2/524.2
1,1,2-Trichloroethane	mg/L	0.005 (4)	0.0005 (5)	79-00-5	EPA 502.2/524.2
Trichloroethylene	mg/L	0.005 (4)	0.0005 (5)	79-01-6	EPA 502.2/524.2
Trichlorofluoromethane	mg/L	0.15 (4)	0.005 (5)	75-69-4	EPA 502.2/524.2
1,1,2-Trichloro-1,2,2-Trifluoroethane.	mg/L	1.2 (4)	0.01 (5)	76-13-1	SM 6200B
Vinyl Chloride	mg/L	0.0005 (4)	0.0005 (5)	75-01-4	EPA 502.2/524.2
Xylenes	mg/L	1.750 (4)	0.0005 (5)	1330-20-7	EPA 502.2/524.2
(b) Non-Volatile Synthetic Organic Chemicals (SOCs)					
Alachlor	mg/L	0.002 (4)	0.001 (5)	15972-60-8	EPA 505/507/508
Atrazine	mg/L	0.001 (4)	0.0005 (5)	1912-24-9	EPA 505/507/508
Bentazon	mg/L	0.018 (4)	0.002 (5)	25057-89-0	EPA 515.1
Benzo(a)pyrene	mg/L	0.0002 (4)	0.0001 (5)	50-32-8	EPA 525.2
Carbofuran	mg/L	0.018 (4)	0.005 (5)	1563-66-2	EPA 531.1
Chlordane	mg/L	0.0001 (4)	0.0001 (5)	57-74-9	EPA 505/508
2,4-D	mg/L	0.07 (4)	0.01 (5)	94-75-7	EPA 515.1
Dalapon	mg/L	0.2 (4)	0.01 (5)	75-99-0	EPA 515.1
Dibromochloropropane	mg/L	0.0002 (4)	0.00001 (5)	96-12-8	EPA 502.2/504.1
Di(2-ethylhexyl)adipate	mg/L	0.4 (4)	0.005 (5)	103-23-1	EPA 506
Di(2-ethylhexyl)phthalate	mg/L	0.004 (4)	0.003 (5)	117-81-7	EPA 506
Dinoseb	mg/L	0.007 (4)	0.002 (5)	88-85-7	EPA 5151-4
Diquat	mg/L	0.02 (4)	0.004 (5)	85-00-7	EPA 549.2
Endothall	mg/L	0.1 (4)	0.045 (5)	145-73-3	EPA 548.1
Endrin.	mg/L	0.002 (4)	0.0001 (5)	72-20-8	EPA 505/508
Ethylene Dibromide	mg/L	0.00005 (4)	0.00002 (5)	106-93-4	EPA 502.2/504.1
Glyphosate	mg/L	0.7 (4)	0.025 (5)	1071-83-6	EPA 547
Heptachlor.	mg/L	0.00001 (4)	0.00001 (5)	76-44-8	EPA 508
Heptachlor Epoxide	mg/L	0.00001 (4)	0.00001 (5)	1024-57-3	EPA 508
Hexachlorobenzene	mg/L	0.001 (4)	0.0005 (5)	118-74-1	EPA 505/508
Hexachlorocyclopentadiene	mg/L	0.05 (4)	0.001 (5)	77-47-4	EPA 505/508
Lindane (gamma-BHC)	mg/L	0.0002 (4)	0.0002 (5)	58-89-9	EPA 505/508
Methoxychlor	mg/L	0.03 (4)	0.01 (5)	72-43-5	EPA 505/508



Constituent	Units	Maximum Contaminant Level		Detection Limit for Reporting		CAS Registry Number	Recommended Analytical Method
Molinate	mg/L	0.02	(4)	0.002	(5)	2212-67-1	EPA 525.1
Oxamyl	mg/L	0.05	(4)	0.02	(5)	23135-22-0	EPA 531.1
Pentachlorophenol	mg/L	0.001	(4)	0.0001	(5)	87-86-5	EPA 515.1-3
Picloram	mg/L	0.5	(4)	0.001	(5)	1918-02-1	EPA 515.1-3
Polychlorinated Biphenyls	mg/L	0.0005	(4)	0.0005	(5)	1336-36-3	EPA 130.1
Simazine	mg/L	0.004	(4)	0.001	(5)	122-34-9	EPA 505
Thiobencarb (Bolero)	mg/L	0.07	(4)	0.001	(5)	28249-77-6	EPA 527
Toxaphene	mg/L	0.003	(4)	0.001	(5)	8001-35-2	EPA 505
1,2,3-Trichloropropane	mg/L	0.000005	(4)	0.000005	(5)	96-18-4	EPA 524.3
2,3,7,8-TCDD (Dioxin)	mg/L	3 x 10-8	(4)	5 x 10-9	(5)	1746-01-6	EPA 130.3
2,4,5-TP (Silvex)	mg/L	0.05	(4)	0.001	(5)	93-72-1	EPA 515.1
Other Organic Chemicals							
Chlorpyrifos	ug/L	0.015	(11)			2921-88-2	EPA 8141A
Diazinon	ug/L	0.10	(11)			333-41-5	EPA 8141A

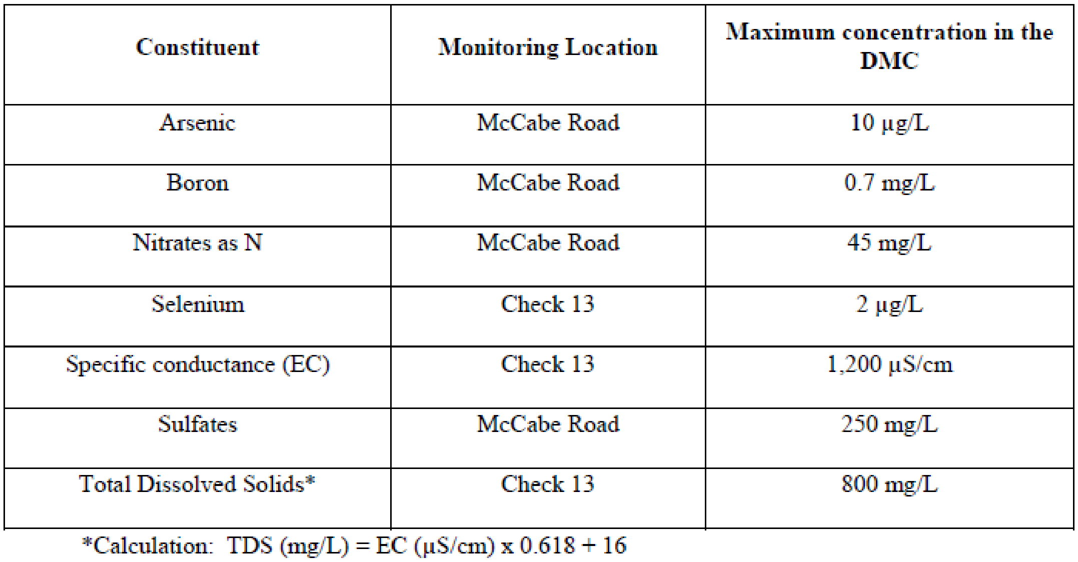
It should be noted that prior to EA-18-007, there were wells participating in the program which did not meet the requirements in **Table 13E-4**. However, the requirements for participating wells **prior** to EA-18-007 applied only to the resultant concentration in the DMC. As stated in the January 2013 DMC Groundwater Pump-In Program Water Quality Monitoring Plan (Appendix A) EA-12-061, "Reclamation and the Authority will allow groundwater to be pumped into the DMC if such water does not cause the concentration of important constituents in the canal to exceed certain thresholds listed." The thresholds which applied from March 2013 to May 2018 are listed in **Table 13E-6**. To reiterate, the requirements listed in **Table 13E-6** were superseded by requirements listed in **Table 13E-5** in May 2018.

As an example, nitrate (as N) was measured in well 23.41 at 20.4 mg/L on February 1, 2014, which exceeds the MCL of 10 mg/L. Records show that the well participated in the groundwater turn-in program in 2014, 2015, and 2016 by pumping 506 AF, 264 AF and 98 AF, respectively. However, the well was sampled again on August 31, 2016 and nitrate as N was much lower, at 4.67 mg/L.

Similarly, nitrate as N was measured in well 64.85 at 11.1 mg/L on April 8, 2016. Records show that the well participated in the groundwater turn-in program in 2015, 2016, and 2017 by pumping 669 AF, 606 AF and 47 AF, respectively. (Delta Mendota Canal Water Quality Monitoring Program Report of Flows, Concentrations and Loads of Salts and Selenium January-March 2017. May 2017. US Bureau of Reclamation. Mid-Pacific Region Sacramento, CA).

Although these wells were allowed to participate in the turn-in program prior to 2018, these wells would likely not qualify to participate under the new requirements set by EA-18-007 **(Table 13E-5).**

Table 13E-6. Maximum Allowable Concentrations of Seven Constituents in the Upper DMC (Between Jones Pumping Plant and Check 13)



Constituent	Monitoring Location	Maximum concentration in the DMC
Arsenic	McCabe Road	10 µg/L
Boron	McCabe Road	0.7 mg/L
Nitrates as N	McCabe Road	45 mg/L
Selenium	Check 13	2 µg/L
Specific conductance (EC)	Check 13	1,200 µS/cm
Sulfates	McCabe Road	250 mg/L
Total Dissolved Solids*	Check 13	800 mg/L

*Calculation: TDS (mg/L) = EC (µS/cm) x 0.618 + 16

SUMMARY

- Although the annual groundwater turn-in volume to the DMC is currently limited to 50,000 AF per year, this is a substantial potential contaminant source.
- Typically, higher turn-in volumes occur during dry years, when supplemental supplies are most needed.
- Resultant downstream water quality is reflective of the sources being turned in, volumes being turned in, and flow in the DMC.
- Similar to turn-ins to the California Aqueduct, the impact of the turn-in program to DMC water quality varies from year to year, as the turn-in volumes vary greatly

RECOMMENDATIONS

It is recommended that DWR staff review/ participate in the yearly selection of wells to participate in the program with the Bureau of Reclamation.

It is recommended that DWR track all future turn-ins to the Delta Mendota Canal, similar to turn-ins to the California Aqueduct. Although well water quality data was requested for participating wells in 2021, no data was received from the Bureau of Reclamation.

REFERENCES

Bureau of Reclamation. 2013. Exchange Agreements and/or Warren Act Contracts for Conveyance of Groundwater in the Delta-Mendota Canal – Contract years 2013 through 2023 (March 1, 2013 – February 29, 2024). Final EA 12-061. South-Central California Area Office. Fresno, CA.

Bureau of Reclamation. 2018. Delta-Mendota Canal Groundwater Pump-In Program Revised Design Constraints Final Environmental Assessment EA-18-007. May 2018. South-Central California Area Office. Fresno, CA.

Delta Mendota Canal Water Quality Monitoring Program Report of Flows, Concentrations and Loads of Salts and Selenium January-March 2017. May 2017. US Bureau of Reclamation. Mid-Pacific Region Sacramento, CA

CHAPTER 13F NORTH VALLEY REGIONAL RECYCLED WATER PROGRAM

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FIGURES

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CHAPTER 13F NORTH VALLEY REGIONAL RECYCLED WATER PROGRAM

BACKGROUND/WATER QUALITY CONCERN

The Central Valley Regional Water Quality Control Board adopted a discharge permit in February 2016 that permits the cities of Modesto and Turlock to discharge up to 59,000 acre-feet of recycled tertiary treated wastewater into the Central Valley Project Delta Mendota Canal (DMC). The recycled water will be transferred to the Del Puerto Water District and to the Central Valley Project Improvement Act designated wildlife refuges. The city of Modesto began discharging recycled water into the DMC on December 11, 2017, while the city of Turlock started discharging on March 12, 2020. **Figure 13F-1** shows the relative location of the cities to the DMC and to the Del Puerto Water District.

Although the wastewater discharge is not directly entering the California Aqueduct, it will eventually impact the State Water Project as the DMC water is normally discharged into the O’Neill Forebay, which then continues into the San Luis Canal, which is part of the San Luis Joint-Use Complex, which serves both the State Water Project and the federal Central Valley Project. More information is provided below.

The operation of the Central Valley Project (CVP) and State Water Project are highly coordinated. Both Projects have independent parallel systems to extract water from the Delta and to convey the extracted water downstream, up to the inlet of the O’Neill Forebay. Both Projects share the O’Neill Forebay, San Luis Reservoir and the California Aqueduct for delivering water further south. Water from the DMC is pumped to the O’Neill Forebay through the O’Neill Pumping and Generating Plant. The DMC also receives water from the O’Neill Forebay through this same facility. Also, both Projects cooperatively extract water from the Delta at a maximum rate allowed by a set of detailed operating guidelines and rules. Both Projects will convey all water extracted from the Delta downstream to meet contractor demands. When Delta extractions exceed demand, the water is conveyed to San Luis Reservoir through the O’Neill Forebay. When Delta extractions are less than demand, water is released from the San Luis Reservoir to the O’Neill Forebay and subsequently to either the DMC or the California Aqueduct. Consequently, any water quality issue in either of the two independent portions of the two Projects can and does have an impact on the shared facilities and within the DMC downstream of the O’Neill Pumping and Generating Plant. It is important to note that the CVP has about 10% M&I users while SWP has 70% M&I users. Both Projects are designed and operated to provide a source of supply for drinking water systems. Therefore, the use of the DMC as a means to convey recycled tertiary treated wastewater downstream is a concern to M&I contractors downstream of the discharge location.

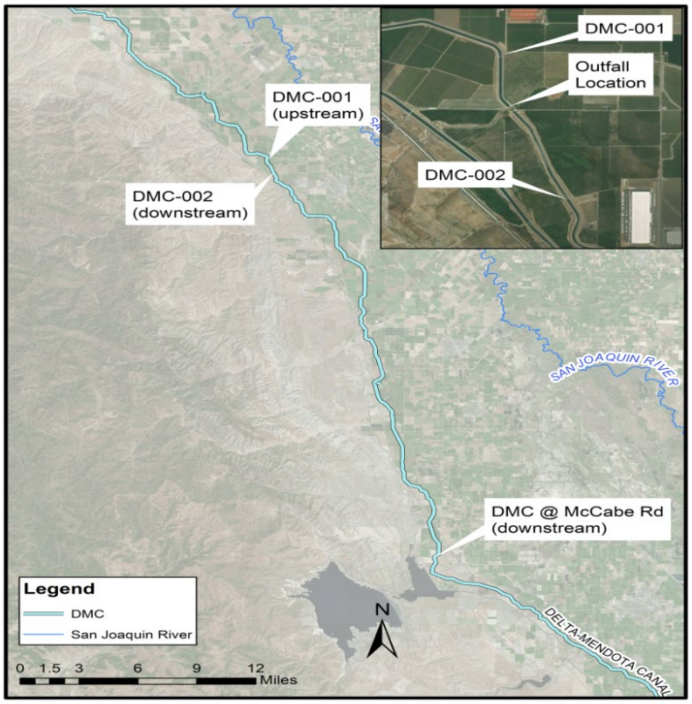
Figure 13F-1. Project Location for North Valley Regional Recycled Water Program (NVRRWP)

Recycled water will be conveyed to Del Puerto Water District via a pipeline from the cities to the Delta-Mendota Canal.

Both the City of Turlock and the City of Modesto are discharging into a joint outfall location as shown in **Figure 13F-2.** DMC-001 (Mile marker 36.81) sampling location is about 0.5 miles upstream of the outfall location, and DMC-002 (Mile marker 38.14) sampling location is about 0.8 miles downstream of the outfall location.

As treated wastewater effluent is currently being discharged directly into the DMC, there is concern about the possibility of increased nutrient loading and resultant algal blooms downstream. Increased salts, pharmaceuticals, and personal care products from the treated wastewater effluent are also a concern.

Figure 13F-2. Monitoring Locations for the City of Turlock along the DMC and Outfall Location



Tertiary Treatment Processes

The Cities of Modesto and Turlock provide tertiary treated water with ammonia removal and total nitrogen removal (nitrification and denitrification). Nitrification converts ammonia to nitrate, and denitrification converts nitrate to nitrogen gas. The City of Modesto's wastewater treatment plant (WWTP) has tertiary treatment using a two-step membrane bioreactor (MBR) process that includes an aerated activated sludge process and a membrane separation process. The MBR provides nitrification and denitrification. An oxidation ditch also provides nitrogen removal.

The City of Turlock's WWTP has tertiary treatment consisting of high rate clarification with chemical addition and cloth disk filters. In July 2019, Turlock converted the activated sludge system to Modified Ludazk-Ettinger (MLE) to remove both ammonia and total nitrogen. Therefore, the City of Turlock was discharging denitrified effluent into the DMC when it started in March 2020.

Current and Future Flows

Actual flow (as shown in **Figure 13F-3**) from the City of Modesto's WWTP is approximately 14.9 mgd (23 cfs) and City of Turlock's WWTP flows are approximately 10 mgd, which together totals 25 mgd or 38.7 cfs. The City of Modesto is permitted to discharge 14.9 mgd to the DMC and the City of Turlock is permitted for 14.2 mgd.

As the City of Turlock WWTP has a design flow of 20 mgd, there are currently no plans for expansion (David Huff, meeting with City of Turlock, October 2019). The City of Modesto would need to expand their WWTP in order to increase above current flows. As shown in **Table 13F-1**, each WWTP has an estimated build out flow for 2035, totaling 32.3 mgd for both WWTPs.

Figure 13F-3. Treated Wastewater Flow into the DMC from the NVRRWP Outfall

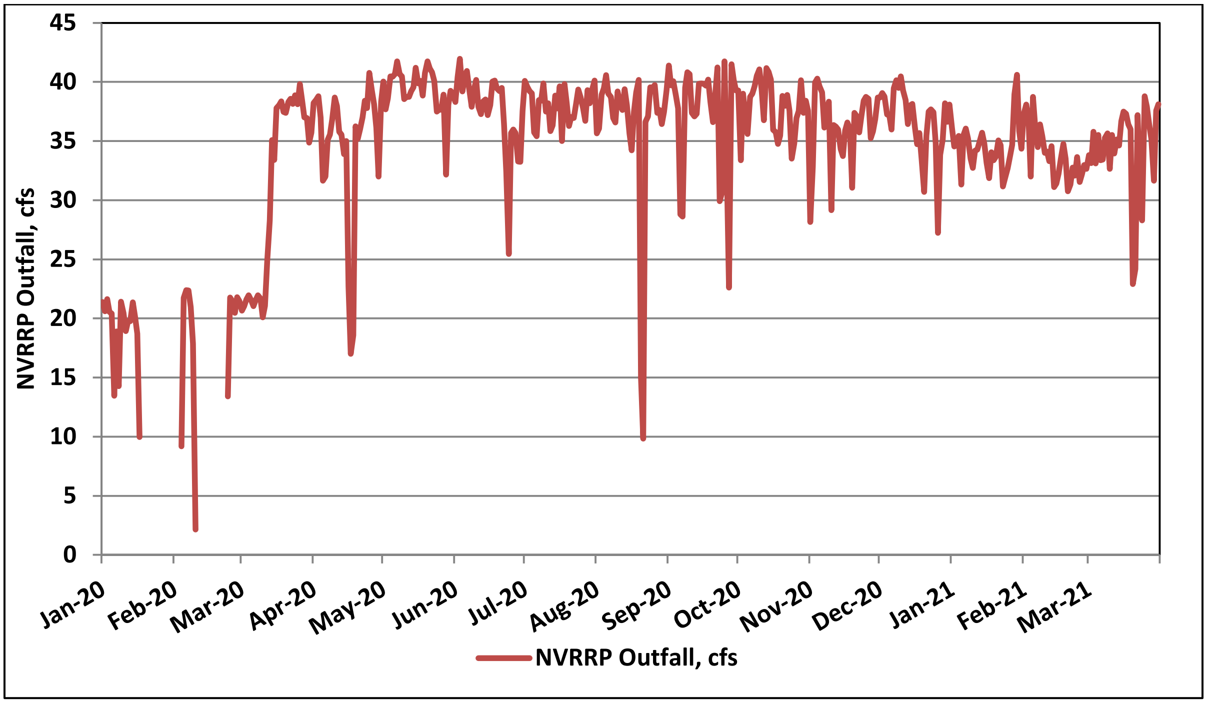


Table 13F-1. Current and Future Treated Wastewater Flows

	City of Modesto	City of Turlock	Total
Current Flow (2021)	14.9	10	25
Build Out Flow (2035)	19.1	13.2	32.3

WATER QUALITY ANALYSIS/STUDIES

There are three main studies which will be discussed herein.

- City of Turlock's monitoring as required by agreement with State Water Contractors
- Effluent characterization Study conducted by both Cities as required by individual NPDES permit
- Constituents of Emerging Concern (CEC) study conducted by the State Water Contractor's Municipal Water Quality Investigations (MWQI) Specific Projects Committee (SPC)

City of Turlock Monitoring Required by State Water Contractors Agreement

The State Water Contractors (SWC) filed a protest to the Wastewater Change Petition filed by the City of Turlock in August 2015. The City of Turlock and SWC reached an agreement in August 2016 for a four-year monitoring study. The monitoring study was initiated by the City of Turlock in December 2016 to assess water quality impacts as the result of the addition of recycled water into the DMC. The focus of the monitoring is nutrients and algal blooms and cyanotoxins.

The City of Turlock reached an agreement with the SWC to monitor for four years, on a monthly basis, for ammonia, nitrate, total kjeldahl nitrogen (TKN), orthophosphate as P, total phosphorus, temperature, electrical conductivity, pH and dissolved oxygen at upstream (DMC-001) and downstream (DMC-002) locations of the discharge, as shown in **Figure 13F-2**. Monitoring will also be conducted for algal biomass, chlorophyll-a, pheophytin-a and algal toxins at McCabe Road and at upstream (DMC-001) during the months from April to October. The McCabe Road location is about 30 miles downstream of the outfall location.

The City of Modesto began discharging treated wastewater effluent to the DMC on December 11, 2017. Therefore, there was no wastewater discharge from the NVRRP during the time period from December 2016 to December 10, 2017. The City of Turlock began discharging treated wastewater to the DMC on March 12, 2020. Therefore, the time period from December 11, 2017 to March 11, 2020 was when only the City of Modesto was discharging, and monitoring from March 12, 2020 to March 2021 represents both Cities discharging to the DMC. The agreement with SWC for monitoring ended in March 2021, as the four years of monitoring were completed.

The following data analysis is taken from the City of Turlock "Delta Mendota Canal Nutrient and Algae Year 4 Annual and Final Study Report", dated July 2021. The report has prepared a number of graphs (not shown here) showing mean concentrations for the analytes mentioned above, over three distinct discharge conditions (No discharge, Modesto, and Modesto and Turlock). In order to compare sites, the report calculates and plots mean values for each site (DMC-001 and DMC-002) during each of the discharge conditions. The report calculated upper and lower 95% confidence intervals around the mean. Confidence levels around the mean demonstrate with 95% certainty a range where the mean would be expected. The report states that "Differences between means are likely not statistically significant if the confidence intervals overlap." However, this is not a true statement. Overlapping confidence intervals do not determine statistical significance. It can only be proven statistically significant if statistical analysis, such as a parametric test (t-test) or a non-parametric equivalent (Mann-Whitney) is conducted.

Therefore, additional data analysis (**Table 13F-2**) was independently conducted during the "Modesto and Turlock" time period when both WWTPs were discharging for the purpose of this watershed sanitary survey report. Using the non-parametric Mann-Whitney test, the mean total phosphorus of 0.18 mg/L at the downstream DMC-002 location is statistically significantly higher than the respective mean concentration of 0.12 mg/L at the upstream DMC-001 location (Mann-Whitney, p=0.0011). Similarly, using the non-parametric Mann-Whitney test, the mean orthophosphate of 0.13 mg/L at the downstream DMC-002 location is statistically significantly higher than the respective mean concentration of 0.09 mg/L at the upstream DMC-001 location (Mann-Whitney, *p*=0.005). Using the Mann-Whitney test, there was no statistical significant difference between the mean upstream and downstream concentrations for nitrate, TKN, and ammonia. This is not surprising as both WWTPs have nitrification and denitrification removal processes.

Figures 13F-4 and **13F-5** show phosphorus and orthophosphate data collected for the study. It appears that phosphorus and orthophosphate started to show an increase from DMC-001 to DMC-002 at the same time when the City of Turlock began discharging in March 2020.

As mentioned earlier, samples were also collected for algal biomass, chlorophyll-a, pheophytin-a and algal toxins at McCabe and upstream of the discharge. Overall, algal productivity increased over the course of the study at both the upstream and downstream locations, but this is likely due to algal blooms originating in the Delta in 2020, and not from increased wastewater discharge. **Table 13F-2** shows that there was no statistical significant difference between the mean upstream and downstream concentration (McCabe Rd.) for algal biomass, chlorophyll-a and pheophytin-a.

Table 13F-2. Means and P-values for Constituents when both City of Modesto and City of Turlock WWTPS discharged to DMC (April 2020 – March 2021)

Constituent, mg/L	**DMC-001(Upstream)**	**DMC-002 (Downstream,)**	**P-value**
Nitrate as N	0.88	1.07	1.00
Ammonia as N	0.023	0.022	0.817
Orthophosphate as P	0.09	0.13	0.005
Phosphorus	0.12	0.18	0.011

Constituent	**DMC-001**	**DMC-McCabe**	**P-value**
Algal Biomass, mg/L	0.40	0.55	0.544
Chlorophyll-a, µg/L	6.9	8.5	0.795
Pheophytin-a, µg/L	0	0	0.665

Figure 13F-4. Phosphorus for Study Period (December 2016 to March 2021)

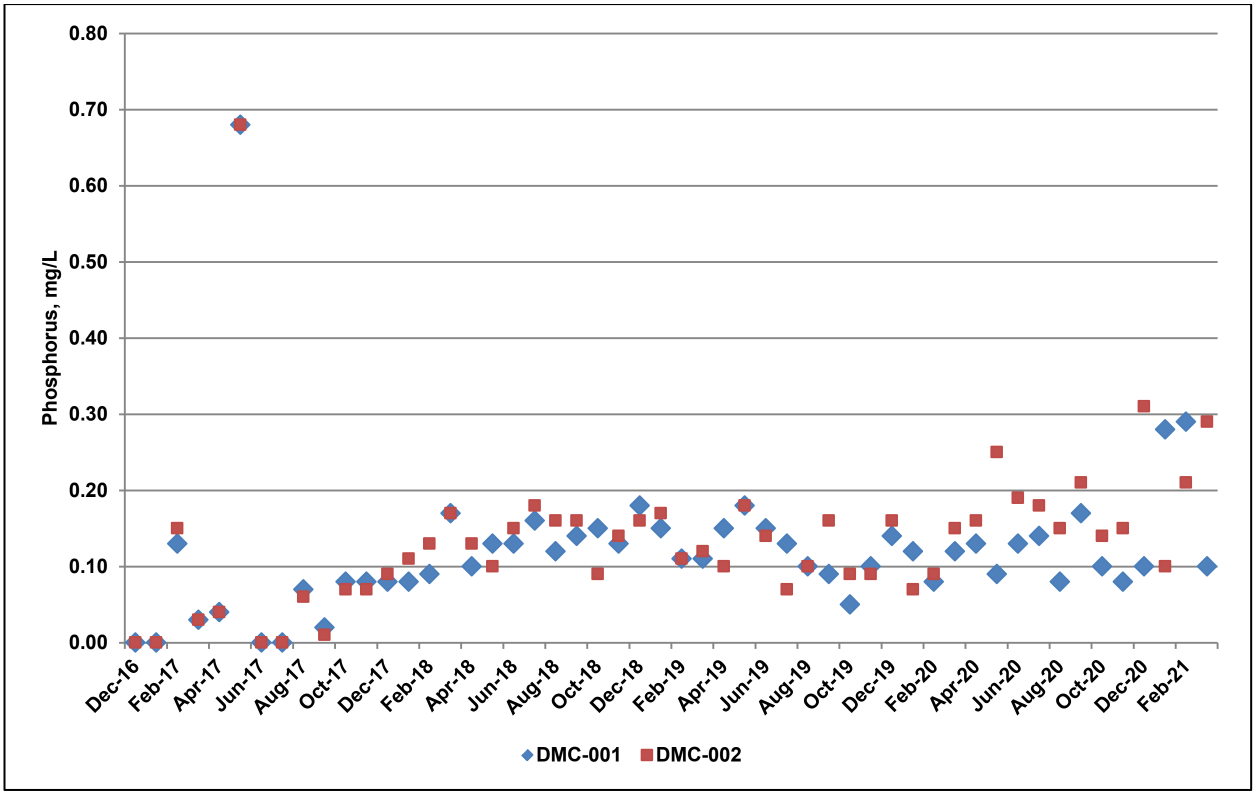
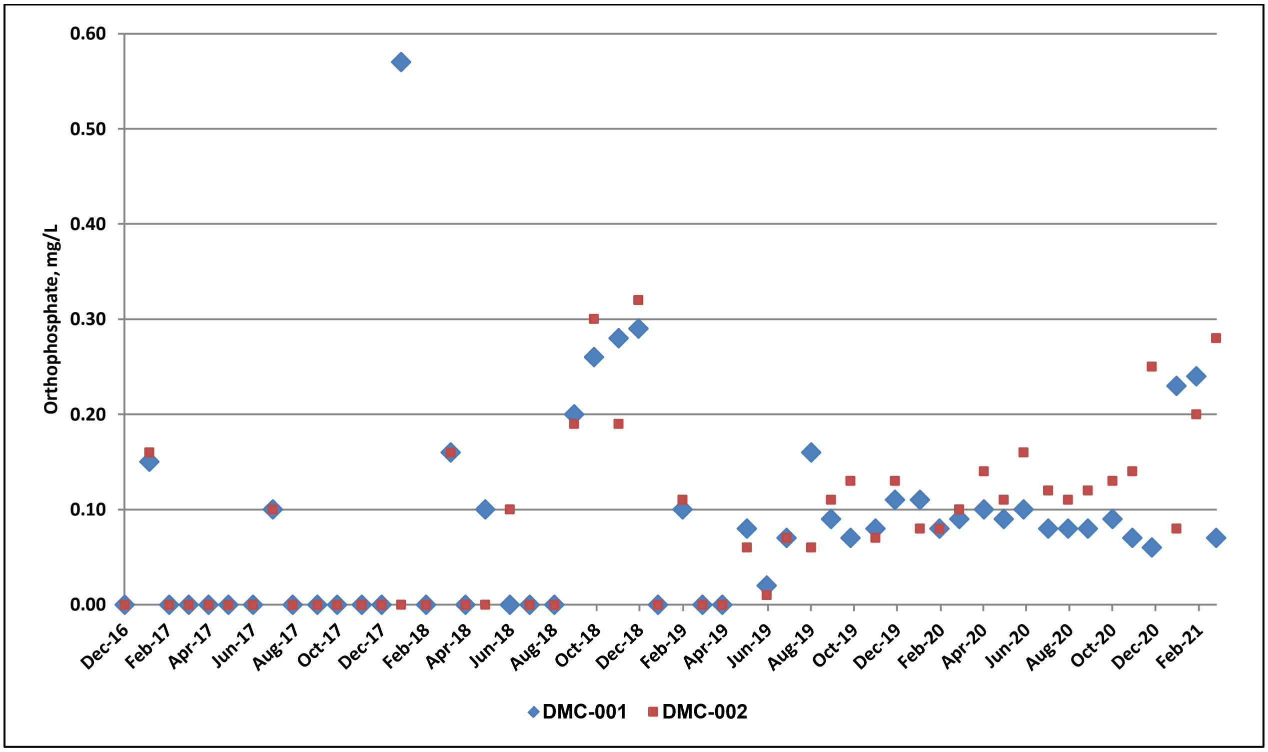
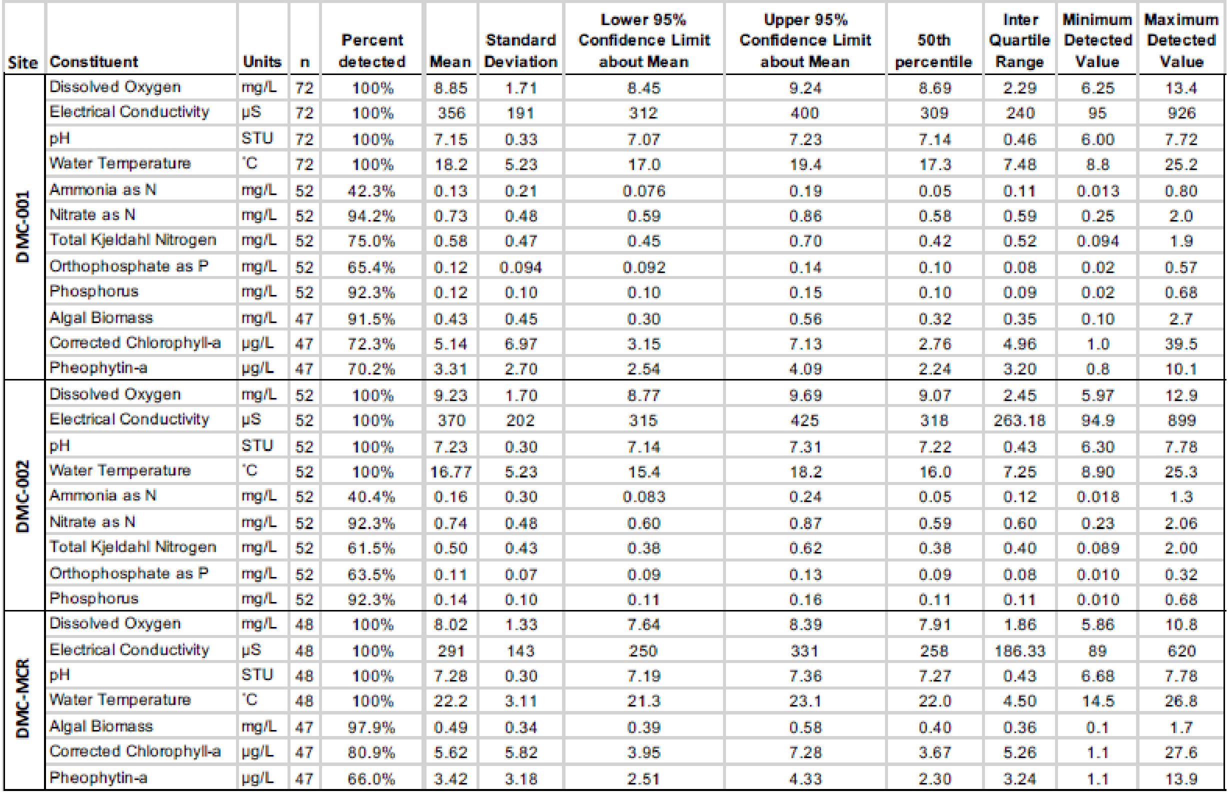


Figure 13F-5. Orthophosphate as P for Study Period (December 2016 to March 2021)



Summary statistics from the City of Turlock's report are presented in **Table 13F-3.** Please refer to the report for additional graphs and data.

Table 13F-3. Constituent Summary Statistics for City of Turlock Study (December 2016 to March 2021)



Site	Constituent	Units	n	Percent detected	Mean	Standard Deviation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
DMC-001	Dissolved Oxygen	mg/L	72	100%	8.85	1.71	8.45	9.24	8.69	2.29	6.25	13.4
	Electrical Conductivity	µS	72	100%	356	191	312	400	309	240	95	926
	pH	STU	72	100%	7.15	0.33	7.07	7.23	7.14	0.46	6.00	7.72
	Water Temperature	˚C	72	100%	18.2	5.23	17.0	19.4	17.3	7.48	8.8	25.2
	Ammonia as N	mg/L	52	42.3%	0.13	0.21	0.076	0.19	0.05	0.11	0.013	0.80
	Nitrate as N	mg/L	52	94.2%	0.73	0.48	0.59	0.86	0.58	0.59	0.25	2.0
	Total Kjeldahl Nitrogen	mg/L	52	75.0%	0.58	0.47	0.45	0.70	0.42	0.52	0.094	1.9
	Orthophosphate as P	mg/L	52	65.4%	0.12	0.094	0.092	0.14	0.10	0.08	0.02	0.57
	Phosphorus	mg/L	52	92.3%	0.12	0.10	0.10	0.15	0.10	0.09	0.02	0.68
	Algal Biomass	mg/L	47	91.5%	0.43	0.45	0.30	0.56	0.32	0.35	0.10	2.7
	Corrected Chlorophyll-a	µg/L	47	72.3%	5.14	6.97	3.15	7.13	2.76	4.96	1.0	39.5
	Pheophytin-a	µg/L	47	70.2%	3.31	2.70	2.54	4.09	2.24	3.20	0.8	10.1
DMC-002	Dissolved Oxygen	mg/L	52	100%	9.23	1.70	8.77	9.69	9.07	2.45	5.97	12.9
	Electrical Conductivity	µS	52	100%	370	202	315	425	318	263.18	94.9	899
	pH	STU	52	100%	7.23	0.30	7.14	7.31	7.22	0.43	6.30	7.78
	Water Temperature	˚C	52	100%	16.77	5.23	15.4	18.2	16.0	7.25	8.90	25.3
	Ammonia as N	mg/L	52	40.4%	0.16	0.30	0.083	0.24	0.05	0.12	0.018	1.3
	Nitrate as N	mg/L	52	92.3%	0.74	0.48	0.60	0.87	0.59	0.60	0.23	2.06
	Total Kjeldahl Nitrogen	mg/L	52	61.5%	0.50	0.43	0.38	0.62	0.38	0.40	0.089	2.00
	Orthophosphate as P	mg/L	52	63.5%	0.11	0.07	0.09	0.13	0.09	0.08	0.010	0.32
	Phosphorus	mg/L	52	92.3%	0.14	0.10	0.11	0.16	0.11	0.11	0.010	0.68
DMC-MCR	Dissolved Oxygen	mg/L	48	100%	8.02	1.33	7.64	8.39	7.91	1.86	5.86	10.8
	Electrical Conductivity	µS	48	100%	291	143	250	331	258	186.33	89	620
	pH	STU	48	100%	7.28	0.30	7.19	7.36	7.27	0.43	6.68	7.78
	Water Temperature	˚C	48	100%	22.2	3.11	21.3	23.1	22.0	4.50	14.5	26.8
	Algal Biomass	mg/L	47	97.9%	0.49	0.34	0.39	0.58	0.40	0.36	0.1	1.7
	Corrected Chlorophyll-a	µg/L	47	80.9%	5.62	5.82	3.95	7.28	3.67	5.26	1.1	27.6
	Pheophytin-a	µg/L	47	66.0%	3.42	3.18	2.51	4.33	2.30	3.24	1.1	13.9

It should be noted that the reporting limits for ammonia, TKN, and orthophosphate as P were significantly lowered in May 2019. The reporting limits for ammonia and TKN were lowered from 1.0 mg/L to 0.1 mg/L, and the reporting limit for orthophosphate as P was lowered from 1.0 mg/L to 0.01 mg/L.

Algal toxins samples were first screened for potentially toxic cyanobacteria (PTOX) and only analyzed for algal toxins if toxic cyanobacteria are present in high enough abundance. If PTOX is not observed or present in low abundance, the analysis for toxins is not recommended and this is shown in **Figures 13F-6 and 13F-7** as a blue square. Over the study period, only 17 samples (seven samples at DMC-001, four samples at McCabe, and seven field samples) were recommended for other toxin analysis such as Cylindrospermopsin, anatoxin-a and saxitoxin. Therefore, the focus of the discussion will be for total microcystin. Total microcystin concentrations at DMC-001 are shown in **Figure 13F-6** and at McCabe (which is 30 miles downstream of DMC-001) in **Figure 13F-7**.

For both locations, total microcystin was detected only in 2018 and 2020, which were both dry years. It is apparent that the microcystin is originating from the Delta, and is traveling downstream to McCabe. Therefore, increased wastewater discharge does not appear to increase algal toxins from this limited data set.

Figure 13F-6. Microcystin Concentrations at DMC-001 (Upstream)

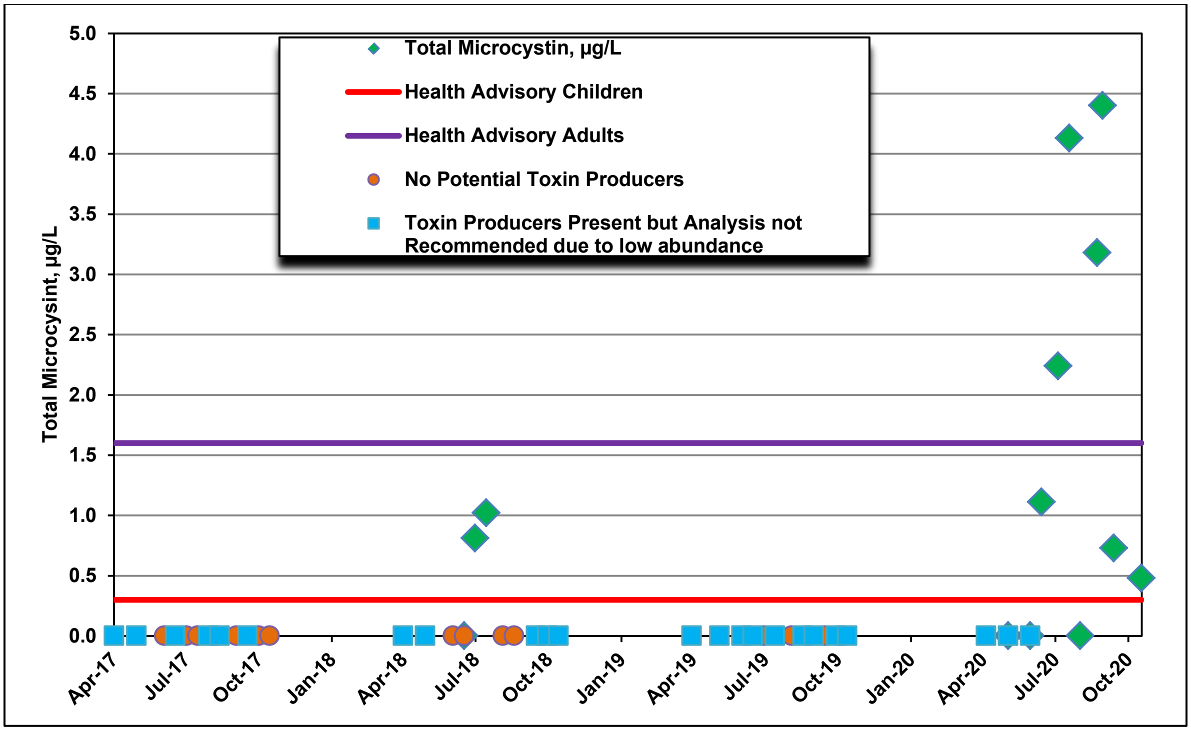
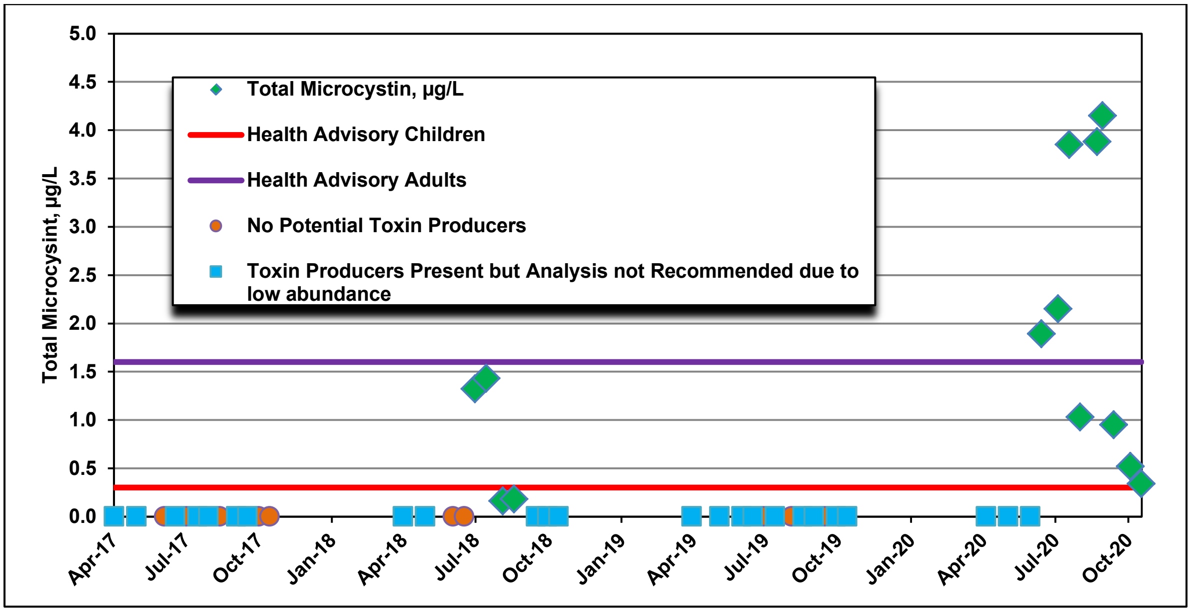
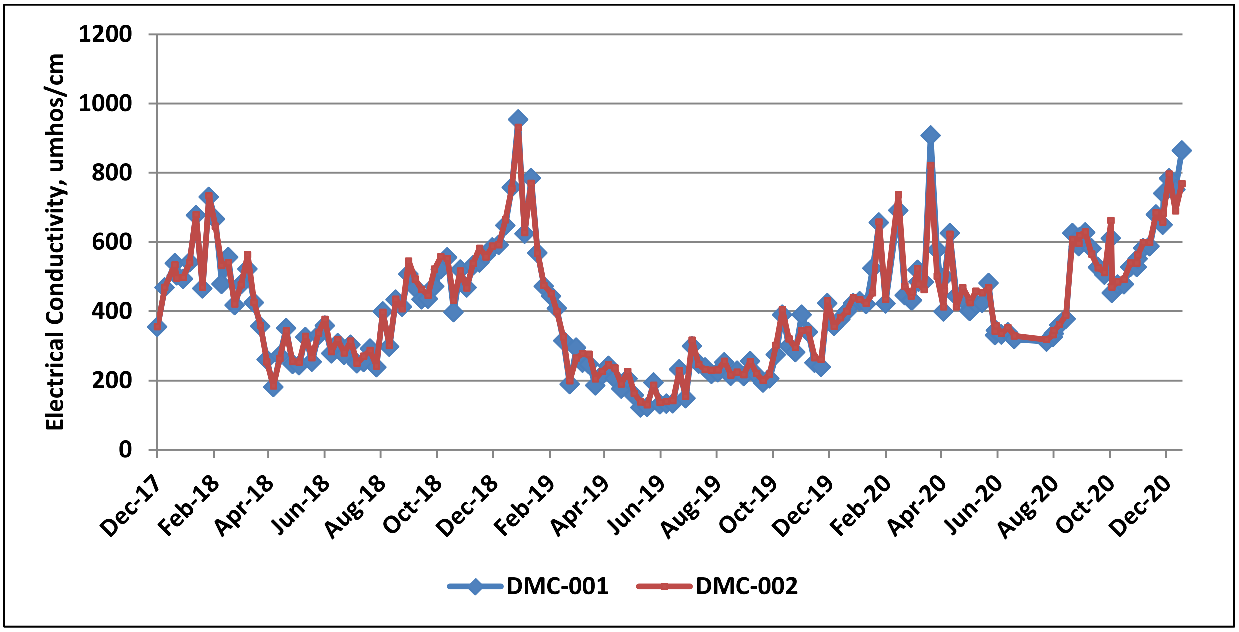


Figure 13F-7. Microcystin Concentrations at McCabe Road



An increase in electrical conductivity for downstream users due to increased wastewater discharge is a water quality concern. Although graphs for electrical conductivity are provided in the City of Turlock's report (similar to nutrients), **Figure 13F-8** was developed independently due to more frequent monitoring conducted by the City of Modesto, as required by their NPDES permit. As the figure shows, electrical conductivity as measured at the downstream location is similar to the upstream location, and therefore no impact from the increased wastewater discharge, based on this limited data, is currently apparent.

Figure 13F-8. Electrical Conductivity for Study Period (December 2016 to March 2021)



After March 2021, both effluents from the two WWTPs and the combined discharge will continue to be monitored under the NPDES permit CA0085316 (Order No. 2016-00), as discussed in the following section.

Both the City of Modesto and City of Turlock have retained their original NPDES permit to discharge to the San Joaquin River. The City of Modesto NPDES permit is (Order No. R5-2017-0064) and the City of Turlock NPDES permit is (Order No. R5-2015-0027).

Conclusions for City of Turlock Study

Although the study was conducted over four years, it is important to note that there was only one year when monitoring was conducted when both wastewater treatment plants were discharging to the DMC. Therefore, these conclusions are based on a limited dataset.

- Ammonia, nitrate or TKN did not statistically significantly increase due to increased wastewater discharge from DMC-001 to DMC-002 during the "Modesto and Turlock" time period when both WWTPS were discharging to the DMC. This is not surprising as both WWTPs have nitrification and denitrification removal processes.
- However, phosphorus and orthophosphate (as P) had a statistically significant increase from DMC-001 to DMC-002 when both WWTPs were discharging.

- Algal biomass, chlorophyll-a, and pheophytin-a did not statistically significantly increase due to increased wastewater discharge from DMC-001 to DMC-McCabe during the "Modesto and Turlock" time period when both WWTPS were discharging to the DMC. Microcystin were present at both DMC-001 and McCabe Road at similar times and concentrations, indicating that the algal bloom was originating in the Delta, and not caused by increased wastewater discharge.
- Electrical conductivity as measured at the downstream location is similar to the upstream location, and no impact from the increased wastewater discharge, based on this limited data, is currently apparent.

Water Quality Monitoring Required by NPDES permit

In addition to the monitoring conducted for the SWC, the Cities of Modesto and Turlock also have monitoring requirements and effluent limitations as required by NPDES CA0085316 (Order No. 2016-00). When discharging to the North Valley Regional Recycled Water Program (NVRRWP) Joint Outfall, the City of Turlock must monitor the treated effluent from its WWTP as shown in **Table 13F-4.** The City of Modesto must monitor for all analytes in **Table 13F-4**, except for bis(2-ethylhexyl)phthalate, chlorodibromomethane, dichlorobromomethane, aluminum, total chlorine residual, dechlorination agent residual, and total coliforms. The City of Turlock has three industrial dischargers that recycle plastic containers, which is the source of bis(2-ethylhexyl)phthalate. The City of Modesto uses UV for disinfection and does not form chlorodibromomethane and dichlorobromomethane.

Based on information included in a PFAS questionnaire submitted by the Cities to the State Water Resources Control Board, the City of Modesto estimates that the type of wastewater entering the WWTP is 72 percent residential/commercial and 28 percent industrial. Industries are breweries/wineries, electronic manufacturing, fabricated metal products, food industry, landfill (no leachate), leather tanning and finishing, and pulp/paper manufacturing. The City of Turlock estimates that the type of wastewater entering the WWTP is 55 percent residential/commercial and 45 percent industrial. Industries are breweries/wineries, industrial laundries, food industry, and plastic recycling. The City of Turlock notes that most industrial types are food processing, with all other industries contributing to no more than 5 percent of the total volume.

Table 13F-4. Effluent Monitoring for City of Turlock

Parameter	Units	Sample Type	Frequency
Flow	MGD	Meter	Continuous
Conventional Pollutants			
Biochemical Oxygen Demand	mg/L	24-hr Composite	1/day
pH	Standard units	Meter	Continuous
Total Suspended Solids	mg/L	24-hr Composite	1/day
Priority Pollutants			
Bis(2-ethylhexyl)phthalate	µg/L	Grab	1/month
Chlorodibromomethane	µg/L	Grab	1/month
Dichlorobromomethane	µg/L	Grab	1/month
Mercury, Total Recoverable	ng/L	Grab	1/month

Parameter	**Units**	**Sample Type**	**Frequency**
Selenium, Total Recoverable	µg/L	Grab	1/month
Non-Conventional Pollutants			
Aluminum, Total Recoverable	µg/L	24-hr Composite	1/month
Ammonia Nitrogen, Total (as N)	mg/L	Grab	1/week
Chlorine, Total Residual	mg/L	Meter	Continuous
Dechlorination Agent Residual	mg/L	Meter	Continuous
Chlorpyrifos	µg/L	Grab	1/year
Diazinon	µg/L	Grab	1/year
Dissolved Oxygen	mg/L	Grab	1/week
Electrical Conductivity	µmhos/cm	Grab	1/week
Hardness, Total	mg/L	24-hr Composite	1/month
Mercury (methyl)	ng/L	Grab	1/month
Nitrate Plus Nitrite (as N)	mg/L	24-hr Composite	1/month
Temperature	°C	Grab	1/week
Total Coliform Organisms	MPN/100 mL	Grab	1/day

The Cities of Turlock and Modesto must also monitor for toxicity, both acute and chronic. For acute whole effluent toxicity, survival of aquatic organisms in 96-hour bioassays of undiluted waste shall be no less than 70 percent for any one bioassay, and 90 percent (median) for any three consecutive bioassay. Chronic toxicity testing shall be conducted with *Ceriodaphnia dubia* (water flea), *Pimephales promelas* (fathead minnow) and *Selenastrum capricornutum* (green alga).

In addition to monitoring requirements, the effluent for the City of Turlock must meet limitations as shown in **Table 13F-5.** Effluent limitations for the City of Modesto are the same as in **Table 13F-4,** but the City of Modesto has no effluent limitations for bis(2-ethylhexyl)phthalate, chlorodibromomethane, dichlorobromomethane, and aluminum. The average weekly effluent limitation for nitrate plus nitrite for the City of Modesto is 19 mg/L, which is higher than the effluent limitation for the City of Turlock, which is 12 mg/L.

Table 13F-5. Effluent Limitations for City of Turlock

Parameter	**Units**	**Effluent Limitations**		
		Average Monthly	Average Weekly	Maximum Daily
Conventional Pollutants				
Biochemical Oxygen Demand	mg/L	10	15	20
Total Suspended Solids	mg/L	10	15	20
Priority Pollutants				
Bis(2-ethylhexyl)phthalate	µg/L	10		30
Chlorodibromomethane	µg/L	19		30
Dichlorobromomethane	µg/L	52		79
Non-Conventional Pollutants				
Aluminum, Total Recoverable	µg/L	330	710	
Ammonia Nitrogen, Total (as N) (April 1- Sept. 30)	mg/L	0.85	1.5	
Ammonia Nitrogen, Total (as N) (Oct 1- March 31)	mg/L	1.6	2.8	
Nitrate Plus Nitrite (as N)	mg/L	10	12	

The dischargers are also required to monitor continuously for flow, and weekly grab samples for pH, dissolved oxygen, temperature and turbidity at the combined point of discharge to the DMC.

It should be noted that at the time of reporting writing (May 2022), the NPDES permit was being renewed and effluent monitoring and effluent limitations in **Tables 13F-4** and **13F-5** are under revision.

Effluent Characterization Study

The City of Modesto conducted monthly sampling of the effluent and the upstream monitoring DMC-001 station from June 2019 through May 2020. The City of Turlock was allowed to submit previous effluent monitoring for January 2017 to December 2017 (for NPDES permit 2015-0027 which is for discharge to San Joaquin River). Sampling for effluent characterization is more extensive than the routine effluent monitoring required by the current NPDES permit (as shown in **Tables 13F-4** and **13F-5**). Effluent characterization monitoring included pesticides, metals, *Cryptosporidium*, and numerous organic chemicals. **Tables 13F-6 and 13F-7** shows the results for the constituents that were detectable and likely of interest for the City of Modesto and City of Turlock, respectively.

Overall, most organics were nondetectable, with the exception of low levels of dalapon in the Turlock effluent, and one low level detection of di-n-butyl phthalate in the Modesto effluent. Samples for *Cryptosporidium* were collected five times in the Modesto effluent and five times at the upstream DMC-001 location; all of the samples collected were nondetectable. Two out of the five samples collected at the effluent had detectable levels of *Giardia*, at 0.1 cysts/L. The City of Turlock was not required to conduct effluent *Cryptosporidium* monitoring in 2017, but began quarterly sampling in June 2020. According to the City of Turlock, effluent samples collected for *Cryptosporidium* in June, September, November 2020 and March 2021 were all nondetectable.

Notably, nitrate, chloride, total dissolved solids, specific conductance, TKN, and total phosphorus were higher in Modesto's effluent compared to upstream location DMC-001. (Total phosphorus was higher the in the Modesto effluent for five out of twelve samples). Similar results were found for Turlock's effluent, except no TKN data was available for Turlock effluent. Additionally, 2017 levels of nitrate and total phosphorus were much higher in Turlock effluent, compared to Modesto effluent. However, current levels of nitrate in Turlock effluent are now similar to Modesto effluent since denitrification started at the City of Turlock's WWTP in July 2019.

Generally, metals such as aluminum, iron, and manganese were lower in both effluents compared to upstream. Results for arsenic are varied, with City of Turlock effluent higher than upstream, but City of Modesto effluent similar to upstream.

Although nitrate, TKN, total phosphorus and, total dissolved solids, specific conductance in Modesto's effluent was higher compared to the upstream monitoring location, this increase does not show at the downstream monitoring location DMC-002 in the DMC, as discussed in the

SWC monitoring results, with the exception of total phosphorus. Total phosphorus increased from DMC-001 to DMC-002 when both WWTPs were discharging, which is likely due to much higher levels of phosphorus in Turlock's effluent compared to Modesto.

Table 13F-6. Effluent Characterization Study for City of Modesto, 2019-2020, µg/L

	6/19/ 2019 DMC-001	6/19/ 2019 Eff.	7/17/ 2019 DMC-001	7/17/ 2019 Eff.	8/21/ 2019 DMC-001	8/21/ 2019 Eff.	9/17/ 2019 DMC-001	9/17/ 2019 Eff.	10/15/ 2019 DMC-001	10/15 2019 Eff.	11/20/ 2019 DMC-001	11/20/ 2019 Eff.
Aluminum	570	ND (<200)	1300	ND (<200)	540	ND (<200)	300	ND (<200)	94	ND (<200)	99	ND (<200)
Arsenic			1.7	<2	ND	<2	2.3	2.6	1.8	2.6	<2	1.6
Barium	23	48	42	50	26	46	26	37	26	48	29	55
Calcium, mg/L	7.7	46	16	41	11	42	14	39	15	44	15	43
Chloride,mg/L	11	190	40	220	22	240	25	150	29	140	33	230
Diethyl phthalate	0.83 J	ND	0.61 J	0.34 J	2.7	ND (<2)	0.87 J	ND (<2)	ND (<2)	ND (<2)	ND (<2)	ND(<2)
Total Dissolved Solids, mg/L	97	460	170	600	110	500	170	470	150	580	160	590
Hardness, Total, mg/L	32	155	77	140	53	141	65	134	70	151	70	146
Iron	860	210	1600	140	720	120	450	160	140	170	180	150
Lead[1]	0.38 J	ND	0.71 J	ND	0.34	ND	0.27 J	ND	ND	ND	ND	ND
Magnesium, mg/L	3.2	9.5	8.9	9.2	6.1	8.9	7.2	8.9	7.7	9.7	7.6	9.4
Manganese	33	11	99	<20	48	<20	31	<20	9	<20	11	<20
Mercury, ng/L	4.64	0.436 J	6.24	0.436 J	3.78	0.423	2.53	0.555	0.878	0.468	2	0.505
Nitrate as N, mg/L	0.22	3.3	0.48	4.8	0.31	4.9	0.57	5.6	0.4	6.4	0.54	4.3
Phosphorus, total, mg/L	0.11	0.071	0.14	0.067	0.13	0.89	0.11	3.3	0.075	1.7	0.094	0.13
Specific Conductance umhos/cm	120	1100	320	1100	190	1100	240	920	270	930	290	1200
Total Kjeldahl Nitrogen, mg/L	ND	0.61	0.35	0.61	0.26	0.52	<1	0.61	<1	0.7	0.22	0.8
Di(2-ethylhexyl)phthalate	ND (<5)	ND (<5)	1 J	1.2 J	ND (<10)	ND (<10)	<7.5	<7.5	< 6.8	<6.8	ND (<5)	ND (<5)
Di-n-butyl phthalate	<10	ND	1.7 J	2 J	2.8	2.8	<10	<10	<10	<10	ND (<10)	ND (<10)

[1] MRL= 0.24, RL =1

Table 13F-6. Cont'd.
Effluent Characterization Study for City of Modesto, 2019-2020, µg/L

	12/19/2019	12/19/2019	1/15/2020	1/15/2020	2/25/2020	2/25/2020	3/18/2020	3/18/2020	4/15/2020	4/15/2020	5/20/2020	5/20/2020
	DMC-001	Eff.	DMC-001	Eff.	DMC-001	Eff.	DMC-001	Eff.	DMC-001	Eff.	DMC-001	Eff.
Aluminum	420	22 J	200	<200	370	<500	270	<200	230	<200	130	<200
Arsenic	2.1	1.4	2	<2	<5	<5	2.4	2.8	2.5	2.9	2.4	2.6
Barium	40	49	35	55	23	85	36	78	34	81	36	65
Calcium, mg/L	23	43	18	44	36	61	16	44	26	71	19	45
Chloride, mg/L	58	190	61	200	110	180	55	240	65	210	56	230
Diethyl phthalate	0.32 J	0.35 J	0.36 J	0.54 J	<2	<2	0.47 J	0.46 J	<2	0.43 J	<2	0.40 J
Total Dissolved Solids, mg/L	270	660	230	620	450	810	220	630	240	720	310	660
Hardness, Total, mg/L	110	148	90	150	174	215	84	154	123	235	92	154
Iron	830	570	410	180	140	320	550	170	410	340	270	260
Lead[1]	0.22 J	0.13 J	ND	0.38 J	<2.5	<2.5	<1	<1	<1	<1	<1	0.25 J
Magnesium, mg/L	13	9.7	11	10	21	15	10	11	14	14	11	10
Manganese	29	9.1	19	17	<50	<50	34	<20	24	<20	11	<20
Mercury, ng/L	2.58	0.38 J	1.48	4.6	0.888	0.535	<5	0.314 J	1.74	0.429J	1.21	0.364 J
Nitrate as N, mg/L	1.3	4.3	0.7	0.451 J	0.72	5.2	0.65	3.2	0.76	5	0.62	4.4
Phosphorus, total, mg/L	0.17	0.12	0.09	0.47	0.11	0.07	0.1	0.059	0.13	0.098	0.11	0.065
Specific Conductance umhos/cm	450	1100	410	1100	760	1200	440	1300	490	1300	430	1200
Total Kjeldahl Nitrogen, mg/L	0.56 J	0.7	0.22	0.79	0.36	0.79	0.44	0.44	<1	0.7	0.31	0.7
Di(2-ethylhexyl)phthalate	ND (<5)	ND (<5)	ND (<5)	ND (<5)	ND (<5)	ND (<5)	ND (<5)	ND (<5)	ND (<5)	ND (<5)	ND (<5)	ND (<5)
Di-n-butyl phthalate	ND (<10)	ND (<10)	ND (<10)	ND (<10)	2.1 J	2.1 J	2.2J	2.8 J	3.5 J	3.8 J	2.2 J	2.9 J

[1] MRL= 0.24, RL =1

Table 13F-7. Effluent Characterization Study for City of Turlock, 2017, µg/L

	1/10/ 2017	2/7/ 2017	3/7/ 2017	4/4/ 2017	5/2/ 2017	6/6/ 2017	7/5/ 2017	8/2/ 2017	9/5/ 2017	10/3/ 2017	11/7/ 2017	12/5/ 2017
	Eff.	Eff.	Eff.	Eff.	Eff.	Eff.	Eff.	Eff.	Eff.	Eff.	Eff.	Eff.
Aluminum	70	328		126			78	37 J	28 J			36 J
Arsenic	6.56	5.47	6.68	4.44	4.85	6.8	5.9	6.21	5.66	5.61	6.7	5.86
Barium	53.1	55.9	60.3	60.2	71	63.3	69	78.6	70.4	73.9	69.6	65.2
Calcium, mg/L												
Chloride, mg/L	95.1	116	116	105	116	114	109	124	117	112	122	108
Dalapon	1	1.1	1.8	1.2	4.5	2.5	ND (<0.4)	3.7	5	2.9	1.6	1.7
Total Dissolved Solids, mg/L	584	612	644	709	702	710	656	732	653	667	710	616
Iron	40.8 J	51.1	34.6 J	42.9 J	41 J	45.2 J	39 J	45.3 J	56.6	53.7	52.5	52.7
Lead	ND (<1)	0.54 J	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	0.52 J	ND (<1)	ND (<1)	ND (<1)	0.65 J
Manganese	12.8	17.8	16.5	13.6	13.7	19.1	15.7	16.2	14.1	19.7	19	18.9
Mercury, ng/L	no data	0.93	1.7	1.9	1.7	2.2	0.94	2.3	1.8	1.1	1.8	1.9
Nitrate as N, mg/L	19.6	23	24.9	18.4	18.5	19.9	25.2	20.4	19.6	18.1	23.6	18.9
Phosphorus, total, mg/L	5.1	ND (<0.05)	5.54	5.85	7.3	7.71	7.82	8.81	7.55	6.92	7.39	7.67
Specific Conductance umhos/cm	880	992	768	1148	1078	1102	1082	1265	1117	1038	1032	918
Di(2-ethylhexyl)phthalate	1.1 J	1.1 J	ND (<0.2)	ND (<0.2)	0.6 J	0.8 J	ND (<0.2)	ND (<0.2)	1.5 J	ND (<0.2)	0.6 J	ND (<0.2)

CEC Study Conducted by State Water Contractors MWQI SPC

Due to concerns with the presence of CECs in treated wastewater, sampling for PFAS, hormones, nitrosamines, and selected pharmaceuticals and personal care products began in February 2020. Samples were also collected in July 2020, November 2020, March 2021, and August 2021. A summary of all data collected is in **Appendix 13F**. It should be noted that direct sampling of the wastewater effluent was not conducted, although a request was made to the Cities of Modesto and Turlock in October 2020 and denied.

A total of 149 chemicals were analyzed at two locations, upstream (DMC-001) and downstream of the wastewater discharge point (DMC-002), as previously shown in **Figure 13F-2**.

Figure 13F-9 shows the chemicals which showed an increase or decrease of twenty percent or greater when comparing the upstream to downstream concentrations. Twenty percent was selected as a threshold since there is variability in the analysis itself. It should be noted that due to varying wastewater flow and flow in the Delta Mendota Canal, the percent of wastewater in the DMC varied from 1 to 4.4 percent, across the five sampling events. Each sampling event is colored coded in **Figure 13F-9.**

Figure 13F-9 shows that out of the 149 chemicals, across the five sampling events, there were 10 chemicals which showed an increase of 20 percent or higher from the upstream to downstream in at least two separate events. Eight chemicals showed an increase of 20 percent or higher from the upstream to downstream in at least three out of five events:

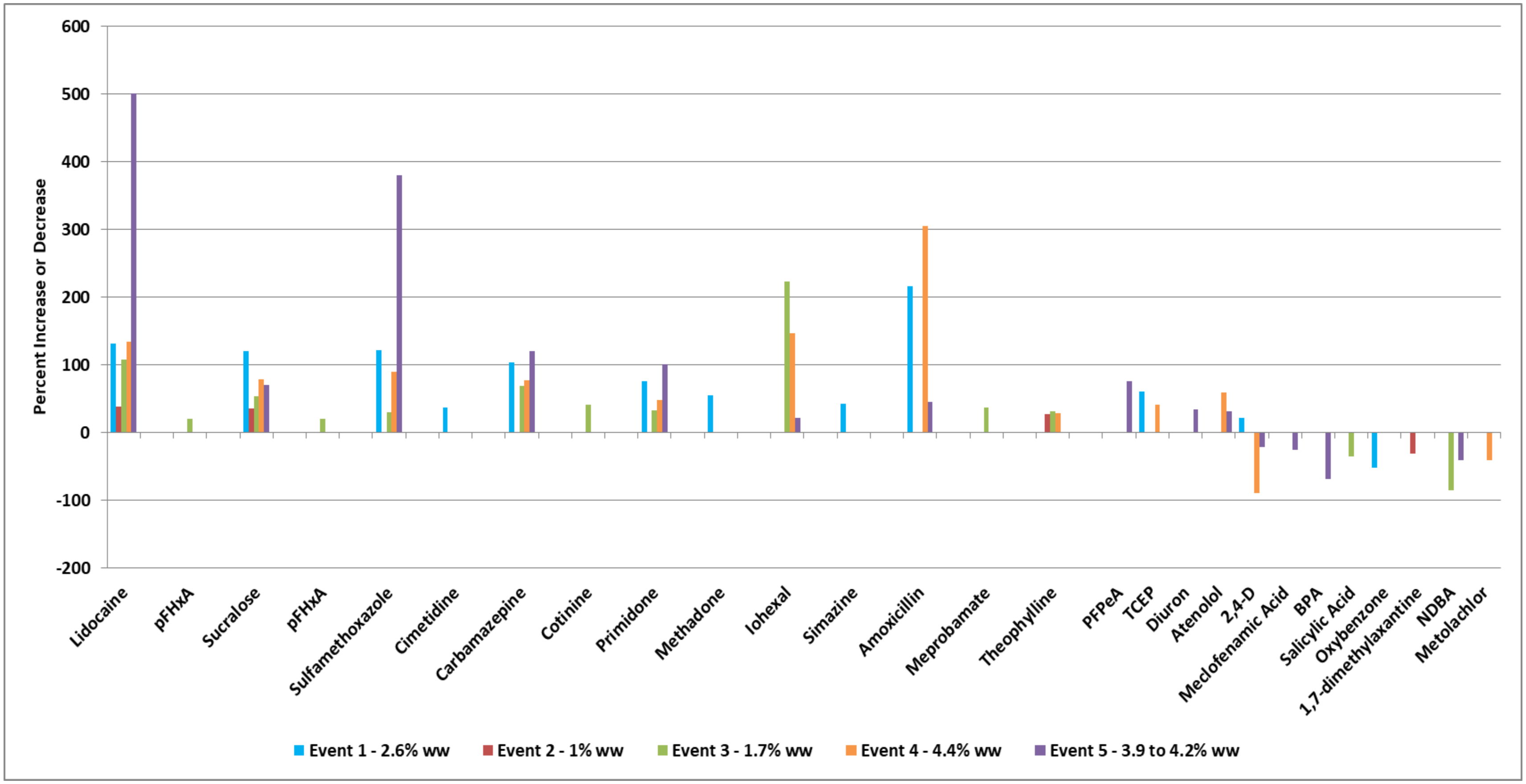
- Lidocaine percent increase ranged from 38 to 500 percent
- Sucralose percent increase ranged from 35 to 120 percent
- Sulfamethoxazole percent increase ranged from 29 to 380 percent
- Carbamazepine percent increase ranged from 68 to 120 percent
- Primidone percent increase ranged from 32 to 100 percent
- Iohexal percent increase ranged from 21 to 223 percent
- Amoxicillin percent increase ranged from 45 to 305 percent
- Theophylline percent increase ranged from 26 to 30 percent.

There were also six chemicals which showed a decrease of greater than 20 percent or more. However, the decrease was not seen consistently, and only seen in one event per chemical, with the exception of NDBA which decreased in two events.

Event 4 (shown in orange) which had the highest wastewater percent of 4.4 percent in the DMC, did not have the most number of chemicals showing an increase downstream of the wastewater discharge. Event 1 (shown in blue) which had 2.6 percent of wastewater in the DMC had the highest number of chemicals increase from upstream to downstream. This might be due to the variable nature of wastewater quality, or other factors such as the introduction of surface water flows approximately 17 miles upstream due to San Joaquin River Restoration which occurred during Event 4 but not during Event 1.

Additional future sampling efforts will likely continue through 2022, and a greater focus will be given to measuring actual flow in the DMC at the location where the sample is collected in order to calculate mass loading in lbs/day. Also, it is planned to better coordinate the sampling time based on time travel in the DMC, to try and capture the same water "packet" as it travels from upstream to downstream. It is also hoped that an opportunity to monitor the wastewater directly will arise in order to better evaluate results.

Figure 13F-9. CECs with Greater than 20 Percent Change from DMC 001 (upstream) to DMC-002 (downstream) of Treated Wastewater Discharge



Communication with DDW and Central Valley Regional Water Quality Control Board

Due to the continued water quality concern of the introduction of recycled wastewater to the DMC, the State Water Contractors had meetings with the Central Valley Regional Water Quality Control Board in October 2021, and with the Central Valley Regional Water Quality Control Board and DDW in February 2022. The purpose of the meeting(s) was to share monitoring results from the CEC Study conducted by the State Water Contractors MWQI SPC and the City of Turlock monitoring which was required by State Water Contractors Agreement in 2016. Both of the studies were described in further detail in earlier sections of this Chapter 13F.

As a result of these meetings, the Central Valley Regional Water Quality Control Board added three items to the Tentative Draft Waste Discharge Requirements for the NVRRP, which was released for public comment in April 2022. The three items were: 1) the addition of total phosphorus to the effluent monitoring requirements for the City of Turlock and City of Modesto, as well as the joint outfall and the receiving waters in the DMC, 2) the addition of a CEC Study for the effluent and receiving water, and 3) a Far-Field Study Dilution Study to estimate the monthly average effluent fraction at O'Neill Forebay and San Luis Reservoir. The SWC greatly appreciates these new requirements in the Tentative Permit to enhance monitoring to better understand the potential water quality impacts downstream of the discharge point.

Another topic of discussion in October 2021 and February 2022 meetings was whether or not the NVRRP falls under the definition of a Surface Source Water Augmentation Project, and if so, the project would be subject to the applicable regulations. Based on a letter dated March 30, 2022 from the DDW Recycled Water Unit to the Central Valley Regional Water Quality Control Board, DDW determined that the NVRRWP is not a surface water augmentation project. However, DDW staff recommended collecting additional information as part of NPDES permit requirements, and also recommended a provision in the NPDES permit to allow a reopening if the determination changed. A reopener provision was added to the Tentative Permit. The SWC followed up with a comment letter to the Central Valley Regional Water Quality Control Board dated May 5, 2022 which requested that the NVRRWP be evaluated again when the regulations for Direct Potable Reuse are finalized in 2023, and that the reopener provision cover both Indirect Potable Reuse (Surface Water Augmentation) and Direct Potable Reuse (Raw Water Augmentation).

CONCLUSIONS FROM CURRENT STUDIES

Based on the monitoring conducted to date, there are impacts to downstream users. It should be noted that as the volume of treated wastewater increases in the future, these impacts will likely worsen.

Although one of the main purposes of monitoring conducted by the MWQI SPC and the SWC was to ascertain downstream impacts, these impacts were not always self-evident in an increase in a constituent's concentration from the downstream to upstream location along the DMC, as the wastewater input is diluted once it enters the DMC. For example, nitrate, TKN, total dissolved solids, and specific conductance were always higher in the effluent compared to upstream, but no increase in these constituents were seen when comparing the upstream to the downstream sample. However, this does not mean there is no impact from wastewater, but rather the impact is diluted.

Out of the monitored nutrients, phosphorus and orthophosphate did have a statistically significant increase from DMC-001 to DMC-002 when both WWTPs were discharging, which is likely due to high levels of phosphorus in Turlock's effluent (compared to Modesto). Increased concentrations of phosphorus could increase the growth of algae and the presence of algal toxins as water travels downstream. Although the City of Turlock conducted algal toxin monitoring at DMC-001 and McCabe, this was only for one year when both WWTPs were discharging.

There were 10 CECs which showed an increase of 20 percent or higher from the upstream to downstream in at least two separate events. Eight chemicals showed an increase of 20 percent or higher from the upstream to downstream in at least three out of five events:

- Lidocaine percent increase ranged from 38 to 500 percent
- Sucralose percent increase ranged from 35 to 120 percent
- Sulfamethoxazole percent increase ranged from 29 to 380 percent
- Carbamazepine percent increase ranged from 68 to 120 percent
- Primidone percent increase ranged from 32 to 100 percent
- Iohexal percent increase ranged from 21 to 223 percent
- Amoxicillin percent increase ranged from 45 to 305 percent
- Theophylline percent increase ranged from 26 to 30 percent.

It should be noted that the percent of wastewater in the DMC flow ranged from 1.1 to 4.4 percent across the five sampling events, so a significant increase to be detected in the downstream must indicate a very high level of these contaminants in the treated wastewater discharge. Overall, most organics were nondetectable, with the exception of low levels of dalapon in the Turlock effluent, and one low level detection of di-n-butyl phthalate in the Modesto effluent.

Water quality monitoring conducted by the City of Turlock demonstrated that downstream users are receiving higher levels of phosphorus and orthophosphate due to the treated wastewater discharge. Water quality monitoring conducted by MWQI demonstrated that downstream users are also receiving higher levels of certain pharmaceuticals. Additionally, it is likely that TDS, electrical conductivity, nitrate and TKN will increase in water received by downstream users as the volume of treated wastewater discharged to the DMC increases in the future.

RECOMMENDATIONS

- Conduct additional sampling of CECs with accompanying flow measurements to calculate lbs/day in the DMC. (In progress)

- Work with DWR to add treated wastewater requirements to DWR's "Water Quality Policy and Implementation Process for Acceptance of Non-Project Water into the State Water Project", if future projects are proposed to be discharged into the California Aqueduct or the Delta Mendota Canal. Request DWR engage with the Bureau of Reclamation on policy once completed.

- Consider requesting additional constituents to be monitored at DMC-001 and DMC-002 by the City of Turlock and City of Modesto when current NPDES permit is up for renewal. (In progress with Central Valley Regional Water Quality Control Board)

- Request DDW to review the current wastewater treatment systems at both the City of Turlock and City of Modesto and determine if the treatment level is sufficient to allow the treated wastewater to be discharged into the conveyance system and reservoir utilized as a source of supply for drinking water contractors located downstream. (In Progress with Central Valley Regional Water Quality Control Board)

REFERENCES

Delta Mendota Canal Nutrient and Algae Year 4 Annual and Final Study Report, prepared for City of Turlock, prepared by Larry Walker Associates, Inc. July 2021.

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CHAPTER 14 RECOMMENDATIONS

CONTENTS

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CHAPTER 14 RECOMMENDATIONS

The recommendations presented in this chapter are for consideration by the State Water Contractors, Municipal Water Quality Investigations (MWQI) Specific Project Committee (SPC), in conjunction with the Department of Water Resources (DWR) MWQI Program and the Division of Operations and Maintenance (O&M).

WATER QUALITY

Salinity

- Due to poor correspondence between on-line EC readings and grab samples at Castaic, it is recommended to verify the proper maintenance of the on-line instrument at Castaic.

Turbidity

- Due to poor correspondence between on-line turbidimeter readings and field samples at Pacheco and Castaic, it is recommended to verify the proper maintenance of these two turbidimeters.

Taste and Odor

- Timely algal counts and algal speciation along the SWP was previously conducted by DWR. It is recommended to re-establish this timely water quality support for the contractors especially during elevated Taste & Odor events.

Harmful Algal Blooms (HAB)

- There are at least two HAB studies being conducted in the Delta which should be tracked by the contractors: 1) Source tracking of *Microcystis* within the Sacramento San Joaquin Delta conducted by Bend Genetics, Robertson-Bryan Inc. and the Central Valley Regional Board, and 2) Cyanotoxin monitoring in the Delta to identify occurrence, duration, and drivers is being conducted by USGS and DWR.

Constituents of Emerging Concern (CEC)

- Continue to track results for the Delta Regional Monitoring Program Constituents of Emerging Concern (CEC) Study Years 2 and 3.
- Continue to track DWR monitoring for PFAS in the SWP System.
- Continue to assess PFAS collected by the SWP Contractors as part of Unregulated Contaminant Monitoring Rule 5.

Pathogens

- The 3-log *Giardia* and 4-log virus reduction requirements for DWR's Banks Water Treatment Plant (WTP) should be carefully reviewed by DDW since there is inconsistency between the coliform and protozoan data.

WILDFIRES IN SWP WATERSHEDS

Recommendation

- Continue post-fire water quality monitoring when needed for SWP watersheds. Data collected by other monitoring programs such as Sacramento Watershed Coordinated Monitoring Program may assist in monitoring impacts further downstream on the mainstem of the Sacramento River. (The Sacramento Watershed Coordinated Monitoring Program collects metal data on a quarterly basis on the mainstem of the Sacramento River at Knights Landing and at Verona. These locations may be useful to monitor post-fire water quality impacts due to wildfires in Upper Sacramento River watershed areas and Lake Oroville.)

AQUATIC VEGETATION IN THE DELTA

Recommendation

- As mentioned earlier, a collaborative effort in 2021 between the DWR/California Department of Fish and Wildlife Fish Restoration Program and the California Department of Parks and Recreation, Division of Boating and Waterways (DBW) Aquatic Invasive Plant Control Program was proposed to rapidly investigate new control methods at two pilot sites, Decker Island and Prospect Island. Contractors should continue to track this effort as chemicals may change, or new tools such as benthic mats or bubble curtains may provide new solutions to control aquatic vegetation.

- Contractors may wish to sample more frequently for endothall and diquat if being used in the Delta more frequently.

NON-PROJECT TURN-INS TO THE CALIFORNIA AQUEDUCT

Recommendation

- Project proponent(s) to provide monthly information on Percent of Aqueduct (POA)s during months of active turn-ins.
- When flow in Aqueduct is zero, consideration should be given to limit or stop turn-ins.
- Participating agencies should continue routine sampling as required by DWR prior to and during active turn-ins. Participating agencies should utilize the best water quality possible.
- DWR to provide timely delivery of participant water quality turn-in data as well as notification of excess surface water flows into the Aqueduct. It is recommended to use a portal such that data can be automatically uploaded by the laboratory conducting the analysis and for interested parties to access data directly. Participant proposal should include requirements for data submission to DWR, as only some proposals currently specify. (In progress with DWR)
- During active pump-ins, DWR to provide Aqueduct water quality data comparison for Check 13 and Check 21, Check 23 to Check 27, as well as Check 21 to Check 41 for COCs. This will provide timely information to verify modeled results from participants. This could be provided or displayed on the portal/website mentioned above.

- Revision of DWR's Water Quality Policy and Implementation Process for Acceptance of Non-Project Water into the State Water Project for better protection of source water quality should address/include (at a minimum):
    - Notification and response levels should be added for new (current and future) constituents of concern as identified by DDW (ie. 1,2,3-trichloropropane and PFAS)
    - Surface water inflows
    - Treated wastewater flows
    - Increased water quality monitoring if warranted during specific operating conditions
    - Definition or criteria should be specified for "nearby" well used to develop water quality monitoring plan and/or allowed substitutions.

NON-PROJECT TURN-INS TO THE DELTA MENDOTA CANAL

Recommendation

- It is recommended that DWR staff review/ participate in the yearly selection of wells to participate in the program with the Bureau of Reclamation.

- It is recommended that DWR track all future turn-ins to the Delta Mendota Canal, similar to turn-ins to the California Aqueduct. Although well water quality data was requested for participating wells in 2021, no data was received from the Bureau of Reclamation.

NORTH VALLEY REGIONAL RECYCLED WATER PROGRAM

Recommendation

- Conduct additional sampling of CECs with accompanying flow measurements to calculate lbs/day in the DMC. (In progress)

- Work with DWR to add treated wastewater requirements to DWR's "Water Quality Policy and Implementation Process for Acceptance of Non-Project Water into the State Water Project", if future projects are proposed to be discharged into the California Aqueduct or the Delta Mendota Canal. Request DWR engage with the Bureau of Reclamation on policy once completed.

- Consider requesting additional constituents to be monitored at DMC-001 and DMC-002 by the City of Turlock and City of Modesto when current NPDES permit is up for renewal. (In progress with Central Valley Regional Water Quality Control Board)

- Request DDW to review the current wastewater treatment systems at both the City of Turlock and City of Modesto and determine if the treatment level is sufficient to allow the treated wastewater to be discharged into the conveyance system and reservoir utilized as a source of supply for drinking water contractors located downstream. (In Progress with Central Valley Regional Water Quality Control Board)

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Appendix 11-1 2020 DWR PFAS data

SAMPLENAME	LABSAMPID	SAMPDATE	BATCH	METHODNAME	ANALYTE	CASNUMBER	Surrogate	Result	DL	RL	UNITS	ANOTE	Laboratory
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	11Cl-PF3OUdS	763051-92-9	FALSE	ND	1	1	ng/l		Weck
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	85			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	84			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	75			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	84			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	76			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	63			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	77	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	77	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	82	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	84	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	70			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C2 PFDA	STL00996	TRUE	75			ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	87			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	80			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	58			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	71			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	65			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	55			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	68	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	66	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	74	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	74	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	66			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C2 PFDoA	STL00998	TRUE	66			ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	90			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	87			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	84			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	85			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	67			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	57			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	76	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	72	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	86	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	82	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	70			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C2 PFHxA	STL00993	TRUE	72			ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	76			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	67			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	46			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	52			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	58			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	46			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	51	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	51	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	58	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	56	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	47			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C2 PFTeDA	STL02116	TRUE	49			ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	89			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	85			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	69			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	78			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	73			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	59			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	68	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	74	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	81	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	79	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	71			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C2 PFUnA	STL00997	TRUE	75			ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C3 PFBS	STL02337	TRUE	81			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C3 PFBS	STL02337	TRUE	73			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C3 PFBS	STL02337	TRUE	83			ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C3 PFBS	STL02337	TRUE	82	21	42	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	80			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	71			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	77			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	382284	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	71			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	56			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	45			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	62	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	56	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	73	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	71	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	57			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C4 PFBA	STL00992	TRUE	64			ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	92			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	89			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	90			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	93			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	70			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	60			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	78	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	76	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	86	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	81	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	71			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C4 PFHpA	STL01892	TRUE	76			ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	90			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	84			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	82			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	90			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	70			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	62			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	84	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	75	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	84	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	82	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	71			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C4 PFOA	STL00990	TRUE	74			ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	83			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	82			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	94			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	83			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	70			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	59			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	68	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	67	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	87	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	89	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	71			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C4 PFOS	STL00991	TRUE	73			ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE	86			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE	85			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE	79			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE	88			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE	82			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE	72			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE	85	23	45	ng/L		TestAmerica

Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE		87	22	44	ng/L	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE		88	21	42	ng/L	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE		86	22	44	ng/L	TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE		76			ng/L	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C5 PFNA	STL00995	TRUE		77			ng/L	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		84			ng/L	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		81			ng/L	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		83			ng/L	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		87			ng/L	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		68			ng/L	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		62			ng/L	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		68	23	45	ng/L	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		66	22	44	ng/L	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		85	21	42	ng/L	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		81	22	44	ng/L	TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		67			ng/L	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C5 PFPeA	STL01893	TRUE		72			ng/L	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		87			ng/L	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		83			ng/L	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		93			ng/L	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		88			ng/L	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		79			ng/L	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		65			ng/L	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		75	23	45	ng/L	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		76	22	44	ng/L	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		94	21	42	ng/L	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		89	22	44	ng/L	TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		72			ng/L	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	13C8 FOSA	STL01056	TRUE		74			ng/L	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		85			ng/L	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		83			ng/L	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		90			ng/L	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		93			ng/L	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		71			ng/L	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		61			ng/L	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		72	23	45	ng/L	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		70	22	44	ng/L	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		93	21	42	ng/L	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		87	22	44	ng/L	TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		70			ng/L	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	18O2 PFHxS	STL00994	TRUE		74			ng/L	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		4.8	18	ng/L	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		4.7	18	ng/L	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		4.6	18	ng/L	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		4.7	18	ng/L	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		4.6	18	ng/L	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		4.6	18	ng/L	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		4.7	18	ng/L	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		4.6	18	ng/L	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		4.4	17	ng/L	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		4.6	18	ng/L	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	4:2 FTS	757124-72-4	FALSE	ND		1	1	ng/l	Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		0.21	1.8	ng/L	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	4:2 FTS	757124-72-4	FALSE	ND		0.22	1.8	ng/L	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		1.8	18	ng/L	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		1.8	18	ng/L	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		1.8	18	ng/L	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		1.8	18	ng/L	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		1.8	18	ng/L	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		1.8	18	ng/L	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		1.8	18	ng/L	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		1.8	18	ng/L	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		1.7	17	ng/L	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		1.8	18	ng/L	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	6:2 FTS	27619-97-2	FALSE	ND		1	1	ng/l	Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		2.2	4.5	ng/L	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	6:2 FTS	27619-97-2	FALSE	ND		2.3	4.6	ng/L	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		1.8	18	ng/L	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		1.8	18	ng/L	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		1.8	18	ng/L	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		1.8	18	ng/L	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		1.8	18	ng/L	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		1.8	18	ng/L	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		1.8	18	ng/L	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		1.8	18	ng/L	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		1.7	17	ng/L	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		1.8	18	ng/L	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	8:2 FTS	39108-34-4	FALSE	ND		1	1	ng/l	Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		0.41	1.8	ng/L	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	8:2 FTS	39108-34-4	FALSE	ND		0.42	1.8	ng/L	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	9Cl-PF3ONS	756426-58-1	FALSE	ND		1	1	ng/l	Weck
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	ADONA	958445-44-8	FALSE	ND		1	1	ng/l	Weck
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		81			ng/L	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		75			ng/L	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		77			ng/L	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		78			ng/L	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		64			ng/L	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		52			ng/L	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		70	23	45	ng/L	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		72	22	44	ng/L	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		81	21	42	ng/L	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		67	22	44	ng/L	TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		65			ng/L	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	d3-NMeFOSAA	STL02118	TRUE		65			ng/L	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		81			ng/L	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		79			ng/L	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		80			ng/L	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		85			ng/L	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		68			ng/L	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		54			ng/L	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		69	23	45	ng/L	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		75	22	44	ng/L	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		82	21	42	ng/L	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		64	22	44	ng/L	TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		66			ng/L	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	d5-NEtFOSAA	STL02117	TRUE		69			ng/L	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	EtFOSA	4151-50-2	FALSE	ND		1	1	ng/l	Weck
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	EtFOSE	1691-99-2	FALSE	ND		1	1	ng/l	Weck
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	HFPO-DA	13252-13-6	FALSE	ND		1	1	ng/l	Weck
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		94			ng/L	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		100			ng/L	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		100			ng/L	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		88			ng/L	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		79			ng/L	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		63			ng/L	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		110	23	45	ng/L	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		110	22	44	ng/L	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		110	21	42	ng/L	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		76	22	44	ng/L	TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		97			ng/L	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	M2-4:2 FTS	STL02395	TRUE		92			ng/L	TestAmerica

Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		96			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		92			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		110			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		82			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		82			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		66			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		100	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		110	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		100	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		75	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		82			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	M2-6:2 FTS	STL02279	TRUE		93			ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		90			ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		87			ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		110			ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		84			ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		89			ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		64			ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		92	23	45	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		90	22	44	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		100	21	42	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		72	22	44	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		81			ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	M2-8:2 FTS	STL02280	TRUE		80			ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	MeFOSA	31506-32-8	FALSE	ND		1	1	ng/l		Weck
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	MeFOSE	24448-09-7	FALSE	ND		1	1	ng/l		Weck
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.8	18	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.7	18	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.7	18	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.7	18	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.7	18	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.7	18	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.7	18	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.7	18	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.6	17	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.7	18	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.2	4.5	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	FALSE	ND		1.2	4.6	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		2.9	18	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		2.8	18	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		2.8	18	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		2.8	18	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		2.7	18	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		2.7	18	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		2.8	18	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		2.7	18	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		2.6	17	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		2.8	18	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		1.1	4.5	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	FALSE	ND		1.1	4.6	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.45	0.18	1.8	ng/L	J	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.51	0.18	1.8	ng/L	J	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.38	0.18	1.8	ng/L	J	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.5	0.18	1.8	ng/L	J	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.46	0.18	1.8	ng/L	J	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.57	0.18	1.8	ng/L	J	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.58	0.18	1.8	ng/L	J	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.67	0.18	1.8	ng/L	J	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.42	0.17	1.7	ng/L	J	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.5	0.18	1.8	ng/L	J	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.5	0.18	1.8	ng/L	J	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorobutanesulfonic acid (PFBS)	375-73-5	FALSE		0.33	0.18	1.8	ng/L	J	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		1.4	0.32	1.8	ng/L	J	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		1.5	0.32	1.8	ng/L	J	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		1.1	0.31	1.8	ng/L	J B	TestAmerica
Teerink PP	320-60989-3	5/19/2020	382284	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		1.8	0.34	1.9	ng/L	J	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		1.3	0.31	1.8	ng/L	J	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		2.1	0.31	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		2	0.32	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		2.1	0.31	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		1.3	0.3	1.7	ng/L	J	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		2.6	0.31	1.8	ng/L	B	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE		1.8	1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE	ND		2.1	4.5	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorobutanoic acid (PFBA)	375-22-4	FALSE	ND		2.2	4.6	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.29	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.29	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.29	1.8	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.29	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.27	1.7	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.29	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorodecanesulfonic acid (PFDS)	335-77-3	FALSE	ND		0.3	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.29	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.27	1.8	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.27	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.27	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.26	1.7	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorodecanoic acid (PFDA)	335-76-2	FALSE	ND		0.29	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.51	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.5	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.49	1.8	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.5	1.8	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.48	1.8	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.48	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.5	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.48	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.47	1.7	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.49	1.8	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.49	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorododecanoic acid (PFDoA)	307-55-1	FALSE	ND		0.51	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.18	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.17	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.17	1.8	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.17	1.8	ng/L		TestAmerica

Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.17	1.8	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.17	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.17	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.17	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.16	1.7	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.17	1.8	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.17	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	FALSE	ND		0.18	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.43	0.23	1.8	ng/L	J	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.42	0.23	1.8	ng/L	J	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.25	0.22	1.8	ng/L	J	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.37	0.23	1.8	ng/L	J	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.58	0.22	1.8	ng/L	J	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.82	0.22	1.8	ng/L	J I	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.65	0.23	1.8	ng/L	J	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.76	0.22	1.8	ng/L	J	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.34	0.21	1.7	ng/L	J	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.47	0.22	1.8	ng/L	J	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.51	0.22	1.8	ng/L	J	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluoroheptanoic acid (PFHpA)	375-85-9	FALSE		0.41	0.23	1.8	ng/L	J	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.52	0.16	1.8	ng/L	J B	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.58	0.15	1.8	ng/L	J B	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.64	0.15	1.8	ng/L	J B	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.65	0.15	1.8	ng/L	J B	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.63	0.15	1.8	ng/L	J B	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.71	0.15	1.8	ng/L	J B	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.53	0.15	1.8	ng/L	J B	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.73	0.15	1.8	ng/L	J B	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.55	0.14	1.7	ng/L	J B	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.53	0.15	1.8	ng/L	J	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE	ND		0.51	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorohexanesulfonic acid (PFHxS)	355-46-4	FALSE		0.54	0.53	1.8	ng/L	J	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		2.3	0.53	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		2.7	0.53	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		0.69	0.52	1.8	ng/L	J	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		1.9	0.52	1.8	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		2.4	0.51	1.8	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		4.2	0.51	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		2.5	0.52	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		2.8	0.51	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		1.4	0.49	1.7	ng/L	J	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		2.8	0.52	1.8	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		2.4	1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		2.6	0.52	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorohexanoic acid (PFHxA)	307-24-4	FALSE		2.2	0.54	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.15	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.15	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.14	1.8	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.14	1.8	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.14	1.8	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.14	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.14	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.14	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.14	1.7	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.14	1.8	ng/L		TestAmerica
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.33	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorononanesulfonic acid (PFNS)	68259-12-1	FALSE	ND		0.34	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE	ND		0.25	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE		0.27	0.25	1.8	ng/L	J	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE	ND		0.24	1.8	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE	ND		0.24	1.8	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE		0.24	0.24	1.8	ng/L	J	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE	ND		0.24	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE		0.39	0.24	1.8	ng/L	J	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE		0.36	0.24	1.8	ng/L	J	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE	ND		0.23	1.7	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE		0.24	0.24	1.8	ng/L	J	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorononanoic acid (PFNA)	375-95-1	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE		0.26	0.24	1.8	ng/L	J	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorononanoic acid (PFNA)	375-95-1	FALSE		0.35	0.25	1.8	ng/L	J I	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE	ND		0.32	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE	ND		0.32	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE		2.4	0.31	1.8	ng/L	B	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE		0.79	0.32	1.8	ng/L	J B	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE		1.8	0.31	1.8	ng/L	B	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE		0.35	0.31	1.8	ng/L	J B	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE		0.51	0.32	1.8	ng/L	J B	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE		0.61	0.31	1.8	ng/L	J B	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE		0.67	0.3	1.7	ng/L	J B	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE		0.69	0.31	1.8	ng/L	J	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE	ND		0.87	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorooctanesulfonamide (FOSA)	754-91-6	FALSE	ND		0.91	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		0.75	0.5	1.8	ng/L	J	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		0.87	0.49	1.8	ng/L	J	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		0.57	0.48	1.8	ng/L	J	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		1.7	0.49	1.8	ng/L	J	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		0.55	0.48	1.8	ng/L	J	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		1	0.47	1.8	ng/L	J	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		1.3	0.49	1.8	ng/L	J	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		1.2	0.47	1.8	ng/L	J	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE	ND		0.46	1.7	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		0.9	0.48	1.8	ng/L	J	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		0.88	0.48	1.8	ng/L	J	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorooctanesulfonic acid (PFOS)	1763-23-1	FALSE		0.65	0.5	1.8	ng/L	J	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		0.94	0.78	1.8	ng/L	J	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		1.1	0.77	1.8	ng/L	J	TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		0.76	0.76	1.8	ng/L	J	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		0.99	0.77	1.8	ng/L	J	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		0.91	0.75	1.8	ng/L	J	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		1.3	0.74	1.8	ng/L	J	TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		1.2	0.77	1.8	ng/L	J	TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		1.6	0.75	1.8	ng/L	J	TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		0.78	0.72	1.7	ng/L	J	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		0.98	0.76	1.8	ng/L	J	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE		0.96	0.76	1.8	ng/L	J	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorooctanoic acid (PFOA)	335-67-1	FALSE	ND		0.79	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.27	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.27	1.8	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.27	1.8	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.26	1.8	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.26	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.27	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.26	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.25	1.7	ng/L		TestAmerica

Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.27	1.8	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.27	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	FALSE	ND		0.28	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		1.4	0.45	1.8	ng/L	J	TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		1.8	0.45	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		0.64	0.44	1.8	ng/L	J	TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		1.3	0.44	1.8	ng/L	J	TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		1.5	0.43	1.8	ng/L	J	TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		2.1	0.43	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		1.8	0.44	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		2.1	0.43	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		0.96	0.42	1.7	ng/L	J	TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		1.7	0.44	1.8	ng/L	J	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		1.5	1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		1.6	0.44	1.8	ng/L	J	TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluoropentanoic acid (PFPeA)	2706-90-3	FALSE		1.4	0.45	1.8	ng/L	J	TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.27	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.26	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.26	1.8	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.26	1.8	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.26	1.8	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.25	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.26	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.26	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.25	1.7	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.26	1.8	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.65	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorotetradecanoic acid (PFTeA)	376-06-7	FALSE	ND		0.67	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.2	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.2	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.2	1.8	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.2	1.8	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.1	1.8	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.1	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.2	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.1	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.1	1.7	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.2	1.8	ng/L	*	TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.2	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluorotridecanoic acid (PFTriA)	72629-94-8	FALSE	ND		1.2	1.8	ng/L		TestAmerica
Teerink PP	320-59590-3	3/17/2020	366106	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		1	1.8	ng/L		TestAmerica
Check 13	320-59659-1	3/17/2020	366106	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		1	1.8	ng/L		TestAmerica
Teerink PP	320-60205-3	4/14/2020	374391	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		0.98	1.8	ng/L		TestAmerica
Teerink PP	320-60989-3	5/19/2020	380481	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		0.99	1.8	ng/L		TestAmerica
Teerink PP	320-61854-3	6/16/2020	387581	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		0.97	1.8	ng/L		TestAmerica
Check 13	320-61867-1	6/16/2020	387581	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		0.96	1.8	ng/L		TestAmerica
Barker Slough PP	320-62211-1	6/25/2020	390687	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		0.99	1.8	ng/L		TestAmerica
Banks PP	320-62211-2	6/25/2020	390687	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		0.97	1.8	ng/L		TestAmerica
Teerink PP	320-63179-3	7/27/2020	399556	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		0.93	1.7	ng/L		TestAmerica
Teerink PP	320-63860-3	8/19/2020	405508	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		0.98	1.8	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		1	1	ng/l		Weck
Barker Slough PP	320-64661-1	9/16/2020	413389	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		0.98	1.8	ng/L		TestAmerica
Banks PP	320-64661-2	9/16/2020	413389	EPA 537(Mod)	Perfluoroundecanoic acid (PFUnA)	2058-94-8	FALSE	ND		1	1.8	ng/L		TestAmerica
Check 13	0H27007-01	9/15/2020	W0J0187	EPA 537M	PFNS	98789-57-2	FALSE	ND		1	1	ng/l		Weck

Appendix 11-2 POTW PFAS data

Site Name	Location ID	Sample ID	Chemical	Qualifier	Value	Reporting Limit	Detection Limit	Lab Notes	Units	Date
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	10:2FTS	ND	0	44	30		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	10:2FTS	ND	0	7.1	4.8		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	10:2FTS	<	4.7	6.9	4.7		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	10:2FTS	<	5.4	8	5.4		NG/L	9/8/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	11ClPF3OUDS	ND	0	28	7.8		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	11ClPF3OUDS	ND	0	4.5	1.2		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	11ClPF3OUDS	<	1.2	4.3	1.2		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	11ClPF3OUDS	<	1.4	5	1.4		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	11ClPF3OUDS	ND	0	80	24		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	11ClPF3OUDS	ND	0	80	24		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	11ClPF3OUDS	ND	0	80	24		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	11ClPF3OUDS	ND	0	80	24		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	11ClPF3OUDS	ND	0	80	24		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	11ClPF3OUDS	ND	0	1.7	0.42	RA,BA,AY	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	11ClPF3OUDS	ND	0	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	11ClPF3OUDS	ND	0	1.8	0.29		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	11ClPF3OUDS	<	0.29	1.8	0.29		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	11ClPF3OUDS	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	11ClPF3OUDS	ND	0	80	24		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	11ClPF3OUDS	ND	0	80	24		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	11ClPF3OUDS	ND	0	80	24		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	11ClPF3OUDS	ND	0	1.8	0.29		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	11ClPF3OUDS	ND	0	1.8	0.29		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	11ClPF3OUDS	ND	0	1.9	0.3		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	11ClPF3OUDS	<	0.29	1.8	0.29		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	11ClPF3OUDS	ND	0	80	24		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	11ClPF3OUDS	ND	0	80	24		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	11ClPF3OUDS	ND	0	80	24		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	11ClPF3OUDS	ND	0	80	24		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	11ClPF3OUDS	ND	0	80	24		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	11ClPF3OUDS	ND	0	80	24		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	11ClPF3OUDS	ND	0	80	24		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	11ClPF3OUDS	ND	0	80	24		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	11ClPF3OUDS	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	11ClPF3OUDS	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	11ClPF3OUDS	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	11ClPF3OUDS	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	11ClPF3OUDS	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	11ClPF3OUDS	ND	0	80	24		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	11ClPF3OUDS	ND	0	80	24		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	11ClPF3OUDS	ND	0	80	24		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	11ClPF3OUDS	ND	0	80	24		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	3:3FTCA	ND	0	28	13		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	3:3FTCA	ND	0	4.5	2.1		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	3:3FTCA	<	2	4.3	2		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	3:3FTCA	<	2.3	5	2.3		NG/L	9/8/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	4:2FTS	ND	0	28	11	DB,GR	NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	4:2FTS	ND	0	4.5	1.8	DB,GR	NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	4:2FTS	<	1.7	4.3	1.7	DB,GR	NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	4:2FTS	<	2	5	2	DB,GR	NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	4:2FTS	ND	0	80	10.8		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	4:2FTS	ND	0	80	10.8		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	4:2FTS	ND	0	80	10.8		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	4:2FTS	ND	0	80	10.8		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	4:2FTS	ND	0	80	10.8		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	4:2FTS	ND	0	1.7	0.42	RA,BA,AY	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	4:2FTS	ND	0	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	4:2FTS	ND	0	1.8	0.22		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	4:2FTS	<	0.21	1.8	0.21		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	4:2FTS	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	4:2FTS	ND	0	80	10.8		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	4:2FTS	ND	0	80	10.8		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	4:2FTS	ND	0	80	10.8		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	4:2FTS	ND	0	1.8	0.22		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	4:2FTS	ND	0	1.8	0.22		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	4:2FTS	ND	0	1.9	0.23		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	4:2FTS	<	0.22	1.8	0.22		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	4:2FTS	ND	0	80	10.8		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	4:2FTS	ND	0	80	10.8		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	4:2FTS	ND	0	80	10.8		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	4:2FTS	ND	0	80	10.8		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	4:2FTS	ND	0	80	10.8		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	4:2FTS	ND	0	80	10.8		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	4:2FTS	ND	0	80	10.8		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	4:2FTS	ND	0	80	10.8		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	4:2FTS	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	4:2FTS	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	4:2FTS	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	4:2FTS	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	4:2FTS	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	4:2FTS	ND	0	80	10.8		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	4:2FTS	ND	0	80	10.8		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	4:2FTS	ND	0	80	10.8		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	4:2FTS	ND	0	80	10.8		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	5:3FTCA	ND	0	44	23		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	5:3FTCA	ND	0	7.1	3.7	SN	NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	5:3FTCA	<	3.5	6.9	3.5		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	5:3FTCA	<	4.1	8	4.1		NG/L	9/8/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	6:2FTS	ND	0	28	8.3		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	6:2FTS	ND	0	4.5	1.3	DB,GR	NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	6:2FTS	ND	1.9	4.3	1.3	DB,GR,J	NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	6:2FTS	ND	4.5	5	1.5	DB,GR,J	NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	6:2FTS	ND	0	80	9		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	6:2FTS	ND	0	80	9		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	6:2FTS	ND	0	80	9		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	6:2FTS	ND	0	80	9		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	6:2FTS	ND	0	80	9		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	6:2FTS	ND	0	4.2	1.7		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	6:2FTS	ND	0	4.2	1.7		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	6:2FTS	ND	0	4.5	2.2		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	6:2FTS	<	2.2	4.5	2.2		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	6:2FTS	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	6:2FTS	ND	0	80	9		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	6:2FTS	ND	0	80	9		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	6:2FTS	ND	0	80	9		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	6:2FTS	=	4.3	4.5	2.3	J,DX	NG/L	12/29/2020

Sacramento Regional WWTP	EFF	EFF	6:2FTS	ND	0	4.5	2.2		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	6:2FTS	=	65	4.7	2.4		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	6:2FTS	<	2.3	4.6	2.3		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	6:2FTS	ND	0	80	9		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	6:2FTS	ND	0	80	9		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	6:2FTS	ND	0	80	9		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	6:2FTS	ND	0	80	9		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	6:2FTS	=	170	80	9		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	6:2FTS	ND	0	80	9		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	6:2FTS	ND	0	80	9		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	6:2FTS	ND	0	80	9		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	6:2FTS	ND	0	3.9	1.6		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	6:2FTS	ND	0	3.9	1.6		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	6:2FTS	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	6:2FTS	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	6:2FTS	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	6:2FTS	ND	0	80	9		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	6:2FTS	ND	0	80	9		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	6:2FTS	ND	0	80	9		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	6:2FTS	ND	0	80	9		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	7:3FTCA	ND	0	44	23		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	7:3FTCA	ND	0	7.1	3.8	SN	NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	7:3FTCA	<	3.6	6.9	3.6		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	7:3FTCA	<	4.2	8	4.2		NG/L	9/8/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	8:2FTS	ND	0	28	7.2		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	8:2FTS	ND	0	4.5	1.2		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	8:2FTS	<	1.1	4.3	1.1		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	8:2FTS	<	1.3	5	1.3	DB,GR	NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	8:2FTS	ND	0	80	20.2		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	8:2FTS	ND	0	80	20.2		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	8:2FTS	ND	0	80	20.2		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	8:2FTS	ND	0	80	20.2		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	8:2FTS	ND	0	80	20.2		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	8:2FTS	ND	0	2.5	0.85		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	8:2FTS	ND	0	2.5	0.85		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	8:2FTS	ND	0	1.8	0.41		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	8:2FTS	<	0.41	1.8	0.41		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	8:2FTS	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	8:2FTS	ND	0	80	20.2		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	8:2FTS	ND	0	80	20.2		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	8:2FTS	ND	0	80	20.2		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	8:2FTS	=	0.96	1.8	0.41	J,DX	NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	8:2FTS	=	0.75	1.8	0.41	J,DX	NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	8:2FTS	ND	0	1.9	0.44		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	8:2FTS	<	0.42	1.8	0.42		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	8:2FTS	ND	0	80	20.2		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	8:2FTS	ND	0	80	20.2		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	8:2FTS	ND	0	80	20.2		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	8:2FTS	ND	0	80	20.2		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	8:2FTS	ND	0	80	20.2		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	8:2FTS	ND	0	80	20.2		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	8:2FTS	ND	0	80	20.2		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	8:2FTS	ND	0	80	20.2		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	8:2FTS	ND	0	2.3	0.78		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	8:2FTS	ND	0	2.3	0.78		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	8:2FTS	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	8:2FTS	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	8:2FTS	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	8:2FTS	ND	0	80	20.2		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	8:2FTS	ND	0	80	20.2		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	8:2FTS	ND	0	80	20.2		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	8:2FTS	ND	0	80	20.2		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	9ClPF3ONS	ND	0	28	4.8		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	9ClPF3ONS	ND	0	4.5	0.77		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	9ClPF3ONS	ND	1.1	4.3	0.74	J	NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	9ClPF3ONS	<	0.86	5	0.86		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	9ClPF3ONS	ND	0	80	23.6		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	9ClPF3ONS	ND	0	80	23.6		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	9ClPF3ONS	ND	0	80	23.6		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	9ClPF3ONS	ND	0	80	23.6		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	9ClPF3ONS	ND	0	80	23.6		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	9ClPF3ONS	ND	0	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	9ClPF3ONS	ND	0	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	9ClPF3ONS	ND	0	1.8	0.22		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	9ClPF3ONS	<	0.21	1.8	0.21		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	9ClPF3ONS	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	9ClPF3ONS	ND	0	80	23.6		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	9ClPF3ONS	ND	0	80	23.6		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	9ClPF3ONS	ND	0	80	23.6		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	9ClPF3ONS	ND	0	1.8	0.22		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	9ClPF3ONS	ND	0	1.8	0.22		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	9ClPF3ONS	ND	0	1.9	0.23		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	9ClPF3ONS	<	0.22	1.8	0.22		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	9ClPF3ONS	ND	0	80	23.6		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	9ClPF3ONS	ND	0	80	23.6		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	9ClPF3ONS	ND	0	80	23.6		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	9ClPF3ONS	ND	0	80	23.6		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	9ClPF3ONS	ND	0	80	23.6		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	9ClPF3ONS	ND	0	80	23.6		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	9ClPF3ONS	ND	0	80	23.6		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	9ClPF3ONS	ND	0	80	23.6		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	9ClPF3ONS	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	9ClPF3ONS	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	9ClPF3ONS	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	9ClPF3ONS	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	9ClPF3ONS	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	9ClPF3ONS	ND	0	80	23.6		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	9ClPF3ONS	ND	0	80	23.6		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	9ClPF3ONS	ND	0	80	23.6		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	9ClPF3ONS	ND	0	80	23.6		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ADONA	ND	0	28	16		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ADONA	ND	0	4.5	2.6		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ADONA	<	2.5	4.3	2.5		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ADONA	<	2.9	5	2.9		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	ADONA	ND	0	80	26		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	ADONA	ND	0	80	26		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	ADONA	ND	0	80	26		NG/L	6/2/2021

City of Modesto WQCF	EFF-001B	21I3139-01	ADONA	ND	0	80	26		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	ADONA	ND	0	80	26		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	ADONA	ND	0	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	ADONA	ND	0	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	ADONA	ND	0	1.8	0.36	LN,AY	NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	ADONA	<	0.36	1.8	0.36		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	ADONA	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	ADONA	ND	0	80	26		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	ADONA	ND	0	80	26		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	ADONA	ND	0	80	26		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	ADONA	ND	0	1.8	0.36		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	ADONA	ND	0	1.8	0.36		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	ADONA	ND	0	1.9	0.38		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	ADONA	<	0.37	1.8	0.37		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	ADONA	ND	0	80	26		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	ADONA	ND	0	80	26		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	ADONA	ND	0	80	26		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	ADONA	ND	0	80	26		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	ADONA	ND	0	80	26		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	ADONA	ND	0	80	26		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	ADONA	ND	0	80	26		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	ADONA	ND	0	80	26		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	ADONA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	ADONA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	ADONA	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	ADONA	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	ADONA	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	ADONA	ND	0	80	26		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	ADONA	ND	0	80	26		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	ADONA	ND	0	80	26		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	ADONA	ND	0	80	26		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ETFOSA	ND	0	44	19		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ETFOSA	ND	0	7.1	3		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ETFOSA	<	2.9	6.9	2.9		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ETFOSA	<	3.4	8	3.4		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	ETFOSA	ND	0	80	60		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	ETFOSA	ND	0	80	60		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	ETFOSA	ND	0	80	60		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	ETFOSA	ND	0	80	60		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	ETFOSA	ND	0	80	60		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	ETFOSA	ND	0	4.2	0.85		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	ETFOSA	ND	0	4.2	0.85		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	ETFOSA	ND	0	1.8	0.78		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	ETFOSA	<	0.78	1.8	0.78		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	ETFOSA	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	ETFOSA	ND	0	80	60		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	ETFOSA	ND	0	80	60		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	ETFOSA	ND	0	80	60		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	ETFOSA	ND	0	1.8	0.78		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	ETFOSA	ND	0	1.8	0.78		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	ETFOSA	ND	0	1.9	0.82		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	ETFOSA	<	0.8	1.8	0.8		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	ETFOSA	ND	0	80	60		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	ETFOSA	ND	0	80	60		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	ETFOSA	ND	0	80	60		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	ETFOSA	ND	0	80	60		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	ETFOSA	ND	0	80	60		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	ETFOSA	ND	0	80	60		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	ETFOSA	ND	0	80	60		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	ETFOSA	ND	0	80	60		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	ETFOSA	ND	0	3.9	0.78		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	ETFOSA	ND	0	3.9	0.78		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	ETFOSA	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	ETFOSA	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	ETFOSA	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	ETFOSA	ND	0	80	60		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	ETFOSA	ND	0	80	60		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	ETFOSA	ND	0	80	60		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	ETFOSA	ND	0	80	60		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ETFOSE	ND	0	44	18		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ETFOSE	ND	0	7.1	2.9		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ETFOSE	<	2.9	6.9	2.9		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	ETFOSE	<	3.3	8	3.3		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	ETFOSE	ND	0	80	60		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	ETFOSE	ND	0	80	60		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	ETFOSE	ND	0	80	60		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	ETFOSE	ND	0	80	60		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	ETFOSE	ND	0	80	60		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	ETFOSE	ND	0	2.5	0.85		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	ETFOSE	ND	0	2.5	0.85		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	ETFOSE	ND	0	1.8	0.76		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	ETFOSE	<	0.76	1.8	0.76		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	ETFOSE	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	ETFOSE	ND	0	80	60		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	ETFOSE	ND	0	80	60		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	ETFOSE	ND	0	80	60		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	ETFOSE	ND	0	1.8	0.77		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	ETFOSE	ND	0	1.8	0.76		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	ETFOSE	ND	0	1.9	0.8		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	ETFOSE	<	0.78	1.8	0.78		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	ETFOSE	ND	0	80	60		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	ETFOSE	ND	0	80	60		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	ETFOSE	ND	0	80	60		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	ETFOSE	ND	0	80	60		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	ETFOSE	ND	0	80	60		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	ETFOSE	ND	0	80	60		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	ETFOSE	ND	0	80	60		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	ETFOSE	ND	0	80	60		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	ETFOSE	ND	0	2.3	0.78		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	ETFOSE	ND	0	2.3	0.78		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	ETFOSE	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	ETFOSE	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	ETFOSE	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	ETFOSE	ND	0	80	60		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	ETFOSE	ND	0	80	60		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	ETFOSE	ND	0	80	60		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	ETFOSE	ND	0	80	60		NG/L	10/28/2020

Easterly WWTP	EFF-001	EFF-001	HFPA-DA	ND	0	2.5	0.42	LM,AY	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	HFPA-DA	ND	0	2.5	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	HFPA-DA	ND	0	3.6	1.3		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	HFPA-DA	<	1.3	3.6	1.3		NG/L	8/16/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	HFPA-DA	ND	0	3.6	1.4		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	HFPA-DA	ND	0	3.6	1.3		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	HFPA-DA	ND	0	3.8	1.4		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	HFPA-DA	<	1.4	3.7	1.4		NG/L	8/11/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	HFPA-DA	ND	0	2.3	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	HFPA-DA	ND	0	2.3	0.39		NG/L	10/7/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	HFPO-DA	ND	0	28	11		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	HFPO-DA	ND	0	4.5	1.7	IL	NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	HFPO-DA	<	1.6	4.3	1.6		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	HFPO-DA	<	1.9	5	1.9		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	HFPO-DA	ND	0	80	49		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	HFPO-DA	ND	0	80	49		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	HFPO-DA	ND	0	80	49		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	HFPO-DA	ND	0	80	49		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	HFPO-DA	ND	0	80	49		NG/L	9/22/2021
Merced WWTF	M-001	EFFLUENT GRAB	HFPO-DA	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	HFPO-DA	ND	0	80	49		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	HFPO-DA	ND	0	80	49		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	HFPO-DA	ND	0	80	49		NG/L	7/28/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	HFPO-DA	ND	0	80	49		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	HFPO-DA	ND	0	80	49		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	HFPO-DA	ND	0	80	49		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	HFPO-DA	ND	0	80	49		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	HFPO-DA	ND	0	80	49		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	HFPO-DA	ND	0	80	49		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	HFPO-DA	ND	0	80	49		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	HFPO-DA	ND	0	80	49		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	HFPO-DA	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	HFPO-DA	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	HFPO-DA	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	HFPO-DA	ND	0	80	49		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	HFPO-DA	ND	0	80	49		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	HFPO-DA	ND	0	80	49		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	HFPO-DA	ND	0	80	49		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	MEFOSA	ND	0	44	27		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	MEFOSA	ND	0	7.1	4.4		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	MEFOSA	<	4.2	6.9	4.2		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	MEFOSA	<	4.9	8	4.9		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	MEFOSA	ND	0	80	60		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	MEFOSA	ND	0	80	60		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	MEFOSA	ND	0	80	60		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	MEFOSA	ND	0	80	60		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	MEFOSA	ND	0	80	60		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	MEFOSA	ND	0	2.5	0.85	LM,AY	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	MEFOSA	ND	0	2.5	0.85		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	MEFOSA	ND	0	1.8	0.39		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	MEFOSA	<	0.38	1.8	0.38		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	MEFOSA	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	MEFOSA	ND	0	80	60		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	MEFOSA	ND	0	80	60		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	MEFOSA	ND	0	80	60		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	MEFOSA	ND	0	1.8	0.39		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	MEFOSA	ND	0	1.8	0.39		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	MEFOSA	ND	0	1.9	0.41		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	MEFOSA	<	0.39	1.8	0.39		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	MEFOSA	ND	0	80	60		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	MEFOSA	ND	0	80	60		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	MEFOSA	ND	0	80	60		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	MEFOSA	ND	0	80	60		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	MEFOSA	ND	0	80	60		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	MEFOSA	ND	0	80	60		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	MEFOSA	ND	0	80	60		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	MEFOSA	ND	0	80	60		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	MEFOSA	ND	0	2.3	0.78		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	MEFOSA	ND	0	2.3	0.78		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	MEFOSA	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	MEFOSA	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	MEFOSA	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	MEFOSA	ND	0	80	60		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	MEFOSA	ND	0	80	60		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	MEFOSA	ND	0	80	60		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	MEFOSA	ND	0	80	60		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	MEFOSE	ND	0	44	27		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	MEFOSE	ND	0	7.1	4.3		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	MEFOSE	<	4.2	6.9	4.2		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	MEFOSE	<	4.8	8	4.8		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	MEFOSE	ND	0	80	60		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	MEFOSE	ND	0	80	60		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	MEFOSE	ND	0	80	60		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	MEFOSE	ND	0	80	60		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	MEFOSE	ND	0	80	60		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	MEFOSE	ND	0	2.5	0.85	RA,BA,AY,LM,AY	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	MEFOSE	ND	0	2.5	0.85		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	MEFOSE	ND	0	3.6	1.3		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	MEFOSE	<	1.2	3.6	1.2		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	MEFOSE	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	MEFOSE	ND	0	80	60		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	MEFOSE	ND	0	80	60		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	MEFOSE	ND	0	80	60		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	MEFOSE	ND	0	3.6	1.3		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	MEFOSE	ND	0	3.6	1.3		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	MEFOSE	ND	0	3.8	1.3		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	MEFOSE	<	1.3	3.7	1.3		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	MEFOSE	ND	0	80	60		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	MEFOSE	ND	0	80	60		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	MEFOSE	ND	0	80	60		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	MEFOSE	ND	0	80	60		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	MEFOSE	ND	0	80	60		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	MEFOSE	ND	0	80	60		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	MEFOSE	ND	0	80	60		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	MEFOSE	ND	0	80	60		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	MEFOSE	ND	0	2.3	0.78		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	MEFOSE	ND	0	2.3	0.78		NG/L	10/7/2020

Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	MEFOSE	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	MEFOSE	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	MEFOSE	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	MEFOSE	ND	0	80	60		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	MEFOSE	ND	0	80	60		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	MEFOSE	ND	0	80	60		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	MEFOSE	ND	0	80	60		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	NETFOSAA	ND	0	44	24		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	NETFOSAA	ND	0	7.1	3.9		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	NETFOSAA	<	3.8	6.9	3.8		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	NETFOSAA	<	4.4	8	4.4		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	NETFOSAA	ND	0	80	5		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	NETFOSAA	ND	0	80	5		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	NETFOSAA	ND	0	80	5		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	NETFOSAA	ND	0	80	5		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	NETFOSAA	ND	0	80	5		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	NETFOSAA	=	0.6	2.5	0.42	J,DX	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	NETFOSAA	=	0.55	2.5	0.42	J,DX	NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	NETFOSAA	ND	0	4.5	1.2		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	NETFOSAA	<	1.2	4.5	1.2		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	NETFOSAA	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	NETFOSAA	ND	0	80	5		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	NETFOSAA	ND	0	80	5		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	NETFOSAA	ND	0	80	5		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	NETFOSAA	ND	0	4.5	1.2		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	NETFOSAA	ND	0	4.5	1.2		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	NETFOSAA	ND	0	4.7	1.2		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	NETFOSAA	<	1.2	4.6	1.2		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	NETFOSAA	ND	0	80	5		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	NETFOSAA	ND	0	80	5		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	NETFOSAA	ND	0	80	5		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	NETFOSAA	<	9.4	80	5	J	NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	NETFOSAA	ND	0	80	5		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	NETFOSAA	ND	0	80	5		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	NETFOSAA	ND	0	80	5		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	NETFOSAA	ND	0	80	5		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	NETFOSAA	ND	0	2.3	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	NETFOSAA	ND	0	2.3	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	NETFOSAA	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	NETFOSAA	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	NETFOSAA	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	NETFOSAA	ND	0	80	5		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	NETFOSAA	ND	0	80	5		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	NETFOSAA	ND	0	80	5		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	NETFOSAA	ND	0	80	5		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	NMEFOSAA	ND	0	44	14		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	NMEFOSAA	ND	0	7.1	2.3		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	NMEFOSAA	<	2.2	6.9	2.2		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	NMEFOSAA	<	2.6	8	2.6		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	NMEFOSAA	ND	0	80	7.2		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	NMEFOSAA	ND	0	80	7.2		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	NMEFOSAA	ND	0	80	7.2		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	NMEFOSAA	ND	0	80	7.2		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	NMEFOSAA	ND	0	80	7.2		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	NMEFOSAA	=	0.7	1.7	0.51	J,DX	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	NMEFOSAA	=	0.84	1.7	0.51	J,DX	NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	NMEFOSAA	ND	0	4.5	1.1		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	NMEFOSAA	ND	1.2	4.5	1.1	J,DX	NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	NMEFOSAA	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	NMEFOSAA	ND	0	80	7.2		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	NMEFOSAA	ND	0	80	7.2		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	NMEFOSAA	ND	0	80	7.2		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	NMEFOSAA	ND	0	4.5	1.1		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	NMEFOSAA	ND	0	4.5	1.1		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	NMEFOSAA	ND	0	4.7	1.1		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	NMEFOSAA	<	1.1	4.6	1.1		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	NMEFOSAA	ND	0	80	7.2		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	NMEFOSAA	ND	0	80	7.2		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	NMEFOSAA	ND	0	80	7.2		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	NMEFOSAA	ND	0	80	7.2		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	NMEFOSAA	ND	0	80	7.2		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	NMEFOSAA	ND	0	80	7.2		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	NMEFOSAA	ND	0	80	7.2		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	NMEFOSAA	ND	0	80	7.2		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	NMEFOSAA	ND	0	1.6	0.47		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	NMEFOSAA	ND	0	1.6	0.47		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	NMEFOSAA	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	NMEFOSAA	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	NMEFOSAA	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	NMEFOSAA	ND	0	80	7.2		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	NMEFOSAA	ND	0	80	7.2		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	NMEFOSAA	ND	0	80	7.2		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	NMEFOSAA	ND	0	80	7.2		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFBA	ND	0	28	12		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFBA	ND	0	4.5	1.9	DB,GR	NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFBA	=	6.6	4.3	1.8	DB,GR	NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFBA	=	31	5	2.1	DB,GR	NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFBA	ND	0	80	5		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFBA	ND	0	80	5		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFBA	<	8.4	80	5	J	NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFBA	<	6.4	80	5	J	NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFBA	ND	0	80	5		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFBA	=	6.5	4.2	1.7	RA,BA,AY	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFBA	=	6.4	4.2	1.7		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFBA	=	6.6	4.5	2.2		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFBA	=	16	4.5	2.1		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFBA	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFBA	ND	0	80	5		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFBA	ND	0	80	5		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFBA	<	19	80	5	J	NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFBA	=	4.2	4.5	2.2	J,DX	NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFBA	ND	0	4.5	2.2		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFBA	=	4.8	4.7	2.3		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFBA	=	6.8	4.6	2.2		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFBA	<	10	80	5	J	NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFBA	<	11	80	5	J	NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFBA	ND	0	80	5		NG/L	11/10/2020

Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFBA	<	5.1	80	5	J	NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFBA	<	8.2	80	5	J	NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFBA	<	5.8	80	5	J	NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFBA	<	37	80	5	J	NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFBA	<	7.2	80	5	J	NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFBA	ND	0	3.9	1.6		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFBA	ND	0	3.9	1.6		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFBA	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFBA	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFBA	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFBA	<	30	80	5	J	NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFBA	<	10	80	5	J	NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFBA	<	19	80	5	J	NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFBA	ND	0	80	5		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFBSA	ND	0	28	13		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFBSA	ND	0	4.5	2.1	SN	NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFBSA	<	2.1	4.3	2.1		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFBSA	<	2.4	5	2.4		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFBSA	ND	0	50	5		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFBSA	ND	0	50	5		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFBSA	ND	0	50	5		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFBSA	<	13	50	5	J	NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFBSA	ND	0	50	5		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFBSA	=	3.4	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFBSA	=	3.7	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFBSA	=	2.9	1.8	0.18		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFBSA	ND	1.7	1.8	0.18	J,DX	NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFBSA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFBSA	ND	0	50	5		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFBSA	ND	0	50	5		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFBSA	=	320	50	5		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFBSA	=	2.6	1.8	0.18	TG	NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFBSA	=	7.6	1.8	0.18	TG	NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFBSA	=	2.6	1.9	0.19		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFBSA	=	8.1	1.8	0.18		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFBSA	ND	0	50	5		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFBSA	=	170	50	5		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFBSA	ND	0	50	5		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFBSA	ND	0	50	5		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFBSA	ND	0	50	5		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFBSA	ND	0	50	5		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFBSA	ND	0	50	5		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFBSA	ND	0	50	5		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFBSA	=	2.3	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFBSA	=	2.2	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFBSA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFBSA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFBSA	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFBSA	ND	0	50	5		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFBSA	ND	0	50	5		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFBSA	ND	0	50	5		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFBSA	ND	0	50	5		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFDOA	ND	0	28	12		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFDOA	ND	0	4.5	1.9		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFDOA	<	1.8	4.3	1.8		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFDOA	<	2.1	5	2.1		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFDOA	ND	0	50	5		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFDOA	ND	0	50	5		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFDOA	ND	0	50	5		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFDOA	ND	0	50	5		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFDOA	ND	0	50	5		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFDOA	ND	0	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFDOA	ND	0	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFDOA	ND	0	1.8	0.49		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFDOA	<	0.49	1.8	0.49		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFDOA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFDOA	ND	0	50	5		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFDOA	ND	0	50	5		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFDOA	ND	0	50	5		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFDOA	ND	0	1.8	0.5		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFDOA	ND	0	1.8	0.49		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFDOA	ND	0	1.9	0.52		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFDOA	<	0.5	1.8	0.5		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFDOA	ND	0	50	5		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFDOA	ND	0	50	5		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFDOA	ND	0	50	5		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFDOA	ND	0	50	5		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFDOA	ND	0	50	5		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFDOA	ND	0	50	5		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFDOA	ND	0	50	5		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFDOA	ND	0	50	5		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFDOA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFDOA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFDOA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFDOA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFDOA	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFDOA	ND	0	50	5		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFDOA	ND	0	50	5		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFDOA	ND	0	50	5		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFDOA	ND	0	50	5		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFDSA	ND	0	28	16		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFDSA	ND	0	4.5	2.5		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFDSA	<	2.4	4.3	2.4		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFDSA	<	2.8	5	2.8		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFDSA	ND	0	50	6.4		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFDSA	ND	0	50	6.4		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFDSA	ND	0	50	6.4		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFDSA	ND	0	50	6.4		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFDSA	ND	0	50	6.4		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFDSA	ND	0	1.7	0.42	RA,BA,AY	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFDSA	ND	0	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFDSA	ND	0	1.8	0.29		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFDSA	<	0.29	1.8	0.29		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFDSA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFDSA	ND	0	50	6.4		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFDSA	ND	0	50	6.4		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFDSA	ND	0	50	6.4		NG/L	7/28/2021

Sacramento Regional WWTP	EFF	2012290073/EFF	PFDSA	ND	0	1.8	0.29		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFDSA	ND	0	1.8	0.29		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFDSA	ND	0	1.9	0.3		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFDSA	<	0.29	1.8	0.29		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFDSA	ND	0	50	6.4		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFDSA	ND	0	50	6.4		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFDSA	ND	0	50	6.4		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFDSA	ND	0	50	6.4		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFDSA	ND	0	50	6.4		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFDSA	ND	0	50	6.4		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFDSA	ND	0	50	6.4		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFDSA	ND	0	50	6.4		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFDSA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFDSA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFDSA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFDSA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFDSA	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFDSA	ND	0	50	6.4		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFDSA	ND	0	50	6.4		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFDSA	ND	0	50	6.4		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFDSA	ND	0	50	6.4		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHA	ND	0	28	21		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHA	=	23	4.5	3.4		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHA	=	32	4.3	3.3		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHA	=	75	5	3.8		NG/L	9/8/2021
Easterly WWTP	EFF-001	EFF-001	PFHA	=	18	1.7	0.42	LM,AY	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFHA	=	29	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFHA	=	25	1.8	0.52		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFHA	=	23	1.8	0.52		NG/L	8/16/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFHA	=	21	1.8	0.52		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFHA	=	25	1.8	0.52		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFHA	=	37	1.9	0.55		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFHA	=	31	1.8	0.53		NG/L	8/11/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFHA	=	11	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFHA	=	12	1.6	0.39		NG/L	10/7/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHPA	ND	0	28	18		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHPA	ND	0	4.5	2.9		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHPA	<	2.8	4.3	2.8		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHPA	<	3.2	5	3.2		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFHPA	<	5.3	50	5	J	NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFHPA	ND	0	50	5		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFHPA	ND	0	50	5		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFHPA	ND	0	50	5		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFHPA	ND	0	50	5		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFHPA	=	1.3	1.7	0.42	J,DX	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFHPA	=	2	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFHPA	=	2.3	1.8	0.22		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFHPA	=	2.2	1.8	0.22		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHPA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFHPA	ND	0	50	5		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHPA	ND	0	50	5		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHPA	ND	0	50	5		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFHPA	=	3.2	1.8	0.23		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFHPA	=	3.9	1.8	0.22		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFHPA	=	4.8	1.9	0.24		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFHPA	=	4	1.8	0.23		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFHPA	ND	0	50	5		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFHPA	ND	0	50	5		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFHPA	ND	0	50	5		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFHPA	ND	0	50	5		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFHPA	ND	0	50	5		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFHPA	ND	0	50	5		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFHPA	ND	0	50	5		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFHPA	ND	0	50	5		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFHPA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFHPA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHPA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHPA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHPA	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFHPA	ND	0	50	5		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFHPA	ND	0	50	5		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFHPA	ND	0	50	5		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFHPA	ND	0	50	5		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHPSA	ND	0	28	11		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHPSA	ND	0	4.5	1.7		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHPSA	<	1.6	4.3	1.6		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHPSA	<	1.9	5	1.9		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFHPSA	ND	0	50	5.6		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFHPSA	ND	0	50	5.6		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFHPSA	ND	0	50	5.6		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFHPSA	ND	0	50	5.6		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFHPSA	ND	0	50	5.6		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFHPSA	ND	0	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFHPSA	ND	0	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFHPSA	ND	0	1.8	0.17		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFHPSA	<	0.17	1.8	0.17		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHPSA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFHPSA	ND	0	50	5.6		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHPSA	ND	0	50	5.6		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHPSA	ND	0	50	5.6		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFHPSA	ND	0	1.8	0.17		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFHPSA	ND	0	1.8	0.17		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFHPSA	ND	0	1.9	0.18		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFHPSA	<	0.17	1.8	0.17		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFHPSA	ND	0	50	5.6		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFHPSA	ND	0	50	5.6		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFHPSA	ND	0	50	5.6		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFHPSA	ND	0	50	5.6		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFHPSA	ND	0	50	5.6		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFHPSA	ND	0	50	5.6		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFHPSA	ND	0	50	5.6		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFHPSA	ND	0	50	5.6		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFHPSA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFHPSA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHPSA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHPSA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHPSA	ND	0	50	50		NG/L	9/13/2021

White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFHPSA	ND	0	50	5.6		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFHPSA	ND	0	50	5.6		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFHPSA	ND	0	50	5.6		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFHPSA	ND	0	50	5.6		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHXDA	ND	0	28	11		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHXDA	ND	0	4.5	1.7	DB,GR	NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHXDA	<	1.6	4.3	1.6		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHXDA	<	1.9	5	1.9		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFHXDA	<	12	50	6.4	J	NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFHXDA	<	10	50	6.4	J	NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFHXDA	<	16	50	6.4	J	NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFHXDA	<	16	50	6.4	J	NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFHXDA	ND	0	50	6.4		NG/L	9/22/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHXDA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFHXDA	<	20	50	6.4	J	NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHXDA	=	55	50	6.4		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHXDA	<	11	50	6.4	J	NG/L	7/28/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFHXDA	<	21	50	6.4	J	NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFHXDA	<	23	50	6.4	J	NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFHXDA	<	16	50	6.4	J	NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFHXDA	<	13	50	6.4	J	NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFHXDA	<	18	50	6.4	J	NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFHXDA	<	29	50	6.4	J	NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFHXDA	<	25	50	6.4	J	NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFHXDA	<	20	50	6.4	J	NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHXDA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHXDA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHXDA	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFHXDA	ND	0	50	6.4		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFHXDA	ND	0	50	6.4		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFHXDA	<	11	50	6.4	J	NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFHXDA	<	23	50	6.4	J	NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHXSA	ND	0	28	11		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHXSA	ND	0	4.5	1.7		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHXSA	=	5.9	4.3	1.6		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFHXSA	<	1.9	5	1.9		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFHXSA	ND	0	50	5		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFHXSA	ND	0	50	5		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFHXSA	ND	0	50	5		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFHXSA	ND	0	50	5		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFHXSA	<	6.2	50	5	J	NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFHXSA	=	3.1	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFHXSA	=	3.3	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFHXSA	=	2.6	1.8	0.51		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFHXSA	ND	1.6	1.8	0.51	J,DX	NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHXSA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFHXSA	ND	0	50	5		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHXSA	ND	0	50	5		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFHXSA	ND	0	50	5		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFHXSA	=	1.4	1.8	0.51	J,DX	NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFHXSA	=	1.5	1.8	0.51	J,DX	NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFHXSA	=	1.7	1.9	0.54	J,DX	NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFHXSA	=	2	1.8	0.52		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFHXSA	<	13	50	5	J	NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFHXSA	<	9.9	50	5	J	NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFHXSA	<	14	50	5	J	NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFHXSA	<	9.1	50	5	J	NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFHXSA	ND	0	50	5		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFHXSA	ND	0	50	5		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFHXSA	ND	0	50	5		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFHXSA	ND	0	50	5		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFHXSA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFHXSA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHXSA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHXSA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFHXSA	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFHXSA	ND	0	50	5		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFHXSA	ND	0	50	5		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFHXSA	ND	0	50	5		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFHXSA	ND	0	50	5		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNA	ND	0	28	12		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNA	ND	0	4.5	2		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNA	<	1.9	4.3	1.9		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNA	<	2.2	5	2.2		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFNA	ND	0	50	5		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFNA	ND	0	50	5		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFNA	ND	0	50	5		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFNA	ND	0	50	5		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFNA	ND	0	50	5		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFNA	=	0.7	1.7	0.42	J,DX	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFNA	=	1.3	1.7	0.42	J,DX	NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFNA	=	1.7	1.8	0.24	J,DX,TG	NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFNA	ND	1	1.8	0.24	J,DX	NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFNA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFNA	ND	0	50	5		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFNA	ND	0	50	5		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFNA	ND	0	50	5		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFNA	=	1	1.8	0.24	J,DX	NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFNA	=	1	1.8	0.24	J,DX	NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFNA	=	1.3	1.9	0.26	J,DX	NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFNA	ND	1.5	1.8	0.25	J,DX,TG	NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFNA	ND	0	50	5		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFNA	ND	0	50	5		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFNA	ND	0	50	5		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFNA	<	5.3	50	5	J	NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFNA	ND	0	50	5		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFNA	ND	0	50	5		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFNA	ND	0	50	5		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFNA	ND	0	50	5		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFNA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFNA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFNA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFNA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFNA	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFNA	ND	0	50	5		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFNA	ND	0	50	5		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFNA	ND	0	50	5		NG/L	8/17/2021

White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFNA	ND	0	50	5		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNDCA	ND	0	28	8.3		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNDCA	ND	0	4.5	1.3		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNDCA	ND	4	4.3	1.3	J	NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNDCA	ND	1.9	5	1.5	J	NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFNDCA	ND	0	50	5		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFNDCA	ND	0	50	5		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFNDCA	ND	0	50	5		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFNDCA	ND	0	50	5		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFNDCA	ND	0	50	5		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFNDCA	=	1.4	1.7	0.42	J,DX	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFNDCA	=	2.5	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFNDCA	=	2.7	1.8	0.28		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFNDCA	=	1.8	1.8	0.28		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFNDCA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFNDCA	ND	0	50	5		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFNDCA	ND	0	50	5		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFNDCA	ND	0	50	5		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFNDCA	=	1.5	1.8	0.28	J,DX	NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFNDCA	=	1	1.8	0.28	J,DX	NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFNDCA	=	2.3	1.9	0.29		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFNDCA	=	2.3	1.8	0.28		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFNDCA	ND	0	50	5		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFNDCA	ND	0	50	5		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFNDCA	ND	0	50	5		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFNDCA	ND	0	50	5		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFNDCA	ND	0	50	5		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFNDCA	ND	0	50	5		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFNDCA	ND	0	50	5		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFNDCA	ND	0	50	5		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFNDCA	=	2.4	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFNDCA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFNDCA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFNDCA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFNDCA	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFNDCA	ND	0	50	5		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFNDCA	ND	0	50	5		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFNDCA	ND	0	50	5		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFNDCA	ND	0	50	5		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNS	ND	0	28	16		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNS	ND	0	4.5	2.6		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNS	<	2.5	4.3	2.5		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFNS	<	2.9	5	2.9		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFNS	ND	0	80	8		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFNS	ND	0	80	8		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFNS	ND	0	80	8		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFNS	ND	0	80	8		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFNS	ND	0	80	8		NG/L	9/22/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFNS	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFNS	ND	0	80	8		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFNS	ND	0	80	8		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFNS	ND	0	80	8		NG/L	7/28/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFNS	ND	0	80	8		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFNS	ND	0	80	8		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFNS	ND	0	80	8		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFNS	ND	0	80	8		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFNS	ND	0	80	8		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFNS	ND	0	80	8		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFNS	ND	0	80	8		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFNS	ND	0	80	8		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFNS	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFNS	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFNS	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFNS	ND	0	80	8		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFNS	ND	0	80	8		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFNS	ND	0	80	8		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFNS	ND	0	80	8		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOA	ND	0	28	15		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOA	=	5.8	4.5	2.4		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOA	=	10	4.3	2.3		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOA	=	11	5	2.7		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFOA	ND	0	50	8.2		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFOA	<	12	50	8.2	J	NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFOA	<	9.3	50	8.2	J	NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFOA	<	17	50	8.2	J	NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFOA	ND	0	50	8.2		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFOA	=	6.6	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFOA	=	11	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFOA	=	11	1.8	0.76		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFOA	=	9.8	1.8	0.76		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFOA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFOA	ND	0	50	8.2		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFOA	<	13	50	8.2	J	NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFOA	ND	0	50	8.2		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFOA	=	6.5	1.8	0.77		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFOA	=	8.9	1.8	0.76		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFOA	=	14	1.9	0.8		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFOA	=	15	1.8	0.78		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFOA	<	10	50	8.2	J	NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFOA	ND	0	50	8.2		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFOA	<	9.3	50	8.2	J	NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFOA	<	11	50	8.2	J	NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFOA	ND	0	50	8.2		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFOA	<	9.7	50	8.2	J	NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFOA	<	9.4	50	8.2	J	NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFOA	<	8.7	50	8.2	J	NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFOA	=	5.5	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFOA	=	6.7	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFOA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFOA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFOA	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFOA	ND	0	50	8.2		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFOA	ND	0	50	8.2		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFOA	ND	0	50	8.2		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFOA	<	9.2	50	8.2	J	NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFODA	ND	0	28	23		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFODA	ND	0	4.5	3.7	DB,GR	NG/L	2/24/2021

City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFODA	<	3.5	4.3	3.5		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFODA	<	4.1	5	4.1		NG/L	9/8/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOS	ND	0	28	8.3		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOS	ND	0	4.5	1.3		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOS	=	9.3	4.3	1.3		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOS	ND	3.5	5	1.5	J	NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFOS	ND	0	50	5		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFOS	ND	0	50	5		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFOS	ND	0	50	5		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFOS	<	7.3	50	5	J	NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFOS	<	29	50	5	J	NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFOS	=	3.1	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFOS	=	4.4	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFOS	=	4.2	1.8	0.48		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFOS	=	4.5	1.8	0.48		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFOS	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFOS	<	6.1	50	5	J	NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFOS	ND	0	50	5		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFOS	ND	0	50	5		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFOS	=	3.9	1.8	0.49		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFOS	=	3.7	1.8	0.49		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFOS	=	4.5	1.9	0.51		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFOS	=	4.9	1.8	0.5		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFOS	<	19	50	5	J	NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFOS	<	14	50	5	J	NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFOS	<	32	50	5	J	NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFOS	<	47	50	5	J	NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFOS	<	29	50	5	J	NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFOS	<	5.8	50	5	J	NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFOS	<	7.1	50	5	J	NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFOS	ND	0	50	5		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFOS	=	2.9	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFOS	=	1.8	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFOS	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFOS	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFOS	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFOS	ND	0	50	5		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFOS	ND	0	50	5		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFOS	ND	0	50	5		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFOS	ND	0	50	5		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOSA	ND	0	44	17		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOSA	ND	0	7.1	2.8		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOSA	<	2.7	6.9	2.7		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFOSA	<	3.1	8	3.1	LP	NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFOSA	ND	0	80	5		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFOSA	ND	0	80	5		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFOSA	ND	0	80	5		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFOSA	ND	0	80	5		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFOSA	ND	0	80	5		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFOSA	ND	0	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFOSA	ND	0	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFOSA	ND	0	1.8	0.88		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFOSA	<	0.87	1.8	0.87		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFOSA	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFOSA	ND	0	80	5		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFOSA	ND	0	80	5		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFOSA	ND	0	80	5		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFOSA	ND	0	1.8	0.88		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFOSA	ND	0	1.8	0.88		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFOSA	ND	0	1.9	0.93		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFOSA	<	0.9	1.8	0.9		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFOSA	ND	0	80	5		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFOSA	ND	0	80	5		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFOSA	ND	0	80	5		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFOSA	ND	0	80	5		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFOSA	ND	0	80	5		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFOSA	ND	0	80	5		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFOSA	ND	0	80	5		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFOSA	ND	0	80	5		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFOSA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFOSA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFOSA	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFOSA	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFOSA	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFOSA	ND	0	80	5		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFOSA	ND	0	80	5		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFOSA	ND	0	80	5		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFOSA	ND	0	80	5		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFPA	ND	0	28	6.1		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFPA	=	6.6	4.5	0.98		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFPA	=	15	4.3	0.95		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFPA	=	17	5	1.1		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFPA	<	25	50	6.2	J	NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFPA	<	27	50	6.2	J	NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFPA	<	31	50	6.2	J	NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFPA	<	40	50	6.2	J	NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFPA	ND	0	50	6.2		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFPA	=	16	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFPA	=	12	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFPA	=	17	1.8	0.44		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFPA	=	18	1.8	0.44		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFPA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFPA	<	9.7	50	6.2	J	NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFPA	<	12	50	6.2	J	NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFPA	<	7.3	50	6.2	J	NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFPA	=	10	1.8	0.44		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFPA	=	17	1.8	0.44		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFPA	=	47	1.9	0.46		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFPA	=	52	1.8	0.45		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFPA	<	7.4	50	6.2	J	NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFPA	<	8.8	50	6.2	J	NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFPA	<	6.9	50	6.2	J	NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFPA	<	6.6	50	6.2	J	NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFPA	ND	0	50	6.2		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFPA	<	15	50	6.2	J	NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFPA	<	25	50	6.2	J	NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFPA	<	10	50	6.2	J	NG/L	12/14/2021

Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFPA	=	8.8	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFPA	=	9.9	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFPA	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFPA	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFPA	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFPA	<	15	50	6.2	J	NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFPA	<	15	50	6.2	J	NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFPA	<	18	50	6.2	J	NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFPA	<	29	50	6.2	J	NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFPES	ND	0	28	17		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFPES	ND	0	4.5	2.8		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFPES	<	2.7	4.3	2.7		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFPES	<	3.1	5	3.1		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFPES	ND	0	50	5.8		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFPES	ND	0	50	5.8		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFPES	ND	0	50	5.8		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFPES	ND	0	50	5.8		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFPES	ND	0	50	5.8		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFPES	ND	0	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFPES	=	0.57	1.7	0.42	J,DX	NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFPES	ND	0	1.8	0.27		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFPES	<	0.27	1.8	0.27		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFPES	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFPES	ND	0	50	5.8		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFPES	ND	0	50	5.8		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFPES	ND	0	50	5.8		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFPES	ND	0	1.8	0.27		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFPES	ND	0	1.8	0.27		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFPES	ND	0	1.9	0.28		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFPES	<	0.28	1.8	0.28		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFPES	ND	0	50	5.8		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFPES	ND	0	50	5.8		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFPES	ND	0	50	5.8		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFPES	ND	0	50	5.8		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFPES	ND	0	50	5.8		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFPES	ND	0	50	5.8		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFPES	ND	0	50	5.8		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFPES	ND	0	50	5.8		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFPES	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFPES	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFPES	ND	0	50	50		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFPES	ND	0	50	50		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFPES	ND	0	50	50		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFPES	ND	0	50	5.8		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFPES	ND	0	50	5.8		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFPES	ND	0	50	5.8		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFPES	ND	0	50	5.8		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFTEDA	ND	0	28	7.2		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFTEDA	ND	0	4.5	1.2		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFTEDA	<	1.1	4.3	1.1		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFTEDA	<	1.3	5	1.3		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFTEDA	ND	0	80	8.6		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFTEDA	ND	0	80	8.6		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFTEDA	ND	0	80	8.6		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFTEDA	ND	0	80	8.6		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFTEDA	ND	0	80	8.6		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFTEDA	ND	0	1.7	0.42		NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFTEDA	ND	0	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFTEDA	ND	0	1.8	0.65		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFTEDA	<	0.65	1.8	0.65		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFTEDA	ND	0	80	80		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFTEDA	ND	0	80	8.6		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFTEDA	ND	0	80	8.6		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFTEDA	ND	0	80	8.6		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFTEDA	ND	0	1.8	0.66		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFTEDA	ND	0	1.8	0.66		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFTEDA	ND	0	1.9	0.69		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFTEDA	<	0.67	1.8	0.67		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFTEDA	ND	0	80	8.6		NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFTEDA	ND	0	80	8.6		NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFTEDA	ND	0	80	8.6		NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFTEDA	ND	0	80	8.6		NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFTEDA	ND	0	80	8.6		NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFTEDA	ND	0	80	8.6		NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFTEDA	ND	0	80	8.6		NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFTEDA	ND	0	80	8.6		NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFTEDA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFTEDA	ND	0	1.6	0.39		NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFTEDA	ND	0	80	80		NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFTEDA	ND	0	80	80		NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFTEDA	ND	0	80	80		NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFTEDA	ND	0	80	8.6		NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFTEDA	ND	0	80	8.6		NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFTEDA	ND	0	80	8.6		NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFTEDA	ND	0	80	8.6		NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFTRIDA	ND	0	28	7.2		NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFTRIDA	ND	0	4.5	1.2		NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFTRIDA	<	1.1	4.3	1.1		NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFTRIDA	<	1.3	5	1.3		NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFTRIDA	ND	0	50	5.8		NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFTRIDA	ND	0	50	5.8		NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFTRIDA	ND	0	50	5.8		NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFTRIDA	ND	0	50	5.8		NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFTRIDA	ND	0	50	5.8		NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFTRIDA	ND	0	1.7	0.42	RA,BA,AY,LN,AY	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFTRIDA	ND	0	1.7	0.42		NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFTRIDA	ND	0	1.8	1.2		NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFTRIDA	<	1.2	1.8	1.2		NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFTRIDA	ND	0	50	50		NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFTRIDA	ND	0	50	5.8		NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFTRIDA	ND	0	50	5.8		NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFTRIDA	ND	0	50	5.8		NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFTRIDA	ND	0	1.8	1.2		NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFTRIDA	ND	0	1.8	1.2		NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFTRIDA	ND	0	1.9	1.2		NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFTRIDA	<	1.2	1.8	1.2		NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFTRIDA	ND	0	50	5.8		NG/L	4/29/2021

Stockton Regional WW Control Facility	EFF-001	EFF-001	PFTRIDA	ND	0	50	5.8	NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFTRIDA	ND	0	50	5.8	NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFTRIDA	ND	0	50	5.8	NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFTRIDA	ND	0	50	5.8	NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFTRIDA	ND	0	50	5.8	NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFTRIDA	ND	0	50	5.8	NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFTRIDA	ND	0	50	5.8	NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFTRIDA	ND	0	1.6	0.39	NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFTRIDA	ND	0	1.6	0.39	NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFTRIDA	ND	0	50	50	NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFTRIDA	ND	0	50	50	NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFTRIDA	ND	0	50	50	NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFTRIDA	ND	0	50	5.8	NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFTRIDA	ND	0	50	5.8	NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFTRIDA	ND	0	50	5.8	NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFTRIDA	ND	0	50	5.8	NG/L	10/28/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFUNDCA	ND	0	28	5.1	NG/L	12/9/2020
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFUNDCA	ND	0	4.5	0.82	NG/L	2/24/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFUNDCA	<	0.8	4.3	0.8	NG/L	6/2/2021
City of Manteca WW Quality Control Facility	EFF-001	EFF-001	PFUNDCA	<	0.92	5	0.92	NG/L	9/8/2021
City of Modesto WQCF	EFF-001B	20L3113-03 EFF-001B	PFUNDCA	ND	0	50	8	NG/L	12/22/2020
City of Modesto WQCF	EFF-001B	21C3069-02 EFF-001B	PFUNDCA	ND	0	50	8	NG/L	3/18/2021
City of Modesto WQCF	EFF-001B	21F0847-02 EFF-001B COMP	PFUNDCA	ND	0	50	8	NG/L	6/2/2021
City of Modesto WQCF	EFF-001B	21I3139-01	PFUNDCA	ND	0	50	8	NG/L	9/22/2021
City of Modesto WQCF	EFF-001B	21I3139-02	PFUNDCA	ND	0	50	8	NG/L	9/22/2021
Easterly WWTP	EFF-001	EFF-001	PFUNDCA	ND	0	1.7	0.42	NG/L	10/29/2020
Easterly WWTP	EFF-001	EFF-001	PFUNDCA	ND	0	1.7	0.42	NG/L	2/23/2021
Easterly WWTP	EFF-001	EFF-001	PFUNDCA	ND	0	1.8	0.99	NG/L	5/12/2021
Easterly WWTP	EFF-001	EFF-001	PFUNDCA	<	0.98	1.8	0.98	NG/L	8/16/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFUNDCA	ND	0	50	50	NG/L	11/9/2020
Merced WWTF	M-001	EFFLUENT GRAB	PFUNDCA	ND	0	50	8	NG/L	2/4/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFUNDCA	ND	0	50	8	NG/L	5/27/2021
Merced WWTF	M-001	EFFLUENT GRAB	PFUNDCA	ND	0	50	8	NG/L	7/28/2021
Sacramento Regional WWTP	EFF	2012290073/EFF	PFUNDCA	ND	0	1.8	0.99	NG/L	12/29/2020
Sacramento Regional WWTP	EFF	EFF	PFUNDCA	ND	0	1.8	0.99	NG/L	2/24/2021
Sacramento Regional WWTP	EFF	EFF	PFUNDCA	ND	0	1.9	1	NG/L	4/28/2021
Sacramento Regional WWTP	EFF	EFF	PFUNDCA	<	1	1.8	1	NG/L	8/11/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFUNDCA	ND	0	50	8	NG/L	4/29/2021
Stockton Regional WW Control Facility	EFF-001	EFF-001	PFUNDCA	ND	0	50	8	NG/L	8/17/2021
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFUNDCA	ND	0	50	8	NG/L	11/10/2020
Stockton Regional WW Control Facility	EFF-001	RWCF EFFLUENT	PFUNDCA	ND	0	50	8	NG/L	2/3/2021
Tracy WWTP	EFF-01	21C2926-01 EFF	PFUNDCA	ND	0	50	8	NG/L	3/17/2021
Tracy WWTP	EFF-01	21F3082-01 EFF	PFUNDCA	ND	0	50	8	NG/L	6/23/2021
Tracy WWTP	EFF-01	21I1080-01 EFF-001	PFUNDCA	ND	0	50	8	NG/L	9/8/2021
Tracy WWTP	EFF-01	21L2036-01 EFF-001	PFUNDCA	ND	0	50	8	NG/L	12/14/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFUNDCA	ND	0	1.6	0.39	NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (Effluent-grab)	PFUNDCA	ND	0	1.6	0.39	NG/L	10/7/2020
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFUNDCA	ND	0	50	50	NG/L	3/3/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFUNDCA	ND	0	50	50	NG/L	6/15/2021
Turlock City, Turlock Regional Water Quality Control Facility	EFF-001	EFF-001 (EFFLUENT-GRAB)	PFUNDCA	ND	0	50	50	NG/L	9/13/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFUNDCA	ND	0	50	8	NG/L	2/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFF-001	PFUNDCA	ND	0	50	8	NG/L	5/10/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT	PFUNDCA	ND	0	50	8	NG/L	8/17/2021
White Slough Water Pollution Control Facility	EFFLUENT	EFFLUENT (GRAB)	PFUNDCA	ND	0	50	8	NG/L	10/28/2020

AY – matrix interference suspected
BA – relative percent difference out of control

DB – QA results outside of acceptance limits due to matrix effect

DX – value <lowest standard (MQL), but > MDL

GR – internal standard recovery is outside method recovery limit

J – EPA Flag, estimated value

LM – MS and/or MSD above acceptance limit, see blank spike (LCS)

LN – MS and/or MSD below acceptance limit, see blank spike (LCS)

LP – LCS recovery above method control limits, analyte ND, data not impacted
RA – RPD exceeds limit due to matrix interference, % recoveries within limits
TG – ion ratio outside limits, value is estimated maximum possible concentration (EMPC)

NORTH COMPLEX WATER QUALITY MONITORING

PRELIMINARY RESULTS: 11/19/2020 Sampling Event

Sampling conducted by the Central Valley Water Board and analysis performed by Basic Laboratory
Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

NOTE: All results presented here are considered draft

LEGEND
- **Result > Primary MCL**
- **Result > Secondary MCL**
- **Result > Bacteria Water Quality Objective**
- *Estimated Result (sample did not pass QAQC)*
- Pending or No Result

APPENDIX 13A-1 North Complex Post-Fire Monitoring Results

Sample ID	Station Name	MINERALS & SOLIDS							BACTERIA		FIELD MEASUREMENTS				
	Analyte:	**Alkalinity**	**Hardness**	**Hardness**	**Sulfate**	**TDS**	**TSS**	**Settleable Solids**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 2340C	SM 2340C	EPA 300.0	SM 2540 C	SM 2540 D	SM 2540 F			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Dissolved	Total	Dissolved	Total	Particulate	Total	Total	Total					
	Primary MCL:														
	Secondary MCL:				250	500					900		6.5-8.5		5
	Bacteria Objective:								320						
	Aquatic Life Threshold:	20										>7.0	6.5-9		
	Agrigulture Threshold					450					700		6.5-8.4		
NC 1	Thermolito Diversion	44	37	39	2.06	65	ND	ND	4	770	97.1	10.2		10.2	
NC 2	Berry Cr./Lake Madrone	64	62	60	7.9	131	69	ND	345	>2420	157	0.57		64	
NC 3	Pondo Dam/SF Feather	28	17	19	1.54	37	ND	ND	8	261	47.8	10.6		10.3	
NC 4	Fall River/Mill Road	56	54	55	5.37	90	35.8	ND	249	>2420	132.9	10.9		42	
NC 5	Milsap Bar														
NC 6	Lake Oroville/MF Feather														

Sample ID	Station Name	NUTRIENTS											
	Analyte:	**Ammonia**	**Nitrate**	**Nitrite**	**Nitrate+Nitrite**	**TKN**	**TKN**	**Organic Nitrogen**	**Nitrogen**	**OrthoPhosphate**	**Phosphorus**	**Phosphorus**	**TOC**
	Method:	SM 4500	EPA 353.2					Calculated		SM 4500P E	SM 4500P E	SM 4500P E	EPA 415.3
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Total
	Primary MCL:		10	1	10								
	Secondary MCL:	1.5											
	Bacteria Objective:												
	Aquatic Life Threshold:	formula											
	Agrigulture Threshold												
NC 1	Thermolito Diversion	ND	0.09		0.09	0.12	0.18	0.12	0.268	0.005	ND	ND	1.5
NC 2	Berry Cr./Lake Madrone	ND	ND		ND	0.55	1.46	0.55	1.49	0.006	0.028	0.463	28.8
NC 3	Pondo Dam/SF Feather	ND	ND		ND	ND	0.22	ND	0.223	ND	ND	ND	1.1
NC 4	Fall River/Mill Road	0.063	0.05		0.05	0.33	0.71	0.27	0.765	0.028	0.048	0.318	11.2
NC 5	Milsap Bar												
NC 6	Lake Oroville/MF Feather												

Sample ID	Station Name	TOTAL METALS										
	Analyte:	**Aluminum**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	10	5	50	1,300			2	100	50	
	Secondary MCL:	200				1,000	300	50				5,000
	Aquatic Life Threshold:	87		formula			1,000		0.05			120
	Agrigulture Threshold	5,000	100	10		200	5,000	200		200	20	
NC 1	Thermolito Diversion	45.8	0.65	ND	0.24	0.73	71.5	19.2	ND	0.73	ND	ND
NC 2	Berry Cr./Lake Madrone	4,840	1.31	0.05	2.49	4.97	2,090	572	ND	2.23	ND	11.4
NC 3	Pondo Dam/SF Feather	47.9	0.34	ND	0.14	0.33	84.8	55.9	ND	1.02	ND	ND
NC 4	Fall River/Mill Road	2,950	0.56	0.05	1.71	3.33	1,610	507	ND	2.62	ND	7.9
NC 5	Milsap Bar											
NC 6	Lake Oroville/MF Feather											

Sample ID	Station Name	DISSOLVED METALS										
	Analyte:	**Aluminum**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	10	5	50	1,300			2	100	50	
	Secondary MCL:	200				1,000	300	50				5,000
	Aquatic Life Threshold:	87	150	formula		9	1,000			52	5	120
	Agrigulture Threshold	5,000				200	5,000	200			20	
NC 1	Thermolito Diversion	6.3	0.6	ND	0.17	0.49	7.9	1.8	ND	0.56	ND	ND
NC 2	Berry Cr./Lake Madrone	299	0.89	ND	ND	1.74	193	413	ND	ND	ND	ND
NC 3	Pondo Dam/SF Feather	5.7	0.31	ND	ND	0.26	11.8	22.7	ND	0.83	ND	ND
NC 4	Fall River/Mill Road	83.6	0.27	ND	ND	0.71	39	208	ND	1.03	ND	3.2
NC 5	Milsap Bar											
NC 6	Lake Oroville/MF Feather											

Sample ID	Station Name	POLYCYCLIC AUROMATIC HYDROCARBONS (PAHs)																						
	Analyte:	**Sum PAHs**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a)pyrene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Carbazole**	**Chrysene**	**Dibenz(a,h)anthracene**	**Dinitrotoluene, 2,4<**	**Dinitrotoluene, 2,6<**	**Fluoranthene**	**Fluorene**	**indeno(1,2,3<c,d)pyrene**	**Isophorone**	**Methylnaphthalene, 2<**	**Naphthalene**	**Nitrobenzene**	**Phenanthrene**	**Pyrene**	**Sum LMW PAHs**	**Sum HMW PAHs**
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																		
	Human Health Threshold*:		70		300	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20														0.049			21					
	Aquatic Life Threshold:		52		110,000										370	14,000				62			11,000		
NC 1	Thermolito Diversion	**0.000**	ND	ND	ND	ND	ND	ND	ND		ND	ND			ND	ND	ND		ND	ND		ND	ND	0.00	0.00
NC 2	Berry Cr./Lake Madrone	**0.000**																						0.00	0.00
NC 3	Pondo Dam/SF Feather	**0.000**																						0.00	0.00
NC 4	Fall River/Mill Road	**0.000**																						0.00	0.00
NC 5	Milsap Bar	**0.000**																						0.00	0.00
NC 6	Lake Oroville/MF Feather	**0.000**																						0.00	0.00

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

NORTH COMPLEX WATER QUALITY MONITORING

PRELIMINARY RESULTS: 12/16/2020 Sampling Event

Sampling conducted by the Central Valley Water Board and analysis performed by Basic Laboratory
Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

NOTE: All results presented here are considered draft

LEGEND

Result > Primary MCL
Result > Secondary MCL
Result > Bacteria Water Quality Objective
Estimated Result (sample did not pass QAQC)
Pending or No Result

Sample ID	Station Name	MINERALS & SOLIDS							BACTERIA		FIELD MEASUREMENTS				
	Analyte:	**Alkalinity**	**Hardness**	**Hardness**	**Sulfate**	**TDS**	**TSS**	**Settleable Solids**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 2340C	SM 2340C	EPA 300.0	SM 2540 C	SM 2540 D	SM 2540 F			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Dissolved	Total	Dissolved	Total	Particulate	Total	Total	Total					
	Primary MCL:														
	Secondary MCL:				250	500					900		6.5-8.5		5
	Bacteria Objective:								320						
	Aquatic Life Threshold:	20										>7.0	6.5-9		
	Agrigulture Threshold					450					700		6.5-8.4		
NC 1	Thermolito Diversion	49	40	43	2.29	57	ND	ND	<1	130	107.9	9.94	8.27	10.4	1.01
NC 2	Berry Cr./Lake Madrone	44	31	34	2.85	78	9	ND	65	>2420	104.3	7.51	7.33	6	15.5
NC 3	Pondo Dam/SF Feather	22	16	18	1.61	36	ND	ND	2	48	49.1	11.4	7.98	8.5	1.12
NC 4	Fall River/Mill Road	32	25	28	2.48	52	ND	ND	2	276	78.5	11.67	7.81	3.7	1.1
NC 5	Milsap Bar														
NC 6	Lake Oroville/MF Feather														

Sample ID	Station Name	NUTRIENTS											
	Analyte:	**Ammonia**	**Nitrate**	**Nitrite**	**Nitrate+Nitrite**	**TKN**	**TKN**	**Organic Nitrogen**	**Nitrogen**	**OrthoPhosphate**	**Phosphorus**	**Phosphorus**	**TOC**
	Method:	SM 4500	EPA 353.2					Calculated		SM 4500P E	SM 4500P E	SM 4500P E	EPA 415.3
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Total
	Primary MCL:		10	1	10								
	Secondary MCL:	1.5											
	Bacteria Objective:												
	Aquatic Life Threshold:	formula											
	Agrigulture Threshold												
NC 1	Thermolito Diversion	ND	0.05		0.05	0.27	0.09	0.269	0.146	ND	ND	ND	1.5
NC 2	Berry Cr./Lake Madrone	ND	ND		ND	0.14	0.41	0.139	0.414	0.004	0.024	0.089	6.6
NC 3	Pondo Dam/SF Feather	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	0.8
NC 4	Fall River/Mill Road	ND	ND		ND	ND	0.09	ND	0.0901	0.026	ND	0.024	1
NC 5	Milsap Bar												
NC 6	Lake Oroville/MF Feather												

Sample ID	Station Name	TOTAL METALS										
	Analyte:	**Aluminum**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	10	5	50	1,300			2	100	50	
	Secondary MCL:	200				1,000	300	50				5,000
	Aquatic Life Threshold:	87		formula			1,000		0.05			120
	Agrigulture Threshold	5,000	100	10		200	5,000	200		200	20	
NC 1	Thermolito Diversion	31.7	0.81	ND	0.22	0.61	46.1	11.9	ND	0.54	ND	1.1
NC 2	Berry Cr./Lake Madrone	743	0.78	ND	0.41	0.92	574	211	ND	0.45	ND	2.4
NC 3	Pondo Dam/SF Feather	36.8	0.31	ND	0.17	0.27	87.4	49	ND	0.86	ND	ND
NC 4	Fall River/Mill Road	71	0.26	ND	ND	0.19	60	37.4	ND	0.37	ND	1.2
NC 5	Milsap Bar											
NC 6	Lake Oroville/MF Feather											

Sample ID	Station Name	DISSOLVED METALS										
	Analyte:	**Aluminum**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	10	5	50	1,300			2	100	50	
	Secondary MCL:	200				1,000	300	50				5,000
	Aquatic Life Threshold:	87	150	formula		9	1,000			52	5	120
	Agrigulture Threshold	5,000				200	5,000	200			20	
NC 1	Thermolito Diversion	6.8	0.79	ND	0.15	0.52	7.2	0.61	ND	0.48	ND	1.5
NC 2	Berry Cr./Lake Madrone	107	0.72	ND	ND	0.51	217	178	ND	0.21	ND	1.5
NC 3	Pondo Dam/SF Feather	4.6	0.26	ND	ND	0.23	35.9	25.6	ND	0.72	ND	ND
NC 4	Fall River/Mill Road	16.1	0.38	ND	ND	0.19	20.3	27.8	ND	0.22	ND	ND
NC 5	Milsap Bar											
NC 6	Lake Oroville/MF Feather											

Sample ID	Station Name	POLYCYCLIC AUROMATIC HYDROCARBONS (PAHs)																							
	Analyte:	**Sum PAHs**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a)pyrene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Carbazole**	**Chrysene**	**Dibenz(a,h)anthracene**	**Dinitrotoluene, 2,4<**	**Dinitrotoluene, 2,6<**	**Fluoranthene**	**Fluorene**	**indeno(1,2,3<c,d)pyrene**	**Isophorone**	**Methylnaphthalene, 2<**	**Naphthalene**	**Nitrobenzene**	**Phenanthrene**	**Pyrene**	**Sum LMW PAHs**	**Sum HMW PAHs**
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																		
	Human Health Threshold*:		70		300	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20														0.049			21					
	Aquatic Life Threshold:		52		110,000										370	14,000				62			11,000		
NC 1	Thermolito Diversion	**0.000**	ND	ND	ND	ND	ND	ND	ND		ND	ND			ND	ND	ND		ND	ND		ND	ND	0.00	0.00
NC 2	Berry Cr./Lake Madrone	**0.000**																						0.00	0.00
NC 3	Pondo Dam/SF Feather	**0.000**																						0.00	0.00
NC 4	Fall River/Mill Road	**0.000**																						0.00	0.00
NC 5	Milsap Bar	**0.000**																						0.00	0.00
NC 6	Lake Oroville/MF Feather	**0.000**																						0.00	0.00

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

NORTH COMPLEX WATER QUALITY MONITORING

PRELIMINARY RESULTS: 1/19/2021 Sampling Event

LEGEND
Result > Primary MCL
Result > Secondary MCL
Result > Bacteria Water Quality Objective
Estimated Result (sample did not pass QAQC)
Pending or No Result

Sampling conducted by the Central Valley Water Board and analysis performed by Basic Laboratory
Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

NOTE: All results presented here are considered draft

Sample ID	Station Name	MINERALS & SOLIDS							BACTERIA		FIELD MEASUREMENTS				
	Analyte:	**Alkalinity**	**Hardness**	**Hardness**	**Sulfate**	**TDS**	**TSS**	**Settleable Solids**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 2340C	SM 2340C	EPA 300.0	SM 2540 C	SM 2540 D	SM 2540 F			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Dissolved	Total	Dissolved	Total	Particulate	Total	Total	Total					
	Primary MCL:														
	Secondary MCL:				250	500					900		6.5-8.5		5
	Bacteria Objective:								320						
	Aquatic Life Threshold:	20										>7.0	6.5-9		
	Agrigulture Threshold					450					700		6.5-8.4		
NC 1	Thermolito Diversion	52	43	47	2.58	69	ND	ND	<1	548	117.4	10.27	7.68	9.7	1.73
NC 2	Berry Cr./Lake Madrone	42	25	30	1.91	75	5.2	ND	10	1120	90.2	7.4	6.99	7.2	8.5
NC 3	Pondo Dam/SF Feather	21	17	18	1.51	36	ND	ND	2	12	48.5	12.1	7.2	7.5	1.03
NC 4	Fall River/Mill Road	25	16	21	1.97	57	ND	ND	<1	114	57.6	11.9	7.22	3.2	0.97
NC 4U	Fall River/MillRd/Upstream	24	17	19	1.84	47	ND	ND	2	206	55.6	12.03	7.33	3.2	1.11
NC 5	Milsap Bar														
NC 6	Lake Oroville/MF Feather														

Sample ID	Station Name	NUTRIENTS											
	Analyte:	**Ammonia**	**Nitrate**	**Nitrite**	**Nitrate+Nitrite**	**TKN**	**TKN**	**Organic Nitrogen**	**Nitrogen**	**OrthoPhosphate**	**Phosphorus**	**Phosphorus**	**TOC**
	Method:	SM 4500	EPA 353.2					Calculated		SM 4500P E	SM 4500P E	SM 4500P E	EPA 415.3
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Total
	Primary MCL:		10	1	10								
	Secondary MCL:	1.5											
	Bacteria Objective:												
	Aquatic Life Threshold:	formula											
	Agrigulture Threshold												
NC 1	Thermolito Diversion	ND	ND		ND	0.11	0.11	0.113	0.137	ND	ND	ND	1.5
NC 2	Berry Cr./Lake Madrone	0.123	0.03		0.03	0.19	0.33	ND	0.37	0.005	ND	0.044	3.1
NC 3	Pondo Dam/SF Feather	ND	ND		ND	ND	0.13	ND	0.132	ND	ND	ND	0.9
NC 4	Fall River/Mill Road	ND	ND		ND	ND	0.12	ND	0.166	0.017	ND	0.024	1.2
NC 4U	Fall River/MillRd/Upstream	ND	ND		ND	ND	ND	ND	ND	0.011	ND	ND	1
NC 5	Milsap Bar												
NC 6	Lake Oroville/MF Feather												

Sample ID	Station Name	TOTAL METALS										
	Analyte:	**Aluminum**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	10	5	50	1,300			2	100	50	
	Secondary MCL:	200				1,000	300	50				5,000
	Aquatic Life Threshold:	87		formula			1,000		0.05			120
	Agrigulture Threshold	5,000	100	10		200	5,000	200		200	20	
NC 1	Thermolito Diversion	50.3	0.82	ND	0.25	0.6	67.1	6.6	ND	0.52	ND	ND
NC 2	Berry Cr./Lake Madrone	513	0.6	ND	0.37	0.66	761	323	ND	0.36	ND	1.7
NC 3	Pondo Dam/SF Feather	24.8	0.35	ND	ND	0.23	35.7	9.63	ND	0.55	ND	ND
NC 4	Fall River/Mill Road	62	0.19	ND	ND	ND	45	27.2	ND	0.16	ND	ND
NC 4U	Fall River/MillRd/Upstream	65	0.2	ND	ND	0.25	44	25.9	ND	ND	ND	ND
NC 5	Milsap Bar											
NC 6	Lake Oroville/MF Feather											

Sample ID	Station Name	DISSOLVED METALS										
	Analyte:	**Aluminum**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	10	5	50	1,300			2	100	50	
	Secondary MCL:	200				1,000	300	50				5,000
	Aquatic Life Threshold:	87	150	formula		9	1,000			52	5	120
	Agrigulture Threshold	5,000				200	5,000	200			20	
NC 1	Thermolito Diversion	8	0.93	ND	ND	0.53	8	1.27	ND	0.43	ND	1.5
NC 2	Berry Cr./Lake Madrone	85	0.49	ND	ND	0.49	444	319	ND	0.19	ND	ND
NC 3	Pondo Dam/SF Feather	7	0.28	ND	ND	0.22	10.9	1.36	ND	0.5	ND	ND
NC 4	Fall River/Mill Road	10.8	0.24	ND	ND	ND	15.5	21.6	ND	0.16	ND	ND
NC 4U	Fall River/MillRd/Upstream	11.3	0.18	ND	ND	ND	11.5	20.3	ND	ND	ND	ND
NC 5	Milsap Bar											
NC 6	Lake Oroville/MF Feather											

Sample ID	Station Name	POLYCYCLIC AUROMATIC HYDROCARBONS (PAHs)																							
	Analyte:	**Sum PAHs**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a)pyrene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Carbazole**	**Chrysene**	**Dibenz(a,h)anthracene**	**Dinitrotoluene, 2,4<**	**Dinitrotoluene, 2,6<**	**Fluoranthene**	**Fluorene**	**indeno(1,2,3<c,d)pyrene**	**Isophorone**	**Methylnaphthalene, 2<**	**Naphthalene**	**Nitrobenzene**	**Phenanthrene**	**Pyrene**	**Sum LMW PAHs**	**Sum HMW PAHs**
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																		
	Human Health Threshold*:		70		300	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20														0.049			21					
	Aquatic Life Threshold:		52		110,000										370	14,000				62			11,000		
NC 1	Thermolito Diversion	**0.000**	ND	ND	ND	ND	ND	ND	ND		ND	ND			ND	ND	ND		ND	ND		ND	ND	0.00	0.00
NC 2	Berry Cr./Lake Madrone	**0.000**																						0.00	0.00
NC 3	Pondo Dam/SF Feather	**0.000**																						0.00	0.00
NC 4	Fall River/Mill Road	**0.000**																						0.00	0.00
NC 5	Milsap Bar	**0.000**																						0.00	0.00

NORTH COMPLEX WATER QUALITY MONITORING

PRELIMINARY RESULTS: 2/17/2021 Sampling Event

LEGEND

- **Result > Primary MCL**
- **Result > Secondary MCL**
- **Result > Bacteria Water Quality Objective**
- *Estimated Result (sample did not pass QAQC)*
- Pending or No Result

Sampling conducted by the Central Valley Water Board and analysis performed by Basic Laboratory
Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

NOTE: All results presented here are considered draft

Sample ID	Station Name	MINERALS & SOLIDS							BACTERIA		FIELD MEASUREMENTS				
	Analyte:	**Alkalinity**	**Hardness**	**Hardness**	**Sulfate**	**TDS**	**TSS**	**Settleable Solids**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 2340C	SM 2340C	EPA 300.0	SM 2540 C	SM 2540 D	SM 2540 F			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Dissolved	Total	Dissolved	Total	Particulate	Total	Total	Total					
	Primary MCL:														
	Secondary MCL:				250	500					900		6.5-8.5		5
	Bacteria Objective:								320						
	Aquatic Life Threshold:	20										>7.0	6.5-9		
	Agrigulture Threshold					450					700		6.5-8.4		
NC 1	Thermolito Diversion	47	42	44	2.85	58	ND	ND	<1	108	112.1	10.52	7.73	9.1	1.55
NC 2	Berry Cr./Lake Madrone	26	18	20	2.45	65	6	ND	18	1050	66.3	10.04	7.39	9.1	15.19
NC 3	Pondo Dam/SF Feather	24	24	26	2.59	47	ND	ND	2	105	65.2	12.38	7.63	7	2.26
NC 4	Fall River/Mill Road	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 4U	Fall River/MillRd/Upstream	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 5	Milsap Bar														
NC 6	Lake Oroville/MF Feather														

Sample ID	Station Name	NUTRIENTS											
	Analyte:	**Ammonia**	**Nitrate**	**Nitrite**	**Nitrate+Nitrite**	**TKN**	**TKN**	**Organic Nitrogen**	**Nitrogen**	**OrthoPhosphate**	**Phosphorus**	**Phosphorus**	**TOC**
	Method:	SM 4500	EPA 353.2					Calculated		SM 4500P E	SM 4500P E	SM 4500P E	EPA 415.3
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Total
	Primary MCL:		10	1	10								
	Secondary MCL:	1.5											
	Bacteria Objective:												
	Aquatic Life Threshold:	formula											
	Agrigulture Threshold												
NC 1	Thermolito Diversion	ND	0.04		0.04	ND	0.09	ND	0.13	ND	ND	ND	1.4
NC 2	Berry Cr./Lake Madrone	0.029	0.16		0.16	0.13	0.22	ND	0.411	0.008	ND	0.043	2.9
NC 3	Pondo Dam/SF Feather	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	1
NC 4	Fall River/Mill Road	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 4U	Fall River/MillRd/Upstream	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	N/a
NC 5	Milsap Bar												
NC 6	Lake Oroville/MF Feather												

Sample ID	Station Name	TOTAL METALS										
	Analyte:	**Aluminum**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	10	5	50	1,300			2	100	50	
	Secondary MCL:	200				1,000	300	50				5,000
	Aquatic Life Threshold:	87		formula			1,000		0.05			120
	Agrigulture Threshold	5,000	100	10		200	5,000	200		200	20	
NC 1	Thermolito Diversion	56.4	0.7	ND	0.27	0.64	79.3	6.3	ND	0.64	ND	ND
NC 2	Berry Cr./Lake Madrone	907	0.4	ND	0.55	0.68	569	115	ND	0.39	ND	1.7
NC 3	Pondo Dam/SF Feather	103	0.59	ND	0.41	0.26	98.8	15.2	ND	1.46	ND	ND
NC 4	Fall River/Mill Road	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 4U	Fall River/MillRd/Upstream	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 5	Milsap Bar											
NC 6	Lake Oroville/MF Feather											

Sample ID	Station Name	DISSOLVED METALS										
	Analyte:	**Aluminum**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	10	5	50	1,300			2	100	50	
	Secondary MCL:	200				1,000	300	50				5,000
	Aquatic Life Threshold:	87	150	formula		9	1,000			52	5	120
	Agrigulture Threshold	5,000				200	5,000	200			20	
NC 1	Thermolito Diversion	9	0.66	ND	ND	0.38	8.8	0.58	ND	0.46	ND	ND
NC 2	Berry Cr./Lake Madrone	144	0.33	ND	ND	0.26	162	97.9	ND	0.15	0.3	ND
NC 3	Pondo Dam/SF Feather	22.7	0.56	ND	0.27	0.23	22.9	2.83	ND	1.14	ND	ND
NC 4	Fall River/Mill Road	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 4U	Fall River/MillRd/Upstream	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 5	Milsap Bar											
NC 6	Lake Oroville/MF Feather											

Sample ID	Station Name	POLYCYCLIC AUROMATIC HYDROCARBONS (PAHs)																					
	Analyte:	**Sum PAHs**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a)pyrene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Carbazole**	**Chrysene**	**Dibenz(a,h)anthracene**	**Dinitrotoluene, 2,4<**	**Dinitrotoluene, 2,6<**	**Fluoranthene**	**Fluorene**	**indeno(1,2,3-c,d)pyrene**	**Isophorone**	**Methylnaphthalene, 2<**	**Naphthalene**	**Nitrobenzene**	**Phenanthrene**	**Pyrene**	**Sum LMW PAHs**	**Sum HMW PAHs**
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																		
	Human Health Threshold*:		70		300	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20														0.049			21					
	Aquatic Life Threshold:		52		110,000										370	14,000				62			11,000		
NC 1	Thermolito Diversion	**0.000**	ND	ND	ND	ND	ND	ND	ND		ND	ND			ND	ND	ND		ND	ND		ND	ND	0.00	0.00
NC 2	Berry Cr./Lake Madrone	**0.000**																						0.00	0.00
NC 3	Pondo Dam/SF Feather	**0.000**																						0.00	0.00
NC 4	Fall River/Mill Road	**0.000**																						0.00	0.00
NC 5	Milsap Bar	**0.000**																						0.00	0.00
NC 6	Lake Oroville/MF Feather	**0.000**																						0.00	0.00

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

NORTH COMPLEX WATER QUALITY MONITORING

PRELIMINARY RESULTS: 4/22/2021 Sampling Event

LEGEND
- **Result > Primary MCL**
- **Result > Secondary MCL**
- **Result > Bacteria Water Quality Objective**
- *Estimated Result (sample did not pass QAQC)*
- Pending or No Result

Sampling conducted by the Central Valley Water Board and analysis performed by Basic Laboratory
Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

NOTE: All results presented here are considered draft

Sample ID	Station Name	MINERALS & SOLIDS							BACTERIA		FIELD MEASUREMENTS				
	Analyte:	**Alkalinity**	**Hardness**	**Hardness**	**Sulfate**	**TDS**	**TSS**	**Settleable Solids**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 2340C	SM 2340C	EPA 300.0	SM 2540 C	SM 2540 D	SM 2540 F			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Dissolved	Total	Dissolved	Total	Particulate	Total	Total	Total					
	Primary MCL:														
	Secondary MCL:				250	500					900		6.5-8.5		5
	Bacteria Objective:								320						
	Aquatic Life Threshold:	20										>7.0	6.5-9		
	Agrigulture Threshold					450					700		6.5-8.4		
NC 1	Thermolito Diversion	52	45	46	3.09	63	ND	ND	3	980	117.3	10.33	7.86	14.6	n/a
NC 2	Berry Cr./Lake Madrone	26	15	15	1.23	55	ND	ND	<1	1050	60.4	10.32	7.2	15.9	n/a
NC 3	Pondo Dam/SF Feather	31	27	28	3.23	52	ND	ND	<1	326	77.8	9.83	7.71	16.2	n/a
NC 4	Fall River/Mill Road	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 4U	Fall River/MillRd/Upstream	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 5	Milsap Bar														
NC 6	Lake Oroville/MF Feather														
NC 7	Canyon Creek	66	64	66	14.7	99	ND	ND	3	649	171.9	9.61	7.27	13.9	n/a

Sample ID	Station Name	NUTRIENTS											
	Analyte:	**Ammonia**	**Nitrate**	**Nitrite**	**Nitrate+Nitrite**	**TKN**	**TKN**	**Organic Nitrogen**	**Nitrogen**	**OrthoPhosphate**	**Phosphorus**	**Phosphorus**	**TOC**
	Method:	SM 4500	EPA 353.2					Calculated		SM 4500P E	SM 4500P E	SM 4500P E	EPA 415.3
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Dissolved	Total	Total
	Primary MCL:		10	1	10								
	Secondary MCL:	1.5											
	Bacteria Objective:												
	Aquatic Life Threshold:	formula											
	Agrigulture Threshold												
NC 1	Thermolito Diversion	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	1.2
NC 2	Berry Cr./Lake Madrone	ND	0.27		ND	0.09	0.11	ND	0.106	ND	ND	0.145	1.5
NC 3	Pondo Dam/SF Feather	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	0.7
NC 4	Fall River/Mill Road	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 4U	Fall River/MillRd/Upstream	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	N/a
NC 5	Milsap Bar												
NC 6	Lake Oroville/MF Feather												
NC 7	Canyon Creek	ND	ND		ND	0.09	ND	ND	ND	ND	ND	ND	0.08

Sample ID	Station Name	TOTAL METALS										
	Analyte:	**Aluminum**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	10	5	50	1,300			2	100	50	
	Secondary MCL:	200				1,000	300	50				5,000
	Aquatic Life Threshold:	87		formula			1,000		0.05			120
	Agrigulture Threshold	5,000	100	10		200	5,000	200		200	20	
NC 1	Thermolito Diversion	29.2	0.66	ND	0.22	0.65	44.1	4.51	ND	0.52	ND	ND
NC 2	Berry Cr./Lake Madrone	98	0.41	ND	0.1	0.28	282	73	ND	ND	ND	ND
NC 3	Pondo Dam/SF Feather	12.6	0.76	ND	0.27	0.27	34	14.9	ND	1.08	ND	ND
NC 4	Fall River/Mill Road	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 4U	Fall River/MillRd/Upstream	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 5	Milsap Bar											
NC 6	Lake Oroville/MF Feather											
NC 7	Canyon Creek	15.4	0.1	ND	0.1	0.74	133	47.1	ND	0.44	ND	2.3

Sample ID	Station Name	DISSOLVED METALS										
	Analyte:	**Aluminum**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	10	5	50	1,300			2	100	50	
	Secondary MCL:	200				1,000	300	50				5,000
	Aquatic Life Threshold:	87	150	formula		9	1,000			52	5	120
	Agrigulture Threshold	5,000				200	5,000	200			20	
NC 1	Thermolito Diversion	6.8	0.61	ND	0.17	0.55	10.6	0.52	ND	0.44	ND	ND
NC 2	Berry Cr./Lake Madrone	41.6	0.39	ND	0.06	0.24	176	59.2	0.04	ND	ND	ND
NC 3	Pondo Dam/SF Feather	5.5	0.73	ND	0.24	0.24	11.6	0.26	ND	0.9	ND	ND
NC 4	Fall River/Mill Road	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 4U	Fall River/MillRd/Upstream	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NC 5	Milsap Bar											
NC 6	Lake Oroville/MF Feather											
NC 7	Canyon Creek	5.3	0.11	ND	0.07	0.63	86.3	44.7	ND	0.4	ND	ND

Sample ID	Station Name	POLYCYCLIC AUROMATIC HYDROCARBONS (PAHs)																							
	Analyte:	**Sum PAHs**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a)pyrene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Carbazole**	**Chrysene**	**Dibenz(a,h)anthracene**	**Dinitrotoluene, 2,4<**	**Dinitrotoluene, 2,6<**	**Fluoranthene**	**Fluorene**	**indeno(1,2,3<c,d)pyrene**	**Isophorone**	**Methylnaphthalene, 2<**	**Naphthalene**	**Nitrobenzene**	**Phenanthrene**	**Pyrene**	**Sum LMW PAHs**	**Sum HMW PAHs**
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																		
	Human Health Threshold*:		70		300	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20														0.049			21					
	Aquatic Life Threshold:		52		110,000										370	14,000				62			11,000		
NC 1	Thermolito Diversion	**0.000**	ND	ND	ND	ND	ND	ND	ND		ND	ND			ND	ND	ND		ND	ND		ND	ND	0.00	0.00
NC 2	Berry Cr./Lake Madrone	**0.000**																						0.00	0.00
NC 3	Pondo Dam/SF Feather	**0.000**																						0.00	0.00
NC 4	Fall River/Mill Road	**0.000**																						0.00	0.00
NC 5	Milsap Bar	**0.000**																						0.00	0.00
NC 6	Lake Oroville/MF Feather	**0.000**																						0.00	0.00

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

CARR POST-FIRE WATER QUALITY MONITORING RESULT

ANALYTE	**Primary MCL***	**Secondary MCL****	**Aquatic Life Threshold*****	**Lab Rpt Limit**	**SW1 - Lewiston Lake**					
					9/24/2018	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
General Chemistry										
Hardness as CaCO3 (mg/L)				5	38	40	40	40	42	44
Alkalinity as CaCO3 (mg/L)			20	5	**42**	**40**	**43**	**42**	**45**	**43**
Bicarbonate (mg/L)				5	51	49	52	51	55	52
Carbonate (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	***0.02***
Nitrite as N (mg/L)	1			0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Sulfate as SO4 (mg/L)		250		0.50	1.18	1.16	1.24	1.21	1.84	1.23
Specific Conductance (umhos/cm)				10	85	84	89	87	99	90
Total Dissolved Solids (mg/L)		500	500	6	49	48	49	53	69	58
Total Suspended Solids (mg/L)				6.0	< 6.0	< 6.0	< 6.0	< 6.0	< 6.0	< 6.0
Settleable Solids (mL/L/hr)				0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Kjeldahl Nitrogen (mg/L)	10			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Orthophosphate as P (mg/L)				0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Total Organic Carbon (mg/L)				0.5	1.6	1.5	1.1	1.2	1.4	1.5
Turbidity (NTU)	0.0	5.0		0.5	***0.4***	**0.9**	**1.1**	**0.6**	**1.4**	**3.2**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	5.0	17.5	60.0	12.1	38.1	**87.6**
Arsenic	10.00			0.50/2.5/5	< 0.5	***0.20***	***0.24***	***0.22***	***0.36***	***0.25***
Cadmium	5			0.20/1/2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50/2.5/5	0.56	0.57	0.64	0.53	0.55	0.85
Copper	1300.00	1000.00		0.50/2.5/5	***0.30***	***0.33***	***0.45***	***0.23***	***0.44***	***0.46***
Iron		300.0	1000.0	15.0/75/150	27.7	72.9	129	65.9	64.0	115.0
Lead	15			0.50/2.5/5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50/2.5/5	2.33	5.75	6.30	3.99	6.75	6.14
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	< 0.20	< 0.20	**< 0.20**	**< 0.20**
Nickel	100			0.50/2.5/5	4.10	4.07	4.37	4.02	3.32	5.09
Selenium	50.0		5.0	2.0/10/20	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Zinc		5000.0	120.0	2.0/10/20	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	***0.5***
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	***2.0***	***1.7***	***4.8***	***3.0***	15.4	5.4
Arsenic	10		150	0.50	< 0.5	***0.21***	***0.22***	***0.21***	***0.33***	***0.21***
Cadmium	5			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	0.57	0.51	0.50	***0.47***	***0.45***	0.60
Copper	1300	1000	9	0.50	***0.30***	***0.31***	***0.27***	***0.21***	***0.39***	***0.17***
Iron		300.0	1000.0	15.0	***11.5***	30.4	33.5	25.9	21.9	25.7
Lead	15		2.5	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	1.02	4.06	3.86	1.92	3.22	2.81
Mercury	2			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	3.86	4.14	4.02	3.84	3.17	4.58
Selenium	50.0		5.0	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Zinc		5000	120	2.0	***0.60***	***1.1***	< 2	< 2	***0.5***	< 2
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**9/24/2018**	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					8.17	7.68	7.19	6.91	6.39	8.66
Specific Conductance					86.9	86.8	87.6	97.4	122.2	89.8
Dissolved Oxygen					10.62	9.68	9.74	8.53	10.12	10.04
Temperature					14.8	8.7	7.9	6.8	11.6	5.6
Turbidity	1	5			0.11	0.00	0.14	0.00	**3.08**	**3.83**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW2 - Upper Clear Creek					
					9/24/2018	11/28/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry										
Hardness as CaCO3 (mg/L)				5	64	66	43	35	23	36
Alkalinity as CaCO3 (mg/L)			20	5	**56**	**49**	**35**	**29**	**24**	**31**
Bicarbonate (mg/L)				5	69	60	43	35	30	38
Carbonate (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	***0.03***	***0.02***	0.41	0.46	0.22	0.55
Nitrite as N (mg/L)	1			0.010	***0.004***	< 0.010	***0.003***	< 0.010	< 0.010	***0.00***
Sulfate as SO4 (mg/L)		250		0.50	13.2	21.5	11.5	7.90	4.82	7.92
Specific Conductance (umhos/cm)				10	219	178	112	85	64	106
Total Dissolved Solids (mg/L)		500	500	6	131	125	73	65	56	77
Total Suspended Solids (mg/L)				6.0	< 6.0	15.6	33.4	156	11.8	67.6
Settleable Solids (mL/L/hr)				0.1	< 0.1	< 0.1	0.1	0.6	0.1	0.20
Total Kjeldahl Nitrogen (mg/L)	10			0.20	< 0.20	0.35	0.25	0.83	< 0.20	0.34
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	< 0.050	0.158	0.138	0.306	***0.044***	0.114
Orthophosphate as P (mg/L)				0.010	0.017	0.059	0.047	0.059	0.030	0.031
Total Organic Carbon (mg/L)				0.5	1.4	5.7	3.7	3.4	1.2	1.9
Turbidity (NTU)	0.0	5.0		0.5	**0.9**	**17.7**	**16.7**	**64.3**	**10.6**	**25.6**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	7.1	**700**	**1210**	**5420**	**415**	**1870.0**
Arsenic	10.00			0.50/2.5/5	3.14	***2.38***	1.68	***3.55***	1.23	2.31
Cadmium	5			0.20/1/2	< 0.20	< 1	***0.11***	< 2	< 0.20	***0.14***
Chromium	50			0.50/2.5/5	< 0.50	***0.85***	1.93	9.73	0.87	3.15
Copper	1300.00	1000.00		0.50/2.5/5	1.41	3.87	3.22	13.8	2.90	6.33
Iron		300.0	1000.0	15.0/75/150	92.2	**705**	**1040**	**6030**	**551**	**1990.0**
Lead	15			0.50/2.5/5	< 0.50	***0.72***	0.81	***3.52***	0.33	0.93
Manganese		50		0.50/2.5/5	8.22	**50.2**	48.8	**211**	12.6	**59.60**
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	**< 0.20**
Nickel	100			0.50/2.5/5	0.50	3.15	2.69	10.7	1.56	2.97
Selenium	50.0		5.0	2.0/10/20	< 2.0	< 10	***0.5***	< 20	0.4	***0.5***
Zinc		5000.0	120.0	2.0/10/20	2.2	14.9	9.3	45.0	7.5	15.6
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	***2.7***	40.2	52.6	86.4	37.7	52.9
Arsenic	10		150	0.50	3.07	2.05	1.27	1.15	1.15	1.22
Cadmium	5			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	< 0.50	< 0.50	***0.13***	***0.16***	**< 0.50**	< 0.50
Copper	1300	1000	9	0.50	1.12	1.89	1.37	1.29	1.50	1.14
Iron		300.0	1000.0	15.0	62.6	78.4	45.8	71.4	34.3	53.4
Lead	15		2.5	0.50	< 0.50	***0.09***	< 0.50	< 0.50	< 0.50	***0.39***
Manganese		50		0.50	6.92	15.1	10.8	9.24	2.69	10.30
Mercury	2			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	***0.44***	1.80	1.32	1.06	0.71	0.62
Selenium	50.0		5.0	2.0	< 2.0	***0.5***	***0.5***	< 2.0	***0.6***	< 2.0
Zinc		5000	120	2.0	2.40	3.5	2.3	***1.9***	3.4	3.1
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**9/24/2018**	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					7.85	7.72	7.61	7.24	7.39	7.74
Specific Conductance					224.7	179.2	109.9	83.3	67.2	106.9
Dissolved Oxygen					9.41	10.69	11.33	11.16	11.52	12.37
Temperature					16.1	8.8	7.5	8.2	7.9	4.2
Turbidity	1	5			0.18	**15.9**	**14.92**	**69.0**	**6.41**	**40**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW3 - Whiskeytown Lake Oak Bottom Campground					
					9/24/2018	11/28/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry										
Hardness as CaCO3 (mg/L)				5	40	39	41	38	25	36
Alkalinity as CaCO3 (mg/L)			20	5	**43**	**43**	**43**	**40**	**26**	**33**
Bicarbonate (mg/L)				5	52	52	52	49	31	41
Carbonate (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	< 0.05	< 0.05	< 0.05	0.12	0.11	0.15
Nitrite as N (mg/L)	1			0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	***0.01***
Sulfate as SO4 (mg/L)		250		0.50	2.18	2.16	2.50	3.73	4.78	2.76
Specific Conductance (umhos/cm)				10	94	94	98	98	68	81
Total Dissolved Solids (mg/L)		500	500	6	59	52	56	58	54	62
Total Suspended Solids (mg/L)				6.0	< 6.0	< 6.0	***3.6***	9.2	***3.2***	9.6
Settleable Solids (mL/L/hr)				0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Kjeldahl Nitrogen (mg/L)	10			0.20	***0.12***	< 0.20	< 0.20	***0.16***	< 0.20	0.29
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	< 0.050	***0.024***	***0.030***	***0.041***	***0.032***	***0.036***
Orthophosphate as P (mg/L)				0.010	< 0.010	< 0.010	0.011	***0.006***	0.025	< 0.010
Total Organic Carbon (mg/L)				0.5	1.9	1.4	1.4	1.8	1.1	2.6
Turbidity (NTU)	0.0	5.0		0.5	**0.7**	**1.3**	**2.7**	**7.2**	**5.5**	**3.9**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	8.0	32.0	**143**	**421**	**166**	**246**
Arsenic	10.00			0.50/2.5/5	0.50	***0.48***	0.58	< 2.5	1.21	0.66
Cadmium	5			0.20/1/2	< 0.20	< 0.20	< 0.20	< 1	< 0.20	< 0.20
Chromium	50			0.50/2.5/5	***0.33***	***0.35***	0.50	***0.94***	0.38	0.82
Copper	1300.00	1000.00		0.50/2.5/5	0.52	0.54	0.67	***1.11***	2.12	1.86
Iron		300.0	1000.0	15.0/75/150	33.0	57.8	139	**547**	227	**649**
Lead	15			0.50/2.5/5	< 0.50	< 0.50	***0.11***	< 2.5	0.11	0.27
Manganese		50		0.50/2.5/5	3.25	7.31	24.7	45.8	19.0	**72.6**
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100			0.50/2.5/5	1.88	1.88	1.95	***2.15***	0.98	2.24
Selenium	50.0		5.0	2.0/10/20	< 2.0	< 2.0	< 2.0	< 10	0.4	< 2.0
Zinc		5000.0	120.0	2.0/10/20	***0.7***	***0.8***	***1.4***	***2.7***	4.6	88.3
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	***1.9***	5.1	22.1	25.2	30.9	38.7
Arsenic	10		150	0.50	0.50	***0.41***	0.52	0.54	1.24	0.54
Cadmium	5			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	***0.37***	***0.30***	***0.32***	***0.23***	< 0.50	***0.31***
Copper	1300	1000	9	0.50	***0.48***	0.51	***0.45***	0.59	1.25	0.86
Iron		300.0	1000.0	15.0	***10.9***	20.9	25.6	92.2	30.6	**345.0**
Lead	15		2.5	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	0.71	5.00	13.8	32.6	13.9	**63.0**
Mercury	2			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	1.74	1.88	1.63	1.54	0.68	1.62
Selenium	50.0		5.0	2.0	< 2.0	< 2.0	< 2.0	< 2.0	***0.5***	< 2.0
Zinc		5000	120	2.0	2.40	***0.7***	***0.7***	***1.70***	2.3	2.1
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**9/24/2018**	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					8.13	7.96	7.49	7.17	7.46	7.73
Specific Conductance					95.4	103.9	98.6	100.5	70.4	88.3
Dissolved Oxygen					9.21	9.17	9.64	10.14	10.68	10.61
Temperature					18.9	11.9	9.2	8.5	9.7	6.7
Turbidity	1	5			0.14	**1.01**	**1.62**	**11.4**	**4.04**	**23.16**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW4 - Whiskey Creek						
					9/24/2018	11/28/2018	11/29/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry											
Hardness as CaCO3 (mg/L)				5	68	81	N/A	50	46	28	40
Alkalinity as CaCO3 (mg/L)			20	5	**60**	**61**	N/A	**42**	**31**	**28**	**32**
Bicarbonate (mg/L)				5	73	74	N/A	52	38	34	39
Carbonate (mg/L)				5	< 5	< 5	N/A	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	N/A	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	< 0.05	0.05	N/A	0.49	0.74	0.30	1.39
Nitrite as N (mg/L)	1			0.010	< 0.010	< 0.010	N/A	***0.003***	***0.003***	***0.005***	***0.003***
Sulfate as SO4 (mg/L)		250		0.50	19.50	28.2	N/A	15.3	9.01	7.91	10.50
Specific Conductance (umhos/cm)				10	166	194	N/A	133	95	80	104
Total Dissolved Solids (mg/L)		500	500	6	109	121	N/A	79	68	66	78
Total Suspended Solids (mg/L)				6.0	< 6.0	< 6.0	N/A	***3.2***	252	11.2	7.0
Settleable Solids (mL/L/hr)				0.1	< 0.1	< 0.1	N/A	< 0.1	1.4	< 0.1	< 0.1
Total Kjeldahl Nitrogen (mg/L)	10			0.20	< 0.20	***0.14***	N/A	0.20	2.14	0.20	0.30
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	N/A	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	< 0.050	0.055	N/A	***0.040***	0.485	***0.042***	***0.034***
Orthophosphate as P (mg/L)				0.010	0.019	0.025	N/A	0.043	0.059	0.023	0.018
Total Organic Carbon (mg/L)				0.5	0.8	3.1	N/A	2.2	4.4	0.7	2.7
Turbidity (NTU)	0.0	5.0		0.5	**0.7**	**0.8**	N/A	**2.6**	**132**	**7.8**	**6.7**
Total Metals (ug/L)											
Aluminum	1000.0	200.0	87.0	5.0/25/50	17.2	13.0	N/A	**103**	**6300**	**409**	**325**
Arsenic	10.00			0.50/2.5/5	1.24	1.39	N/A	1.09	7.18	0.89	0.93
Cadmium	5			0.20/1/2	< 0.20	< 0.20	N/A	***0.09***	2.63	0.14	0.12
Chromium	50			0.50/2.5/5	< 0.50	< 0.50	N/A	***0.24***	10.7	1.06	0.61
Copper	1300.00	1000.00		0.50/2.5/5	***0.43***	0.87	N/A	1.19	20.0	1.13	1.55
Iron		300.0	1000.0	15.0/75/150	88.4	188	N/A	151	**7370**	**565**	**375**
Lead	15			0.50/2.5/5	< 0.50	< 0.50	N/A	***0.21***	6.81	0.28	0.22
Manganese		50		0.50/2.5/5	9.56	17.0	N/A	10.9	**415**	17.9	14.5
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	N/A	< 0.20	***0.11***	< 0.20	< 0.20
Nickel	100			0.50/2.5/5	0.55	1.29	N/A	1.39	***20.5***	1.55	1.59
Selenium	50.0		5.0	2.0/10/20	***0.3***	***0.4***	N/A	***0.5***	< 20	0.6	0.6
Zinc		5000.0	120.0	2.0/10/20	3.6	4.3	N/A	5.1	**138**	10.2	8.7
Total Metals - Dissolved (ug/L)											
Aluminum	1000.0	200.0	87.0	5.0	< 5.0	***4.1***	N/A	16.6	67.2	23.6	53.0
Arsenic	10		150	0.50	1.21	1.27	N/A	0.97	1.04	0.65	0.70
Cadmium	5			0.20	< 0.20	< 0.20	N/A	< 0.20	< 0.20	***0.08***	***0.08***
Chromium	50			0.50	< 0.50	< 0.50	N/A	< 0.50	***0.19***	< 0.50	***0.14***
Copper	1300	1000	9	0.50	***0.37***	0.79	N/A	0.91	1.05	***0.39***	0.80
Iron		300.0	1000.0	15.0	63.1	141	N/A	29.2	65.5	17.6	44.1
Lead	15		2.5	0.50	< 0.50	< 0.50	N/A	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	7.27	14.8	N/A	5.17	6.22	2.89	3.89
Mercury	2			0.20	< 0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	***0.48***	1.36	N/A	1.10	1.21	0.85	0.87
Selenium	50.0		5.0	2.0	< 2.0	***0.5***	N/A	***0.6***	< 2.0	***0.6***	***0.6***
Zinc		5000	120	2.0	2.7	3.7	N/A	3.0	3.5	5.4	4.2
Polycyclic Aromatic Hydrocarbons (ug/L)											
1-Methylnaphthalene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Field Measurements											
Sampling Dates					**9/24/2018**	**11/28/2018**	**11/29/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					7.88	7.37	7.54	7.45	7.57	7.40	7.49
Specific Conductance					168.7	195.1	155.7	130.8	92.1	81.1	104.8
Dissolved Oxygen					9.74	9.52	10.24	10.68	10.60	10.69	11.56
Temperature					14.8	10.3	10.72	9.6	10.1	10.9	6.9
Turbidity	1	5			0.03	0.60	**115.46**	**2.18**	**133.0**	**5.81**	**6.13**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW5 - Whiskeytown Lake East Beach					
					9/24/2018	11/28/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry										
Hardness as CaCO3 (mg/L)				5	38	38	42	32	26	39
Alkalinity as CaCO3 (mg/L)			20	5	**43**	**42**	**43**	**38**	**28**	**36**
Bicarbonate (mg/L)				5	53	52	52	46	34	44
Carbonate (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	< 0.05	< 0.05	< 0.05	0.08	0.12	0.12
Nitrite as N (mg/L)	1			0.010	< 0.010	< 0.010	< 0.010	***0.004***	< 0.010	***0.01***
Sulfate as SO4 (mg/L)		250		0.50	2.33	1.88	2.28	3.05	3.63	2.78
Specific Conductance (umhos/cm)				10	94	91	98	87	70	84
Total Dissolved Solids (mg/L)		500	500	6	59	52	50	58	56	57
Total Suspended Solids (mg/L)				6.0	< 6.0	19.6	< 6.0	< 6.0	46.0	***3.6***
Settleable Solids (mL/L/hr)				0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	< 0.1
Total Kjeldahl Nitrogen (mg/L)	10			0.20	< 0.20	***0.15***	< 0.20	< 0.20	0.20	< 0.20
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	< 0.050	***0.029***	***0.037***	***0.027***	***0.046***	< 0.050
Orthophosphate as P (mg/L)				0.010	< 0.01	< 0.01	0.010	***0.009***	0.011	< 0.01
Total Organic Carbon (mg/L)				0.5	1.9	1.3	1.3	2.0	1.3	1.5
Turbidity (NTU)	0.0	5.0		0.5	**0.5**	**4.8**	**1.0**	**2.4**	**15.4**	**3.4**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	9.4	43.5	56.1	**103**	**801**	**147**
Arsenic	10.00			0.50/2.5/5	***0.49***	***0.47***	0.51	< 2.5	0.98	0.50
Cadmium	5			0.20/1/2	< 0.20	< 0.20	< 0.20	< 1	< 0.20	< 0.20
Chromium	50			0.50/2.5/5	***0.34***	***0.37***	***0.33***	< 2.5	1.20	0.42
Copper	1300.00	1000.00		0.50/2.5/5	0.55	0.55	***0.49***	***1.16***	3.23	0.82
Iron		300.0	1000.0	15.0/75/150	22.8	64.8	31.6	126	**940**	190
Lead	15			0.50/2.5/5	< 0.50	< 0.50	< 0.50	< 2.5	0.62	0.09
Manganese		50		0.50/2.5/5	2.22	7.00	5.17	8.14	26.3	9.5
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100			0.50/2.5/5	1.75	1.84	1.47	***1.02***	1.58	1.26
Selenium	50.0		5.0	2.0/10/20	< 2.0	< 2.0	< 2.0	< 10	< 2.0	< 2.0
Zinc		5000.0	120.0	2.0/10/20	6.6	***0.6***	***0.6***	< 10	4.9	0.9
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	< 5.0	5.8	20.6	29.5	54.5	22.9
Arsenic	10		150	0.50	***0.44***	0.56	***0.48***	***0.39***	0.84	***0.44***
Cadmium	5			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	***0.33***	***0.33***	***0.28***	***0.18***	***0.20***	***0.25***
Copper	1300	1000	9	0.50	***0.46***	***0.45***	***0.40***	1.03	0.71	***0.39***
Iron		300.0	1000.0	15.0	< 15	< 15	***8.2***	35.0	43.3	18.2
Lead	15		2.5	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	***0.28***	1.25	1.04	4.48	3.45	3.03
Mercury	2			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	1.57	1.67	1.35	0.93	0.88	0.89
Selenium	50.0		5.0	2.0	< 2.0	< 2.0	< 2.0	< 2.0	***0.4***	***0.3***
Zinc		5000	120	2.0	2.8	< 2.0	< 2.0	< 2.0	***0.6***	***0.7***
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**9/24/2018**	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					8.11	7.56	7.62	7.21	7.60	7.80
Specific Conductance					95.3	92.6	96.0	90.1	71.6	85.0
Dissolved Oxygen					9.05	9.31	9.45	10.16	11.29	11.30
Temperature					18.8	13.0	11.0	9.6	9.9	7.3
Turbidity	1	5			0.50	0.72	0.52	0.99	**7.30**	**2.00**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW6 - Clear Creek Peltier Valley Road Bridge					
					9/24/2018	11/28/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry										
Hardness as CaCO3 (mg/L)				5	38	42	42	39	30	41
Alkalinity as CaCO3 (mg/L)			20	5	**41**	**44**	**43**	**45**	**30**	**39**
Bicarbonate (mg/L)				5	50	54	53	55	36	48
Carbonate (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	0.05	***0.03***	***0.04***	0.42	0.18	0.15
Nitrite as N (mg/L)	1			0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	***0.01***
Sulfate as SO4 (mg/L)		250		0.50	2.36	3.09	2.57	3.79	3.63	2.96
Specific Conductance (umhos/cm)				10	90	100	100	105	75	90
Total Dissolved Solids (mg/L)		500	500	6	57	59	49	65	58	59
Total Suspended Solids (mg/L)				6.0	< 6.0	< 6.0	< 6.0	< 6.0	***2.6***	< 6.0
Settleable Solids (mL/L/hr)				0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Kjeldahl Nitrogen (mg/L)	10			0.20	< 0.20	***0.16***	< 0.20	< 0.20	< 0.20	< 0.20
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	< 0.050	***0.029***	***0.037***	***0.025***	***0.037***	< 0.050
Orthophosphate as P (mg/L)				0.010	< 0.01	< 0.01	0.012	0.021	0.018	< 0.01
Total Organic Carbon (mg/L)				0.5	1.2	1.6	1.4	1.4	1.3	1.5
Turbidity (NTU)	0.0	5.0		0.5	**0.9**	**1.6**	**1.1**	**1.2**	**8.3**	**1.1**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	8.5	67.4	65.0	52.2	**220**	52
Arsenic	10.00			0.50/2.5/5	***0.47***	0.61	0.53	0.52	0.77	0.55
Cadmium	5			0.20/1/2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50/2.5/5	***0.38***	***0.39***	***0.36***	***0.33***	0.57	0.38
Copper	1300.00	1000.00		0.50/2.5/5	0.58	0.70	0.54	0.53	1.20	0.67
Iron		300.0	1000.0	15.0/75/150	35.5	84.0	60.2	71.0	289	76
Lead	15			0.50/2.5/5	< 0.50	***0.10***	***0.08***	< 0.50	0.17	< 0.50
Manganese		50		0.50/2.5/5	16.4	12.2	12.6	13.5	9.68	15.70
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100			0.50/2.5/5	2.30	2.08	1.62	1.54	1.13	1.53
Selenium	50.0		5.0	2.0/10/20	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Zinc		5000.0	120.0	2.0/10/20	***1.5***	***0.8***	***0.8***	< 2.0	2.2	0.6
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	< 5.0	10.6	16.9	15.6	51.5	12.7
Arsenic	10		150	0.50	***0.40***	0.56	***0.48***	0.52	0.76	***0.49***
Cadmium	5			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	***0.39***	***0.31***	***0.29***	***0.27***	***0.22***	***0.28***
Copper	1300	1000	9	0.50	***0.49***	0.54	***0.42***	***0.45***	0.67	***0.43***
Iron		300.0	1000.0	15.0	< 15	24.9	16.3	19.5	41.0	23.0
Lead	15		2.5	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	1.22	5.34	6.91	7.54	2.79	8.15
Mercury	2			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	1.79	1.84	1.51	1.32	0.76	1.27
Selenium	50.0		5.0	2.0	< 2.0	< 2.0	< 2.0	< 2.0	***0.3***	< 2.0
Zinc		5000	120	2.0	< 2.0	***0.5***	< 2.0	< 2.0	***1.3***	< 2.0
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	***0.011***
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**9/24/2018**	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					7.44	7.45	7.60	7.38	7.45	7.75
Specific Conductance					90.2	99.6	97.4	97.2	76.6	91.2
Dissolved Oxygen					10.38	10.15	10.53	10.75	11.43	11.44
Temperature					11.1	11.5	10.4	8.9	8.5	7.8
Turbidity	1	5			0.22	**1.30**	0.69	0.56	**4.21**	0.22

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW7 - Rock Creek					
					11/28/2018	11/29/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry										
Hardness as CaCO3 (mg/L)				5	89	N/A	44	30	24	25
Alkalinity as CaCO3 (mg/L)			20	5	**66**	N/A	**38**	**27**	**27**	**23**
Bicarbonate (mg/L)				5	80	N/A	46	33	33	28
Carbonate (mg/L)				5	< 5	N/A	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	N/A	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	0.96	N/A	1.05	0.78	0.37	0.68
Nitrite as N (mg/L)	1			0.010	***0.006***	N/A	***0.004***	< 0.010	< 0.010	***0.01***
Sulfate as SO4 (mg/L)		250		0.50	20.2	N/A	11.7	6.95	5.51	5.81
Specific Conductance (umhos/cm)				10	285	N/A	137	87	78	75
Total Dissolved Solids (mg/L)		500	500	6	166	N/A	86	69	66	71
Total Suspended Solids (mg/L)				6.0	< 6.0	N/A	< 6.0	7.6	***2.0***	64.7
Settleable Solids (mL/L/hr)				0.1	< 0.1	N/A	< 0.1	< 0.1	< 0.1	0.10
Total Kjeldahl Nitrogen (mg/L)	10			0.20	0.34	N/A	0.27	***0.18***	< 0.20	0.48
Ammonia as N (mg/L)		1.5		0.050	< 0.050	N/A	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	0.064	N/A	< 0.050	***0.038***	< 0.050	0.074
Orthophosphate as P (mg/L)				0.010	0.021	N/A	0.014	0.015	***0.006***	***0.011***
Total Organic Carbon (mg/L)				0.5	5.4	N/A	3.7	3.1	1.5	4.3
Turbidity (NTU)	0.0	5.0		0.5	**2.2**	N/A	**2.8**	**5.8**	**2.2**	**48.6**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	83.3	N/A	**124**	**364**	**140**	**2010**
Arsenic	10.00			0.50/2.5/5	< 2.5	N/A	***0.43***	< 2.5	0.25	0.69
Cadmium	5			0.20/1/2	< 1	N/A	< 0.20	< 1	< 0.20	< 1
Chromium	50			0.50/2.5/5	< 2.5	N/A	***0.14***	< 2.5	**< 0.50**	***1.51***
Copper	1300.00	1000.00		0.50/2.5/5	4.26	N/A	3.88	3.70	2.62	7.61
Iron		300.0	1000.0	15.0/75/150	116	N/A	138	**354**	120	**2040**
Lead	15			0.50/2.5/5	< 2.5	N/A	***0.15***	***0.36***	0.09	1.15
Manganese		50		0.50/2.5/5	11.80	N/A	8.05	13.2	6.35	**71.00**
Mercury	2		0.05	0.20/0.50	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.50
Nickel	100			0.50/2.5/5	< 2.5	N/A	***0.32***	< 2.5	0.29	1.14
Selenium	50.0		5.0	2.0/10/20	< 10	N/A	< 2.0	< 10	< 2.0	< 10
Zinc		5000.0	120.0	2.0/10/20	***2.9***	N/A	3.1	***5.9***	7.8	16.1
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	27.9	N/A	23.2	58.4	51.0	**185.0**
Arsenic	10		150	0.50	0.60	N/A	***0.40***	***0.34***	***0.25***	***0.30***
Cadmium	5			0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	< 0.50	N/A	< 0.50	< 0.50	< 0.50	< 0.50
Copper	1300	1000	9	0.50	3.75	N/A	3.49	2.74	2.18	3.11
Iron		300.0	1000.0	15.0	59.2	N/A	25.9	39.5	26.4	123.0
Lead	15		2.5	0.50	< 0.50	N/A	< 0.50	< 0.50	< 0.50	***0.07***
Manganese		50		0.50	8.24	N/A	4.52	3.05	4.03	9.64
Mercury	2			0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	***0.31***	N/A	***0.26***	***0.23***	***0.26***	***0.21***
Selenium	50.0		5.0	2.0	***0.3***	N/A	< 2.0	< 2.0	< 2.0	< 2.0
Zinc		5000	120	2.0	***1.9***	N/A	2.8	2.9	6.9	4.5
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					11/28/2018	11/29/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
pH					7.81	7.74	7.45	7.64	7.40	7.46
Specific Conductance					283.4	109.9	134.0	88.6	78.0	77.7
Dissolved Oxygen					10.27	10.76	11.10	10.94	10.90	11.97
Temperature					12.3	10.94	9.6	10.2	10.9	7.0
Turbidity	1	5			**1.60**	**201.61**	**2.55**	**6.08**	**1.42**	**104.58**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW8 - Keswick Boat Ramp					
					9/25/2018	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
General Chemistry										
Hardness as CaCO3 (mg/L)				5	47	48	48	46	42	46
Alkalinity as CaCO3 (mg/L)			20	5	**57**	**61**	**63**	**57**	**50**	**53**
Bicarbonate (mg/L)				5	69	74	77	69	61	64
Carbonate (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	0.08	0.12	0.09	0.11	0.11	0.11
Nitrite as N (mg/L)	1			0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Sulfate as SO4 (mg/L)		250		0.50	3.17	3.48	3.14	4.74	3.98	3.28
Specific Conductance (umhos/cm)				10	124	135	142	131	119	123
Total Dissolved Solids (mg/L)		500	500	6	80	84	91	103	82	83
Total Suspended Solids (mg/L)				6.0	< 6.0	< 6.0	< 6.0	< 6.0	< 6.0	< 6.0
Settleable Solids (mL/L/hr)				0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Kjeldahl Nitrogen (mg/L)	10			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	< 0.050	***0.044***	< 0.050	***0.031***	< 0.050	< 0.050
Orthophosphate as P (mg/L)				0.010	0.025	0.021	0.020	0.017	0.016	0.020
Total Organic Carbon (mg/L)				0.5	1.2	0.9	0.7	0.9	1.1	1.2
Turbidity (NTU)	0.0	5.0		0.5	**2.1**	**1.6**	**1.2**	**2.1**	**4.1**	**2.0**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	**92.3**	55.7	38.5	60.5	**197**	85
Arsenic	10.00			0.50/2.5/5	1.64	1.83	2.26	2.00	1.59	1.74
Cadmium	5			0.20/1/2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50/2.5/5	0.57	***0.40***	***0.45***	***0.39***	0.60	0.49
Copper	1300.00	1000.00		0.50/2.5/5	1.66	1.09	1.08	2.48	3.40	2.37
Iron		300.0	1000.0	15.0/75/150	135.0	65.6	45.3	84.6	219	89
Lead	15			0.50/2.5/5	***0.16***	***0.32***	< 0.50	***0.14***	0.10	< 0.50
Manganese		50		0.50/2.5/5	5.82	5.72	5.33	6.60	7.15	3.56
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100			0.50/2.5/5	1.10	0.58	***0.32***	***0.37***	1.17	0.86
Selenium	50.0		5.0	2.0/10/20	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Zinc		5000.0	120.0	2.0/10/20	3.5	2.5	***1.4***	4.6	6.3	3.4
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	24.4	10.8	5.8	14.0	30.0	18.5
Arsenic	10		150	0.50	1.45	1.94	2.28	1.93	1.55	1.72
Cadmium	5			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	***0.45***	***0.35***	***0.40***	***0.33***	***0.34***	***0.40***
Copper	1300	1000	9	0.50	0.88	0.87	0.84	1.57	2.32	1.60
Iron		300.0	1000.0	15.0	29.8	***13.3***	< 15	***14.0***	26.7	***13.6***
Lead	15		2.5	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	3.15	2.16	1.31	2.85	3.56	0.93
Mercury	2			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	0.89	0.55	***0.26***	***0.32***	0.89	0.56
Selenium	50.0		5.0	2.0	***0.4***	< 2.0	< 2.0	< 2.0	***0.4***	< 2.0
Zinc		5000	120	2.0	***1.9***	***1.0***	***1.1***	3.8	4.7	2.9
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**9/25/2018**	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					7.42	7.23	7.43	7.62	7.51	7.58
Specific Conductance					126.0	135.1	141.0	133.2	119.3	123.0
Dissolved Oxygen					9.07	7.26	9.41	9.66	11.14	10.15
Temperature					12.20	12.2	12.1	10.8	9.2	9.6
Turbidity	1	5			**1.45**	**1.27**	**2.00**	**1.63**	**2.23**	**1.11**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW9 - Middle Creek					
					11/28/2018	11/29/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry										
Hardness as CaCO3 (mg/L)				5	144	N/A	68	48	37	42
Alkalinity as CaCO3 (mg/L)			20	5	**83**	N/A	**48**	**36**	**32**	**27**
Bicarbonate (mg/L)				5	101	N/A	59	44	39	33
Carbonate (mg/L)				5	< 5	N/A	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	N/A	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	1.10	N/A	1.46	1.16	0.50	0.69
Nitrite as N (mg/L)	1			0.010	***0.008***	N/A	***0.005***	***0.003***	< 0.010	***0.01***
Sulfate as SO4 (mg/L)		250		0.50	35.9	N/A	17.8	17.2	11.3	12.9
Specific Conductance (umhos/cm)				10	650	N/A	229	148	114	112
Total Dissolved Solids (mg/L)		500	500	6	370	N/A	137	104	84	94
Total Suspended Solids (mg/L)				6.0	***2.3***	N/A	***2.4***	6.0	***3.0***	113.0
Settleable Solids (mL/L/hr)				0.1	< 0.1	N/A	< 0.1	< 0.1	< 0.1	0.30
Total Kjeldahl Nitrogen (mg/L)	10			0.20	0.40	N/A	0.31	***0.16***	< 0.20	0.69
Ammonia as N (mg/L)		1.5		0.050	< 0.050	N/A	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	0.062	N/A	***0.038***	***0.042***	**< 0.050**	0.11
Orthophosphate as P (mg/L)				0.010	0.018	N/A	0.023	0.024	***0.008***	0.016
Total Organic Carbon (mg/L)				0.5	5.1	N/A	3.2	2.7	1.2	3.9
Turbidity (NTU)	0.0	5.0		0.5	**2.1**	N/A	**2.2**	**3.7**	**1.7**	**107.0**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	**88.5**	N/A	**107**	**220**	**147**	**4170**
Arsenic	10.00			0.50/2.5/5	< 0.5	N/A	***0.46***	***0.43***	0.27	1.64
Cadmium	5			0.20/1/2	< 0.20	N/A	< 0.20	< 1	< 0.20	< 1
Chromium	50			0.50/2.5/5	< 0.50	N/A	***0.15***	***0.25***	0.22	3.37
Copper	1300.00	1000.00		0.50/2.5/5	4.15	N/A	2.99	3.03	1.86	13.10
Iron		300.0	1000.0	15.0/75/150	136	N/A	148	289	201	**5030**
Lead	15			0.50/2.5/5	< 0.50	N/A	***0.25***	***0.44***	0.17	3.48
Manganese		50		0.50/2.5/5	19.4	N/A	11.5	17.7	10.7	**187.0**
Mercury	2		0.05	0.20/0.50	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.50
Nickel	100			0.50/2.5/5	< 0.5	N/A	***0.30***	***0.37***	0.24	2.12
Selenium	50.0		5.0	2.0/10/20	< 2.0	N/A	< 2.0	< 10	< 2.0	< 10
Zinc		5000.0	120.0	2.0/10/20	3.8	N/A	2.6	3.5	4.3	19.3
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	19.0	N/A	15.0	29.3	23.5	**195.0**
Arsenic	10		150	0.50	0.72	N/A	***0.42***	***0.34***	***0.28***	***0.37***
Cadmium	5			0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	< 0.50	N/A	< 0.50	< 0.50	< 0.50	***0.15***
Copper	1300	1000	9	0.50	3.75	N/A	2.55	2.10	1.12	2.36
Iron		300.0	1000.0	15.0	44.2	N/A	25.6	29.9	22.1	153.0
Lead	15		2.5	0.50	< 0.50	N/A	< 0.50	< 0.50	< 0.50	***0.10***
Manganese		50		0.50	14.6	N/A	7.26	6.23	5.68	11.30
Mercury	2			0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	***0.38***	N/A	***0.22***	***0.26***	<0.50	***0.14***
Selenium	50.0		5.0	2.0	***0.6***	N/A	< 2.0	< 2.0	< 2.0	< 2.0
Zinc		5000	120	2.0	***1.8***	N/A	***1.4***	2.0	2.4	***1.6***
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**11/28/2018**	**11/29/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					7.77	7.74	7.43	7.63	7.37	7.60
Specific Conductance					648.0	140.25	225.8	149.4	116.1	113.7
Dissolved Oxygen					9.97	10.55	10.87	10.76	10.89	11.86
Temperature					12.3	11.0	9.9	10.3	11.0	7.0
Turbidity	1	5			**1.59**	**423.88**	**1.83**	**4.61**	**1.43**	**67.89**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW10 - Salt Creek					
					11/28/2018	11/29/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry										
Hardness as CaCO3 (mg/L)				5	137	N/A	59	44	42	54
Alkalinity as CaCO3 (mg/L)			20	5	**61**	N/A	**48**	**39**	**42**	**47**
Bicarbonate (mg/L)				5	75	N/A	59	48	51	57
Carbonate (mg/L)				5	< 5	N/A	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	N/A	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	3.78	N/A	0.13	1.69	0.58	0.68
Nitrite as N (mg/L)	1			0.010	< 0.010	N/A	< 0.010	< 0.010	< 0.010	***0.00***
Sulfate as SO4 (mg/L)		250		0.50	20.4	N/A	10.2	6.62	4.90	7.30
Specific Conductance (umhos/cm)				10	550	N/A	189	126	111	146
Total Dissolved Solids (mg/L)		500	500	6	319	N/A	117	95	79	126
Total Suspended Solids (mg/L)				6.0	< 6.0	N/A	< 6.0	***2.3***	< 6.0	51.0
Settleable Solids (mL/L/hr)				0.1	< 0.1	N/A	< 0.1	< 0.1	< 0.1	0.10
Total Kjeldahl Nitrogen (mg/L)	10			0.20	0.46	N/A	0.33	***0.19***	< 0.20	0.45
Ammonia as N (mg/L)		1.5		0.050	< 0.050	N/A	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	***0.042***	N/A	< 0.050	***0.038***	< 0.050	0.069
Orthophosphate as P (mg/L)				0.010	0.012	N/A	0.017	0.014	***0.006***	***0.007***
Total Organic Carbon (mg/L)				0.5	5.0	N/A	3.2	2.4	1.3	3.1
Turbidity (NTU)	0.0	5.0		0.5	**2.8**	N/A	**2.5**	**3.1**	**0.9**	**73.0**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	**89.5**	N/A	**102**	**137**	54.4	**3470.0**
Arsenic	10.00			0.50/2.5/5	< 2.5	N/A	***0.40***	***0.35***	0.25	1.02
Cadmium	5			0.20/1/2	< 1	N/A	< 0.20	< 0.20	< 0.20	< 1
Chromium	50			0.50/2.5/5	< 2.5	N/A	***0.46***	0.51	0.19	10.70
Copper	1300.00	1000.00		0.50/2.5/5	3.66	N/A	2.51	1.93	1.12	9.08
Iron		300.0	1000.0	15.0/75/150	129	N/A	148	195	66.5	**4100.0**
Lead	15			0.50/2.5/5	< 2.5	N/A	< 0.50	***0.10***	< 0.50	***1.11***
Manganese		50		0.50/2.5/5	***2.05***	N/A	3.08	4.40	2.41	**66.80**
Mercury	2		0.05	0.20/0.50	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.50
Nickel	100			0.50/2.5/5	< 2.5	N/A	***0.46***	***0.42***	< 0.5	**7.61**
Selenium	50.0		5.0	2.0/10/20	< 10	N/A	< 2.0	< 2.0	< 2.0	< 10
Zinc		5000.0	120.0	2.0/10/20	***2.7***	N/A	***1.2***	2.0	2.1	11.6
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	5.6	N/A	10.4	14.1	13.5	86.7
Arsenic	10		150	0.50	***0.40***	N/A	***0.39***	***0.33***	***0.25***	***0.27***
Cadmium	5			0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	< 0.50	N/A	***0.14***	***0.15***	< 0.50	***0.29***
Copper	1300	1000	9	0.50	3.04	N/A	2.17	1.57	0.96	1.78
Iron		300.0	1000.0	15.0	< 15	N/A	***8.4***	***13.5***	***12.0***	88.0
Lead	15		2.5	0.50	< 0.50	N/A	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	0.83	N/A	1.04	0.78	1.04	2.94
Mercury	2			0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	***0.35***	N/A	***0.21***	***0.18***	**<0.50**	***0.3***
Selenium	50.0		5.0	2.0	***0.6***	N/A	< 2.0	< 2.0	< 2.0	< 2.0
Zinc		5000	120	2.0	***0.8***	N/A	***0.9***	***1.3***	2.1	***0.8***
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**11/28/2018**	**11/29/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					7.79	7.65	7.50	7.79	7.62	7.79
Specific Conductance					550	140.25	187.1	126.0	112.9	145.9
Dissolved Oxygen					10.27	10.64	11.07	10.91	10.95	11.79
Temperature					12.0	11.17	9.9	10.2	11.2	7.3
Turbidity	1	5			**1.97**	**420.67**	**2.16**	**2.87**	0.69	**53.89**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW11 - Sacramento River- Intake #1						
					9/25/2018	11/28/2018	11/29/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry											
Hardness as CaCO3 (mg/L)				5	46	51	N/A	50	50	44	42
Alkalinity as CaCO3 (mg/L)			20	5	**56**	**60**	N/A	**60**	**55**	**48**	**54**
Bicarbonate (mg/L)				5	68	73	N/A	73	67	59	66
Carbonate (mg/L)				5	< 5	< 5	N/A	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	N/A	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	0.10	0.13	N/A	2.21	0.16	0.11	0.13
Nitrite as N (mg/L)	1			0.010	< 0.010	< 0.010	N/A	***0.004***	< 0.010	***0.004***	***0.003***
Sulfate as SO4 (mg/L)		250		0.50	3.20	3.46	N/A	3.82	9.03	5.58	3.81
Specific Conductance (umhos/cm)				10	124	135	N/A	141	141	117	124
Total Dissolved Solids (mg/L)		500	500	6	81	80	N/A	86	97	85	90
Total Suspended Solids (mg/L)				6.0	< 6.0	< 6.0	N/A	< 6.0	< 6.0	< 6.0	***2.8***
Settleable Solids (mL/L/hr)				0.1	< 0.1	< 0.1	N/A	< 0.1	< 0.1	< 0.1	< 0.1
Total Kjeldahl Nitrogen (mg/L)	10			0.20	< 0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	***0.10***
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	N/A	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	< 0.05	***0.044***	N/A	< 0.050	***0.029***	< 0.050	< 0.050
Orthophosphate as P (mg/L)				0.010	0.024	0.023	N/A	0.021	0.017	0.016	0.019
Total Organic Carbon (mg/L)				0.5	1.3	0.9	N/A	0.8	1.0	1.3	1.3
Turbidity (NTU)	0.0	5.0		0.5	**1.7**	**1.7**	N/A	**1.8**	**2.4**	**4.3**	**4.7**
Total Metals (ug/L)											
Aluminum	1000.0	200.0	87.0	5.0/25/50	79.6	49.6	N/A	**161**	79.9	**233**	**193**
Arsenic	10.00			0.50/2.5/5	1.58	1.77	N/A	1.99	1.79	1.53	1.78
Cadmium	5			0.20/1/2	< 0.20	< 0.20	N/A	< 0.20	***< 0.20***	***< 0.20***	***< 0.20***
Chromium	50			0.50/2.5/5	0.50	***0.42***	N/A	0.57	***0.42***	0.63	0.72
Copper	1300.00	1000.00		0.50/2.5/5	0.94	0.87	N/A	2.00	2.48	3.58	2.22
Iron		300.0	1000.0	15.0/75/150	72.6	65.0	N/A	245	114	243	259
Lead	15			0.50/2.5/5	< 0.50	< 0.50	N/A	***0.38***	***0.13***	0.16	0.14
Manganese		50		0.50/2.5/5	2.71	6.64	N/A	16.6	12.7	8.74	11.40
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	N/A	< 0.20	< 0.20	**< 0.20**	**< 0.20**
Nickel	100			0.50/2.5/5	1.01	0.68	N/A	0.73	0.54	1.19	1.04
Selenium	50.0		5.0	2.0/10/20	< 2.0	< 2.0	N/A	< 2.0	< 2.0	< 2.0	< 2.0
Zinc		5000.0	120.0	2.0/10/20	10.2	***1.4***	N/A	4.2	5.7	6.6	4.0
Total Metals - Dissolved (ug/L)											
Aluminum	1000.0	200.0	87.0	5.0	23.8	11.0	N/A	8.8	21.7	34.4	23.5
Arsenic	10		150	0.50	1.45	1.84	N/A	1.99	1.71	1.40	1.64
Cadmium	5			0.20	< 0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	***0.45***	***0.37***	N/A	***0.36***	***0.32***	***0.34***	***0.39***
Copper	1300	1000	9	0.50	0.80	0.70	N/A	0.86	1.60	2.30	1.30
Iron		300.0	1000.0	15.0	15.8	***13.2***	N/A	***12.4***	17.8	25.0	16.9
Lead	15		2.5	0.50	< 0.50	< 0.50	N/A	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	1.04	2.71	N/A	4.89	7.71	3.86	1.72
Mercury	2			0.20	< 0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	0.87	0.64	N/A	***0.40***	***0.47***	0.87	0.54
Selenium	50.0		5.0	2.0	< 2.0	< 2.0	N/A	< 2.0	< 2.0	< 2.0	< 2.0
Zinc		5000	120	2.0	***1.1***	***0.9***	N/A	***1.1***	4.5	4.4	2.2
Polycyclic Aromatic Hydrocarbons (ug/L)											
1-Methylnaphthalene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Field Measurements											
Sampling Dates					**9/25/2018**	**11/28/2018**	**11/29/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					7.51	7.45	7.38	7.32	7.62	7.55	7.69
Specific Conductance					126.2	134.2	125.8	138.8	140.7	119.2	125.1
Dissolved Oxygen					10.03	9.94	9.91	10.47	11.02	11.34	11.08
Temperature					11.5	12.3	11.86	11.9	10.5	9.3	9.6
Turbidity	1	5			0.86	**1.0**	**105.12**	**1.78**	**1.99**	**2.54**	**3.54**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW12 - Carter Creek					
					11/28/2018	11/29/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry										
Hardness as CaCO3 (mg/L)				5	111	N/A	62	44	48	43
Alkalinity as CaCO3 (mg/L)			20	5	**70**	N/A	**47**	**35**	**45**	**35**
Bicarbonate (mg/L)				5	86	N/A	57	43	55	42
Carbonate (mg/L)				5	< 5	N/A	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	N/A	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	2.10	N/A	2.16	1.52	0.51	0.98
Nitrite as N (mg/L)	1			0.010	< 0.010	N/A	***0.006***	***0.005***	< 0.010	***0.01***
Sulfate as SO4 (mg/L)		250		0.50	29.2	N/A	14.0	8.42	10.2	7.6
Specific Conductance (umhos/cm)				10	286	N/A	170	116	129	109
Total Dissolved Solids (mg/L)		500	500	6	167	N/A	101	94	92	119
Total Suspended Solids (mg/L)				6.0	< 6.0	N/A	< 6.0	***2.0***	< 6.0	54.0
Settleable Solids (mL/L/hr)				0.1	< 0.1	N/A	< 0.1	< 0.1	< 0.1	0.20
Total Kjeldahl Nitrogen (mg/L)	10			0.20	0.40	N/A	0.38	0.27	***0.12***	0.66
Ammonia as N (mg/L)		1.5		0.050	< 0.050	N/A	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	***0.037***	N/A	< 0.050	***0.024***	< 0.050	0.098
Orthophosphate as P (mg/L)				0.010	***0.006***	N/A	0.013	0.014	***0.005***	0.018
Total Organic Carbon (mg/L)				0.5	4.2	N/A	3.4	2.7	1.7	3.9
Turbidity (NTU)	0.0	5.0		0.5	**1.3**	N/A	**4.5**	**9.0**	**4.7**	**103.0**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	30.8	N/A	***137***	**324**	**221**	**4230**
Arsenic	10.00			0.50/2.5/5	< 2.5	N/A	***0.45***	< 2.5	0.34	1.65
Cadmium	5			0.20/1/2	< 1	N/A	< 0.20	< 1	< 0.20	< 1
Chromium	50			0.50/2.5/5	< 2.5	N/A	0.55	***0.88***	0.65	8.06
Copper	1300.00	1000.00		0.50/2.5/5	***2.41***	N/A	2.37	***2.16***	1.50	8.92
Iron		300.0	1000.0	15.0/75/150	***71.2***	N/A	220	**434**	**315**	**5330**
Lead	15			0.50/2.5/5	< 2.5	N/A	***0.08***	< 2.5	0.10	1.31
Manganese		50		0.50/2.5/5	***1.88***	N/A	3.32	6.74	4.44	**81.30**
Mercury	2		0.05	0.20/0.50	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.50
Nickel	100			0.50/2.5/5	***0.83***	N/A	0.95	***1.13***	0.79	6.40
Selenium	50.0		5.0	2.0/10/20	< 10	N/A	< 2.0	< 10	< 2.0	< 2.0
Zinc		5000.0	120.0	2.0/10/20	***3.9***	N/A	***1.1***	< 10	1.5	12.2
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	14.5	N/A	20.2	36.9	42.9	**228.0**
Arsenic	10		150	0.50	***0.34***	N/A	***0.38***	***0.35***	***0.28***	***0.36***
Cadmium	5			0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	***0.14***	N/A	***0.21***	***0.26***	***0.19***	***0.45***
Copper	1300	1000	9	0.50	2.16	N/A	2.10	2.06	1.06	1.90
Iron		300.0	1000.0	15.0	30.7	N/A	26.9	38.9	40.5	169.0
Lead	15		2.5	0.50	< 0.50	N/A	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	1.04	N/A	1.30	1.59	1.07	2.85
Mercury	2			0.20	< 0.20	N/A	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	0.77	N/A	0.70	0.67	***0.43***	0.72
Selenium	50.0		5.0	2.0	< 2.0	N/A	< 2.0	< 2.0	< 2.0	< 2.0
Zinc		5000	120	2.0	***1.70***	N/A	***0.5***	***0.6***	***0.6***	***0.8***
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	N/A	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**11/28/2018**	**11/29/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					7.65	7.46	7.31	7.59	7.46	7.69
Specific Conductance					287.1	100.4	168.7	117.2	129.4	110.1
Dissolved Oxygen					9.64	10.54	10.87	10.66	10.79	11.79
Temperature					13.4	11.00	9.7	10.2	10.9	7.0
Turbidity	1	5			0.58	**122.32**	**3.86**	**8.10**	**2.67**	**91.09**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW13 - Sacramento River- 44 Bridge					
					9/25/2018	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
General Chemistry										
Hardness as CaCO3 (mg/L)				5	48	50	49	51	46	49
Alkalinity as CaCO3 (mg/L)			20	5	**57**	**59**	**60**	**55**	**48**	**55**
Bicarbonate (mg/L)				5	69	71	73	67	59	67
Carbonate (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	0.08	0.12	0.13	0.17	0.11	0.12
Nitrite as N (mg/L)	1			0.010	< 0.010	< 0.010	< 0.010	< 0.010	***0.003***	< 0.010
Sulfate as SO4 (mg/L)		250		0.50	3.22	3.31	3.67	9.49	5.59	4.00
Specific Conductance (umhos/cm)				10	127	133	140	143	120	125
Total Dissolved Solids (mg/L)		500	500	6	85	83	88	97	89	88
Total Suspended Solids (mg/L)				6.0	< 6.0	< 6.0	< 6.0	9.0	< 6.0	< 6.0
Settleable Solids (mL/L/hr)				0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Kjeldahl Nitrogen (mg/L)	10			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	**< 0.050**	***0.044***	**< 0.050**	***0.024***	**< 0.050**	**< 0.050**
Orthophosphate as P (mg/L)				0.010	0.023	0.021	0.020	0.018	0.015	0.021
Total Organic Carbon (mg/L)				0.5	1.1	0.9	0.9	1.0	1.6	1.5
Turbidity (NTU)	0.0	5.0		0.5	**1.9**	**1.7**	**1.8**	**3.1**	**4.5**	**2.2**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	67.3	53.8	82.2	**98.2**	**220**	**103**
Arsenic	10.00			0.50/2.5/5	1.70	1.95	2.00	1.92	1.56	1.74
Cadmium	5			0.20/1/2	***< 0.20***	***< 0.20***	***< 0.20***	***< 0.20***	***< 0.20***	***< 0.20***
Chromium	50			0.50/2.5/5	***0.47***	***0.42***	***0.48***	***0.44***	0.61	0.57
Copper	1300.00	1000.00		0.50/2.5/5	0.89	0.88	1.32	2.74	3.52	2.01
Iron		300.0	1000.0	15.0/75/150	65.5	65.5	104	129	237	103
Lead	15			0.50/2.5/5	< 0.50	***0.07***	***0.11***	***0.13***	0.12	0.09
Manganese		50		0.50/2.5/5	2.33	5.04	8.14	11.1	8.40	4.77
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100			0.50/2.5/5	0.93	0.76	0.53	0.53	1.22	0.88
Selenium	50.0		5.0	2.0/10/20	< 2.0	< 2.0	< 2.0	< 2.0	0.3	< 2.0
Zinc		5000.0	120.0	2.0/10/20	2.1	***1.4***	***1.9***	5.4	6.3	3.7
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	25.5	12.8	9.3	16.3	31.9	18.1
Arsenic	10		150	0.50	1.48	1.90	1.98	1.80	1.44	1.73
Cadmium	5			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	***0.42***	***0.35***	***0.38***	***0.32***	***0.34***	***0.39***
Copper	1300	1000	9	0.50	0.81	0.70	0.85	1.64	2.34	1.31
Iron		300.0	1000.0	15.0	17.0	***12.4***	***8.2***	***13.2***	23.7	***12.2***
Lead	15		2.5	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	0.72	1.16	1.63	5.15	3.85	1.26
Mercury	2			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	0.79	0.60	***0.39***	***0.41***	0.90	0.55
Selenium	50.0		5.0	2.0	< 2.0	< 2.0	< 2.0	< 2.0	***0.3***	< 2.0
Zinc		5000	120	2.0	***0.9***	***0.8***	***0.9***	3.8	4.4	2.5
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**9/25/2018**	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					7.89	7.54	7.24	7.70	7.51	7.84
Specific Conductance					124.9	134.0	138.2	141.9	119.6	126.6
Dissolved Oxygen					11.75	10.44	10.38	10.87	11.33	10.94
Temperature					12.0	12.3	11.7	10.5	9.3	9.7
Turbidity	1	5			**10.0**	**1.30**	**1.66**	**2.34**	**2.44**	**1.17**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW14 - Lower Clear Creek					
					9/25/2018	11/28/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry										
Hardness as CaCO3 (mg/L)				5	38	44	46	36	28	34
Alkalinity as CaCO3 (mg/L)			20	5	**40**	**42**	**43**	**38**	**30**	**34**
Bicarbonate (mg/L)				5	49	52	52	47	36	41
Carbonate (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	***0.04***	0.07	0.23	0.29	0.22	0.35
Nitrite as N (mg/L)	1			0.010	< 0.010	< 0.010	***0.003***	< 0.010	< 0.010	***0.00***
Sulfate as SO4 (mg/L)		250		0.50	2.15	3.59	3.74	3.95	3.75	3.49
Specific Conductance (umhos/cm)				10	91	119	112	96	77	87
Total Dissolved Solids (mg/L)		500	500	6	60	67	67	72	68	63
Total Suspended Solids (mg/L)				6.0	< 6.0	9.2	15.4	17.2	***3.4***	8.2
Settleable Solids (mL/L/hr)				0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Kjeldahl Nitrogen (mg/L)	10			0.20	< 0.20	***0.13***	***0.15***	***0.16***	< 0.20	***0.18***
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	< 0.050	0.053	0.071	0.054	***0.025***	< 0.050
Orthophosphate as P (mg/L)				0.010	< 0.01	0.018	0.021	0.019	0.017	***0.007***
Total Organic Carbon (mg/L)				0.5	1.6	2.0	2.1	5.0	1.4	2.2
Turbidity (NTU)	0.0	5.0		0.5	**0.8**	**6.4**	**9.0**	**10.0**	**5.6**	**8.0**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	11.4	**440**	**715**	**794**	**200**	**393**
Arsenic	10.00			0.50/2.5/5	0.53	< 2.5	0.55	< 2.5	0.44	0.47
Cadmium	5			0.20/1/2	< 0.20	< 1	< 0.20	< 1	< 0.20	< 0.20
Chromium	50			0.50/2.5/5	***0.39***	***1.03***	1.48	***1.59***	0.52	1.04
Copper	1300.00	1000.00		0.50/2.5/5	0.58	***1.18***	1.53	***1.23***	0.98	1.50
Iron		300.0	1000.0	15.0/75/150	31.5	**353**	**533**	**645**	225	**435**
Lead	15			0.50/2.5/5	< 0.50	***0.51***	0.79	***0.69***	0.17	0.32
Manganese		50		0.50/2.5/5	7.51	27.8	38.3	29.6	8.97	26.60
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100			0.50/2.5/5	2.08	***2.34***	1.87	***1.62***	0.69	1.61
Selenium	50.0		5.0	2.0/10/20	< 2.0	< 10	< 2.0	< 10	< 2.0	< 2.0
Zinc		5000.0	120.0	2.0/10/20	4.2	***3.0***	3.7	***2.6***	2.1	1.9
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	< 5.0	26.0	40.6	43.1	46.8	**105.0**
Arsenic	10		150	0.50	***0.40***	0.53	***0.44***	***0.40***	0.60	***0.31***
Cadmium	5			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	***0.34***	***0.31***	***0.29***	***0.25***	***0.21***	***0.26***
Copper	1300	1000	9	0.50	0.54	0.62	0.72	0.66	0.63	0.98
Iron		300.0	1000.0	15.0	< 15	42.6	39.4	37.8	34.8	111.0
Lead	15		2.5	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Manganese		50		0.50	1.38	10.1	17.3	7.34	3.60	8.67
Mercury	2			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	1.68	1.56	1.07	0.83	***0.43***	0.60
Selenium	50.0		5.0	2.0	< 2.0	< 2.0	< 2.0	< 2.0	***0.3***	***0.4***
Zinc		5000	120	2.0	***0.6***	***0.5***	***1.3***	< 2.0	***1.9***	< 2.0
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**9/25/2018**	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					8.05	7.81	7.80	7.59	7.61	7.88
Specific Conductance					90.5	115.7	108.7	96.0	79.3	88.1
Dissolved Oxygen					11.08	10.76	11.21	11.20	11.58	12.05
Temperature					11.5	11.4	9.9	9.6	9.4	7.2
Turbidity	1	5			0.00	**4.81**	**7.35**	**8.70**	**3.29**	**6.60**

CARR POST-FIRE WATER QUALITY MONITORING RESULTS

Attachment C

ANALYTE	Primary MCL*	Secondary MCL**	Aquatic Life Threshold***	Lab Rpt Limit	SW15 - North Fork Cottonwood Creek					
					9/25/2018	11/28/2018	12/17/2018	1/9/2019	3/26/2019	1/16/2020
General Chemistry										
Hardness as CaCO3 (mg/L)				5	63	74	95	75	48	89
Alkalinity as CaCO3 (mg/L)			20	5	**66**	**62**	**64**	**54**	**46**	**49**
Bicarbonate (mg/L)				5	80	76	78	65	56	60
Carbonate (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide (mg/L)				5	< 5	< 5	< 5	< 5	< 5	< 5
Nitrate as N (mg/L)	10			0.05	< 0.05	0.45	1.17	0.68	0.07	0.46
Nitrite as N (mg/L)	1			0.010	< 0.010	< 0.010	***0.006***	***0.004***	< 0.010	***0.00***
Sulfate as SO4 (mg/L)		250		0.50	2.30	16.2	35.7	24.1	11.0	47.70
Specific Conductance (umhos/cm)				10	213	217	256	186	123	241
Total Dissolved Solids (mg/L)		500	500	6	128	139	166	144	91	181
Total Suspended Solids (mg/L)				6.0	< 6.0	20.0	70.0	66.0	27.0	233.0
Settleable Solids (mL/L/hr)				0.1	0.1	< 0.1	< 0.1	0.1	< 0.1	0.30
Total Kjeldahl Nitrogen (mg/L)	10			0.20	***0.17***	0.44	0.53	0.49	< 0.20	0.69
Ammonia as N (mg/L)		1.5		0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Total Phosphorus as P (mg/L)				0.050	< 0.050	0.165	0.172	0.147	0.051	0.230
Orthophosphate as P (mg/L)				0.010	***0.006***	0.043	0.030	0.024	0.013	0.013
Total Organic Carbon (mg/L)				0.5	2.0	6.1	5.7	2.2	1.2	3.7
Turbidity (NTU)	0.0	5.0		0.5	**0.8**	**22.3**	**55.3**	**37.5**	**19.0**	**173.0**
Total Metals (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0/25/50	18.7	**1180**	**3200**	**2950**	**914**	**10000**
Arsenic	10.00			0.50/2.5/5	0.80	< 2.5	< 2.5	< 5	0.53	1.99
Cadmium	5			0.20/1/2	< 0.20	< 1	< 1	< 2	< 0.20	< 1
Chromium	50			0.50/2.5/5	***0.14***	***1.39***	4.43	***4.27***	2.37	16.60
Copper	1300.00	1000.00		0.50/2.5/5	0.70	***1.79***	3.01	***2.63***	1.94	12.00
Iron		300.0	1000.0	15.0/75/150	106	**776**	**2190**	**2390**	**1100**	**10500**
Lead	15			0.50/2.5/5	< 0.50	***1.79***	***2.41***	***2.10***	0.34	3.36
Manganese		50		0.50/2.5/5	30.2	**61.3**	**111**	**106**	24.4	**205.00**
Mercury	2		0.05	0.20/0.50	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.50
Nickel	100			0.50/2.5/5	0.59	***1.82***	5.55	***4.45***	2.91	13.90
Selenium	50.0		5.0	2.0/10/20	< 2.0	< 10	< 10	< 20	< 2	***1.5***
Zinc		5000.0	120.0	2.0/10/20	5.4	***4.7***	***9.5***	***8.5***	8.0	27.7
Total Metals - Dissolved (ug/L)										
Aluminum	1000.0	200.0	87.0	5.0	< 5.0	**95.1**	**165**	**116**	54.2	**105.0**
Arsenic	10		150	0.50	0.67	***0.47***	***0.43***	***0.43***	***0.45***	***0.31***
Cadmium	5			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Chromium	50			0.50	< 0.50	***0.32***	***0.41***	***0.38***	***0.30***	***0.26***
Copper	1300	1000	9	0.50	***0.40***	1.05	1.20	1.14	***0.44***	0.98
Iron		300.0	1000.0	15.0	68.0	109	148	105	42.3	111.0
Lead	15		2.5	0.50	< 0.50	***0.17***	***0.12***	***0.07***	< 0.50	< 0.50
Manganese		50		0.50	23.4	17.1	31.1	14.1	7.56	8.67
Mercury	2			0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Nickel	100		52	0.50	***0.42***	0.96	1.31	1.31	0.93	0.60
Selenium	50.0		5.0	2.0	< 2.0	***0.4***	***0.6***	< 2.0	***0.4***	***0.4***
Zinc		5000	120	2.0	***0.5***	***0.8***	***0.5***	< 2.0	< 2.0	< 2.0
Polycyclic Aromatic Hydrocarbons (ug/L)										
1-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
2-Methylnaphthalene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthene			52	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Acenaphthylene			110000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (a) pyrene	0.2			0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (b) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (g,h,i) perylene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Benzo (k) fluoranthene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Chrysene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Dibenzo (a,h) anthracene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluoranthene			370	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Fluorene			14000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Indeno (1,2,3-cd) pyrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Naphthalene			62	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Phenanthrene				0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Pyrene			11000	0.10	< 0.10	< 0.10	< 0.10	< 0.10	N/A	< 0.10
Field Measurements										
Sampling Dates					**9/25/2018**	**11/28/2018**	**12/17/2018**	**1/9/2019**	**3/26/2019**	**1/16/2020**
pH					8.09	7.70	7.85	7.62	7.68	7.56
Specific Conductance					213.4	216.6	251.5	186.4	125.3	235.8
Dissolved Oxygen					9.39	10.85	11.59	11.18	11.47	12.31
Temperature					16.9	9.8	7.9	9.1	9.3	5.6
Turbidity	1	5			0.10	**19.84**	**36.43**	**38.82**	**9.10**	**130.00**

Appendix 13A-3 Camp Post-Fire Monitoring Results

Sample ID	Station Name	NUTRIENTS, MINERALS, SOLIDS															BACTERIA		FIELD MEASUREMENTS				
	Analyte:	Alkalinity	Ammonia	Hardness	Magnesium	Nitrate	Nitrite	Nitrite+Nitrate	TKN	OrthoPhosphate	Phosphorus	Sulfate	SS	TDS	TOC	TSS	E. coli	Coliform	Conductivity	DO	pH	Temp	Turbidity
	Method:	SM 2320 B	SM 4500			SM 4500	SM 4500	Calculated		SM 4500-P E		EPA 300.0	SM 2540 F	SM 2540 C		SM 2540 D			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	mg/L	mg/L	mg/L	MPN	MPN	µS/Cm	mg/L		°C	NTU
	Fraction:	Total	Total	Total	Dissolved	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Total	Particulate	Total	Total					
	Primary MCL:					10	1	10															
	Secondary MCL:		1.5									250		500					900		6.5-8.5		5
	Bacteria Objective:																320						
	Aquatic Life Threshold:	20	formula																	>7.0	6.5-9		
	Agrigulture Threshold													450					700		6.5-8.4		
Camp 1	Butte Cr. (BCK Gage)	**48**	<0.2	46	4.95	1.55		0.36	0.94	<0.05	0.05		0.75	73	3.3	33			93.9	11.34	7.26	9.1	32.4
Camp 2	Butte Cr. (Control)	**41**	<0.2	37	3.87	0.37		0.05	0.68	<0.05	<0.01		0.30	110	3.7	49			77.5	12.25	7.87	8.4	40.2
Camp 3	Little Butte Cr.	**61**	<0.2	69	8.35	6.43		1.71	0.79	0.051	0.11		0.40	62	3.1	18			126.5	11.2	7.71	10.6	75.7
Camp 4	Hamlin Cr. (Valley)	<1.7	0.040		2.56	0.10	0.01	0.10		0.02		**1020.0**		99		11	70.3	>2419.6	102.2	10.55	7.48	10.8	17.7
Camp 5	Clear Cr. (Paradise)	<1.7	0.020		1.73	0.44	0.00	0.44		0.01		**838.0**		75		5	307.6	>2419.6	80.8	10.61	7.24	10.5	10.7
Camp 6	Dry Cr. (Paradise)	<1.7	<0.003		No Result	0.04	0.01	0.05		0.02		**895.0**		82		11	275.5	>2419.6	81.8	10.58	7.34	10.5	23.3
Camp 7	Little Dry Cr. (Valley)	14	0.053		2.9	0.03	0.02	0.05		0.12		15.7		129		31	**727.0**	>2419.6	112	11.05	7.87	10.9	29.6
Camp 8	Clear Cr. (Valley)	<1.7	0.023		3.41	0.02	0.03	0.05		0.24		53.2		162		40	**816.4**	>2419.6	134	11.02	7.87	10.9	37.7
Camp 9	Dry Cr. (Valley)	13	0.026		2.3	0.02	0.02	0.04		0.08		28.2		127		54	139.6	>2419.6	124.7	11.21	7.80	10.9	36.0
Camp 10	Lake Oroville (WB)	<1.7	0.013		No Result	0.01	<0.002	0.01		0.02		**926.0**		104		6	3.1	461.1	107.8	10.18	7.48	9.1	9.6

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Sample ID	Station Name	TOTAL METALS																			
	Analyte:	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	6	10	1,000	4	5	50		1,300		15		2		100	50		2		
	Secondary MCL:	200								1,000	300		50					100			5,000
	Aquatic Life Threshold:	87	610				formula				1,000			0.05				formula			120
	Agrigulture Threshold	5,000		100		100	10		50	200	5,000	5,000	200		10	200	20				
Camp 1	Butte Cr. (BCK Gage)	**321**		0.7			<0.1	1.54		1.8	297	0.249	23.9	<0.20		2.78	0.213	<0.03			1.72
Camp 2	Butte Cr. (Control)	**283**		0.6			<0.1	1.54		1.49	**306**	0.111	21.8	<0.20		1.97	0.217	<0.03			1.24
Camp 3	Little Butte Cr.	**1,700**		1.0			<0.1	4.95		3.7	**1470**	0.249	**105**	<0.20		7.96	0.353	<0.03			7.29
Camp 4	Hamlin Cr. (Valley)	**500**	**20**	2.0	30	0.8	1.1	3.1	1.9	0.7	Pending	*3.6*	Pending	**0.09**	4.0	2.1	*3.8*	**121.0**	*2.18*	4.1	*20.9*
Camp 5	Clear Cr. (Paradise)	**289**	**7**	<0.06	20	<0.2	0.33	1.2	<0.159	<0.032	Pending	*7.1*	Pending	**0.11**	38.6	<0.032	*4.0*	1.2	*2.37*	1.5	*26.0*
Camp 6	Dry Cr. (Paradise)	**715**	3	2.0	20	<0.2	<0.08	4.6	0.8	<0.032	Pending	*1.8*	Pending	<0.001	<0.159	2.6	*0.5*	<0.16	*<0.0318*	3.3	*29.9*
Camp 7	Little Dry Cr. (Valley)	**1,640**	**9**	<0.06	30	<0.2	<0.08	5.2	1.0	0.5	Pending	*3.3*	Pending	<0.001	<0.159	4.9	*2.3*	<0.16	*<0.0318*	7.3	*62.0*
Camp 8	Clear Cr. (Valley)	**2,530**	1	<0.06	30	<0.2	<0.08	6.6	1.6	1.7	Pending	*1.5*	Pending	<0.001	1.1	6.0	*2.3*	<0.16	*<0.0318*	13.2	*32.7*
Camp 9	Dry Cr. (Valley)	**2,120**	4	<0.06	30	<0.2	<0.08	6.0	2.0	1.3	Pending	*2.2*	Pending	<0.001	<0.159	5.1	*4.4*	<0.16	*<0.0318*	11.7	*16.2*
Camp 10	Lake Oroville (WB)	**231**	**9**	<0.06	10	<0.2	<0.08	1.1	<0.159	<0.032	Pending	*<0.159*	Pending	**0.1**	<0.159	1.5	*<0.0064*	<0.16	*1.58*	2.2	*12.1*

Sample ID	Station Name	DISSOLVED METALS																			
	Analyte:	Aluminum		Arsenic			Cadmium	Chromium		Copper	Iron	Lead	Manganese	Mercury		Nickel	Selenium				Zinc
	Method:	EPA 200.7		EPA 200.7			EPA 200.7	EPA 200.7		EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1		EPA 200.7	EPA 200.7				EPA 200.7
	Units:	µg/L		µg/L			µg/L	µg/L		µg/L	µg/L	µg/L	µg/L	µg/L		µg/L	µg/L				µg/L
	Fraction:	Dissolved		Dissolved			Dissolved	Dissolved		Dissolved	Dissolved	Dissolved	Dissolved	Dissolved		Dissolved	Dissolved				Dissolved
	Primary MCL:	1,000		10			5	50		1,300		15		2		100	50				
	Secondary MCL:	200								1,000	300		50								5,000
	Aquatic Life Threshold:	87		150			formula			9	1,000	2.5				52	5				120
	Agrigulture Threshold	5,000								200	5,000	5,000	200				20				
Camp 1	Butte Cr. (BCK Gage)	31.1		0.54			<0.01	0.8		0.88	28	<0.004	0.29			0.90	<0.2				0.25
Camp 2	Butte Cr. (Control)	33.7		0.44			<0.01	0.8		0.76	46	<0.004	0.25			0.81	<0.2				0.17
Camp 3	Little Butte Cr.	60.7		0.65			<0.01	1.8		1.34	32	<0.004	0.50			1.56	0.27				0.79
Camp 4	Hamlin Cr. (Valley)	55.4		11.8			12.90	13.4		9.29	144	13.4	*22.6*	<0.00015		8.51	14.10				*29.0*
Camp 5	Clear Cr. (Paradise)	<0.318		<0.064			<0.08	<0.159		<0.032	5	1.8	*2.42*	<0.00015		<0.032	0.82				*16.4*
Camp 6	Dry Cr. (Paradise)	109		<0.064			<0.08	<0.159		<0.032	113	<0.159	***2,260***	<0.00015		<0.032	<0.0064				*4.58*
Camp 7	Little Dry Cr. (Valley)	**869**		<0.064			<0.08	1.69		<0.032	**811**	Pending	*24.2*	<0.00015		1.39	1.93				*19.3*
Camp 8	Clear Cr. (Valley)	**1580**		<0.064			<0.08	4.42		0.95	**1,500**	Pending	*28.2*	0.02		4.12	<0.0064				*14.0*
Camp 9	Dry Cr. (Valley)	**293**		<0.064			<0.08	1.06		<0.032	**398**	Pending	*ND*	0.02		<0.032	0.46				*9.57*
Camp 10	Lake Oroville (WB)	<0.318		<0.064			<0.08	<0.159		<0.032	**365**	<0.159	***1,950***	<0.00015		<0.032	0.98				*7.24*

Sample ID	Station Name	PAH DETAILED RESULTS																					
	Analyte:	Sum PAHs	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Carbazole	Chrysene	Dibenz(a,h)anthracene	Dinitrotoluene, 2,4-	Dinitrotoluene, 2,6-	Fluoranthene	Fluorene	indeno(1,2,3-c,d)pyrene	Isophorone	Methylnaphthalene, 2-	Naphthalene	Nitrobenzene	Phenanthrene	Pyrene
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:						0.2																	
	Human Health Threshold*:		70		300	0.0044	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960
	Taste & Odor Threshold:		20															0.049			21			
	Aquatic Life Threshold:		52		110,000											370	14,000				62			11,000
Camp 1	Butte Cr. (BCK Gage)	1.37	<0.0005	<0.0005	0.02	0.04	<0.0005	0.07	<0.0005	1.15	<0.0005	0.04	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.05	<0.0005
Camp 2	Butte Cr. (Control)	0.715	0.005	<0.0005	<0.0005	0.05	0.1	0.1	<0.0005	0.36	<0.0005	0.07	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.03	<0.0005
Camp 3	Little Butte Cr.	0.55	<0.0005	0.02	0.02	<0.0005	<0.0005	0.11	<0.0005	0.36	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.04	<0.0005
Camp 4	Hamlin Cr. (Valley)	2.48	<0.0005	<0.0005	0.01	0.21	0.06	0.29	0.42	0.82	<0.0005	0.62	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0004	0.03	0.02
Camp 5	Clear Cr. (Paradise)	0.034	0.004	<0.0005	<0.0005	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.03	<0.0005
Camp 6	Dry Cr. (Paradise)	0.65	<0.0005	<0.0005	<0.0005	0.04	<0.0005	0.16	<0.0005	0.33	<0.0005	0.09	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.03	<0.0005
Camp 7	Little Dry Cr. (Valley)	0.09	<0.0005	<0.0005	0.02	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.07	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005
Camp 8	Clear Cr. (Valley)	0.035	0.005	<0.0005	0.03	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005
Camp 9	Dry Cr. (Valley)	0.02	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.02	<0.0005
Camp 10	Lake Oroville (WB)	0.88	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.19	0.14	0.51	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.04	<0.0005

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

Sample ID	Station Name	NUTRIENTS, MINERALS, SOLIDS														BACTERIA		FIELD MEASUREMENTS				
	Analyte:	Alkalinity	Ammonia	Hardness	Nitrate	Nitrite	Nitrite+Nitrate	TKN	OrthoPhosphate	Phosphorus	Sulfate	SS	TDS	TOC	TSS	E. coli	Coliform	Conductivity	DO	pH	Temp	Turbidity
	Method:	SM 2320 B	SM 4500		SM 4500	SM 4500	Calculated		SM 4500-P E		EPA 300.0	SM 2540 F	SM 2540 C		SM 2540 D			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	mg/L	mg/L	mg/L	MPN	MPN	µS/Cm	mg/L		ºC	NTU
	Fraction:	Total	Total	Total	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Total	Particulate	Total	Total					
					10	1	10															
	S		1.5								250		500					900		6.5-8.5		5
	Bacteri															320						
	Aquatic Life	20	formula										450					700	>7.0	6.5-9		
	Agrigulture																			6.5-8.4		
Camp 1	Butte Cr. (BCK Gage)															No Result	No Result					
Camp 2	Butte Cr. (Control)															No Result	No Result					
Camp 3	Little Butte Cr.															No Result	No Result					
Camp 4	Hamlin Cr. (Valley)	12			0.01	0.11	0.12		0.01		8.7					104.3	>2419.6	174.3	10.48	6.93	10.9	13.4
Camp 5	Clear Cr. (Paradise)	30			0.01	0.08	0.09		<0.005		12.6					**410.6**	>2419.6	83.3	10.59	6.87	10.4	15.9
Camp 6	Dry Cr. (Paradise)	*8*			0.01	0.08	0.09		0.06		9.7					228.2	>2419.6	88.7	10.55	7.20	10.7	24.8
Camp 7	Little Dry Cr. (Valley)	<1.7			0.03	0.08	0.11		0.09		**877.0**					**435.2**	>2419.6	117.0	10.77	7.62	11	26.3
Camp 8	Clear Cr. (Valley)	<1.7			0.03	0.07	0.10		0.13		**908.0**					**517.2**	>2419.6	144.0	10.56	7.61	11	27.3
Camp 9	Dry Cr. (Valley)	<1.7			0.02	0.07	0.09		0.06		**883.0**					248.9	>2419.6	123.1	10.77	7.59	11.1	25.8
Camp 10	Lake Oroville (WB)	<1.7			0.05	<0.002	0.05		0.23		98.6					107.6	>2419.6	63.9	11.9	7.36	8.5	162.0

Sample ID	Station Name	TOTAL METALS												
	Analyte:	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Zinc
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
		1,000	6	10	5	50	1,300		15		2	100	50	
	S	200					1,000	300		50				5,000
	Aquatic Life	87	610	100	formula		200	1,000	5,000	200	0.05	200	20	120
	Agrigulture	5,000			10			5,000						
Camp 1	Butte Cr. (BCK Gage)													
Camp 2	Butte Cr. (Control)													
Camp 3	Little Butte Cr.													
Camp 4	Hamlin Cr. (Valley)	516	0.9	*2.6*	<0.08	1.93	<0.05	**709**	Pending	31.3	0.03	3.3	<0.12	*35.0*
Camp 5	Clear Cr. (Paradise)	533	3.4	*<1.7*	<0.08	1.26	<0.05	**531**	Pending	41.6	<0.0001	1.8	<0.12	*31.9*
Camp 6	Dry Cr. (Paradise)	1,150	2.2	*3.0*	<0.08	2.62	<0.05	1180	Pending	34.1	<0.0001	2.5	6.9	*21.8*
Camp 7	Little Dry Cr. (Valley)	2,030	<0.1	*3.3*	<0.08	3.62	<0.05	1750	Pending	42.1	0.04	2.7	<0.12	*18.6*
Camp 8	Clear Cr. (Valley)	2,410	<0.1	*<1.7*	<0.08	5.14	<0.05	2160	Pending	45	<0.0001	5.2	1.5	*27.6*
Camp 9	Dry Cr. (Valley)	1,850	<0.1	*5.3*	<0.08	4.76	<0.05	1980	Pending	48.6	<0.0001	8.0	<0.12	*20.0*
Camp 10	Lake Oroville (WB)	5,130	1.7	*<1.7*	<0.08	19.8	3.89	5290	Pending	**156**	<0.0001	20.7	0.7	*30.9*

LEGEND

Result > Primary MCL

Result > Secondary MCL

Result > Bacteria Water Quality Objective

Result > Aquatic Life Threshold

Result > Agricuture Threshold

Result > MCL and Aquatic Life Threshold

Result > MCL and Agricuture Threshold

Estimated Result (sample did not pass QAQC)

Pending or No Result

Sample ID	Station Name	DISSOLVED METALS												
	Analyte:	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Zinc
	Method:	EPA 200.7	EPA 200.7	EPA	EPA 200.7	EPA 200.7	EPA	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolve	Dissolved	Dissolve	Dissolved	Dissolved	Dissolve	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
		1,000	6	10	5	50	1,300		15		2	100	50	
	S	200					1,000	300		50				5,000
	Aquatic Life	87	610	150	formula		9	1,000	2.5			52	5	120
	Agrigulture	5,000					200	5,000	5,000	200			20	
Camp 1	Butte Cr. (BCK Gage)													
Camp 2	Butte Cr. (Control)													
Camp 3	Little Butte Cr.													
Camp 4	Hamlin Cr. (Valley)	<0.000318	*<0.00016*	*0.0028*	<0.00008	<0.000159	<0.000032	*0.09*	Pending	<0.00637	<0.00015	<0.000032	0.0035	*0.0296*
Camp 5	Clear Cr. (Paradise)	<0.000318	*0.0076*	*0.0025*	<0.00008	<0.000159	<0.000032	*0.11*	Pending	0.090	<0.00015	0.002	0.0058	*0.0381*
Camp 6	Dry Cr. (Paradise)	0.15	*0.0005*	*0.0056*	<0.00008	0.0006	<0.000032	*0.24*	Pending	<0.00637	<0.00015	<0.000032	<0.0000064	*0.024*
Camp 7	Little Dry Cr. (Valley)	1.02	*0.0013*	*0.0027*	<0.00008	0.0026	<0.000032	*0.98*	Pending	0.026	0.07	0.002	<0.0000064	*0.0307*
Camp 8	Clear Cr. (Valley)	1.39	*0.0012*	*0.0044*	<0.00008	0.0039	<0.000032	*1.39*	Pending	0.028	<0.00015	0.005	<0.0000064	*0.0260*
Camp 9	Dry Cr. (Valley)	0.96	*<0.00016*	*0.0026*	<0.00008	0.0031	<0.000032	*1.09*	Pending	0.027	<0.00015	0.005	0.0022	*0.0379*
Camp 10	Lake Oroville (WB)	3.39	*<0.00016*	*<0.000064*	<0.00008	0.0137	0.0077	*3.76*	Pending	0.127	<0.00015	0.016	0.0007	*0.0357*

Sample ID	Station Name	PAH DETAILED RESULTS																						
	Analyte:	Sum PAHs																						
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M
	Units:	µg/L	µg/L	µg/L	µg/L	µ g/L	µg/L	µg/L	µg/L	µ g/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Tot	Total	T otal	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Tot	Total	Total
							0.2																	
	Human Health Threshold*:		70		300	0.0044	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960
	Taste & Odor Threshold:		20															0.049			21			
	Aquatic Life		52		110,000											370	14,000				62			11,000
Camp 1	Butte Cr. (BCK Gage)	2.65	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.08	2.4	<0.0004	<0.0001	0.17	<0.0004	<0.0001	<0.0001	<0.0004	<0.0004	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0004	<0.0004
Camp 2	Butte Cr. (Control)	1.95	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0005	1.95	<0.0004	<0.0001	<0.0004	<0.0004	<0.0001	<0.0001	<0.0004	<0.0004	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0004	<0.0004
Camp 3	Little Butte Cr.	4.51	<0.0004	<0.0004	0.08	<0.0004	<0.0004	0.27	1.91	0.28	<0.0001	<0.0004	0.53	0.07	<0.0001	<0.0004	<0.0004	1.09	<0.0001	<0.0001	<0.0004	<0.0001	0.14	0.14
Camp 4	Hamlin Cr. (Valley)	1.96	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	0.07	1.89	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004
Camp 5	Clear Cr. (Paradise)	1.38	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	1.38	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004
Camp 6	Dry Cr. (Paradise)	0.42	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	0.42	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004
Camp 7	Little Dry Cr. (Valley)	4.39	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	4.39	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004
Camp 8	Clear Cr. (Valley)	1.95	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	1.95	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004
Camp 9	Dry Cr. (Valley)	1.14	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	1.14	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004
Camp 10	Lake Oroville (WB)	1.34	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	1.34	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

CAMP POST-FIRE WATER QUALITY MONITORING PRELIMINARY RESULTS

Sampling conducted by the Central Valley Regional Water Quality Control Board (Central Valley Water Board), Department of Water Resources (DWR) and Department of Transportation (Caltrans)

NOTE: Results are preliminary and have not been finalized for distrubtion to the general public

Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

02/26/2019 Sampling Event

Sample ID	Station Name	NUTRIENTS, MINERALS, SOLIDS														BACTERIA		FIELD MEASUREMENTS				
	Analyte:	**Alkalinity**	**Ammonia**	**Hardness**	**Nitrate**	**Nitrite**	**Nitrite+Nitrate**	**TKN**	**OrthoPhosphate**	**Phosphorus**	**Sulfate**	**SS**	**TDS**	**TOC**	**TSS**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 4500		SM 4500	SM 4500	Calculated		SM 4500-P E		EPA 300.0	SM 2540 F	SM 2540 C		SM 2540 D			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	mg/L	mg/L	mg/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Total	Total	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Total	Particulate	Total	Total					
	Primary MCL:				10	1	10															
	Secondary MCL:		1.5								250		500					900		6.5-8.5		5
	Bacteria Objective:															320						
	Aquatic Life Threshold:	20	formula																>7.0	6.5-9		
	Agrigulture Threshold												450					700		6.5-8.4		
Camp 1	Butte Cr. (BCK Gage)	**30**	<0.05	28	2.18		0.49	1.5	<0.05	0.49	2.3		57	2.5	660							
Camp 2	Butte Cr. (Control)	**27**	<0.05	23	0.40		0.10	0.2	<0.05	0.07	1.3		46	2	60							
Camp 3	Little Butte Cr.	**31**	<0.05	33	5.28		1.24	2.8	0.05	0.84	4.1		69	3.5	947							
Camp 4	Hamlin Cr. (Paradise)				1.74	<0.011	1.74				11.0					290.9	>2419.6	73.0	11	7.44	8.5	197.7
Camp 5	Clear Cr. (Paradise)				1.45	<0.011	1.45				7.6					290.9	>2419.6	60.3	11.09	7.44	8.1	150.7
Camp 6	Dry Cr. (Paradise)				1.37	<0.011	1.37				31.3					290.9	>2419.6	72.7	10.96	7.38	8.6	358.0
Camp 7	Little Dry Cr. (Valley)				1.16	<0.011	1.16				44.6					**1119.9**	>2419.6	82.8	13.46	7.87	7.3	188.5
Camp 8	Clear Cr. (Valley)				1.14	<0.011	1.14				8.5					**833.4**	>2419.6	95.9	13.31	7.66	9.3	135.0
Camp 9	Dry Cr. (Valley)				1.14	<0.011	1.14				16.0					290.9	>2419.6	82.7	13.47	7.64	9.3	269.4
Camp 10	Lake Oroville (WB)				0.14	<0.011	0.14				2.5					48.7	275.5	83.3	11.1	7.75	7.9	12.6

Sample ID	Station Name	TOTAL METALS												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610		formula			1,000			0.05			120
	Agrigulture Threshold	5,000		100	10		200	5,000	5,000	200		200	20	
Camp 1	Butte Cr. (BCK Gage)	**7,100**		1.9	<0.1	15.2	12.6	**7550**	5.16	**490**	<0.1	31.1	<0.2	21.7
Camp 2	Butte Cr. (Control)	**1,640**		0.5	<0.1	3.4	3.0	**1670**	0.662	**70**	<0.1	5.2	<0.2	3.9
Camp 3	Little Butte Cr.	**9,390**		2.9	0.3	20.0	19.3	**9140**	8.92	**837**	**0.14**	53.6	0.389	35.4
Camp 4	Hamlin Cr. (Paradise)	**4,530**	*9.7*	*6.5*	4.0	30.4	26.6	**4550**	*8.7*	**199**	**0.4**	7.3	*<0.12*	35.8
Camp 5	Clear Cr. (Paradise)	**5,170**	*3.3*	*4.4*	3.5	28.7	24.9	**4110**	*8.3*	**133**	**0.4**	8.0	***26.4***	40.2
Camp 6	Dry Cr. (Paradise)	**9,660**	*0.9*	*<1.7*	3.6	46.4	30.1	**8240**	*8.8*	**294**	**0.5**	16.3	*10.7*	38.9
Camp 7	Little Dry Cr. (Valley)	**7,270**	*1.2*	*6.6*	3.5	33.8	26.1	**6100**	*10.7*	**259**	**0.3**	12.2	*12.8*	40.8
Camp 8	Clear Cr. (Valley)	**6,430**	*17.9*	*<1.7*	3.5	34.4	26.8	**5910**	*7.2*	**183**	**0.2**	16.3	*<0.12*	36.0
Camp 9	Dry Cr. (Valley)	**8,950**	*11.2*	*3.0*	4.0	49.3	33.1	**8860**	*5.9*	**294**	**0.3**	27.5	***26.4***	34.6
Camp 10	Lake Oroville (WB)	**418**	*14.7*	*<1.7*	2.7	16.8	16.4	**314**	*6.4*	11.6	**0.1**	2.6	*<0.12*	8.7

LEGEND

Result > Primary MCL

Result > Secondary MCL

Result > Bacteria Water Quality Objective

Result > Aquatic Life Threshold

Result > Agricuture Threshold

Result > MCL and Aquatic Life Threshold

Result > MCL and Agricuture Threshold

Estimated Result (sample did not pass QAQC)

Pending or No Result

Sample ID	Station Name	DISSOLVED METALS												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610	150	formula		9	1,000	2.5			52	5	120
	Agrigulture Threshold	5,000					200	5,000	5,000	200			20	
Camp 1	Butte Cr. (BCK Gage)	**218**		0.4	<0.1	0.9	0.7	145	<0.04	1.6		1.8	<0.2	0.4
Camp 2	Butte Cr. (Control)	126		0.2	<0.1	1.4	0.5	92	<0.04	1.0		1.2	<0.2	0.3
Camp 3	Little Butte Cr.	**354**		0.7	<0.1	1.5	0.9	198	0.07	2.6		2.4	<0.2	0.7
Camp 4	Hamlin Cr. (Paradise)	**279**	*13.4*	*5.5*	2.7	16.8	21.0	97	*4.7*	45.3	<0.08	1.8	***20.6***	4.6
Camp 5	Clear Cr. (Paradise)	**252**	*19.3*	*8.0*	3.2	21.0	19.2	**359**	*2.0*	40.6	<0.08	1.7	*<0.064*	12.0
Camp 6	Dry Cr. (Paradise)	196	*13.6*	*7.5*	2.9	19.2	17.8	64	*4.9*	46.8	<0.08	2.0	***24.5***	2.3
Camp 7	Little Dry Cr. (Valley)	**208**	*3.9*	*<0.064*	3.0	20.1	20.2	**476**	*4.0*	24.7	<0.08	1.8	*<0.064*	8.1
Camp 8	Clear Cr. (Valley)	**318**	*13.6*	*6.5*	2.7	16.7	14.9	47	*4.0*	29.2	<0.08	2.5	***12.8***	1.2
Camp 9	Dry Cr. (Valley)	190	*<0.16*	*5.2*	2.6	17.7	17.4	97	*3.5*	39.5	<0.08	1.3	*<0.064*	0.4
Camp 10	Lake Oroville (WB)	**210**	*8.7*	*4.2*	2.6	17.7	16.1	59	*1.8*	<6.37	<0.08	3.2	***13.5***	<0.032

Sample ID	Station Name	PAH DETAILED RESULTS																						
	Analyte:	**Sum PAHs**	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Carbazole	Chrysene	Dibenz(a,h)anthracene	Dinitrotoluene, 2,4-	Dinitrotoluene, 2,6-	Fluoranthene	Fluorene	indeno(1,2,3-c,d)pyrene	Isophorone	Methylnaphthalene, 2-	Naphthalene	Nitrobenzene	Phenanthrene	Pyrene	Sum LMW PAHs	Sum HMW PAHs
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																			
	Human Health Threshold*:		70		300	0.0044	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20															0.049			21					
	Aquatic Life Threshold:		52		110,000											370	14,000				62			11,000		
Camp 1	Butte Cr. (BCK Gage)	0.14	<0.0005	<0.0005	<0.0006	<0.0005	<0.0005	<0.0006	<0.0005	<0.0005	<0.0001	<0.0005	<0.0006	<0.0001	<0.0001	<0.0006	0.14	<0.0006	<0.0001	<0.0001	<0.0005	<0.0001	<0.0006	<0.0005	0.140	0.000
Camp 2	Butte Cr. (Control)	ND	<0.0005	<0.0005	<0.0006	<0.0005	<0.0005	<0.0006	<0.0005	<0.0005	<0.0001	<0.0005	<0.0006	<0.0001	<0.0001	<0.0006	<0.0006	<0.0006	<0.0001	<0.0001	<0.0005	<0.0001	<0.0006	<0.0005	0.000	0.000
Camp 3	Little Butte Cr.	ND	<0.0005	<0.0005	<0.0006	<0.0005	<0.0005	<0.0006	<0.0005	<0.0005	<0.0001	<0.0005	<0.0006	<0.0001	<0.0001	<0.0006	<0.0006	<0.0006	<0.0001	<0.0001	<0.0005	<0.0001	<0.0006	<0.0005	0.000	0.000
Camp 4	Hamlin Cr. (Paradise)	ND	<0.0006	<0.0006	<0.0007	<0.0006	<0.0006	<0.0007	<0.0006	<0.0006	<0.0001	<0.0006	<0.0007	<0.0001	<0.0001	<0.0007	<0.0007	<0.0007	<0.0001	<0.0001	<0.0006	<0.0001	<0.0006	<0.0006	0.000	0.000
Camp 5	Clear Cr. (Paradise)	ND	<0.0006	<0.0006	<0.0007	<0.0006	<0.0006	<0.0007	<0.0006	<0.0006	<0.0001	<0.0006	<0.0007	<0.0001	<0.0001	<0.0007	<0.0007	<0.0007	<0.0001	<0.0001	<0.0006	<0.0001	<0.0006	<0.0006	0.000	0.000
Camp 6	Dry Cr. (Paradise)	ND	<0.0005	<0.0006	<0.0006	<0.0005	<0.0006	<0.0007	<0.0006	<0.0006	<0.0001	<0.0006	<0.0006	<0.0001	<0.0001	<0.0006	<0.0006	<0.0006	<0.0001	<0.0001	<0.0006	<0.0001	<0.0006	<0.0006	0.000	0.000
Camp 7	Little Dry Cr. (Valley)	ND	<0.0005	<0.0006	<0.0006	<0.0005	<0.0006	<0.0007	<0.0006	<0.0006	<0.0001	<0.0006	<0.0006	<0.0001	<0.0001	<0.0006	<0.0006	<0.0006	<0.0001	<0.0001	<0.0006	<0.0001	<0.0006	<0.0006	0.000	0.000
Camp 8	Clear Cr. (Valley)	ND	<0.0005	<0.0006	<0.0006	<0.0005	<0.0006	<0.0007	<0.0006	<0.0006	<0.0001	<0.0006	<0.0006	<0.0001	<0.0001	<0.0006	<0.0006	<0.0006	<0.0001	<0.0001	<0.0006	<0.0001	<0.0006	<0.0006	0.000	0.000
Camp 9	Dry Cr. (Valley)	ND	<0.0005	<0.0006	<0.0006	<0.0005	<0.0006	<0.0007	<0.0006	<0.0006	<0.0001	<0.0006	<0.0006	<0.0001	<0.0001	<0.0006	<0.0006	<0.0006	<0.0001	<0.0001	<0.0006	<0.0001	<0.0006	<0.0006	0.000	0.000
Camp 10	Lake Oroville (WB)	ND	<0.0005	<0.0006	<0.0006	<0.0005	<0.0006	<0.0007	<0.0006	<0.0006	<0.0001	<0.0006	<0.0006	<0.0001	<0.0001	<0.0006	<0.0006	<0.0006	<0.0001	<0.0001	<0.0006	<0.0001	<0.0006	<0.0006	0.000	0.000

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

CAMP POST-FIRE WATER QUALITY MONITORING PRELIMINARY RESULTS

Sampling conducted by the Central Valley Regional Water Quality Control Board (Central Valley Water Board), Department of Water Resources (DWR) and Department of Transportation (Caltrans)

NOTE: Results are preliminary and have not been finalized for distrubtion to the general public

Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

03/27/2019 Sampling Event

Sample ID	**Station Name**	**NUTRIENTS, MINERALS, SOLIDS**														**BACTERIA**		**FIELD MEASUREMENTS**				
	Analyte:	**Alkalinity**	**Ammonia**	**Hardness**	**Nitrate**	**Nitrite**	**Nitrite+Nitrate**	**TKN**	**OrthoPhosphate**	**Phosphorus**	**Sulfate**	**SS**	**TDS**	**TOC**	**TSS**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 4500		SM 4500	SM 4500	Calculated		SM 4500-P E	EPA 365.1	EPA 300.0	SM 2540 F	SM 2540 C	EPA 415.3	SM 2540 D			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	mg/L	mg/L	mg/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Total	Total	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Total	Particulate	Total	Total					
	Primary MCL:				10	1	10															
	Secondary MCL:		1.5								250		500					900		6.5-8.5		5
	Bacteria Objective:															320						
	Aquatic Life Threshold:	20	formula																>7.0	6.5-9		
	Agrigulture Threshold												450					700		6.5-8.4		
Camp 1	Butte Cr. (BCK Gage)	**35**	<0.20	30	0.66		0.162	<0.20	<0.05	0.017	1.73		54	1	5			74.0	11.37	7.41	9.4	4.75
Camp 2	Butte Cr. (Control)	**33**	0.24	25	<0.1		<0.05	<0.20	<0.05	0.014	1.17		50	0.8	2			66.0	11.74	7.33	8.6	8.29
Camp 3	Little Butte Cr.	**37**	<0.20	36	3.21		0.731	<0.20	<0.05	0.02	2.86		72	1	7			91.0	10.82	7.37	11.1	8.97
Camp 4	Hamlin Cr. (Paradise)				2.14	0.01	2.15			0.08		ND		0.91	10.20			96.7	10.36	7.39	11.2	20.6
Camp 5	Clear Cr. (Paradise)				1.19	0.03	1.22			0.18		0.22		1.30	57.90			47.6	10.59	7.42	10.5	66.0
Camp 6	Dry Cr. (Paradise)				1.66	0.01	1.67			0.13		0.06		0.75	20.20			75.5	10.39	7.62	11.1	25.6
Camp 7	Little Dry Cr. (Valley)				0.89	0.01	0.90			0.16		ND		2.78	7.89			102.0	10.48	7.75	12.1	9.0
Camp 8	Clear Cr. (Valley)				0.81	0.02	0.83			0.21		ND		3.84	15.00			127.9	10.46	7.79	12.1	12.3
Camp 9	Dry Cr. (Valley)				1.16	0.01	1.17			0.17		ND		2.12	13.20			108.6	10.64	7.69	11.8	7.7

Sample ID	**Station Name**	**TOTAL METALS**												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610		formula			1,000			0.05			120
	Agrigulture Threshold	5,000		100	10		200	5,000	5,000	200		200	20	
Camp 1	Butte Cr. (BCK Gage)						0.462	96.5	<0.04	3.5	<0.2	1.01	<0.2	0.296
Camp 2	Butte Cr. (Control)						0.348	45.7	<0.04	1.22	<0.2	0.762	<0.2	0.172
Camp 3	Little Butte Cr.						0.649	199	0.14	17.3	<0.2	1.85	<0.2	0.783
Camp 4	Hamlin Cr. (Paradise)	**585**	**48**	**37.4**	**5.3**	27.6	26.1	**511**	**93.8**	27.9	**0.3**	18.5	**126**	24.9
Camp 5	Clear Cr. (Paradise)	**2,070**	**64**	**39.6**	4.6	30.5	30.8	**1440**	**100.0**	**71.3**	**0.4**	23.5	**142**	71.5
Camp 6	Dry Cr. (Paradise)	**863**	**214**	**41.4**	4.6	29.1	27.7	**709**	**99.3**	33.1	**0.4**	18.4	**140**	20.0
Camp 7	Little Dry Cr. (Valley)	**805**	**300**	**39.6**	4.5	27.1	27.1	**630**	**99.4**	26	**0.6**	18.2	**128**	13.1
Camp 8	Clear Cr. (Valley)	**1,090**	**144**	**42.1**	4.9	30.6	28.2	**836**	**102.0**	32	**0.6**	20.8	**141**	15.6
Camp 9	Dry Cr. (Valley)	**720**	**83**	**41.0**	4.9	30.2	28.6	**624**	**107.0**	22.7	**0.8**	19.9	**136**	13.4

LEGEND

Result > Primary MCL
Result > Secondary MCL
Result > Bacteria Water Quality Objective
Result > Aquatic Life Threshold
Result > Agricuture Threshold
Result > MCL and Aquatic Life Threshold
Result > MCL and Agricuture Threshold
Estimated Result (sample did not pass QAQC)
Pending or No Result

Sample ID	**Station Name**	**DISSOLVED METALS**												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610	150	formula		9	1,000	2.5			52	5	120
	Agrigulture Threshold	5,000					200	5,000	5,000	200			20	
Camp 1	Butte Cr. (BCK Gage)						0.332	11.9	<0.04	0.225		0.767	<0.2	<0.1
Camp 2	Butte Cr. (Control)						0.257	16.5	<0.04	0.172		0.522	<0.2	<0.1
Camp 3	Little Butte Cr.						0.326	43.3	<0.04	0.306		0.86	<0.2	0.11
Camp 4	Hamlin Cr. (Paradise)	**252**	**80**	**41.2**	**5.4**	29.1	27.9	**335**	**104.0**	<6.37	<0.08	17.5	**150**	15.0
Camp 5	Clear Cr. (Paradise)	**291**	**20**	**46.2**	**7.5**	27.9	27.9	**336**	**106.0**	<6.37	<0.08	18.9	**149**	27.6
Camp 6	Dry Cr. (Paradise)	**268**	**50**	**42.1**	**5.2**	29.5	29	**345**	**108.0**	<6.37	<0.08	18.5	**145**	15.7
Camp 7	Little Dry Cr. (Valley)	**262**	<0.16	**45.0**	**5.0**	29.5	29	**348**	**109.0**	<6.37	<0.08	18.6	**162**	11.0
Camp 8	Clear Cr. (Valley)	**300**	<0.16	**44.7**	**5.4**	30.7	37.1	**385**	**113.0**	<6.37	**0.3**	21.6	**157**	28.6
Camp 9	Dry Cr. (Valley)	**299**	**10**	**50.2**	**5.9**	34.1	43.9	**414**	**123.0**	<6.37	**0.2**	24.4	**170**	39.0

Sample ID	**Station Name**	**PAH DETAILED RESULTS**																								
	Analyte:	**Sum PAHs**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a)pyrene**	**Benzo(b)fluoranthene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Carbazole**	**Chrysene**	**Dibenz(a,h)anthracene**	**Dinitrotoluene, 2,4-**	**Dinitrotoluene, 2,6-**	**Fluoranthene**	**Fluorene**	**indeno(1,2,3-c,d)pyrene**	**Isophorone**	**Methylnaphthalene, 2-**	**Naphthalene**	**Nitrobenzene**	**Phenanthrene**	**Pyrene**	**Sum LMW PAHs**	**Sum HMW PAHs**
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																			
	Human Health Threshold*:		70		300	0.0044	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20															0.049			21					
	Aquatic Life Threshold:		52		110,000											370	14,000				62			11,000		
Camp 1	Butte Cr. (BCK Gage)	0.63	0.03	0.02	0.02	**0.05**	**0.04**	**0.04**	0.05	**0.04**	0.03	**0.03**	**0.06**	<0.000002	<0.000002	0.03	0.03	**0.06**	<0.000002	<0.000002	0.03	<0.000002	0.04	0.03	0.17	0.46
Camp 2	Butte Cr. (Control)	0.55	0.01	<0.000008	0.02	**0.04**	**0.04**	**0.05**	0.04	**0.04**	0.02	**0.04**	**0.04**	<0.000002	<0.000002	0.03	0.02	**0.06**	<0.000002	0.02	0.02	<0.000002	0.04	0.02	0.13	0.42
Camp 3	Little Butte Cr.	0.01	<0.000008	<0.000008	<0.000009	<0.000008	<0.000008	<0.00001	<0.000009	<0.000008	<0.000002	<0.000009	<0.000009	<0.000002	<0.000002	<0.000009	<0.000009	<0.00001	<0.000002	<0.000002	<0.000008	<0.000002	0.01	<0.000009	0.01	0.00
Camp 4	Hamlin Cr. (Paradise)	0.31	<0.000008	<0.000008	0.01	**0.02**	**0.02**	**0.03**	0.02	**0.02**	0.02	**0.02**	**0.03**	<0.000002	<0.000002	0.02	0.01	**0.03**	<0.000002	<0.000002	0.01	<0.000002	0.03	0.02	0.06	0.25
Camp 5	Clear Cr. (Paradise)	0.66	0.02	0.01	0.02	<0.000008	**0.05**	**0.06**	0.04	**0.04**	0.03	**0.04**	**0.05**	<0.000002	<0.000002	0.05	0.02	**0.08**	<0.000002	0.02	0.02	<0.000002	0.06	0.05	0.17	0.49
Camp 6	Dry Cr. (Paradise)	0.55	0.02	<0.000008	0.02	**0.04**	**0.04**	**0.05**	0.03	**0.04**	0.02	**0.04**	**0.04**	<0.000002	<0.000002	0.03	0.02	**0.05**	<0.000002	0.01	0.02	<0.000002	0.04	0.04	0.13	0.42
Camp 7	Little Dry Cr. (Valley)	0.18	<0.000008	<0.000008	0.01	<0.000008	**0.01**	**0.01**	<0.000009	**0.01**	0.01	**0.01**	**0.01**	<0.000002	<0.000002	0.03	0.01	**0.02**	<0.000002	<0.000002	<0.000008	<0.000002	0.03	0.02	0.05	0.13
Camp 8	Clear Cr. (Valley)	0.52	0.02	<0.000008	0.03	**0.04**	**0.03**	**0.04**	0.03	**0.03**	0.03	**0.03**	**0.04**	<0.000002	<0.000002	0.03	0.02	**0.05**	<0.000002	0.01	0.02	<0.000002	0.04	0.03	0.14	0.38
Camp 9	Dry Cr. (Valley)	0.31	0.02	<0.000008	0.02	<0.000008	**0.02**	**0.02**	0.01	**0.02**	0.01	**0.02**	**0.02**	<0.000002	<0.000002	0.02	0.02	**0.02**	<0.000002	0.01	0.02	<0.000002	0.04	0.02	0.13	0.18

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

CAMP POST<FIRE WATER QUALITY MONITORING PRELIMINARY RESULTS

Sampling conducted by the Central Valley Regional Water Quality Control Board (Central Valley Water Board), Department of Water Resources (DWR) and Department of Transportation (Caltrans)

NOTE: Results are preliminary and are considered draft

Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

05/15/2019 Sampling Event

Sample ID	Station Name	NUTRIENTS, MINERALS, SOLIDS														BACTERIA		FIELD MEASUREMENTS				
	Analyte:	**Alkalinity**	**Ammonia**	**Hardness**	**Nitrate**	**Nitrite**	**Nitrite+Nitrate**	**TKN**	**OrthoPhosphate**	**Phosphorus**	**Sulfate**	**SS**	**TDS**	**TOC**	**TSS**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 4500		SM 4500	SM 4500	Calculated		SM 4500<P E	EPA 365.1	EPA 300.0	SM 2540 F	SM 2540 C	EPA 415.3	SM 2540 D			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	mg/L	mg/L	mg/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Total	Total	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Total	Particulate	Total	Total					
	Primary MCL:				10	1	10															
	Secondary MCL:		1.5								250		500					900		6.5-8.5		5
	Bacteria Objective:															320						
	Aquatic Life Threshold:	20	formula																>7.0	6.5-9		
	Agrigulture Threshold												450					700		6.5-8.4		
Camp 1	Butte Cr. (BCK Gage)		0.13					<0.10				<0.1						70	10.9	7.1	11.7	1.26
Camp 2	Butte Cr. (Control)		0.14					<0.10				<0.1						64	11.1	7.2	10.6	1.58
Camp 3	Little Butte Cr.		<0.10					<0.10				<0.1						117	9.9	7.8	15.6	1.25
Camp 4	Hamlin Cr. (Paradise)	**31.4**	<0.001	40	1.45	<0.002	1.45	<0.04	0.03	0.19	8.77	0	74	0.34	1.57	6.3	2419.6	100	9.4	7.4	15.2	8.45
Camp 5	Clear Cr. (Paradise)	15.6	<0.001	26	1.60	0.01	1.61	<0.04	0.03	0.18	7.44	0.1	62	2.38	13.3	45.0	2419.6	64	9.7	7.3	14.1	34.7
Camp 6	Dry Cr. (Paradise)	**28.8**	<0.001	38	1.39	<0.002	1.39	<0.04	0.04	0.21	6.55	0	80	0.23	1.97	41.4	2419.6	83	9.7	7.5	13.6	3.52
Camp 7	Little Dry Cr. (Valley)	**51.2**	<0.001	65	0.70	<0.002	0.70	<0.04	0.04	0.35	7.39	0	101	1.14	3.55	**770.1**	2419.6	129	8.6	7.7	19.0	2.24
Camp 8	Clear Cr. (Valley)	**65.6**	<0.001	69	0.44	<0.002	0.44	<0.04	0.07	0.40	7.40	0	113	0.92	<0.5	248.1	2419.6	154	9.3	7.8	16.6	2.43
Camp 9	Dry Cr. (Valley)	**49.0**	<0.001	54	1.00	<0.002	1.00	<0.04	0.06	0.39	7.60	0	101	0.47	<0.5	203.5	2419.6	122	9.6	7.7	15.9	1.72

Sample ID	Station Name	TOTAL METALS												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610		formula			1,000			0.05			120
	Agrigulture Threshold	5,000		100	10		200	5,000	5,000	200		200	20	
Camp 1	Butte Cr. (BCK Gage)										<0.2			
Camp 2	Butte Cr. (Control)										<0.2			
Camp 3	Little Butte Cr.										<0.2			
Camp 4	Hamlin Cr. (Paradise)	56	1.4	<1.7	<0.1	<0.1	<0.05	40	***82.5***	17.8	**1.4**	<0.6	<0.12	<0.04
Camp 5	Clear Cr. (Paradise)	**229**	2.5	<1.7	<0.1	<0.082	<0.05	70	***38.7***	20.7	**0.7**	<0.6	<0.12	8.0
Camp 6	Dry Cr. (Paradise)	72	4.4	<1.7	<0.1	<0.082	<0.05	40	***16.3***	16.8	**0.6**	<0.6	<0.12	<0.04
Camp 7	Little Dry Cr. (Valley)	84	**8.1**	<1.7	<0.1	<0.082	77.7	70	***84.0***	28.6	**0.9**	44.7	<0.12	2.0
Camp 8	Clear Cr. (Valley)	121	**8.1**	3.1	<0.1	1.53	1.19	80	*4.7*	45	**1.0**	0.9	<0.12	0.6
Camp 9	Dry Cr. (Valley)	50	1.7	<1.7	<0.1	<0.082	<0.05	110	***23.5***	10.2	**0.9**	<0.6	<0.12	<0.04

LEGEND

Result > Primary MCL

Result > Secondary MCL

Result > Bacteria Water Quality Objective

Result > Aquatic Life Threshold

Result > Agricuture Threshold

Result > MCL and Aquatic Life Threshold

Result > MCL and Agricuture Threshold

Estimated Result (sample did not pass QAQC)

Pending or No Result

Sample ID	Station Name	DISSOLVED METALS												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610	150	formula		9	1,000	2.5			52	5	120
	Agrigulture Threshold	5,000					200	5,000	5,000	200			20	
Camp 1	Butte Cr. (BCK Gage)													
Camp 2	Butte Cr. (Control)													
Camp 3	Little Butte Cr.													
Camp 4	Hamlin Cr. (Paradise)	*48*	<0.16	<0.1	<0.1	<0.159	<0.032	*52*	<0.2	<6.37	<0.08	<0.032	<0.064	<0.032
Camp 5	Clear Cr. (Paradise)	*83*	<0.16	<0.1	<0.1	<0.159	<0.032	*110*	<0.2	<6.37	**0.28**	<0.032	**23.6**	6.9
Camp 6	Dry Cr. (Paradise)	*43*	<0.16	<0.1	<0.1	<0.159	<0.032	*48*	**99.9**	<6.37	**0.80**	<0.032	**8.5**	<0.032
Camp 7	Little Dry Cr. (Valley)	*22*	<0.16	3.3	<0.1	<0.159	<0.032	*50*	**126.0**	<6.37	<0.08	<0.032	<0.064	<0.032
Camp 8	Clear Cr. (Valley)	*39*	<0.16	<0.1	<0.1	<0.159	<0.032	*71*	<0.2	<6.37	<0.08	<0.032	4.8	<0.032
Camp 9	Dry Cr. (Valley)	*47*	**42**	**50.6**	**5.4**	22.4	1.75	***400***	<0.2	<6.37	<0.08	13.8	<0.064	<0.032

Sample ID	Station Name	PAH DETAILED RESULTS																								
	Analyte:	**Sum PAHs**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a)pyrene**	**Benzo(b)fluoranthene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Carbazole**	**Chrysene**	**Dibenz(a,h)anthracene**	**Dinitrotoluene, 2,4<**	**Dinitrotoluene, 2,6<**	**Fluoranthene**	**Fluorene**	**indeno(1,2,3<c,d)pyrene**	**Isophorone**	**Methylnaphthalene, 2<**	**Naphthalene**	**Nitrobenzene**	**Phenanthrene**	**Pyrene**	**Sum LMW PAHs**	**Sum HMW PAHs**
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																			
	Human Health Threshold*:		70		300	0.0044	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20															0.049			21					
	Aquatic Life Threshold:		52		110,000											370	14,000				62			11,000		
Camp 1	Butte Cr. (BCK Gage)	0.00	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0005	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 2	Butte Cr. (Control)																								0.00	0.00
Camp 3	Little Butte Cr.	0.30	<0.0004	<0.0004	0.01	**0.03**	**0.02**	**0.02**	0.03	**0.02**	<0.0001	**0.02**	**0.04**	<0.0001	<0.0001	0.02	0.01	**0.04**	<0.0001	<0.0001	<0.0004	<0.0001	0.02	0.02	0.04	0.26
Camp 4	Hamlin Cr. (Paradise)	0.23	<0.0004	<0.0004	<0.0005	**0.02**	**0.02**	**0.02**	0.03	**0.02**	<0.0001	**0.01**	**0.06**	<0.0001	<0.0001	<0.0005	<0.0005	**0.05**	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.23
Camp 5	Clear Cr. (Paradise)	0.29	<0.0004	<0.0004	0.02	**0.02**	**0.01**	**0.02**	0.03	**0.01**	<0.0001	**0.02**	**0.03**	<0.0001	<0.0001	0.03	0.01	**0.04**	<0.0001	<0.0001	<0.0004	<0.0001	0.03	0.02	0.06	0.23
Camp 6	Dry Cr. (Paradise)	0.17	<0.0004	<0.0004	<0.0005	**0.02**	**0.01**	**0.01**	0.02	**0.01**	<0.0001	**0.01**	**0.03**	<0.0001	<0.0001	0.01	<0.0005	**0.03**	<0.0001	<0.0001	<0.0004	<0.0001	0.01	0.01	0.01	0.16
Camp 7	Little Dry Cr. (Valley)	0.29	<0.0004	<0.0004	0.02	**0.02**	**0.02**	**0.02**	0.03	**0.01**	<0.0001	**0.02**	**0.04**	<0.0001	<0.0001	0.02	0.02	**0.04**	<0.0001	<0.0001	<0.0004	<0.0001	0.02	0.01	0.06	0.23
Camp 8	Clear Cr. (Valley)																								0.00	0.00
Camp 9	Dry Cr. (Valley)																								0.00	0.00

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

CAMP POST<FIRE WATER QUALITY MONITORING PRELIMINARY RESULTS

Sampling conducted by the Central Valley Regional Water Quality Control Board (Central Valley Water Board), Department of Water Resources (DWR) and Department of Transportation (Caltrans)
Analysis performed by Delta Environmental Laboratory.

NOTE: Results are preliminary and are considered draft
Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

11/13/2019 Sampling Event

Sample ID	Station Name	NUTRIENTS, MINERALS, SOLIDS														BACTERIA		FIELD MEASUREMENTS				
	Analyte:	**Alkalinity**	**Ammonia**	**Hardness**	**Nitrate**	**Nitrite**	**Nitrite+Nitrate**	**TKN**	**OrthoPhosphate**	**Phosphorus**	**Sulfate**	**SS**	**TDS**	**TOC**	**TSS**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 4500	SM 2340 B	SM 4500	SM 4500	Calculated		SM 4500<P E	EPA 365.1	EPA 300.0	SM 2540 F	SM 2540 C	EPA 415.3	SM 2540 D			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	mg/L	mg/L	mg/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Total	Total	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Total	Particulate	Total	Total					
	Primary MCL:				10	1	10															
	Secondary MCL:		1.5								250		500					900		6.5-8.5		5
	Bacteria Objective:															320						
	Aquatic Life Threshold:	20	formula																>7.0	6.5-9		
	Agrigulture Threshold												450					700		6.5-8.4		
Camp 1	Butte Cr. (BCK Gage)	**51**	<0.001	57	0.04	<0.002	0.04	<0.1	*<0.0001*	0.024	1.51	<0.25	106	2.49	0.89	9.8						
Camp 2	Butte Cr. (Control)	**52**	0.012	51	0.03	<0.002	0.03	<0.1	*0.03*	0.020	1.05	<0.25	101	0.81	<0.5							
Camp 3	Little Butte Cr.	**53**	0.021	71	0.11	<0.002	0.11	<0.1	*0.02*	0.017	5.13	<0.25	125	0.974	0.73	12.1						
Camp 4	Hamlin Cr. (Paradise)	**44**	0.033	39	1.04	0.0024	1.04	<0.1	*0.02*	0.024	2.20	<0.25	87	1.02	1.58	**435.2**						
Camp 5	Clear Cr. (Paradise)	19	0.027	18	1.04	<0.002	1.04	<0.1	*0.02*	0.024	1.07	<0.25	52	0.56	1.33	57.1						
Camp 6	Dry Cr. (Paradise)	**39**	0.012	36	1.13	<0.002	1.13	<0.1	*0.02*	0.014	0.83	<0.25	79	0.66	<0.5	47.1						
Camp 7	Little Dry Cr. (Valley)																					
Camp 8	Clear Cr. (Valley)	**54**	0.015	80	0.19	<0.002	0.19	<0.1	*0.02*	0.027	2.81	<0.25	152	1.58	0.67	129.6						
Camp 9	Dry Cr. (Valley)	**53**	0.006	66	0.30	<0.002	0.30	<0.1	*0.01*	0.030	1.36	<0.25	134	1.31	<0.5	**517.2**						

Sample ID	Station Name	TOTAL METALS												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610		formula			1,000			0.05			120
	Agrigulture Threshold	5,000		100	10		200	5,000	5,000	200		200	20	
Camp 1	Butte Cr. (BCK Gage)	14	<0.1	<1.7	<0.1	*1.00*	<0.05	*42*	<0.25	<0.23	<0.0001	0.62	*7.31*	*1.44*
Camp 2	Butte Cr. (Control)	15	<0.1	<1.7	<0.1	*1.50*	<0.05	*3000*	<0.25	<0.23	<0.0001	0.61	*6.48*	*7.8*
Camp 3	Little Butte Cr.	33	<0.1	<1.7	<0.1	*2.34*	<0.05	*73*	<0.25	7.6	<0.0001	0.93	*6.44*	*0.64*
Camp 4	Hamlin Cr. (Paradise)	126	<0.1	<1.7	<0.1	*2.2*	<0.05	*2540*	<0.25	33.6	<0.0001	<0.60	*7.02*	*1.8*
Camp 5	Clear Cr. (Paradise)	163	<0.1	<1.7	<0.1	*2.54*	<0.05	*119*	<0.25	5.3	<0.0001	<0.60	*6.9*	*9.5*
Camp 6	Dry Cr. (Paradise)	63	<0.1	<1.7	<0.1	*2.65*	<0.05	*2530*	<0.25	15.3	<0.0001	<0.60	*7.61*	*7.9*
Camp 7	Little Dry Cr. (Valley)													
Camp 8	Clear Cr. (Valley)	98	<0.1	<1.7	<0.1	*3.37*	<0.05	*151*	<0.25	8	<0.0001	2.4	*7.77*	*0.8*
Camp 9	Dry Cr. (Valley)	58	<0.1	<1.7	<0.1	*3.65*	<0.05	*124*	<0.25	<0.23	<0.0001	1.0	*8.4*	*1.1*

LEGEND
Result > Primary MCL
Result > Secondary MCL
Result > Bacteria Water Quality Objective
Result > Aquatic Life Threshold
Result > Agricuture Threshold
Result > MCL and Aquatic Life Threshold
Result > MCL and Agricuture Threshold
Estimated Result (sample did not pass QAQC)
Pending or No Result

Sample ID	Station Name	DISSOLVED METALS												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610	150	formula		9	1,000	2.5			52	5	120
	Agrigulture Threshold	5,000					200	5,000	5,000	200			20	
Camp 1	Butte Cr. (BCK Gage)	*4.2*	<0.2	<0.1	<0.1	<0.16	<0.032	<6.4	<0.2	<6.4	<0.08	<0.032	<0.064	*1.5*
Camp 2	Butte Cr. (Control)	*4.6*	<0.2	<0.1	<0.1	<0.16	<0.032	35.5	<0.2	<6.4	<0.08	<0.032	<0.064	*1.4*
Camp 3	Little Butte Cr.	*4.4*	<0.2	<0.1	<0.1	<0.16	<0.032	<6.4	<0.2	<6.4	<0.08	<0.032	<0.064	*2.6*
Camp 4	Hamlin Cr. (Paradise)	*20.5*	<0.2	<0.1	<0.1	<0.16	<0.032	41	<0.2	<6.4	<0.08	<0.032	<0.064	*3.9*
Camp 5	Clear Cr. (Paradise)	*47.8*	<0.2	<0.1	<0.1	<0.16	<0.032	*33*	<0.2	<6.4	<0.08	<0.032	<0.064	*13.8*
Camp 6	Dry Cr. (Paradise)	*30.1*	<0.2	<0.1	<0.1	0.528	<0.032	21	<0.2	<6.4	<0.08	<0.032	<0.064	*1.3*
Camp 7	Little Dry Cr. (Valley)													
Camp 8	Clear Cr. (Valley)	*31.2*	<0.2	<0.1	<0.1	<0.16	<0.032	23	<0.2	<6.4	<0.08	<0.032	<0.064	*1.9*
Camp 9	Dry Cr. (Valley)	*5.1*	<0.2	<0.1	<0.1	<0.16	<0.032	26	<0.2	<6.4	<0.08	<0.032	<0.064	*2.0*

Sample ID	Station Name	PAH DETAILED RESULTS																								
	Analyte:	**Sum PAHs**	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Carbazole	Chrysene	Dibenz(a,h)anthracene	Dinitrotoluene, 2,4<	Dinitrotoluene, 2,6<	Fluoranthene	Fluorene	indeno(1,2,3<c,d)pyrene	Isophorone	Methylnaphthalene, 2<	Naphthalene	Nitrobenzene	Phenanthrene	Pyrene	Sum LMW PAHs	Sum HMW PAHs
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																			
	Human Health Threshold*:		70		300	0.0044	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20															0.049			21					
	Aquatic Life Threshold:		52		110,000											370	14,000				62			11,000		
Camp 1	Butte Cr. (BCK Gage)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 2	Butte Cr. (Control)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 3	Little Butte Cr.	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 4	Hamlin Cr. (Paradise)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 5	Clear Cr. (Paradise)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 6	Dry Cr. (Paradise)	0.02	<0.0004	<0.0004	0.02	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.02	0.00
Camp 7	Little Dry Cr. (Valley)																									
Camp 8	Clear Cr. (Valley)	ND	<0.0004	<0.0004	<0.0005	0.00	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 9	Dry Cr. (Valley)	ND	<0.0004	<0.0004	<0.0005	0.00	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

Sample ID	Station Name	PCB DETAILED RESULTS								
	Analyte:	**Sum PCBs**	PCB 1262	PCB 1268	PCB AROCLOR 1016	PCB AROCLOR 1221	PCB AROCLOR 1232	PCB AROCLOR 1242	PCB AROCLOR 1248	PCB AROCLOR 1254	PCB AROCLOR 1260
	Method:	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082
	Units:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:										
	Human Health Threshold*:										
	Taste & Odor Threshold:										
	Aquatic Life Threshold:										
Camp 1	Butte Cr. (BCK Gage)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 2	Butte Cr. (Control)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 3	Little Butte Cr.	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 4	Hamlin Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 5	Clear Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 6	Dry Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 7	Little Dry Cr. (Valley)										
Camp 8	Clear Cr. (Valley)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 9	Dry Cr. (Valley)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

CAMP POST<FIRE WATER QUALITY MONITORING PRELIMINARY RESULTS

Sampling conducted by the Central Valley Regional Water Quality Control Board (Central Valley Water Board), Department of Water Resources (DWR) and Department of Transportation (Caltrans)
Analysis performed by Delta Environmental Laboratory.

NOTE: Results are preliminary and are considered draft
Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

12/19/2019 Sampling Event

Sample ID	Station Name	NUTRIENTS, MINERALS, SOLIDS														BACTERIA		FIELD MEASUREMENTS				
	Analyte:	**Alkalinity**	**Ammonia**	**Hardness**	**Nitrate**	**Nitrite**	**Nitrite+Nitrate**	**TKN**	**OrthoPhosphate**	**Phosphorus**	**Sulfate**	**SS**	**TDS**	**TOC**	**TSS**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 4500		SM 4500	SM 4500	Calculated		SM 4500<P E	EPA 365.1	EPA 300.0	SM 2540 F	SM 2540 C	EPA 415.3	SM 2540 D			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	mg/L	mg/L	mg/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Total	Total	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Total	Particulate	Total	Total					
	Primary MCL:				10	1	10															
	Secondary MCL:		1.5								250		500					900		6.5-8.5		5
	Bacteria Objective:															320						
	Aquatic Life Threshold:	20	formula																>7.0	6.5-9		
	Agrigulture Threshold												450					700		6.5-8.4		
Camp 1	Butte Cr. (BCK Gage)	**49**	<0.001	47	0.10	<0.002	0.10	<0.1	<0.0001	0.01	2.35	<0.25	90	0.87	<0.50	13.4						
Camp 2	Butte Cr. (Control)	**48**	0.019	44	0.01	<0.002	0.01	<0.1	<0.0001	0.01	1.51	<0.25	81	0.80	0.98	12.1						
Camp 3	Little Butte Cr.	**50**	<0.001	54	0.76	<0.002	0.76	<0.1	<0.0001	0.01	4.82	<0.25	105	1.18	1.85	121						
Camp 4	Hamlin Cr. (Paradise)	**34**	<0.001	37	2.54	<0.002	2.54	<0.1	<0.0001	0.01	4.96	<0.25	98	0.75	2.26	77.6						
Camp 5	Clear Cr. (Paradise)	15	<0.001	21	1.93	<0.002	1.93	<0.1	<0.0001	0.01	1.79	<0.25	55	0.44	2.40	58.1						
Camp 6	Dry Cr. (Paradise)	**28**	<0.001	30	1.84	<0.002	1.84	<0.1	<0.0001	0.02	1.42	<0.25	72	0.48	1.11	307.6						
Camp 7	Little Dry Cr. (Valley)	**48**	<0.001	53	2.07	<0.002	2.07	<0.1	<0.0001	0.02	3.64	<0.25	108	1.75	<0.50	83.6						
Camp 8	Clear Cr. (Valley)	**52**	0.025	74	1.25	0.02	1.27	<0.1	0.003	0.03	4.06	<0.25	157	3.28	3.11	**866.4**						
Camp 9	Dry Cr. (Valley)	**50**	<0.001	57	1.42	<0.002	1.42	<0.1	<0.0001	0.02	3.36	<0.25	116	2.04	1.00	224.7						

Sample ID	Station Name	TOTAL METALS												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610		formula			1,000			0.05			120
	Agrigulture Threshold	5,000		100	10		200	5,000	5,000	200		200	20	
Camp 1	Butte Cr. (BCK Gage)	***29***	<0.15	<0.05	<0.15	*1.5*	<0.05	***58***	<0.5	*4.3*	***5.3***	<0.33	*5.0*	*1.3*
Camp 2	Butte Cr. (Control)	***33***	<0.15	<0.05	<0.15	*2.0*	<0.05	***101***	<0.5	*2.6*	***8.4***	<0.33	*4.5*	*4.2*
Camp 3	Little Butte Cr.	***72***	<0.15	<0.05	<0.15	*2.3*	<0.05	***120***	<0.5	*9.1*	***5.6***	1.22	*4.1*	*<0.4*
Camp 4	Hamlin Cr. (Paradise)	*142*	<0.15	<0.05	<0.15	*1.9*	<0.05	*176*	<0.5	*17.0*	***4.9***	<0.33	*4.2*	*2.2*
Camp 5	Clear Cr. (Paradise)	***220***	<0.15	<0.05	<0.15	*1.9*	<0.05	*214*	<0.5	*8.4*	***5.1***	<0.33	*4.0*	*5.8*
Camp 6	Dry Cr. (Paradise)	*118*	<0.15	<0.05	<0.15	*2.2*	<0.05	*131*	<0.5	*5.7*	***3.8***	<0.33	*3.8*	*<0.4*
Camp 7	Little Dry Cr. (Valley)	*43*	<0.15	<0.05	<0.15	*1.8*	<0.05	*88*	<0.5	*2.5*	***4.3***	<0.33	*4.0*	*<0.4*
Camp 8	Clear Cr. (Valley)	***2,300***	<0.15	<0.05	<0.15	*5.3*	1.51	***1940***	<0.5	*33.5*	***2.2***	3.45	*3.6*	*5.5*
Camp 9	Dry Cr. (Valley)	***614***	<0.15	<0.05	<0.15	*2.5*	<0.05	***773***	<0.5	*6.0*	***2.2***	<0.33	*3.5*	*<0.4*

LEGEND

- **Result > Primary MCL**
- **Result > Secondary MCL**
- **Result > Bacteria Water Quality Objective**
- **Result > Aquatic Life Threshold**
- **Result > Agricuture Threshold**
- **Result > MCL and Aquatic Life Threshold**
- **Result > MCL and Agricuture Threshold**
- *Estimated Result (sample did not pass QAQC)*
- Pending or No Result

Sample ID	Station Name	DISSOLVED METALS												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 245.1	EPA 200.7	EPA 200.7	EPA 200.7
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610	150	formula		9	1,000	2.5			52	5	120
	Agrigulture Threshold	5,000					200	5,000	5,000	200			20	
Camp 1	Butte Cr. (BCK Gage)	7.56	<0.16	20.9	<0.1	2.3	0.60	29	1.7	<6.37	<0.16	<0.032	3.7	3.3
Camp 2	Butte Cr. (Control)	6.62	<0.16	31.6	1.2	3.8	0.47	32	<0.16	<6.37	<0.16	<0.032	2.3	3.7
Camp 3	Little Butte Cr.	13.5	<0.16	34.8	1.2	9.5	0.76	86	<0.16	<6.37	<0.16	3.21	3.0	2.5
Camp 4	Hamlin Cr. (Paradise)	55.7	<0.16	35.6	1.2	4.4	0.71	88	<0.16	<6.37	<0.16	<0.032	3.4	2.2
Camp 5	Clear Cr. (Paradise)	32.1	<0.16	35.5	1.0	4.7	0.45	50	<0.16	<6.37	<0.16	<0.032	3.5	19.3
Camp 6	Dry Cr. (Paradise)	108.0	<0.16	36.6	1.5	5.2	0.59	123	<0.16	<6.37	<0.16	<0.032	3.6	<0.032
Camp 7	Little Dry Cr. (Valley)	48.3	<0.16	39.9	1.1	5.0	0.83	82	<0.16	<6.37	<0.16	<0.032	3.9	<0.032
Camp 8	Clear Cr. (Valley)	**1580.0**	<0.16	43.0	1.0	8.0	3.04	1050	<0.16	21.2	<0.16	3.5	4.2	1.2
Camp 9	Dry Cr. (Valley)	**829.0**	<0.16	41.0	0.9	5.8	1.15	387	<0.16	<6.37	<0.16	1.4	3.7	<0.032

Sample ID	Station Name	PAH DETAILED RESULTS																								
	Analyte:	**Sum PAHs**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a)pyrene**	**Benzo(b)fluoranthene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Carbazole**	**Chrysene**	**Dibenz(a,h)anthracene**	**Dinitrotoluene, 2,4<**	**Dinitrotoluene, 2,6<**	**Fluoranthene**	**Fluorene**	**indeno(1,2,3<c,d)pyrene**	**Isophorone**	**Methylnaphthalene, 2<**	**Naphthalene**	**Nitrobenzene**	**Phenanthrene**	**Pyrene**	**Sum LMW PAHs**	**Sum HMW PAHs**
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																			
	Human Health Threshold*:		70		300	0.0044	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20															0.049			21					
	Aquatic Life Threshold:		52		110,000											370	14,000				62			11,000		
Camp 1	Butte Cr. (BCK Gage)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 2	Butte Cr. (Control)	0.36	<0.0004	0.1	0.03	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	0.04	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	0.15	0.04	0.28	0.08
Camp 3	Little Butte Cr.	0.01	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	0.01	<0.0004	0.01	0.00
Camp 4	Hamlin Cr. (Paradise)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 5	Clear Cr. (Paradise)	0.08	<0.0004	0.01	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	0.01	0.01	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	0.04	0.01	0.05	0.02
Camp 6	Dry Cr. (Paradise)	0.03	<0.0004	<0.0004	<0.0005	<0.0004	**0.01**	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	0.02	<0.0004	0.02	0.01
Camp 7	Little Dry Cr. (Valley)	0.03	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	0.01	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	0.01	0.01	0.01	0.02
Camp 8	Clear Cr. (Valley)	0.04	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	0.01	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	0.01	0.02	0.01	0.03
Camp 9	Dry Cr. (Valley)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

Sample ID	Station Name	PCB DETAILED RESULTS									
	Analyte:	**Sum PCBs**	**PCB 1262**	**PCB 1268**	**PCB AROCLOR 1016**	**PCB AROCLOR 1221**	**PCB AROCLOR 1232**	**PCB AROCLOR 1242**	**PCB AROCLOR 1248**	**PCB AROCLOR 1254**	**PCB AROCLOR 1260**
	Method:	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082
	Units:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:										
	Human Health Threshold*:										
	Taste & Odor Threshold:										
	Aquatic Life Threshold:										
Camp 1	Butte Cr. (BCK Gage)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 2	Butte Cr. (Control)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 3	Little Butte Cr.	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 4	Hamlin Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 5	Clear Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 6	Dry Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 7	Little Dry Cr. (Valley)										
Camp 8	Clear Cr. (Valley)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 9	Dry Cr. (Valley)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

CAMP POST<FIRE WATER QUALITY MONITORING PRELIMINARY RESULTS

Sampling conducted by the Central Valley Regional Water Quality Control Board (Central Valley Water Board), Department of Water Resources (DWR) and Department of Transportation (Caltrans)
Analysis performed by Delta Environmental Laboratory.

NOTE: Results are preliminary and are considered draft

Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

02/06/2020 Sampling Event

Sample ID	**Station Name**	**NUTRIENTS, MINERALS, SOLIDS**														**BACTERIA**		**FIELD MEASUREMENTS**				
	Analyte:	**Alkalinity**	**Ammonia**	**Hardness**	**Nitrate**	**Nitrite**	**Nitrite+Nitrate**	**TKN**	**OrthoPhosphate**	**Phosphorus**	**Sulfate**	**SS**	**TDS**	**TOC**	**TSS**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 4500		SM 4500	SM 4500	Calculated		SM 4500<P E	EPA 365.1	EPA 300.0	SM 2540 F	SM 2540 C	EPA 415.3	SM 2540 D			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	mg/L	mg/L	mg/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Total	Total	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Total	Particulate	Total	Total					
	Primary MCL:				10	1	10															
	Secondary MCL:		1.5								250		500					900		6.5-8.5		5
	Bacteria Objective:															320						
	Aquatic Life Threshold:	20	formula																>7.0	6.5-9		
	Agrigulture Threshold												450					700		6.5-8.4		
Camp 1	Butte Cr. (BCK Gage)	**48.6**	0.051	36.4	0.03	<0.002	0.03	<0.45	<0.0001	0.026	2.32	<0.25	26	0.82	0.50	5.2	547.5	101	12.8	8.0	6.1	0.60
Camp 2	Butte Cr. (Control)	**43.1**	0.060	19.4	<0.0007	<0.002	ND	<0.45	<0.0001	0.003	1.52	<0.25	22	0.78	0.90	1.0	125.9	93	12.9	7.8	5.5	0.57
Camp 3	Little Butte Cr.	**45.6**	0.060	58.0	0.95	<0.002	0.95	<0.45	<0.0001	0.003	6.49	<0.25	59	0.93	1.30	1.0	579.4	139	11.9	8.0	8.7	1.16
Camp 4	Hamlin Cr. (Paradise)	**36.6**	0.025	35.0	2.34	0.003	2.34	<0.45	<0.0001	<0.0005	4.26	<0.25	36	0.73	0.90	63.1	1553.1	106	10.6	6.6	10.4	2.72
Camp 5	Clear Cr. (Paradise)	**26.1**	0.012	24.0	2.03	<0.002	2.03	<0.45	<0.0001	0.016	1.72	<0.25	10	0.48	1.90	16.0	1299.7	65	10.4	6.9	11.8	3.76
Camp 6	Dry Cr. (Paradise)	**40.1**	0.004	30.0	1.88	<0.002	1.88	<0.45	<0.0001	0.013	1.48	<0.25	23	0.47	1.90	31.5	770.1	84	10.5	7.3	11.2	2.60
Camp 7	Little Dry Cr. (Valley)	**51.6**	0.023	47.0	1.57	0.004	1.57	<0.45	<0.0001	0.016	3.54	<0.25	54	1.31	2.30	22.8	1299.7	128	12.2	7.8	8.6	3.12
Camp 8	Clear Cr. (Valley)	**54.1**	0.020	74.0	0.81	<0.002	0.81	<0.45	<0.0001	0.039	3.32	<0.25	93	1.95	0.90	104.3	980.4	187	12.0	7.6	8.4	1.24
Camp 9	Dry Cr. (Valley)	**51.6**	0.009	52.0	1.29	0.002	1.29	<0.45	<0.0001	0.036	4.60	<0.25	65	1.14	1.10	235.9	816.4	133	11.7	7.6	9.0	4.11

Sample ID	**Station Name**	**TOTAL METALS**												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610		formula			1,000			0.05			120
	Agrigulture Threshold	5,000		100	10		200	5,000	5,000	200		200	20	
Camp 1	Butte Cr. (BCK Gage)	*34.5*	<0.15	*<0.05*	<0.15	*103*	6.78	*96.6*	<0.5	*67.9*	*<0.114*	<0.3	23.7	<0.4
Camp 2	Butte Cr. (Control)	*22.6*	0.91	*0.74*	<0.15	*2.30*	2.34	*86.9*	<0.5	*<0.25*	*<0.114*	1.82	<0.05	1.34
Camp 3	Little Butte Cr.	*108*	<0.15	*<0.05*	<0.15	*157*	7.41	*184*	<0.5	*53.2*	*<0.114*	<0.3	53.3	<0.4
Camp 4	Hamlin Cr. (Paradise)	*221*	<0.15	*0.90*	<0.15	*<0.1*	<0.05	*157*	<0.5	*80.1*	*<0.114*	<0.3	<0.05	1.64
Camp 5	Clear Cr. (Paradise)	*145*	<0.15	*4.05*	<0.15	*<0.1*	<0.05	*57.4*	<0.5	*70.7*	*0.90*	<0.3	<0.05	3.51
Camp 6	Dry Cr. (Paradise)	*147*	<0.15	*4.13*	<0.15	*<0.1*	<0.05	*185*	<0.5	*62.3*	*0.60*	<0.3	<0.05	<0.4
Camp 7	Little Dry Cr. (Valley)	*44.9*	<0.15	*0.23*	<0.15	*<0.1*	<0.05	*50.6*	<0.5	*52.3*	*0.86*	<0.3	<0.05	6.71
Camp 8	Clear Cr. (Valley)	*33.6*	<0.15	*3.18*	<0.15	*<0.1*	<0.05	*132*	<0.5	*56.0*	*0.66*	<0.3	<0.05	<0.4
Camp 9	Dry Cr. (Valley)	*<2*	<0.15	*2.56*	<0.15	*13.7*	<0.05	*785*	<0.5	*45.5*	*0.41*	<0.3	<0.05	30.2

LEGEND

Result > Primary MCL
Result > Secondary MCL
Result > Bacteria Water Quality Objective
Result > Aquatic Life Threshold
Result > Agricuture Threshold
Result > MCL and Aquatic Life Threshold
Result > MCL and Agricuture Threshold
Estimated Result (sample did not pass QAQC)
Pending or No Result

Sample ID	**Station Name**	**DISSOLVED METALS**												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610	150	formula		9	1,000	2.5			52	5	120
	Agrigulture Threshold	5,000					200	5,000	5,000	200			20	
Camp 1	Butte Cr. (BCK Gage)	*1.39*	<0.16	<0.1	<0.1	*46.3*	<0.03	*74*	<0.50	*50.4*	<0.114	<0.1	*95.7*	*2.3*
Camp 2	Butte Cr. (Control)	*23.8*	0.70	<0.1	<0.1	*9.2*	4.10	*254*	<0.50	*<0.23*	<0.114	7.58	*11.1*	*3.4*
Camp 3	Little Butte Cr.	*31.5*	<0.16	<0.1	<0.1	*106*	8.64	*108*	<0.50	*67.6*	<0.114	26.1	*<0.064*	*26.7*
Camp 4	Hamlin Cr. (Paradise)	*<0.3*	<0.16	<0.1	<0.1	*<0.2*	<0.03	*186*	<0.50	*154*	<0.114	<0.1	*23.2*	*2.3*
Camp 5	Clear Cr. (Paradise)	*18.1*	<0.16	<0.1	<0.1	*18.5*	<0.03	*110*	<0.50	*110*	<0.114	3.93	*31.2*	*6.4*
Camp 6	Dry Cr. (Paradise)	*<0.3*	<0.16	<0.1	<0.1	*23.8*	<0.03	*203*	<0.50	*103*	<0.114	4.94	*33.8*	*0.50*
Camp 7	Little Dry Cr. (Valley)	*<0.3*	<0.16	<0.1	<0.1	*32.3*	<0.03	*135*	<0.50	*84.4*	<0.114	7.17	*38.2*	*<0.03*
Camp 8	Clear Cr. (Valley)	*66.3*	<0.16	<0.1	<0.1	*34.5*	<0.032	*144*	<0.50	*83.0*	<0.114	5.6	*46.8*	*0.9*
Camp 9	Dry Cr. (Valley)	*81.2*	<0.16	<0.1	<0.1	*38.7*	<0.032	*151*	<0.50	*62.7*	<0.114	<0.1	*61.9*	*1.4*

Sample ID	**Station Name**	**PAH DETAILED RESULTS**																								
	Analyte:	**Sum PAHs**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a)pyrene**	**Benzo(b)fluoranthene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Carbazole**	**Chrysene**	**Dibenz(a,h)anthracene**	**Dinitrotoluene, 2,4<**	**Dinitrotoluene, 2,6<**	**Fluoranthene**	**Fluorene**	**indeno(1,2,3<c,d)pyrene**	**Isophorone**	**Methylnaphthalene, 2<**	**Naphthalene**	**Nitrobenzene**	**Phenanthrene**	**Pyrene**	**Sum LMW PAHs**	**Sum HMW PAHs**
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																			
	Human Health Threshold*:		70		300	0.0044	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20															0.049			21					
	Aquatic Life Threshold:		52		110,000											370	14,000				62			11,000		
Camp 1	Butte Cr. (BCK Gage)	**0.37**	0.010	0.010	0.050	**0.0400**	-0.0004	-0.0004	<0.0004	<0.0004	<0.0004	**0.050**	<0.0004	<0.0004	<0.0004	0.040	0.040	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.090	0.040	0.20	0.17
Camp 2	Butte Cr. (Control)	**0.42**	<0.0004	<0.0004	0.030	**0.0400**	**0.020**	**0.020**	0.020	**0.040**	<0.0004	**0.040**	<0.0004	<0.0004	<0.0004	0.040	0.030	**0.030**	<0.0004	<0.0004	<0.0004	<0.0004	0.070	0.040	0.13	0.29
Camp 3	Little Butte Cr.	ND	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.00	0.00
Camp 4	Hamlin Cr. (Paradise)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 5	Clear Cr. (Paradise)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 6	Dry Cr. (Paradise)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 7	Little Dry Cr. (Valley)	**0.03**	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	0.010	0.010	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	0.010	<0.0004	0.02	0.01
Camp 8	Clear Cr. (Valley)	ND	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 9	Dry Cr. (Valley)	**0.07**	<0.0004	<0.0004	<0.0005	**0.020**	<0.0004	**0.020**	<0.0004	<0.0004	<0.0001	**0.020**	<0.0005	<0.0001	<0.0001	0.01	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.07

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

Sample ID	**Station Name**	**PCB DETAILED RESULTS**									
	Analyte:	**Sum PCBs**	**PCB 1262**	**PCB 1268**	**PCB AROCLOR 1016**	**PCB AROCLOR 1221**	**PCB AROCLOR 1232**	**PCB AROCLOR 1242**	**PCB AROCLOR 1248**	**PCB AROCLOR 1254**	**PCB AROCLOR 1260**
	Method:	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082
	Units:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:										
	Human Health Threshold*:										
	Taste & Odor Threshold:										
	Aquatic Life Threshold:										
Camp 1	Butte Cr. (BCK Gage)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 2	Butte Cr. (Control)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 3	Little Butte Cr.	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 4	Hamlin Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 5	Clear Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 6	Dry Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 7	Little Dry Cr. (Valley)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 8	Clear Cr. (Valley)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 9	Dry Cr. (Valley)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

CAMP POST<FIRE WATER QUALITY MONITORING PRELIMINARY RESULTS

Sampling conducted by the Central Valley Regional Water Quality Control Board (Central Valley Water Board), Department of Water Resources (DWR) and Department of Transportation (Caltrans)
Analysis performed by Delta Environmental Laboratory.

NOTE: Results are preliminary and are considered draft

Contact: Michael Parker, Central Valley Water Board Email: michael.parker@waterboards.ca.gov

03/12/2020 Sampling Event

Sample ID	Station Name	NUTRIENTS, MINERALS, SOLIDS														BACTERIA		FIELD MEASUREMENTS				
	Analyte:	**Alkalinity**	**Ammonia**	**Hardness**	**Nitrate**	**Nitrite**	**Nitrite+Nitrate**	**TKN**	**OrthoPhosphate**	**Phosphorus**	**Sulfate**	**SS**	**TDS**	**TOC**	**TSS**	**E. coli**	**Coliform**	**Conductivity**	**DO**	**pH**	**Temp**	**Turbidity**
	Method:	SM 2320 B	SM 4500		SM 4500	SM 4500	Calculated		SM 4500<P E	EPA 365.1	EPA 300.0	SM 2540 F	SM 2540 C	EPA 415.3	SM 2540 D			YSI ProDSS	YSI ProDSS	YSI ProDSS	YSI ProDSS	Hach 2100
	Units:	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/L	mg/L	mg/L	mg/L	MPN	MPN	µS/Cm	mg/L		oC	NTU
	Fraction:	Total	Total	Total	Dissolved	Dissolved	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Total	Particulate	Total	Total					
	Primary MCL:				10	1	10															
	Secondary MCL:		1.5								250		500					900		6.5-8.5		5
	Bacteria Objective:															320						
	Aquatic Life Threshold:	20	formula																>7.0	6.5-9		
	Agrigulture Threshold												450					700		6.5-8.4		
Camp 1	Butte Cr. (BCK Gage)	**44.2**	0.003	68.6	0.030	<0.002	0.030	<0.45	<0.0001	0.020	1.70	<0.5	53	0.80	1.00	9.8	488.4	100	12.2	8.1	10.2	0.92
Camp 2	Butte Cr. (Control)	**37.1**	0.412	27.2	<0.001	<0.002	ND	<0.45	0.0034	0.013	1.23	<0.5	54	0.76	<0.50	4.1	204.6	94	11.9	7.8	8.4	0.83
Camp 3	Little Butte Cr.	**35.3**	0.138	71.4	0.640	<0.002	0.640	<0.45	<0.0001	0.020	5.61	<0.5	96	0.88	<0.50	3.1	1986.3	140	11.3	8.1	12.7	1.34
Camp 4	Hamlin Cr. (Paradise)	**40.6**	<0.001	40.0	1.53	<0.002	1.53	<0.45	<0.0001	0.013	2.90	<0.5	70	0.91	<0.50	83.6	1413.6	111	9.9	6.8	12.2	-0.39
Camp 5	Clear Cr. (Paradise)	8.8	0.068	25.7	5.74	<0.002	5.74	<0.45	<0.0001	0.026	1.49	<0.5	24	0.57	<0.50	148.3	1732.9	66	9.9	7.1	13.1	1.6
Camp 6	Dry Cr. (Paradise)	**33.6**	<0.001	10.0	1.62	<0.002	1.62	<0.45	0.0102	0.052	1.13	<0.5	45	0.53	<0.50	14.6	648.8	85	9.8	7.5	13.4	1.05
Camp 8	Clear Cr. (Valley)	**90.1**	0.035	<1.0	0.590	<0.002	0.590	<0.45	0.0068	0.049	2.47	<0.5	124	1.77	<0.50	235.9	2419.6	194	10.6	7.9	11.9	1.22
Camp 9	Dry Cr. (Valley)	**38.9**	0.047	90.5	0.950	<0.002	0.950	<0.45	0.0102	0.023	3.46	<0.5	86	1.15	<0.50	275.5	1413.6	141	10.7	7.9	12	2.33
Camp 12	Butte Cr. (Valley)	**37.1**	0.182	64.2	0.003	<0.002	0.003	<0.45	<0.0001	0.007	1.66	<0.5	66	0.93	<0.50	6.3	387.3	106	11.4	8.0	13.5	0.96
Camp 13	Concow Cr. (Concow)	**38.9**	0.091	66.7	0.006	<0.002	0.006	<0.45	0.0068	0.023	1.25	<0.5	72	0.85	<0.50	<1.0	461.1	118	10.8	7.9	12.2	3.31
Camp 14	Cirby Cr. (Concow)	**115.0**	0.018	1.3	0.009	<0.002	0.009	<0.45	0.0034	0.430	1.58	<0.5	114	1.21	<0.50	21.3	686.7	165	9.4	7.9	15.3	1.80

Sample ID	Station Name	TOTAL METALS												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610		formula			1,000			0.05			120
	Agrigulture Threshold	5,000		100	10		200	5,000	5,000	200		200	20	
Camp 1	Butte Cr. (BCK Gage)	*248*	*<0.15*	*<0.05*	<0.15	*229*	*164*	*7,560*	*2.45*	<0.25	<0.114	<0.33	*2.26*	*111*
Camp 2	Butte Cr. (Control)	*307*	*<0.15*	*<0.05*	0.95	*234*	*177*	*7,860*	*2.45*	<0.25	<0.114	<0.33	*2260*	*106*
Camp 3	Little Butte Cr.	*454*	*0.78*	*<0.05*	1.25	*348*	*228*	*8,290*	*7.22*	<0.25	<0.114	<0.33	*2.25*	*129*
Camp 4	Hamlin Cr. (Paradise)	*Pending*	*Pending*	<0.05	0.99	*181*	*174*	*6960*	*2.94*	<0.25	<0.114	<0.33	*1950*	*104*
Camp 5	Clear Cr. (Paradise)	*1,260*	*4.29*	**54.2**	2.37	***21000***	*816*	*3500*	*6.48*	**6160**	<0.114	**1800**	*1800*	*4280*
Camp 6	Dry Cr. (Paradise)	*66.6*	*<0.15*	<0.05	0.99	*108*	***1480***	*7060*	*1.43*	<0.25	<0.114	<0.33	*1880*	*81.2*
Camp 8	Clear Cr. (Valley)	*288*	*1.46*	<0.05	<0.15	*223*	*149*	*7820*	*2.11*	<0.25	<0.114	<0.33	*2230*	*87.8*
Camp 9	Dry Cr. (Valley)	*398*	*1.23*	<0.05	1.51	*206*	*162*	*7970*	*1.89*	<0.25	<0.114	<0.33	*2150*	*78.2*
Camp 12	Butte Cr. (Valley)	*43.8*	*<0.15*	*<0.05*	<0.15	*10.0*	*1.27*	*246*	*<0.5*	22.7	<0.114	<0.33	*<0.05*	*<0.40*
Camp 13	Concow Cr. (Concow)	*405*	*2.70*	**65.5**	<0.15	*221*	*169*	*8100*	*1.61*	<0.25	<0.114	<0.33	*2100*	*89.0*
Camp 14	Cirby Cr. (Concow)	*867*	*1.12*	<0.05	<0.15	*230*	*162*	*1100*	*2.25*	**373**	<0.114	<0.33	*2100*	*72.8*

LEGEND

- **Result > Primary MCL**
- **Result > Secondary MCL**
- **Result > Bacteria Water Quality Objective**
- **Result > Aquatic Life Threshold**
- **Result > Agricuture Threshold**
- **Result > MCL and Aquatic Life Threshold**
- **Result > MCL and Agricuture Threshold**
- *Estimated Result (sample did not pass QAQC)*
- Pending or No Result

Sample ID	Station Name	DISSOLVED METALS												
	Analyte:	**Aluminum**	**Antimony**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Iron**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Selenium**	**Zinc**
	Method:	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	Fraction:	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved
	Primary MCL:	1,000	6	10	5	50	1,300		15		2	100	50	
	Secondary MCL:	200					1,000	300		50				5,000
	Aquatic Life Threshold:	87	610	150	formula		9	1,000	2.5			52	5	120
	Agrigulture Threshold	5,000					200	5,000	5,000	200			20	
Camp 1	Butte Cr. (BCK Gage)	*20.5*	0.64	2.02	<0.1	*7.28*	4.40	*53.9*	<0.50	*<0.23*	<0.08	7.72	*2.37*	*3.35*
Camp 2	Butte Cr. (Control)	*23.8*	<0.16	2.52	<0.1	*7.72*	4.61	*61.0*	<0.50	*<0.23*	<0.08	8.35	*7.68*	*3.92*
Camp 3	Little Butte Cr.	*32.9*	<0.16	3.00	<0.1	*9.06*	5.53	*102*	<0.50	*<0.23*	<0.08	10.2	*16.40*	*3.58*
Camp 4	Hamlin Cr. (Paradise)	*39.2*	1.45	<0.1	<0.1	*9.12*	5.32	*121*	<0.50	*<0.23*	<0.08	8.1	*12.6*	*3.87*
Camp 5	Clear Cr. (Paradise)	*167*	1.30	3.44	<0.1	*11.3*	5.82	*228*	<0.50	*<0.23*	<0.08	8.45	*14.7*	*15.9*
Camp 6	Dry Cr. (Paradise)	*11.8*	<0.16	1.66	0.67	*<0.2*	<0.03	*<6*	<0.50	*6.48*	<0.08	<0.1	*<0.1*	*8.36*
Camp 8	Clear Cr. (Valley)	*35.0*	1.26	1.22	<0.1	*12.1*	7.25	*213*	<0.50	*<0.2*	<0.08	12.0	*22.1*	*4.62*
Camp 9	Dry Cr. (Valley)	*23.9*	<0.16	<0.1	<0.1	*5.18*	3.65	*31.3*	<0.50	*<0.2*	<0.08	5.6	*<0.1*	*2.04*
Camp 12	Butte Cr. (Valley)	*22.8*	<0.16	0.86	0.27	*9.17*	4.96	*100*	<0.50	*<0.23*	<0.08	7.72	*18.4*	*3.00*
Camp 13	Concow Cr. (Concow)	*29.4*	<0.16	0.75	<0.1	*7.50*	5.12	*116*	<0.50	*<0.2*	<0.08	11.8	*9.38*	*2.14*
Camp 14	Cirby Cr. (Concow)	*36.9*	<0.16	2.83	<0.1	*10.8*	3.70	*130*	<0.50	*52.1*	<0.08	17.4	*<0.1*	*3.70*

Sample ID	Station Name	PAH DETAILED RESULTS																								
	Analyte:	**Sum PAHs**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benz(a)anthracene**	**Benzo(a)pyrene**	**Benzo(b)fluoranthene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**	**Carbazole**	**Chrysene**	**Dibenz(a,h)anthracene**	**Dinitrotoluene, 2,4<**	**Dinitrotoluene, 2,6<**	**Fluoranthene**	**Fluorene**	**indeno(1,2,3<c,d)pyrene**	**Isophorone**	**Methylnaphthalene, 2<**	**Naphthalene**	**Nitrobenzene**	**Phenanthrene**	**Pyrene**	**Sum LMW PAHs**	**Sum HMW PAHs**
	Method:	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M	EPA 8270M		
	Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total		
	Primary MCL:						0.2																			
	Human Health Threshold*:		70		300	0.0044	0.0044	0.0044		0.0044		0.0044	0.0044	0.11		300	1,300	0.0044	8.4	28	0.29	17		960		
	Taste & Odor Threshold:		20															0.049			21					
	Aquatic Life Threshold:		52		110,000											370	14,000				62			11,000		
Camp 1	Butte Cr. (BCK Gage)	**ND**	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.001	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 2	Butte Cr. (Control)	**0.040**	<0.0004	<0.0004	<0.0005	**0.0100**	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	**0.020**	<0.0005	<0.0001	<0.0001	0.010	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.04
Camp 3	Little Butte Cr.	**0.010**	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	0.010	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.01
Camp 4	Hamlin Cr. (Paradise)	**ND**	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 5	Clear Cr. (Paradise)	**0.097**	<0.0004	<0.0004	0.020	**0.0070**	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	**0.030**	<0.0005	<0.0001	<0.0001	0.010	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	0.020	0.010	0.04	0.06
Camp 6	Dry Cr. (Paradise)	**0.200**	0.010	0.010	0.040	**0.0200**	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	**0.040**	<0.0005	<0.0001	<0.0001	0.020	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	0.040	0.020	0.10	0.10
Camp 8	Clear Cr. (Valley)	**0.020**	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	**0.020**	<0.0005	<0.0001	<0.0001	<0.001	<0.001	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.001	<0.0004	0.00	0.02
Camp 9	Dry Cr. (Valley)	**0.022**	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	**0.020**	<0.0005	<0.0001	<0.0001	0.002	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.02
Camp 12	Butte Cr. (Valley)	**0.010**	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	0.010	<0.0005	<0.0004	0.00	0.00
Camp 13	Concow Cr. (Concow)	**ND**	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	<0.0004	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.00
Camp 14	Cirby Cr. (Concow)	**0.010**	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0005	<0.0004	<0.0004	<0.0001	**0.010**	<0.0005	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0004	<0.0001	<0.0005	<0.0004	0.00	0.01

*From California Toxic Rule, USEPA National Recommended Water Quality Criteria, and CalEPA Cancer Potency Factor

Sample ID	Station Name	PCB DETAILED RESULTS								
	Analyte:	**Sum PCBs**	**PCB 1262**	**PCB 1268**	**PCB AROCLOR 1016**	**PCB AROCLOR 1221**	**PCB AROCLOR 1232**	**PCB AROCLOR 1242**	**PCB AROCLOR 1248**	**PCB AROCLOR 1254**	**PCB AROCLOR 1260**
	Method:	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082	EPA 8082
	Units:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	Fraction:	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
	Primary MCL:										
	Human Health Threshold*:										
	Taste & Odor Threshold:										
	Aquatic Life Threshold:										
Camp 1	Butte Cr. (BCK Gage)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 2	Butte Cr. (Control)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 3	Little Butte Cr.	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 4	Hamlin Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 5	Clear Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 6	Dry Cr. (Paradise)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 8	Clear Cr. (Valley)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 9	Dry Cr. (Valley)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 12	Butte Cr. (Valley)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 13	Concow Cr. (Concow)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Camp 14	Cirby Cr. (Concow)	ND	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

Department of Water Resources Water Quality Policy and Implementation Process for Acceptance of Non-Project Water into the State Water Project (October 2012)

It is the Department of Water Resources (DWR) policy to assist with the conveyance of water to provide water supply, and to protect the State Water Project (SWP) water quality within the California Aqueduct. To facilitate this policy DWR provides the following implementation process for accepting non-project water into the SWP (Policy). For purposes of this document, SWP and California Aqueduct are interchangeable and the same.

POLICY PROVISIONS

DWR shall consider and evaluate all requests for Non-Project (NP) water input directly into the SWP conveyance facilities based upon the criteria established in this document. NP water shall be considered to be any water input into the SWP for conveyance by the SWP that is not directly diverted from the Sacramento-San Joaquin Delta or natural inflow into SWP reservoirs.

The proponent of any NP water input proposal shall demonstrate that the water is of consistent, predictable, and acceptable quality.

DWR will consult with State Water Project (Contractors), existing NP participants and the Department of Public Health (DPH) on drinking water quality issues relating to NP water as needed to assure the protection of SWP water quality.

Nothing in this document shall be construed as authorizing the objectives of Article 19 of the SWP water supply contracts or DPH drinking water maximum contaminant levels to be exceeded.

This Policy shall not constrain the ability of DWR to operate the SWP for its intended purposes and shall not adversely impact SWP water deliveries, operation or facilities.

EVALUATING NP WATER PROPOSALS

DWR shall use a two-tiered approach for evaluating NP water for input into the California Aqueduct.

NP Tier 1

Tier 1 NP pump-in proposals (PIP) shall exhibit water quality that is essentially the same, or better, than what occurs in the California Aqueduct. PIP’s considered to be tier 1 shall be approved by DWR (see baseline water quality tables 1 through 4).

NP Tier 2

Tier 2 PIP’s are those that exhibit water quality that is different and possibly worse than in the California Aqueduct and/or have the potential to cause adverse impacts to the Contractors. Tier 2 PIP’s shall be referred to a NP Facilitation Group (FG), which would review the project and if needed make recommendations to DWR in consideration of the PIP.

SWC Facilitation Group

This advisory group consists of representatives from each Contractor that chooses to participate and DWR. The group shall review tier 2 PIP’s based on the merits, impacts, mitigation, water quality monitoring, cost/benefits or other issues of each PIP and provide recommendations to DWR. Upon initial review of tier 2 PIP by DWR, it shall then be submitted to the FG for review. A consensus recommendation from the FG would be sought regarding approval of the PIP. DWR shall base its decision on the merits of the PIP, recommendations of the FG and the PIP’s ability to provide overall benefits to the SWP and the State of California.

Blending Water Sources

Blending of multiple water sources prior to inflow into the SWP is acceptable and may be preferred depending upon water quality of the PIP. Blending of water in this manner may be used to quality a project as NP Tier 1.

Mixing (blending) within the California aqueduct can be considered but shall not be adjacent to municipal and industrial (M&I) delivery locations. PIP’s that are coordinating water discharged to maintain or improve SWP water quality are an example of the mixing approach. The PIP shall demonstrate by model or an approach acceptable to DWR and the FG that the water is adequately mixed before reaching the first M&I customer. Generally NP PIP’s that involve mixing with SWP water shall be considered NP Tier 2.

Baseline Water Quality

To aid in developing and evaluating PIP’s both historical and current SWP water quality levels shall be considered. A representative baseline water quality summary is shown in Tables 1 through 4, using historical SWP water quality records at O’Neill Forebay.

NP IMPLEMENTATION PROCESS

Project Proposals

The NP project proponent requesting to introduce water into the SWP shall submit a detailed PIP to DWR. The proponent shall demonstrate that the NP water is of consistent,
predictable and reliable quality, and is responsible for preparing and complying with any and all contracts, environmental documents, permits or licenses that are necessary consistent with applicable laws, regulations, agreements, procedures, or policies.

Project Description

The proponent will submit to DWR a PIP describing the proposed program, identifying the water source(s), planned operation, characterizing the inflow water quality and any anticipated impacts to SWP water quality and/or operations. The PIP should be submitted at least one month prior to proposed start up to allow for DWR and FG review. The PIP shall include:

- Project proponent names, locations, addresses, and contact person(s).
- Maps identifying all sources of water, point of inflow to the SWP and ultimate fate of the introduced water.
- Terms and conditions of inflow, timing, rates and volumes of inflow, pumping, conveyance and storage requirements.
- Construction details of any facilities located adjacent to the SWP including valves, meters, and pump and piping size.
- All potential impacts and/or benefits to downstream SWP water contractors.
- Detailed water quality data for all sources of water and any blend of sources that will be introduced into the SWP.
- Identify anticipated water quality changes within the SWP.
- Identify other relevant environmental issues such as subsidence, ground water overdraft or, presents of endangered species.
- Provide performance measures and remedial actions that will be taken in the event projected SWP water quality levels are not met.
- Reference an existing contract or indicate that one is in process with DWR to conduct a PIP.

Water Quality Monitoring

In order to demonstrate that the water source(s) are of consistent, predictable, and acceptable quality the NP proponent shall monitor water quality. The proponent shall, for the duration of the program, regularly report on operations as they affect water quality, monitoring data and water quality changes. Both DPH title 22 and a short list of Constituents of Concern (COC) shall be monitored for based upon one of the following water quality monitoring options.

Constituents of Concern Current COC are Arsenic, Bromide, Chloride, Nitrate, Sulfate, Organic Carbon, and Total Dissolved Solids. These COC’s may be changed as needed.

Water Quality Monitoring Options NP proponents shall select one of the testing options below and perform all water quality testing and provide analytical results in a timely manner as described herein. Monitoring shall be conducted for initial well start-up, periodic well re-testing and on-going testing during operation. Well data should be no more than three years old. Title 22 results should be provided to DWR and the FG within two weeks of testing and COC results within one week of testing, unless other schedules are agreed upon by DWR and the FG.

Option 1 - Baseline tests for Individual Wells

Well Start-up: Title 22 tests are required for all wells participating in the program prior to start-up. An existing title 22 test that is no more than three years old may be used. A Title 22 test may be substituted for any well near a similar well with a Title 22 test of record.

Well Re-testing: Title 22 test for all wells participating every three years.

Ongoing Monitoring: COC tests are required for all discharge locations to the SWP at start up and quarterly thereafter for new programs and resumption of established programs. New programs or those with constituents that may potentially degrade the SWP shall conduct at least weekly COC sampling of all discharge locations until the proponent demonstrates that the NP water is of consistent, predictable and reliable quality. Once the nature of the discharge has been clearly established, the COC tests are required quarterly for each discharge point.

Option 2 - Baseline tests for Representative Wells

Well Start-up: COC tests of record are required for all wells participating in the program and Title 22 tests of record are required for representative wells comprising a subset of all wells. This would typically be a group of wells that are manifold together and discharge to one pipe. Representative wells shall be identified on a case-by-case basis to be representative of the manifold area, well proximity, and water levels.

Well Re-testing: Same as required in Option 1.

On-going Monitoring: COC tests are required for all discharge locations to the SWP at start up and monthly thereafter for the duration of the program and annually at each well. New programs or those with constituents that may potentially degrade the SWP shall conduct weekly COC sampling of all discharge locations until the proponent demonstrates that the NP water is of consistent, predictable and reliable quality.

Option 3 – Self Directed

A PIP may propose a water quality monitoring program for approval by DWR and the FG that is different from options 1 or 2. It must include COC and title 22 testing that will fully characterize water pumped into the SWP and be at an interval to show a consistent, predictable and reliable quality.

Analytical Methods

Analytical laboratories used by project proponents shall be DPH certified by the Environmental Laboratory Accreditation Program (ELAP) and use EPA prescribed and ELAP accredited methods for drinking water analysis. Minimum Reporting Levels must be at least as low as the DPH required detection limits for purposes of reporting (DLR). The current DLRs are listed on the DPH website at Http://www.cdph.ca.gov/certlic/drinkingwater/Pages/MCLsandPHGs. DWR shall continue to use Bryte Chemical Laboratory as it's analytical and reference lab.

Flow Measurements

The project proponent shall maintain current, accurate records of water production rate and volume from each source, as well as, each point of discharge into the SWP. All flow measurements shall be submitted to regularly to DWR.

RECONSIDERATION

If an NP proponent disagrees with the FG or DWR decision or feels that there is an overriding benefit of the proposal, the proponent may request reconsideration from DWR on the basis of overriding public benefit or water supply deficiency. DWR shall consider these requests on a case-by-case basis.

ONGOING PROGRAM

Any NP Proponent who has successfully established a NP water inflow program (Including existing Kern Fan Banking Projects, Kern Water Bank, Pioneer and Berrenda Mesa Projects, Semitropic Water Storage District Wheeler Ridge Mariposa Water Storage District and Arvin Edison Water Storage District) may reinitiate the program by notifying DWR at least ten days before inflow is scheduled to begin and provide the following information:

- Updated water quality data and/or updated modeling that adequately reflects the quality of water to be introduced into the SWP.
- Turn-in location.
- Expected rate and duration of inflow. DWR shall notify the FG of this reinitiating of inflow.
- Water quality monitoring schedule that meets the objective of this policy.

FUTURE NP PROGRAMS

Future NP projects should be planned and designed considering the following items:

- Projects involving water quality exceeding primary drinking water standards shall show that the water shall be treated or blended before it enters the SWP to prevent water quality impacts.
- The project proponent of a Tier 2 proposal should clearly identify and establish that water inflow shall be managed and operated such that poor quality water will be blended with better quality water so that SWP water quality will not be degraded upon acceptable levels as determined by the FG and DWR.
- If a significant water supply deficiency exists and it is recommended by the FG that raw water quality criteria be set aside to ensure adequate supply, such action shall be subject to approval by the DPH.
- The project proponent of a NP inflow program which degrades SWP water quality shall identify mitigation to downstream water contractors for water quality impacts associated with increased water supply or treatment costs.

DWR ROLE

DWR shall seek, as needed, DPH or SWC recommendations on changes or additions to this document governing the NP water quality projects. The FG shall review proposed changes or additions prior to implementation by DWR, as needed.

DWR and or the United States Bureau of Reclamation (for San Luis Canal inflow) shall have ultimate responsibility for approving the water quality of all NP inflow, as well as, the oversight of monitoring and tracking the water quality of operating programs. DWR shall also ensure that the proponents of the NP inflow program perform according to their proposals, and will take appropriate action in the event of non-conformance.

Project Proposal Review Process

Upon receipt of a proposal for PIP, DWR shall review it for adequacy. DWR shall consider all PIPs based upon these guidelines. Review shall take no more than one month after receiving a complete program proposal. If necessary, DWR will convene timely meetings with the FG during the review. At a minimum the review will include

- Examination of all documents and data for completeness of the PIP.
- Notification of the affected Field Divisions, and the FG has been received by DWR.
- Consideration by DWR of comments from all parties before the final decision.
- Upon completion of the review DWR will notify the proponent and FG of the acceptance of the PIP or explain the reason(s) for rejecting it.
- DWR may reconsider a decision on a PIP based upon a recommendation from the FG. Reconsideration by DWR will be on a case-by-case basis.

Periodic Review

DWR may schedule periodic reviews of each operating NP inflow with input from the FG. As part of the review, program proponents shall provide the following information:

- Summary of deliveries to the Aqueduct.
- Water quality monitoring results.
- Proposed changes in the program operation.

The review may result in changes in monitoring and testing required of the program proponent as a result of;

- New constituents being added to the EPA /DPH list of drinking water standards.
- Changes in the maximum contaminant levels for the EPA/DPH list of drinking water standards.
- Identification of new constituents of concern.
- Changes in the water quality provided by the program.
- Changes in constituent background levels in the California Aqueduct.

This procedure shall recognize emerging contaminants and/or those detrimental to agricultural viability as they are identified by the regulatory agencies and shall set appropriate standards for water introduction based upon ambient levels in the California Aqueduct or State Notification Levels. Emerging contaminants are those that may pose significant risk to public health, but as yet do not have an MCL. Currently the Office of Environmental Health Hazard Assessment and the DPH establish Public Health Goals and Notification Levels, respectively. These levels, though not regulated, do provide health-based guidance to water utilities and can require public notification if exceeded.

Water Quality Review

DWR shall track and periodically report to the FG on water quality monitoring results on the SWP from NP water inflow and make all water quality data available to the public upon request.

- DWR shall review analyze and maintain all records of water quality testing conducted by the proponent of the well(s), source(s) and discharge(s) into the SWP.
- DWR shall determine what additional water quality monitoring, if any, is necessary within the SWP to ensure adequate protection of SWP water quality. DWR shall conduct all water quality monitoring within the SWP.
- DWR may prepare periodic reports of NP projects.

On-site Surveillance

The appropriate Field Division within DWR will be responsible for review and approval of all construction activities within the SWP right-of-way. Plans showing the discharge system piping, valves, sampling point, meters and locations must be submitted and approved prior to any construction. In addition, the appropriate Field Division will be responsible for confirmation of all meter readings and water quality monitoring conducted by the proponent.

- Field division staff may visit, inspect, and calibrate meters and measure flow conditions at each source or point of inflow into the SWP.
- Flow meters, sampling ports and anti-siphon valves must be conveniently located near the SWP right-of-way.
- Field division staff may collect water samples at each source or point of discharge into the SWP.
- The appropriate Field Division shall conduct additional water quality monitoring within the SWP, if deemed necessary, to assure compliance with the NP Inflow Criteria.
- DWR shall monitor aqueduct water quality and analyze several "split samples" of the water at the point of introduction into the aqueduct to ensure consistent analytical results.

Table A1 HISTORICAL WATER QUALITY CONDITIONS 1988 TO 2011 AT O'NEILL FOREBAY OUTLET (mg/L)

Parameter	Mean	Min.	Max.	Std. Dev.
Aluminum	0.03	0.01	0.527	0.05
Antimony	0.002	0.001*	0.005	0.002
Arsenic	0.002	0.001	0.004	0.001
Barium	0.05	0.05	0.068	0.002
Beryllium	0.001*	0.001*	0.001*	0.000
Bromide	0.22	0.04	0.54	0.16
Cadmium	0.003	0.001	0.005	0.002
Chromium	0.004	0.001	0.011	0.002
Copper	0.004	0.001	0.028	0.003
Fluoride	0.1	0.1	0.5	0.1
Iron	0.037	0.005	0.416	0.050
Manganese	0.009	0.005	0.06	0.007
Mercury	0.001	0.0002	0.001	0.0004
Nickel	0.001	0.001	0.004	0.0005
Nitrate	2.9	0.2	8.1	1.6
Selenium	0.001	0.001	0.002	0.0001
Silver	0.003	0.001	0.005	0.002
Sulfate	42	14	99	15
Total Organic Carbon	4.0	0.8	12.6	1.6
Zinc	0.007	0.005	0.21	0.01

*These values represent reporting limits. Actual values would be lower

Table A2 O'Neill Forebay Outlet Total Dissolved Solids Criteria by Water Year Classification, 1988-2011 (mg/L)

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Wet	227.2	262.5	295.4	228.9	213.8	231.2	184.4	226.5	181.5	171.4	195.7	157.3
Near Normal	317.9	324.7	351.7	295.4	268.1	302.7	270.0	285.1	230.1	211.9	170.9	202.6
Dry	286.4	319.6	370.0	362.0	344.2	305.2	240.4	278.2	307.3	234.8	269.0	336.6
Critical	256.6	312.9	372.9	367.0	361.0	335.0	307.1	291.8	335.1	325.7	339.4	328.8

* Year type is based on water year classification. Below normal and above normal year types have been combined into one designation called "near normal."

Table A3 O'Neill Forebay Outlet Bromide Criteria by Water Year Classification, 1988-2011 (mg/L)

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Wet	0.19	0.24	0.28	0.13	0.10	0.12	0.12	0.17	0.12	0.12	0.13	0.10
Near Normal	0.31	0.31	0.34	0.21	0.15	0.15	0.18	0.22	0.15	0.15	0.14	0.19
Dry	0.25	0.29	0.35	0.35	0.24	0.20	0.17	0.24	0.27	0.13	0.29	0.41
Critical	0.26	0.28	0.32	0.37	0.33	0.27	0.22	0.22	0.28	0.28	0.32	0.37

* Year type is based on water year classification. Below normal and above normal year types have been combined into one designation called "near normal."

Table A4 O'Neill Forebay Outlet Total Organic Carbon Criteria by Water Year Classification, 1988-2011 (mg/L)

Year Type*	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Wet	2.8	2.9	3.9	5.2	4.8	3.8	3.9	3.4	3.1	3.2	3.1	2.7
Near Normal	3.7	4.1	4.0	7.0	6.3	5.6	4.7	4.4	4.0	3.3	3.3	3.4
Dry	3.0	3.0	4.0	5.7	4.8	5.7	4.5	3.6	3.7	2.9	2.9	2.7
Critical	2.8	3.1	3.3	4.9	6.0	5.7	4.7	4.0	3.8	3.9	4.0	3.5

* Year type is based on water year classification. Below normal and above normal year types have been combined into one designation called "near normal."

Appendix 13F. CEC Monitoring Results for City of Modesto and City of Turlock Treated Wastewater Discharge

		DMC-1 Upstream	DMC-2 Downstream	DMC-1 Upstream	DMC-2 Downstream	DMC-1 Upstream	DMC-2 Downstream	DMC-1 Upstream	DMC-2 Downstream	DMC-40	DMC-42	DMC-1 Upstream	DMC-2 Downstream
		Mile Marker 36.81	Mile Marker 38.14	Mile Marker 36.81	Mile Marker 38.14	Mile Marker 36.81	Mile Marker 38.14	Mile Marker 36.81	Mile Marker 38.14	Mile Marker 40.37	Mile Marker 41.49	Mile Marker 36.81	Mile Marker 38.14
		2/25/2020	2/25/2020	7/29/2020	7/29/2020	11/17/2020	11/17/2020	3/23/2021	3/23/2021	3/23/2021	3/23/2021	8/31/2021	8/31/2021
Endocrine Disruptors Positive Mode -SPE, ng/L	MRL												
1,7-Dimethylxanthine	5	ND	ND	14	9.5	16	15	16	18	21	28	ND	ND
Acetaminophen	10	<5	<5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Albuterol	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Amoxicillin (antibiotic)	20	ND	63	ND	ND	ND	ND	ND	81	110	110	ND	29
Andorostenedione	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Atenolol	5	ND	ND	ND	ND	ND	ND	ND	7.9	8.6	6	ND	6.5
Atrazine	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bezafibrate	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromacil	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Caffeine	10	ND	ND	22	21	14	12	36	39	49	52	14	12
Carbadox	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbamazepine (anticonvulsant)	5	6.4	13	ND	ND	ND	8.4	ND	8.8	10	11	ND	11
Carisoprodol	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloridazon	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorotoluron	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cimetidine (antacid/antihistamine)	5	ND	6.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Codeine	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cotinine	10	ND	ND	11	12	10	14	ND	ND	ND	11	ND	ND
Cyanazine	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DACT	20	<10	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DEA	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DEET	10	ND	ND	18	21	13	14	ND	12	12	15	ND	ND
Dehydronifedipine	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIA	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diazepam	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dilantin	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diltiazem	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diuron (herbicide)	5	23	27	11	10	ND	5.7	49	45	51	50	9.7	13
Epitestosterone	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Erythromycin	10	ND (R7)	ND	ND	ND	ND	ND	<20	<20	<20	<20	<20	<20
Flumeqine	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoxetine	10	<5	<5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hydrocodone	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isoproturon	100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ketoprofen	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ketorolac	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lidocaine (anesthetic)	5	13	30	ND	6.9	9.2	19	18	42	47	46	ND	30
Lincomycin	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Linuron	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lopressor	20	ND	ND	ND	ND	ND	ND	ND	21	26	21	ND	ND
Meclofenamic Acid	20	<5	<5	ND	ND	ND	ND	ND	ND	ND	ND	71	52
Meprobamate (tranquilizer)	5	ND	5.4	ND	ND	ND	6.8	ND	ND	6.7	6.7	ND	5.9
Metazachlor	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Metformin	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methadone (narcotic)	5	ND	7.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Metolachlor (herbicide)	5	6.1	5.1	7.9	7.5	ND	ND	34	20	14	18	9.9	8.3
Morphine	20	<5 (LK,LM)	<5 (LK,LM)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nifedipine	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Norethisterone	10	<5	<5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
OUST	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oxolinic acid	10	<5	<5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oxybenzone (sunscreen)	30	26	12	170	140	ND	ND	ND	ND	ND	ND	ND	ND
Pentoxifylline	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenazone	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Primidone (anticonvulsant)	5	5.5	9.6	ND	ND	ND	6.6	ND	7.4	9.3	6	ND	10
Progesterone	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propazine	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propranolol	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Quinoline	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Simazine (herbicide)	5	5.5	7.8	ND	ND	ND	ND	11	8.9	8.7	8.9	ND	ND
Sulfachloropyridazine	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sulfadiazine	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sulfadimethoxine	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sulfamerazine	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sulfamethazine	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sulfamethizole	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sulfamethoxazole (antibiotic)	5	24	53	14	14	14	18	18	34	37	36	5	24
Sulfathiazole	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCEP (reducing agent)	10	10	16	10	ND	11	ND	ND	14	21	16	18	18
TCPP	200	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TDCPP	100	<50	<50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Testosterone	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Theobromine	50	ND	ND	ND	ND	ND	ND	ND	ND	64	54	ND	ND
Theophylline	10	ND	ND	23	29	20	26	22	28	49	50	ND	ND
Thiabendazole	5	ND (BA)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trimethoprim (antibiotic)	5	ND	5.3	ND	ND	ND	ND	ND	ND	5	ND	ND	ND
Endocrine Disruptors Negative Mode -SPE, ng/L													

2,4-D (herbicide)	5	8.3	10	220	200	ND	ND	52	ND	ND	52	720	560
4-nonylphenol	400	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<4000	<4000
4-tert-Octylphenol	25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<250	<250
Acesulfame-K (artificial sweetener)	20	91	92	290	320	160	170	160	140	130	120	<200	37
Bendroflumethiazide	10	<5	<5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BPA	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	32	ND
Butalbital	10	<5	<5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butylparaben	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<100	<10
Chloramphenicol	10	<5	<5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Clofibric Acid	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<50	<5
Diclofenac	5	<50 (E7)	<50 (E7)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Estradiol	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Estriol	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Estrone	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethinyl Estradiol - 17 alpha	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<100	<10
Ethylparaben	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Gemfibrozil	5	<50 (E7)	<50 (E7)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ibuprofen	25	<10	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iohexal (contrasting agent)	50	340 (R7)	380 (R7)	250	280	99	320	370	910	920	720	240	290
Iopromide	10	<5	<5	ND	ND	ND	ND	ND	ND	ND	ND	ND	<100
Isobutylparaben	10	<5	<5	ND	ND	ND	ND	ND	ND	ND	ND	<100	ND
Lipitor (Atorvastatin)	100	ND	ND	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Methylparaben	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naproxen	20	<100 (E7)	<100	ND	ND	ND	ND	ND	ND	ND	ND	<200	<20
Propylparaben	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Salicylic Acid	200	<100	<100	ND	ND	310	ND	ND	ND	ND	ND	ND	ND
Sucralose (artificial sweetener)	1000	2000	4400	960	1300	1700	2600	1800	3200	4600	4800	1000	1700
Triclocarban	50	<20(R7)	<20	ND	ND	ND	ND	ND	ND	ND	ND	<500	<500
Triclosan	25	<200	<200	<250	<250	ND	ND	ND	ND	ND	ND	<250	ND
Warfarin	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Method 539 - Hormones, ug/L													
17 alpha-ethynylestradiol	0.0009	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17-beta-Estradiol	0.0004	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-androstene-3,17-dione	0.0003	ND	ND	ND	ND	ND	<0.0032	ND	ND	ND	ND	<0.0030	<0.003
Equilin	0.004	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Estriol	0.0008	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Estrone	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Testosterone	0.0001	ND	ND	ND	ND	ND	<0.001	ND	ND	ND	ND	<0.001	<0.001
Method 521 - Nitrosamines, ng/L													
N-Nitrosodibutylamine (NDBA)	2	ND	ND	ND	ND	19	2.7	ND	ND	2.2	ND	3.4	ND
N-Nitrosodiethylamine (NDEA)	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-dimethylamine (NDMA)	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodi-n-propylamine (NDPA)	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosomethylethylamine (NMEA)	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosopyrollidine (NPYR)	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Method 537.1 - PFAS, ug/L													
11-chloroeicosafluoro-3-oxaundecane-sulfonic acid	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9-chlorohexadecafluoro-3-oxanone-sulfonic acid	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexafluoropropylene oxide dimer acid (HFPO-DA)	0.005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-ethyl Perfluorooctanesulfonamidoacetic acid	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-methyl Perfluorooctanesulfonamidoacetic acid	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorobutanesulfonic acid (PFBS)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorodecanoic acid (PFDA)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorododecanoic acid (PFDoA)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluoroheptanoic acid (PFHpA)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorohexanesulfonic acid (PFHxS)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorohexanoic acid (PFHxA)grease and stain-proof coating	0.002	ND	0.0021	ND	0.002	0.002	0.0024	0.002	0.002	0.0025	0.0027	ND	0.0022
Perfluorononanoic acid (PFNA)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorooctanesulfonic acid (PFOS)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorooctanoic acid (PFOA)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	0.0021	0.002	ND	ND
Perfluorotetradecanoic acid (PFTA)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorotridecanoic acid (PFTrDA)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluoroundecanoic acid (PFUnA)	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Additional PFAS from Method 533, ug/L													
1H,1H, 2H, 2H-Perfluorohexane sulfonic acid (4:2FTS)	0.002	not sampled	not sampled	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid (6:2FTS)	0.002	not sampled	not sampled	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid (8:2FTS)	0.002	not sampled	not sampled	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	0.002	not sampled	not sampled	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorobutanoic acid (PFBA)	0.002	not sampled	not sampled	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	0.002	not sampled	not sampled	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluoroheptanesulfonic acid (PFHpS)	0.002	not sampled	not sampled	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluoro-4-methoxybutanoic acid (PFMBA)	0.002	not sampled	not sampled	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluoro-3-methoxypropanoic acid (PFMPA)	0.002	not sampled	not sampled	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluoropentanoic acid (PFPeA)	0.002	not sampled	not sampled	ND	ND	0.0025	0.0029	ND	0.0021	0.0032	0.0031	ND	0.0035
Perfluoropentanesulfonic acid (PFPeS)	0.002	not sampled	not sampled	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

BA - Target analyte detected in method blank at or above the laboratory minimum reporting limits (MRL), but analyte not present in the sample.

BF - Target analyte detected in method blank is at or above the method acceptance limits, but below the method reporting limit and analyte not present in the sample.

LK - The associated blank spike recovery was above method detection limits. This target analyte was not detected in the sample.

LM- MRL Check recovery was above laboratory acceptance limits. This target analyte was not detected in the sample.

R7 - LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.

E7 - Concentration estimated. Internal standard recoveries did not meet laboratory acceptance criteria. All other QC was acceptable.