State of California

The Resources Agency

Department of Water Resources

The Municipal Water Quality Investigations Program

State Water Project Sanitary Survey Volume 1 of 5: The San Joaquin River Watershed

June 2015

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EXECUTIVE SUMMARY

The California State Water Project Watershed Sanitary Survey, 2013/14 Update (2013/14 Update) is part one of the sixth sanitary survey of the State Water Project (SWP). Since 1990, State Water Contractors have been required to conduct a watershed sanitary survey every five years to comply with the California Surface Water Treatment Rule now under the purview of the State Water Resources Control Board Division of Drinking Water (DDW). Although a sanitary survey is required to be completed every five years, a new annual reporting format was developed with the approval of DDW that will spread the reporting workload evenly each year and satisfy the requirement of a sanitary survey every five years. Five annual reports each focusing on a particular issue, region of interest, or as an overall review, will be submitted as they are completed, and then packaged together in the 5th year.

This is the first annual survey using this new format and focuses on the San Joaquin River watershed upstream of the Vernalis water quality station, which is the legal boundary for the Sacramento-San Joaquin River Delta. This survey evaluates the water quality of the San Joaquin River, identifies contaminant sources, evaluates vulnerabilities, and develops key findings and recommendations based on data collected from 2008 through 2012. The survey area is bounded on the south by the watersheds that contain the San Joaquin River, on the west by the coastal range mountains, on the east by the major reservoirs, and on the north by the Vernalis water quality station.

Regulatory Environment

Chapter 2 contains a discussion of the San Joaquin River watershed’s regulatory framework. This includes a description of the irrigated lands program, confined animal facility requirements, urban runoff regulatory programs, wastewater discharge regulatory programs, total maximum daily loads (TMDLs), CV-SALTS, and programs to manage and control agricultural drainage into the San Joaquin River, such as the Grasslands Bypass Project.

Watershed Description

Chapter 3 contains a description of the San Joaquin Valley watershed, which is used extensively for agriculture, but also contains some urban, industrial, and rangelands. The watershed has been divided into eastern and western sub-watersheds by the Central Valley and State Water Boards. The eastern watershed includes the three major tributaries to the San Joaquin River, which are the Stanislaus, Tuolumne, and Merced Rivers. The western watershed has a drier climate, where small tributaries contribute flows to the San Joaquin River during storm events or through agricultural drainage.

Potential Contaminant Sources

Chapter 4 contains a detailed description of several potential contaminant sources located in the San Joaquin River watershed from 2008 through 2012. Key findings for each of the topics discussed in Section 4 are presented below.

Wastewater Treatment Plants

There are six wastewater treatment plants in the San Joaquin River watershed study area. Currently wastewater treatment plants in the San Joaquin River watershed study area discharge 51.4 million gallons per day (mgd) based on average dry weather flow. The plants are permitted 120.67 mgd.

Regulation of wastewater treatment occurs through National Pollutant Discharge Elimination System (NPDES) permits. These permits require the discharger to meet effluent limitations. Four of the wastewater treatment plants in the San Joaquin River watershed are tertiary level treatment facilities. Current tertiary plants are Manteca/Lathrop, Turlock, Merced, and Clovis. Atwater and Modesto are in the process of upgrading to tertiary.

There is limited data on the concentrations of key drinking water constituents in wastewater effluent because NPDES monitoring programs do not include many of the drinking water constituents. Data analysis was conducted on constituents that were collected from the plants.

There were few spill events at the wastewater treatment plants, with the majority of spills occurring at the Modesto facility. There were also few Administrative Civil Liability (ACL) complaints issued. Manteca/Lathrop reported two spill events and issued six violations. Modesto was issued seven violations, Turlock three, and none for Merced, Atwater, and Clovis. Of the Category 1 Sanitary Sewer Overflows, Modesto reported 31, Clovis with eight, and Manteca/Lathrop one.

Urban Runoff

Urban runoff from Fresno, Modesto, and a number of smaller communities in the San Joaquin River watershed discharge to the San Joaquin River, either directly or through smaller tributaries.

Urban runoff in the San Joaquin River watershed is regulated by Central Valley Water Control Board through Municipal Separate Storm Sewer System (MS4) NPDES permits. There are both Phase I and Phase II permit holders, each with their own requirements. Phase I permits require medium (100,000 - 250,000 population) and large (greater than 250,000 population) municipalities to develop stormwater management plans and conduct monitoring of stormwater discharges and receiving waters. Phase II permits require smaller communities (less than 100,000 population) to develop management plans but does not require them to conduct monitoring. There are six minimum control measures a Phase II stormwater management program must include, and a selection of best management practices (BMPs) must be identified. Low impact development (managing stormwater as close to its original naturally occurring source as possible) has been required historically for Phase I permit holders, but has now been expanded to Phase II permits.

Urban runoff levels of drinking water constituents were generally low in the San Joaquin River and Tuolumne River. There was a general trend of increased concentrations during the wet seasons, however there were a large number of non-detects. The drinking water constituents of concern are:

- Total and dissolved organic carbon
- Salinity (total dissolved solids and electrical conductivity)
- Nutrients (total nitrogen, nitrate, nitrite, ammonia, and total phosphorus)
- Turbidity

- Pathogen indicator organisms (total coliforms, fecal coliform, *Escherichia coli*)
- Pesticides

Agricultural Discharges

Agricultural discharges are regulated by the State Water Board through the Irrigated Lands Program. Monitoring occurs throughout the watershed for nutrients, pesticides, and other constituents of concern, such as pathogens. Nutrients were found in nearly all samples, while pesticides were rarely found in samples. Fresno, Merced, and Stanislaus counties all had exceedances of nitrate plus nitrite, nitrate, or both. Madera and Merced counties had exceedances of the pesticide Simazine. No other exceedances were reported.

Confined Animal Facilities

Confined animal facilities (CAF) have had the potential to cause water quality problems. New regulations have required facility improvements, including expanded wastewater containment. This has resulted in very few discharges from CAFs to surface waters.

Water Quality

Chapter 5 contains water quality data from 2008 through 2012 along the San Joaquin River focusing on several stations between Mendota and Vernalis. The key findings from chapter 5 are presented below.

Several stations were selected along the San Joaquin River and drinking water constituents were analyzed. Constituents analyzed were:

- Organic carbon: Dissolved Organic Carbon and Total Organic Carbon
- Salinity: Electrical Conductivity and Total Dissolved Solids
- Bromide
- Nutrients: Ammonia, Nitrate, Nitrite, Nitrate+Nitrite, Total Kjeldahl Nitrogen, Total Nitrogen and Total Phosphorus
- Pathogen indicator organisms: fecal coliform, total coliform, and *E. coli*
- Trace elements and pesticides

Stations were selected by distance from other stations, proximities to other tributaries, and the amount of data sampled.

There is a general trend in increasing water quality for drinking water constituents when moving from upstream to downstream.

Key Findings and Recommendations

Chapter 6 contains a discussion of the key findings and recommendations from the Potential Contaminant Sources and Water Quality sections. These are recommendations that the Municipal Water Quality Investigations Program (MWQI) and the State Water Project Contractors Authority (SWPCA) can implement to improve water quality. Recommendations are listed below:

- Wastewater treatment plants –MWQI and SWPCA to track progress of NPDES permits
- Urban runoff – no current recommendations

- Ag discharges – no current recommendations
- Confined Animal Facilities – no current recommendations
- Water Quality – the amount of data currently collected at Vernalis by the Municipal Water Quality Investigations program warrants no further actions as the amount of data collected is sufficient in supplying accurate and reliable information regarding San Joaquin River water quality.

ACRONYMS AND ABBREVIATIONS

2011 Update	California State Water Project Watershed Sanitary Survey 2011 Update
ACL	Administrative Civil Liability
AGR	agricultural supply
ASBS	Areas of Special Biological Significance
Basin Plan	Water Quality Control Plan for the Sacramento River and San Joaquin River basins
Bay – Delta	San Francisco Bay/Sacramento – San Joaquin Delta Estuary
BDCP	Bay Delta Conservation Plan
BIOL	Biological Habitats of Special Significance
BMPs	best management practices
CAF	Confined animal facilities
CAFOs	concentrated animal feeding operations
CALFED	California Bay Delta Program
Caltrans	California Department of Transportation
CDPH	California Department of Public Health
CEDEN	California Environmental Data Exchange Network
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CIWQS	California Integrated Water Quality System
COC	constituents of concern
Conditional Waiver	Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands
CUWA	California Urban Water Agencies

CV-SALTS	Central Valley Salinity Alternatives for Long Term Sustainability
CWA	Federal Water Pollution Control Act
Dairy General Order	Reissued Waste Discharge Requirements General Order for Existing Milk Cow Dairies
DBPs	disinfection byproducts
D/DBP	Disinfectants and Disinfection Byproducts
DDW	State Water Resources Control Board Division of Drinking Water
Delta Reform Act	Sacramento-San Joaquin Delta Reform Act of 2009
DMC	Delta Mendota Canal
DNQ	Data Not Quantifiable
DO	dissolved oxygen
DOC	Dissolved Organic Carbon
DWP	Drinking Water Program
DWR	Department of Water Resources
EC	Electrical Conductivity
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
FFR	fixed film reactor
FID	Fresno Irrigation District
GWR	groundwater recharge
HAA5s	haloacetic acids
ILRP	Irrigated Lands Regulatory Program
IND	Industrial Service Supply
LID	Low Impact Development

maf	million acre-feet
MBR	membrane bioreactor
MCL	maximum contaminant level
MEP	maximum extent practicable
mgd	million gallons per day
MPN/100 mL	Most Probable Number per 100 milliliters
MRP	Monitoring and Reporting Program
MS4	municipal separate storm sewer system
MUN	municipal and domestic supply
MWQI	Municipal Water Quality Investigations
NAV	Navigation
NDN	nitrification and denitrification
NMP	Nutrient Management Plan
NNE	Nutrient Numeric Endpoint
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
PID	Patterson Irrigation District ()
POC	Pollutants of Concern
POI	Pollutants of Interest
POW	Hydropower Generation
RAS	return activated sludge
REC	Water Contact Recreation
Reclamation	U.S. Bureau of Reclamation

RG	State Water Board's Regulatory Group
RMP	Representative Groundwater Monitoring Program
ROWD	Report of Waste Discharge
Sanitary Sewer Order	Statewide General Waste Discharge Requirements for Sanitary Sewer Systems, Water Quality Order No. 2006-0003
SAG	Stakeholder Advisory Group
SED	Substitute Environmental Document
Small MS4	Small Municipal Separate Storm Sewer System
SMARTS	Storm Water Multi-Application Reporting and Tracking System
SNMP	Salinity and Nitrate Management Plan
SSMPs	sewer system management plans
SQMP	Surface Water Quality Management Plans
SSOs	sanitary sewer overflows
STAG	Stakeholder Technical Advisory Group
ST/WRF	Sewage Treatment and Water Reuse Facility
SWMP	stormwater management plan
SWP	State Water Project
SWPCA	State Water Project Contractors Authority
SWPPP	Stormwater Pollution Prevention Plans
SWQMP	Stormwater Quality Management Program
SWRCB	State Water Resources Control Board
T&O	taste and odor
TDS	Total Dissolved Solids
THMs	trihalomethanes

TID	Turlock Irrigational District
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TOC	Total Organic Carbon
USGS	United States Geologic Survey
UV	Ultraviolet
WAS	waste activated sludge
WDL	California Department of Water Resources Water Data Library
WDR	Waste Discharge Requirement
WRP	wastewater recycling plant

METRIC CONVERSION TABLE

Quantity	To Convert from Metric Unit	To Customary Unit	Multiply Metric Unit By	To Convert to Metric Unit Multiply Customary Unit By
Length	millimeters (mm)	inches (in)	0.03937	25.4
	centimeters (cm) for snow depth	inches (in)	0.3937	2.54
	Meters (m)	feet (ft)	3.2808	0.3048
	kilometers (km)	miles (mi)	0.62139	1.6093
Area	Square millimeters (mm^2)	square inches (in^2)	0.00155	645.16
	Square meters (m^2)	square feet (ft^2)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	Square kilometers (km^2)	square miles (mi^2)	0.3861	2.590
Volume	liters (L)	gallons (gal)	0.26417	3.7854
	megaliters (ML)	million gallons (10*)	0.26417	3.7854
	cubic meters (m^3)	cubic feet (ft^3)	35.315	0.028317
	cubic meters (m^3)	cubic yards (yd^3)	1.308	0.76455
	cubic dekameters (dam^3)	acre-feet (ac-ft)	0.8107	1.2335
Flow	cubic meters per second (m^3/s)	cubic feet per second (ft^3/s)	35.315	0.028317
	liters per minute (L/mn)	gallons per minute (gal/mn)	0.26417	3.7854
	liters per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megaliters per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekameters per day (dam^3/day)	acre-feet per day (ac-ft/day)	0.8107	1.2335
Mass	kilograms (kg)	Pounds (lbs)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb.)	1.1023	0.90718
Velocity	Meters per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (kW)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa) kilopascals (kPa)	pounds per square inch (psi) feet head of water	0.14505 0.32456	6.8948 2.989
Specific capacity	liters per minute per meter drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per liter (mg/L)	parts per million (ppm)	1.0	1.0
Electrical conductivity	microsiemens per centimeter (µS/cm)	micromhos per centimeter (µmhos/cm)	1.0	1.0
Temperature	degrees Celsius (°C)	Degrees Fahrenheit (°F)	(1.8X°C)+32	0.56(°F-32)

CHAPTER 1: INTRODUCTION

History of the SWP Sanitary Survey

The California State Water Project Watershed Sanitary Survey, 2013/14 Update (2013/14 Update) is part one of the sixth sanitary survey of the State Water Project (SWP). Since 1990, State Water Contractors have been required to conduct a watershed sanitary survey every five years to comply with the California Surface Water Treatment Rule, administered by the California Department of Public Health (CDPH). Beginning July 1, 2014 the Drinking Water Program (DWP) was transferred from CDPH to the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW). In Title 22 of the California Code of Regulations, a sanitary survey is defined as "a physical and hydrogeological description of the watershed, a summary of source water quality monitoring data, a description of activities and sources of contamination, a description of any significant changes that have occurred since the last survey which could affect the quality of the source water, a description of watershed control and management practices, an evaluation of the system's ability to meet requirements of this chapter, and recommendations for corrective actions." A description of each of the Sanitary Surveys follows:

- 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 aqueduct; with minimal effort on the contaminant sources in the SWP reservoir watersheds.
- The 1996 Sanitary Survey focused on the recommendations from the 1990 Sanitary Survey and any major changes in the watersheds between 1990 and 1996. In addition, it provided more detail 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 Sanitary Survey provided detail on contaminant sources in the watersheds of the SWP reservoirs and along the aqueducts; a detailed analysis of indicator organisms and pathogen data; and to provide the SWP Contractors with information needed to comply with the CDPH Drinking Water Source Assessment Program requirements.
- The 2006 Sanitary Survey focused on the key water quality issues that challenged the SWP Contractors, addressed the Jones Tract levee failure, emergency response procedures, efforts to coordinate pathogen monitoring in response to the Long Term 2 Enhancement Surface Water Treatment Rule, and reviewed significant changes to the watershed and impacts on water quality.
- The 2011 Sanitary Survey provided a detailed review of all of the water quality data collected over the last 20+ years at key Delta locations and along the aqueducts. The contaminant sources discussed in the 2006 Sanitary Survey were updated and several new issues were addressed, including the impacts of the biological opinions on water quality, the impacts of drought on water quality, the potential impacts of the California Aqueduct/Delta-Mendota Canal Intertie, and subsidence along the aqueduct.

Although a sanitary survey is required to be completed every five years, a new approach is being taken with the State Water Project Sanitary Survey. In prior years, one survey was completed to satisfy the mandated requirement in the 5th year. This was a tremendous effort each time the survey was completed. DDW, MWQI staff, and SWPCA have agreed to an approach that will make the sanitary surveys more useful to DDW and the SWP Contractors, and will not require an inordinate amount of staff time in one year. The new format consists of annual sanitary surveys. The first four sanitary surveys will focus on a particular issue or region of interest. The fifth survey will be a review of water quality data for the entire SWP. The five annual reports will be submitted to DDW as they are completed and then packaged together in the 5th year. This new format has been developed with the approval of DDW, and will satisfy the requirement of a sanitary survey every five years.

Scope and Objectives of 2013/14 Update

This is the first annual survey using the new format. The focus is on the San Joaquin River watershed upstream of the Vernalis water quality station. This survey is a classical sanitary survey that evaluates the water quality of the San Joaquin River, identifies contaminant sources, evaluates vulnerabilities, and develops key findings and recommendations. The data collected for the survey was from 2008 through 2012. The area that is within the scope of the project is bounded on the south by the watersheds that contain the San Joaquin River, on the west by the coastal range mountains, on the east by the major reservoirs, and on the north by the Vernalis water quality station. The Vernalis station is the legal boundary for the Sacramento-San Joaquin River Delta.

Report Organization

This report is organized in the following manner:

Chapter 1 – Introduction

Chapter 2 – Regulatory Environment

This chapter contains a description of the regulatory framework of the San Joaquin River watershed. This includes a description of the irrigated lands program, confined animal facility requirements, urban runoff regulatory programs, wastewater discharge regulatory programs, total maximum daily loads (TMDLs), CV-SALTS, and programs to manage and control agricultural drainage into the San Joaquin River, such as the Grasslands Bypass Project.

Chapter 3 – Watershed Description

This chapter includes a description of the San Joaquin River watershed, with a discussion of the area's climate, geology, hydrology, and land uses. The east side tributaries and west side streams are also discussed.

Chapter 4 – Potential Contaminant Sources

This chapter contains detailed information on several potential contaminant sources, identified by the Sanitary Survey Subcommittee as the key factors that may adversely affect water quality of the San Joaquin River. Each source is briefly described:

Wastewater Treatment Plants – Wastewater treatment plants discharging to the San Joaquin River watershed are described in detail. Available data from the last five years for each plant was obtained from the California Integrated Water Quality System (CIWQS). Information is also presented on wastewater spills and permit violations.

Urban Runoff – the Cities of Fresno and Modesto are the major urban areas in the San Joaquin River watershed. As their populations are greater than 100,000, they are designated as Phase I municipal separate storm sewer system (MS4) permit holders. Stormwater data was obtained from each municipality and the impacts on San Joaquin River water quality are discussed. Phase II NPDES permits are also described in detail.

Agricultural Discharges – Agricultural discharges in the San Joaquin watershed are regulated under the Central Valley Regional Water Quality Control Board's (Central Valley Water Board) Irrigated Lands Program. There are three coalitions in the San Joaquin watershed (East San Joaquin Water Quality Coalition, Westside San Joaquin River Watershed Coalition, and Westlands Stormwater District).

Confined Animal Facilities – Confined Animal Facilities (CAFs) are regulated by the Central Valley Water Board through NPDES permits, Waste Discharge Requirements (WDRs), and conditional waivers. The types of CAF's and numbers of animals are discussed, as well as compliance and violations. Information for CAFs was gathered through the USDA.

Chapter 5 – Water Quality

This chapter contains water quality data obtained from several stations located along the San Joaquin River, focusing on drinking water constituents of concern. Mendota is the furthest upstream station and Vernalis is the downstream location. Other stations located between Mendota and Vernalis were chosen based on several factors, including the amount of available data and distance from other selected stations. It was also important to incorporate the influences of the San Joaquin River's eastside tributaries; the Merced River, Tuolumne River, and the Stanislaus River. Stations were also selected from Mud and Salt Slough as they are heavily influenced by agricultural drainage. Data was obtained through the California Environmental Data Exchange Network (CEDEN), the Department of Water Resources (DWR) Water Data Library (WDL), and from the United States Geologic Survey (USGS). All of the available data was analyzed for upstream to downstream trends. The collected data included the constituents of concern listed below:

- Total and dissolved organic carbon
- Bromide
- Salinity (Total dissolved solids and electrical conductivity)
- Nutrients (total nitrogen, nitrate, ammonia, and total phosphorus)
- Turbidity
- Pathogen indicator organisms (total coliforms, fecal coliform, *Escherichia coli*)
- Pesticides and trace elements

Chapter 6 – Key Findings and Recommendations

This chapter discusses the findings and recommendations based on the analysis of each section. Only recommendations that were determined to be directly controlled by the State Water Project Contractors and MWQI were included.

Statistical Analysis

Throughout the report, the following summary statistics are presented in tabular form:

- Detects/Samples: The number of samples that were detected above the reporting limit followed by the number of samples collected.
- Range: the data between the minimum and maximum concentrations.
- Mean: Presented mostly for historical reasons. Skewed data of wide variability such as water quality data should not be averaged because the mean is usually strongly influenced by data at both extremes and is often misleading. Non-detects were not included in the mean calculations.
- Median: A more resistant measure for water quality data. The median is thus a generally preferred measure over the mean. Non-detects were not included in median calculations.
- Standard deviation: a measure of how tightly clustered the data is around the mean, indicating how normal the data distribution is.
- Standard Error: a measure of the error of the standard deviation, and indicates how far the mean is from the true population center.
- 95% Confidence Interval: The interval that contains the true population mean 95 percent of the time.

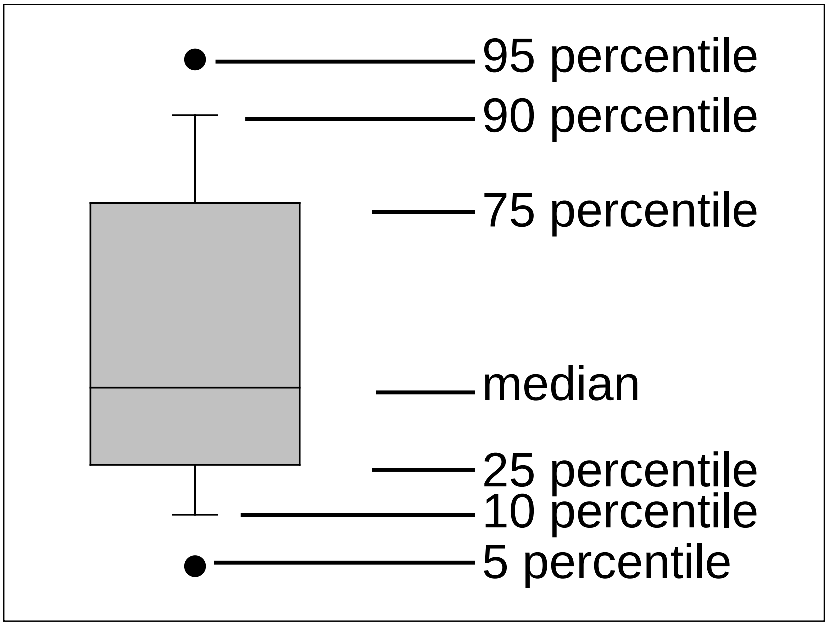
Most of the data is presented in descriptive plots. Summary statistics were computed using Microsoft Excel.

Descriptive Plots

Data is plotted over time to demonstrate general behavior of the data during the reporting period. Non-detects were not graphed. Data interpretations are illustrated with bar, line or scatter plots.

Box plots are used to illustrate summary statistics throughout the study period. In the box plot, the boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers (error bars) above and below the box indicate the 90th and 10th percentile. The outliers plot the 5th and 95th percentiles and symbols (Figure 1-1).

Figure 1-1. Illustrative Boxplot



CHAPTER 2: REGULATORY ENVIRONMENT

The California State Water Project Watershed Sanitary Survey 2011 Update (2011 Update) contains a detailed description of drinking water and source water protection regulations (Archibald et al. 2012). This chapter contains an update on source water protection regulations that specifically apply to the San Joaquin watershed.

State Plans and Policies

The State Water Board adopted the San Francisco Bay/Sacramento-San Joaquin Delta Water Quality Control Plan (Bay-Delta Water Quality Control Plan). In addition, there are several policies that have been adopted by the State Water Board that must be implemented in the Sacramento and San Joaquin basins by the Central Valley Water Board.

San Francisco Bay/Sacramento-San Joaquin Delta Water Quality Control Plan

The original Bay Delta Water Quality Control Plan was adopted in 1978, revised in 1991, and then substantially revised in 1995. The water quality and flow objectives for the Delta were substantially changed in the 1995 Plan. The State Water Board adopted Water Rights Decision 1641 to implement the objectives. The State Water Board made minor revisions to the 1995 Plan and adopted a new plan in 2006.

The Bay Delta Water Quality Control Plan establishes water quality control measures that protect the beneficial uses of San Francisco Bay and the Delta, that require control of salinity (caused by seawater intrusion, municipal discharges, and agricultural drainage) and water project operations (flows and diversions). The plan contains specific numeric standards for Delta inflow and outflow, and standards for chloride and electrical conductivity (EC) at various locations in the Delta. The California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation) are responsible for meeting the flow objectives; salinity objectives are met through a combination of flow and salinity control measures.

The State Water Board initiated its periodic review of the 2006 Bay-Delta Plan in August 2008, by issuing a notice of a public workshop to receive comments on potential modifications of the Bay-Delta Plan. The workshop was held in October 2008. In February 2009, the State Water Board issued a Notice of Preparation for the update of the Bay-Delta Plan, indicating that the update would be conducted in four phases.

The Sacramento-San Joaquin Delta Reform Act of 2009 (Delta Reform Act) was approved by the legislature and signed by Governor Schwarzenegger in November 2009. This Act required the State Water Board to develop flow criteria for the Delta ecosystem. In addition, the Act specified that construction of the Bay Delta Conservation Plan (BDCP) facilities are contingent on the State Water Board’s approval, in changes of points of diversion, and inclusion of appropriate Delta flow criteria. Flow objectives were recommended to be adopted and implemented by June 2014.

The State Water Board is currently in the process of implementing a four-phase process to update the San Joaquin River flow and Southern Delta water quality requirements included in the Bay Delta Plan:

- Phase 1 involves updating the San Joaquin River flow and the southern Delta water quality requirements.
- Phase 2 involves other comprehensive changes to the Bay Delta Plan to protect beneficial uses not addressed in Phase 1.
- Phase 3 involves changes to water rights and other measures to implement changes from Phase 1 and 2.
- Phase 4 involves developing and implementing flow objectives for priority Delta tributaries outside of the Bay Delta Plan updates.

Phase 1 (the San Joaquin River flows and southern Delta salinity objectives) and Phase 2 (the comprehensive review of other elements of the Bay-Delta Plan) are discussed in the following sections. Phases 3 and 4 have not commenced.

San Joaquin River Flows and Southern Delta Salinity Objectives

The State Water Board held a number of public workshops from 2009 to 2011, issuing a report on salt tolerance of crops in the southern Delta (Hoffman 2010) and a technical report providing the scientific basis for alternative San Joaquin River flow and Southern Delta salinity objectives. The State Water Board requested an external peer review be conducted on both the crop salt tolerance report (Hoffman 2010) and the draft final technical report (State Water Board 2011). Five peer reviewers were identified, and their reviews were completed mid-November 2011. The final technical report contains the proposed basin plan amendment language.

In compliance with the California Environmental Quality Act, the California Water Code, and other applicable state and federal requirements, the State Water Board prepared a draft Substitute Environmental Document (SED) (State Water Resources Control Board 2012). The State Water Board released the draft SED on December 31, 2012 for public review and comment. The draft SED includes an analysis of the expected environmental, water supply, economic, and hydropower effects of the Lower San Joaquin River flow and Southern Delta salinity alternatives (State Water Resources Control Board 2012). A final draft SED and final draft changes to the Bay Delta Plan are projected to be released late 2014 after incorporating March 2013 workshop comments. Proposed adoption of Phase 1 is expected for fall 2015 (Lindsay pers. comm 2014).

Proposed changes to the Bay-Delta Plan include:

- A new narrative flow objective for the lower San Joaquin River and salmon-bearing tributaries from February through June, and an associated implementation program to support and maintain the natural production of viable native lower San Joaquin River watershed fish populations migrating through the Delta.
- Revised numeric Southern Delta salinity objectives and an associated implementation program to protect agricultural beneficial uses in the Southern Delta.
- The preferred alternative in the SED requires flow in the tributaries of the San Joaquin River from February through June to be 35% unimpaired. The SED defines unimpaired flows as the flow that would occur if all runoff from the watershed remained in the river, without storage in reservoirs or diverted for irrigation, power generation, or water supply. “The 35% unimpaired flow proposal strikes a balance between providing water for the protection of fish and other competing uses of

water, including agriculture and hydropower generation" (SED, Executive Summary, pages 9-10). (State Water Resources Control Board 2012 and 2013)

Comprehensive Review of Other Elements of the Bay-Delta Plan

In August 2009, the State Water Board published a Staff Report on the Periodic Review of the 2006 Plan. On January 24, 2012, the State Water Board issued a supplemental Notice of Preparation seeking public input on the issues to address in the comprehensive review. The State Water Board held an informational item in February to receive comments on the schedule for updating the Bay-Delta Plan and issued a Revised Public Notice on August 16, 2012. From September to November, the State Water Board held six days of workshops concentrating on ecosystem changes and the low salinity zone; Bay-Delta fishery resources; and analytical tools for evaluating water supply, hydrodynamics, and hydropower effects. An informational item on the next steps related to a draft summary report was held April 9, 2013 which summarized the comprehensive (phase 2) review of the fall 2012 technical workshops. An email notice was sent out April 12, 2013 with comments due back April 23, 2013, specifically for input on areas of disagreement identified in the summary report needing to be resolved. The Delta Science Program held workshops on Delta Outflow and Related Stressors, and Interior Delta Flow and Related Stressors from February 10-11, and April 16-17, 2014, respectively. On May 15, 2014 the Delta Science Program presented "Workshop on Delta Outflows and Related Stressors, Panel Summary Report" fulfilling the State Water Boards request for workshops to resolve key scientific uncertainties and disagreements associated with the comprehensive review (State Water Resources Control Board 2014).

Phase 2 of the review focuses on the following issues:

- Delta outflow objectives
- Export/inflow objectives
- Delta Cross Channel gate closure objectives
- Suisun Marsh objectives
- Reverse flow objectives for Old and Middle Rivers
- Floodplain habitat flow objectives
- Changes to the monitoring and special studies program
- Other changes to the program of implementation

The State Water Board staff has indicated they will also consider other potential changes during this phase of the comprehensive review of the Bay-Delta Plan. Proposed adoption of Phase 2 is projected for fall 2015.

Proposed Policy for Nutrients for Inland Surface Waters of the State of California

In October 2011, the State Water Board convened a California Environmental Quality Act scoping meeting on a proposed Statewide Nutrient Policy for Inland Surface Waters. The policy was projected to include water quality objectives and establish control strategies for nutrients. The purpose of the meeting was to solicit early public consultation on the policy development; outline the environmental considerations of nutrients; and present the alternatives for developing objectives, implementation, and monitoring. The CEQA scoping alternatives considered were: (1) no action, (2) adopt the EPA Recommended Nutrient Criteria, or (3) adopt a Statewide Nutrient Policy based on the Nutrient Numeric Endpoint (NNE) approach. The State Water Board identified the State Nutrient Policy using the NNE approach as their preferred option. This approach has already been demonstrated in several TMDLs around the State.

The development of the Statewide Nutrient Policy is composed of 3 Boards' efforts moving in parallel but independently in relation to different levels of development: the State Water Board's nutrient project for wadeable streams, the San Francisco Regional Board's work on a nutrient policy for the Bay, and the Central Valley Water Board's effort to develop a nutrient research plan for the Delta (State Water Resources Control Board 2014. The nutrient policy is projected to evaluate the relative risk of nutrients potentially causing eutrophication, and plans to develop numeric guidance with consideration to regional environmental conditions based on supporting evidence.

In order to accomplish these goals, each Board's staff has assembled nutrient Technical Advisory Groups that consist of various interest groups. One interest group consists of the regulatory community, such as the State Water Board's Regulatory Group (RG). The other interest group is the Stakeholder Advisory Group (SAG), which consists of various stakeholder groups from dischargers to non-governmental organizations. Together these groups will go through their individual work plans to determine if nutrient concentrations and response indicators cause or contribute to impairments of beneficial uses. The State Water Board is in the process of assembling a Science Panel of nutrient and eutrophication experts to review all results of the overall nutrient project (State Water Resources Control Board 2014).

The State Water Board's process for developing stream nutrient objectives with numeric guidance, an assessment framework, and an implementation program is currently underway. The introductory face-to-face stakeholder outreach/SAG meeting was held in June 2014 with the second meeting held December 2014. The technical foundational science continues to be developed and will be reviewed by the RG, SAG, and an independent science panel. Rulemaking and adoption of any amendments to the statewide policy for nutrient control is projected for 2017 (Camacho pers. comm. 2014).

The Central Valley Water Board's nutrient study plan for the Delta assembled its first nutrient Stakeholder Technical Advisory Group (STAG) meeting on September 2014. The STAG is Central Valley's version of the State Water Boards' SAG. The goal of the STAG is to develop and implement a study plan, similar to the San Francisco Bay's efforts. The study plan will determine if nutrient objectives in the freshwater Delta are needed. Staff is projected to present the nutrient study plan to the Central Valley Water Board and Delta Stewardship Council in December 2014 for review and comments. A white paper is scheduled to be created by summer 2015 with a recommendation following in fall, after consultation with the TAC and SAG. The white paper will summarize new information and evaluate if the Central Valley nutrients cause or contribute water quality impairments to the Delta or San Francisco Bay (Foe pers. comm. 2014).

Central Valley Plans and Programs

The Central Valley Water Board regulates waste discharges from the San Joaquin watershed that could affect the quality of the waters of the state, pursuant to the Porter-Cologne Water Quality Act. The Central Valley Water Board has the authority to ensure protection of the beneficial uses of both surface and groundwater and the prevention of nuisances.

In the last five years, point source dischargers have continued to face increasingly stringent regulations and more prescriptive NPDES permits. The Central Valley Water Board has also continued to focus on regulating nonpoint source discharges.

Water Quality Control Plan for the Sacramento River and San Joaquin River Basins

The Central Valley Water Board adopted the Water Quality Control Plan for the Sacramento River and San Joaquin River basins (Basin Plan) in 1975, and has periodically updated the plan. The Basin Plan designates beneficial uses and water quality objectives for waters of the Sacramento and San Joaquin basins and contains an implementation plan for achieving the water quality objectives. Water quality standards consist of both the beneficial use and the water quality objectives (water quality criteria in the federal regulations) to protect the use. To protect both existing and potential future beneficial uses, water quality standards normally apply throughout the bodies of surface water and groundwater for which they were established rather than at points of current water use or withdrawal. The Basin Plan designates many waterways in the Sacramento and San Joaquin basins as municipal and domestic supply (MUN) beneficial use. Because of the large number of small streams and creeks that flow into major waterways in the Sacramento and San Joaquin basins, it is not possible to designate specific beneficial uses for each waterway. The Central Valley Water Board relies on the Sources of Drinking Water Policy and the Tributary Rule to establish the MUN beneficial use for waterways not specifically mentioned in the Basin Plan. The Tributary Rule simply states that beneficial uses of any specifically identified water body generally apply to its tributary streams. The Central Valley Water Board applied the Sources of Drinking Water Policy to all water bodies that are not specifically listed in the Basin Plan. This includes small tributaries, effluent dominated waterways, agricultural dominated waterways, and agricultural drains.

The Basin Plan for the Sacramento and San Joaquin basins contains both numeric and narrative water quality objectives to protect the MUN beneficial use, as well as other beneficial uses. Numeric objectives are established for bacteria, EC, TDS, turbidity, dissolved oxygen (DO), pH, pesticides, temperature, and trace elements. Many of the numeric objectives are specific to individual waterbodies and were established to protect aquatic life. The fecal coliform bacteria objectives were established to protect contact recreational use, rather than MUN. The fecal coliform objective is a 30-day geometric mean of 200 Most Probable Number per 100 milliliters (MPN/100 mL) and no more than 10 percent of the samples in a 30-day period can exceed 400 MPN/100 mL. MCLs established by DDW are incorporated into the Basin Plan as numeric objectives for the protection of the MUN beneficial use. The narrative water quality objectives are listed below:

- Chemical Constituents – Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.
- Taste and Odor – Water shall not contain taste or odor-producing substances in concentrations that impart undesirable tastes or odors to domestic or municipal water supplies or to fish flesh or

other edible products of aquatic origin, or that cause nuisance or otherwise adversely affect beneficial uses.

- Sediment – The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
- Suspended Material – Water shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
- Toxicity – All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effects of multiple substances.

Under current regulations, once water quality objectives are adopted into an approved Basin Plan, the Central Valley Water Board is responsible for ensuring compliance with the objectives through adoption of discharge permits and implementation of other water quality control programs. Point source discharges to surface waters, such as wastewater treatment plants and industries, are regulated under NPDES permits. NPDES permits, excluding stormwater permits, normally include effluent and receiving water limits to protect the beneficial uses of the receiving water. Urban runoff dischargers are also required to obtain NPDES permits, but they are not assigned effluent limitations. Urban runoff permits require the discharger to implement BMPs to reduce pollutant loadings to the maximum extent practicable.

The Central Valley Water Board regulates nonpoint source discharges through waste discharge requirements, conditional waivers, or discharge prohibitions. Nonpoint source regulation typically entails discharger implementation of BMPs to control pollutant sources. Agricultural discharges are currently regulated as an interim program under a conditional waiver, but will soon be converted to a long-term program. More detail on the specifics of these control programs is provided in the following sections.

Section 303(d) of the Clean Water Act requires the identification of waterbodies that do not meet, or are not expected to meet, water quality standards (i.e., impaired waterbodies). These are then prioritized in the 303(d) List. A total maximum daily load (TMDL) must be developed for each listing. In 2008, California began integrating the 303(d) List of Impaired Waters and the 305(b) Water Quality Assessment Report into a single report (Integrated Report). The California 2008-2010 Integrated Report was approved by the State Water Board in August 2010 and approved by USEPA in October 2011. This Integrated Report can be viewed through an interactive map on the State Water Board website (http://www.swrcb.ca.gov/water_issues/programs/tmdl/integrated2010.shtml). The State Water Board is currently working on the 2012 Integrated Report which will cover Regions 1, 6, and 7. This iteration of the report is projected to be submitted to the USEPA July 2014. Timeline for the 2014 Integrated Report covering Regions 3, 5, and 9, and the 2016 Integrated Report covering Regions 2, 4, and 8, is set to be completed June 2015 and June 2016, respectively (Bingen pers. comm. 2014). (The San Joaquin Watershed is located in Region 5.)

2013 Triennial Review of the Water Quality Control Plans for the Sacramento and San Joaquin River Basins

The 2013 Triennial Review by the Central Valley Water Quality Control Board (Regional Water Board) is in accordance with the Federal Clean Water Act to review water quality standards contained in the Water Quality Control Plans. Two public workshops were held in October and December 2012.

Comments received are ordered into a priority list of potential issues that may result in basin plan amendments; this list is used to direct basin planning efforts for the next three years. Due to staff resource constraints only a small portion of the highest priority issues are addressed. The Work Plan for the 2013 Triennial Review is projected to be completed in April 2014 (Yee pers. comm. 2014).

Below are the high priority issues identified in the 2011 Triennial Review and the status update for the 2013 Triennial Review (Central Valley Regional Water Quality Control Board 21013a):

- Issue 1: Salt and Nitrate Management for Surface and Ground Waters

Status: The Central Valley Salinity Alternatives for Long Term Sustainability (CV-SALTS) addresses surface waters and ground waters of the Central Valley. See CV-SALTS section for more information.

- Issue 2: Effluent Dominated Water bodies

Status: Effluent dominated water bodies were requested to be included in CV-SALTS effort to assess the beneficial uses of agriculturally dominated water bodies.

- Issue 3: Agricultural Dominated Water Bodies

Status: As part of the CV-SALTS, beneficial uses and water quality objectives are being reevaluated for agricultural water bodies.

- Issue 4: Beneficial Use Designation

Status: As part of the CV-SALTS project, the applicability of the municipal and domestic supply beneficial use (MUN) in receiving waters characterized as agricultural drains is being assessed. CV-SALTS is also evaluating groundwater beneficial uses.

- Issue 5: Delta Issues

Status: Work has been started to evaluate the role of ammonia on the Sacramento-San Joaquin Delta and Suisun Bay ecosystem. The plan is to determine current water quality conditions, evaluate nutrient roles in algae species abundance, and recommend implementing nutrient criteria to the Water Boards.

- Issue 6: Dissolved Oxygen Problems in the San Joaquin River near Stockton

Status: During the Last Triennial Review, the Central Valley Water Board adopted an operation control program to achieve the dissolved oxygen objective. Part of the control program was the installation and operation of an aerator for the Port of Stockton. The Central Valley Water Board staff is evaluating the Dissolved Oxygen Control Plan and will provide the Board recommended next steps by February 2015.

- Issue 7: Pesticide Control Efforts

Status: An amendment to the Water Quality Control Plan for the Sacramento River and San Joaquin River basins for the control of diazinon and chlorpyrifos discharges was adopted by the Central Valley Water Board in March 2014 (Central Valley Regional Water Quality Control Board 2014).

- Issue 8: Mercury Reduction Program

Status: State and Regional Water Board staff is developing a statewide water quality control program for mercury (statewide mercury program) that will include: (1) mercury control program for reservoirs; and (2) mercury water quality objectives (State Water Resources Control Board 2014; Central Valley Regional Water Quality Control Board 2013). Amendment to the Water Quality Control Plan for the Sacramento River and San Joaquin River basins for the control of methylmercury and total mercury in the

Sacramento-San Joaquin River Delta estuary was adopted by the State Water Board April 22, 2010 and approved by the USEPA October 20, 2011 (Central Valley Regional Water Quality Control Board 2010).

- Issue 9: Drinking Water Policy

Status: The Drinking Water Policy was adopted by the Central Valley Water Board in July 2013 and by the State Water Board in December 2013.

- Issue 10: Protection of Central Valley Fisheries and other Aquatic Life

Status: No activity was conducted on this issue.

- Issue 11: Secondary MCLs as Water Quality Objectives

Status: As part of the development of the Central Valley Salt and Nitrate Management Plan, CV-SALTS is considering alternatives to the way secondary MCLs are regulated. This is discussed in more detail in the section on CV-SALTS.

Total Maximum Daily Loads

The Clean Water Act section 303(d) requires that states develop a list of waters that are not attaining water quality standards and that they develop TMDLs for each constituent that results in the exceedance of a standard. The TMDLs generally consist of a maximum allowable load of a water quality constituent that will allow the water quality standard to be met. The load is allocated to both point and non-point sources contributing to the water quality standard exceedance. In the San Joaquin Basin, TMDLs have been established for DO, selenium, diazinon, chlorpyrifos, salt, boron, and pathogens.

The Central Valley Water Board adopted a Basin Plan Amendment for the control of diazinon and chlorpyrifos for the Sacramento River and San Joaquin River basins in March 2014 (Central Valley Regional Water Quality Control Board 2014). The amendment contains water quality objectives and an implementation program to achieve those objectives. The Board is currently developing amendments to address additional pesticides of concern, such as pyrethroid insecticides and the herbicide diuron.

The TMDLs for drinking water constituents addressed in this sanitary survey are briefly described.

San Joaquin River Salt and Boron TMDL

The Central Valley Water Board adopted a TMDL for salt and boron in the San Joaquin River in 2004. The TMDL was adopted by the State Water Board in 2005 and by the USEPA in February 2007. This TMDL requires that the existing water quality objectives for EC of 700 µS/cm during the irrigation season and 1,000 µS/cm during the non-irrigation season be met in the San Joaquin River at Vernalis. The San Joaquin River Water Quality Management Group, consisting of stakeholders in the San Joaquin Basin, is working cooperatively to meet the water quality objectives.

A Management Agency Agreement was signed between Reclamation and the Central Valley Water Board in December 2008 to address salt loads from the Delta Mendota Canal. The Action Plan focuses on providing flows to the system, reducing salt load to the river, and facilitating mitigation. Following public comments, in December 2010, a draft Phase II Management Agency Agreement (MAA), revised Action Plan, revised Compliance Plan, and revised Compliance Report were prepared. However in February 2011, staff was directed to continue working with stakeholders by the Central Valley Water Board to resolve outstanding issues before bringing a Phase II MAA back for approval. To address one of the outstanding issues on quantifying dilution flow, Reclamations submitted two final Technical Memoranda in February 2013. The Central Valley Water Board and Reclamation staffs are projected to jointly prepare a Revised Management Agency Agreement by October 2014 with final approval scheduled for December 2014.

Wastewater Discharges

Municipal and industrial wastewater dischargers are required to obtain NPDES permits, which are reviewed and readopted by the Central Valley Water Board every five years or whenever there is a proposed change in discharge quality or quantity that is not included within the existing permit. As described previously, the beneficial uses and receiving water objectives to protect those uses are established in the Basin Plan. The Central Valley Water Board establishes effluent limitations for wastewater dischargers based on the beneficial uses and the water quality objectives of the water body that receives the discharge and the state's antidegradation policy. There are specific steps necessary to determine whether a discharge permit needs a limit for a constituent and if so, what the limit should be. To determine a permit limit, the Central Valley Water Board determines: (1) whether a discharge has a reasonable potential to cause or contribute to an exceedance of a receiving water objective for a particular constituent or parameter, (2) identifies the water quality objectives for the protection of the beneficial uses that have been designated for the receiving water body, and (3) selects criteria (numerical water quality objectives or water quality goals that implement a narrative objective).

The permit limit derivation procedures take into account acute and chronic aquatic life toxicity effects, human health effects, dilution, ambient background concentrations, and antidegradation requirements. For drinking water constituents, if a discharge has the reasonable potential to cause an excursion above an existing objective or MCL, then the discharge permit will include a limit and requirements for monitoring that constituent. However, this process does not apply to constituents for which objectives do not already exist (for example, TOC and pathogens). If a discharge is to an ephemeral stream or a stream that the Central Valley Water Board determines does not have any assimilative capacity for a contaminant, the discharger must meet the receiving water quality objectives in the effluent. If there is dilution capacity available in the receiving water, the Central Valley Water Board may establish effluent limitations that allow for a mixing zone and dilution of the effluent in the receiving water.

To provide a consistent, statewide regulatory approach to address sanitary sewer overflows (SSOs), the State Water Board adopted Statewide General Waste Discharge Requirements for Sanitary Sewer Systems, Water Quality Order No. 2006-0003 (Sanitary Sewer Order) on May 2, 2006. The Sanitary Sewer Order requires public agencies that own or operate sanitary sewer systems to develop and implement sewer system management plans (SSMPs) and report all SSOs to the State Water Board's online SSO database.

The Sanitary Sewer Order requires the owners and operators of sanitary sewer systems to take all feasible steps to eliminate SSOs and to develop and implement a system-specific SSMP. SSMPs must include provisions to provide proper operation and maintenance while considering risk management and cost. The SSMP must contain a spill response plan that establishes standard procedures for immediate response to an SSO in a manner designed to minimize water quality impacts and potential nuisance conditions. The SSMPs must be updated every five years. A key requirement of the Sanitary Sewer Order is that SSOs must be entered into the State Water Board's SSO online database. Wastewater spills greater than 1,000 gallons, all wastewater spills that enter waters of the state, and spills that occur where public contact is likely, regardless of the volume are classified as Category 1 SSOs. Category 1 SSOs must be reported to the SSO database as soon as possible but no later than three business days after the SSO is detected. The Sanitary Sewer Order contains other requirements for reporting of SSOs that do not reach surface waters and for monthly reporting if no SSOs occurred. If spills are not reported, this is considered a violation of the California Water Code and it is grounds for enforcement action. Reporting began in September 2007. This process simplifies the ability of water purveyors to identify spills of interest and obtain specific information about a spill using the State Water Board California Integrated Water Quality System website.

In August 2008, the Central Valley Water Board issued Spill Reporting Procedures for wastewater treatment plant spills. This was issued to ensure consistency in notification procedures with the State Water Board Order for Sanitary Sewer Systems (see discussion above). This requires facilities to notify the California Office of Emergency Services, the local health department, and the Central Valley Water Board within two hours of a spill or discharge. Wastewater spills greater than 1,000 gallons, all wastewater spills that enter waters of the state (surface and groundwater), and spills that occur where public contact is likely, regardless of the volume, must be reported to the Central Valley Water Board. This notification must be made by telephone as soon as notification is possible, but should not impede the cleanup or other emergency measures required. The notification must occur within 24 hours of detection of the spill. In addition to oral notification, a written report must be submitted to the Central Valley Water Board within five days of the spill.

Urban Runoff

In 1972, the Federal Water Pollution Control Act (now referred to as the CWA) was amended to provide that the discharge of pollutants to waters of the United States from any point source is unlawful, unless the discharge is in compliance with an NPDES permit. The 1987 amendments to the CWA added section 402(p) which directs that stormwater discharges are point source discharges and establishes a framework for regulating municipal and industrial stormwater discharges under the NPDES program. On November 16, 1990, the USEPA promulgated final regulations that established the stormwater permit requirements. The regulations addressed municipal stormwater and also specified a requirement for stormwater permits from 10 categories of industry, as well as construction activities greater than one acre. Stormwater permits are required for discharges from a municipal separate storm sewer system (MS4). The USEPA developed its stormwater regulation in two phases.

Municipal urban runoff in the San Joaquin River watershed is regulated by the Central Valley Water Board through MS4 permits. Both the Phase I and Phase II stormwater regulations require municipalities to reduce urban runoff pollution to the maximum extent practicable through implementation of BMPs. Management programs must include public education, pollution prevention, and good housekeeping for municipal operations, implementation of new development BMPs, erosion and sediment control at construction sites, and control of illicit discharges. Both the Phase I and II regulations provide the regulated municipalities with the flexibility to make their own selection of BMPs in designing their individual programs (Central Valley Regional Water Quality Control Board 2014).

Phase I NPDES permits prevent harmful pollutants from being washed or dumped into MS4, medium and large cities, or certain counties. Medium cities have a population size of 100,000 to 250,000, and large cities have a population size greater than 250,000. Municipalities implement stormwater management plans, conduct storm discharge, receive water monitoring, and include control programs for industrial sites. Phase 1 permits are issued to individual permittees or to groups of permittees in contiguous areas.

Phase II regulation was promulgated in 1999 for cities and other contiguous areas with populations less than 100,000. The Phase II first generation permit was adopted in 2003; it contained the six control measures in broad terms and required permittees to develop stormwater management plans (SWMPs). The General Permit from the State Water Board expired in 2008, but remained in effect until a new General Permit was adopted. The Phase II Small Municipal Separate Storm Sewer System (Small MS4) General Permit was adopted February 5, 2013 and came into effect July 1, 2013. The permit aims to prevent and reduce the impacts of urbanization by controlling discharge of stormwater pollution. The 2013 Small MS4 permit specifies action necessary to clearly define the Water Board's expectation from Phase II dischargers. It also addresses concerns by the federal courts regarding permittees' ability to write their own permit without public review or comment. The 2013 MS4 permit enables the permitting authority to enforce the MS4 permits, improve water quality of stormwater discharges, and eliminates the need for the municipalities to prepare a SWMP. Significant provisions of the Phase II Small SM4 General Permit include: (1) implementation of low impact development principles, (2) protection of areas of special biological significance, (3) TMDL implementation requirements, (4) specific management measures, (5) elimination of submission of SWMP, (6) designation criteria and waiver certification, (7) program management, (8) annual reports submitted electronically using stormwater multi-application reporting and tracking system (SMARTS), (9) water quality monitoring, and (10) program effectiveness assessments (State Water Resources Control Board 2013).

The State Water Board has issued general NPDES permits for stormwater discharges from construction sites greater than one acre in size (Construction General Permit) and for industrial discharges (Industrial General Permit). These two permits require that the permittees prepare Stormwater Pollution Prevention Plans (SWPPP) that identify the BMPs to be implemented to control stormwater runoff. The Construction General Permit was renewed in 2009 and contained significant changes, including technology based numeric action levels and numeric effluent limits for pH and turbidity, a shift to risk-based permitting, a requirement that the Stormwater Pollution Prevention Plan be prepared by a qualified developer, a requirement for a sediment monitoring plan if the site discharges to a waterbody listed on the 303(d) list for sediment, a requirement for post-construction stormwater runoff reduction, additional monitoring and reporting requirements, and training and action plans. The Industrial General Permit is in the process of being renewed and is expected to include minimum BMPs, enhanced procedures and reporting, and increased monitoring requirements.

The existing Industrial General Permit was adopted in 1997 and has expired but remains in effect until a new General Permit is adopted. The permit was originally scheduled to be reissued in 2003, however concerns regarding the role of numeric effluent limitations in stormwater permits halted the effort. In 2006, the State Water Board considered recommendations from an expert panel on the role of numeric effluent limitations (NELs) in stormwater permits. A draft permit was issued in January 2011 and comments were due by April 29, 2011. Due to the volume of comments regarding associated increased regulatory costs and NELs in the proposed permits, the State Water Board released subsequent draft permits in July 2012 and July 2013 for additional comments. The 2014 Final Draft Industrial General

Permit does not include NELs due to the concerns over increased regulatory compliance costs. The goals of the 2014 Final Draft Industrial General Permit are to clarify the permit's key requirement and to achieve permit compliance within the five year permit cycle for most dischargers. Final comments were due April 1, 2014.

The State Water Board has also issued a statewide permit for the California Department of Transportation (Caltrans). This permit regulates stormwater discharges from all Caltrans properties, facilities, and activities.

Agricultural Discharges

The Central Valley has about 7.5 million acres of cropland, with over 6.5 million of those acres irrigated. Approximately two-thirds of the acreage is in the San Joaquin Valley (including the Tulare Lake Basin). In 2007, five counties within the San Joaquin River watershed — Fresno, Madera, Merced, San Joaquin, and Stanislaus —contained approximately 4.8 million acres of agricultural land. The main regulatory program related to irrigated agriculture in the San Joaquin watershed is the Irrigated Lands Regulatory Program. The Irrigated Lands Regulatory Program covers a wide array of constituents. The program has significantly increased the regulatory oversight of agricultural discharges in the Central Valley and contributed to a much better understanding of the actual water quality threats and how those threats can be mitigated (Central Valley Regional Water Quality Control Board 2014).

The Irrigated Lands Regulatory Program (ILRP) was created to address discharge of waste from irrigated lands that affect surface and ground water quality. Discharges of irrigation water and stormwater runoff from agricultural fields were largely unregulated until the Central Valley Water Board adopted the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Conditional Waiver) in 2003. In June 2006, the Central Valley Water Board adopted a new waiver that maintained many of the elements of the 2003 Conditional Waiver. The Conditional Waiver required all irrigated agriculture, including row crops, field crops, tree crops, commercial nurseries, managed wetlands, and pastureland, to develop a monitoring program to assess the sources and impacts of discharges from irrigated lands, and to determine if reduction strategies needed to be implemented. Dischargers have the option of obtaining individual permits or joining a coalition.

Most dischargers opted to join Coalition Groups that encompass large geographic areas. The Coalition Groups that cover the watershed of the San Joaquin River are:

- East San Joaquin Water Quality Coalition
- Westside San Joaquin River Watershed Coalition
- Westlands Stormwater Coalition

In addition, Merced, Modesto, Oakdale, South San Joaquin, and Turlock irrigation districts obtained individual discharge orders.

In 2006, the Central Valley Water Board also began the process of developing a long-term ILRP to address discharges from irrigated agriculture. This included development of an Existing Conditions Report, which served as a foundation to develop alternatives for a long-term water quality regulatory program. An Advisory Workgroup was formed in 2008 to begin development of the form and content of the long-term program. This resulted in development of a Long-Term ILRP Alternatives Document, which presented five alternatives to move forward in the process. In 2010, the Central Valley Water

Board began General Stakeholder meetings to inform the public of the current status, provide a “Straw Proposal” of how the long-term program will be presented, and begin to receive comments. A Draft Programmatic EIR was published in July 2010. The PEIR was certified by the Central Valley Water Board in April 2011 as part of the long term program; however the PEIR did not specify program alternatives.

New Waste Discharge Requirements tailored to specific geographic areas will rescind existing Irrigated Lands Conditional Waivers. The regulatory requirements contained within the Waste Discharge Requirements General Order for specific regions fall within the range of alternatives evaluated in the PEIR. WDRs have already been approved for the Eastern San Joaquin River Watershed (Order R5-2012-0116-R2) (Central Valley Regional Water Quality Control Board 2012), Individual Growers (Order R5-2013-0100), and the Western San Joaquin River Watershed (R5-2014-0002) (Central Valley Regional Water Quality Control Board 2014). The Westlands Water District submitted a Notice of Intent (NOI) to represent growers in the Western Tulare Lake Basin Area and fulfill the requirements and conditions of the WDR (R5-2014-001) (Central Valley Regional Water Quality Control Board 2014).

Discharge Prohibitions, and Limitations

The General Orders require protection of both surface water and groundwater quality. To protect water quality, the General Orders prohibit discharges of: (1) waste to water of the state, from irrigated agricultural operations other than those defined in “Findings” of specific General Orders, (2) of hazardous waste, (3) of wastes (e.g., fertilizers, fumigants, pesticides) into groundwater via backflow through a water supply well, and (4) of any waste (e.g., fertilizers, fumigants, pesticides) down a ground water well casing. To protect water quality, the General Orders contain receiving water limitations: wastes discharged shall not cause or contribute to an exceedance of applicable water quality objectives in either surface or underlying groundwater, unreasonably affect applicable beneficial uses, or cause or contribute to a condition of pollution or nuisance.

Key Elements to the New Waste Discharge Requirements

- Expands the program to include discharges to groundwater.
- Known high vulnerability areas have more regulatory requirements, low threats have fewer requirements.
- Tailors requirements to specific geographic areas or commodities.
- Identifies specific expectations that must be met to avoid individual regulation by the Board.
- Requires growers to conduct evaluations of their management practices; in nitrate impacted or potentially impacted areas, growers are required to develop nitrogen management plans.
- Requires third parties to develop regional water quality management plans for areas where irrigated agriculture is contributing to water quality problems.
- Conducts monitoring to fill data gaps, determine the effectiveness of management practices, and track water quality trends.
- Focus on areas where irrigated agriculture is contributing to water quality problems and is impacting the beneficial uses of water.

Key Surface Water Reports

Monitoring Report – The Irrigated Lands Program General Orders require coalition groups to monitor agricultural drainage for a variety of constituents. The constituents vary according to agriculture type and pesticides used and can include TOC, TDS, nutrients, and bacteria. Sampling also varies and is typically conducted during the irrigation season and during storm events. A Monitoring and Reporting Program (MRP) plan must be developed by each coalition group or individual discharger. These must be submitted to and approved by the Central Valley Water Board. All entities are required to submit periodic monitoring reports to the Central Valley Water Board.

Surface Water Exceedance Report – The General Orders require agricultural dischargers to meet water quality objectives in receiving waters. The coalition group is required to file exceedance reports with the Central Valley Water Board if surface water monitoring results exceed adopted numeric water quality objectives or trigger limits.

Surface Water Quality Management Plans (SQMP) – Dischargers must prepare and implement Management Plans for constituents discharged by irrigated agriculture when (1) a water quality objective or trigger limit is exceeded twice in a three year period for the same constituent, (2) Basin Plan requires development of SQMP, or (3) Executive Officer determines that irrigated agriculture may be causing or contributing to a trend of degradation of surface water that may threaten applicable Basin Plan beneficial uses. These have been prepared throughout the Central Valley for constituents ranging from toxicity to bacteria to pesticides. The management plan must evaluate the effectiveness of existing management practices in (1) achieving applicable water quality objectives, (2) identifying additional actions, (3) including different or additional management practices or education outreach that the coalition group and/or its participants propose to implement to achieve applicable water quality objectives, and (4) identifying how the effectiveness of those additional actions will be evaluated.

Confined Animal Facilities

Confined animal facilities (CAF) are defined as any place where cattle, calves, sheep, swine, horses, mules, goats, fowl, or other domestic animals are corralled, penned, tethered, or otherwise enclosed or held and where feeding is by means other than grazing (Environmental Protection Agency 2012). All CAFs, as defined in the California Code of Regulations Title 27, including dairies, are subject to the Water Boards regulatory authority (State Water Resources Control Board 2014). Dairies in the San Joaquin River watershed are regulated through the Dairy General Order or individual waste discharge requirements.

As part of a new regulatory process, the Central Valley Water Board requested each existing milk cow dairy to submit a Report of Waste Discharge by October 2005. In May 2007, the Central Valley Water Board adopted Order No. R5-2007-0035 Waste Discharge Requirements for Existing Milk Cow Dairies (General Order). In October 2013, the Central Valley Water Board adopted Order No. R5-2013-0122 Reissued Waste Discharge Requirements General Order for Existing Milk Cow Dairies (Dairy General Order) (Central Valley Regional Water Quality Control Board 2013). This order rescinds and replaces the 2007 General Order. The Dairy General Order applies to all dairies that submitted Reports of Waste Discharge in 2005 and have not been expanded since October 17, 2005. Due largely to economic reasons, the Board estimates only 1,300 of the 1,600 dairy operations within the Central Valley covered by the 2007 General Order will be subject to the reissued Dairy General Order.

All dairies receiving coverage under the Dairy General Order are required to:

- Monitor wastewater, soil, crops, manure, surface water discharges, and stormwater discharges;
- Monitor surface water and groundwater in accordance with a monitoring and reporting program (regulated dairies have the option to join a Representative Groundwater Monitoring Program (RMP) in lieu of individual monitoring of first encountered groundwater);
- Implement a Waste Management Plan for the dairy production area;
- Implement a Nutrient Management Plan (NMP) for all land application areas;
- Retain records for the production area and the land application areas;
- Submit annual monitoring reports;
- Improve or replace management practices that are found not to be protective of water quality;

The Dairy General Order defines dairy waste as "manure, leachate, process wastewater, and any water, precipitation or rainfall runoff that comes into contact with raw materials, products, or byproducts such as manure, compost piles, feed, silage, milk, or bedding." Waste generated at dairies is stored dry in piles or in liquid form in waste retention ponds. The wastes are then applied to cropland or transported offsite for utilization on cropland as a nutrient source. Dairy wastes contain high concentrations of nutrients (organic nitrogen, ammonia, phosphorus, and potassium), organic carbon, salts, and pathogens. Although the waste materials provide nutrients to crops, they can create nuisance conditions if improperly managed or cause degradation of surface waters and groundwater. The primary waste constituents of concern (COC) due to discharges of waste from dairies with respect to surface waters are: nitrogen in its various forms (ammonia and un-ionized ammonia, nitrate, nitrite, and total Kjeldahl nitrogen), phosphorus, potassium, salts (as measured by total dissolved solids and electrical conductivity), total suspended solids, and pathogens. The COCs due to discharges of waste from dairies with respect to groundwater are: nitrogen (ammonia and un-ionized ammonia, nitrate, nitrite, and total Kjeldahl nitrogen), salts, and general minerals (calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulfate, and chloride). The discharge of waste from dairies must not cause surface water or groundwater to exceed the applicable water quality objectives for those constituents.

Discharge Prohibitions and Monitoring Requirements

The Dairy General Order reduces impacts to surface water by prohibiting discharges of (1) waste and/or stormwater to surface water from the production area, (2) wastewater to surface water during or following application to cropland, and (3) stormwater to surface water from the land application area where manure or process wastewater has been applied, unless the land application has been managed consistent with a certified nutrient management plan. Owners are required to design detention basins large enough to retain waste and stormwater onsite for a 25-year, 24-hour event. The Dairy General Order reduces impact to groundwater by requiring: (1) development and implementation of Nutrient Management Plans that will control nutrient losses from land application areas, (2) implementation of remedial measures when groundwater monitoring demonstrates that an existing pond has adversely impacted groundwater quality, (3) design and construction of new ponds and reconstructed existing ponds to comply with the groundwater limitations and specifications in the Dairy General Order, (4) documentation that no cross connections exist that would allow the backflow of wastewater into a water supply well, and (5) submittal of an Operation and Maintenance Plan. The Dairy General Order also prohibits discharges that cause or contribute to exceedances of water quality objectives in surface water and groundwater. The Dairy General Order requires monitoring of discharges, surface water, groundwater, stormwater, and tailwater for general physical characteristics, nutrients, TDS, and bacteria.

Reports

The Dairy General Order requires each dairy to submit an initial Existing Conditions Report, and then annual reports and summary reports demonstrating that they are taking specific steps toward complying with all terms and conditions of the Dairy General Order within six years. By 1 July 2012, the 2007 General Order required submission of an Annual Report including the Annual Dairy Facility Assessment with a description of facility modifications implemented to date and certification that the Nutrient Management Plan has been completely implemented. These reports must demonstrate that they have adequate waste containment to prevent discharges to surface water, have adequate flood protection to comply with state regulations, can operate and maintain their facilities in compliance with the Dairy General Order, and can manage their waste applications to land application areas in a manner that will minimize or eliminate the transport of nutrients to surface water.

Compliance

As stated in the Dairy General Order, the Executive Officer has initiated and taken a significant number of enforcement actions against owners and operators of existing milk cow dairies for failure to comply with the terms of the 2007 General Order. Such actions have included, but are not limited to issuance of: 770 Notices of Violation; 94 Water Code 13267 investigations; 71 Selective Enforcement Letters; 67 Administrative Civil Liability complaints (Wat. Code, Sections 13385 and 13323); and 12 Expedited Payment Letters.

The Dairy Quality Assurance Program

Owners will receive a 50 percent fee reduction if they complete certification through the Dairy Quality Assurance Program. The Dairy Quality Assurance Program was formed in late 1996 as a voluntary program, sponsored by the State Water Board, the California Department of Food and Agriculture, and the University of California Cooperative Extension, to assist dairy owners in complying with regulations and improving sanitary conditions at dairies. The program core components include:

- Attendance of a six hour education short course on farm management.
- Development of an individual Farm Management Plan.
- Third party evaluation, conducted by California Department of Food and Agriculture inspectors who have received additional training from the University of California, Davis and the Central Valley Water Board.

Once a dairy operator completes all three of these components, a certification is issued.

Central Valley Salinity Alternatives for Long-Term Sustainability

The Central Valley Water Board, the State Water Board, and the Central Valley Salinity Coalition are working collaboratively on the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) project. The Coalition was formed in July 2008 to organize, facilitate, and fund efforts needed to achieve the goals of the CV-SALTS initiative. The goal of this effort is to develop a comprehensive Salinity and Nitrate Management Plan (SNMP) for the Central Valley. This effort was initiated in January 2006 and a background report on the salinity issues in the Central Valley was prepared in May 2006 (Central Valley Water Board 2006). The scope of the initiative includes salinity, namely salt and boron, as well as nitrate. This includes impacts to both surface water and groundwater. The work focuses on studies to assess sources of salinity, strategies for reduction, development of key tolerance information, as well as public outreach to identify all salinity concerns. Development of the Basin Plan Amendment for salt and boron on the San Joaquin River upstream of Vernalis has been assigned to the CV-SALTS initiative. The Lower San Joaquin River Committee was created to review information and develop recommendations for this basin planning effort (Central Valley Regional Water Quality Control Board 2013).

The Central Valley Water Board is proposing to incorporate the CV-SALTS SNMP through amendments to the Water Quality Control Plans for the Sacramento River and San Joaquin River Basin Plans. The 2013 Triennial Review of the Water Quality Control Plans identified five key regulatory elements to support basin-wide salt and nitrate management: (1) refinement of the agricultural supply (AGR), municipal and domestic supply (MUN), and groundwater recharge (GWR) beneficial uses, (2) revision of water quality objectives for these uses, (3) establishment of policies for assessing compliance with the beneficial uses and water quality objectives, (4) establishment of management areas where there are large scale differences in baseline water quality, land use, climate conditions, soil characteristics, existing infrastructure, and where short and long term salt and/or nitrate management is needed, and (5) overarching framework to provide consistency for the development of management plans within the management areas to facilitate implementation effects and insure a sustainable future. The proposed amendments will potentially incorporate many components of a stakeholder developed Central Valley-wide SNMP. Components of the SNMP that the Central Valley Water Board may develop and incorporate into the Basin Plans are (1) Changing the Basin Plan's Beneficial Use Classification System, (2) Specifically Delineating Waterbodies, (3) Management Zone Concept, (4) Changing Existing Salinity Water Quality Objectives, (5) Adding Implementation Plans and or Changing Existing Implementation Plans, and (6) Adopting New Policies. The current planning efforts will also satisfy the Recycled Water Policy requirements (Central Valley Regional Water Quality Control Board 2013).

The component of CV-SALTS of most interest to drinking water agencies is the possible change to the manner in which secondary MCLs are incorporated into the Basin Plan. Currently, the secondary MCLs are incorporated by reference and are applied as water quality objectives to be met in the receiving water. In the development of the SNMP, CV-SALTS is considering several alternatives:

- No changes to the Basin Plan with regards to secondary MCLs (no action alternative).
- Remove the secondary MCLs from the Basin Plans and utilize narrative objectives to prevent nuisance conditions, including objectionable tastes or odors in drinking water supplies.
- Include implementation language for secondary MCLs in the Basin Plans that explains how the secondary MCLs shall be implemented.
- Specify that the full range of secondary MCLs provided in the California Code of Regulations, title 22 for continuous use are considered "reasonable" protection of MUN.
- Specify implementation and compliance evaluation methods including identification of points of compliance and procedures for evaluating how compliance with secondary MCLs will be evaluated, e.g., through use of appropriate averaging periods.
- Specifically recognize that secondary MCLs are applicable to treated drinking water supplies and develop translators to ensure the adequate protection of raw water supplies.

The Central Valley Water Board held four public workshops in October 2013 to discuss the SNMP and solicit comments. The draft SNMP is projected to be completed in 2014 and the final SNMP is projected to be completed in May 2016. The Final Staff Report and Basin Plan Amendments are scheduled for December 2017.

Grassland Bypass Project

Subsurface agriculture drain water was historically discharged to the San Joaquin River by farmers in the Grassland area of the western San Joaquin Valley. The agricultural discharge contained elevated concentrations of selenium, salt, boron, and other trace elements. Drain water traveled through wetland channels in the San Luis National Wildlife Refuge Complex to the San Joaquin River. Consequently, the elevated concentrations of water quality contaminants disrupted the normal ionic balance of the aquatic system. State health advisories were put in effect for the grassland area's wildlife due to continued contamination of water delivery channels (Central Valley Regional Water Quality Control Board 2001).

To address the agriculture discharge problem, the Grassland Bypass Project was initiated by Reclamation in September 1996. The Grassland Bypass Project is a drainage control program that implements the basin plan's selenium control program. Discharge of agricultural subsurface drainage is prohibited unless the discharge is regulated by a WDR or water quality objectives. Subsurface agricultural drainage, tailwater and stormwater runoff is discharged to Mud Slough (north) after being transported via Grassland Bypass Channel and a portion of the San Luis Drain for eventual discharge into the San Joaquin River. The project serves approximately 97,400 acres of farmland and is designed to route tile drainage containing high levels of selenium and other constituents around Grassland watershed wetlands. Phase I of the Grassland Bypass Project was an interim measure regulated by the Regional Boards WDR Order No. 98-171 and was adopted on 24 July 1998. Phase II continued separation of drainage discharge from the Grassland Drainage Area from wetland water supply conveyance channels from 2001 through 2009. The Phase II goal was to facilitate drainage management, maintain the viability of agriculture in the Grassland Drainage Area, and promote continuous improvements in the San Joaquin River's water quality (San Luis and Delta Mendota Water Authority 2010).

The Central Valley Water Board WDRs for the Grassland Bypass Project specified the maximum monthly and annual loads of selenium that may be discharged into Mud Slough and the San Joaquin River. Requirements included monthly monitoring for molybdenum and nutrients such as nitrate, ammonia, total Kjeldahl nitrogen, total phosphate and orthophosphate. Weekly monitoring is also required for salinity, selenium, boron, chronic toxicity testing, and other parameters. Program monitoring of storm water discharges from both inside and outside of the Grassland Drainage Area into the Grassland wetlands is specified in the WDR. Consolidating the subsurface drainage removes the primary source of selenium and removes drainage from Salt Slough. The Grassland Bypass Project manages drainage through source control, which includes selective land retirement, irrigation efficiency, and channel lining to control seepage. Management strategies to reduce the amount of discharge include drainage blending and reuse, and limited temporary discharges (Bureau of Reclamation 2013).

Reducing selenium from approximately 90 miles of canals within the Grassland Watershed enables water supply for wetland habitats and improves the health of waterfowl susceptible to hazardous concentrations of selenium. All discharges from the Grassland Drainage area into the wetlands and refuges have been eliminated since the implementation of the Grassland Bypass Project. Loads of selenium and salt discharged from the Grassland Area is reported to have decreased by 61 and 39 percent, respectively. Although discharge has substantially been reduced, subsurface drainage from areas outside the Grassland Bypass Project area continues to discharge to the San Joaquin River through Salt Slough and/or Mud Slough (north). The Grassland Bypass Project remains incomplete or in various stages of planning and implementation.

Central Valley Drinking Water Policy

In the 1990s, California Urban Water Agencies (CUWA) recognized that many of the constituents of concern to drinking water suppliers are not included as objectives in the Basin Plan (disinfection byproduct precursors, pathogens, nutrients) or the current objectives are not based on drinking water concerns (salinity, chloride). CUWA worked with the Central Valley Water Board and the California Bay Delta Program (CALFED) to include the development of a drinking water policy for the Central Valley in the CALFED Record of Decision. As a result, the Central Valley Water Board engaged in a multi-year stakeholder effort to develop a policy for protecting source water for the beneficial use of drinking water. The Central Valley Water Board adopted an amendment to the Sacramento River and San Joaquin River Basin Plan in July 26 to incorporate the Drinking Water Policy elements, which include recognition of all existing regulations that protect drinking water uses, clarification that the chemical constituents narrative objective applies to drinking water constituents of concern (such as organic carbon), recognition of the importance of a multi-barrier approach to public health protection, and a new narrative objective for *Cryptosporidium* and *Giardia*.

The new narrative objective reads, "Waters shall not contain *Cryptosporidium* and *Giardia* in concentrations that adversely affect the public water system component of the MUN beneficial use. This narrative water quality objective for *Cryptosporidium* and *Giardia* shall be applied within the Sacramento-San Joaquin Delta and its tributaries below the first major dams (shown in Figure A44-1) and should be implemented as specified in Section IV of the Basin Plan. Compliance with this objective will be assessed at existing and new public water system intakes."

The Basin Plan amendment was approved by the State Water Board in December 2013, and is awaiting final approval by the Office of Administrative Law and the USEPA before becoming effective.

San Joaquin River Restoration Program

The San Joaquin River was dammed in 1942 and most of the water was diverted to farms and cities on the east side of the San Joaquin Valley. This resulted in a 60 mile stretch of the river essentially drying up and cut off Chinook salmon from their historic spawning grounds. A coalition led by the Natural Resources Defense Council filed a lawsuit in 1988, challenging the U.S. Department of the Interior's intention to renew the Friant Division 40-year water service contracts without the preparation of an EIS. The complaint was expanded to include other claims, including a claim under the federal Endangered Species Act, and a claim that operation of Friant Dam violated a California Fish and Game Code section that requires dams to release sufficient water to keep fish in good condition below the dam. This latter claim became the focus of the litigation, with all claims resolved by the settlement.

The San Joaquin River Restoration Program resulted from a September 2006 settlement of the 18-year-old lawsuit regarding sufficient fish habitat on the San Joaquin River below Friant Dam. The parties to the settlement are the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council, and the Friant Water Users Authority. The program's goals are to restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River between Friant Dam and the confluence of the Merced River while reducing or avoiding adverse water supply impacts to all the Friant Division long-term contractors, which may result from the interim flows and restoration flows, required by the settlement.

The effort to restore the San Joaquin River covers 153 miles and involves not only restoring flows to about 60 miles of dry river bed, but also requires significant improvements to channels, levees, and fish passages. Funds for the project come from water users, state bond initiatives, and federal authorizations. In 2012 the implementing agencies finalized the PEIS/R, and signed the Record of Decision and Notice of Determination. Progress also continued on site specific projects in Reach 2B, Reach 4B, and Arroyo Canal Fish Screen and Sack Dam Fish Passage Project.

The site-specific project's studies are part of the Phase 1 actions identified in the Settlement. These studies support the implementation of the settlement by focusing on the release of interim flow, river modifications, and are in compliance with NEPA and CEQA. Reach 2B and Mendota Pool Bypass is a channel improvement project. Actions include construction, and operation and maintenance of the Mendota Pool Bypass. They also include improvements to the San Joaquin River channel to allow Reach 2B to convey approximately 4,500 cubic feet per second. Reach 4B, Eastside Bypass and Mariposa Bypass, is a low flow channel and structural improvement project. Actions include improving conveyance capacity from Reach 4B headgates near Washington Road to the confluence of the Mariposa Bypass. The modifications will allow conveyance of interim and restoration flows, include fish habitat and maintain or possibly improve the existing flood system. Arroyo Canal Fish Screen and Sack Dam Fish Passage project implements two of the highest priority projects. Actions include fish screen on the Arroyo Canal to prevent entrainment of juvenile Chinook salmon in the canal and modifications to Sack Dam to allow fish passage around the structure (San Joaquin River Restoration Program 2013).

The settlement requires specific water releases from Friant Dam to meet the various life stage needs for spring-run and fall-run Chinook salmon. In addition to a base volume equal to the average Friant Dam release of 116,741 acre-feet/year, the settlement requires approximately 247,000 acre-feet/year in most dry years and about 555,000 acre-feet/year in wet years. The first interim restoration flows were released from Friant Dam in October 2009. Flows were gradually increased with full restoration flows scheduled to begin by January 1, 2014. However, due to the "critical low" year designation, starting in March 2014, no water will be allocated to the program under the terms of the settlement unless hydrologic conditions change (Bureau of Reclamation 2014).

Efforts to implement the settlements goals of reestablishing spring run Chinook salmon populations in the San Joaquin River began in the fall 2012. Eggs from the Feather River Fish Hatchery created a genetic base population for the reestablishment of the spring run salmon brood stock. Efforts continued in 2013 with 560 eggs collected at the Feather River Hatchery, contributing to the San Joaquin captive brood stock program. Once eggs developed into juvenile fish they were transported and reared to adulthood at the Salmon Conservation and Research Facility near Friant Dam. With the completion of the Final Environmental Assessment and the final rule, the first spring-run Chinook salmon were released into the river in spring 2014 (National Marine Fisheries Service 2013).

The Final Environmental Assessment regarding the final rule analyzed the environmental impacts to the San Joaquin River below Friant Dam for proposed action to reintroduce a nonessential experimental population of spring-run salmon. The final rule identified the Central Valley spring run Chinook salmon (*Oncorhynchus tshawytscha*) as the nonessential experimental population (Government Printing Office 2013). NMFS designated the species under the Endangered Species Act. Reintroduction of the species to the San Joaquin River below Friant Dam was promulgated through the experimental population rule and associated take exceptions. The final rule affecting portion of the San Joaquin River went into effect January 30, 2014 (San Joaquin River Restoration Program 2014).

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Yee, B. 2014. Provided an updated timeline on the completion of the 2013 Triennial Review. Personal communication to O. Lindsey.

CHAPTER 3: WATERSHED DESCRIPTION

This chapter focuses on the description of the San Joaquin River watershed and includes descriptions of land use, geology and soils, climate, precipitation, and the hydrology of the watershed.

The San Joaquin River watershed is bounded by the Sierra Nevada Mountains on the east, the Coast Ranges on the west, the Delta to the north, and the Tulare Basin to the south. From its sources in the Sierra Nevada Mountains, the San Joaquin River flows southwesterly until it reaches Friant Dam. Below Friant Dam, the river flows westerly to the center of the San Joaquin Valley near Mendota, where it turns northwesterly to eventually join the Sacramento River in the Delta. The main stem of the San Joaquin River is about 300 miles long and drains approximately 16,000 square miles (Environmental Protection Agency 2014). The San Joaquin River has three major tributaries that drain from the Sierra Nevada. In downstream order, they are the Merced River (drainage area 1,270 square miles, average flow 1,350 cubic feet per second (cfs)), Tuolumne River (1,884 square miles, average flow 2,254 cfs), and Stanislaus River (980 square miles, average flow 1,400 cfs). Together, inflow historically contributed more than 60-70% of the flows in the San Joaquin River as measured at Vernalis. There are a number of minor tributaries that drain the Coastal Range on the west side of the watershed.

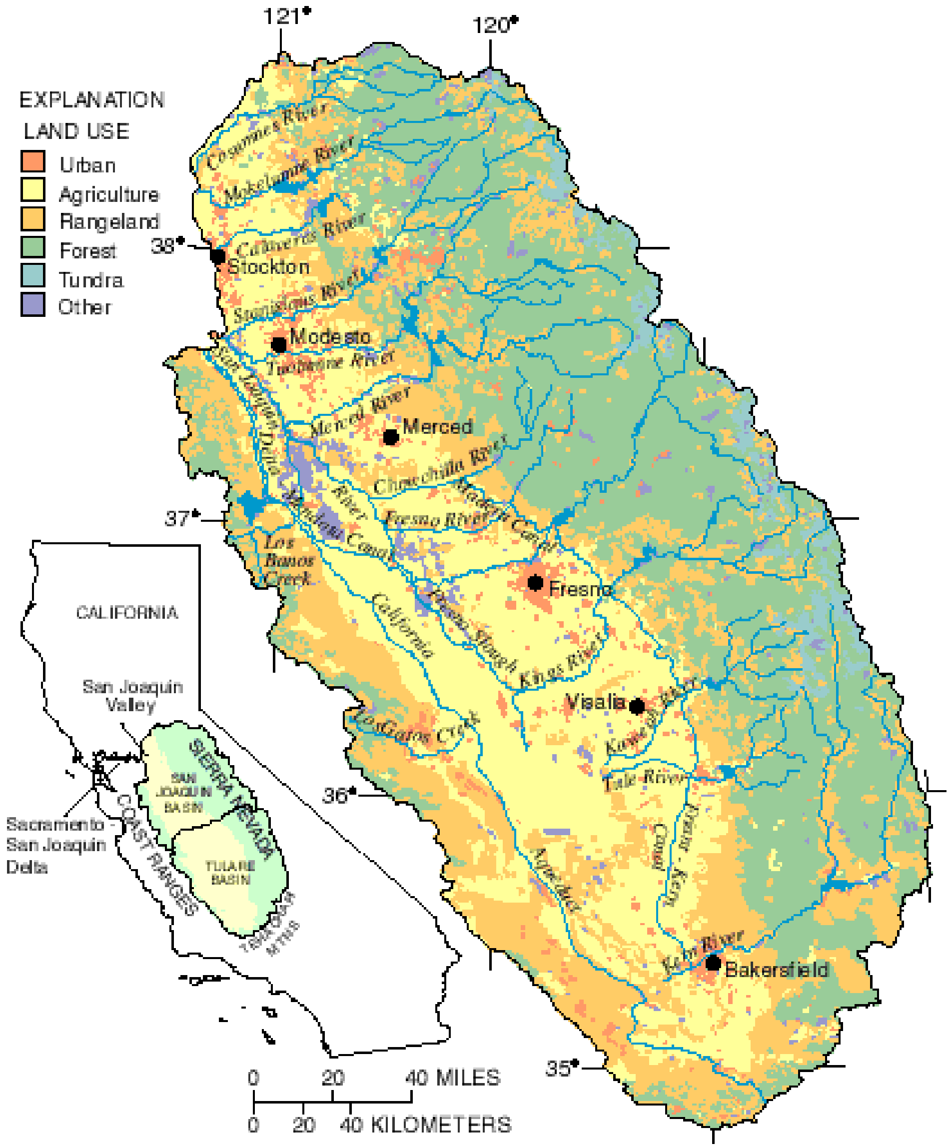
The watershed examined in this sanitary survey consisted of the area below the major rim reservoirs to the boundary of the legal Delta at Vernalis. Contaminant sources above the major rim reservoirs have limited to no impact on water quality at Vernalis due to the substantial retention time and dilution provided by the reservoirs. Contaminant sources downstream of the reservoirs have more potential to impact water quality at Vernalis, and from Vernalis, the State Water Project.

The Central Valley Water Board and State Water Board have divided the San Joaquin Valley into sub-basins. The sub-basins are characterized by differing watershed boundaries, hydrologies, climates, and land uses. The two prominent sub-basins within the study area are the east and west San Joaquin sub-basins. The East San Joaquin Water Quality Coalition monitors the eastern side of the San Joaquin Valley under WDR Order R5-2012-0116-R2. The Westside San Joaquin River Watershed Coalition monitors the western side of the San Joaquin Valley under WDR Order R5-2014-0002.

Land Use

Land uses in the San Joaquin River watershed include agriculture, grazing, open space, and urban areas (Figure 3-1). Agriculture, which developed early and quickly in the watershed, has remained the dominant land use. Almost 70% of the lowlands have been converted to irrigated agricultural lands. Historically, the lowlands were a large floodplain of the San Joaquin River that supported vast expanses of permanent and seasonal marshes, lakes, and riparian areas (Department of Water Resources 2001).

Figure 3-1. General Land Use of the San Joaquin Basin and the Tulare Basin



Land uses for the San Joaquin River's three major tributaries are as follows:

- The Merced River Basin consists of rural and privately owned lands. The primary land use is agricultural and aggregate mining. Many tracts are under active cultivation with orchards, vineyards, and grazed annual grassland pastures close to the river's edge.
- The Tuolumne River Basin is primarily used for irrigated agriculture, but it also used for ranching, mining, and tourism.
- The Stanislaus River Basin has been developed extensively for water, hydroelectricity, gravel, and conversion of floodplain to agricultural and residential uses. Most of the river floodplain is residential, rural development, and agriculture.

Land uses surrounding the San Joaquin River within the San Joaquin watershed are:

- Ranches, grazing, and small farming communities on the western side of the valley
- Agriculture and some urban use within the San Joaquin Valley
- Grazing and open space in the eastern mountains and foothills

Many San Joaquin River riparian communities were lost when historical waterways ran dry as water was diverted through irrigation channels and artificial drainages. However, isolated riparian communities exist in the lower portions of the San Joaquin River watershed, and more intact communities can be found along the eastern reaches of the watershed.

Wetland areas were once very common in the northern, southern, and parts of the western reaches of the San Joaquin River watershed; but since the mid-19th century, wetlands have been reduced to a fraction of their historical acreage. Wetlands are still situated in the northern and western reaches of the watershed but are less abundant than in other parts of the watershed.

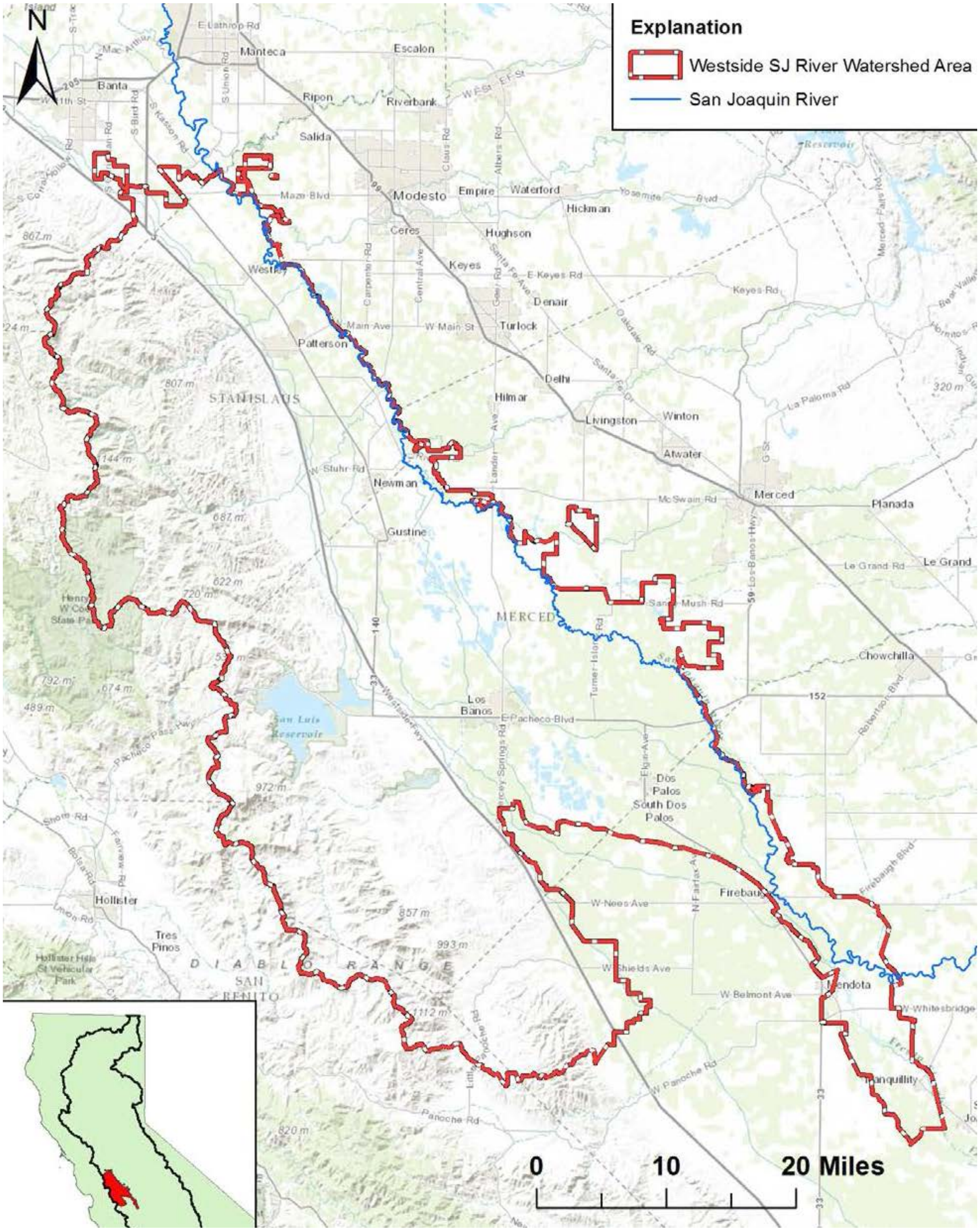
Currently, there are approximately 1,000,000 and 530,000 acres of irrigated agricultural land within the western and eastern San Joaquin watersheds, respectively. Based on 2010 data for the total harvested acreage in the San Joaquin River watershed, the top ten crops were: almonds, hay, silage, corn, grapes, tomatoes, irrigated pasture, wheat, cotton, and walnuts. Approximately 60 different crops are grown in the western San Joaquin River watershed area.

For the west side of the San Joaquin River watershed (Figure 3-2), 105,303 acres were surveyed. There were 98,902 (94%) acres of irrigated agriculture in the surveyed area. Of that, 13,812 acres were tree crops (14%) and 73,744 acres were field crops (75%). Table 3-1 shows the west side of the San Joaquin River watershed area monitored at seven locations by the Westside San Joaquin River Coalition. The locations were chosen based on hydrology, crop types, land use, soil types, and rainfall.

Table 3-1 Inventory Data for Monitoring Locations on the West Side of the San Joaquin River watershed

Monitoring locations	Hospital Creek Acres (%)	Ingram Creek Acres (%)	Del Puerto Creek Acres (%)	Orestimba Creek Acres (%)	Westley Waterway Acres (%)	Poso Slough Acres (%)	Salt Slough Acres (%)
Survey Area	7,142	5,779	9,195	12,851	5,248	11,525	53,563
Irrigated Area	5,193 (73%)	5,526 (96%)	7,926 (86%)	11,714 (91%)	4,565 (87%)	11,410 (99%)	52,568 (98%)
Land Use (% Irrigated Acres)							
Tree Crops			4,237 (53%)	5,481 (47%)	2,891 (63%)	196 (2%)	1,007 (2%)
Field Crops			3,678 (46%)	5,626 (48%)	1,670 (37%)	11,209 (98%)	51,561 (98%)

Figure 3-2. **West Side of the San Joaquin River Watershed**

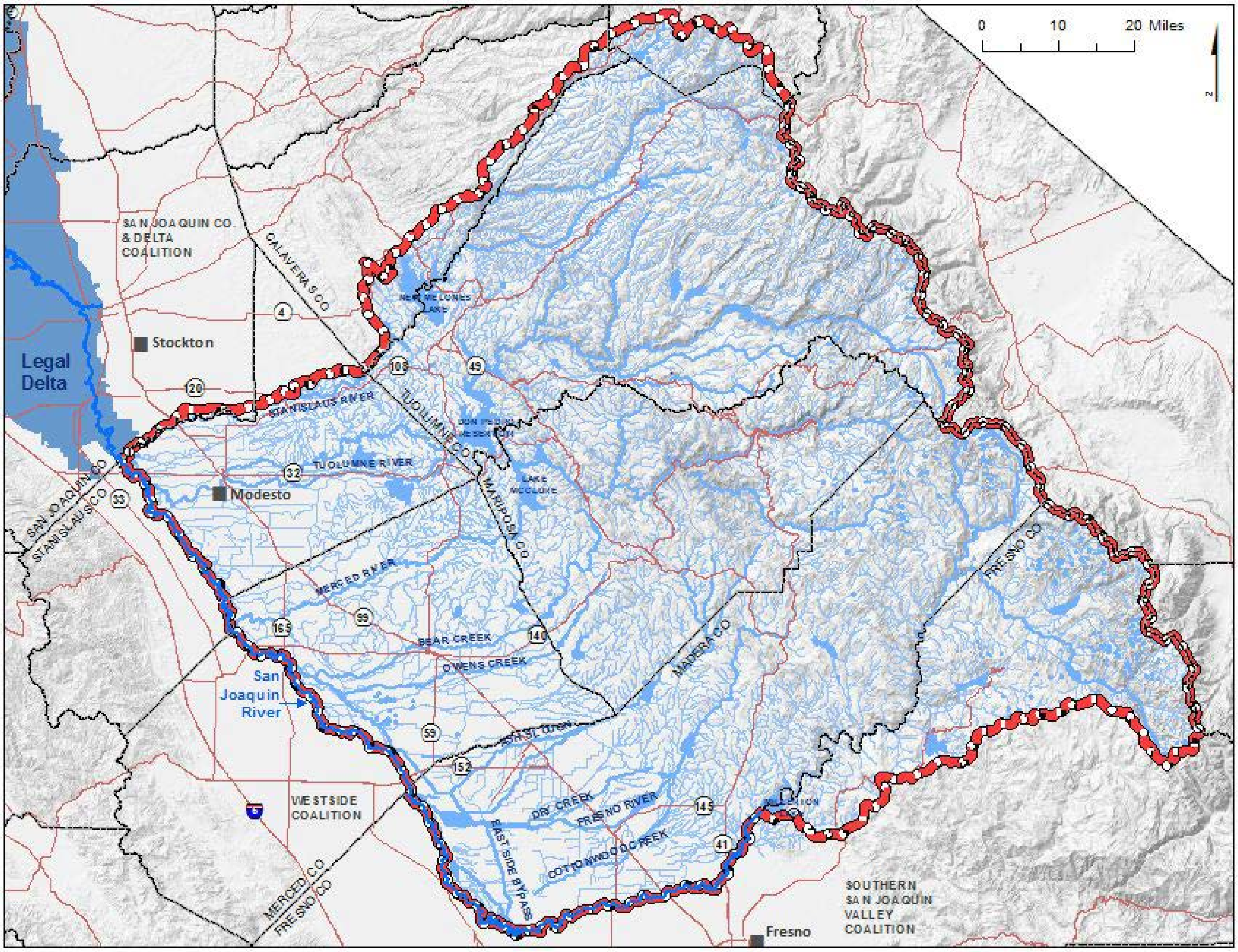


For the east side of the San Joaquin watershed (Figure 3-3), 7,224,793 acres were surveyed. There were 987,058 (14%) acres of irrigated agriculture in the surveyed area. There were 987,058 acres of irrigated agriculture in the surveyed area (14%). Of that, 511,213 acres were deciduous fruits and nuts (52%), 198,503 acres were field crops (20%), 30,878 acres were grains and hay (3%), 220,561 acres were pasture (22%), and 132,531 acres were vineyard (13%). Table 3-2 shows the east side of the San Joaquin River watershed area monitored at six locations by the Eastern San Joaquin Water Quality Coalition. The locations were chosen based on hydrology, crop types, land use, soil types, and rainfall.

Table 3-2. Inventory Data for Monitoring Locations on the East Side of the San Joaquin River watershed

Monitoring locations	Dry Creek at Wellsford	Prairie Flower Drain at Crows Landings	Highline Canal at Hwy 99	Merced River at Santa Fe	Duck Slough at Gurr Road	Cottonwood Creek at Road 20
	Acres (%)	Acres (%)	Acres (%)	Acres (%)	Acres (%)	Acres (%)
Survey Area	2,739,268	757,502	1,213,340	608,352	637,819	1,268,513
Irrigated Area	134,307 (5%)	164,633 (22%)	88,617 (7%)	121,746 (20%)	142,686 (22%)	335,069 (26%)
Land Use (% of irrigated acres)						
Deciduous Fruits/Nuts	52,662 (39%)	62,281 (38%)	54,969 (62%)	71,550 (59%)	56,447 (40%)	213,305 (64%)
Field Crops	21,852 (16%)	37,421 (23%)	14,037 (16%)	27,089 (22%)	46,872 (33%)	51,232 (15%)
Grains/Hay	1,195 (1%)	1,334 (1%)	1,391 (2%)	4,712 (4%)	7,905 (6%)	14,341 (4%)
Pasture	47,061 (35%)	50,839 (31%)	9,863 (11%)	23,838 (20%)	44,832 (31%)	44,129 (13%)
Vineyard	5,050 (4%)	5,383 (3%)	7,648 (9%)	6,927 (6%)	2,411 (2%)	105,111 (31%)

Figure 3-3. East Side of the San Joaquin River Watershed



Geology and Soils

Two geomorphic provinces make up the San Joaquin watershed: the Sierra Nevada province, and the Great Valley province which includes the San Joaquin Valley. There are three distinct areas within the San Joaquin Valley: the San Joaquin Valley floor, the Coast Range, and the Sierra Nevada. The San Joaquin Valley is a large sediment-filled trough which in some areas is thousands of feet thick. Many lenses, at varying depths within the subsurface, are scattered throughout the trough. Lens depths range from 100 to 500 feet and are composed of fine-grained deposits, including Corcoran Clay. Vertically and horizontally scattered lenses of Corcoran Clay are major restrictive structures that act as the confining layer, separating the underlying confined aquifer from the overlying unconfined aquifers. The valley floor rises from near sea level at the edge of the Delta to around 1,000 feet at the top of older sediment deposits in the southeast (United States Geological Survey 1998). The Coast Range elevations are between 3,000 and 5,000 feet, and between 8,000 and 14,000 feet for the Sierra Nevada Mountains. The valley floor is a mix of marine sediment on the west side and sediment derived from granite on the east side.

The primary aquifer system occurs in unconsolidated alluvial and continental deposits. Alluvium of the Coast Range consists mainly of uplifted marine sedimentary rocks. Coastal alluvium soil, found on the western side of the valley, tends to be finer textured and saline. Alluvium of the Sierra Nevada consists mainly of granitic rocks. Sierran alluvium soil, found on the eastern side of the valley, tends to be coarse textured and non-saline. The alluvial soils make up some of the best agricultural land in the state. Poorly drained saline and alkali soils are found in the valley trough and on the basin rims. These soils are used mainly for pasture, rice, and cotton. Areas above the valley floor contain terrace and foothill soils, which are primarily used for grazing and timberland.

Figure 3-4-a and 3-4-b show the geology of both the western and eastern San Joaquin River watersheds. This information is provided in Section 13, "Conceptual Understanding and Groundwater Quality of the Basin-Fill Aquifer in the Central Valley," of the USGS study, *Conceptual Understanding and Groundwater Quality of Selected Basin-Fill Aquifers in the Southwestern United States*.

Figure 3-4a. Generalized Geology of the Western San Joaquin River Watershed

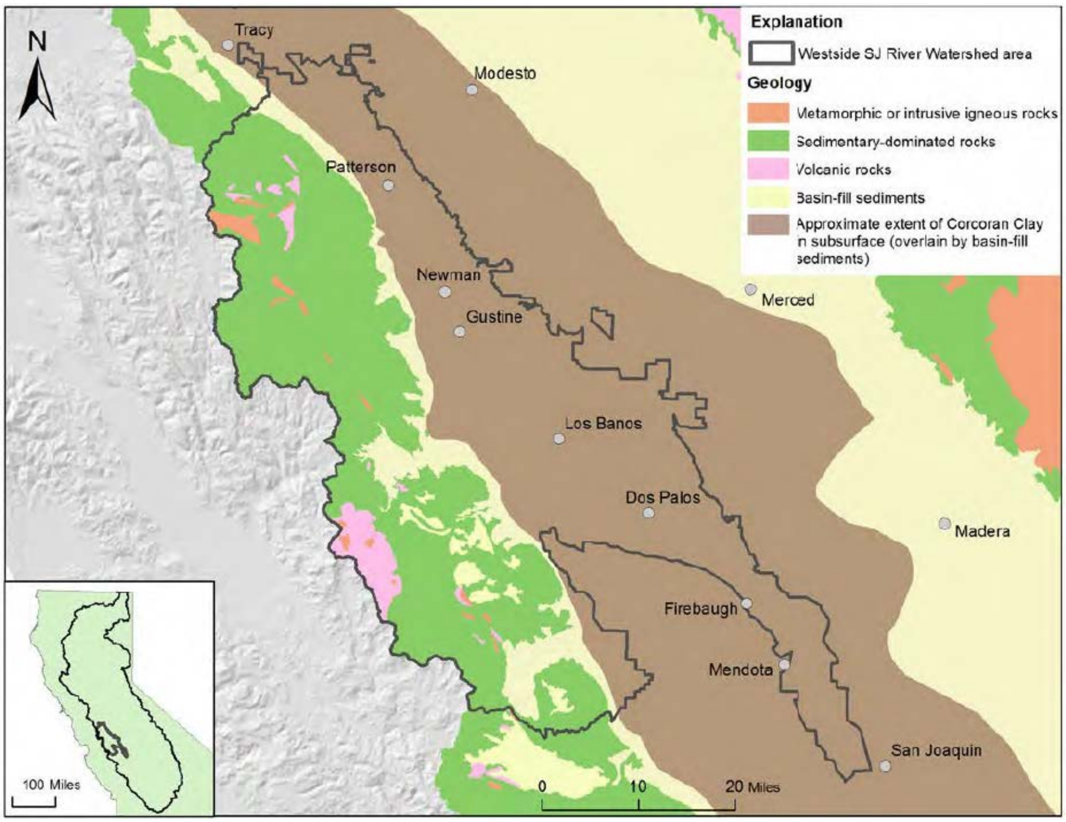
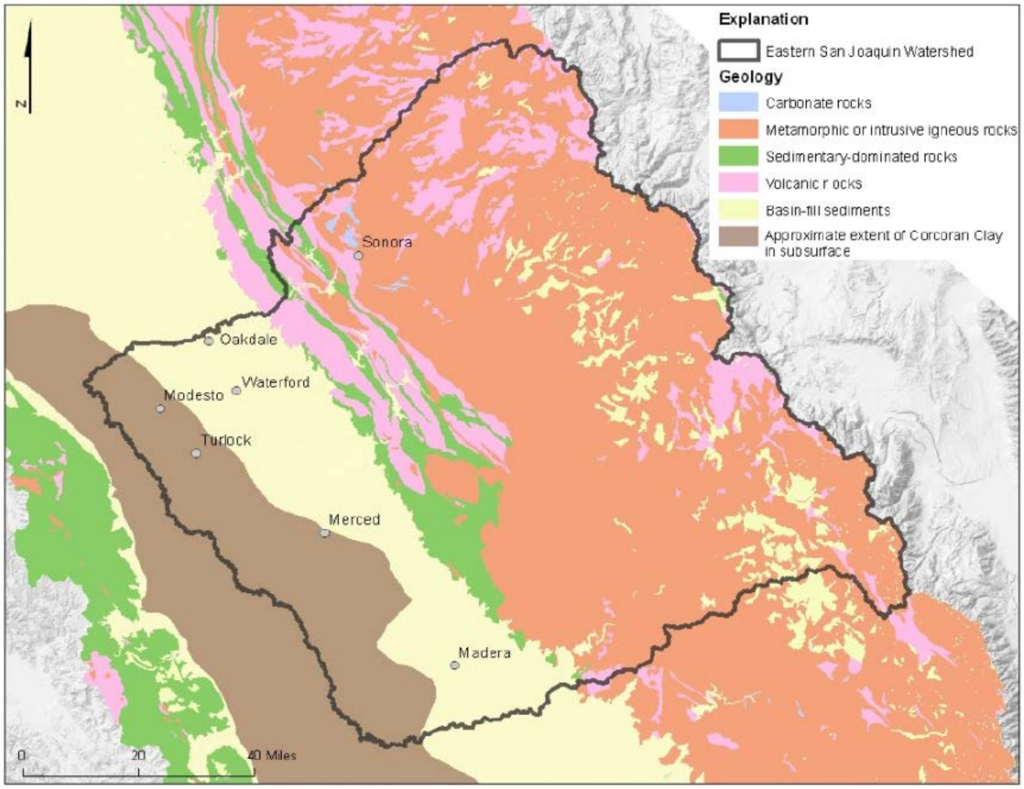


Figure 3-4b. Generalized Geology of the Eastern San Joaquin River Watershed



Climate

The San Joaquin Valley is arid to semi-arid; its climate is characterized by hot, dry summers and cool, mild winters. The San Joaquin Valley and its eastern slopes are in the rain shadow of the Coast Range. However, precipitation occurring as both rainfall and snow, from the western slopes of the Sierra Nevada, is the major source of water entering the basin. Winter storms, moving onshore from Pacific low pressure systems, drop rain in the Central Valley and snow at higher elevations in the Sierra Nevada. Most precipitation occurs between November and April, with an average of 15 inches a year in the northern San Joaquin Valley and 5 inches a year in the southern San Joaquin Valley.

Precipitation data was collected by DWR from nine California Irrigation Management Information System (CIMIS) weather stations in the west and east San Joaquin valley watershed and are presented in this section. The CIMIS program was designed to assist irrigators in managing their water resources more efficiently (DWR). Stations used on the west side include Patterson, Kesterson, Los Banos, Panoche, Firebaugh/Telles, and Westlands. Stations used on the east side include Modesto, Oakdale, and Merced. Because of the Coast Range's rain shadow, the western side of the valley receives less rainfall than the eastern side of the valley (Figure 3-5 and Figure 3-6). Monthly precipitation varies seasonally through the year (Figure 3-6). On a WY basis, there was a significant difference between west side and the east side mean annual precipitation ($p=0.03$, Mann-Whitney test). However, on a monthly basis, there is no significant difference between the west side and east mean monthly precipitation ($p=0.40$, Mann-Whitney test.)

Figure 3-5. Mean Annual 2008-2012 Precipitation for West Side and East Side San Joaquin Valley Locations

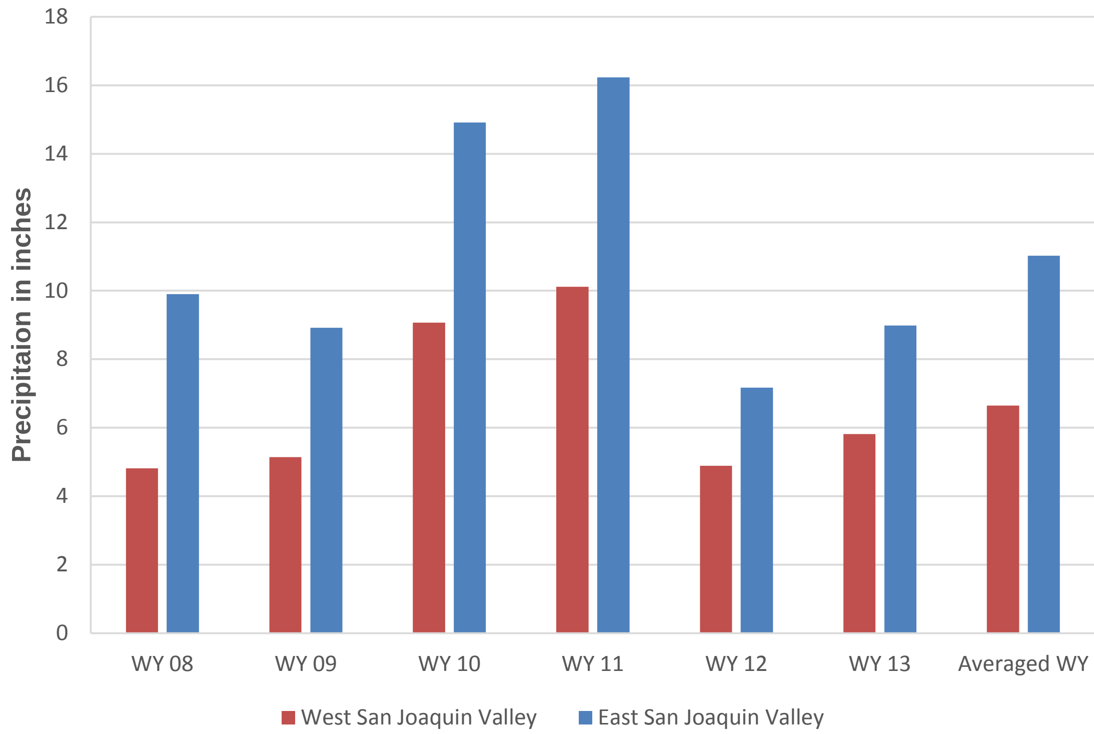
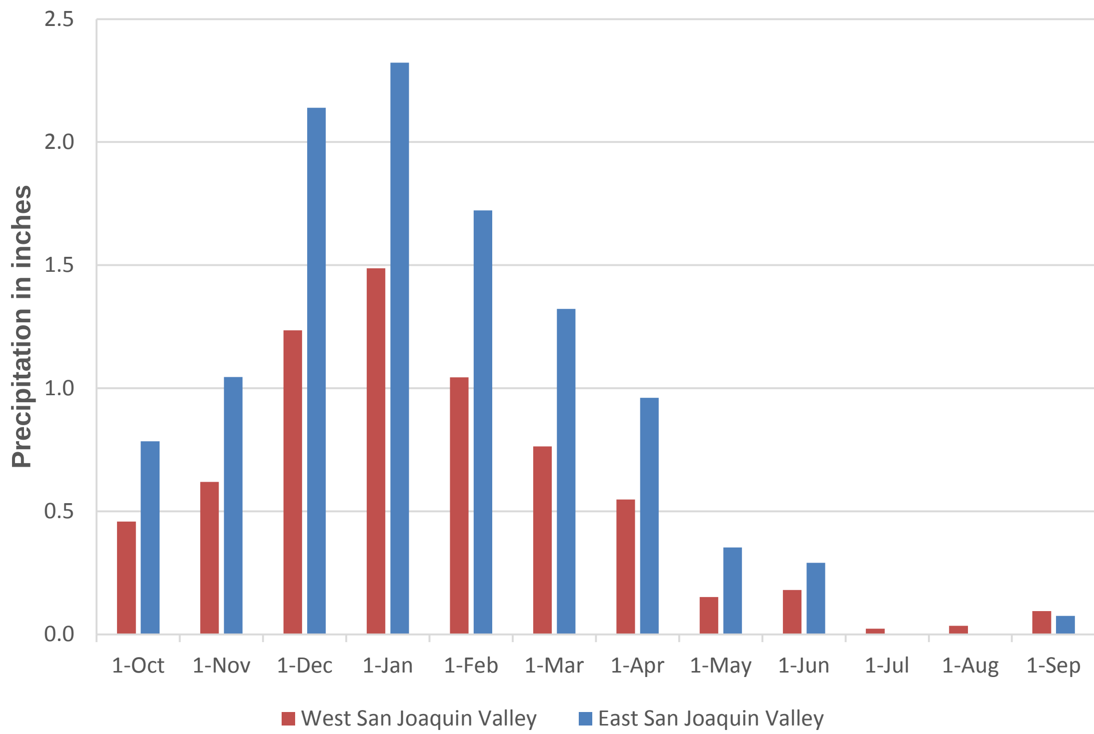


Figure 3-6. Mean Monthly Total Precipitation for 2008-2012 for the West Side and East Side San Joaquin Valley locations



Hydrology

The San Joaquin River has its headwaters in the Sierra Nevada Mountains, from which it flows southwesterly until it reaches Millerton Lake impounded by the Central Valley Project's Friant Dam in Fresno County. Below Friant Dam, the river flows through the San Joaquin Valley towards the city of Mendota, where it changes its trajectory and flows northwards to the Delta, ultimately joining the Sacramento River. The main stem of the San Joaquin River is about 300 miles long and drains approximately 16,000 square miles (Environmental Protection Agency 2014). The tributaries to the San Joaquin River drain the Coastal Range on the west side of the watershed, and the Sierra Nevada on the East side of the watershed. All of the tributaries that drain the west side of the watershed are minor tributaries. On the east side of the watershed, there are three major tributaries: the Merced River, the Tuolumne River, and the Stanislaus River.

The water year classification index of the San Joaquin Valley is based on the sum of unimpaired flow in million acre-feet (maf) at:

- Stanislaus River below Goodwin Reservoir (aka inflow to New Melones Res.)
- Tuolumne River below La Grange (aka inflow to New Don Pedro Reservoir)
- Merced River below Merced Falls (aka inflow to Lake McClure)
- San Joaquin River inflow to Millerton Lake

This index, originally specified in the 1995 SWRCB Water Quality Control Plan, is used to determine the San Joaquin Valley water year type as implemented in SWRCB Water Right Decision 1641 (D-1641). Year types are set by first of month forecasts beginning in February. Using this index produces five water year types:

- Wet – equal to or greater than 3.8
- above normal – greater than 3.1 and less than 3.8
- below normal greater than 2.5 and less than 3.1
- dry – greater than 2.1 and less than 2.5
- critical – equal to or less than 2.1

Generally the San Joaquin watershed from 2008 through 2013 was drier, with 2010 and 2011 being the only above normal and wet water years out the six years presented (Table 3-3).

Table 3-3. San Joaquin Valley Water Year Hydrologic Classification Indices

	San Joaquin Valley Runoff (million acre-feet)				
Year	**Oct – Mar**	**Apr – Jul**	**WY Sum**	**WY Index**	**WY**
2008	0.99	2.45	3.49	2.06	C
2009	1.51	3.35	4.94	2.72	BN
2010	1.43	4.53	6.08	3.55	AN
2011	3.68	6.90	10.99	5.58	W
2012	0.83	1.86	2.76	2.18	D
2013	1.33	1.67	3.05	1.71	C

Tributaries

West Side Tributaries

The west-side tributaries along the main steam of the San Joaquin River account for 16% of the total flow at Vernalis, which is approximately 250,000 acre-feet/year. Eight tributaries on the west side of the San

Joaquin River drain the eastern slopes of the Coastal Range: Panoche-Silver Creek, San Luis Drain, Salt Slough, Mud Slough, Spanish Grant Drain, Orestimba Creek, Hospital and Ingram creeks, and Del Puerto Creek (Figure 3-7). These tributaries are ephemeral and convey sparse runoff during storm events in the rainy season. Agricultural drainage return flows dominate the inflow the remainder of the year. The water quality from these tributaries is considered relatively poor.

The Panoche-Silver Creek watershed lies on the southern boundary of the San Joaquin Basin and provides drainage for over 350 square miles of the Coast Range Mountains. During and after sustained precipitation, considerable runoff is generated within the watershed. Flood flows move east along Belmont Avenue into the town of Mendota and then discharge directly into Mendota Pool. The Mendota Pool is formed by Mendota Dam on the San Joaquin River and is the terminus of the Delta-Mendota Canal.

The San Luis Drain is a concrete-lined conveyance that once formed part of a Valley Master Drain system, providing drainage relief for the entire west-side of the basin. Today, 28 miles of the drain service five agricultural water districts and convey subsurface drainage water into Mud Slough, which is six miles upstream of the confluence with the San Joaquin River.

Between the Mendota Pool and Merced River, the Salt Slough conveys a mix of agricultural drainage and wetland return flows from the eastern half of the Grasslands watershed to the San Joaquin River (Tulloch Engineering 2002). The water in Salt Slough is not affected by selenium, unlike Mud Slough.

Mud Slough receives agricultural drainage from the selenium affected area of the Grassslands Basin, as well as wetland return flow from the Grassland Water District. The Grassland Water District supplies water to private duck clubs and cattle grazing properties north and south of the City of Los Banos (Tulloch Engineering 2002).

The Spanish Grant Drain is located at River Mile 105, about 4 miles north of Orestimba Creek. The drain collects mostly return flows from riparian pump diversions along a short reach of the San Joaquin River. A small volume of return flow from the Central California Irrigation District is also conveyed to the river through this drain. Unlike Orestimba Creek, Del Puerto Creek, and Hospital and Ingram creeks, this drain does not extend into the west-side Coast Range. Hence the drain flows mostly during the summer. Flows in Spanish Grant Drain range from 12 to 29 cubic feet per second (cfs) during the summer.

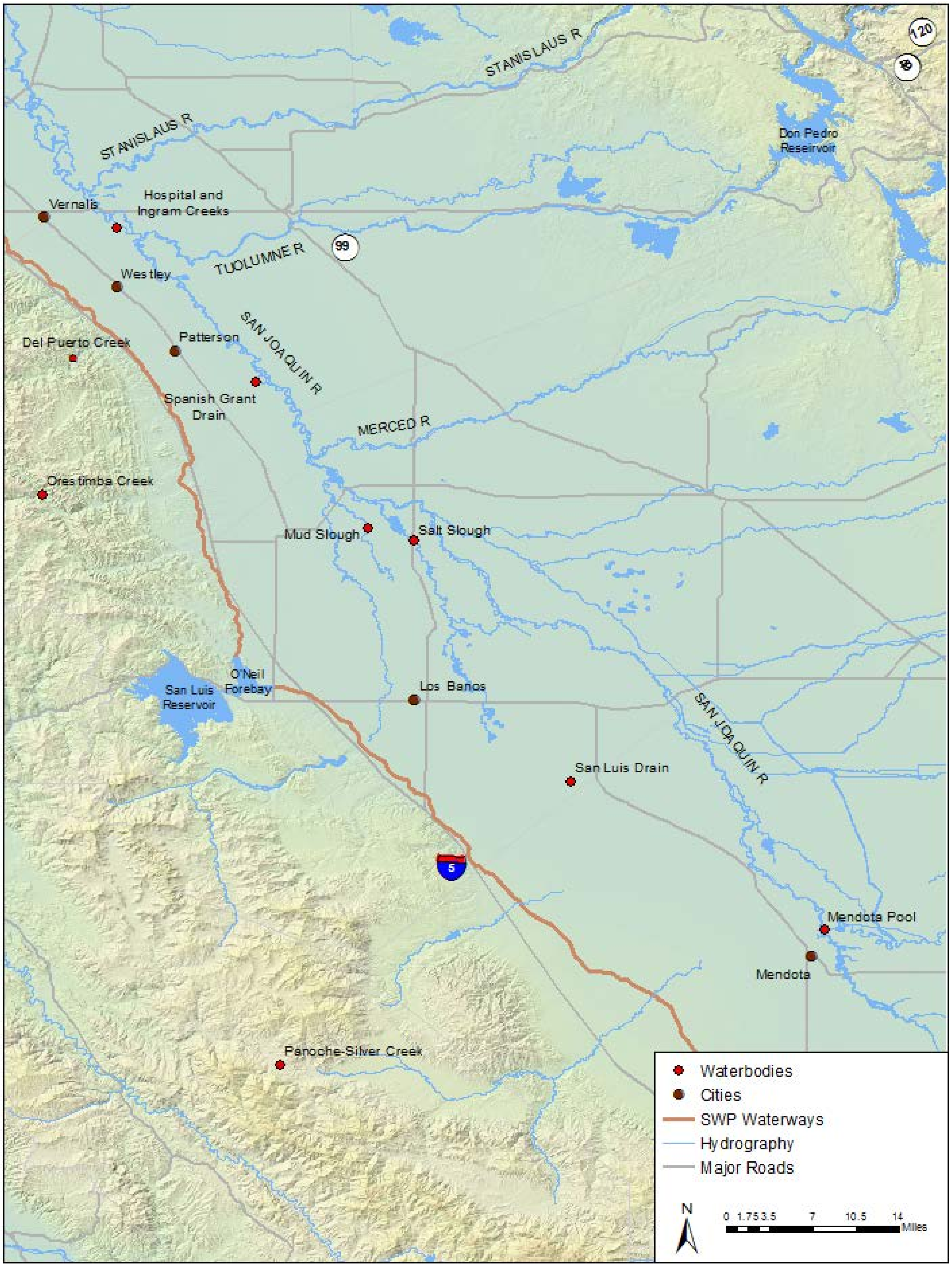
Orestimba Creek is the dominant west-side tributary in the basin. The creek is north of Little Panoche Creek, and discharges to the San Joaquin River at river mile 109. Orestimba Creek drains a medium sized watershed in the Coast Range and can produce substantial flood flows during and after major storm events. These events can produce flows of as much as 850 cfs. More consistent flows due to irrigation season return flows result in discharge that is less than 70 cfs.

Hospital Creek and Ingram Creek combine to the east of Highway 33 and are usually considered to be one conveyance. Hospital and Ingram creeks run through the West Stanislaus Irrigation District prior to discharge to the San Joaquin River at river mile 80. Flows fall in the range of 15–30 cfs during the summer months.

Del Puerto Creek runs through the southern quarter of the West Stanislaus Irrigation District between the towns of Patterson and Westley. Like the other west-side creeks, it conveys rainfall runoff during the winter months and agricultural drainage during the summer. The creek discharges to the San Joaquin River at River Mile 93. The flows peak in early June at about 19 cfs and average about 15 cfs during the late spring and summer months of May, June, and July.

In addition to the west side tributaries is the Delta Mendota Canal (DMC), which carries water southeasterly from the C. W. "Bill" Jones Pumping Plant in Tracy, along the west side of the San Joaquin Valley. The water is primarily used for irrigation supply in the San Luis Unit, but is also used to replace San Joaquin River water stored at Friant Dam, and used in the Friant-Kern and Madera systems. Up to 2.5 maf of the typical 3 maf of water delivered by the DMC can be used by agriculture (San Luis and Delta-Mendota Water Authority 2014). The canal is about 117 miles long and terminates at the Mendota Pool, approximately 30 miles west of Fresno (Reclamation 2011).

Figure 3-7. West-Side Tributaries of the San Joaquin River



East Side Tributaries

The east side tributaries constitute the major tributaries to the San Joaquin River. These consist of the Merced River with a drainage area of 1,270 square miles and average flows of 1,350 cfs, the Tuolumne River with a drainage area of 1,960 square miles and average flows of 2,254 cfs, and the Stanislaus River with a drainage area of 1,075 square miles and average flows of 1,400 cfs (Figure 3-8). These three tributaries historically contributed to 60-70% of the flows to the San Joaquin River. However, these flows have been reduced over time due to dams and diversions.

Merced River

The Merced River originates in Yosemite National Park and runs through the southern portion of the San Joaquin Valley. Most of the headwaters of this 145 mile long river are within Yosemite National Park and lands managed by the United States Forest Service and Bureau of Land Management (National Marine Fisheries Service 2009).

Flows in the lower Merced River are affected by four mainstem dams. The two largest dams, owned by Merced Irrigation District, are New Exchequer Dam (which impounds Lake McClure) and McSwain Dam (which impounds Lake McSwain). New Exchequer Dam controls 81% of the runoff in the basin as it impounds the flows from the Sierra Nevada, and it provides agricultural water supply, power generation, flood control, recreation, and environmental flows (National Marine Fisheries Service 2009). Lake McClure, the largest reservoir on the river, can store 1.024 million acre feet (MAF) of water.

Flow into the Merced Irrigation District Northside Canal and Main Canal are diverted by the Merced Falls Dam and the Crocker-Huffman Dam. Flows from these diversions are returned to the lower Merced River, and eventually join the San Joaquin River. Additionally, there are three small dams, the MacMahon, Green Valley, and Metzger that sit on tributaries upstream of the New Exchequer Dam. The only major tributary on the Merced River downstream of the main dams is Dry Creek, which is impounded by Kelsey Dam. In the 52 river miles between New Exchequer Dam and the confluence with the San Joaquin River, there are over 200 diversions, which are primarily for agricultural use (National Marine Fisheries Service 2009).

Tuolumne River

The Tuolumne River originates in Yosemite National Park and flows 130 miles southwest to its confluence with the San Joaquin River, approximately 10 miles west of the City of Modesto (San Francisco Planning Department 2008). This river is the largest of three major tributaries to the San Joaquin River.

The Tuolumne River flows to O’Shaughnessy Dam at Hetch Hetchy Reservoir, then to the Early Intake Reservoir, which lies above Don Pedro Reservoir. Several tributaries, including Cherry Creek, Jawbone Creek, the Clavey River, the North Fork of the Tuolumne River, and Turnback Creek, join the river between Hetch Hetchy and Don Pedro Reservoirs. Moccasin Creek and Woods Creek drain directly into Don Pedro Reservoir. Don Pedro Reservoir, formed by the New Don Pedro Dam, impounds 2 million acre-foot (MAF) of the upper Tuolumne River flows from the Sierra Nevada and is operated by the Turlock and Modesto Irrigation Districts. Water released from Don Pedro Reservoir flows into Turlock and Modesto Irrigation Districts' canals and into the lower Tuolumne River which then flows to the San Joaquin River. Below Don Pedro lies La Grange Dam, where water is diverted to two irrigation canals. Dry Creek, the last major tributary, joins the river from the north in the City of Modesto (San Francisco Planning Department 2008).

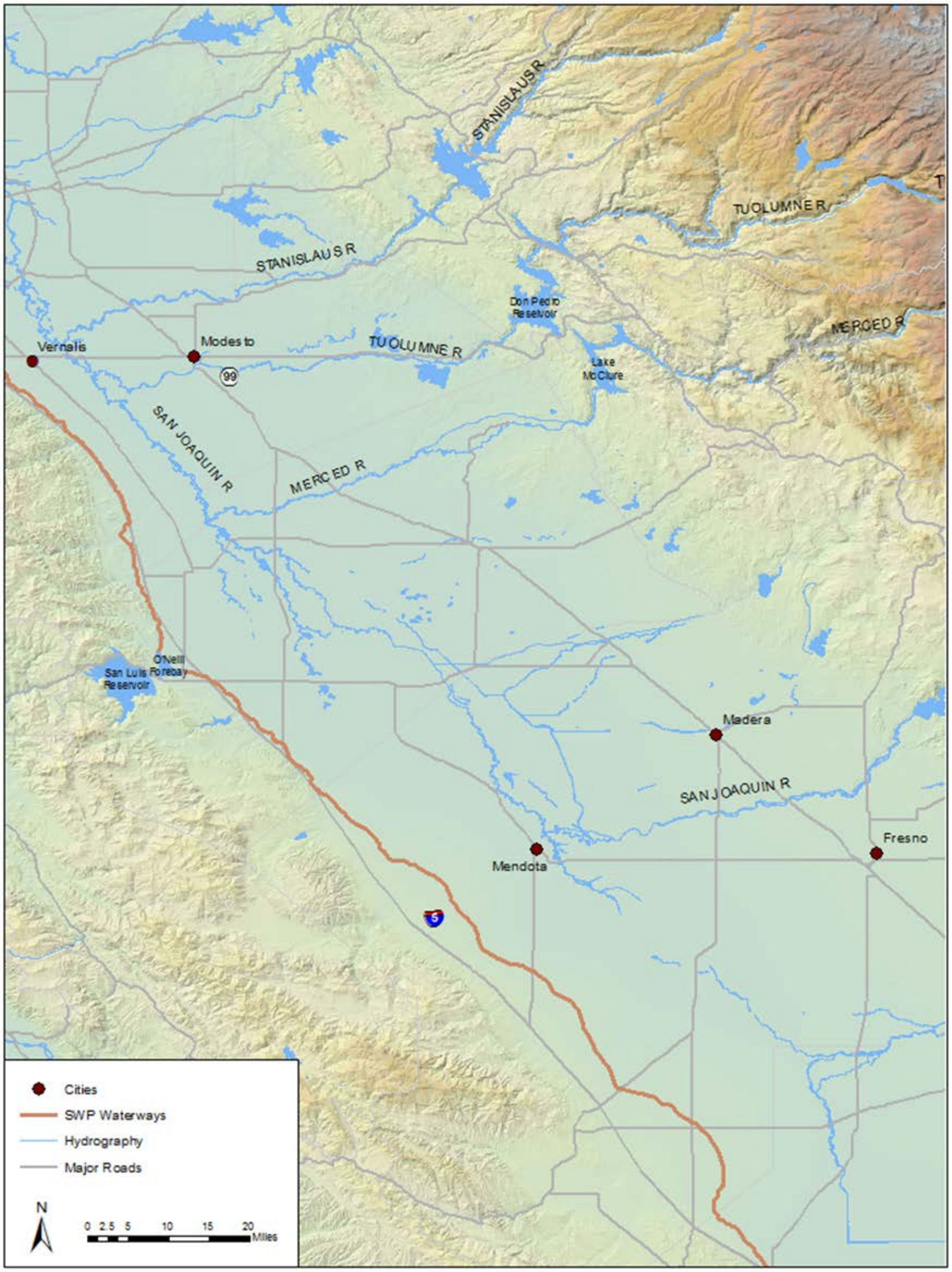
Stanislaus River

The Stanislaus River originates on the western slopes of the Sierra Nevada. The Stanislaus River is approximately 113 miles long and covers an area of approximately 1,075 square miles and is a highly managed system. The 32 dams within the watershed have a capacity of 2.85 MAF (National Marine Fisheries Service 2009). McKay's Point Diversion Dam diverts water on the north fork, and New Spicer Meadow Dam sits on Highland Creek, a tributary of the north fork. Donnells Dam and Beardsley Dam are located on the middle fork. Lyons Dam and Strawberry Dam are located on the south fork. The New Melones Dam sits below the confluence of all three forks. The New Melones Reservoir is the largest reservoir in the basin, with a storage capacity of 2.4 MAF, and is located 60 miles upstream from the confluence of the Stanislaus River and the San Joaquin River. Releases from the reservoir flow into the Oakdale and South San Joaquin Irrigation Districts canals, and into the lower Stanislaus River (National Marine Fisheries Sevice 2009). Downstream from New Melones Dam is Tulloch Dam and lastly, Goodwin Dam.

The main diversion point on the Stanislaus River is Goodwin Dam, located approximately 1.9 miles downstream of Tulloch Dam. Oakdale Irrigation District and South San Joaquin Irrigation District constructed Goodwin Dam, which is used for diversions for their irrigation districts as well as a re-regulating reservoir for releases from Tulloch Power Plant. Water impounded behind Goodwin Dam may also be pumped into the Goodwin Tunnel for deliveries to the Central San Joaquin Water Conservation District and the Stockton East Water District.

The lower portion of the Stanislaus River has 20 tributaries below Goodwin Dam. Intermittently flowing streams occur primarily from November through April. Agricultural return flows and irrigation canals that receive water from the Stanislaus and Tuolumne rivers enter the lower portion of the Stanislaus River. Additionally, ground water contributes to the flow in the lower reach of the river (National Marine Fisheries Service 2009).

Figure 3-8. **East-Side Tributaries to the San Joaquin River**



San Joaquin River Flows

The San Joaquin River flows westward from its headwaters in the Sierra National Forest and is impounded in Millerton Lake by Friant Dam. Most of the river flow is diverted into the Friant-Kern Canal and Madera Canal at Friant Dam, which leaves the river channel upstream of the Mendota Pool dry, except during periods of wet weather flow and major snow melt. The river flows west downstream of Friant Dam until it separates close to the Valley trough, with the majority of the water flowing along a series of bypasses until it reaches the main stem of the lower San Joaquin River. The remaining water flows westward, often disappearing into the streambed before reaching Mendota Pool. The river then flows northward from Mendota Pool to the Sacramento San Joaquin Delta. The main stem is about 300 miles long. The Merced, Tuolumne, and Stanislaus rivers, with headwaters in the Sierra Nevada, drain the east side of the watershed and enter the San Joaquin River in the valley. The high quality rivers are heavily influenced by the winter snowpack. The west side streams convey surface runoff from the Coast Range during winter and contain mostly agricultural surface drainage during the summer months. The Delta-Mendota Canal is the primary source of water for the agricultural areas on the westside of the San Joaquin Valley.

Flow in the Merced, Tuolumne, and Stanislaus rivers is typified by late spring and early summer snowmelt, fall and winter rainfall, and low summer base flows. Peak stream flows are driven by snowmelt and occur in May and June, while minimal river flow is observed in September and October. Approximately 85% of the precipitation falls between November and April, mostly as snow in the upper elevations.

Flow in the San Joaquin River is controlled by releases from Millerton Lake, as well as from several reservoirs on the San Joaquin's tributaries. The San Joaquin River provides about 10 to 15 percent of the freshwater flow to the Delta. Peak flows can exceed 50,000 cfs, but flows are typically much lower. Flows on the San Joaquin River at Vernalis from 2008 through 2013 are presented in Figure 3-9. Following the high precipitation levels in 2010, 2011 had the highest flows at all locations. The lowest flows mostly occurred in 2009. Flows were highly variable over the study period. The San Joaquin River at Vernalis had a high flow of over 28,575 cfs in 2011, and a low flow of less than 465 cfs in 2013. The east side tributaries have much lower flows than Vernalis (Figure 3-9 and Figure 3-10).

Figure 3-9. **Flows in the San Joaquin River at Vernalis 2008 to 2013**

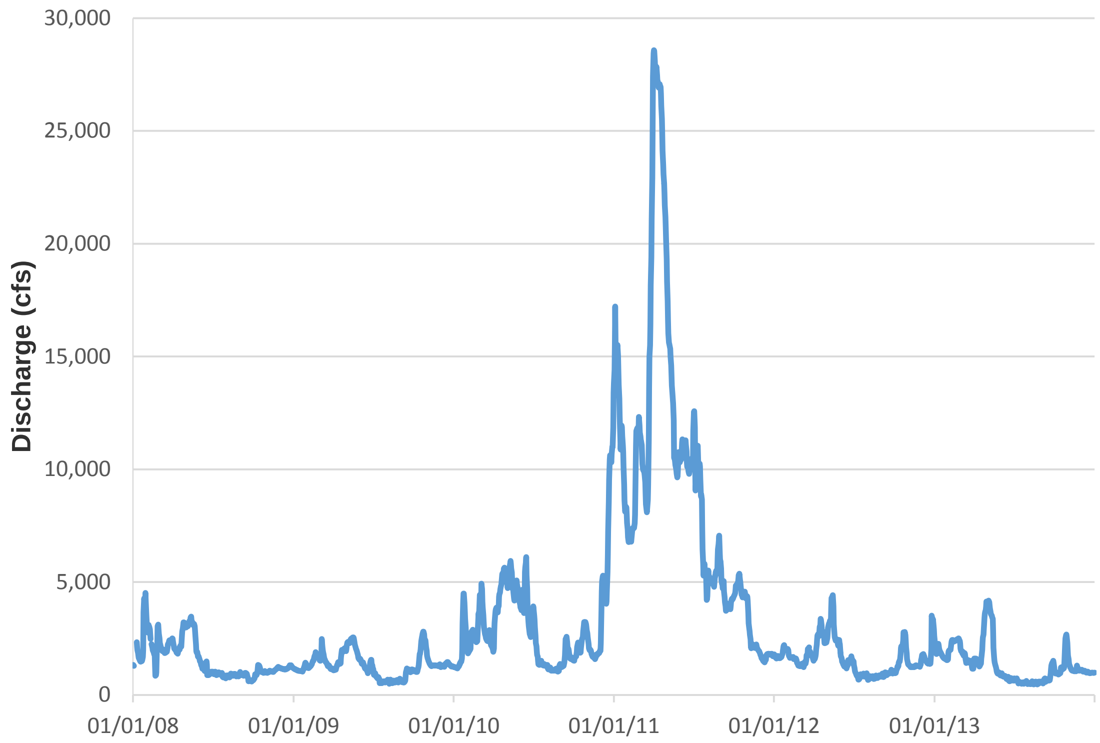
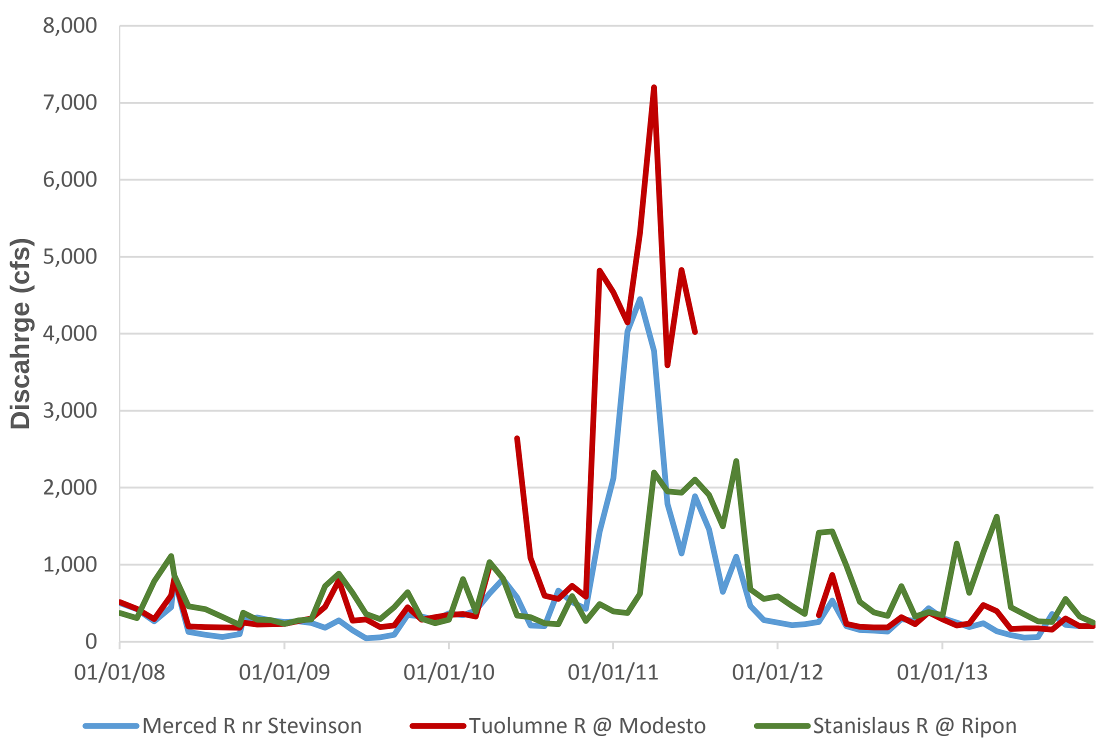


Figure 3-10. **River Flows at the East Side Tributaries to the San Joaquin River**



Water diversions and discharge points

The San Joaquin River system has numerous diversions and discharge points. The three largest water districts can account for 50% of the total estimated diversions from the San Joaquin River between Vernalis and Lander Avenue. The three water districts are El Soyo Water District, West Stanislaus Irrigation District, and Patterson Water District. The water is used for agricultural and some urban uses.

In 1986, an extensive survey of diversions and discharges from the San Joaquin River from the Mendota Dam to Tracy was conducted. Below is a summary of data from *Water Diversions and Discharge Points along the San Joaquin River: Mendota Pool Dam to Mossdale Bridge. Volume 1: Main Report* (California Regional Water Quality Control Board 1989). The San Joaquin River from Mendota Dam to Vernalis is 132.5 miles long. There were 61 diversions and 104 discharge/inflow sites in that section of river. The summaries below provide the name of the section, length of river section, the number of diversion points and discharge/inflow sites, as well as any additional relevant information on that river section. Table 3-4 provides the river section, mileage, diversions, and discharges for the sections described below:

- Mendota Dam to Avenue 7½ is 9.6 miles long, and is completely influenced by releases from the Mendota Pool for irrigation use downstream. There is one diversion and three discharge/inflow sites.
- Avenue 7½ to Sack Dam is 13.2 miles long and receives minor inflows from surface drains on the east side of the river. Most of the flow in this section is diverted for irrigation. Flow beyond the Sack Dam is from irrigation season seepage and high flows that occur during floods in the winter season. There is one diversion and four discharge/inflow sites.
- Sack Dam to Santa Rita Bridge on Highway 152 is 8.1 miles long, and has only one diversion into the Paso Canal. There are no discharge/inflow sites.
- Santa Rita Bridge (Highway 152) to Mariposa Bypass (Intake) is 5.4 miles long and is characterized by low flows consisting mostly of seepage water. Although the Fresno River enters in this section, there is almost no flow reaching the San Joaquin River except during periods of flood flows. There are three diversion pumps and two discharge/inflow sites.
- Mariposa Bypass (Intake) to Turner Island Road is 11.4 miles long and has very low flow, almost all of which consists of seepage water and operational spills from upstream. There are two diversion pumps and one discharge/inflow site.
- Turner Island Road to Mariposa Bypass (Outlet) is 9.8 miles long and has almost no flow past its two diversion pumps. At Mariposa Bypass, surface return flows from Turner Island Water District enter the river during irrigation season or during flood flows. There are a total of two discharge/inflow sites.
- Mariposa Bypass (Outlet) to Bear Creek Inflow is 11.4 miles long and has very low flow that consist of irrigation return flows, flood water, or seepage to the river. There are three diversions, 14 discharge/inflow sites, and 20 flood gates.
- Bear Creek to Lander Avenue Bridge (Highway 165) is a three mile section with no diversions, four discharge/inflow sites, and 11 flood gates. Bear Creek is the only significant discharge, consisting of irrigation return flows and flows from the Eastside Bypass. The Lander Avenue Bridge site is often used as the reference site for background water quality in the San Joaquin River prior to significant inflows of subsurface tile drainage entering the river.
- Lander Avenue Bridge (Highway 165) to upstream of Salt Slough is 3.4 miles long and has one diversion, no discharge/inflow sites, and 19 flood gates. Flow is influenced by upstream flows and inflow from Salt Slough.

- Salt Slough Inflow to Fremont Ford Bridge (Highway 140) is 4.3 miles with no diversions, four discharge/inflow sites, and four flood gates. Salt Slough provides the most significant inflow, consisting of irrigation return flows or flood water, and can make up 75 percent of the river flow at Ford Bridge during the irrigation season.
- Fremont Ford Bridge (Highway 140) to Upstream of Mud Slough (north) is 4.1 miles long, and has one diversion and no discharge/inflow sites. Flows are mostly unchanged from those at Fremont Ford Bridge.
- Mud Slough (north) to Hills Ferry Road Bridge is a 3 mile section with no diversions, but three major and two minor discharge/inflow sites. Mud Slough carries return flows from irrigation and from waterfowl management areas. The Newman Wasteway carries operational spill water from the Delta-Mendota Canal and surface return flows from irrigated agriculture. The Merced River is the first of three major east side tributaries that enter the San Joaquin River. Additionally, the Newman Slough receives water from an 800-acre tile drainage system, surface water from 4,500 acres of irrigated land, and the occasional discharge from the City of Newman wastewater treatment plant.
- Hills Ferry Road Bridge to Crows Landing Road Bridge is 11 miles long and is highly developed. There are 10 diversions and 14 discharge/inflow sites. On the east side of the river, eight diversions serve over 1,000 acres of cropland and three discharge/inflow sites return water. On the west side of the river are two diversions and nine discharge/inflow sites that drain over 15,000 acres. The most significant discharge, Orestimba Creek, receives operational spill water from the Central California Irrigation District Main Canal and return flows from irrigated land. Newman Drainage District, the other significant discharge, discharges surface tile drainage water from over 2,000 acres of irrigated land.
- Crows Landing Road Bridge to Patterson Bridge is 8.3 miles of highly developed land with eight diversions and nine discharge/inflow sites. The eight diversions irrigate over 7,000 acres on both sides of the river. Of the five discharge sites on the west side of the river, Ramona Lake and Spanish Grant Drain are the two largest. Turlock Irrigation District Lateral No. 5 is the largest discharge on the east side.
- Patterson Bridge to Grayson Road Bridge is a 9.7 mile section in a highly developed area, with eight diversion and 16 discharge/inflow sites. The dominant diversion is from the Patterson Water District Main Lift Pumps, which covers over 10,000 acres. There are 13 discharge sites on the west side and three discharge sites on the east side. The three dominant west side discharge sites, Olive Avenue Drain, Del Puerto Creek, and the Houk Ranch Drain, carry predominantly surface return flow, but can also carry tile drainage. Modesto Wastewater Treatment Plant had been discharging to the east side; long terms plans were to cease this discharge and reuse the water for crop production.
- River Section 16 — Grayson Road Bridge to Maze Road Bridge (Highway 132) is an 11.9 mile section of the San Joaquin River with 13 diversions and 22 discharge points. It is the most highly developed and subject to the greatest changes in river hydrology due to irrigation development. There are four dominant diversions. The Blewett Mutual Water Company, the El Solyo Water District, and the West Stanislaus Irrigation District, are on the west side of the river and Bogetti Farms Pump Site is on the east side of the river. The West Stanislaus Irrigation District is the largest diverter. There are 15 west side discharge sites, with the major drains being the Blewett Drain, Ingram-Hospital Creek Combined Outfall, and the Old Grayson Channel. The most dominant of the three is the Ingram/Hospital Creek Combined Outfall, which receives both

surface and subsurface flows. The Tuolumne River inflow is the most significant discharge from the east side.

- Maze Road Bridge (Highway 132) to Airport Way (Vernalis) is 4.9 miles with six diversion and four discharge/inflow points. The Reclamation District 2101 is the largest diverter. The most significant discharge is the Stanislaus River inflow from the east side. Additionally, the San Joaquin City Drain is the most significant inflow from the west side of the River.

Table 3-4. Hydrologic Influences within Each San Joaquin River Section

Name	River Section	River Section Mileage	Length	Diversion Points	Discharge/ Inflow Sites
Mendota Dam to Avenue 7½	1	195.2-204.8	9.6	1	3
Avenue 7½ to Sack Dam	2	182.0-195.2	13.2	1	4
Sack Dam to Santa Rita Bridge (Hwy152)	3	173.9-182.0	8.1	1	0
Santa Rita Bridge (Hwy 152) to Mariposa Bypass (Intake)	4	158.5-173.9	5.4	3	2
Mariposa Bypass (Intake) to Turner Island Road	5	157.1-168.5	11.4	2	1
Turner Island Road to Mariposa Bypass (Outlet)	6	147.3-157.1	9.8	2	2
Mariposa Bypass (Outlet) to Bear Creek Inflow	7	135.9-147.3	11.4	3	14
Bear Creek Inflow to Lander Avenue Bridge (Hwy 165)	8	132.9-135.9	3.0	0	4
Lander Avenue Bridge (Hwy 165) to Upstream of Salt Slough	9	129.5-132.9	3.4	1	0
Salt Slough Inflow to Fremont Ford Bridge (Hwy 140)	10	125.2-129.5	4.3	0	4
Fremont Ford Bridge (Hwy 140) to Upstream of Mud Slough (north)	11	121.1-125.2	4.1	1	0
Mud Slough (north) to Hills Ferry Road Bridge	12	118.1-121.1	3.0	0	5
Hills Ferry Road Bridge to Crows Landing Road Bridge	13	107.1-118.1	11.0	11	14
Crows Landing Road Bridge to Patterson Bridge	14	98.8-107.1	8.3	8	9
Patterson Bridge to Grayson Road Bridge	15	89.1- 98.8	9.7	8	16
Grayson Road Bridge to Maze Road Bridge (Hwy 132)	16	77.2- 89.1	11.9	13	22
Maze Road Bridge (Hwy 132) to Airport Way (Vernalis)	17	72.3- 77.2	4.9	6	4

Source: "Water Diversions and Discharge Points along the San Joaquin River: Mendota Pool Dam to Mossdale Bridge. Volume 1: Main Report" 1986.

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CHAPTER 4: POTENTIAL CONTAMINANT SOURCES

This chapter of the San Joaquin River Watershed Sanitary Survey focuses on evaluating the potential contaminant sources in the watershed that could adversely affect water quality. The chapter contains a discussion of the following topics:

- Wastewater Treatment Plants: Discusses the quality of the effluent from the waste water treatment plants that discharge to surface waters in the San Joaquin River watershed.
- Urban Runoff: Discusses the stormwater discharges from two major urban areas (Fresno and Modesto) and a few selected small municipalities within the watershed.
- Agricultural Discharges: Discusses the water quality of the discharges to surface water from agricultural drains.
- Confined Animal Feeding Operations (CAFOs): Discusses of the types of CAFOs, the potential impacts of cattle grazing in the watershed, and compliance and violations with regulatory requirements.

Wastewater Treatment Plants

Background

The 2011 Sanitary Survey Update contains updated information regarding wastewater treatment plants in the Central Valley and Sacramento-San Joaquin Delta. This section contains updated information on the major wastewater treatment plants and the major spills/permit violations in the San Joaquin River watershed of the Central Valley.

Population Growth

The San Joaquin River watershed area has experienced rapid urbanization with increased population growth. As agricultural lands are converted to urbanized areas, maintaining water quality of open waters such as rivers, lakes, and streams becomes increasingly important. Many of the wastewater treatment plants discharge into tributaries of the San Joaquin River and it is not well known how larger populations will affect discharge in addition to urban runoff.

The population in the San Joaquin River Watershed is projected to increase from 2.5 million in 2010 to 2.9 million in 2020 and to 4.5 million in 2050, an increase of 16 and 73 percent, respectively. In comparison, the Central Valley is projected to increase in population from 6.8 million in 2010 to 7.8 million in 2020 and to 11.7 million in 2050 (Figure 4-1), an increase of 15 percent and 80 percent respectively. Overall, California’s population is projected to grow from 37.3 million in 2010 to 40.6 million in 2020 and 50.3 million by 2050. This represents a population increase of 9 percent by 2020 and of 35 percent increase by 2050 (California Department of Finance 2013). Table 4-1 presents the populations of the counties included in the San Joaquin River watershed.

Figure 4-1. Population Projections for the Central Valley and San Joaquin Watershed

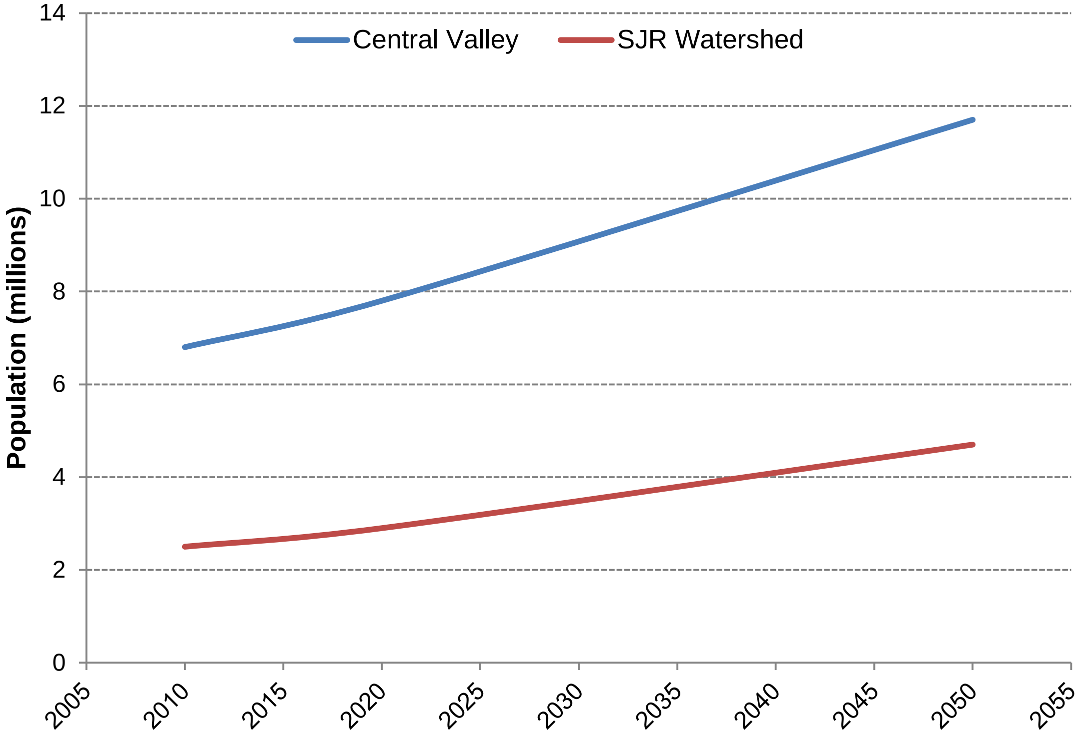


Table 4-1. 2008 and 2013 Population Estimate for Counties in the San Joaquin River Watershed

County	Total Population Jan 2008	Jan 2013	% Change
Fresno	906,521	952,166	5.0
Madera	147,958	152,711	3.2
Merced	250,734	262,478	4.7
San Joaquin	672,492	698,414	3.9
Stanislaus	509,389	524,124	2.9

Wastewater Facilities in the Watershed

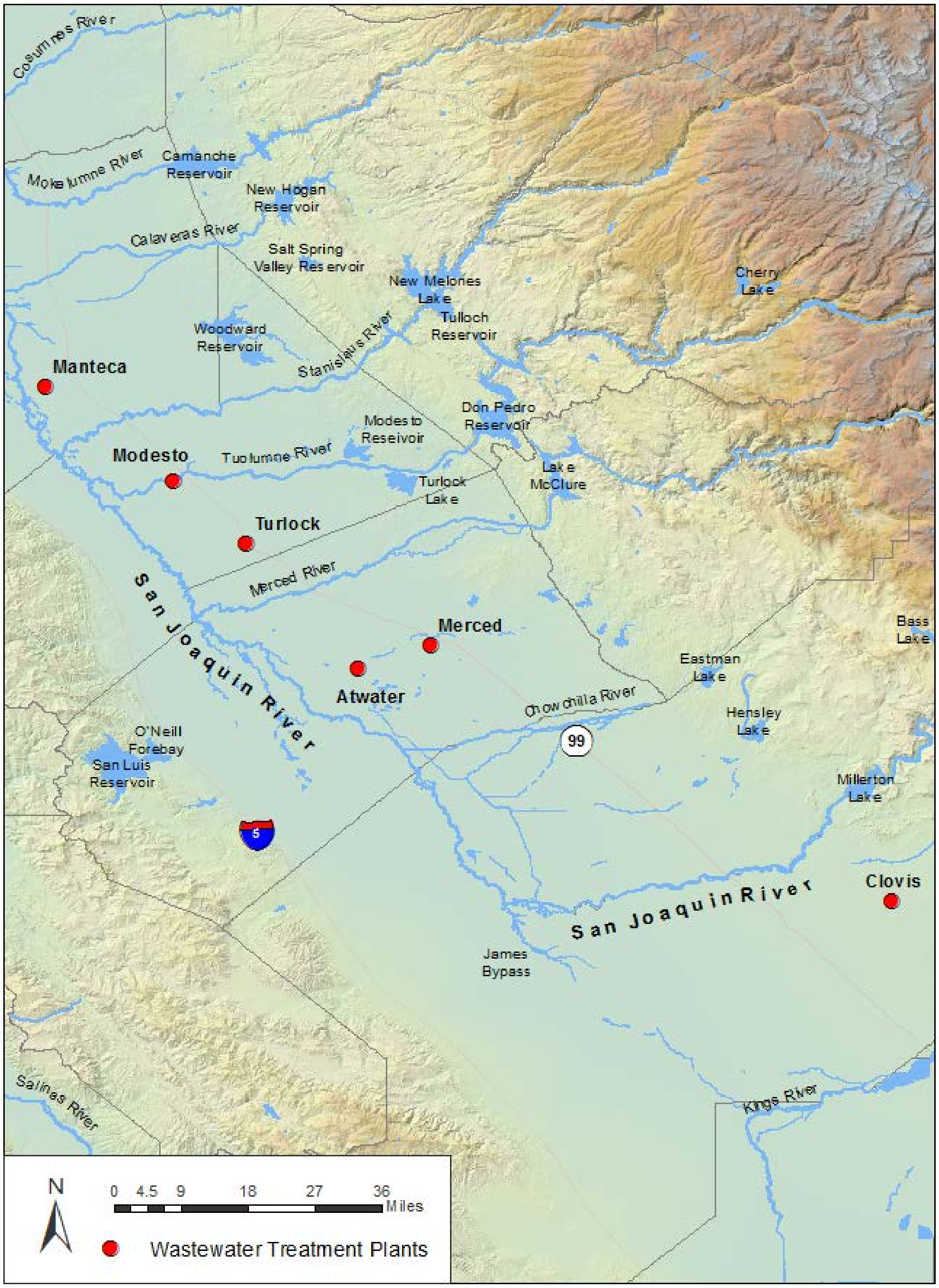
Wastewater discharged into Central Valley waterways contain numerous contaminants including human pathogens, organic carbon, nutrients that stimulate algal growth, and, in some cases, elevated levels of salinity that can adversely affect San Joaquin River water quality. Table 4-2 presents the major wastewater dischargers in the watershed. The California Regional Water Quality Control Board (Regional Water Board), Central Valley Region, defines major dischargers as those that exceed 1 million gallons per day (mgd). The 2011 Sanitary Survey Update estimated that the major wastewater treatment plants in the San Joaquin River watershed totaled 51.4 mgd (Archibald et al. 2012). Figure 4-2 presents the locations of the wastewater treatment plants in the San Joaquin River watershed.

Table 4-2. Major Wastewater Treatment Plants in the San Joaquin Watershed

Discharger	Recent Average Dry Weather Flow[a] (mgd)	Permitted Average Dry Weather Flow (mgd)	Level of Treatment
Manteca/Lathrop	5.7	9.87	Tertiary with NDN[b]
Modesto	20	70	Secondary (Upgrading to Tertiary)
Turlock	11.4	20	Tertiary with Nitrification
Merced	8.5	12	Tertiary with Nitrification
Atwater	3.0	6.0	Secondary with Nitrification (Tertiary with NDN by 2013)
Clovis	2.8	2.8	Tertiary with NDN

[a] Data on recent flows came from various permits, discharger reports and West Yost (2011)
[b] NDN – Nitrification and Denitrification

Figure 4-2. Wastewater Treatment Plant Locations



Manteca/Lathrop

Manteca and Lathrop are two cities within the San Joaquin River watershed that jointly own the Manteca Wastewater Quality Control Facility, which serves approximately 80,500 people. The City of Manteca operates the facility under Waste Discharge Order R5-2009-0095, issued by the Regional Water Board. Currently, it has an average dry weather design flow of 9.87 mgd, but is expected to increase to 17.5 mgd (Regional Water Board 2011). The Manteca Wastewater Quality Control Facility is divided into two parallel treatment systems, the north and south treatment systems. Primary treatment consists of mechanical screening, aerated grit removal, and primary sedimentation. The north plant primary effluent undergoes additional treatment through two biotowers with high-rate plastic media. The secondary treatment systems consist of conventional activated sludge, including nitrification and denitrification (NDN), followed by secondary sedimentation. Effluent from the secondary sedimentation is un-disinfected, which is mixed with food processing waste and applied to approximately 260 acres of agricultural fields. Excess secondary effluent undergoes tertiary treatment through coagulation and flocculation, cloth media filtration, and UV disinfection. Disinfected tertiary level treated effluent is discharged to the San Joaquin River. Grit and screenings are hauled offsite to a landfill for disposal. Sludge removed from primary and secondary sedimentation is thickened by dissolved air flotation, and then pumped to anaerobic digesters. After digestion, the treated sludge is dewatered by centrifuge, and then removed offsite for disposal (Archibald et al. 2012).

Lathrop currently owns and operates a wastewater recycling plant (WRP-1) with a capacity of 0.75 mgd. Lathrop filed a Report of Waste Discharge in 2004 and requested that the Regional Water Board modify their waste discharge requirements to allow the city to expand WRP-1 to 3.12 mgd, and to construct WRP-2 which will be identical to WRP-1. The Regional Water Board issued a Master Reclamation Permit in 2006 to expand the existing plant and construct the new plant. The wastewater is treated to tertiary standards and meets California Code of Regulations Title 22 (Title 22) requirements for reclaimed water using membrane bioreactor technology. The recycled water irrigates agricultural crops, parks, and median strips (Archibald et al. 2012). Figure 4-3 shows the wastewater treatment plant in relation to its discharge location on the San Joaquin River.

Manteca/Lathrop had two spill events in 2012 and several permit violations in 2009 and 2011 (Regional Water Board 2011):

- Spills: On October 22 and November 30, 2012, approximately 496,500 gallons and 294,300 gallons, respectively, of un-disinfected tertiary treated effluent was discharged to the San Joaquin River. The spills were caused by electrical short-circuits in one of the six UV systems' air conditioner units. The air conditioner unit failures were attributed to the electrical sensitivity settings for the electrical circuit protection devices. The sensitivity settings cut off all power feeding the entire UV system if an electrical short occurred in a minor sub-system. The problem was corrected on December 4, 2012. The facility was fined $87,492.
- Permit Violations: The Regional Water Board issued Administrative Civil Liability (ACL) complaints in October 2009 and January 2011 for effluent violations between February 2009 and September 2010. There were a total of 11 effluent violations: coliform (8), turbidity (1), and ammonia (2). Manteca was assessed minimum penalties of $18,000 for six of the violations.

Figure 4-3. **Manteca WWTP and Discharge Location**

Modesto

The City of Modesto Water Quality Control Facility serves approximately 225,000 people for the City of Modesto, the community of Empire, and a portion of the City of Ceres. The facility currently operates under Waste Discharge Order R5-2012-0031. The facility's treatment system consists of separate primary and secondary treatment plants. The primary treatment plant provides pumping, screening, grit removal, flow measurement, primary clarification, and sludge digestion. The clarified effluent is then transported to the secondary treatment plant, which has a peak hydraulic treatment capacity of 70 mgd. At the secondary treatment plant, approximately half of the primary plant effluent is treated in fixed film reactors (FFRs). The remaining primary effluent is discharged to an aerated recirculation channel where it is combined with the effluent from the FFR. Flow in the aerated recirculation channel is then distributed to three parallel facultative ponds for further treatment. Treated wastewater is transferred to one of two storage ponds until it can be discharged to the San Joaquin River, or applied to a 2,526 acre ranch. Prior to being discharged to the San Joaquin River, the secondary-level treated effluent is disinfected with chlorine in a contact basin, and then dechlorinated with sulfur dioxide. The secondary treated effluent is discharged seasonally from October 1 through May 31 (Regional Water Board 2011).

The facility is currently upgrading the tertiary treatment facility. Phase 1A was completed in July 2010. The capacity of the tertiary treatment facility is 2.3 mgd, but will be increased to 14.9 mgd by February 2018 with the completion of Phase 2. Upgrades for Phase 2 will include constructing a two-step membrane bioreactor (MBR) process that includes an aerated activated sludge process and a membrane separation process that separates smaller particles from the water. The activated sludge process begins with an oxidation ditch that provides biological treatment, reducing biochemical oxygen demand and providing nitrogen removal (NDN). Ultraviolet (UV) light radiation disinfects the filtered wastewater prior to storage or discharge. Following Phase 2, Phase 3 will increase treatment capacity from 14.9 mgd to 19.1 mgd. Once all upgrades are complete, the seasonal discharge of the secondary treated effluent will cease and the tertiary treated effluent will be discharged year-round to the San Joaquin River (Regional Water Board 2011). Figure 4-4 shows the Modesto wastewater treatment plant in relation to its discharge location on the San Joaquin River.

The Regional Water Board issued ACL complaints in 2013 for effluent violations between December 2007 and May 2013. There were a total of 7 violations: total recoverable iron (1), total recoverable aluminum (1), chloride (4), and total suspended solids percent removal (1). Modesto was assessed a minimum penalty of $3,000 as most of the violations were non-serious violations and not subject to mandatory minimum penalties.

Figure 4-4. Modesto WWTP and Discharge Location

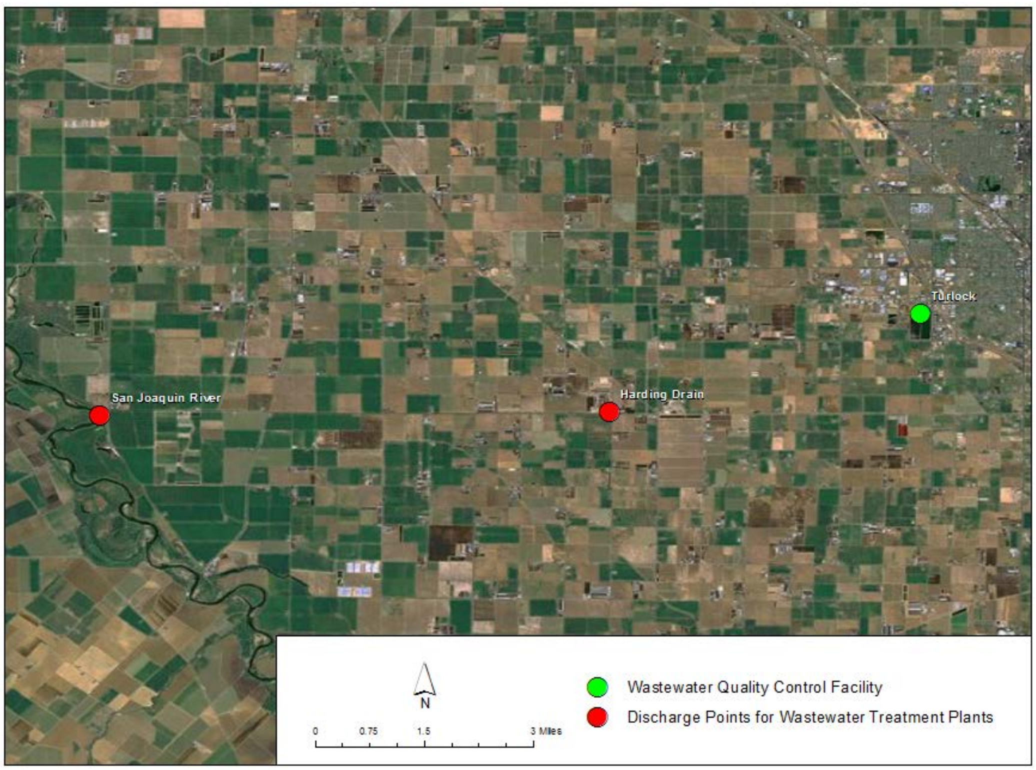
Turlock

The City of Turlock Water Quality Control Facility serves approximately 78,179 people from the City of Turlock, Keyes, and Denair community service districts, and 10 significant industrial users. The facility operates under Waste Discharge Order R5-2010-0002 with a daily average dry weather flow capacity of 20 mgd. The treatment system at the facility consists of: screening; primary treatment (flotation); secondary treatment (activated sludge) that includes biotowers, aeration, and nitrification (waste solids are treated via a gravity belt thickener and anaerobic digestion); secondary clarification; high rate clarifier/thickener; cloth disk filters; and chlorine disinfection and sodium bisulfite dechlorination. The facility houses a 37.2 million gallon earthen emergency storage basin, which allows the diversion and storage of primary effluent if necessary (Regional Water Board 2011).

The facility currently discharges to Harding Drain. Harding Drain (also known as the Turlock Irrigational District (TID) Lateral 5 Canal) is a man-made agricultural drainage facility designed and maintained by TID for drainage purposes while also being a tributary to the San Joaquin River. Besides carrying effluent from the facility, Harding Drain also carries flows from TID operational spill water, tailwater from row and orchard crops, municipal stormwater, and other runoff. Plans are currently underway to construct a dedicated pipeline to transport and discharge treated wastewater from the facility directly to the San Joaquin River. The pipeline will serve two benefits: (1) discharges from the treatment facility will not need to be coordinated with TID, allowing TID to efficiently operate and maintain its system; (2) the pipeline will allow treated effluent to be transported directly to the SJR which allows TID and agricultural operations that discharge to Harding Drain to separately monitor and manage water quality associated with agricultural activities (Regional Water Board, 2011). Figure 4-5 shows the Turlock plant in relation to its discharge locations at Harding Drain and the San Joaquin River.

The Regional Water Board issued ACL complaints in 2013 for effluent violations between January 2008 and August 2012. There were a total of 3 violations: chlorine (1), total chlorine residual (1), and pH (1). Turlock was assessed the minimum penalty for the violations, totaling $6,000.

Figure 4-5. Turlock WWTP and Discharge Location



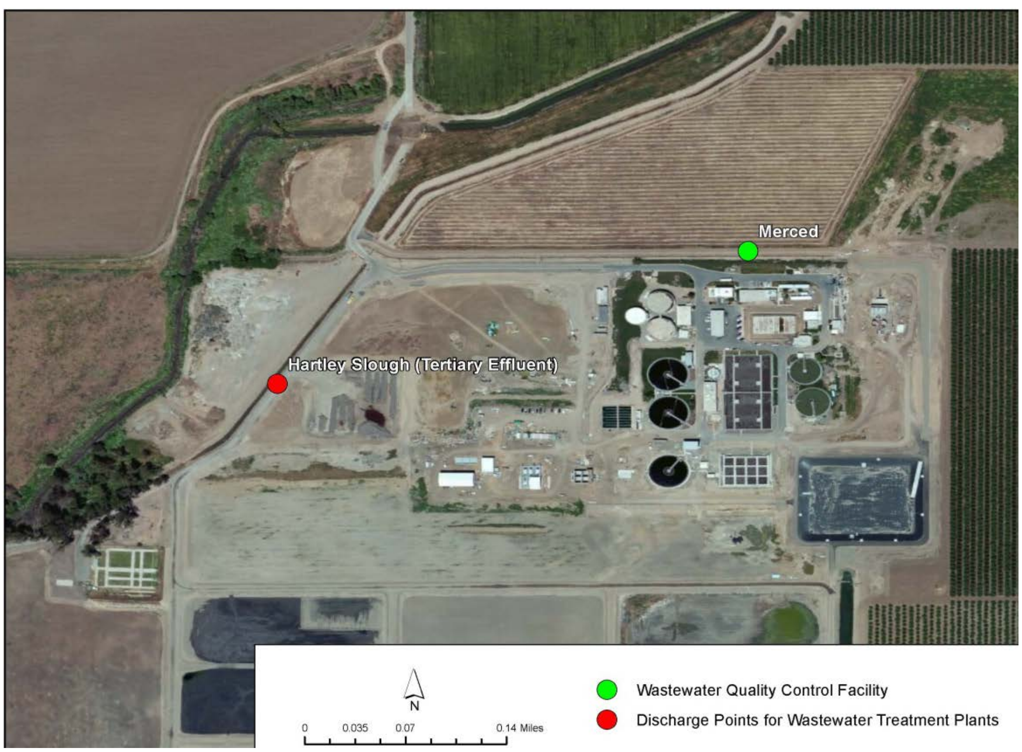
Merced

The Merced Wastewater Treatment Facility provides sewerage service to the City of Merced, with an approximate population of 90,000. The Facility operates under Waste Discharge Order R5-2014-0096. The Facility has recently undergone upgrades and now provides tertiary treated effluent with a current flow of 12.0 mgd. Based on demand, the Facility is expected to increase the daily average flow capacity in a two phased expansion. The first phase will see the flow increase from 12.0 mgd to 16.0 mgd while the second phase will provide an increase from 16.0 mgd to 20.0 mgd (Regional Water Board 2014).

Before the planned upgrades, the facility consisted of a tertiary headworks pump station with fine screens and grit removal, a septage receiving area, two primary clarifiers, three activated sludge basins with three separate anoxic denitrification basins, three secondary clarifiers, flocculation basins, filters, UV light disinfection, a re-aeration outfall, and chlorination and dechlorination units. Solids handling and treatment upgrades include: a dissolved air flotation thickener, primary digesters, solids holding tank, digester gas holder, solids dewatering facility, centrate pump station and equalization tank, and a lined active solar dryer. The first phase of the new expansion to increase the flow rate to 16.0 mgd will consist of adding a fourth activated sludge basin, a third sludge digester, a solids holding tank, and additional active solar driers. In the second phase of the expected expansion, a fourth primary clarifier, a fifth activated sludge basin, and a fifth secondary clarifier will be constructed. Once all expansions are complete, the flow rate will be increased to 20.0 mgd while effluent quality is anticipated to stay the same. The treated effluent is discharged into Harley Slough, an ephemeral, effluent dominated water body that flows to Owens Creek and then to the San Joaquin River. Effluent is also discharged to the Merced Wildlife Area and the Land Application Area (which is currently planted with a wheat and rye hybrid). Figure 4-6 shows the Merced treatment plant location in relation to its discharge location in Hartley Slough.

The Regional Water Board issued no ACL complaints for this facility during the study period (2008-2013).

Figure 4-6. Merced WWTP and Discharge Location



Atwater

The Atwater Regional Wastewater Treatment Facility serves a population of approximately 40,000 people, supplying sewerage services to the City of Atwater, the unincorporated community of Winton, the Federal Bureau of Prisons-Atwater, and the Castle Airport Aviation and Development Center. The facility operates under Waste Discharge Order R5-2011-0082. This facility replaced the Atwater Wastewater Treatment Plant. The new facility has an average flow capacity of 6.0 mgd and contains a treatment system consisting of headworks with screens and a vortex grit removal system, two oxidation ditches, three secondary clarifiers, three cloth media tertiary filters, and an ultraviolet light disinfection system. Sludge wasted from the secondary clarifiers will be sent to a return activated sludge (RAS) or wasted from the system as waste activated sludge (WAS). RAS will be pumped back to the oxidation ditches and WAS will be pumped to two concrete aerobic digesters. Supernatant from the digesters will be conveyed to the headworks of the facility. Stabilized biosolids will be pumped to temporary holding tanks prior to mechanical dewatering. Mechanically dewatered biosolids will be transferred to an onsite drying/storage area and/or hauled offsite to a disposal facility. Also included at the facility is an unlined, onsite stormwater retention pond that will be used to collect all stormwater runoff from the facility. The pond may also be used as an emergency storage basin to divert wastewater as the need arises. The treated wastewater is discharged to Peck/Atwater Drain, which is hydraulically connected to the San Joaquin River, but is not a direct tributary. Both Peck and Atwater Drain are man-made unlined constructed channels. Atwater Drain feeds wetland habitat of the Merced National Wildlife Refuge, owned and operated by the U.S. Fish and Wildlife Service. Natural surface water channels convey water from the wetland habitat to the southwest corner of the Refuge, bounded by a levee. A breach in the levee allows the Refuge to exchange water with the East Side Canal, and water in the Canal is periodically diverted to the San Joaquin River between Sac Dam and the mouth of the Merced River. Atwater Drain empties into Peck Drain, and the primary use of Peck Drain is irrigation by Joseph Gallo Farms (Regional Water Board, 2011). Figure 4-7 shows the location of the Atwater treatment plant in relation to its discharge location into Peck/Atwater Drain.

The Regional Water Board issued no ACL complaints for this facility during the study period (2008-2013).

Figure 4-7. Atwater WWTP and Discharge Location

Clovis

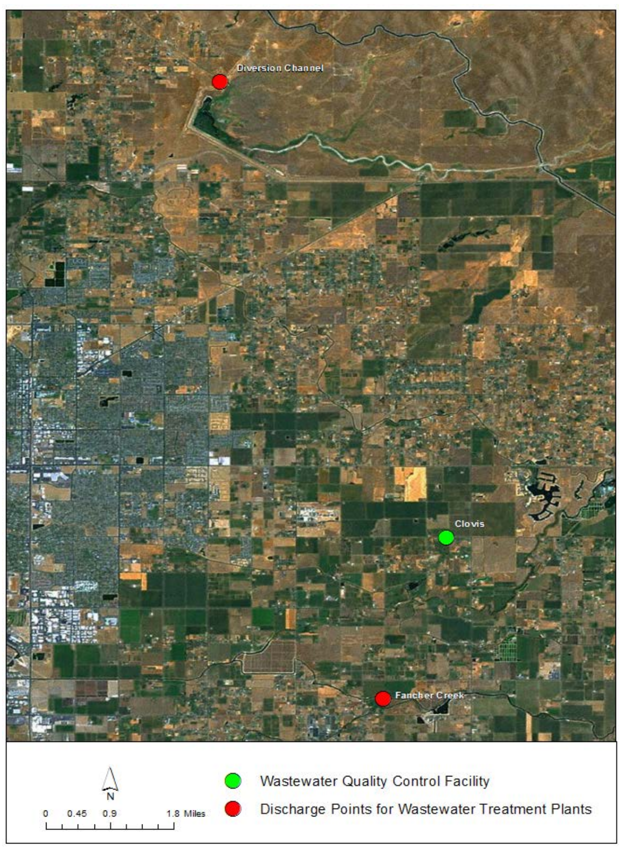
The Clovis Sewage Treatment and Water Reuse Facility (ST/WRF) provide sewerage service for the City of Clovis, serving a population of approximately 89,924. The facility operates under Waste Discharge Order R5-2014-0005. The current average flow capacity for this facility is 2.8 mgd. This facility is proposing a three phase process to upgrade the capabilities of the system to handle an increasing population. These phases will increase the average flow capacity from 2.8 mgd (phase 1) to 5.6 mgd (phase 2), and eventually to 8.4 mgd (phase 3). Sewage is currently conveyed to the Fresno-Clovis Regional Wastewater Treatment Facility. The Fresno-Clovis facility will continue to receive and treat some sewage from Clovis due to the limited capacities of the ST/WRF and the projected population growth of the city.

The treatment system at the ST/WRF consists of headworks with screens, a cyclone to remove grit and settleable materials (acting as a primary treatment), an anaerobic and aerobic treatment tank (acting as secondary treatment), and membrane filtration units (acting as tertiary treatment). The disinfected tertiary treated effluent will be disinfected with ultraviolet radiation. Odor will be captured throughout the process and recycled into the aerobic treatment tank or into the final biological odor treatment beds. The tertiary treated effluent will be stored in 3.08 million gallon bolted-steel tanks for use as recycled water or for discharge to one of the two surface water locations. One tank will be present by the completion of phase 1, while adding another 3.08 million gallon tank with the completion of phase 2.

Solids will pass through the patented Cannibal Solids Reduction Process. The Cannibal process reduces solids in the secondary treatment system by holding RAS in the interchange between tanks for approximately 10 days under specific environmental conditions that work to break down the solids. A single solids holding tank/aerobic digester will be used to handle the occasional purge of solids needed by the Cannibal process. Class B solids, which are treated but still contain detectible levels of pathogens (Environmental Protection Agency 2013), from the digester will be intermittently discharged through a submersible pump to a sludge filtration dewatering box located at the headworks. Dewatered biosolids will be hauled offsite for disposal at a Class B Solids Disposal Facility or for further treatment at a composting facility. Wastewater will be discharged to Fancher Creek and may be discharged to the Diversion Channel. Fancher Creek is a modified natural creek used and managed by Fresno Irrigation District (FID) to deliver irrigation water for agricultural purposes. The Diversion Channel is a man-made, unlined channel constructed to convey flood flows from the Big Dry Creek Reservoir to Little Dry Creek. Little Dry Creek is a tributary of the San Joaquin River (Regional Water Board, 2011). The data collected from the Clovis ST/WRF was not from the effluent from either of the discharge locations as it was not available. The data was collected from effluent monitoring after disinfection and prior to storage in the steel tank. Figure 4-8 shows the Clovis treatment plant in relation to its discharge locations at Fancher Creek and the Diversion Channel.

The Regional Water Board issued no ACL complaints for this facility during the study period (2008-2013).

Figure 4-8. Clovis WWTP and Discharge Location



Drinking Water Constituents

The Central Valley Water Board's Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan) and the San Joaquin River, establishes water quality objectives to protect the beneficial uses in the San Joaquin watershed. The beneficial uses include: Municipal and Domestic Supply (MUN), Agricultural Supply (AGR), Industrial Service Supply (IND), Hydropower Generation (POW), Water Contact Recreation (REC_1), Navigation (NAV), preservation of Biological Habitats of Special Significance (BIOL), and many others (Basin Plan 2009). The Basin plan states that water quality objectives are primarily achieved through the adoption of waste discharge requirements, and cleanup and abatement orders. The Regional Water Board establishes effluent limitations that are specific to each discharge based on the beneficial uses and the water quality objectives of the water body receiving the discharge. The discharger must meet receiving water quality objectives in the effluent if the discharge is to an ephemeral stream or a stream that the Regional Board determines does not have any assimilative capacity for contaminant. If there is dilution capacity available in the receiving water, effluent limitations are established that allow for a mixing zone and dilution of the effluent. Although there are water quality objectives for many water quality constituents, there are no objectives for many constituents important to drinking water suppliers, such as coliforms, nutrients, and organic carbon. As a result there is limited or no data on many of the key drinking water constituents of concern because the dischargers are not required to monitor such constituents.

Pathogens and Indicator Organisms

Wastewater that is inadequately treated may contain disease causing organisms including bacteria, parasites, and viruses (Environmental Protection Agency 2013). Certain indicator species occur naturally in the environment like coliforms; however, other pathogens such as *Cryptosporidium* and *Giardia* are derived from human and animal waste. The Basin Plan does not contain a coliform objective for the protection of drinking water sources; however the Regional Water Board recently adopted a pathogen narrative objective that applies at existing drinking water intakes. The Regional Water Board establishes effluent limitations for total coliform for all wastewater discharges but does not establish effluent limitations for actual pathogens. Wastewater treatment plants that provide secondary treatment are required to have a 7-day median total coliform count that does not exceed 23 MPN/100 mL and a maximum of 240 MPN/100 mL not more than once in 30 days. Wastewater treatment plants that provide tertiary treatment (filtration) are required to have a 7-day median total coliform count that does not exceed 2.2 MPN/100 mL, a monthly maximum of 23 MPN/100 mL, and a maximum of 240 MPN/100 mL. Turbidity effluent limitations are also included as a second indicator of the effectiveness of the treatment process. Coliform testing is not done continuously and may require several hours to days to complete. If the filtration system fails such that virus or bacteria removal is impaired, an increase in particles in the effluent will result in a higher effluent turbidity reading. The requirements for turbidity have been established as 2 NTU as a daily average, 10 NTU as an instantaneous maximum, and shall not exceed 5 NTU more than 5 percent of the time. Table 4-3 presents effluent limitations for coliforms for the wastewater treatment plants that discharge to the San Joaquin River watershed; table 4-4 presents coliform summary statistics. Of the wastewater treatment plants, Merced had 4 exceedances of the instantaneous maximum. None of the other wastewater treatment plants had exceedances.

Table 4-3. Total Coliform Effluent Limitations (MPN/100 mL)

Dischargers	Weekly Median	Monthly Maximum[a]	Instantaneous Maximum
Manteca/Lathrop	2.2	23	240
Modesto[b]	2.2	23	240
Turlock	2.2	23	-
Merced	2.2	23	240
Atwater	2.2	23	240
Clovis	2.2	23	240

[a] Cannot exceed more than once in any 30-day period.
[b] Secondary treated effluent; 23 MPN/100 mL as 7 day median, and 240 MPN/100 mL maximum

Table 4-4. Coliform Summary Statistics (MPN/100 mL)

Stations	Detects/ Samples	Range	Mean	Median[a]	5th Percentile	95th Percentile
Manteca/Lathrop	70/964	2-170	3	2	2	2
Modesto	21/148	2-79	3	2	2	6
Turlock	82/1248	2-80	2	2	2	2
Merced	62/831	2-1600	11	2	2	4
Atwater	21/21	2-11	2	2	2	10
Clovis	9/1503	2-14	2	2	2	2

Nutrients

Untreated wastewater contains high concentrations of nitrogen and phosphorus. The concentrations in the effluent depend upon the types of treatment processes that are used to treat wastewater. The Basin Plan does not have numeric water quality objectives for nutrients based on the potential to cause algal growth but does have the following narrative objective:

> "Water shall not contain biostimulatory substances which promote aquatic growth in concentrations that cause nuisance or adversely affect beneficial uses."

The narrative objective is included in every waste discharge permit as a receiving water limitation. Effluent limitations for nitrate and ammonia are established in most waste discharge permits for Delta dischargers. The effluent limitations for ammonia are based on aquatic toxicity and are determined based on the dilution capacity of the receiving water. The effluent limitations for nitrate and nitrite are based on another narrative objective that is included in the Basin Plan:

> "Water shall not contain chemical constituents in concentrations that adversely affect beneficial uses."

This narrative objective is used to incorporate by reference all of the maximum contaminant levels (MCLs) established by the U.S. Environmental Protection Agency (EPA) and the DDW. Therefore, the Basin Plan establishes receiving water quality objectives of 10 mg/L as N for nitrate and 1 mg/L as N for Nitrite for all water designated with the municipal and domestic beneficial use, based on the MCLs. If the receiving water has sufficient assimilative capacity so that the discharge does not cause an exceedance of these objectives beyond the mixing zone in the water body, the Regional Water Board does not establish an effluent limitation. If the receiving water does not contain assimilative capacity, the Central Valley Water Board requires that the effluent limitations be set at 10 mg/L as N for nitrate and 1 mg/L as N for nitrite.

Nutrients are monitored by all of the wastewater plants, however the monitoring frequencies varied by plants. Table 4-5 shows the variability in the effluent limitations between the selected plants in the SJR watershed. Manteca/Lathrop nitrate and ammonia data can be seen in Figure 4-9. Nitrate exceeded the 10.0 mg/L effluent limit twice, with ammonia exceeding the daily maximum of 3.4 mg/L three times. Nitrite was not included in the figures or the tables, as it is converted to nitrate, and most of the values for nitrite are reported as less than the reporting limit. Figure 4-10 includes total nitrogen along with nitrate and ammonia for Atwater. Atwater calculates total nitrogen as the sum of TKN (ammonia, organic and reduced nitrogen) and nitrate + nitrite; TKN data was not available for analysis. There was one exceedance for nitrate while all of the ammonia values came in under the daily max. The nitrate values for Atwater were calculated from measured nitrate + nitrite and nitrite values. Nitrite was collected at Atwater; however, of the 54 samples, 53 were recorded as Data Not Quantifiable (DNQ). Nutrient information for Clovis is represented in Figure 4-11. Nitrate concentrations exceeded the 10.0 mg/L effluent limit eight times. There is no daily maximum for ammonia at Clovis. Most of the nitrite values recorded fell below the detection limit. The values that were reported as less than the reporting limit are shown as the reporting limit. Data for Modesto, Turlock, and Merced was limited. For plants that utilize tertiary treatment processes (Manteca, Atwater, Turlock), ammonia is converted to nitrate and some nitrate to nitrogen gas. Ammonia and nitrate information is summarized in Table 4-6 while available total nitrogen data is summarized in Table 4-7. Figures 4-9 through 4-11 have different scales to more accurately represent the data as each plant had varying results across different time periods.

Total phosphorus is also a constituent that was not consistently sampled, with only Modesto and Clovis collecting total phosphorus data (Figure 4-12). For Modesto, total phosphorus levels ranged from 1.6 to 3.4 mg/L as P with a median of 2.5 mg/L as P. Clovis had a range of 4.2 to 5.3 mg/L as P with a median of 4.9 mg/L as P as shown in Table 4-8. Clovis sampled less frequently than Modesto, however the concentrations were consistently higher. Due to the small amount of samples, no trends can be discussed.

Table 4-5. **Ammonia and Nitrate + Nitrite Effluent Limitations (mg/L as N)**

	Ammonia		Nitrate + Nitrite	
Dischargers	**Avg. Mthly**	**Daily Max**	**Avg. Mthly**	**Daily Max**
Manteca/Lathrop	1.4	3.4	10	-
Modesto	1.1	2.1	10	-
Turlock	1.1	2.1	10	-
Merced	1.0	2.0	10	-
Atwater	2.1	5.5	10	-
Clovis (Fancher Creek)	1.0	5.4	-	-
Clovis (Little Dry Creek)	1.0	4.6	-	-

Figure 4-9. **Nitrate and Ammonia Concentrations at Manteca/Lathrop**

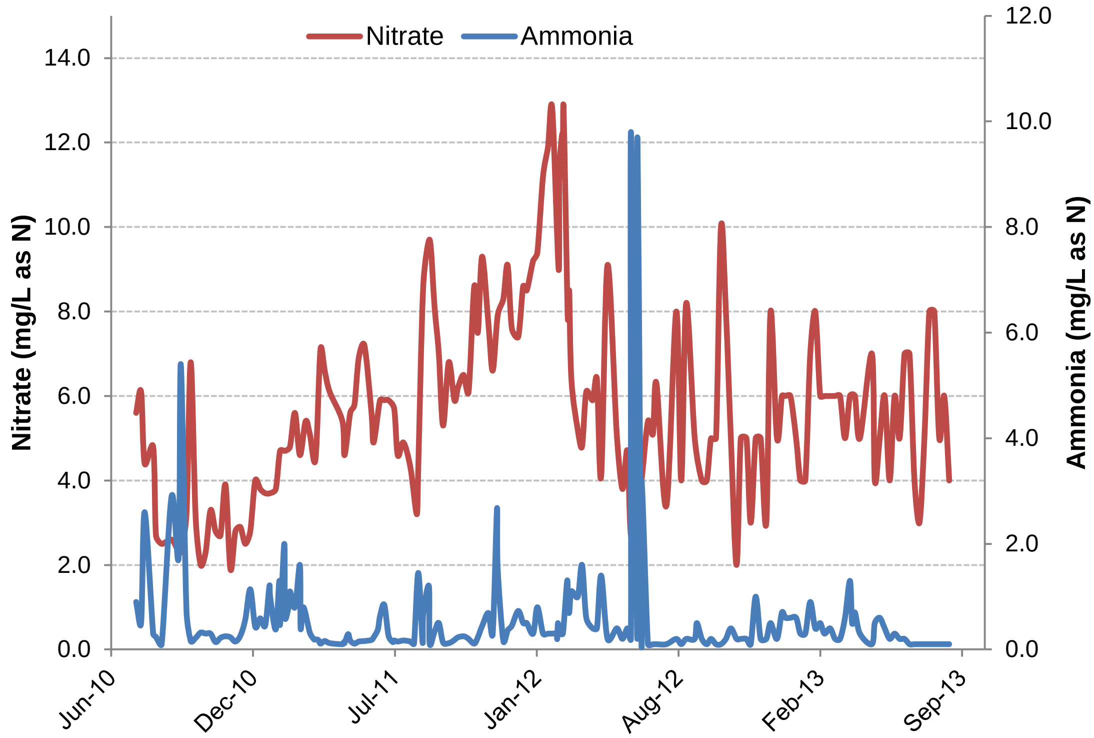


Figure 4-10. Nitrate, Total Nitrogen, and Ammonia Concentrations at Atwater

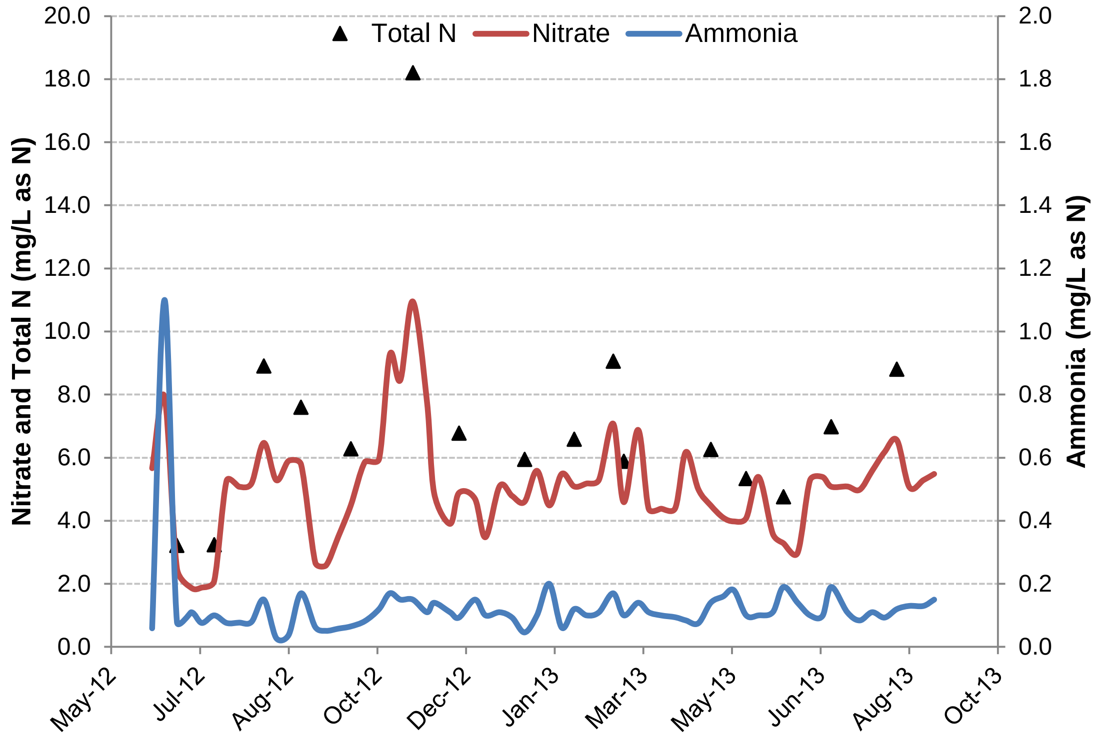


Figure 4-11. Nitrate, Total Nitrogen, and Ammonia Concentrations at Clovis

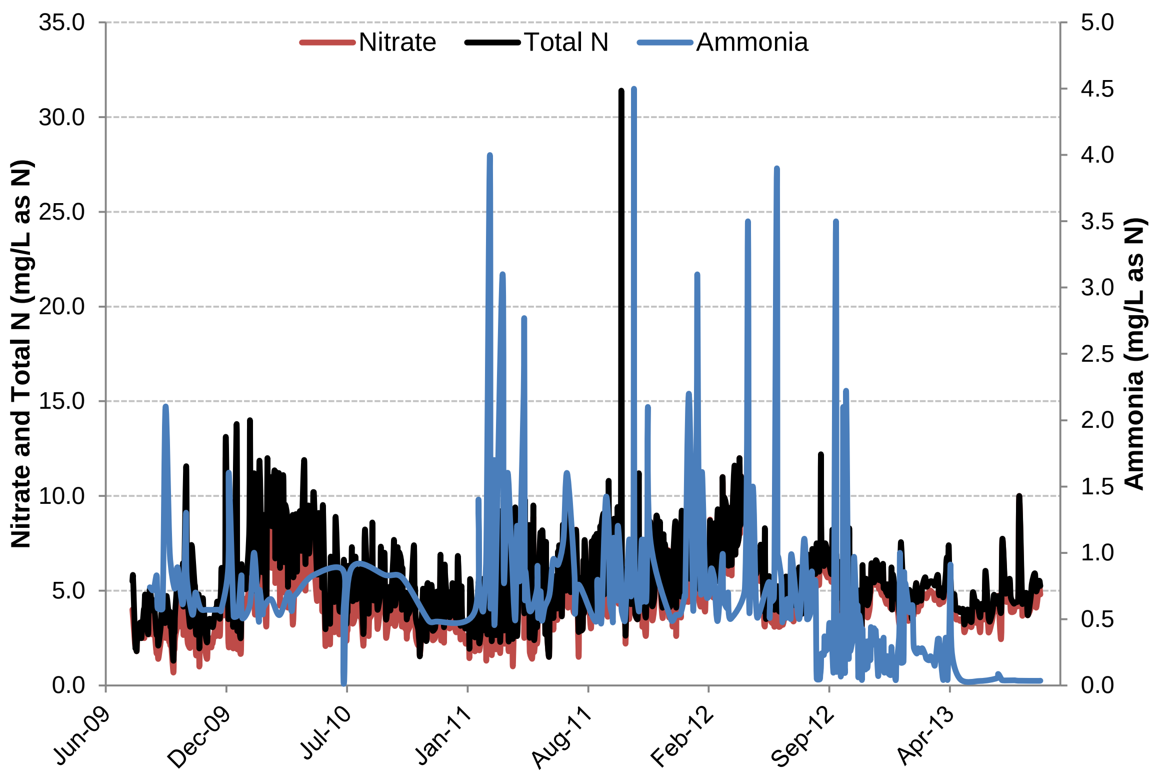


Table 4-6. Ammonia and Nitrate Summary Statistics (mg/L as N)

Dischargers	Ammonia			Nitrate		
	Range	Mean	Median	Range	Mean	Median
Manteca/Lathrop	0.10-9.80	0.60	0.30	1.90-12.80	5.78	5.50
Modesto	0.61-15.40	4.63	2.63	2.09-10.60	5.45	5.44
Turlock	0.60-1.10	0.90	0.90	11.50-20.80	16.47	16.50
Merced	0.05-4.82	0.56	0.15	-	-	-
Atwater[a]	0.03-1.10	0.13	0.11	1.88-10.95	5.07	5.08
Clovis[b]	0.02-4.50	0.69	0.57	0.68-12.00	4.68	4.40

[a] Nitrate values were calculated from reported nitrate + nitrite values

[b] The majority of Ammonia values (253/299) were reported as DNQ, but included in analysis

Table 4-7. Total Nitrogen Summary Statistics (mg/L)

Dischargers	Range	Mean	Median
Manteca/Lathrop	-	-	-
Modesto	-	-	-
Turlock	-	-	-
Merced[a]	0.59-12.50	6.73	6.50
Atwater[b]	3.22-18.20	7.11	6.43
Clovis	1.30-31.40	5.65	5.22

[a] Total nitrogen was included however the majority of TKN values reported as DNQ (165/230).

[b] Nitrate values were calculated from reported nitrate + nitrite values

Figure 4-12. Total Phosphorus Concentrations at Modesto and Clovis

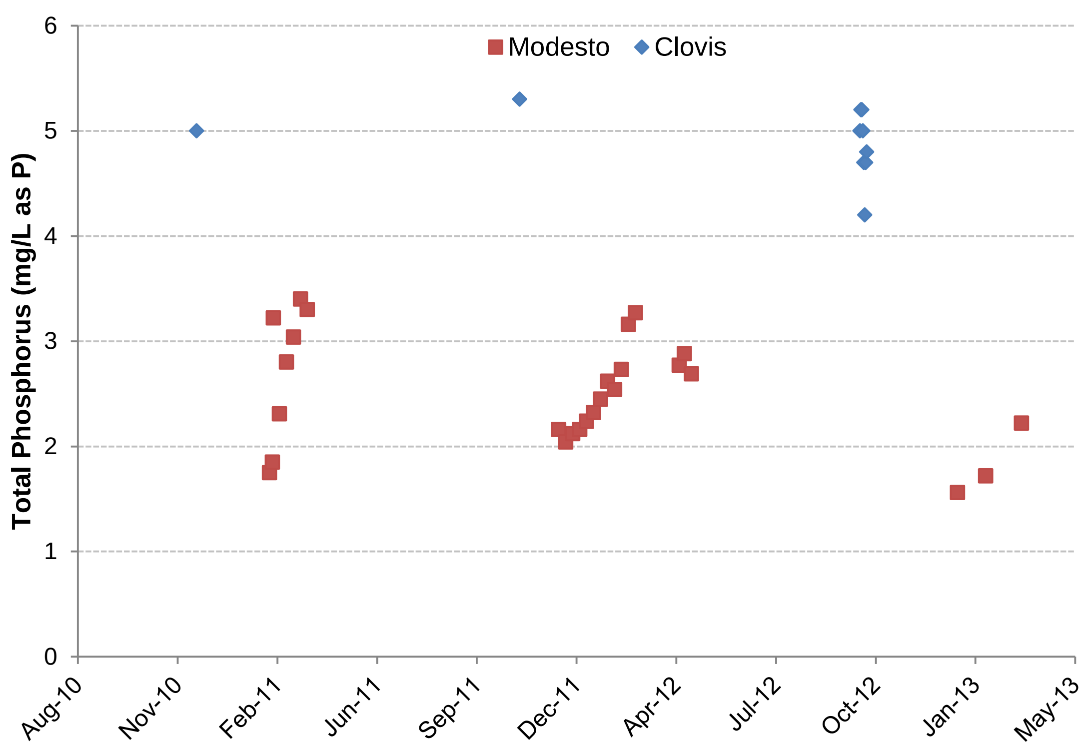


Table 4-8. Total Phosphorus Summary Statistics at Modesto and Clovis (mg/L)

Dischargers	Range	Mean	Median
Modesto	1.56-3.40	2.51	2.50
Clovis	4.20-5.30	4.91	5.00

Organic Carbon

The Basin Plan does not contain a water quality objective for total organic carbon so the Regional Water Board does not establish effluent limitations and has not required dischargers to monitor the effluent for total organic carbon (TOC). The Wastewater Control Measures Study conducted for the Central Valley Drinking Water Policy Workgroup provides a value of TOC based on the treatment level: secondary – 20 mg/L, secondary with nitrification and tertiary – 10 mg/L, and tertiary with nitrification or NDN – 8 mg/L (West Yost Associates 2011). Modesto was the only plant in the watershed that collected TOC. TOC concentrations ranged from 9.6 to 11 mg/L with a median of 9.9 mg/L (Figure 4-13, Table 4-9). There were only nine samples collected from 2011 through 2013.

Figure 4-13. TOC Concentrations at Modesto

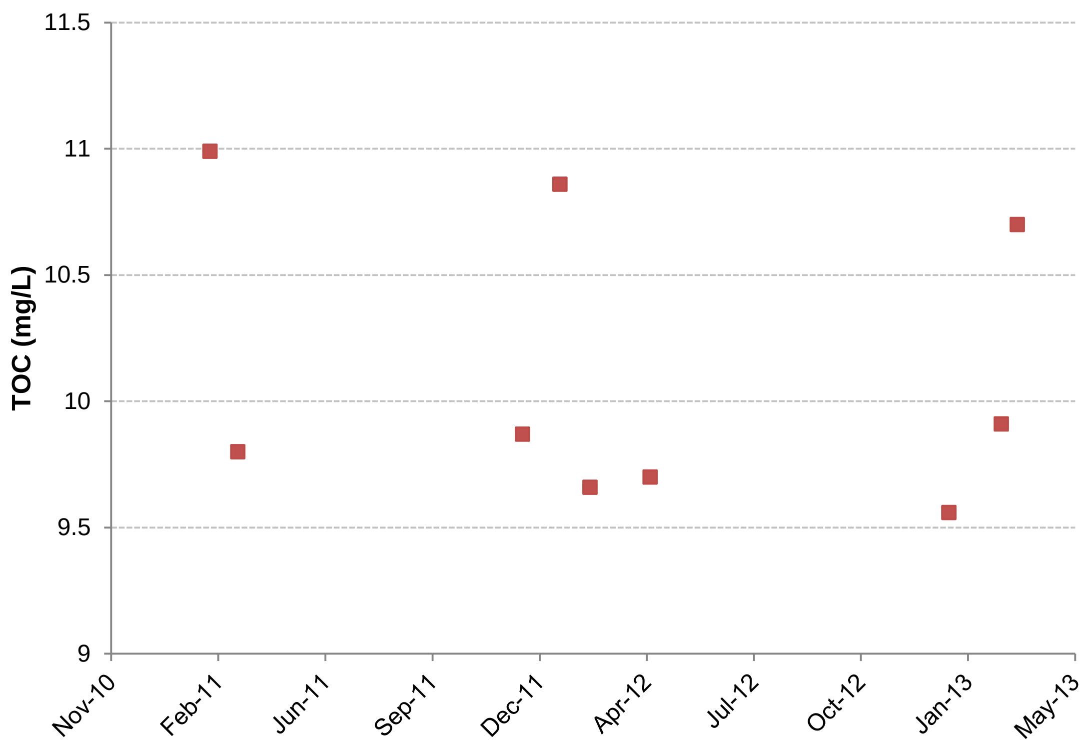


Table 4-9. TOC Summary Statistics at Modesto (mg/L)

Dischargers	Detects/Samples	Range	Mean	Median
Modesto	9/9	9.6-11.0	10.1	9.9

Salinity

Salinity is the amount of dissolved minerals in water and is measured by electric conductivity (EC) and total dissolved solids (TDS). TDS is measured directly in the laboratory or estimated from electrical conductivity. High levels of salinity cause objectionable taste in drinking water. The Basin Plan incorporated the secondary MCLs for EC and TDS as MUN water quality objectives. The secondary MCL for EC is 900 µs/cm and for TDS is 500 mg/L. Salinity in wastewater discharges is largely determined by the salinity of the drinking water supplied to the area of the discharger. Human use and industrial dischargers result in additional salt being added to the wastewater. Manteca/Lathrop did not exceed the secondary MCL for EC, but did on several occasions for TDS (Figure 4-14). Turlock exceeded secondary MCLs for both EC and TDS on a regular basis (Figure 4-15). Modesto did not sample for EC and TDS as regular as the other plants, but the measured values all exceeded the secondary MCLs (Figure 4-16). Atwater had no secondary MCL exceedances for both EC and TDS (Figure 4-17). Clovis had very few secondary MCL exceedances for EC and TDS (Figure 4-18). Merced only measured for EC but no values exceeded the secondary MCL (Figure 4-19). Table 4-10 presents the summary statistics for EC and TDS for all available plants.

Figure 4-14. EC and TDS Concentrations at Manteca/Lathrop

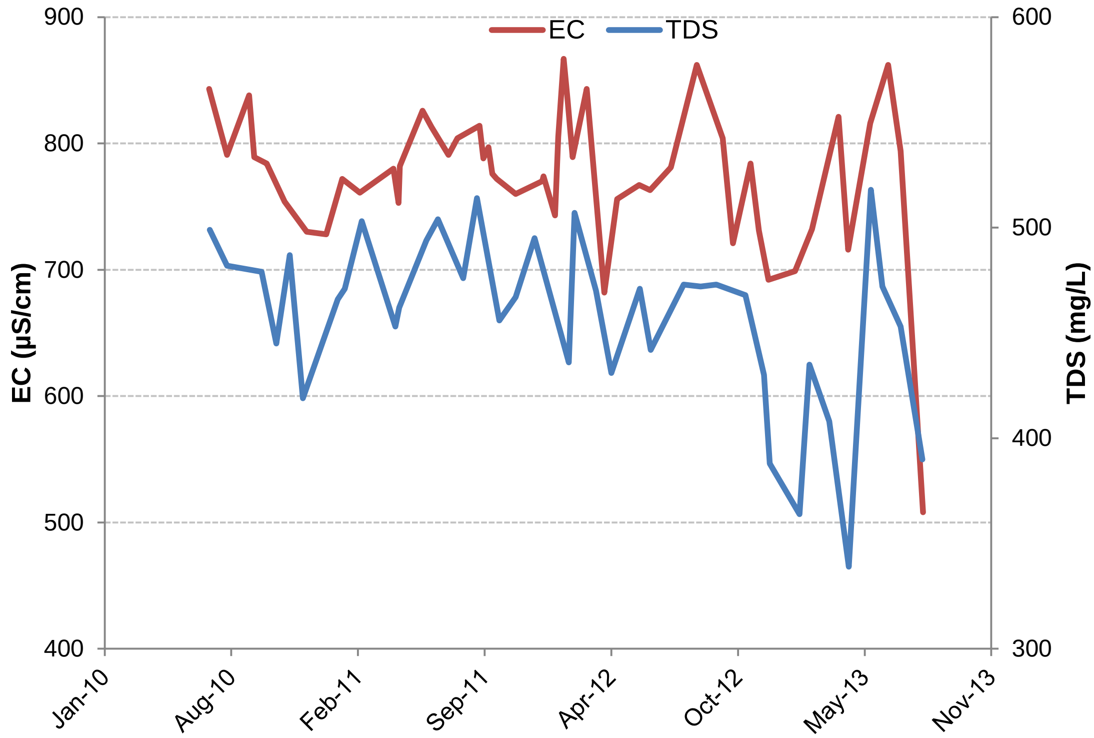


Figure 4-15. **EC and TDS Concentrations at Turlock**

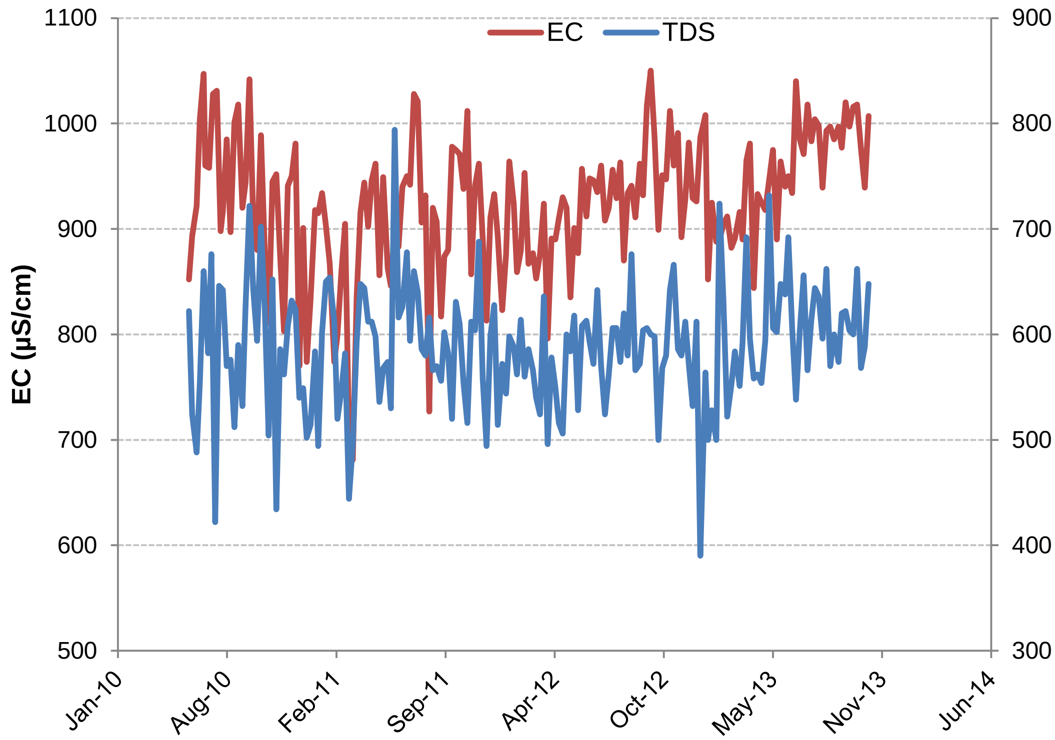


Figure 4-16. **EC and TDS Concentrations at Modesto**

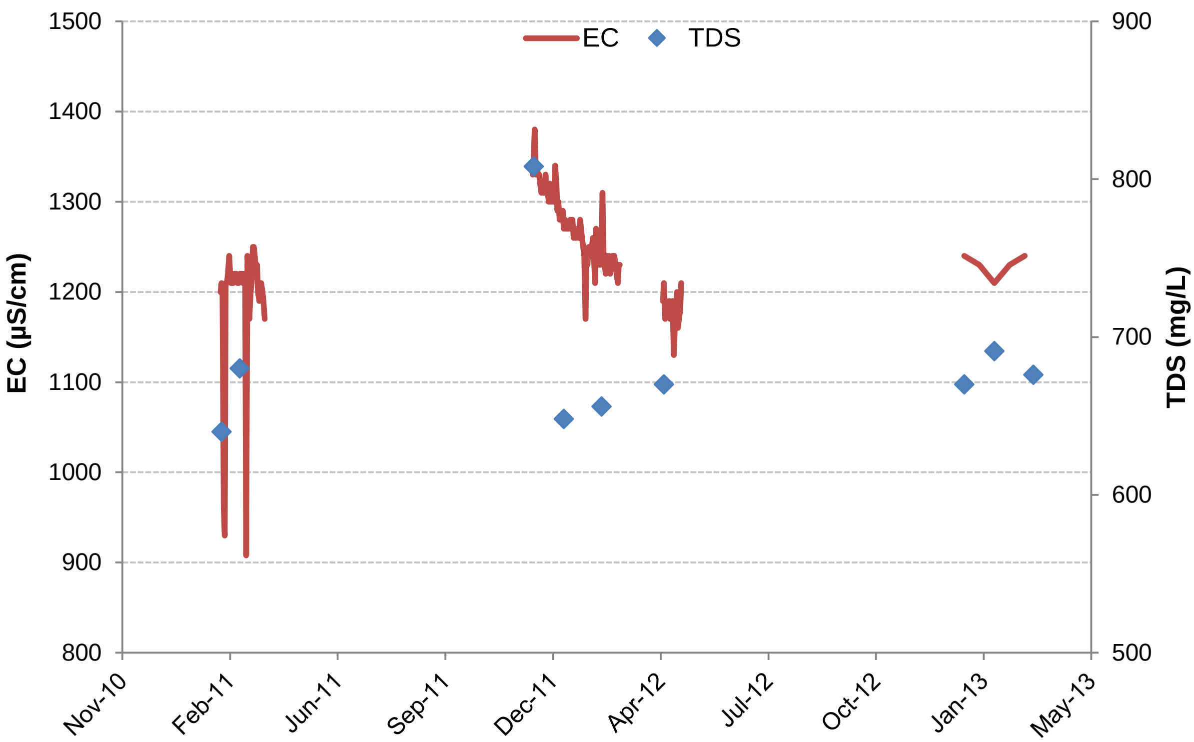


Figure 4-17. EC and TDS Concentrations at Atwater

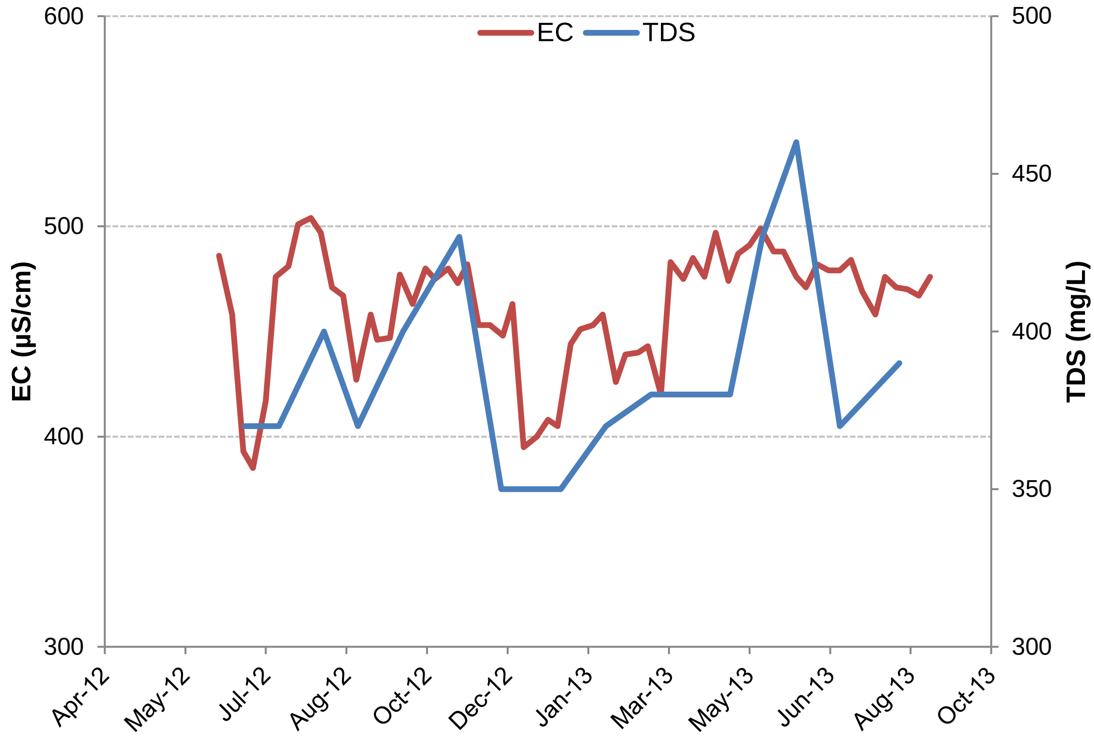


Figure 4-18. EC and TDS Concentrations at Clovis

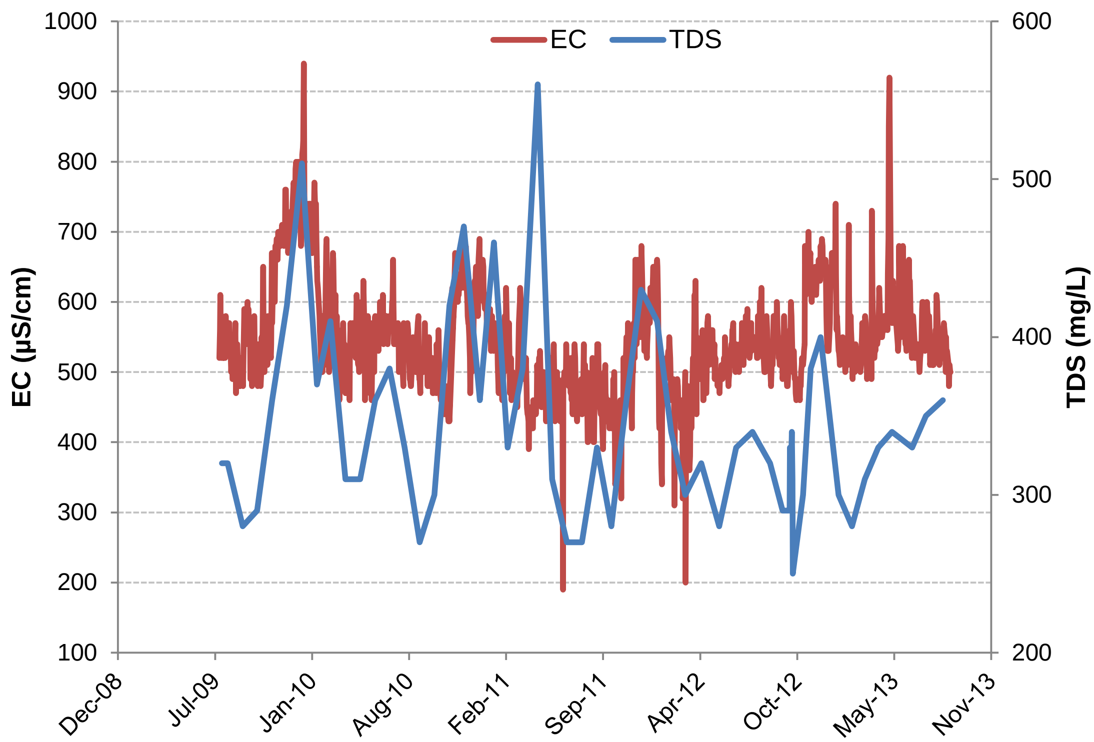


Figure 4-19. **EC Concentrations at Merced**

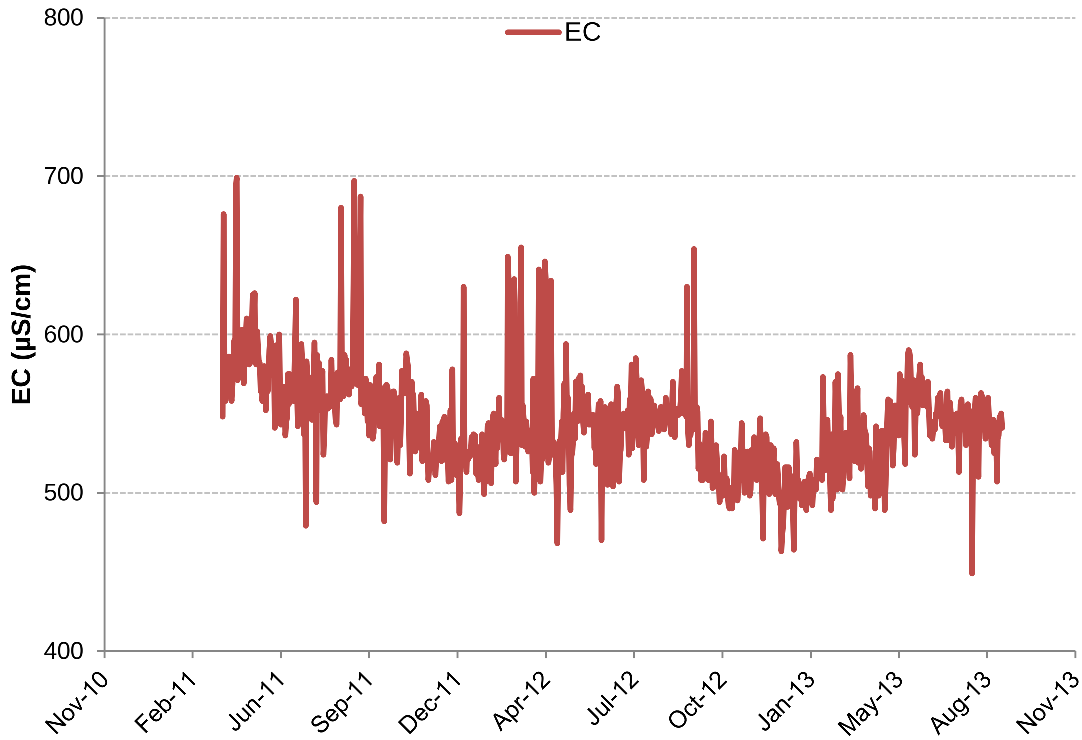


Table 4-10. **EC and TDS Summary Statistics**

	EC (µS/cm)				TDS (mg/L)			
Discharger	**Detects/ Samples**	**Range**	**Mean**	**Median**	**Detects/ Samples**	**Range**	**Mean**	**Median**
Manteca/Lathrop	50/50	508-867	775	782	38/38	339-518	458	469
Modesto	146/146	908-1380	1237	1230.0	9/9	640-808	682	670
Turlock	180/180	681-1050	925	930	179/179	390-794	588	590
Merced	884/884	449-699	544	543	-	-	-	-
Atwater	64/64	385-504	462	471	15/15	350-460	388	380
Clovis	1448/1448	190-940	543	530	58/58	250-560	3423	330

Wastewater Spills Reported in the San Joaquin River Watershed

Spills of raw or partially treated wastewater occur from collection systems and from wastewater treatment plants. A sanitary sewer overflow (SSO) is any overflow, spill, release, discharge, or diversion of untreated or partially treated wastewater from a sanitary sewer system. Major causes of SSOs include grease, root, and debris blockages; sewer line flood damage; manhole structure failures; vandalism; pump station mechanical failures; power outages; excessive stormwater inflow or groundwater infiltration; improper construction; lack of proper operation and maintenance; insufficient capacity; and contractor caused damage. Spills of raw or partially treated wastewater occur due to equipment malfunctions or operator errors at wastewater treatment plants. Spills also occur when there is stormwater inflow into a wastewater collection system and the capacity of the wastewater treatment plant is exceeded.

Reported Spills

Reported spills in four counties within the San Joaquin River watershed (Fresno, Merced, Stanislaus, and San Joaquin) accumulated 40 Category 1 SSO events that contributed over 120,000 gallons of wastewater to the watershed. Category 1 SSOs are any wastewater spill greater than 1,000 gallons, all wastewater spills that enter waters of the state, and spills that occur where public contact is likely, regardless of the volume. Collection systems regulated by the Central Valley Water Board were required to start reporting spills electronically in September 2007. Table 4-11 presents a summary of the collection systems in the San Joaquin River watershed reporting Category 1 SSOs between January 1, 2008 and December 31, 2012.

Table 4-11. Collection Systems with Category 1 SSOs in the San Joaquin River Watershed, January 2008-December 2012

Collection System	Number of Category 1 SSOs	Total Volume of SSOs (gallons)	Total Volume Reaching Surface Water (gallons)	Percent Reaching Surface Water
Modesto CS	31	83,277	46,052	55.3
Clovis City CS	8	35,756	30,031	84.0
Lathrop CS to Manteca WQCF CS	1	1,800	1,600	88.9

All of the reported spills discharged into a waterway (some were as small as 5 gallons). 21 of the spills discharged less than 1,000 gallons, while the remaining 19 spills discharged 1,000 to 26,000 gallons.

Urban Runoff

Background

Stormwater and dry season runoff from the major urban areas of Modesto and Fresno, as well as smaller communities, is discharged into waterways of the Central Valley. Urban runoff is generated by rain and snowmelt events that flow over land or onto impervious surfaces such as paved streets, parking lots, or rooftops (United States Environmental Protection Agency 2012). As the runoff continues to flow over these surfaces, contaminants may be accumulated from various sources, including vehicles (through emissions and maintenance wastes), household hazardous wastes, landscaping chemicals, pet wastes, trash, debris, sediment, and waste from other anthropogenic sources. As populations continue to grow in many cities in the Central Valley, more agricultural and natural lands are converted into urban areas. Natural vegetated areas absorb rainfall and remove contaminants through soil infiltration. The conversion of these lands to urban uses affects runoff by increasing the impervious surface area which results in an increase of flows to surface waters and higher concentrations of runoff contaminants due to the elimination of soil infiltration. Urban runoff containing numerous amounts of contaminants can greatly affect water quality if discharged into waterways untreated.

Urban runoff in the Central Valley is regulated by the Regional Water Board through Municipal Separate Storm Sewer System (MS4), National Pollutant Discharge Elimination System (NPDES) permits. There are two phases in which permits can be obtained. Phase I permits require large (population size greater than 250,000) and medium (population size of 100,000 to 250,000) municipalities to develop stormwater management plans, and conduct stormwater discharge and receiving water monitoring. There are also various other program requirements that are included under Phase I permits, such as runoff control from construction sites, industrial facilities, and municipal operations; illicit discharges; public involvement and education; planning and land development; stormwater quality monitoring; and program effectiveness assessment and reporting. Phase II NPDES permits cover small MS4s (populations of 10,000 to 100,000). Regulated Small MS4s are automatically designated as such if they are located within an "urbanized area" determined by the latest Decennial Census by the Bureau of the Census. Small MS4s located outside of urbanized areas may also be designated as Regulated Small MS4s if they have a high population (10,000 or more) and high population density (density of 1,000 residents per square mile or greater), or if the Small MS4 discharges to Areas of Special Biological Significance (ASBS) as defined in the California Ocean Plan. Phase II permittees are required to develop stormwater management plans but are not required to conduct monitoring. Table 4-12 presents a list of the currently permitted MS4 systems in the San Joaquin River Watershed (Regional Board 2013).

In 2005, the State Water Board adopted sustainability as a core value for all activities and programs and directed staff to consider sustainability in all future policies, guidelines, and regulatory actions. Low Impact Development (LID) is a sustainable practice applied to urban development that takes a different approach by using site design and stormwater management to maintain the site's pre-development runoff rates and volumes. The goal of LID is to mimic a site's pre-development hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source of rainfall (Archibald et al. 2012). LID is currently in use for many of the Phase I stormwater NPDES permits and was added to the renewed Phase II General Permit, adopted in February of 2013.

LID practices result in less disturbance of the development area, conservation of natural features, and are less expensive than traditional stormwater controls. LID includes specific techniques, tools, and materials to control the amount of impervious surface, increase infiltration, improve water quality by reducing runoff from developed sites, and reduce costly infrastructure. LID practices include; bioretention facilities or rain gardens, grass swales and channels, vegetated rooftops, rain barrels, cisterns, vegetated filter strips, and permeable pavements (Archibald et al. 2012).

Also included in the most recent update, is the idea of Hydromodification Management. Hydromodification is the alteration of the natural flow of water. If soil and water resources are not protected during development projects that modify hydrology, then many problems can result, including excess sediment flowing into the watershed, downstream erosion, disruption of natural drainage, irregular stream flows, and elevated water temperatures. Hydromodification Management is the management of post project runoff flows so that they are maintained at the levels of the pre-project condition (San Diego County website) which can be accomplished by creating or replacing impervious surface areas. The 2013 permit update requires the permittees to implement Hydromodification Management procedures within the third year of the effective date of the permit.

Table 4-12. Currently Permitted Municipal Separate Storm Sewer Systems in the San Joaquin Watershed Study Area

MS4 System Name	MS4 Permit Type
Fresno County	
Fresno Metropolitan Flood Control District	Phase I
City of Mendota	Phase II
Stanislaus County	
City of Modesto	Phase I
City of Atwater	Phase II
City of Patterson	Phase II
City of Turlock	Phase II
City of Riverbank	Phase II
City of Oakdale	Phase II
City of Ceres	Phase II
City of Newman	Phase II
Madera County	
City of Chowchilla	Phase II
City of Madera	Phase II
Merced County	
City of Atwater	Phase II
City of Los Banos	Phase II
City of Livingston	Phase II
City of Merced	Phase II

Key Urban Runoff Discharges to the San Joaquin River Watershed

The major urban runoff discharges in the watershed come from the cities of Fresno, Clovis, and Modesto, with additional discharges coming from smaller cities in the watershed. A portion of the urban runoff from the cities of Fresno and Clovis is discharged to the San Joaquin River while urban runoff from the city of Modesto is discharged to the Tuolumne River and Dry Creek. These stormwater programs, and those of selected smaller cities in the San Joaquin River Watershed, focus their efforts at reducing contaminants discharged to receiving waters to protect all beneficial uses (Regional Board 2012).

Fresno Metropolitan Flood Control District

The Fresno Metropolitan Flood Control District (the District), the County of Fresno, the City of Fresno, the City of Clovis, and the California State University Fresno (CSUF) are all covered under the Phase I NPDES permit (Order No. R5-2013-0080) because of the proximity of urbanized areas, their physical interconnections to the storm sewer system, and the locations of their discharges. The Fresno Metropolitan Flood Control District owns and operates the stormwater infrastructure that serves the cities of Fresno and Clovis and parts of the County of Fresno. The system is considered a Regional Stormwater Basin System (equivalent to LID) that consists of underground drain pipes and stormwater management basins. The regional system is unique as there are 158 total drainage areas for stormwater, with 153 of those areas containing detention or retention basins. Three of the five drainage areas use a pump station to discharge directly to the surface water through an irrigation canal, and the remaining two areas drain by gravity to the San Joaquin River without benefits of basin storage. There are six drainage areas that discharge to the river upon release from storm basins. The smaller cities that engage in stormwater management discharge to other receiving waters of the San Joaquin. Within the MS4 permit area, the District's Basin Hydrologic Study estimates that 90% of the urban runoff is retained in stormwater basins, 8 % is discharged after being detained, and 2% is discharged directly. In 1984 the District prepared a Services Plan that described the responsibilities and goals of stormwater management and related services. The plan is continuously updated as new regulations take effect, with the last update in

September 2009. One such example was the development of the Stormwater Quality Management Program (SWQMP) as a result of the NPDES permit program.

The SWQMP outlined 6 key objectives: 1. to protect water resources from degradation by urban runoff and the habitat those resources provide; 2. identify pollutants in urban runoff that pose a significant threat to those resources and beneficial uses; 3. identify and control those sources of pollutants; 4. comply with the NPDES mandate to eliminate or control, to the maximum extent practicable, the discharge of pollutants from urban runoff associated with the metropolitan storm drainage system; 5. seek cost effective alternative solutions where prevention is not practical; and 6. cooperate with other local environmental regulatory programs to ensure a coordinated effort to control pollutants of common concern. Highlights of the progress the District has made over the last five years are described below:

- Public Involvement – Besides engaging in education and outreach programs, the District held a Hazardous Waste Collection event that focused on collecting oil, filters, and antifreeze. There was also a Residential Landscape Award Program that promoted residents to employ principles of Integrated Pest Management (IPM), water conservation, yard waste reduction, habitat creation, and use of native plants.
- Structural Control Improvements – Structural Controls designed to reduce stormwater pollutants were added. These improve the quality of stormwater runoff, generally by filtration, settling, and/or nutrient uptake. These improvements were also included to the Storm Drainage and Flood Control Master Plan.
- Maintenance – Maintaining vehicles, equipment, and facilities; operating and landscape practices; chemical use, application, and storage practices; waste management practices; and material handling practices are used to minimize potential sources of pollution.

The City of Modesto

The City of Modesto is located at the confluence of Dry Creek and the Tuolumne River, both of which are tributaries of the San Joaquin River. The storm drain system has approximately 77 miles of storm drain lines and 20 pump stations within the city. Surface water discharges generally occur in the older areas of the city or those immediately adjacent to the Tuolumne River, Dry Creek, or irrigation canals of the Modesto Irrigation District. Forty percent of stormwater discharges from the city drain to detention/retention basins (13 detention and 11 retention basins), twenty percent to receiving waters of the Tuolumne River and Dry Creek (approximately 18 major outfalls to receiving waters), ten percent directly to MID laterals/drains, and thirty percent to approximately 11,000 rock wells.

The City of Modesto first established their Stormwater Management Program in 1993 to address urban runoff. Their first NPDES permit was received in 1994 as a response to federal laws and regulations. The city's current permit issued in June 2008 (Order No R5-2008-0092) included extensive requirements for the Storm Water Management Plan (SWMP). The objectives of the SWMP are very similar to that of the District's SWQMP. The SWMP objectives are: 1. Identify and control pollutants that pose significant threats to waters of the U.S., the State, and their beneficial uses; 2. Reduce discharges of pollutants in stormwater discharges to the maximum extent practicable (MEP); 3. Protect groundwater and surface water resources; 4. Develop a cost effective program focusing on pollution prevention of urban stormwater; 5. Seek cost effective solutions where prevention is not practical; 6. Coordinate with other agencies; and 7. Achieve compliance with water quality standards.

Although all NPDES Phase I permit holders need to meet certain objectives, the individual programs of the permit holders may vary. The City of Modesto has programs dedicated to each of the requirements listed in the introduction (Public Outreach, Illicit dumping, etc.). For each program element, the City created specific control measures each with its own Best Management Practices (BMPs). The control measures discussed below are those that have the greatest direct impacts to drinking water quality. These control measures were all integrated into the NPDES permit covering 2008-2013:

- Developing a Sanitary Sewer Overflow and Backup Response Plan – In 2006, Modesto developed and implemented a SSO and Backup Response Plan to minimize potential impacts from SSOs and spills to the storm drain system. The plan was updated in 2010.
- Landscape and Pest Management – The city developed a pesticide reduction and Integrated Pest Management Program in cooperation with the University of California. Some of the procedures of this program include not applying pesticides or fertilizers immediately before, after, or during a storm event; not using or storing banned or unregistered pesticides or herbicides; storing the chemicals indoors or under cover on paved surfaces; engaging in annual inspections of storage areas; and requiring all staff applying pesticides to be certified by the California Department of Food and Agriculture.
- Water Quality Based Programs:
    - Discharge Characterization – In 2002-2007 the city identified Pollutants of Concern (POC) and Pollutants of Interest (POI), and a workplan is in place to address the issue of potential discharge of these POCs to stormwater and minimize the effects on the San Joaquin and Tuolumne Rivers. The POCs found were total aluminum, copper, lead, and iron; total dissolved solids; diazinon; *E.coli*; fecal coliform; pH; and turbidity.
    - Pesticide Plan – This work plan includes quantifying pesticide loads, identifying pesticide sources, determining available control strategies for identified sources, identifying methods to evaluate control strategies, and developing an implementation plan.
    - Treatment Feasibility Study – Investigates the feasibility of diverting dry weather discharges to the sanitary sewer system or treatment control BMPs. Originally developed in 2005-2006, objectives were updated for the current permit.
    - Incorporating Water Quality Protection into city procedures and policies – Modesto has integrated urban runoff and stormwater issues into city planning and land development procedures and policies. This allows impacts of urban development to be minimized by controlling the amount of impervious area while preserving natural areas.

Other Systems

The USEPA established regulations for Small MS4s to be regulated pursuant to a NPDES permit in 1999. Adopted in 2003 by the SWRCB, the Phase II NPDES permit specified six minimum control measures including: 1. Public Education and Outreach, 2. Public Participation/Involvement, 3. Illicit Discharge Detection and Elimination, 4. Construction Site Run-off Control, 5. Post-Construction Run-off, and 6. Pollution Prevention/Good Housekeeping. The permit also required the permittees to develop SWMPs with time frames for accomplishing the tasks. Although the first generation permits (2003) contained the six control measures, they were only in very broad terms (State Water Resources Control Board 2013). The City of Los Banos is one such Small MS4 in the San Joaquin River watershed. Los Banos had their SWMP approved in 2007 and has been submitting annual reports for the past five years. Their most recent annual report in 2012-2013 represented year 6, one year beyond the fifth and final year of the pollution prevention work plan. The six minimum control measures for Los Banos are listed below as an example of the steps being taken by Small MS4s to reduce the impact of stormwater runoff to water quality:

1. Public Education and Outreach – BMPs for this section include distributing educational materials to schools, events, and local businesses.
2. Public Involvement and Participation – This section builds on the first by marking storm drains to enhance public awareness, and also by engaging in two annual community cleanup days with volunteers.
3. Illicit Discharge Detection and Elimination – The City of Los Banos is committed to protecting its waterways from improper disposal of waste through inspections, investigations, education, and enforcement as needed.
4. Construction Site Stormwater Control – For any construction project greater than one acre or less than one acre but part of a larger plan of development or sale, a Stormwater Pollution Prevention Plan (SWPPP) is required.
5. Post Construction Stormwater Management – Although there are no measurable goals beyond this permit time frame, the City of Los Banos will continue to comply with the storm ordinance that was adopted in February of 2010. This includes routinely visiting and inspecting sights for the purpose of enforcement or compliance.
6. Pollution Prevention and Good Housekeeping for Municipal Operations – Along with training and employee meetings, the City of Los Banos engages in bi-weekly street sweeping and fall leaf removal programs. They also have standard operating procedures for chemical or sewer spills in place and are in the process of constructing a real time flow monitoring and water quality sampling station.

The 2013 Small MS4 permit specifies actions necessary to reduce the discharge of pollutants in stormwater to the MEP. The significant changes in the 2013 Phase II Small MS4 General Permit are as follows:

- Implementation of LID Principles – Includes LID requirements emphasizing landscape-based site design features and providing multiple benefits in addition to stormwater and pollutant load reduction.
- ASBS – Incorporates the Special Protections for discharges of stormwater to ASBS that were recently adopted by the State Water Board. These Special Protections will ensure that natural water quality in the ASBS will be maintained. ASBS are those areas designated by the State Water Board as ocean areas requiring protection of species or biological communities to the extent that alteration of natural water quality is desirable.
- Total Maximum Daily Load (TMDL) Implementation Requirements – Incorporates implementation requirements for adopted TMDLs and the associated waste load allocations and load allocations. TMDLs set a limit for the amount and types of pollution allowed to enter receiving waters that stormwater may drain into.
- Specific Management Measures – Includes specific management measures and describes the associated tasks and implementation levels that municipalities must meet.
- Elimination of the submission of a SWMP – Eliminates the requirement to submit a SWMP for review and approval by the Regional Water Boards.
- Designation Criteria & Waiver Certification – Describes the criteria used for designation and provides for some communities to “opt out” of the permit if specific waiver criteria are met.
- Program Management – Requires that the stormwater program is actively managed and has a specific point person responsible for permit administration and compliance.

- Storm Water Multi-Application Reporting and Tracking System (SMARTS) – Requires that Notices of Intent and Annual Reports be submitted electronically using the SMARTS system, an online database maintained by the State Water Board.
- Water Quality Monitoring – Prioritizes monitoring for ASBS, TMDLs, and 303(d) listed waterbodies. Permittees having a population of 50,000 or more are required to choose from a number of monitoring options. While Regional collaboration among jurisdictions is encouraged, the permit provides options for conducting the monitoring program.
- Program Effectiveness Assessments – Requires Permittees to assess their programs to ensure that efforts to control pollutants and debris are effective. The MS4 programs should be able to demonstrate the link between program activities and water quality improvements.

Urban Runoff Water Quality for Drinking Water Constituents

Although the MS4 permits do not contain effluent limitations, they do require municipalities to reduce potential urban runoff pollution by the maximum extent practicable (MEP) through implementation of BMPs. Water quality data obtained by Modesto and Fresno from 2008 through 2013 are summarized in this section. Data presented is solely to provide a general understanding of the quality of urban runoff in the San Joaquin River watershed. Urban runoff is highly variable in the duration and severity of storm events, and in the concentrations of constituents sampled.

Fresno is required to monitor the San Joaquin River at three locations. As shown in Figure 4-20, the monitoring locations are:

- Site 1: Friant Dam (upstream of the urban area)
- Site 2: Rice Road (upstream of the urban area)
- Site 3: Jura Farms Bridge (downstream of the urban area)

Modesto is required to monitor the Tuolumne River and Dry Creek upstream and downstream of the urban area. The monitoring locations are shown in Figure 4-21.

Figure 4-20. **San Joaquin River Monitoring Locations**

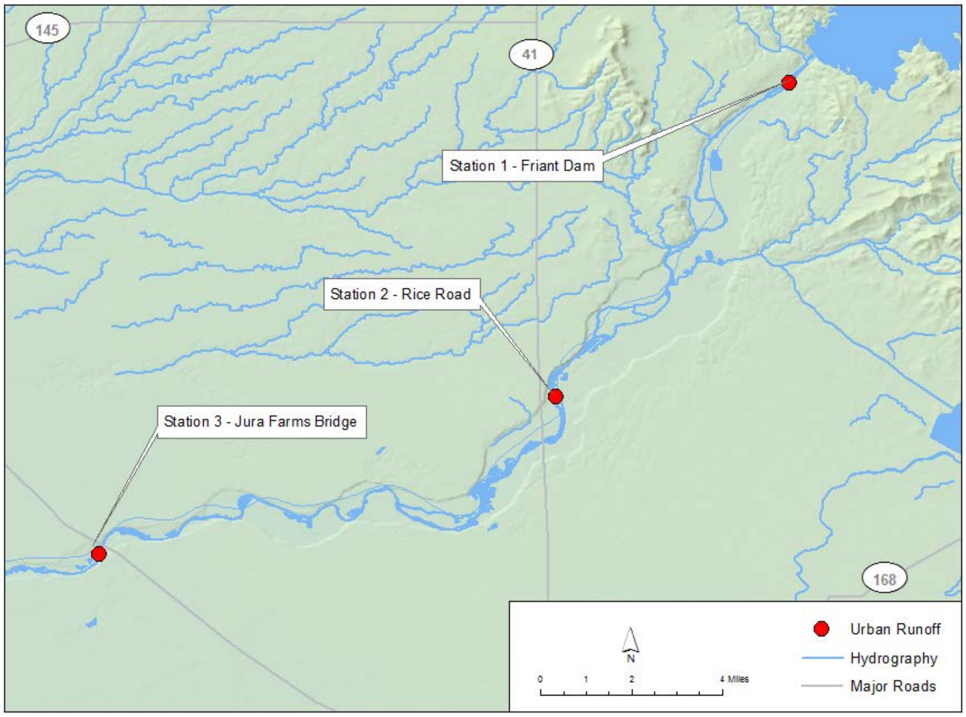
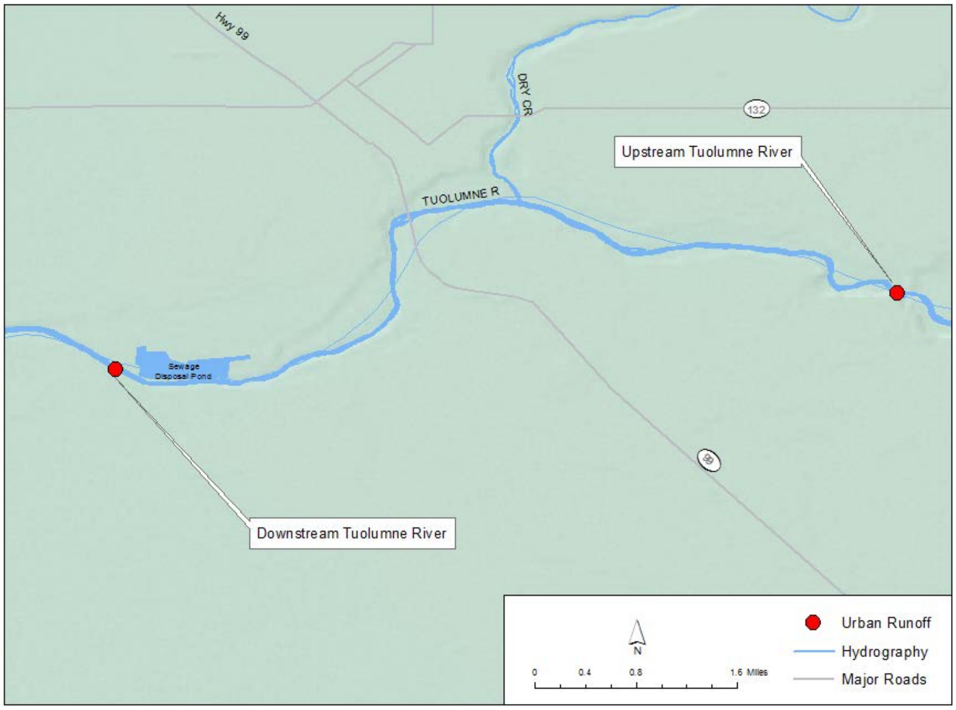


Figure 4-21. **Tuolumne River Monitoring Locations**



Pathogens and Indicator Organisms

Urban runoff contains high levels of coliform bacteria, relative to the levels found in receiving waters. Although the Basin Plan does not have limitations on fecal and total coliforms for MUN, it does however have them for REC_1. The fecal coliform concentration based on a minimum of not less than five samples for any 30-day period, shall not exceed a geometric mean of 200/100 ml, nor shall more than ten percent of the total number of samples taken during any 30-day period exceed 400/100 mL, while total coliform shall not exceed 10,000/100 mL. Sources of fecal contamination in urban runoff include domestic and wild animals, in addition to human sources from illicit connections to the storm drain system, or sewage spills. Since fecal coliforms are used as indicators of fecal contamination, their presence indicates that urban runoff may carry a significant amount of fecal material into the San Joaquin River water bodies. The primary impact of fecal contamination on water bodies is the potential presence of pathogens that may be associated with feces. The actual amount of pathogens discharged in urban runoff cannot be extrapolated from the indicator organism data (Archibald et al. 2012).

Figure 4-22 shows median coliform levels for the San Joaquin River. Fecal coliform and total coliform concentrations for the San Joaquin River are presented as box plots below (Figure 4-23 and 4-24). Figure 4-25 represents median coliform levels for the Tuolumne River. Figure 4-26 and 4-27 present box plots of fecal coliform and *Escherichia coli* (*E. coli*) respectively. Table 4-13 presents the fecal and total coliform data from the San Joaquin River monitoring sites from 2008 through 2013. The wet season is classified as the general storm season (dates may vary) while the dry season is when there is generally no or very little precipitation. Table 4-14 presents the fecal coliform and *E. coli* data for the Tuolumne River upstream and downstream sites of the Modesto urban area from 2008 through 2013.

For the San Joaquin River data, the graphs show a downstream increase of total coliform median concentrations, whereas fecal coliform concentrations remain relatively consistent among sites. Inputs from non-urban sources could explain much of the site to site variability (Fresno-Clovis Annual Report 2013). As shown in Table 4-13, there is an increasing trend in coliform concentration between sites moving downstream, but a decreasing trend when compared by sampling season, with higher concentrations seen during the wet season. This is probably due to the storm events flushing more material into the river. For fecal coliforms, all of the sites show a decreasing trend from the wet season to the dry season. Friant Dam had a wet season median of 30 MPN/100 mL compared to 8 MPN/100 mL. Rice Road had a wet season median of 30 MPN/100 mL compared to 8 MPN/100 mL for the dry, and finally Jura Farms Bridge had a wet season median of 180 MPN/100 mL compared to 11 MPN/100 mL dry. For total coliforms, the same trend for fecal coliforms was seen except there was a decrease in total coliform levels from Rice Road to Jura Farms Bridge. Friant Dam had a wet season total coliform median of 170 MPN/100 mL and a dry season median of 110 MPN/100 mL. Rice Road had a wet season median of 900 MPN/100 mL compared to dry season median 130 MPN/100 mL. Finally, Jura Farms Bridge had a wet season median of 1350 MPN/100 mL and a dry season median of 80 MPN/100 mL.

As for the Tuolumne River data, the downstream sampling site had higher levels of both fecal coliforms and *E.coli*. This may be because the upstream sampling site drains primarily agriculture lands while the downstream site drains a combination of agricultural and urban land uses (Modesto, NPDES 2008). With the San Joaquin River Tuolumne River data, both fecal coliform and *E. coli* data increased from the wet season to the dry season at the upstream site, but decreased by season at the downstream site. Fecal coliform had a wet season median of 37 MPN/100 mL and a dry season median of 40 MPN/100 mL at the upstream site. The downstream site showed the opposite with a wet season median of 495 MPN/100 mL and a dry season median of 230 MPN/100 mL. The wet and dry season medians for *E. coli* were the same as fecal coliforms for the upstream site (37 MPN/100 mL and 40 MPN/100 mL respectively). The wet season median for the downstream site was 315 MPN/100 mL and the dry season median was 230 MPN/100 mL.

Figure 4-22. Median Coliform Levels in the San Joaquin River

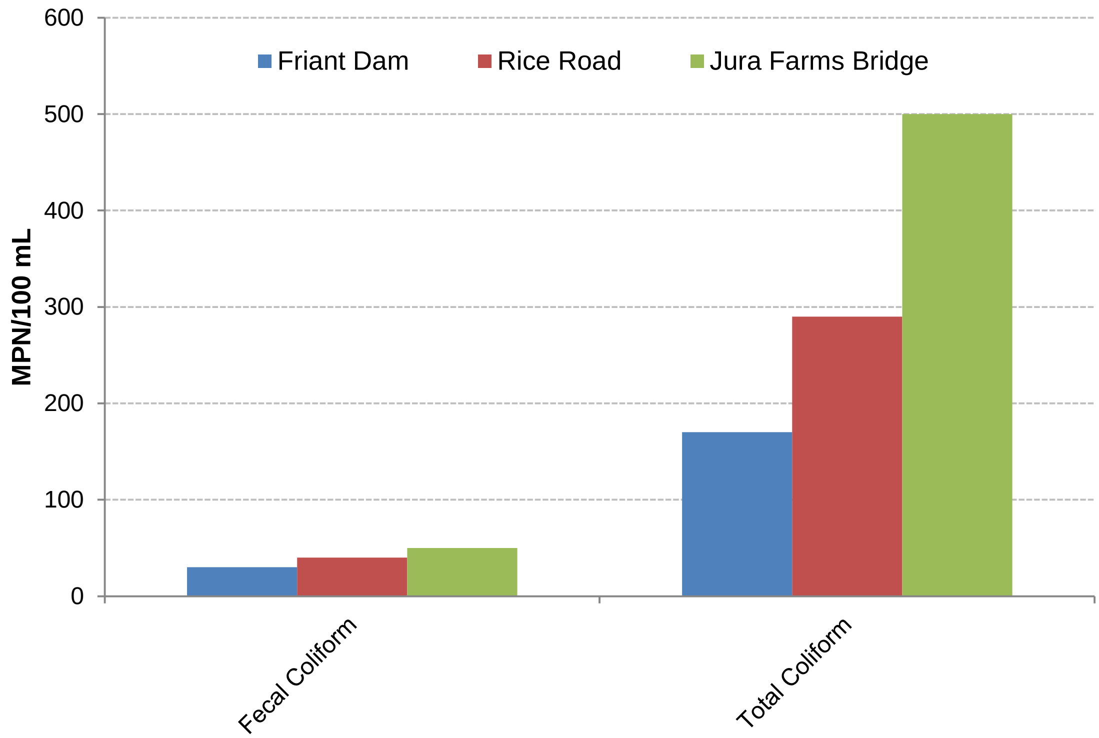


Figure 4-23. Fecal Coliform Levels in the San Joaquin River (log scale)

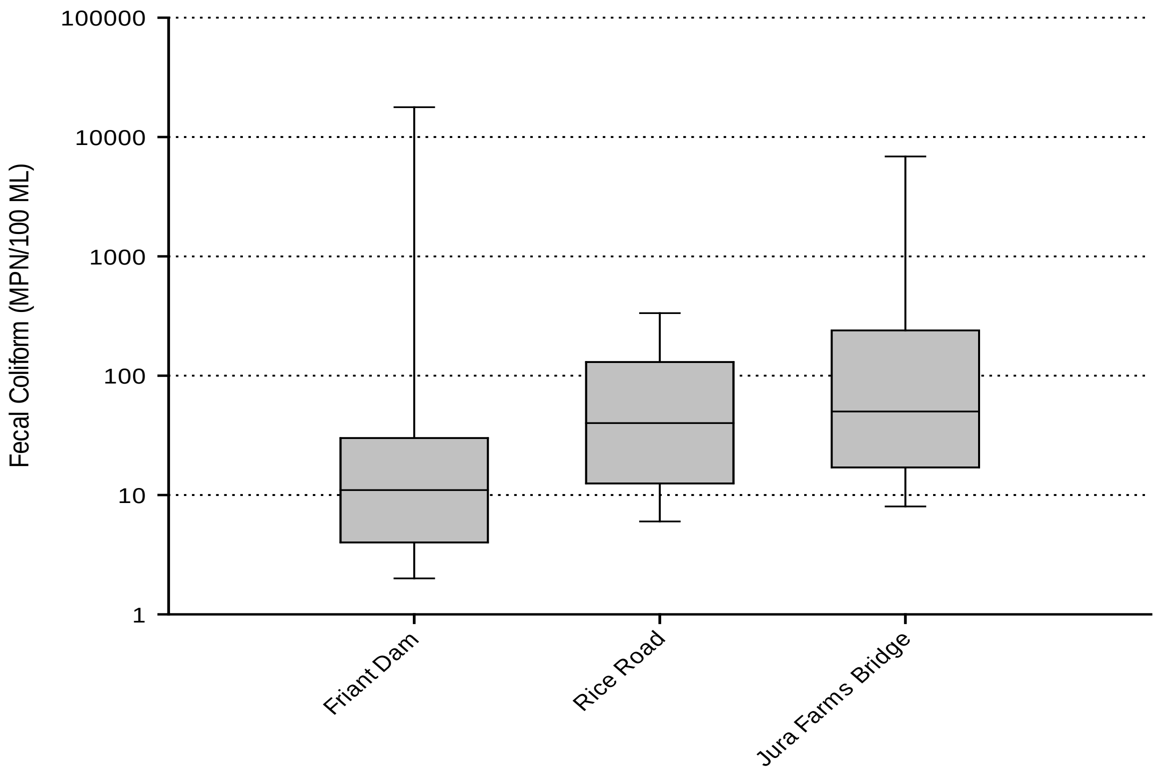


Figure 4-24. Total Coliform Levels in the San Joaquin River (log scale)

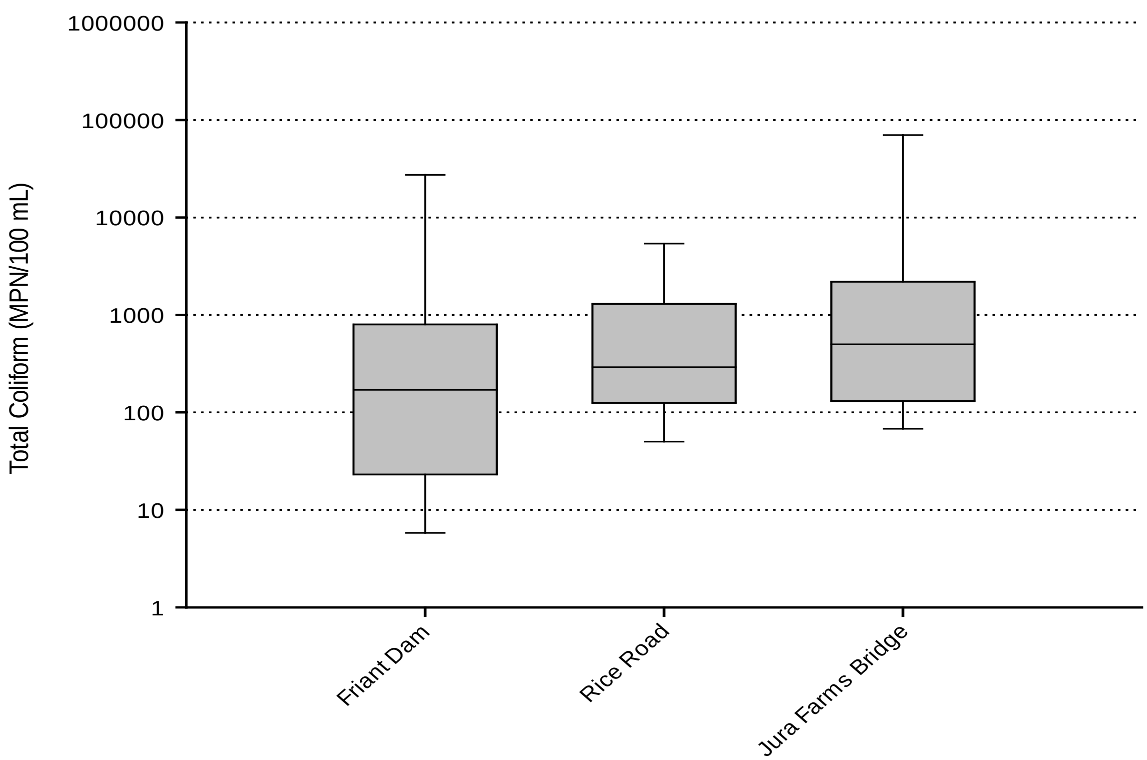


Figure 4-25. Median Coliform Levels in the Tuolumne River

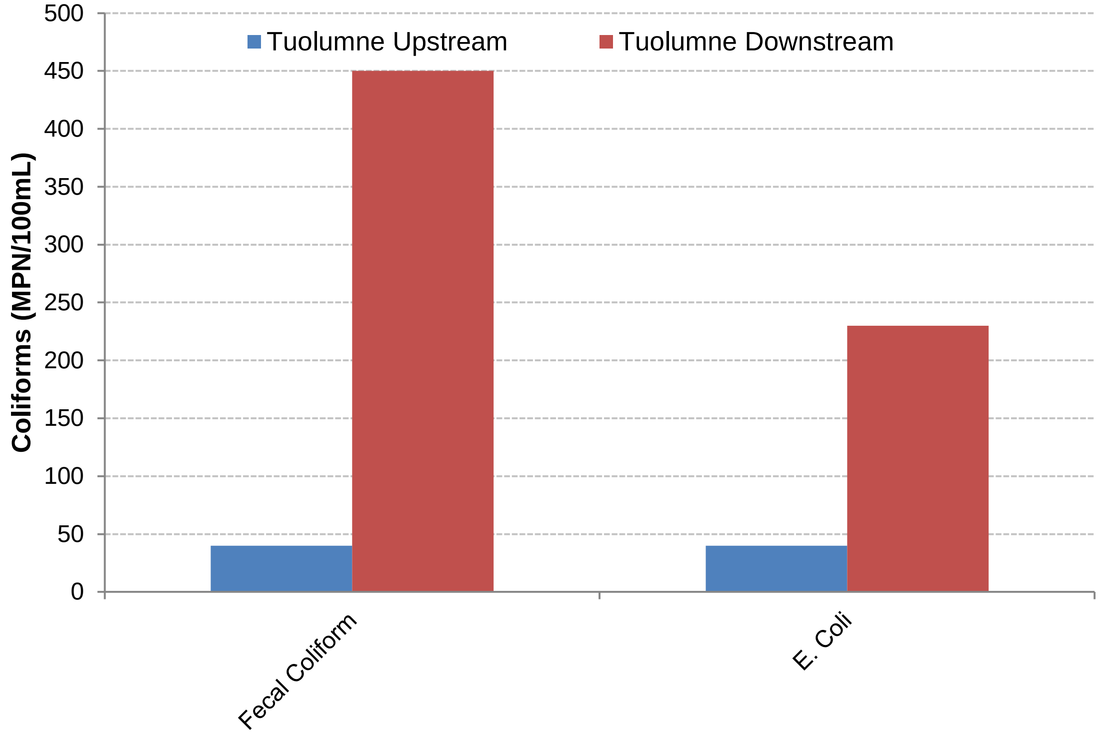


Figure 4-26. Fecal Coliform Levels in the Tuolumne River (log scale)

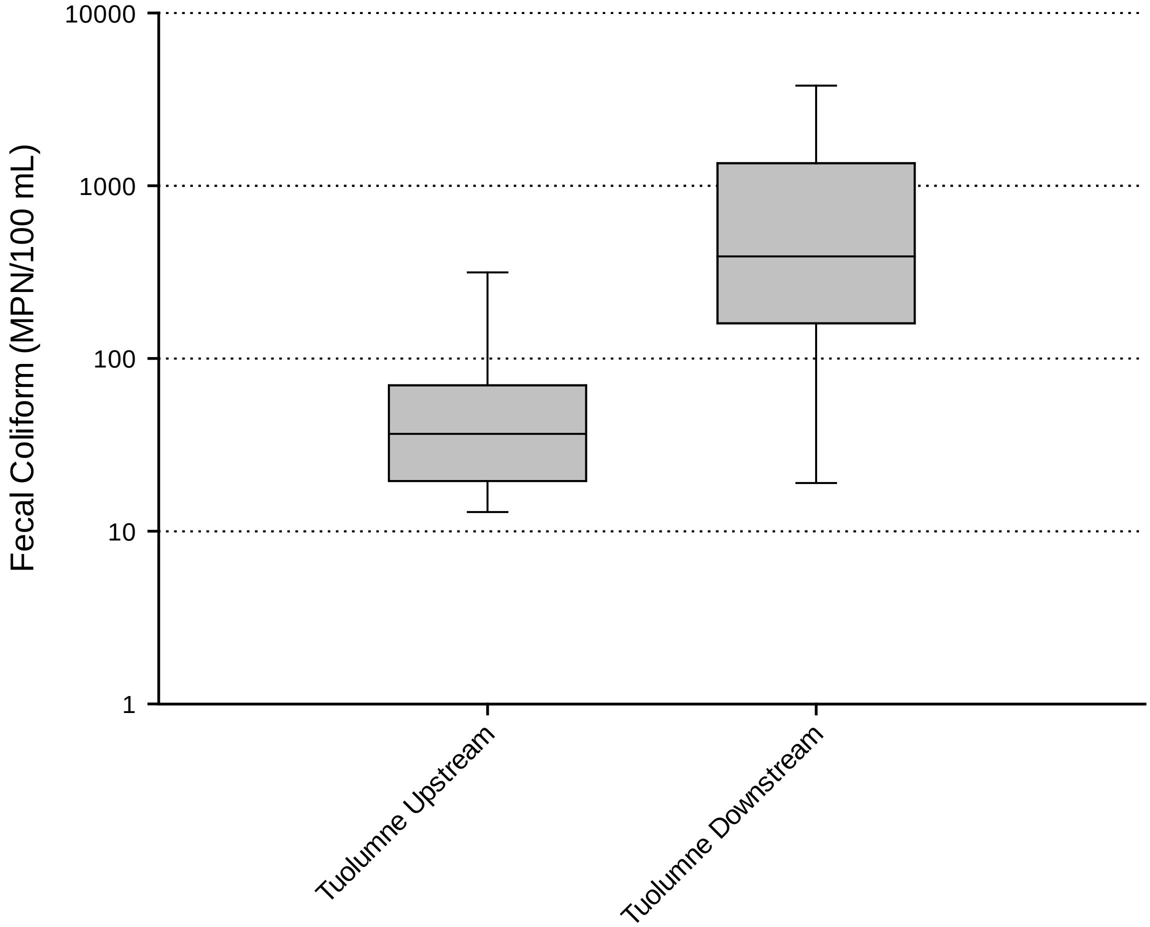


Figure 4-27. ***E. coli* Levels in the Tuolumne River (log scale)**

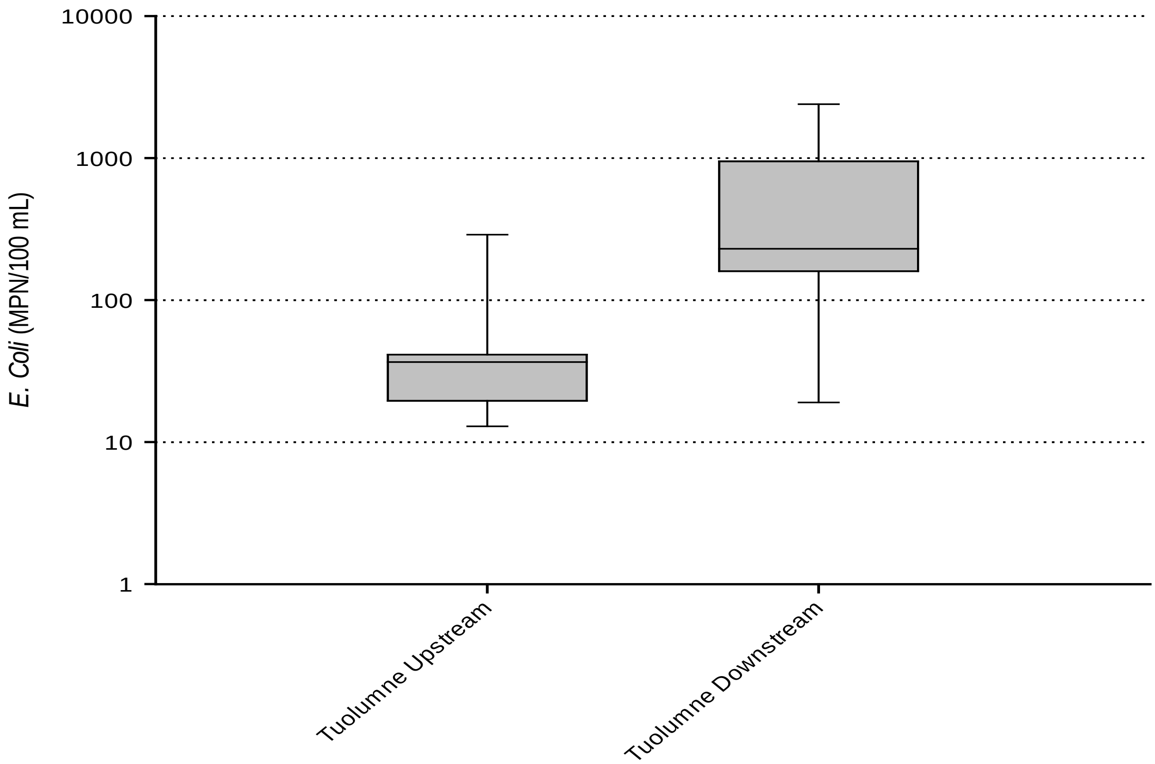


Table 4-13. **Coliform Levels for the San Joaquin River (MPN/100 mL)**

Locations	Fecal Coliform[a]			Total Coliform[b]		
	Range	Wet Median	Dry Median	Range	Wet Median	Dry Median
Friant Dam	4-28,000	30	8	4-43,000	170	110
Rice Road	4-500	80	11	50-8,000	900	130
Jura Farms Bridge	2-13,000	180	14	50-130,000	1350	80

[a]There were a total of 15 samples taken (10 from the wet season and 5 from the dry, with tow ND from the dry and one ND from the wet season at Friant Dam, not included)
[b]There were a total of 14 samples taken (9 from the wet season and 5 from the dry)

Table 4-14. **Coliform Levels for the Tuolumne River (MPN/100 mL)**

Locations	Fecal Coliform			*E. coli*		
	Range	Wet Median	Dry Median	Range	Wet Median	Dry Median
Tuolumne (Upstream)	8-500	37	40	8-500	37	40
Tuolumne (Downstream)	20-4600	495	230	20-3000	315	230

Nutrients

Urbanized areas contribute nutrients to rivers and streams in a multitude of ways. Fertilizers from lawns can be one contributor, but also the release of nutrients from the degradation of leaves, woody debris, and insects which can be carried to receiving waters through stormwater (USEPA 2012). Nutrient data is presented in Table 4-15 for the San Joaquin River and includes nitrate, TKN, and ammonia. Ammonia and nitrate data is presented in Figures 4-28 and 4-29. Because there were so few detects in the San Joaquin River, it is difficult to see a trend between sites or assess trends associated with seasonality.

Figure 4-28. Ammonia Concentrations at the San Joaquin River

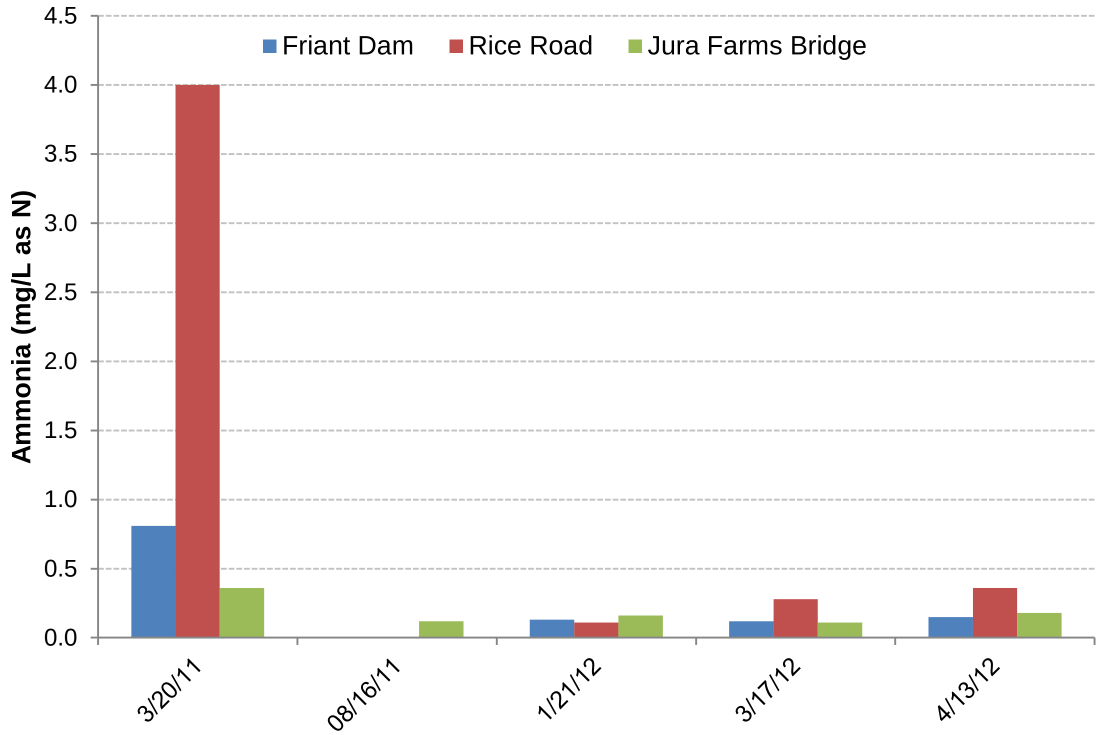


Figure 4-29. **Nitrate Concentrations for the San Joaquin River**

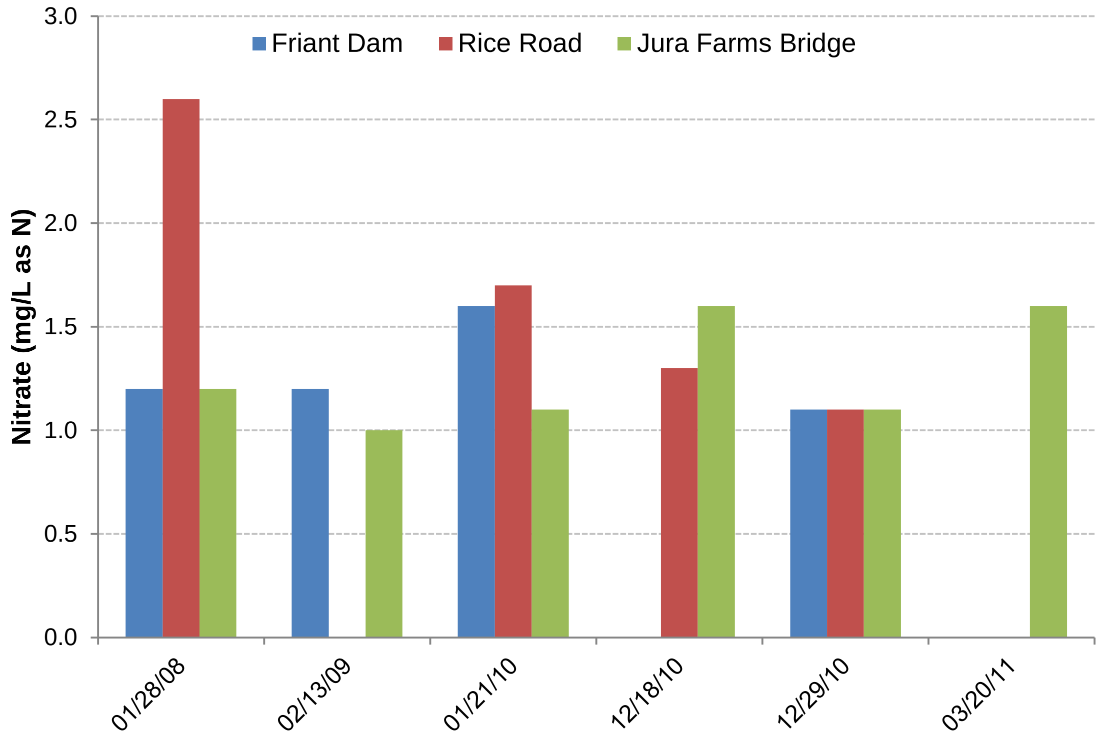


Table 4-15. **Nutrient Summary Statistics at the San Joaquin River (mg/L as N)**

Constituents	Detects/Samples	Range	Mean	Median
Friant Dam				
Nitrate	4/17	1.10-1.60	1.28	1.20
TKN[a]	-	-	-	-
Ammonia	4/17	0.12-0.81	0.30	0.14
Rice Road				
Nitrate	4/16	1.10-2.60	1.68	1.50
TKN	1/13	1.20	-	-
Ammonia	4/16	0.11-4.00	1.46	0.28
Jura Farms Bridge				
Nitrate	6/17	1.00-1.60	1.27	1.15
TKN	1/14	1.20	-	-
Ammonia[b]	5/17	0.11-0.36	0.19	0.16

[a] All samples were NDs
[b] For all other ammonia values, all dry season samples were NDs except for one at Jura Farms Bridge

As was the case with the San Joaquin River data, there were many non-detects for nutrients sampled in the Tuolumne River. Table 4-16 presents the nutrient data for the Tuolumne River. Figures 4-30 through 4-34 show the ammonia, nitrate, nitrite, TKN, and total phosphorus concentrations in the Tuolumne River.

The data presented shows the variability of nutrients in the Tuolumne River. For ammonia, there is an increase in concentrations at the downstream location during the first three sampling events, possibly due to first flush events. During these events, the ammonia concentrations remain relatively stable for the upstream sampling location. After these sampling events, there is a slight decrease in ammonia concentrations from February, 2011 through November, 2012 at the downstream location, possibly due to smaller amounts of precipitation each year, causing less runoff. The upstream location concentrations are much more variable. For nitrate, there is a change from the wet season medians to the dry season medians at both upstream (wet median of 2.0 mg/L to dry of 0.58 mg/L) and downstream (wet median of 3.0 mg/L to 0.89 mg/L) locations. The upstream concentrations generally follow the same trends as downstream, except for one sampling event in October, 2009, when the upstream concentration of nitrate decreased from the concentration in the dry season sampled in May, 2009. For nitrite and TKN concentrations, no trends can be seen, with one unusually high TKN concentration recorded during a dry sampling event in June, 2009. For total phosphorus, there are high concentrations located at the downstream sampling location in October 2009 and 2010, which might be related to first flush events. Most of the data collected at the upstream location was reported as less than the detection limit. No other constituents showed any significant changes from wet to dry seasons.

Figure 4-30. Ammonia Concentrations in the Tuolumne River

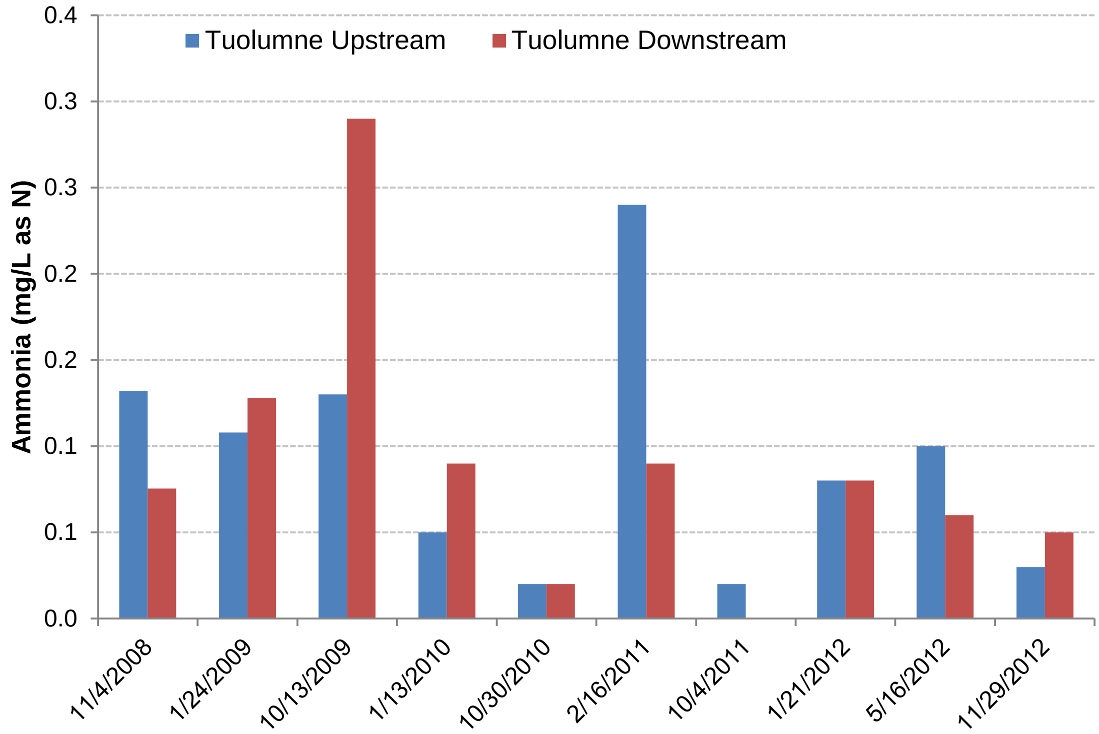


Figure 4-31. **Nitrate Concentrations in the Tuolumne River**

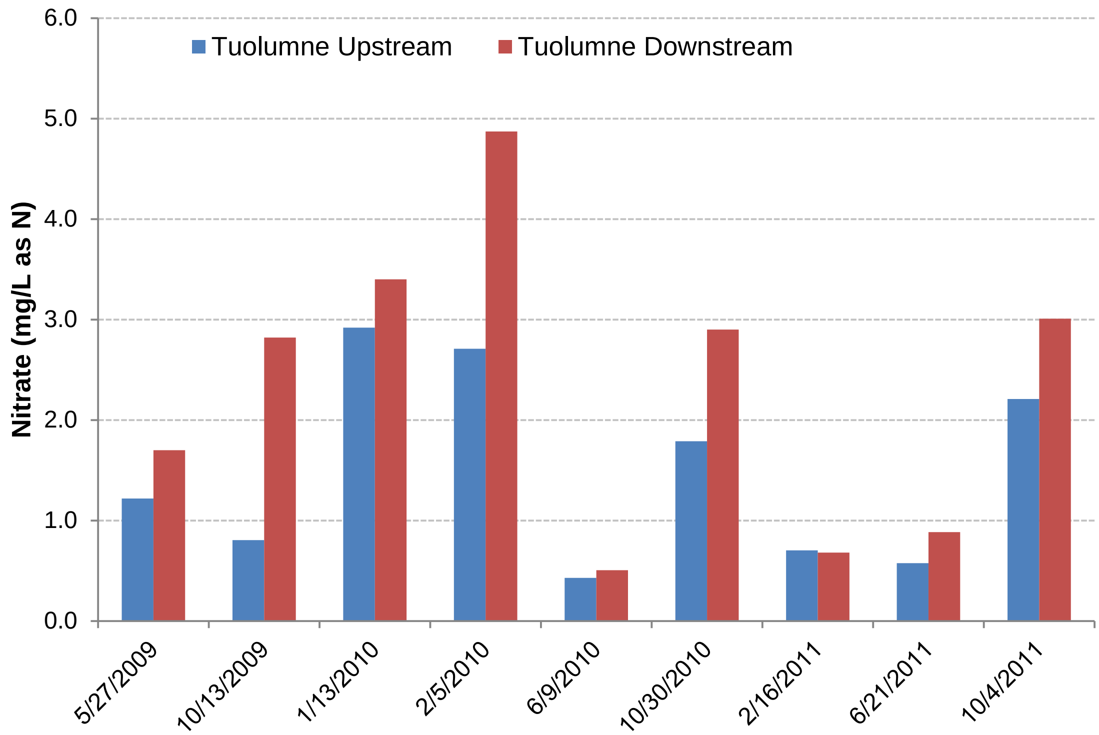


Figure 4-32. **Nitrite Concentrations in the Tuolumne River**

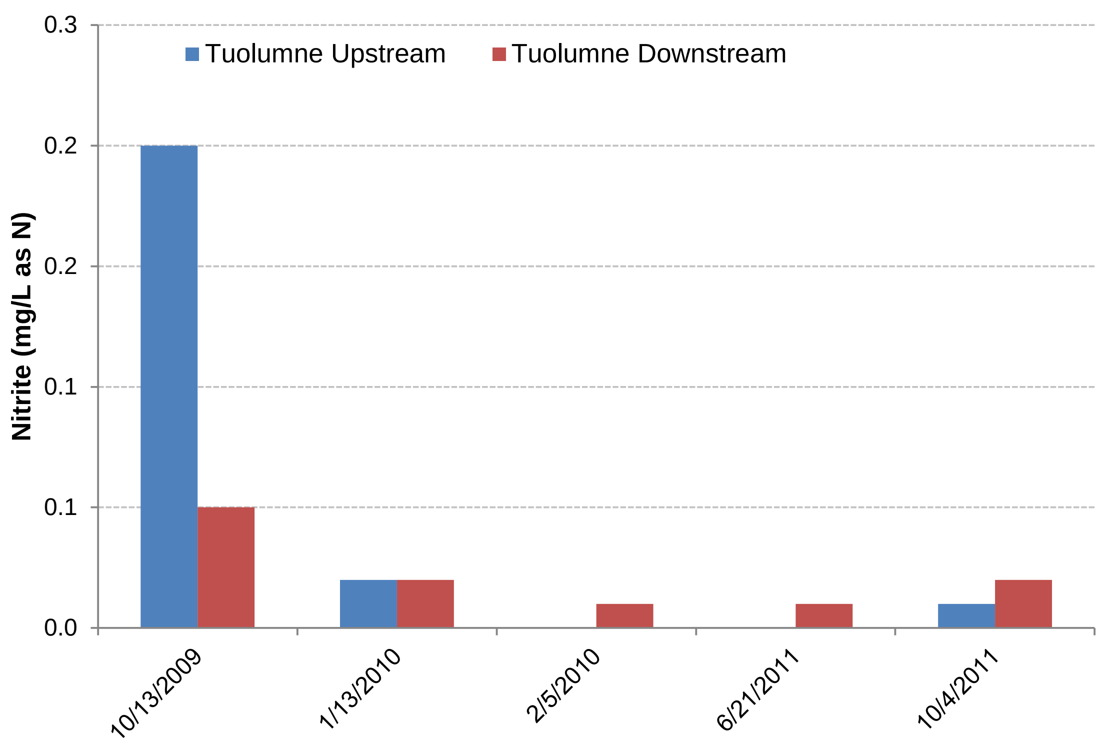


Figure 4-33. **TKN Concentrations in the Tuolumne River**

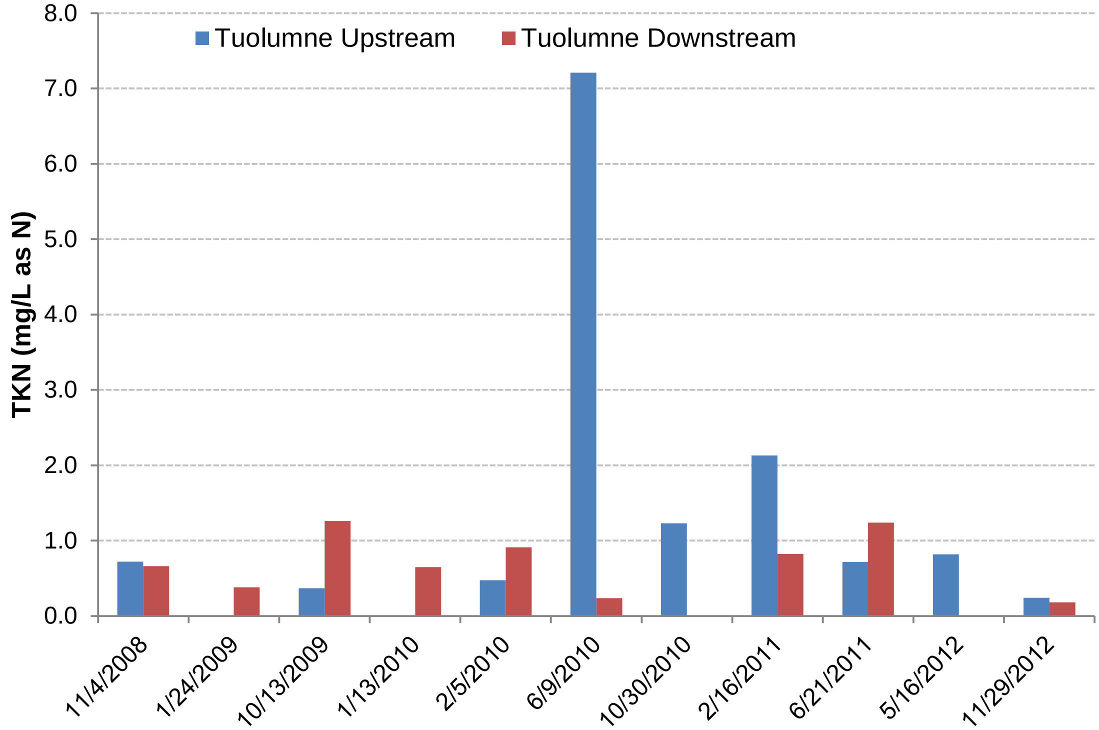


Figure 4-34. **Total Phosphorus Concentrations in the Tuolumne River**

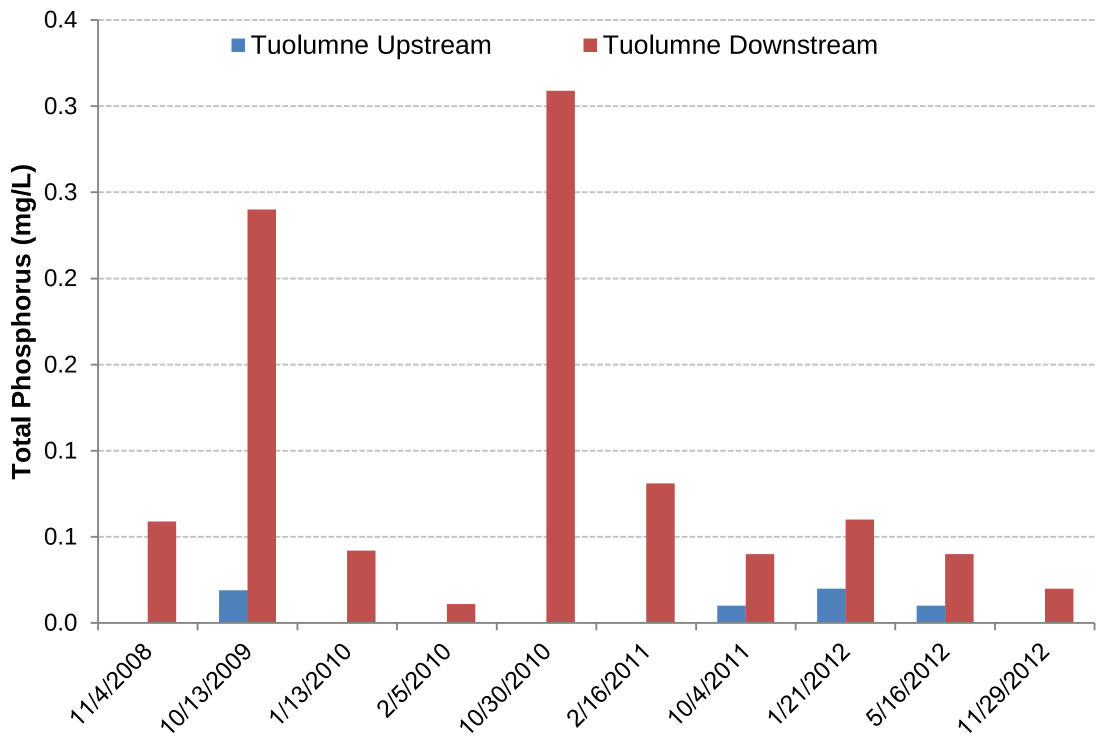


Table 4-16. Median Nutrient Concentrations in the Tuolumne River (mg/L)

Constituent	Tuolumne (Upstream)			Tuolumne (Downstream)		
	Range	Wet Median	Dry Median	Range	Wet Median	Dry Median
Nitrate (mg/L as N)	0.58-2.92	2.0	0.58	0.51-4.87	3.0	0.89
Nitrite (mg/L as N)	0.01-0.2	0.02	-	0.01-0.05	0.02	0.01
TKN (mg/L as N)	0.24-7.21	0.60	0.82	0.18-1.26	0.66	0.74
Ammonia (mg/L as N)	0.02-0.13	0.08	0.10	0.02-0.13	0.09	0.06
Total Phosphorus (mg/L)	0.01-0.02	0.02	0.01	0.01-0.06	0.06	0.04

Organic Carbon

Organic carbon can come in a variety of forms ranging from small soil particles, woody debris, or even the decomposition of small animals such as rodents (Archibald et al. 2012). Figure 4-35 is the TOC data from all of the sampling sites in the San Joaquin River and Figure 4-36 presents the TOC data from the two Tuolumne River sampling sites. Table 4-17 and Table 4-18 summarize median TOC levels for both the San Joaquin River and Tuolumne River respectively.

The San Joaquin River TOC data again shows the variability between the sites. The data follows the same general trend that has been seen with the other constituents and as the season changes from dry to wet, the TOC values generally increase (wet medians of 1.4 mg/L upstream and 2.2 mg/L for downstream, and dry medians of 1.5 mg/L upstream and 1.7 mg/L downstream). Each site has peaks in TOC data at different times which is most notable in the Jura Farms Bridge data. There are two large peaks, and in the first peak (October 2008), the TOC data for the other two sites are dropping. For the second peak (March 2011), all three sites show an increase but none are at such a drastic increase as the Jura Farms Bridge site. These variations could again be related to non-urban runoff sources.

As for the Tuolumne River TOC data, the upstream sampling site does not show much variation as shown in the table (there is very little difference between wet and dry seasons). The downstream site however, shows much more variability between the seasons and the very large peak in October 2009 skews the wet season median. There is not a large difference between the two sites during the dry season sampling.

Figure 4-35. TOC Concentrations in the San Joaquin River

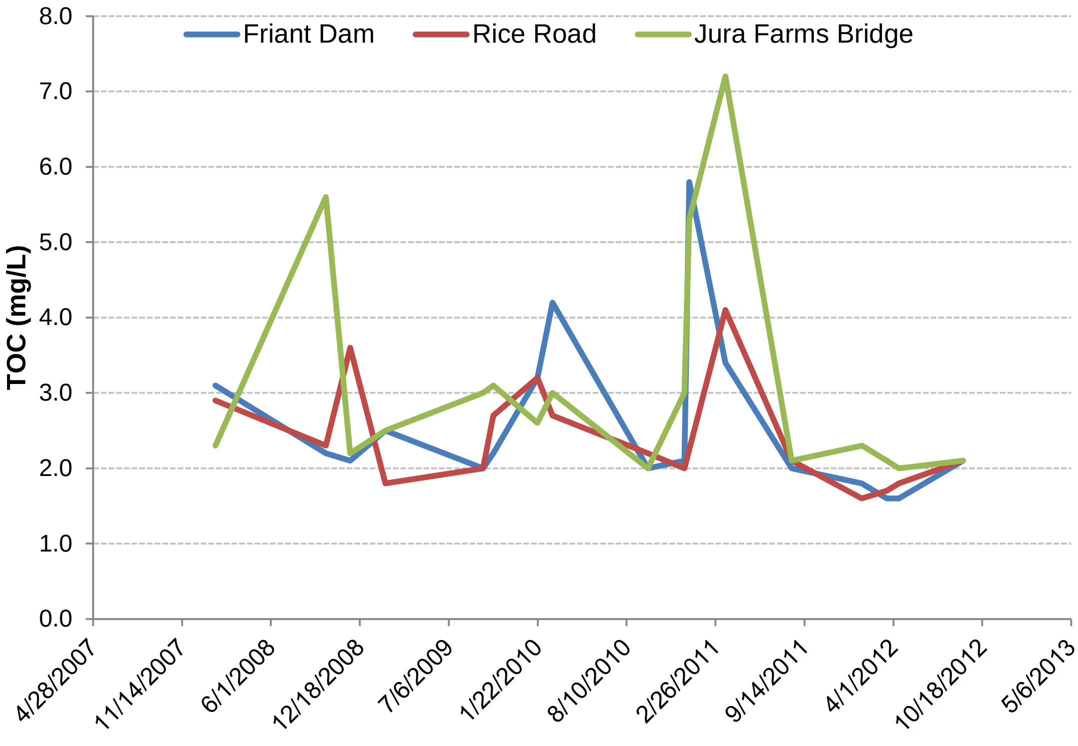


Figure 4-36. TOC Concentrations in the Tuolumne River

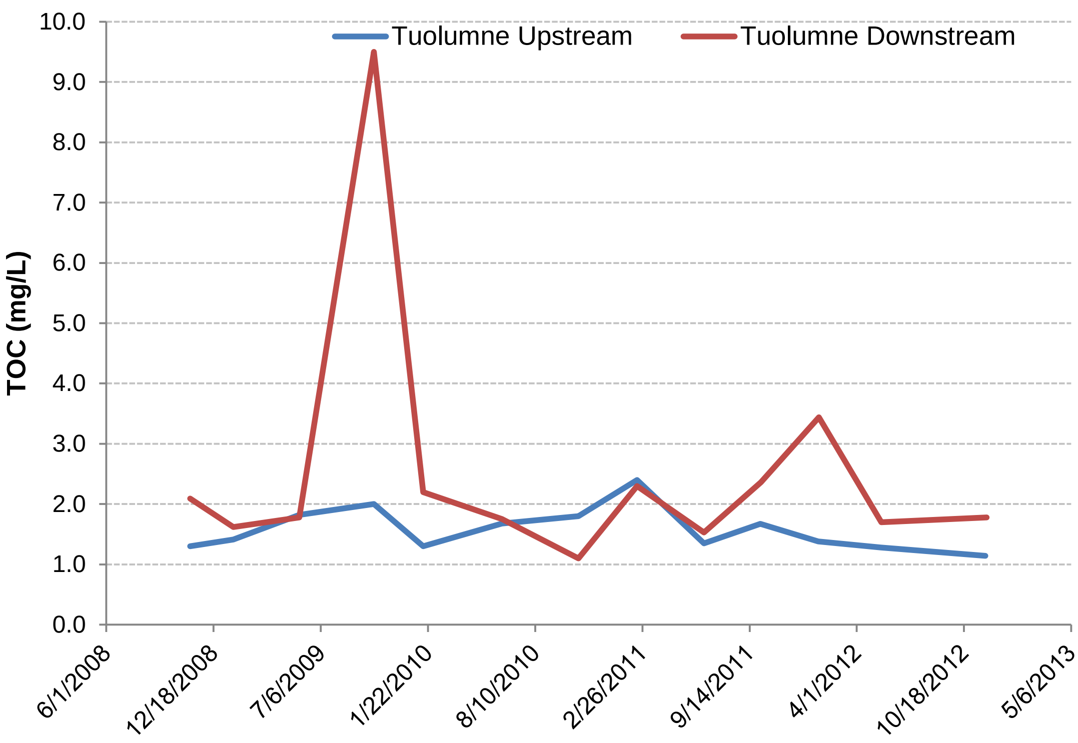


Table 4-17. **Median Total Organic Carbon Concentrations (mg/L) in the San Joaquin River**

	Friant Dam		Rice Road		Jura Farms Bridge	
Constituent	**Wet Median**	**Dry Median**	**Wet Median**	**Dry Median**	**Wet Median**	**Dry Median**
TOC	2.4	2.0	2.7	2.1	2.6	2.1

Table 4-18. **Median Total Organic Carbon Concentrations (mg/L) in the Tuolumne River**

	Tuolumne (Upstream)		Tuolumne (Downstream)	
Constituent	**Wet Median**	**Dry Median**	**Wet Median**	**Dry Median**
TOC	1.4	1.5	2.2	1.7

San Joaquin River Salinity

Salinity (measured as EC and TDS) in receiving waters can be quite variable. During the first part of the storm, EC and TDS concentrations are generally high as impervious areas are washed. The highest concentrations of EC and TDS are usually seen after the first major storm event. After each subsequent storm, EC and TDS concentrations decrease as there is less material to be washed into receiving waters and an increase in dilution (Archibald et al. 2012). EC data (Figure 4-37) and TDS data (Figure 4-38) for the San Joaquin River can be found below. The Tuolumne River data is found in Figures 4-39 (EC) and 4-40 (TDS). Table 4-19 presents salinity summary data for the San Joaquin River and while data for the Tuolumne River is presented in Table 4-20.

There is significant variability in the San Joaquin River of both EC and TDS concentrations with no apparent trends over time. An examination of the wet and dry medians between Friant Dam and Jura Farms Bridge, shows that Rice Road generally has the lowest concentrations which is consistent with the other constituents. The wet season median concentrations are higher than the dry season concentrations for EC and TDS at all three locations on the San Joaquin River.

The Tuolumne River EC data showed no trends although there was an elevated concentration in the upstream site on February 16, 2011. TDS data shows a seasonal trend with the highest concentrations at the beginning of the wet season, although there are a few exceptions for the downstream site (TDS increases from February to June 2011 and January to May 2013). The wet season median TDS concentrations are higher than the dry season TDS concentrations at both locations on the Tuolumne River.

Figure 4-37. **EC in the San Joaquin River**

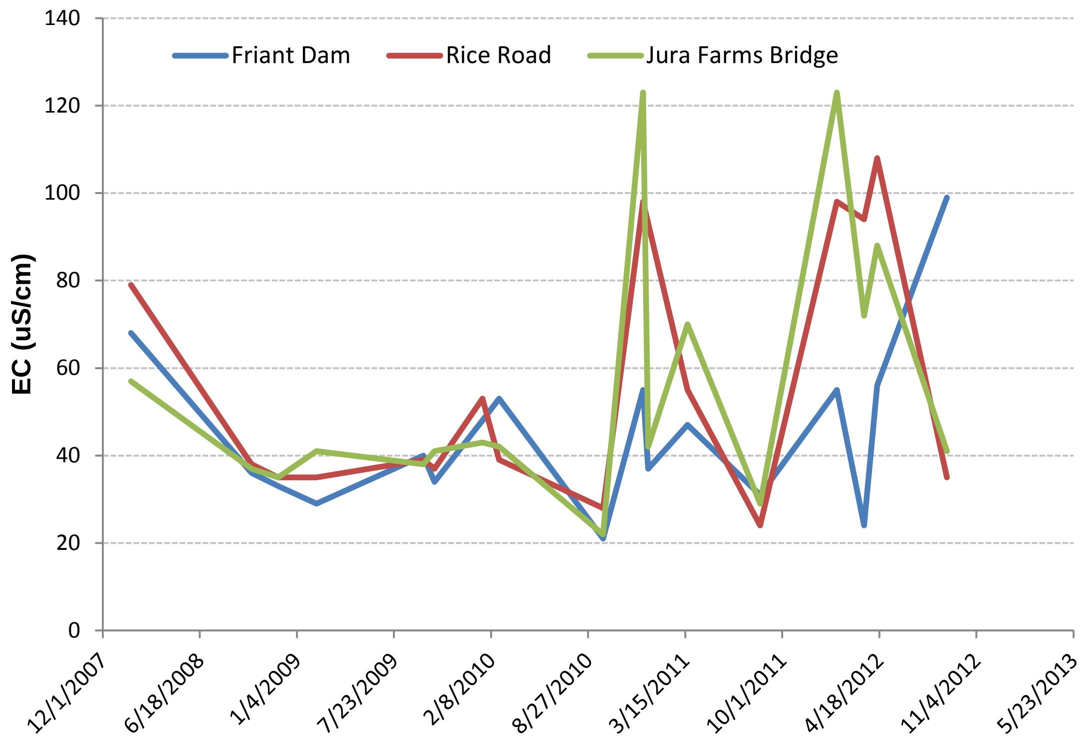


Figure 4-38. **TDS in the San Joaquin River**

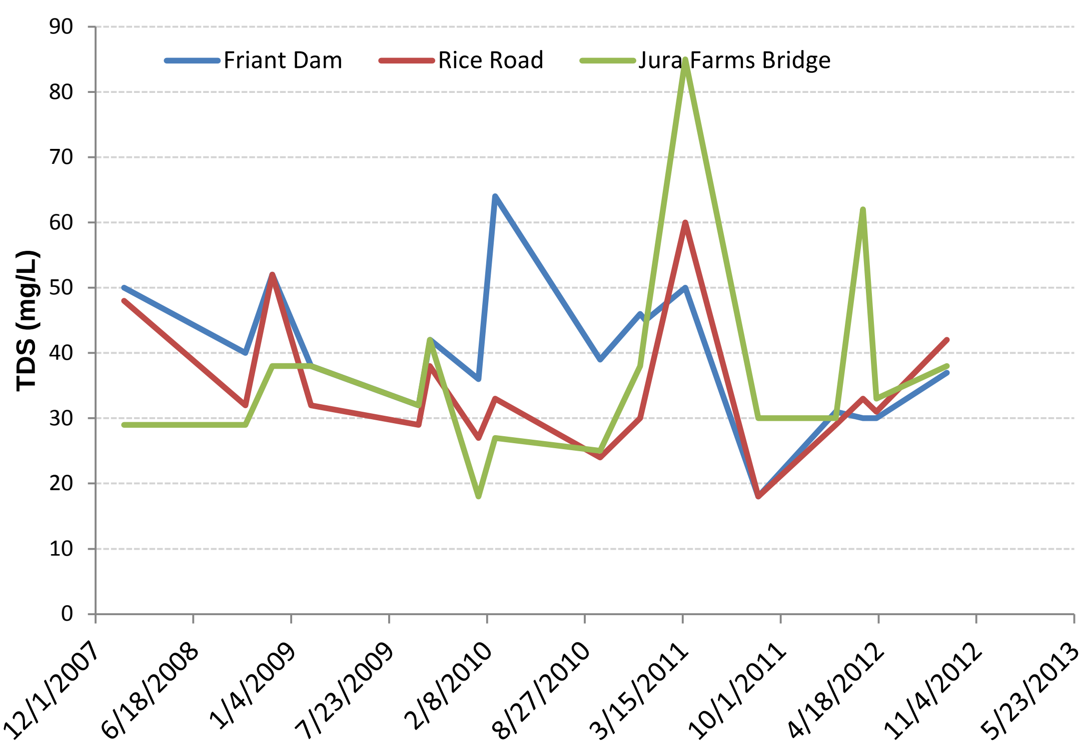


Figure 4-39. **EC in the Tuolumne River**

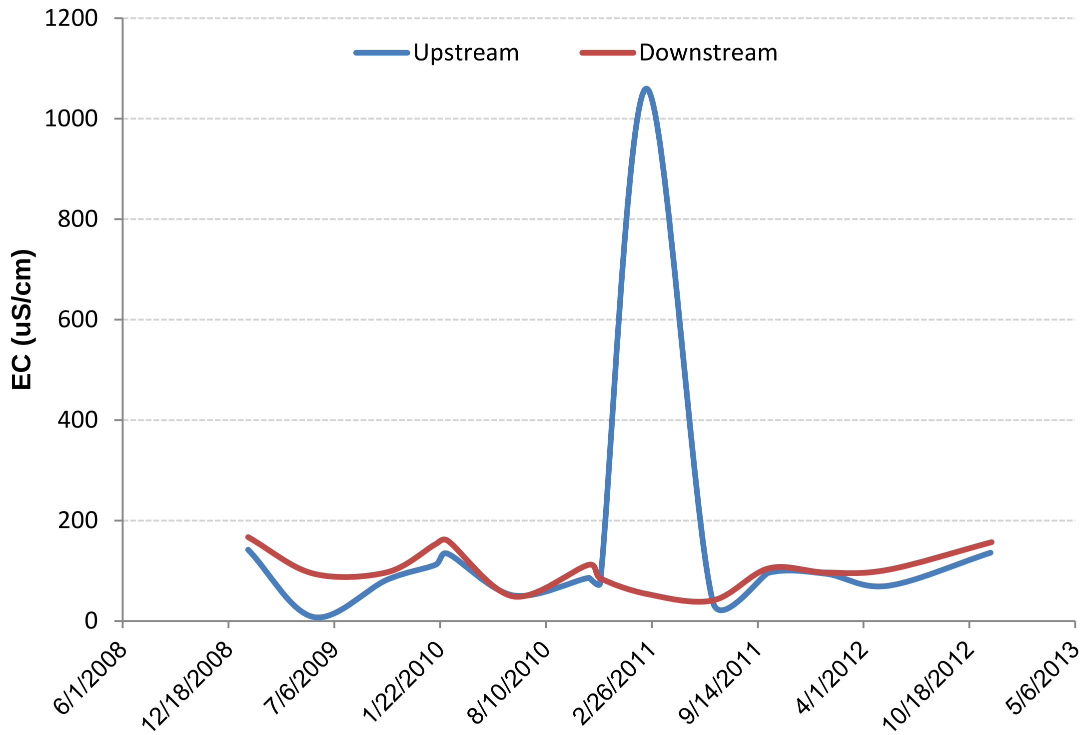


Figure 4-40. **TDS in the Tuolumne River**

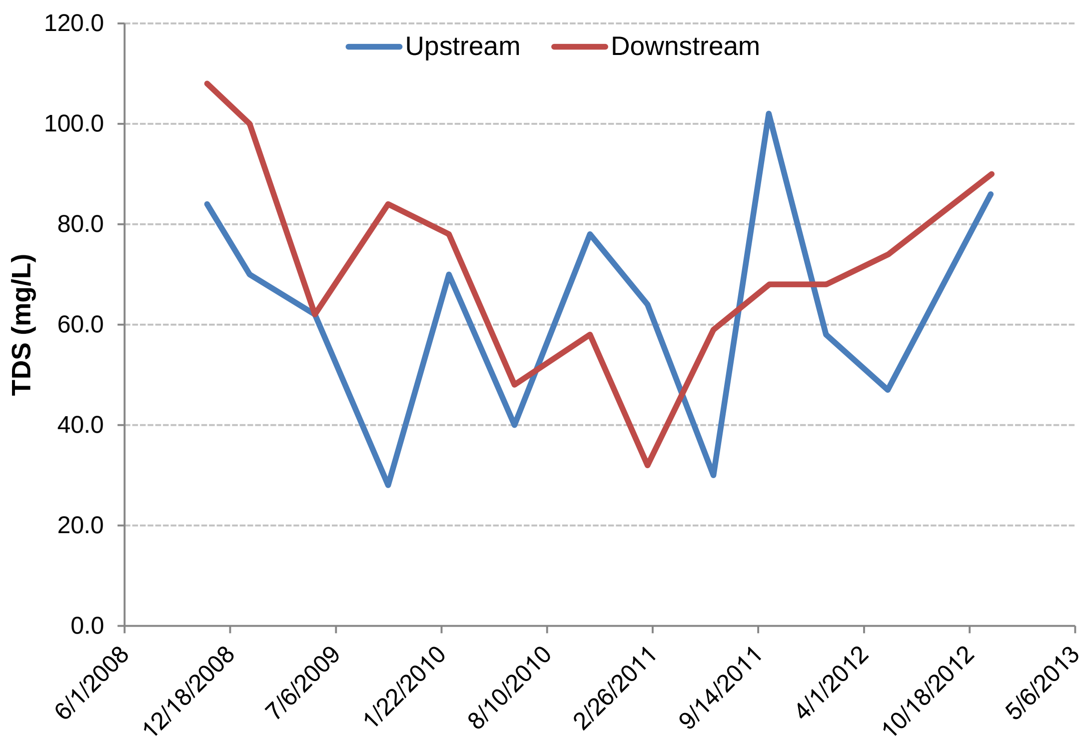


Table 4-19. Median TDS Concentrations (mg/L) in the San Joaquin River

Constituent	Friant Dam		Rice Road		Jura Farms Bridge	
	Wet Median	Dry Median	Wet Median	Dry Median	Wet Median	Dry Median
TDS	44	37	33	29	38	30

Table 4-20. Median TDS Concentrations (mg/L) in the Tuolumne River

Constituent	Tuolumne (Upstream)		Tuolumne (Downstream)	
	Wet Median	Dry Median	Wet Median	Dry Median
TDS	70	44	78	61

Agricultural Discharges in the San Joaquin Watershed

Background

The San Joaquin Valley consists of primarily agricultural land uses. Water discharges from agricultural operations in California include irrigation runoff, flows from tile drains (agricultural drains that remove excess water from soil subsurfaces), and stormwater runoff. These discharges can affect water quality by transporting pollutants, including pesticides, sediment, nutrients, and organics from cultivated fields into surface waters of the San Joaquin River watershed. The volume and quality of agricultural drainage are largely dependent on the season and on crop-specific practices. These practices include application of fertilizer, pesticides, and irrigation water, and are responsible for seasonal episodic occurrences of agricultural chemicals in agricultural drains. Drainage volumes are typically highest in the late fall and early winter, when agricultural fields are flooded to leach out salts, and during the summer irrigation season. Rainfall-related agricultural area runoff occurs from approximately October to April (NMFS, 2009).

Agricultural discharges are regulated through the Irrigated Lands Program in which coalitions and individual waste discharge requirement (WDR) holders implement management practices that protect water quality, conduct farm evaluations to determine what is being done and what improvements can be made to protect water quality, develop a nutrient/nitrogen management plan if necessary, conduct water quality monitoring, and possibility participate in studies to evaluate management practices. The four irrigation districts in the watershed that hold individual WDRs are Merced, Modesto, Oakdale, and Turlock. The three coalitions within the watershed are East San Joaquin Water Quality Coalition, Westlands Stormwater Coalition, and Westside San Joaquin River Watershed Coalition. A Monitoring and Reporting Program (MRP) plan must be developed by each coalition group or individual discharger and be submitted to and approved by the Central Valley Regional Water Board. Agricultural drainage must be monitored for a variety of constituents according to agriculture type and pesticides used, and can include nutrients, pesticides, organic carbon, salinity, and coliforms. Sampling frequency varies and is typically conducted during the irrigation season and during storm events.

County Agricultural Statistics

The most recent information available for agricultural crops is from the United States Department of Agriculture. The release of the 2012 statistics has been delayed. The information presented in the following paragraphs is summarized in Tables 4-21 and 4-22.

In 2007, Fresno County had 6,081 farms on 1,636,224 acres, which averaged 269 acres per farm. Agriculture accounted for 43% of the land use within the county. Agricultural land was further classified as 67.4% cropland, 28.6% pasture, and 4.1% other uses (United States Department of Agriculture 2007). The top crop items by acre were grapes (215,170 acres), vegetables harvested for sale (195,401 acres), cotton (139,655 acres), almonds (123,117 acres), and tomatoes (109,758 acres). The top five crops make up 47.8% of the total agricultural acres (783,101 acres).

In 2007, Madera County had 1,708 farms on 679,729 acres, which averaged 398 acres per farm. Agriculture accounted for 50% of the land use within the county. Agricultural land was further classified as 51.2% pasture, 42.8% cropland, and 6% other uses. The top five crop items by acre were grapes (79,161 acres); almonds (70,299 acres); forage, which is hay, haylage, grass silage, and greenchop (43,842 acres); pistachios (22,850 acres); and corn for silage (21,290 acres). The top five crops make up 34.9% of the total agricultural acres (237,442 acres).

In 2007, Merced County had 2,607 farms on 1,041,115 acres, which averaged 399 acres per farm. Agriculture accounted for 84% of the land use within the county. Agricultural land was further classified as 51.7% cropland, 43.8% pasture, and 4.5% other uses. The top five crop items by acre were forage, which includes hay, haylage, grass silage, and greenchop (141,744 acres); almonds (103,736 acres); corn for silage (71,535 acres); vegetables harvested for sale (59,533 acres); and cotton (57,425 acres). The top five crops make up 41.7% of the total agricultural acres (433,973 acres).

In 2007, San Joaquin County had 3,624 farms on 737,503 acres, which averaged 204 acres per farm. Agriculture accounted for 82% of the land use within the county. Agricultural land was further classified as 66.7% cropland, 28 % pasture, and 5.3% other uses. The top five crop items by acre were forage, which includes hay, haylage, grass silage, and greenchop (92,750 acres); grapes (81,958 acres); vegetables harvested for sale (69,433 acres); corn for grain (48,684 acres); and almonds (42,312 acres). The top five crops make up 45.4% of the total agricultural acres (335,164 acres).

In 2007, Stanislaus County had 4,114 farms on 788,954 acres, which averaged 192 acres per farm. Agriculture accounted for 82% of the land use within the county. Agricultural land was further classified as 51.2% pasture, 44.51% cropland, and 4.3% other uses. The top five crop items were almonds (123,528 acres); forage, which includes hay, haylage, grass silage, and greenchop (73,812 acres); corn for silage (57,680 acres); English walnuts (24,414 acres); and vegetables harvested for sale (20,770 acres). The top five crops make up 38.1% of the total agricultural acres (300,204 acres).

Table 4-21. County Agricultural Statistics from 2007 Agriculture Census, United States Department of Agriculture

County	Farms	Acres	% of county in agriculture	Cropland %	Pasture %	Other %	Average size farm in acres
Fresno	6,081	1,636,224	43%	67.4%	28.6%	4.1%	269
Madera	1,708	679,729	50%	51.2%	42.8%	6.0%	398
Merced	2,607	1,041,115	84%	51.7%	43.8%	4.5%	399
San Joaquin	3,624	737,503	82%	66.7%	28.0%	5.3%	204
Stanislaus	4,114	788,954	82%	51.2%	44.5%	4.3%	192

Table 4-22. Top Crops for each County, with Acres Planted, and State Rank[a] from 2007

Crop	Total Acres Planted	Counties (with State Rank)
Almonds	462,992	Stanislaus (2), Fresno (3), Merced (4), Madera (5), San Joaquin (6)
Grapes	376,316	Fresno (1), San Joaquin (3), Madera (4)
Forage - land used for all hay and haylage, grass silage, and greenchop	352,148	Merced (3), San Joaquin (7), Stanislaus (10), Madera (14)
Vegetables harvested for sale	345,137	Fresno (2) San Joaquin (5), Merced (7), Stanislaus (14)
Corn for silage	150,505	Merced (2), Stanislaus (4), Madera (8)
Cotton, all	197,080	Fresno (1), Merced (4)
Tomatoes in the open	109,758	Fresno (1)
Corn for grain	46,684	San Joaquin (1)
Walnuts, English	24,414	Stanislaus (14)
Pistachios	22,850	Madera (2)

[a]The State Rank shows what rank each county is per crop within the State of California

Drinking Water Constituents

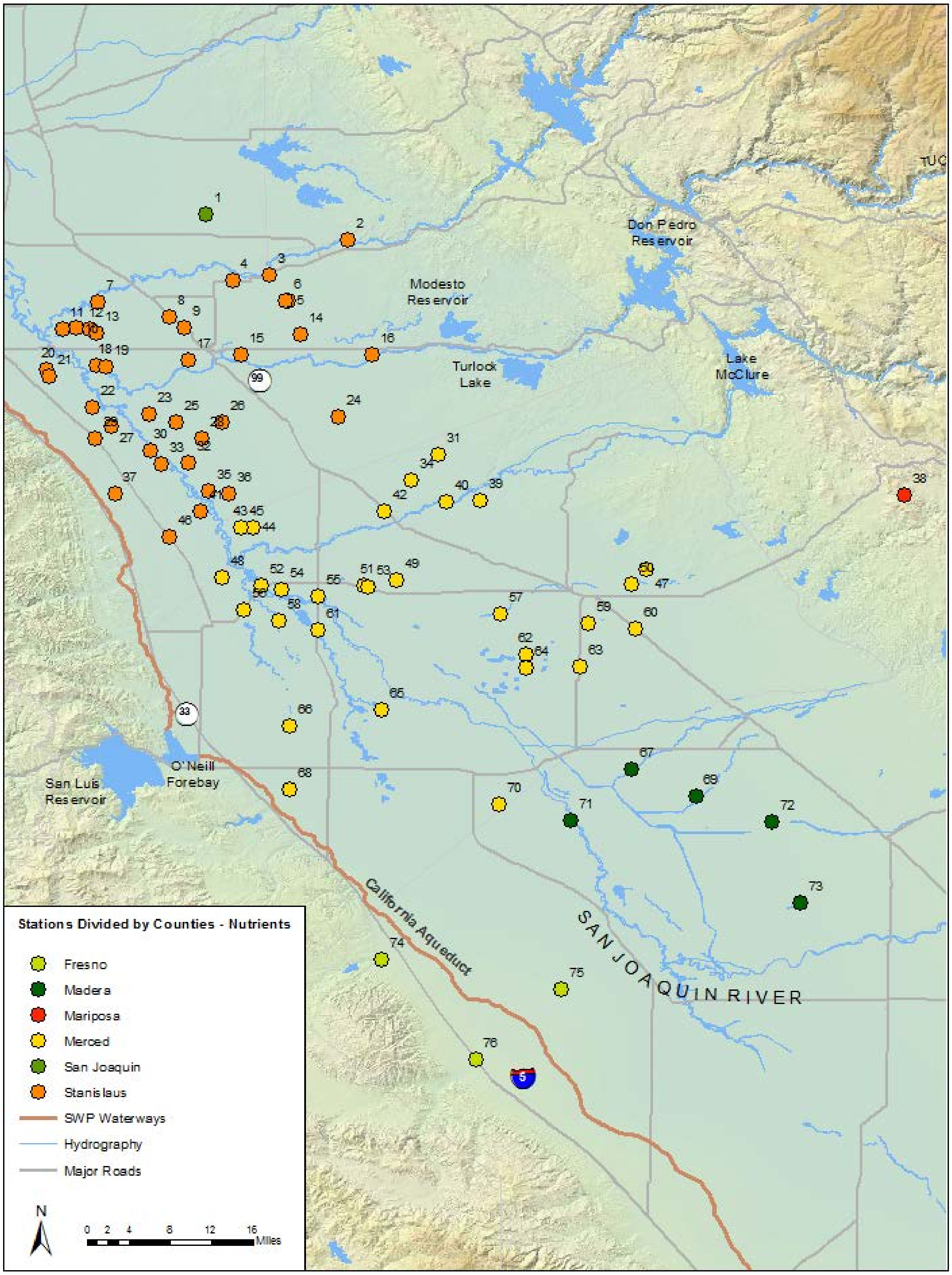
Many fertilizers and pesticides are applied to agricultural lands to enhance crop production. Agriculture fertilizers and pesticides in cropland runoff can be discharged to the San Joaquin River and its tributaries. Contamination from the large quantities of pesticides used within the basin receives the greatest publicity; however, loading of nutrients, pathogens, organic carbon, and salinity from agricultural drains have a greater impact on drinking water quality as compared to pesticides.

Nutrients

Nitrogen is monitored as nitrate, nitrite, nitrate plus nitrite, ammonia, and TKN. Phosphorus is monitored as total phosphorus, and orthophosphate. Total phosphorus is composed of the particulate and dissolved phase of phosphorus; orthophosphates are soluble, inorganic fractions of phosphorus. Orthophosphate is the only form that is generally available for algal and plant uptake, but total phosphorus is a better indicator of the productivity of a system (Archibald et al. 2012).

Detected samples, which are above the method detection limit and above the reporting limit, are summarized. The following data was collected from CEDEN. Figure 4-41 shows the locations of where nutrient sampling occurred in the watershed, color coded by county.

Figure 4-41. Nutrient Sampling Locations by the Coalitions Within the Watershed for 2008-2012



Fresno County Nutrients

Portions of northern Fresno County are within the watershed boundaries for this study. Data was submitted by the Westside San Joaquin River Watershed Coalition and the Westlands Stormwater Coalition. Of the 114 nutrient samples collected, 85 samples (75%) were detects. Table 4-23, Figure 4-42, and Figure 4-43 present a summary of the nutrients data.

Sampling occurred between the months of January and June, from 2009 to 2011. June had the highest values for nearly all nutrients, followed by higher nutrient levels in January and February, as compared to the other months.

Fresno's three stations within the study area are located to the southwest of the San Joaquin River. Nitrate, nitrate plus nitrite, TKN, and total phosphorus were detected at all locations sampled. The highest median and maximum nitrate plus nitrite, TKN, ammonia, orthophosphate, and total phosphorus values were found at Panoche-Silver Creek at Belmont Avenue (#75 on Figure 4-41). There was one exceedance of the California MCL (10 mg/L) for nitrate plus nitrite, and no MCL exceedances for nitrate.

Table 4-23. Fresno County Nutrient Concentrations (mg/L) 2008-2012

Analyte	Detects/Samples	Range	Mean	Median	MCL mg/L	Exceed MCL
Nitrate + Nitrite (mg/L as N)	14/21	0.06-13.00	1.33	0.38	10	1
Nitrate (mg/L as N)	1/1	0.15	-	-	10	0
TKN (mg/L as N)	22/24	0.21-13.00	2.15	0.68	NA	NA
Ammonia (mg/L as N)	12/24	0.066-1.10	0.31	0.26	NA	NA
Orthophosphate (mg/L as P)	14/19	0.015-2.500	0.231	0.046	NA	NA
Total Phosphorus (mg/L)	22/25	0.021-5.400	0.955	0.180	NA	NA

Detects = Only samples above the reporting limit.
Samples = Above and below the reporting limit.
Medians are calculated using values at or above the detection limit.

Figure 4-42. Nitrogen Constituent Concentrations for Fresno County

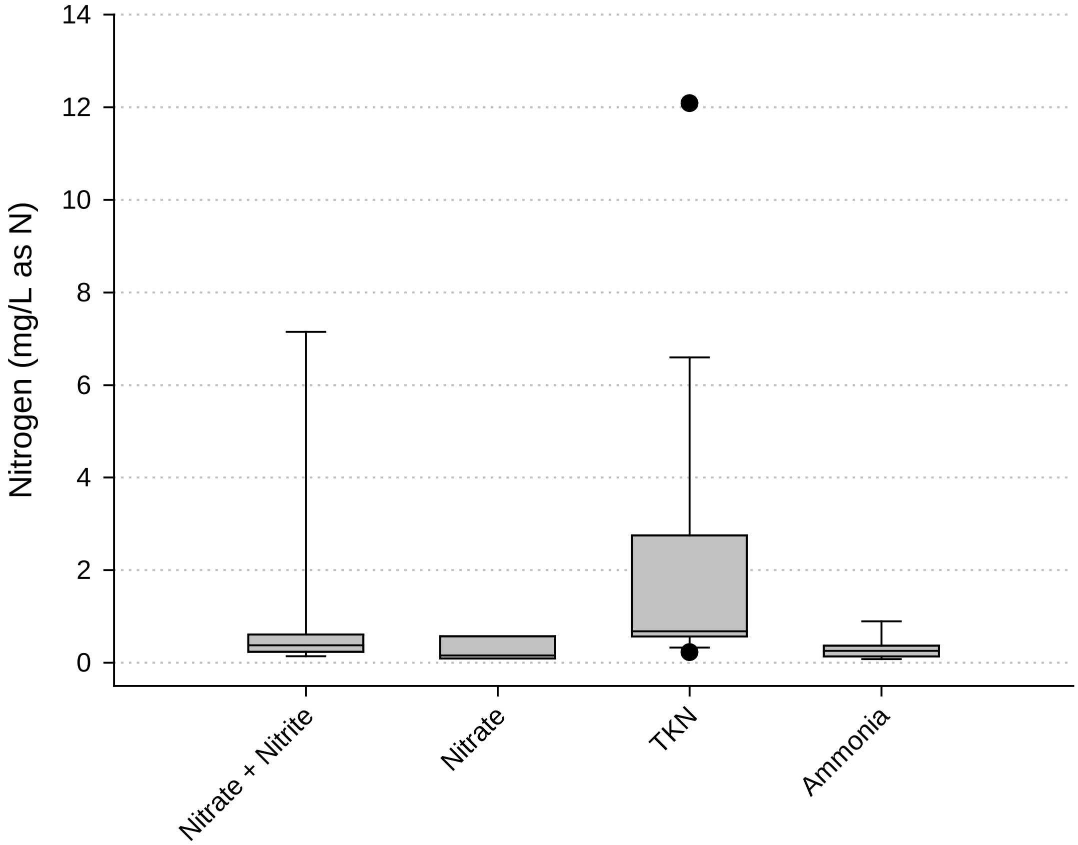
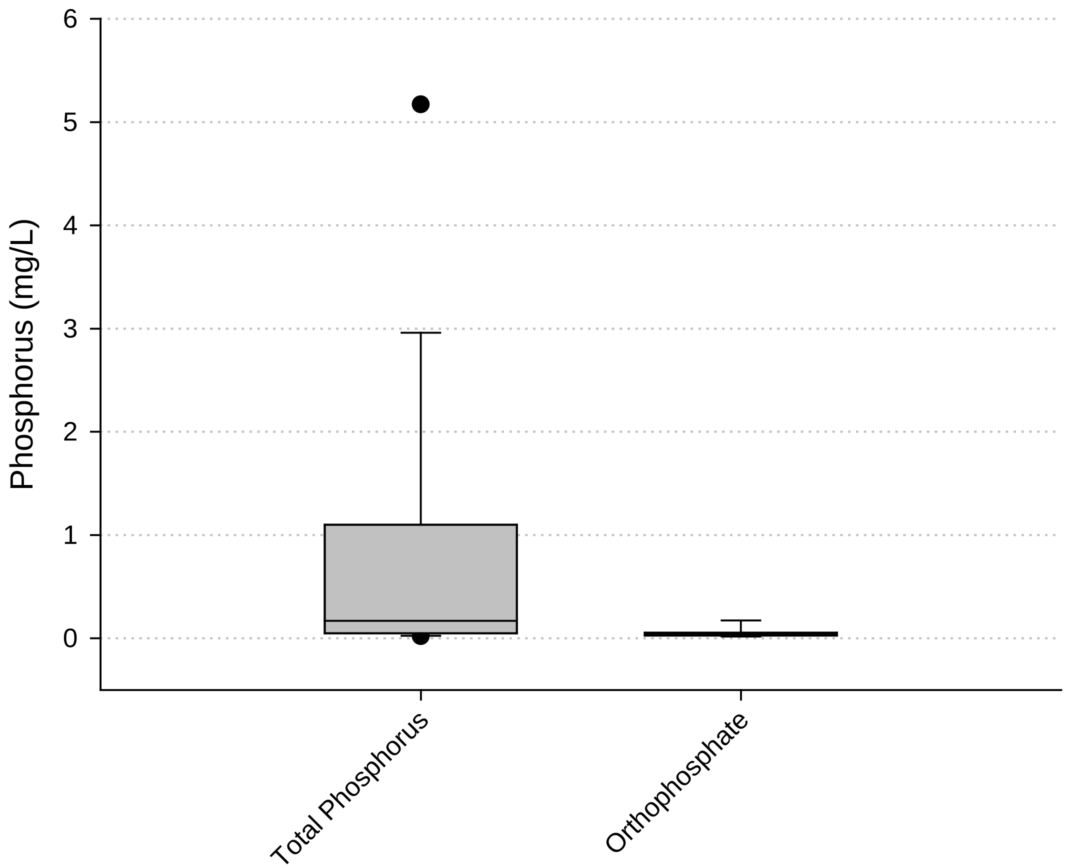


Figure 4-43. Total Phosphorus (mg/L) and Orthophosphate (mg/L as P) Concentrations for Fresno County



Madera County Nutrients

Madera County is completely within the watershed boundary of this study. Data was submitted by East San Joaquin Water Quality Coalition and Westside San Joaquin River Watershed Coalition. Of the 280 samples collected, 172 samples (61%) were detects. Figures 4-44 and 4-45, and Table 4-24 present a summary of the nutrients data.

All of the stations in Madera County are located to the east of the San Joaquin River, except for Sac Dam (#71 on Figure 4-41), which lies on the river. Berenda Slough along Avenue 18½ (#69 on Figure 4-41), Dry Creek at Road 18 (#72 on Figure 4-41), and Ash Slough at Avenue 21 (#67 on Figure 4-41) drain to the Fresno River, which could flow into the San Joaquin River under heavy, extended precipitation events. Cottonwood Creek at Road 20 and Berenda Slough along Avenue 18½ are near a confined animal facility.

Sampling typically occurred year-round. Nitrate, nitrite, TKN, phosphate, and orthophosphate were detected at all five locations sampled. Nitrate plus nitrite was found at three of the locations sampled and ammonia was detected at four of the locations sampled.

Higher nutrient concentrations are found between December and February. Nearly all of the samples were collected at Cottonwood Creek at Road 20 (119 samples). Cottonwood Creek had the maximum values for nitrate plus nitrite, nitrite, TKN, ammonia, orthophosphate, and phosphate. Dry Creek at Road 18 (#72 on Figure 4-41) had the maximum value for nitrate. In general, the concentrations of nutrients in Madera County, tended to be lower than the concentrations of nutrients in other counties.

San Joaquin River at Sack Dam (#71 on Figure 4-41) had the highest median concentrations of nitrate plus nitrite (0.79 mg/L), orthophosphate (0.048 mg/L), and phosphate (0.097 mg/L). Dry Creek at Road 18 (#72 on Figure 4-41) had the highest TKN median (0.91 mg/L), as well as higher nitrate, nitrite, and ammonia levels as compared to the rest of the stations. There were no exceedances of the California MCL for nitrate plus nitrite (10 mg/L), nitrate (10 mg/L), or nitrite (1 mg/L).

Table 4-24. Madera County Nutrient Concentrations (mg/L) 2008-2012

Analyte	Detect/Samples	Range	Mean	Median	MCL mg/L	Exceed MCL
Nitrate + Nitrite (mg/L as N)	22/48	0.063-6.90	1.05	0.25	10	0
Nitrate (mg/L as N)	4/14	0.28-2.90	1.29	0.98	10	0
Nitrite (mg/L as N)	2/9	0.033-0.240	0.137	0.137	1	0
TKN (mg/L as N)	42/47	0.15-2.40	0.64	0.42	NA	NA
Ammonia (mg/L as N)	18/62	0.11-0.32	0.16	0.14	NA	NA
Orthophosphate (mg/L as P)	28/41	0.010-0.140	0.042	0.033	NA	NA
Total Phosphorus (mg/L)	56/59	0.012-0.880	0.114	0.064	NA	NA

Detects = Only samples above the reporting limit.
Samples = Above and below the reporting limit.
Medians are calculated using values at or above the detection limit.

Figure 4-44. **Nitrogen Constituent Concentrations for Madera County**

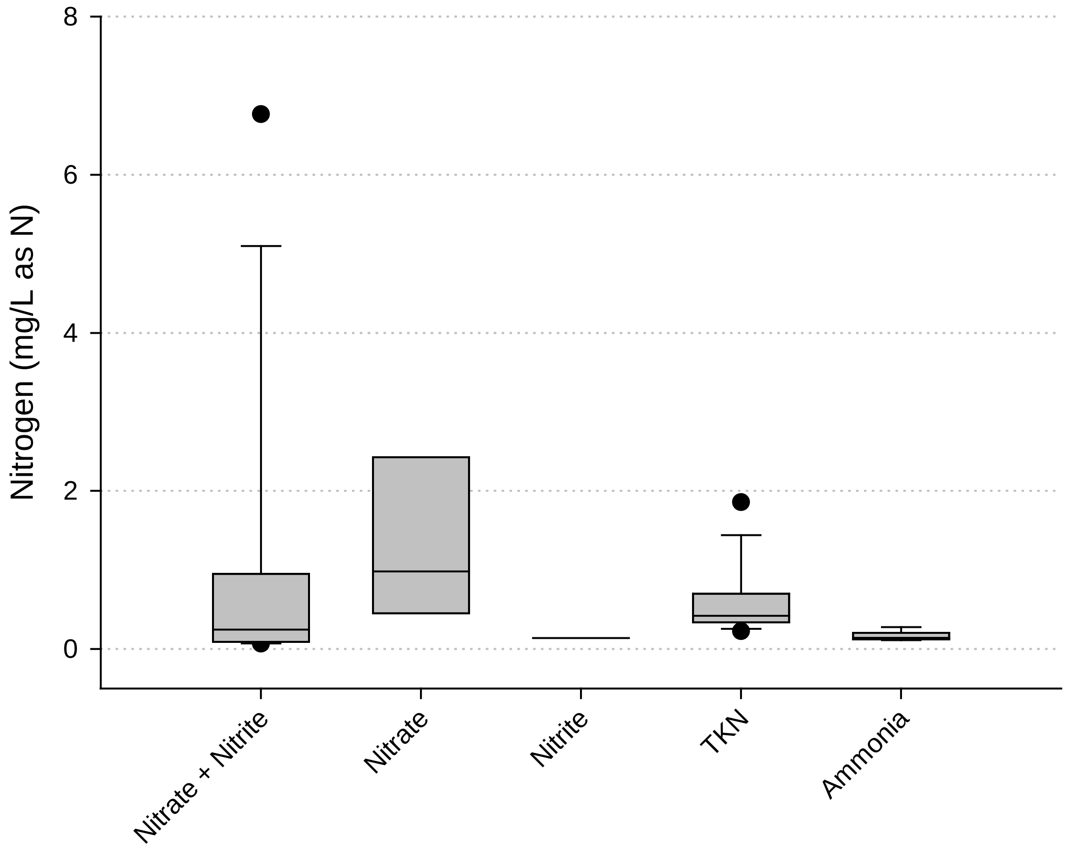
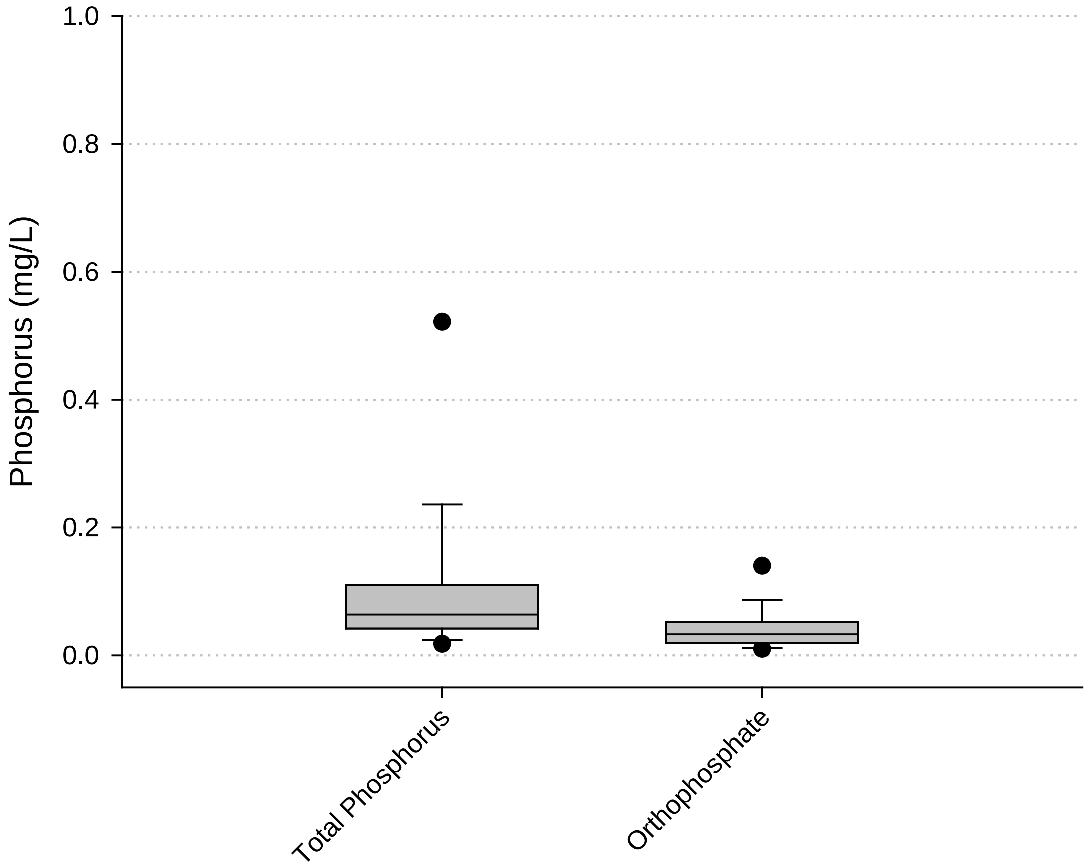


Figure 4-45. Total Phosphorus (mg/L) and Orthophosphate Concentrations for Madera County



Mariposa County Nutrients

Madera County is primarily outside watershed boundary of this study. The only station located within the boundary is Marshall Road Drain near River Road (#38 on Figure 4-41) and is sampled by the Westside San Joaquin River Watershed Coalition. Of the 185 samples collected, 173 samples (94%) were detects. Table 4-25, Figure 4-46, and Figure 4-47 present a summary of the nutrients data.

Sampling typically occurred year-round, except for January and February. No clear patterns could be seen and there were no exceedances of the California MCL for nitrate plus nitrite (10 mg/L). Compared with the rest of the counties, Mariposa had the second lowest concentration of nutrients.

Table 4-25. Mariposa County Nutrient Concentrations (mg/L) 2008-2012

Analyte	Detects/Samples	Range	Mean	Median	MCL mg/L	Exceed MCL
Nitrate + Nitrite (mg/L as N)	36/37	0.99-8.50	4.00	3.45	10	0
TKN (mg/L as N)	36/37	0.56-5.360	2.01	1.60	NA	NA
Ammonia (mg/L as N)	29/37	0.11-1.80	0.45	0.24	NA	NA
Orthophosphate (mg/L as P)	36/37	0.038-1.40	0.23	0.18	NA	NA
Total Phosphorus (mg/L)	36/37	0.08-1.40	0.41	0.32	NA	NA

Detects = Only samples above the reporting limit.
Samples = Above and below the reporting limit.
Medians are calculated using values at or above the detection limit.

Figure 4-46. Nitrogen Constituent Concentrations for Mariposa County

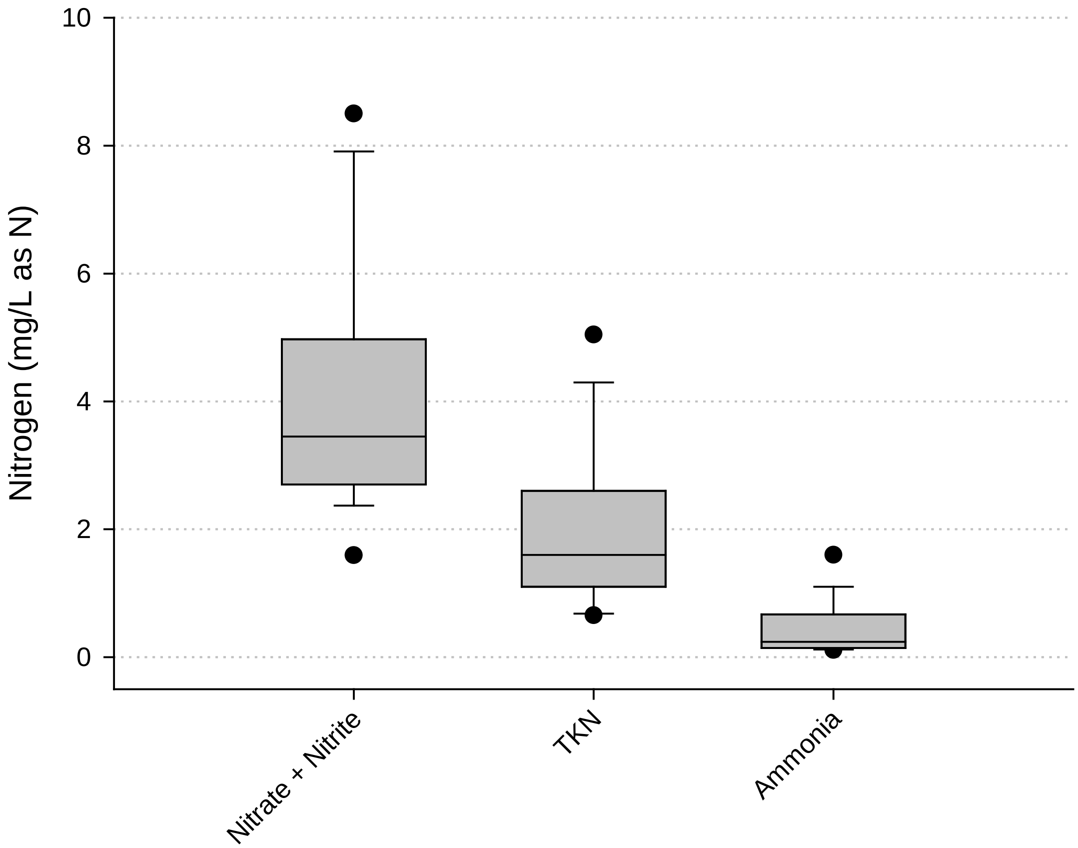
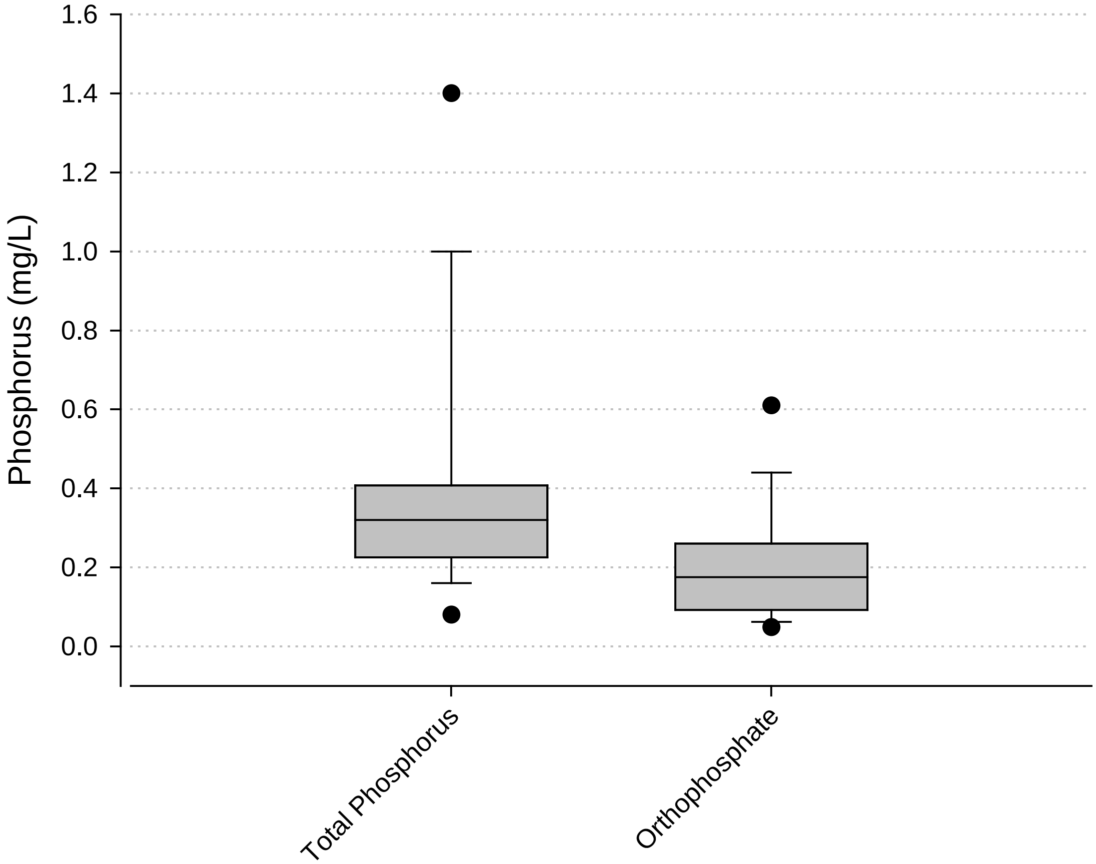


Figure 4-47. **Phosphate and Orthophosphate Concentrations for Mariposa County**



Merced County Nutrients

Merced County is completely within the watershed boundary of this study. Data was submitted by East San Joaquin Water Quality Coalition and Westside San Joaquin River Watershed Coalition. Of the 3,973 samples collected, 3,380 samples (85%) were detects. Figures 4-48 and 4-49, and Table 4-26 present a summary of the nutrients data.

Merced County's stations are located in the central portion of the San Joaquin watershed and are on tributaries to the San Joaquin and Merced Rivers. Mustang Creek and Hilmar Drain are connected to the San Joaquin River by Crow Creek. Duck Slough connects to the San Joaquin River southwest of the city of Merced. Livingston Drain and Howard Lateral connect to the middle San Joaquin west of Merced through Lower Bear Creek. Silva Drain flows to the upper Merced River. Mustang Creek, both Hilmar Drain sites, Howard Lateral, Silva Drain, and Deadman Creek are either next to or nearby confined animal facilities.

Nitrate plus nitrite, nitrate, TKN, orthophosphate, and total phosphorus were detected at all of the locations sampled. Nitrite was detected at 10 of the locations sampled. Ammonia was detected at 27 of the locations sampled.

The following locations had the highest median concentrations of the following nutrients:

Mustang Creek at East Avenue (#31 on Figure 4-41) nitrate plus nitrite (5.95 mg/L) and ammonia (0.82 mg/L), Hilmar Drain at Central Avenue (#45 on Figure 4-41) nitrate median (8.2 mg/L), Highland Canal at Highway 99 (#42 on Figure 4-41) nitrite (0.29 mg/L), Los Banos Creek at Highway 140 (#56 on Figure 4-41) TKN (1.9 mg/L), and Deadman Creek (Dutchman) at Gurr Road (#64 on Figure 4-41) orthophosphate (0.21 mg/L), and total phosphorus (median 0.45 mg/L). Three samples exceeded the California MCL of 10 mg/L for nitrate plus nitrite. Five samples exceeded the California MCL of 10 mg/L nitrate. No samples exceeded the California MCL of 1 mg/L for nitrite.

Table 4-26. Merced County Nutrient Concentrations (mg/L) 2008-2012

Analyte	Detects/Samples	Range	Mean	Median	MCL mg/L	Exceed MCL
Nitrate + Nitrite (mg/L as N)	606/659	0.05-13.00	1.30	0.63	10	3
Nitrate (mg/L as N)	73/102	0.05-28.00	3.26	0.92	10	5
Nitrite (mg/L as N)	30/92	0.03-0.41	0.13	0.09	1	0
TKN (mg/L as N)	714/736	0.11-44.00	1.48	1.10	NA	NA
Ammonia (mg/L as N)	493/829	0.11-50.00	0.61	0.22	NA	NA
Orthophosphate (mg/L as P)	653/738	0.01-6.80	0.22	0.12	NA	NA
Total Phosphorus (mg/L)	811/817	0.01-21.88	0.40	0.23	NA	NA

Detects = Only samples above the reporting limit.
Samples = Above and below the reporting limit.
Medians are calculated using values at or above the detection limit.

Figure 4-48. **Nitrogen Constituent Concentrations for Merced County**

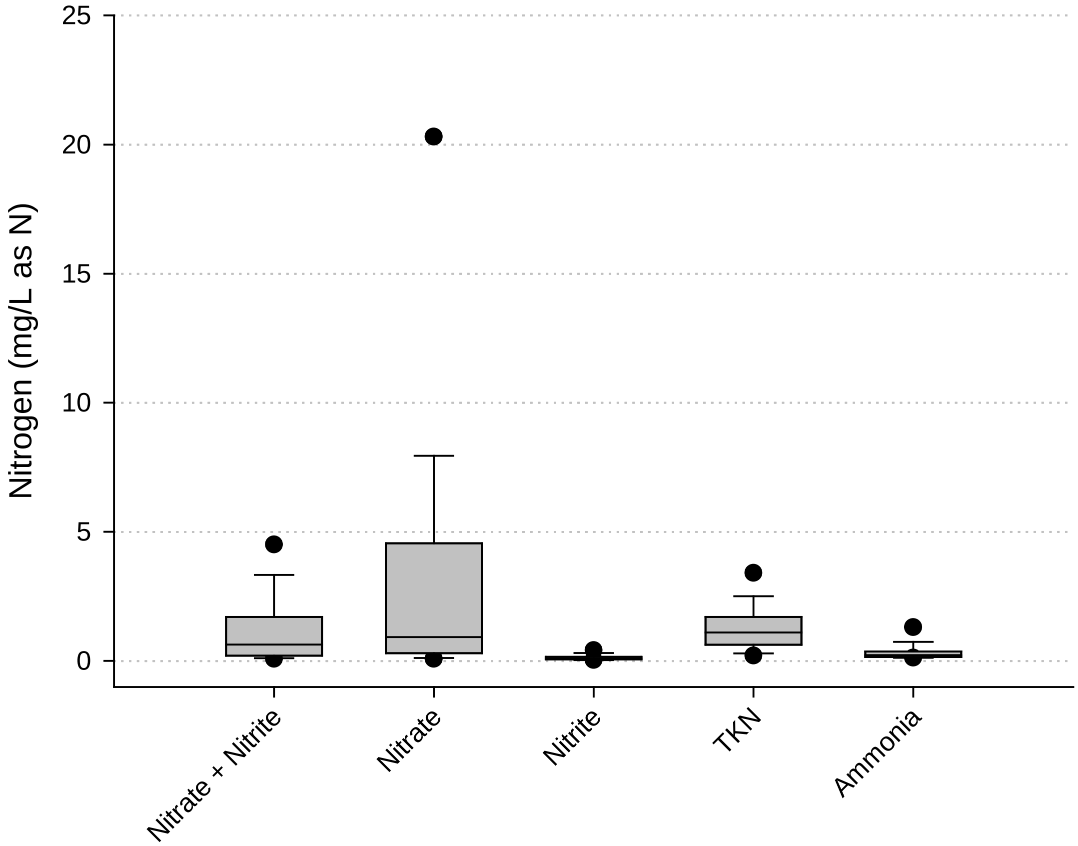
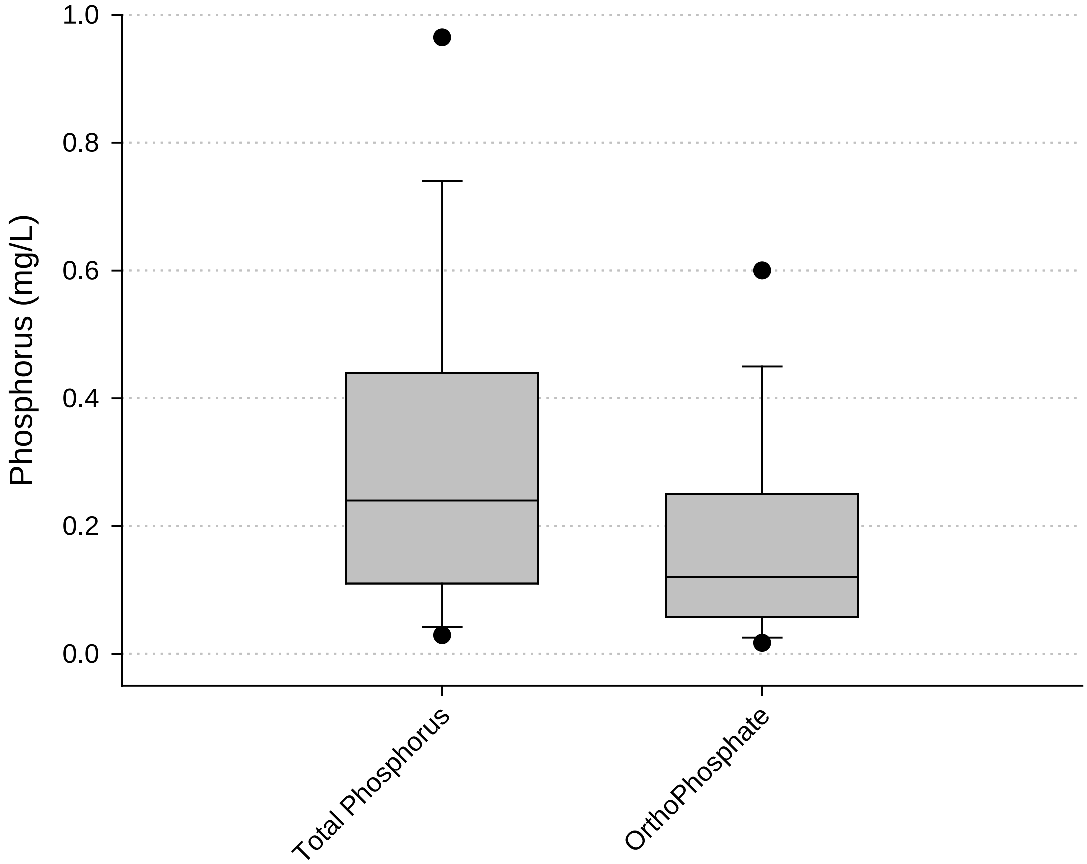


Figure 4-49. Total Phosphorus (mg/L) and Orthophosphate (mg/L as P) Concentrations for Merced County



San Joaquin County Nutrients

Portions of southern San Joaquin County are within the watershed boundaries for this study. The Oakdale Irrigation District has only one station in San Joaquin County. At Sweet Lateral (#1 on Figure 4-41), four samples were taken, and all four samples (100%) were detects. Sweet Lateral is next to a confined animal facility. Table 4-27 presents a summary of the nutrients data.

All samples were taken at Sweet Lateral on July 23, 2008 or October 6, 2008. TKN and total phosphorus were detected in all samples, but there were no MCL exceedances.

Table 4-27. **San Joaquin County Nutrient Concentrations (mg/L) 2008-2012**

Analyte	Detects/Samples	Range	Mean	Median	MCL mg/L	Exceed MCL
TKN (mg/L as P)	2/2	1.6-2.2	1.9	1.9	NA	NA
Total Phosphorus (mg/L)	2/2	0.15-0.50	0.33	0.33	NA	NA

Detects = Only samples above the reporting limit.
Samples = Above and below the reporting limit.
Medians are calculated using values at or above the detection limit.

Stanislaus County Nutrients

Stanislaus County is completely within the watershed of this study. Data was submitted by the East San Joaquin Water Quality Coalition, the Westside San Joaquin River Watershed Coalition, the Modesto Irrigation District, and the Oakdale Irrigation District. Of the 2,489 samples collected, 2,157 samples (87%) were detects. Table 4-28, Figure 4-50, and Figure 4-51 present a summary of the nutrients data.

The Stanislaus County stations are located in the northern portion of the watershed and are primarily on tributaries to the San Joaquin and Stanislaus Rivers or on the Delta-Mendota Canal. Spenker Spill connects to the Stanislaus River. Ingram Creek, Del Puerto Creek, and Orestimba Creek flow to the San Joaquin River from the west side of the valley. Delta Mendota Canal at DPWD is on the Delta-Mendota Canal south of Patterson. Ramona Lake is adjacent to the San Joaquin River east of Patterson. Levee Drain at Carpenter Road drains to the San Joaquin River near Pear Slough. Prairie Flower Drain flows to the San Joaquin River, southeast of Turlock. Hatch Drain, Lateral 2½, Westport Drain, and Lateral 3 are east of the San Joaquin River.

Nitrate plus nitrite, nitrate, nitrite, TKN, orthophosphate, and total phosphorus were detected at all of the locations sampled. Ammonia was detected at 20 of the locations sampled.

The following locations had the highest median concentrations of the following nutrients: Ingram Creek at River Road (#21 on Figure 4-41) for ammonia (0.33 mg/L), Spenker Spill (#4 on Figure 4-41) for TKN (4.65 mg/L) and total phosphorus (2.9 mg/L), Prairie Flower Drain at Crows Landing Road (#36 on Figure 4-41) for nitrate plus nitrite (30.5 mg/L) and orthophosphate (1.3 mg/L), Prairie Flower Drain at Morgan Road (#36 on Figure 4-41) for nitrate (29 mg/L), and Hatch Drain at Tuolumne Road (#28 on Figure 4-41) for nitrite (0.59 mg/L). Seventy-eight samples exceeded the California MCL of 10 mg/L for nitrate plus nitrite. Twenty-nine samples exceeded the California MCL of 10 mg/L for nitrate. No samples exceeded the California MCL of 1 mg/L for nitrite.

Table 4-28. Stanislaus County Nutrient Concentrations (mg/L) 2008-2012

Analyte	Detects/Samples	Range	Mean	Median	MCL mg/L	Exceed MCL
Nitrate + Nitrite (mg/L as N)	424/450	0.05-43.00	6.39	2.80	10	78
Nitrate Nitrite (mg/L as N)	37/38	0.14-35.00	18.39	23.00	10	29
Nitrite Nitrite (mg/L as N)	26/32	0.047-0.820	0.415	0.415	1	0
TKN Nitrite (mg/L as N)	460/494	0.13-16.00	1.60	1.10	NA	NA
Ammonia Nitrite (mg/L as N)	319/483	0.11-12.00	0.49	0.23	NA	NA
Orthophosphate (mg/L as P)	367/446	0.01-4.80	0.33	0.14	NA	NA
Total Phosphorus (mg/L)	424/450	0.05-43.00	6.39	2.80	10	78

Detects = Only samples above the reporting limit.
Samples = Above and below the reporting limit.
Medians are calculated using values at or above the detection limit.

Figure 4-50. Nitrogen Constituent Concentrations for Stanislaus County

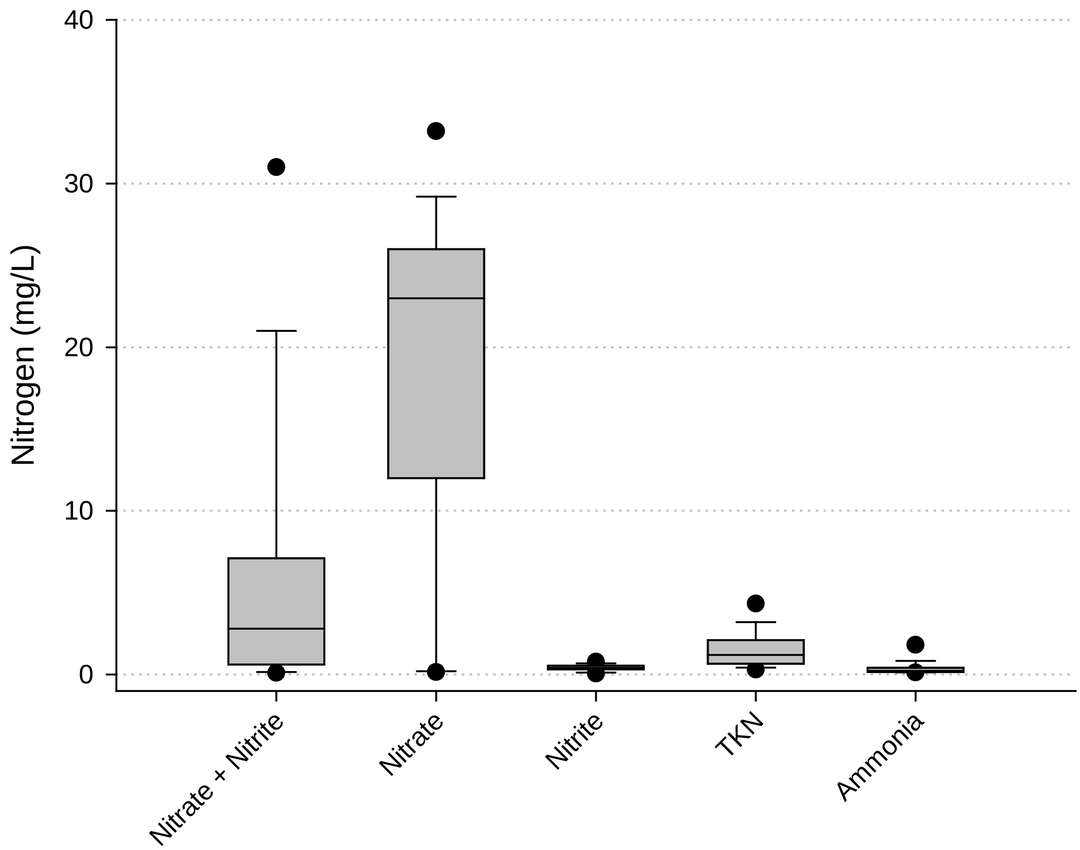
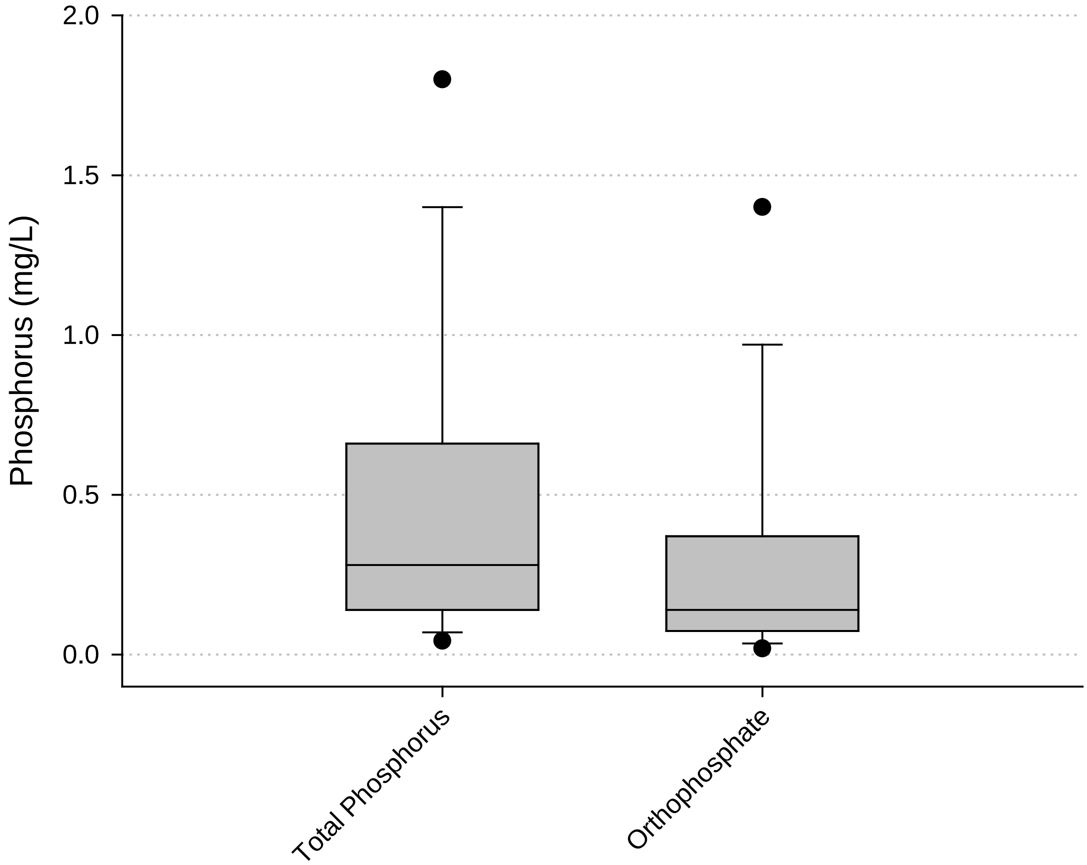


Figure 4-51. Total Phosphorus Constituent Concentrations for Stanislaus County



Exceedances

There were 82 nitrate plus nitrite exceedances of the California MCL (10 mg/L) at 16 different locations during the study period. Nitrate plus nitrite samples exceeded the MCL twice in Fresno County, four times in Merced County, and 74 times in Stanislaus County. Nitrate samples exceeded the California MCL (10 mg/L) on 34 occasions at seven different locations. The nitrite California MCL of 1.0 mg/L was not exceeded. Table 4-29 presents the data for the MCL exceedances. Exceedances were reported by Westlands Stormwater Coalition, East San Joaquin Water Quality Coalition, and the Westside San Joaquin River Watershed Coalition.

In Fresno County, a nitrate plus nitrite exceedance occurred in 2011 along Panoche Creek. In Merced County, the highest reported exceedance was 39 mg/L at Hilmar Drain at Mitchell Road (#44 on Figure 4-41), but the most exceedances occurred at Hilmar Drain at Central Avenue (#45 on Figure 4-41), with values between 20 and 26 mg/L. In Merced County the three exceedances were between 12 and 13 mg/L at Duck Slough at Gurr Road (#62 on Figure 4-41), Howard Lateral at Highway 140 (#53 on Figure 4-41), and Mustang Creek (#31 on Figure 4-41). In Stanislaus County, the most exceedances occurred at Prairie Flower Drain at Crows Landing Road (#35 on Figure 4-41), with 40 exceedances having a range from 11 mg/L to a high of 43 mg/L.

In Stanislaus County nitrate values exceeded the MCL of 10 mg/L on 29 occasions in 2008. Hatch Drain (#28 on Figure 4-41), Prairie Flower Drain at Crows Landing Road (#35 on Figure 4-41), and Westport Drain at Vivian Road (#25 on Figure 4-41) each had eight exceedances with values ranging from 15 to 27 mg/L, 11 to 33 mg/L, and 23 to 28 mg/L. Prairie Flower Drain at Morgan Road (#36 on Figure 4-41) had five exceedances with values ranging from 20 to 35 mg/L.

Table 4-29. Nutrient MCL Exceedances for All Counties 2008-2012

County	Analyte	Location	Range (mg/L)	Exceedances
Fresno	Nitrate + Nitrite	Little Panoche Creek at W. Boundary	13	1
Merced	Nitrate + Nitrite	Duck Slough at Gurr Road	13	1
Merced	Nitrate + Nitrite	Howard Lateral at Hwy 140	13	1
Merced	Nitrate + Nitrite	Mustang Creek at East Avenue	12	1
Stanislaus	Nitrate + Nitrite	Del Puerto Creek near Cox Road	10-13	6
Stanislaus	Nitrate + Nitrite	Delta Mendota Canal at DPWD	16	1
Stanislaus	Nitrate + Nitrite	Ingram Creek at River Road	10-21	9
Stanislaus	Nitrate + Nitrite	Lateral 2½ near Keyes Road	15	1
Stanislaus	Nitrate + Nitrite	Lateral 3 along East Taylor Road	20	1
Stanislaus	Nitrate + Nitrite	Levee Drain at Carpenter Road	13-31	11
Stanislaus	Nitrate + Nitrite	Orestimba Creek at Highway 33	11	1
Stanislaus	Nitrate + Nitrite	Orestimba Creek at River Road	10	1
Stanislaus	Nitrate + Nitrite	Prairie Flower Drain at Crows Landing Road	11-43	40
Stanislaus	Nitrate + Nitrite	Ramona Lake near Fig Avenue	11-28	4
Stanislaus	Nitrate + Nitrite	San Joaquin River at PID Pumps	29	2
Stanislaus	Nitrate + Nitrite	Westley Wasteway near Cox Road	17	1
Merced	Nitrate	Hilmar Drain at Central Avenue	20-26	3
Merced	Nitrate	Hilmar Drain at Mitchell Road	28	1
Merced	Nitrate	Livingston Drain at Robin Avenue	11	1
Stanislaus	Nitrate	Hatch Drain at Tuolumne Road	15-27	8
Stanislaus	Nitrate	Prairie Flower Drain at Crows Landing Road	11-33	8
Stanislaus	Nitrate	Prairie Flower Drain at Morgan Road	20-35	5
Stanislaus	Nitrate	Westport Drain at Vivian Road	23-28	8

Pesticides

Pesticides and herbicides are widely used in the study area. Most application is associated with agricultural usage; however, pesticides are also widely used on rights-of-way and median strips. Application occurs during the irrigation and dormant seasons. Dormant season pesticides, such as organophosphates, are carried to surface water by stormwater runoff. The amount of pesticides washed off is a very small fraction of the amount applied, but can still be toxic to aquatic invertebrates (Central Valley Regional Water Quality Control Board 2005). Pesticides applied during the irrigation season travel with irrigation water, or water from the occasional storm, to surface water.

Irrigation methods have a direct influence on pesticide loading to rivers. Furrow and flood irrigation tailwater (waters located immediately downstream from the irrigated area) is usually discharged to a drainage channel that leads to streams. Occasionally, tailwater is recycled onto another field. Flood and furrow tailwater return flows generate the largest loads because of the large volumes of water discharged directly. Sprinkler irrigation increases pesticide wash-off from foliage, but produces little tailwater, as compared with flood and furrow irrigation. Drip irrigation generates little to no runoff.

Variations in the amounts of pesticides used are typical and are due to changes in planted acreage, types of crop planted, pest problems, weather conditions, and economics. Pesticide use is submitted by farmers to the California Agricultural Commissioner.

County Summary of Pesticides Detected From 2008-2012

Data was collected from CEDEN through the Irrigated Lands Regulatory Program by the three coalitions and two irrigation districts in the watershed: the East San Joaquin Water Quality Coalition, Westlands Stormwater Coalition, Westside San Joaquin River Watershed Coalition, Modesto Irrigation District, and Oakdale Irrigation District. The watershed covers Madera County, Merced County, and Stanislaus County. The watershed also includes southern San Joaquin County, northern Fresno County, and western Mariposa County. Figure 4-52 shows the sampling locations for pesticides.

Detected samples which are above the method detection limit and above the reporting limit are summarized. Table 4-30 shows the non-detected pesticides by county from 2008-2012.

Figure 4-52. **Pesticide Sampling Locations by the Coalitions Within the Watershed for 2008-2012**

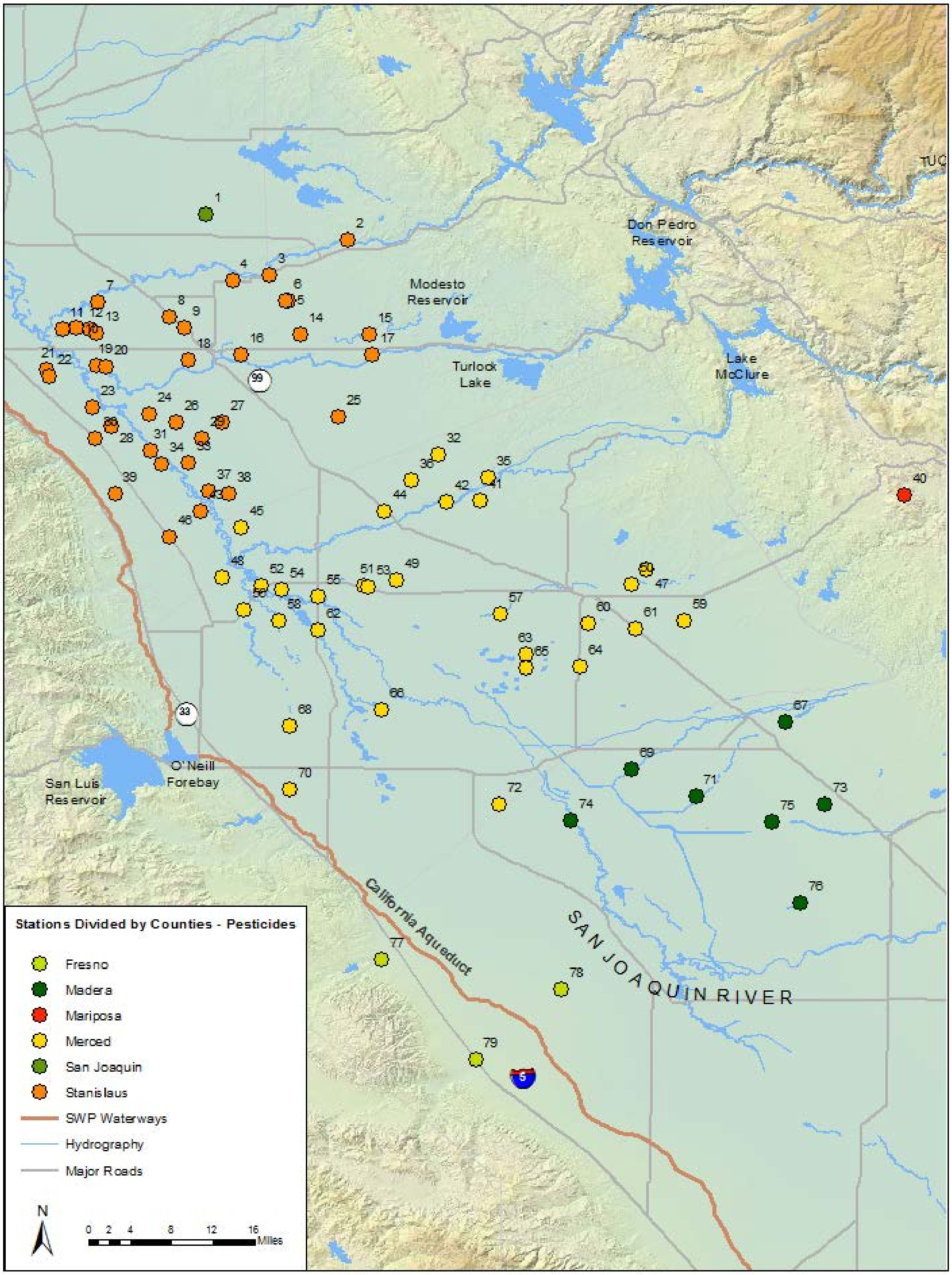


Table 4-30. Non-Detected Pesticides for All Counties 2008-2012

Analyte	Fresno Samples	Madera Samples	Mariposa Samples	Merced Samples	San Joaquin Samples	Stanislaus Samples
Aldicarb	2	46	9			269
Aldrin	22	18	24			251
Atrazine	22	55	25	611		372
Azinphos Methyl	22	95	25	625		457
Bifenthrin		7		83		16
Carbaryl	22	46	9			
Carbofuran	22	46	9			269
Chlordane, cis-	2	4	24	258		206
Chlordane		14		55		45
Chlordane, trans-	2	4		258		
Cyanazine	22		25			372
Cyfluthrin, total		7		83		16
Cyhalothrin, Lambda		7		83		16
Cypermethrin, Total		7		83		16
DDD		32	24	433		283
DDE		32				
DDT	22	32				
Demeton-s	22	81	25	518		424
Diazinon	22					
Dichlorvos	22	81	25	518		425
Dicofol	22	32	24	443		
Dieldrin	22	32	24			
Dimethoate	22	95				
Disulfoton	22	95	25	625		457
Endosulfan I		18				
Endosulfan II	22	18	24			251
Endosulfan Sulfate	2	4	24			206
Endrin	22	32	24	433		
EPTC	1	53	25	361		
Esfenvalerate/Fenvalerate		7		83		16
Glyphosate	26				2	
HCH, alpha-	22	18	24	313		
HCH, beta-	22	18	24	313		251
HCH, delta-	22	18				251
HCH, gamma-	22	18	24	313		251
Heptachlor Epoxide	22	18	24	313		251
Heptachlor Peroxide						
Heptachlor	22	18	24	313		251
Linuron	22	46	24	611		352
Malathion	22	95	25			
Methamidophos	23	96	24	642		
Methidathion	22	95	25			427

Methiocarb	22	46	9	438		269
Methomyl		46	9			269
Methoxychlor	2	32		443		
Molinate		14		107		32
Oxamyl	22	46	9	438		269
Paraquat	23	26				74
Parathion, Ethyl	1	53	25			315
Parathion, Methyl	22	95	25	625		457
Pendimethalin	1				2	16
Permethrin		7		83		
Phorate	22	95	25	625		457
Phosmet	22	91	25	625		457
Simazine	22		25			
Thiobencarb		14		107		32
Toxaphene	22	18	24	313		
Triclopyr					2	4

Fresno County

Portions of northern Fresno County are within the watershed boundaries for this study. Data was submitted by Westlands Stormwater Coalition and Westside San Joaquin River Watershed Coalition. The Fresno County samples included 48 pesticides; of which six (13%) were detected. Of the 972 samples collected, 7 samples (0.7%) were detects. Table 4-31 presents a summary of the pesticide data.

Pesticides were detected very infrequently in the samples collected from December through July. Only six pesticides were detected. The majority of detects occurred in June. No trends are observed in the pesticides detected.

Three Stations in Fresno Country were within the study area. The stations are Panoche-Silver Creek at Belmont Avenue (#78 Figure 4-52), Panoche-Silver Creek at I-5 Crossing (#79 Figure 4-52) and Little Panoche Creek at W. boundary (#77 Figure 4-52).Other stations in Fresno County were excluded because they were either in the Tulare or Upper Lake watershed areas, which were outside of the study area.

All of Fresno's stations are located to the southwest of the San Joaquin River. Pesticides were detected at Panoche-Silver Creek at Belmont Avenue and Panoche-Silver Creek at I-5 Crossing. The detections occurred in either March 2010 or June 2011. There were no MCL exceedances.

Table 4-31. Fresno County Pesticide Concentrations (µg/L) 2008-2012

Analyte	Detects/Samples	Concentration	Mean	Median
Chlordane	1/21	0.20	-	-
Chlorpyrifos	1/22	0.016	-	-
DDE	1/22	0.076	-	-
Diuron	1/22	0.66	-	-
Endosulfan I	1/22	0.081	-	-
Methomyl	1/22	0.16	-	-

Detects = Only samples above the reporting limit.
Samples = Number of samples collected.
Means and Medians are calculated using values at or above the detection limit.

Madera County

Madera County is completely within the watershed boundary of this study. Data was submitted by East San Joaquin Water Quality Coalition and Westside San Joaquin River Watershed Coalition. The Madera County samples included 58 pesticides; of which seven (12%) were detected. Of the 2,490 samples collected, 30 samples (1%) were detects. Table 4-32 presents a summary of the pesticide data.

Pesticides were detected very infrequently in the samples collected between 2008 and 2012. Pesticides were sampled for year-round, but detections only occurred between December and July. Of the seven pesticides detected, the pesticides in order of the most detects were diuron, simazine, chlorpyrifos, and diazinon. No trends are observed in the pesticides detected.

All of the stations in Madera County are located to the east of the San Joaquin River, except for Sac Dam (#74 on Figure 4-52), which is on the river. Pesticides were detected at four of the seven locations sampled: 12 detects at Cottonwood Creek at Road 20 (#76 on Figure 4-52), 11 detects at Dry Creek at Road 18 (#75 on Figure 4-52), six detects at San Joaquin River at Sack Dam (#74 on Figure 4-52), and one detect at Berenda Slough along Ave 18½ (#71 on Figure 4-52). Pesticides were not detected at Ash Slough at Avenue 21 (#69 on Figure 4-52), Brenda Slough at Road 19 (#67 on Figure 4-52), and Dry Creek at Road 22 (#73 on Figure 4-52). There was 1 exceedance of the simazine MCL.

Table 4-32. Madera County Pesticide Concentrations (µg /L) 2008-2012

Analyte	Detects/Samples	Range	Mean	Median
Chlorpyrifos	5/103	0.021-0.210	0.067	0.036
Cyanazine	2/68	0.82-1.10	0.96	0.96
Diazinon	4/98	0.049-0.240	0.147	0.150
Diuron	11/50	0.58-68.0	16.3	1.6
Glyphosate	1/26	11	-	-
Pendimethalin	1/53	0.13	-	-
Simazine*	6/68	0.53-5.10	1.62	0.75

*Exceeded MCL in 2008
Detects = Only samples above the reporting limit.
Samples = Above and below the reporting limit.
Means and Medians are calculated using values at or above the detection limit.

Mariposa County

Mariposa County is almost completely out of the watershed of this study; however the Westside San Joaquin River Watershed Coalition has one station in Mariposa County. At Marshall Road Drain near River Road, 47 pesticides were sampled for, of which 11 (23%) were detected. Of the 1,056 samples collected, 51 samples (5%) were detects. Table 4-33 presents a summary of the pesticide data.

Pesticides were detected infrequently in the samples collected between 2008 and 2012. Pesticides were sampled for and detected year-round. Of the 11 pesticides detected, the pesticides in order of the most detects were pendimethalin, chlorpyrifos, and DDE. No trends are observed in the pesticides detected.

All of the pesticides were detected at the one location sampled, Marshall Road Drain near River Road (#40 Figure 4-52). There were no MCL exceedances.

Table 4-33. Mariposa County Pesticide Concentrations (µg /L) 2008-2012

Analyte	Detects/Samples	Range	Mean	Median
Chlordane, trans	2/24	0.031-0.043	0.037	0.037
Chlorpyrifos	9/25	0.054-0.530	0.202	0.091
DDE	8/24	0.011-0.047	0.025	0.021
DDT	4/24	0.012-0.047	0.022	0.015
Diazinon	1/24	0.027	-	-
Dimethoate	6/25	0.40-0.68	0.51	0.50
Diuron	5/25	0.42-3.50	1.67	1.60
Endosulfan I	2/24	0.025-0.081	0.053	0.053
HCH, delta-	1/24	0.031	-	-
Methoxychlor	1/24	0.02	-	-
Pendimethalin	12/25	0.12-1.10	0.42	0.38

Detects = Only samples above the reporting limit.
Samples = Above and below the reporting limit.
Means and Medians are calculated using values at or above the detection limit.

Merced County

Merced County is completely within the watershed boundary of this study. Data was submitted by East San Joaquin Water Quality Coalition and Westside San Joaquin River Watershed Coalition. The Merced County samples include 58 pesticides of which 24 (41%) were detected. Of the 22,806 samples collected, 255 samples (1%) were detects. Table 4-34 presents a summary of the pesticide data.

Pesticides were detected infrequently in the samples taken between 2008 and 2012. Of the 24 pesticides detected, the pesticides in order of the most detects were diuron, chlorpyrifos, simazine, and pendimethalin.

Pesticides were detected at 26 of the 30 locations sampled. Three locations had the most pesticide detections: 37 detects at Salt Slough at Sand Dam (#66 on Figure 4-52), 30 detects at Salt Slough at Lander Avenue (#62 on Figure 4-52), and 29 detects at Poso Slough at Indian Avenue (#72 on Figure 4-52). Pesticides were not detected at Bear Creek at Kibby Road (#50 Figure on 4-52), Dry Creek at Oakdale Road (#35 on Figure 4-52), Duck Slough at Whealan Road (#59 on Figure 4-52), and Los Banos Creek at Sunset Avenue (#70 on Figure 4-52). The simazine MCL was exceeded 4 times.

Table 4-34. Merced County Pesticide Concentrations (µg/L) 2008-2011

Analyte	Detects/Samples	Range	Mean	Median
Aldicarb	1/438	0.53	-	-
Aldrin	1/314	0.067	-	-
Carbaryl	3/438	0.2-1.3	0.5	0.2
Carbofuran	1/457	0.073	-	-
Chlorpyrifos	44/679	0.016-1.300	0.116	0.040
Cyanazine	2/611	0.55-0.96	0.76	0.76
DDE	3/433	0.010-0.022	0.014	0.011
DDT	4/433	0.012-0.016	0.014	0.015
Diazinon	9/625	0.021-0.078	0.177	0.048
Dieldrin	1/433	0.028	-	-
Dimethoate	10/625	0.11-3.30	0.62	0.33
Diuron	92/617	0.43-38.0	2.21	1.0
Endosulfan I	1/313	0.033	-	-
Endosulfan II	1/313	0.024	-	-
Endosulfan Sulfate	2/258	0.025-0.032	0.029	0.029
Glyphosate	3/165	5.0-10.0	7.1	6.4
HCH, delta-	1/313	0.051	-	-
Malathion	6/625	0.20-0.60	0.33	0.25
Methidathion	2/625	0.23-2.30	1.27	1.27
Methomyl	6/438	0.07-0.36	0.18	0.12
Paraquat	3/165	0.61-1.50	0.96	0.76
Parathion, Ethyl	2/361	0.17-0.31	0.24	0.24
Pendimethalin	27/361	0.25-1.90	0.52	0.36
Simazine[b]	30/611	0.5-25.0	2.95	1.0

[b] exceeded MCL in 2008
Detects = Only samples above the reporting limit.
Samples = Number of samples collected.
Means and Medians are calculated using values at or above the detection limit.

San Joaquin County

Portions of southern San Joaquin County are within the watershed boundaries for this study. The Oakdale Irrigation District has only one station in San Joaquin County. At this station, Sweet Lateral (#1 on Figure 4-52), three pesticides were sampled. Six samples were taken; all samples were non-detects.

Stanislaus County

Stanislaus County is completely within the watershed of this study. Data was submitted by the East San Joaquin Water Quality Coalition and the Westside San Joaquin River Watershed Coalition. The Stanislaus County samples include 62 pesticides, of which 22 (36%) were detected. Of the 15,910 samples collected, 352 samples (2%) were detects (Table 4-35). Pesticides were detected infrequently in the samples collected between 2008 and 2012. Of the 22 pesticides detected, the pesticides in order of the most detects were diuron, DDE, and chlorpyrifos.

Pesticides were detected year-round at 31 of the 37 locations sampled. Three locations had the most pesticide detections: 60 detects at Ingram Creek at River Road (#22 on Figure 4-52), 54 detections at Orestimba Creek at Hwy 33 (#46 on Figure 4-52) and 46 detects at Hospital Creek at River Road (#21 on Figure 4-52).

Table 4-35. Stanislaus County Pesticide Concentrations (µg /L) 2008-2011

Analyte	Detects/Samples	Range (µg /L)	Mean	Median
Carbaryl	9/269	0.076-13.0	1.91	0.19
Chlordane, trans-	2/206	0.015-0.026	0.021	0.021
Chlorpyrifos	54/474	0.015-1.60	0.116	0.061
DDE	70/283	0.01-0.27	0.03	0.02
DDT	11/283	0.01-0.11	0.03	0.01
Diazinon	4/457	0.026-0.130	0.056	0.034
Dicofol	1/283	0.12	-	-
Dieldrin	4/283	0.010-0.021	0.014	0.012
Dimethoate	39/457	0.11-10.0	0.87	0.44
Diuron	74/405	0.04-31.0	4.53	1.60
Endosulfan I	1/251	0.06	-	-
Endrin	3/283	0.017-0.050	0.033	0.033
EPTC	4/315	0.12-0.81	0.38	0.30
Glyphosate	16/129	5.7-79.0	15.8	9.2
HCH, alpha-	1/251	0.013	-	-
Malathion	2/457	0.12-0.55	0.03	0.03
Methamidophos	2/466	0.38-1.30	0.84	0.84
Methoxychlor	2/283	0.011-0.016	0.014	0.014
Norflurazon	14/51	0.09-0.23	0.15	0.15
Pendimethalin	31/319	0.14-3.0	0.44	0.30
Simazine	8/372	0.64-3.40	1.86	1.55
Toxaphene	2/251	0.50-0.77	0.64	0.64

Detects = Only samples above the reporting limit.
Samples = Above and below the reporting limit.
Means and Medians are calculated using values at or above the detection limit.

Pesticides Exceedances

There are 33 pesticides with MCL's in California. Seven of those pesticides were detected within the study area. The pesticides detected were carbofuran (1 detect), chlordane (1 detect), endrin (3 detects), glyphosate (20 detects), methoxychlor (3 detects), simazine (44 detects), and toxaphene (2 detects) (Table 4-36).

Simazine was the only pesticide that exceeded the MCL of 4.0 µg /L. The MCL was exceeded four times with all exceedances in 2008. One of these exceedances occurred in Madera Country and three occurred in Merced County. The simazine exceedance in Madera County occurred at Cottonwood Creek at Road 20 (#76 on Figure 4-52), with a value of 5.1 µg/L. In Merced County, the first and highest exceedance was at Deadman Creek at Hwy 59 (#64 on Figure 4-52) with a value of 25 µg/L. The other two exceedances occurred at Highline Canal at Lombardy Road (#36 on Figure 4-52) with a value of 12 µg/L and Mustang Creek at East Avenue (#32 on Figure 4-52) with a value of 17 µg/L.

Table 4-36. Pesticides with Detects and MCL Exceedances for All Counties (µg /L) 2008-2012

County	Analytes	Detects/ Samples	Range	MCL	Number of Exceedances	Value of Exceedance
Merced	Carbofuran	1/457	0.073	40	0	
Fresno	Chlordane	1/21	0.2	2	0	
Stanislaus	Endrin	3/283	0.017-0.060	2	0	
Madera	Glyphosate	1/26	12	700	0	
Merced	Glyphosate	3/165	5.0-11.0	700	0	
Stanislaus	Glyphosate	16/129	5.7-80.0	700	0	
Mariposa	Methoxychlor	1/24	1.02	40	0	
Stanislaus	Methoxychlor	2/283	0.011-0.016	40	0	
Madera	Simazine	6/68	0.53-5.20	4	1	5.1
Merced	Simazine	30/632	0.5-26.0	4	3	12-25
Stanislaus	Simazine	8/372	0.64-3.50	4	0	
Stanislaus	Toxaphene	2/251	0.50-0.78	3	0	

County Summary of Pesticide Use

Pesticide use data for the counties in the watershed was obtained from the Department of Pesticide Regulation. San Joaquin Valley counties rank in the top 10 in the state for pounds of pesticides applied. As shown, in Table 4-37, more pounds of pesticides were applied in Fresno County than in any other county in the state between 2008 and 2011.

Table 4-37. Pounds of Pesticides Applied by County 2008-2011

County	2008 Pounds	State Rank	2009 pounds	State Rank	2010 pounds	State Rank	2011 pounds	State Rank	Average pounds
Fresno	27,623,919	1	27,769,122	1	30,250,572	1	36,784,255	1	30,606,967
Madera	7,591,131	5	7,698,784	6	9,130,306	5	11,639,271	4	9,014,873
Merced	6,934,022	6	5,977,272	8	7,730,240	7	7,022,329	9	6,915,966
San Joaquin	6,777,463	7	8,490,520	4	9,425,876	4	10,861,698	5	8,888,889
Stanislaus	5,706,370	10	5,548,517	10	5,961,405	10	6,664,842	10	5,970,284

Pesticide Application

Most pesticides are applied at rates of 1 to 2 pounds per acre; however, some active ingredients are applied at rates of ounces per acre, while fumigants are usually applied at rates of hundreds of pounds per acre. Data is presented in this section for pounds of pesticides applied and total acres to which pesticides are applied to provide a more complete picture of pesticide use in the watershed.

The data presented in this section were taken from the California Department of Pesticide Regulation, from the pesticide use reporting summary data for each year, using both the top five pesticides list and the top five pesticides by acres treated list.

Combined Counties Pesticide Use by Pounds

For all counties in the watershed boundary, sulfur was the most used pesticide by weight every year, which corresponds with state trends. Unclassified Petroleum Oil was the second most used pesticide for each year. The remaining eight pesticides varied in rank each year (Table 4-38). Total pounds of pesticides applied ranged from a low of 54,465,934 pounds in 2008, and rose each year to a high of 72,972,394 pounds in 2011. During the years of 2008-2011 combined, a total of 245,534,361 pounds of pesticides were applied to a total of 103,780,962 acres.

Table 4-38. Top Pesticides Used in the Five Counties, by Pounds for 2008-2011 Combined

Top Pesticides by Pounds Used 2008-2011	Pounds	Acres	Number of Years Used	Average lbs/year	Average acres/year
Sulfur	96,548,401	9,132,584	4	24,137,100	2,283,146
Petroleum Oil, Unclassified	22,604,701	1,555,883	4	5,651,175	388,971
Mineral Oil	14,535,822	1,542,456	4	3,633,956	385,614
1,3-Dichloropropene	11,788,675	62,292	4	2,947,169	15,573
Potassium N-Methyldithiocarbamate	9,627,757	115,774	4	2,406,939	28,944
Metam-Sodium	7,461,345	82,054	3	2,487,115	27,351
Glyphosate, Isopropylamine Salt	2,900,768	1,916,616	4	725,192	479,154
Copper Hydroxide	608,912	180,274	3	202,971	60,091
Glyphosate, Potassium Salt	477,283	296,106	1	477,283	296,106
Calcium Hydroxide	197,845	11,563	1	197,845	11,563

Combined Counties Pesticide Use by Acres

When pesticides uses are analyzed by acre, a different ranking emerges. This is because some pesticides were only applied by ounces per acre, versus other pesticides, like fumigants, which were applied by hundreds of pounds per acre.

Alpha-(Para-Nonylphenyl)-Omega-Hydroxypoly (Oxyethylene) was the most used pesticide by acre. Sulfur was the second most applied pesticide by acre. Sulfur, in addition to Glyphosate, Isopropylamine Salt and Glyphosate, Potassium Salt rank in the top by both acres treated and pounds used (Table 4-39). As a comparison, Abamectin and Fatty Acids (Mixed) covered over 300,000 acres from 2008-2011, but used less than 7,000 pounds of pesticides. The acres planted ranged from a low 24,016,780 acres in 2009, to a high of 33,279,056 in 2011. During the years of 2008-2011 combined, a total of 110,166,396 acres were treated with 245,570,960 pounds of pesticides.

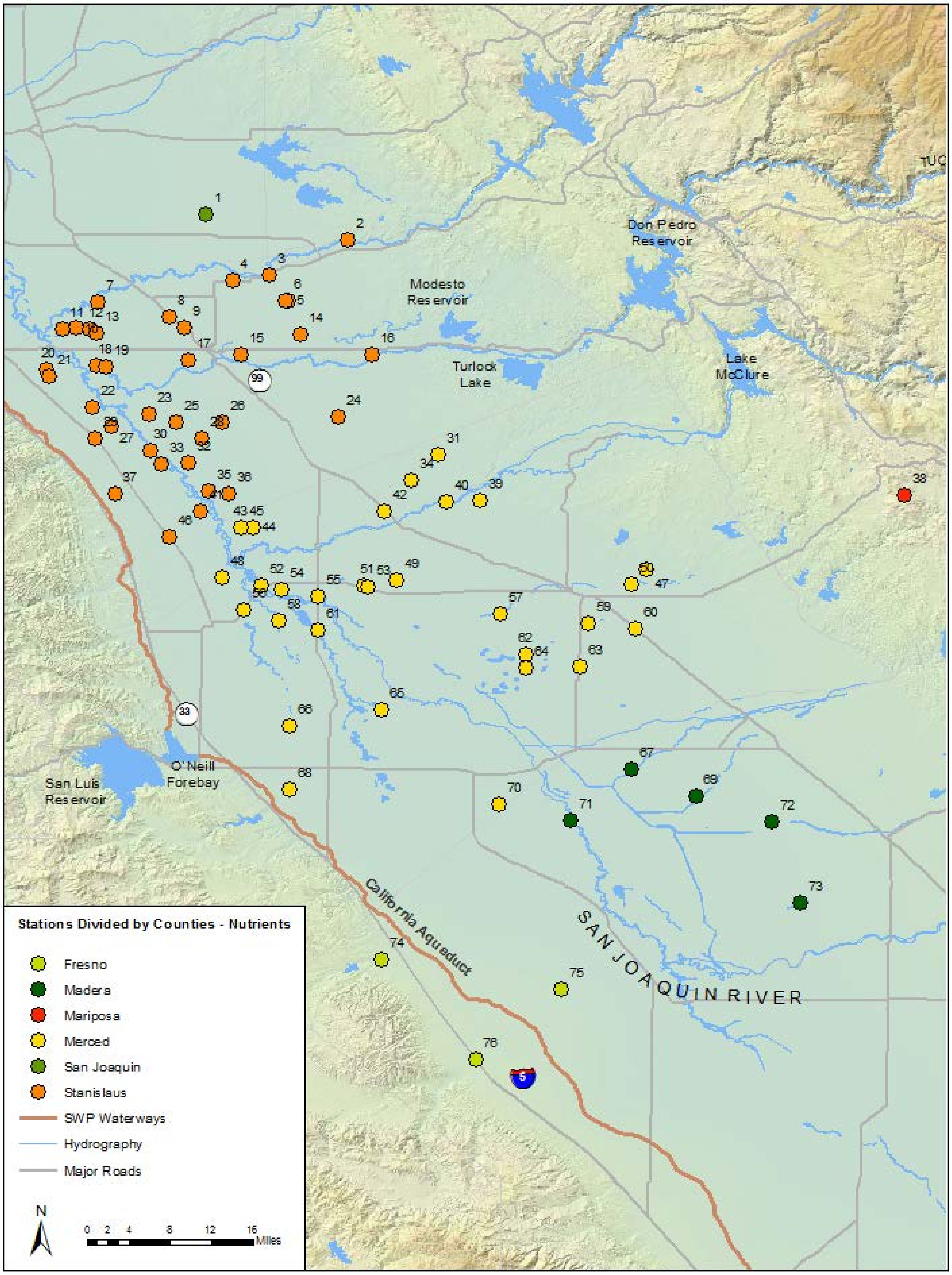
Table 4-39. Top Pesticides Used in the Five Counties, by Acres for 2008-2011 Combined

Top Pesticides by Acres Applied 2008-2011	Acres	Pounds	Number of Years Used	Average acres/year	Average lbs/year
Alpha-(Para-Nonylphenyl)-Omega-Hydroxypoly(Oxyethylene)	9,236,165	1,771,672	4	2,309,041	442,918
Sulfur	8,297,670	85,913,090	4	2,074,418	21,478,273
Dimethylpolysiloxane	5,270,025	188,270	4	1,317,506	47,068
Isopropyl Alcohol	4,364,660	199,250	4	1,091,165	49,813
Glyphosate, Isopropylamine Salt	4,095,256	6,379,499	3	1,365,085	2,126,500
Phosphoric Acid	1,223,573	96,594	2	611,787	48,297
Oxyfluorfen	769,127	362,025	3	256,376	120,675
Ammonium Sulfate	625,367	164,860	3	208,456	54,953
Glyphosate, Potassium Salt	500,692	788,036	1	500,692	788,036
Abamectin	156,793	2,095	1	156,793	2,095
Fatty Acids, Mixed	155,154	4,870	1	155,154	4,870

Other Constituents Measured

Figure 4-53 below shows the sampling locations for the other constituents measured which include pathogen indicator organisms, organic carbon, salinity, and turbidity.

Figure 4-53. Sampling Locations for Other Constituents by the Coalitions Within the Watershed for 2008-2012



Pathogen Indicators

Coliforms, which are generally not harmful themselves, are used as indicators of the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans. Table 4-40, Figure 4-54, and Figure 4-55 present the fecal coliform and *E. coli* data collected by the various coalitions for the counties that are in the watershed. For fecal coliforms, the upper range that was reported was ≥ 1,600 MPN/100 mL. No data was available for San Joaquin County.

E. coli densities for all counties reached a maximum of > 2,400 MPN/100 mL. Fresno County had the highest median fecal coliform and *E. coli* densities in all of the counties. Madera County had the lowest median fecal coliform and *E. coli* densities in all of the counties.

In Fresno County, the median fecal coliform density was 1,250 MPN/100 mL. Panoche-Silver Creek had a higher median (1,600 MPN/100 mL) than Panoche-Silver Creek at Belmont Avenue (median 900 MPN/100 mL). The median *E. coli* density was 690 MPN/ 100 mL. While nearly all locations reported a maximum of > 2,400 MPN/100 mL for *E. coli*, the largest median was also at Panoche-Silver Creek at I-5 crossing (770 MPN/100 mL).

In Madera County, the median fecal coliform density was 22 MPN/100 mL, while the median *E. coli* density was 57 MPN/100 mL. Cottonwood Creek at Road 20 (#73 on Figure 4-53) had the largest median *E. coli* density (195 MPN/100 mL).

In Mariposa County, Marshall Road Drain near River Road (#38 on Figure 4-53) was the only location sampled. The one fecal coliform sample was 70 MPN/100 mL. The median *E. coli* density was 150 MPN/100 mL. The mean and median *E. coli* densities were the second largest of all the counties.

In Merced County, the median fecal coliform density was 75 MPN/100 mL. The highest fecal coliform median density was found at Los Banos Creek at Highway 140 (median 1,600 MPN/100 mL) (#54 on Figure 4-53). The median *E. coli* density was 120 MPN/100 mL. The highest median *E. coli* density was at Black Rascal Creek at Yosemite Road (#45 Figure 4-53) (770 MPN/100 mL).

In Stanislaus County, the median fecal coliform density was 195 MPN/100 mL. The highest median fecal coliform density was found at Orestimba Creek at River Road (1,600 MPN/100 mL) (#41 on Figure 4-53). The median *E. coli* density was 150 MPN/100 mL. The highest median *E. coli* densities were at Mootz Drain downstream of Landwort Pond (median 2,400 MPN/100 mL) (#6 on Figure 4-53) and Mootz Drain at Langworth Road (median 1,850 MPN/100 mL) (#5 on Figure 4-53).

Table 4-40. Fecal Coliform and *E. coli* Summary for the Five Counties (MPN/100 mL) 2008-2012

County	Fecal coliform Detects/ Samples	Range	Mean	Median	*E. coli* Detects/ Samples	Range	Mean	Median
Fresno	20/22	2 - ≥1,600	871	1,250	23/24	1 - ≥2,400	1,077	690
Madera	6/6	2-30	19	22	110/111	1 - ≥2,400	225	57
Mariposa	1/1	70	-	-	32/32	2 - ≥2,400	648	150
Merced	46/48	2 - ≥1,600	316	75	753/788	1 - ≥2,400	393	130
Stanislaus	36/36	5 - ≥1,600	461	195	547/562	2 - ≥2,400	460	150

Means and Medians are calculated using values at or above the detection limit.
No data was available for San Joaquin County

Figure 4-54. Fecal Coliforms for All Counties

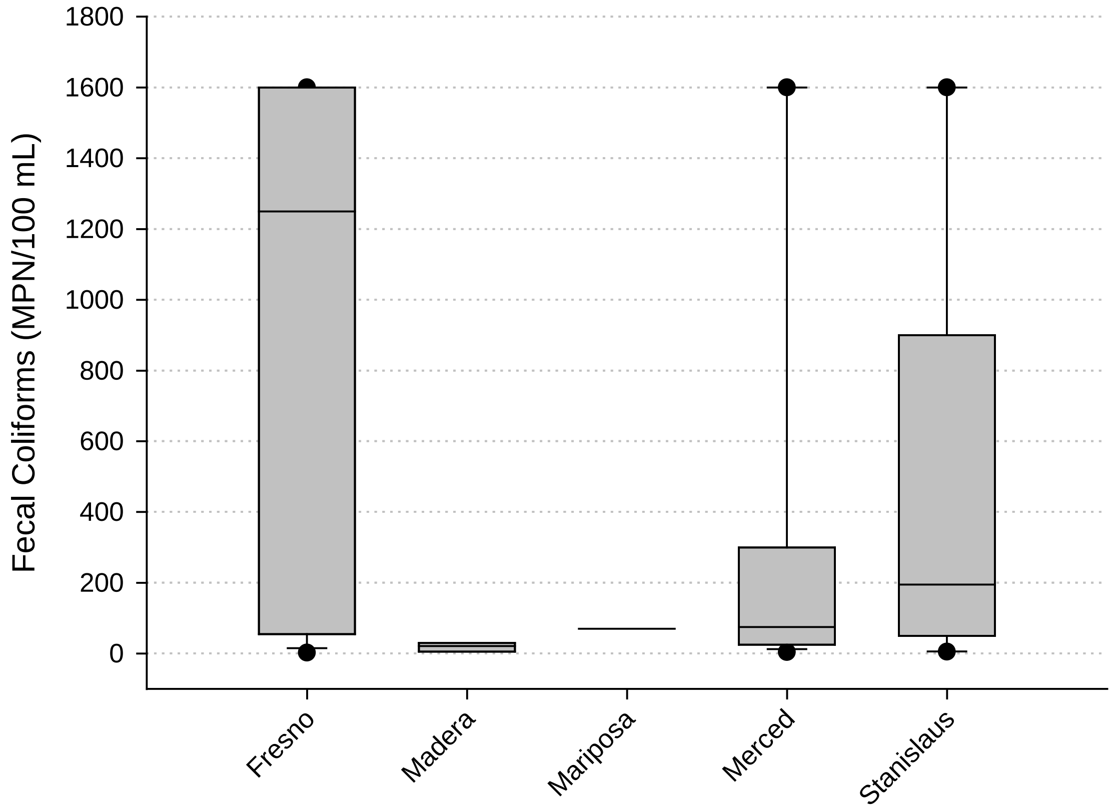
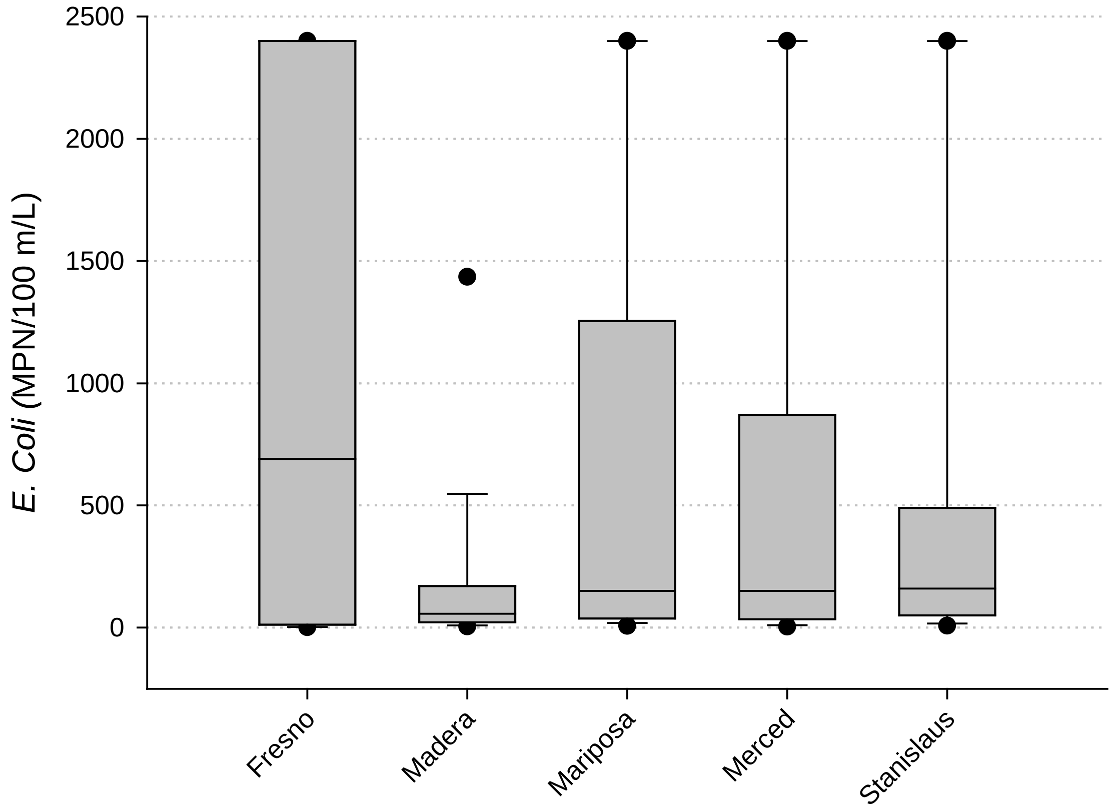


Figure 4-55. *E. coli* for All Counties



Organic Carbon

Organic carbon present in an aquatic system is composed of particulate and dissolved materials from plant, animal, and bacterial sources, in varying stages of degradation. The dissolved organic carbon and total organic carbon data is summarized in Table 4-41, Figure 4-56, and Figure 4-57. The data summarized contains a dataset that is larger for TOC than DOC. In some cases, this results in DOC medians that are higher than TOC medians.

Fresno County had the highest median TOC and DOC concentrations in all of the counties, whereas Madera County had the lowest median TOC and DOC concentrations.

In Fresno County, the median TOC value was 9.6 mg/L, while the median DOC value was 14.5 mg/L. Approximately 53-100% of TOC was composed of DOC. DOC was only sampled once at Little Panoche Creek at West Boundary and Panoche-Silver Creek at I-5 crossing. The highest median TOC values were at Panoche-Silver Creek at Belmont Avenue (median 9.9 mg/L) (#75 on Figure 4-53), followed by Panoche-Silver Creek at I-5 crossing (median 8.0 mg/L, #76 on figure 4-53).

In Madera County, the median TOC value was 4.5 mg/L, while the median DOC value was 2.9 mg/L. Approximately 35-109% of TOC was composed of DOC. DOC was only sampled at San Joaquin River at Sack Dam (#70 on Figure 4-53). The largest median TOC value was at San Joaquin River at Sack Dam (median 5.1), followed by Cottonwood Creek at Road 20 (median 4.8 mg/L, #73 on Figure 4-53).

In Mariposa County, the TOC median was 6.0 mg/L and the DOC median was 6.1 mg/L. Approximately 81-122% of TOC was composed of DOC. All the samples were taken at Marshall Road Drain near River Road (#38 on Figure 4-53).

In Merced County, the median TOC was 4.9 mg/L and the median DOC was 5.8 mg/L. Approximately 39-120% of TOC was composed of DOC. The highest median TOC values were at Mustang Creek at East Avenue (median 26 mg/L, #32 on Figure 4-53), followed by Los Banos Creek at Highway 140 (median 14 mg/L, #54 on figure 4-53). Median DOC values were highest at Los Banos Creek at Highway 140 (median 13 mg/L, #54 on Figure 4-53), followed by Mud Slough upstream of San Luis Drain (median 10 mg/L, #56 on Figure 4-53).

In San Joaquin County, the median TOC value was 5.0 mg/L. No DOC samples were taken. All samples were taken at Sweet Lateral (#1 on Figure 4-53).

In Stanislaus County, the median TOC was 5.9 mg/L and the median DOC was 4.5 mg/L. Approximately 54-121% of TOC was composed of DOC. For TOC, Spenker Spill (#4 on Figure 4-53) had the largest median (18.9 mg/L), and the four samples taken had a range of 5.9-23.2 mg/L. Mootz Drain at Langworth Road (#5 on Figure 4-53), Mootz Drain downstream of Langworth Road (#6 on Figure 4-53), and Prairie Flower Drain at Crows Landing Road (#36 on Figure 4-53) had median TOC values between 15.0 and 15.5 mg/L. The largest median DOC value was at Ramona Lake near Fig Avenue (median 7.0 mg/L, #34 on Figure 4-53), followed by Hospital Creek at River Road (median 6.5 mg/L, #21 on Figure 4-53).

Table 4-41. Summary Statistics for TOC and DOC for All Counties (mg/L) 2008-2012

County	TOC Detects/ Samples	TOC Range	TOC Mean	TOC Median	DOC Detects/ Samples	DOC Range	DOC Mean	DOC Median
Fresno	24/24	4.3-53.0	13.3	9.6	2/2	11.0-18.0	14.5	14.5
Madera	61/61	1.9-15.0	4.9	4.5	4/4	2.3-3.8	3.0	2.9
Mariposa	32/32	2.4-13.0	6.5	6.0	32/32	2.2-11.0	6.2	6.1
Merced	777/811	0.9-52.0	6.5	4.9	467-484	2.1-35.0	7.1	5.8
San Joaquin	2/2	3.7-6.3	5.0	5.0	-	-	-	-
Stanislaus	510/524	1.1-45.0	7.6	5.9	252/266	2.2-27.0	5.3	4.5

Means and Medians are calculated using values at or above the detection limit.

Figure 4-56. TOC for All Counties

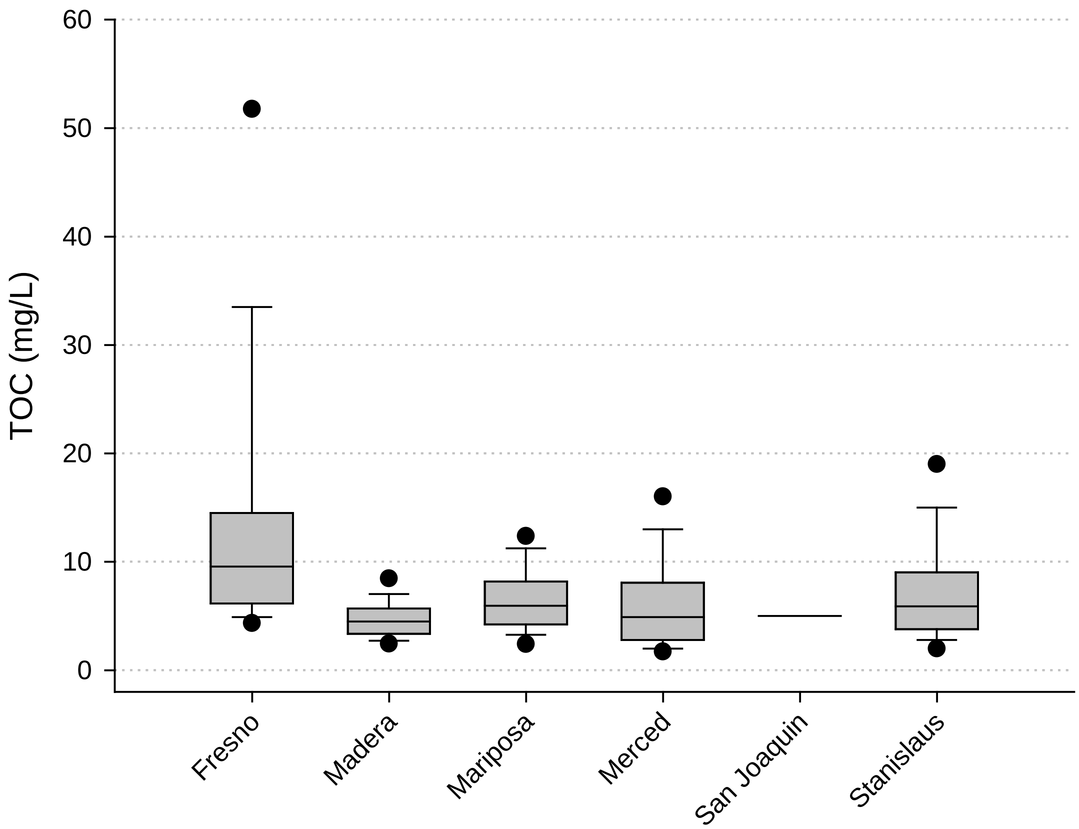
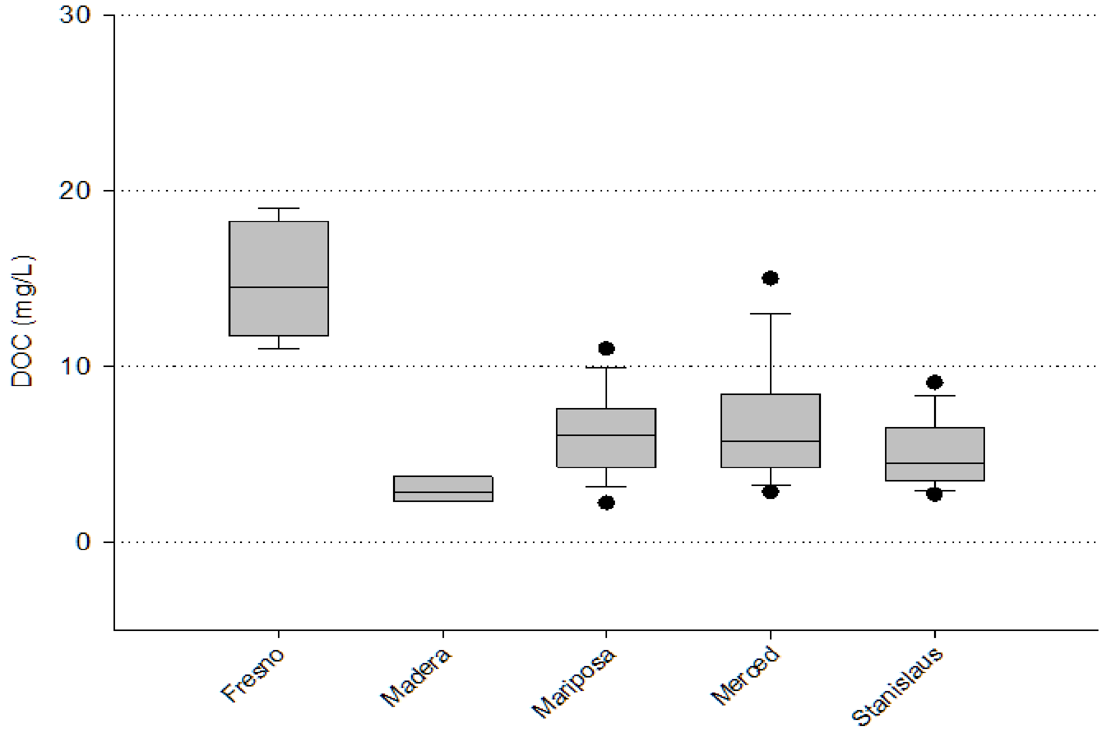


Figure 4-57. DOC for All Counties



Salinity

Salinity is the quantity of dissolved ions in water, and two measures of salinity are TDS and EC. TDS is an approximate measure of the total quantity of dissolved salts, whereas EC is a measure of the water's ability to conduct an electrical current.

For the Irrigated Lands Program, 18 samples of EC were collected at 18 different locations during one day in 2009. No EC samples were taken in Fresno County or San Joaquin County. The one sample in Mariposa County had high EC levels (1,400 µs/cm), while the one sample in Madera County had low EC levels (440 µs/cm). The median values of EC for Merced and Stanislaus counties were 1,100 µs/cm and 1,300 µs/cm. Table 4-42 provides the summary of the EC and TDS data. Figure 4-58 presents the TDS detects. There was insufficient EC data for graphical representation.

Some of the TDS samples were collected in areas with tile drains that were constructed to move the salty water away from the plant root zones. Salinity here is a legacy issue that growers have been dealing with for years. Some of the irrigation drainages have little to no flow, leading to very high TDS levels.

Fresno County had higher median, mean, and maximum TDS values as compared to the other counties. The data distribution shows skewing towards the maximum values (Figure 4-58). Madera County had lower TDS values as compared to the other counties. Merced and Stanislaus counties had similar medians, means, and ranges. Mariposa had smaller range, but a higher TDS median, as compared to Merced and Stanislaus. There was insufficient TDS data for San Joaquin County to compare to the other counties.

In Fresno County, the median TDS value was 2,300 mg/L. One sample was taken at Little Panoche Creek at west boundary (#74 on Figure 4-53); the sample had maximum value (6,500 mg/L). Panoche-Silver Creek at I-5 crossing (#76 on Figure 4-53) and Panoche-Silver Creek at both Belmont Avenue (#75 on Figure 4-53) had medians of 2,400 mg/L and 1,900 mg/L, respectively.

In Madera County, the median TDS was 115 mg/L. The highest median value was at San Joaquin River at Sack Dam (median 280 mg/L, #70 on Figure 4-53), followed by Cottonwood Creek at Road 20 (median 90 mg/L, #73 on Figure 4-53).

In Mariposa County, the median TDS was 570 mg/L. Samples were only taken at Marshall Road Drain near River Road (#38 on Figure 4-53).

In Merced County, the median TDS was 425 mg/L. San Joaquin River at Fremont Ford (#50 on Figure 4-53) had the largest median (1,120 mg/L), and the four samples taken had a range of 500-1,800 mg/L. The next largest median TDS value was at Mud Slough upstream of San Luis Drain (median 980 mg/L, #56 on Figure 4-53).

In San Joaquin County, the median TDS was 92 mg/L. Samples were only taken at Sweet Lateral (#1 on Figure 4-53).

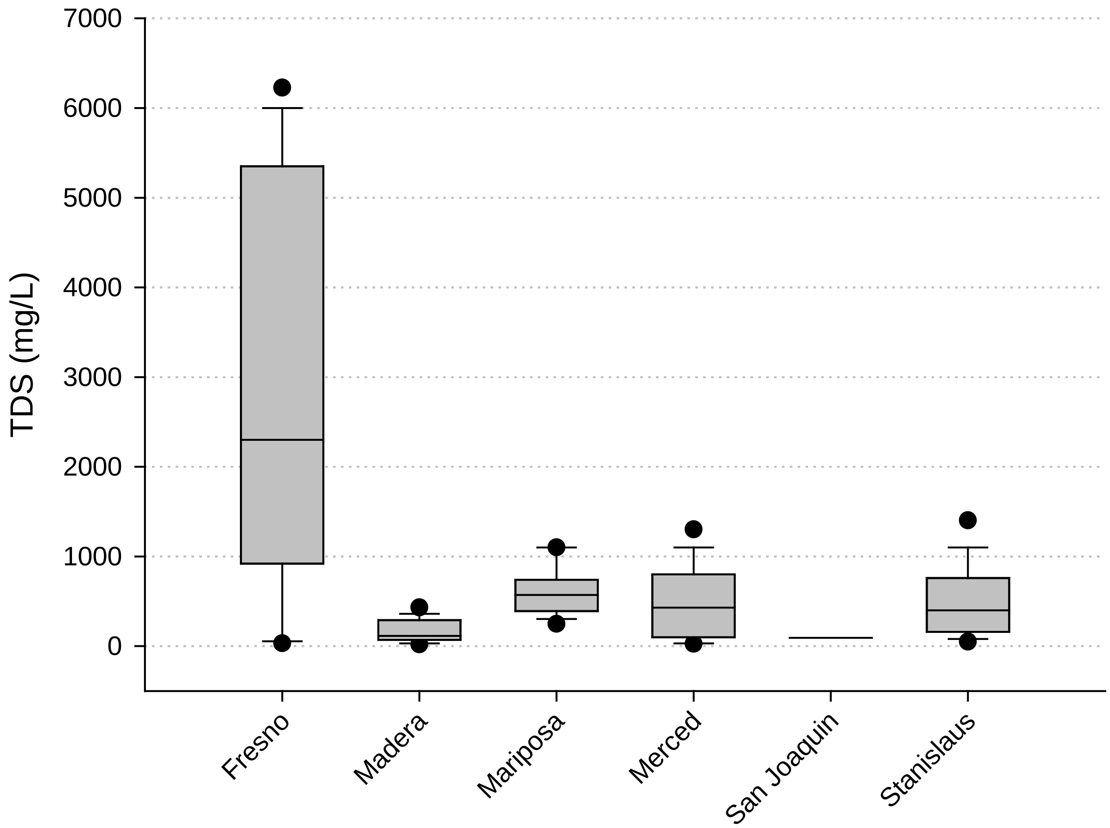
In Stanislaus County, the median TDS was 400 mg/L. Prairie Flower Drain at Crows Landing Road (#36 on Figure 4-53) consistently had high TDS levels, with a median of 1,500 mg/L. Levee Drain at Carpenter Road has the next highest median value (median 1,150 mg/L).

Table 4-42. Salinity Summary for All Counties 2008-2012

	Specific Conductivity (µS/cm)				Total Dissolved Solids (mg/L)			
County	Detects/ Samples	Range	Mean	Median	Detects/ Samples	Range	Mean	Median
Fresno	-	-	-	-	30/30	9-6,500	2,810	2,300
Madera	1/1	440	-	-	114/115	13-520	173	115
Mariposa	1/1	1,400	-	-	32/32	270-1,100	608	570
Merced	7/7	690-2,000	1,179	1,100	780/810	5-2,400	506	425
San Joaquin	-	-	-	-	2/2	63-120	92	92
Stanislaus	9/9	440-1,500	1,141	1,300	618/632	11-2,900	518	400

Means and Medians are calculated using values at or above the detection limit.

Figure 4-58. Total Dissolved Solids for All Counties



Turbidity

Mariposa's only station had a large range of turbidities, which made Mariposa the county with the second highest turbidity. Merced and Stanislaus counties had similar data distributions (Figure 4-59). The limited amount of data for San Joaquin County does not allow it to be compared to the other counties. Table 4-43 and Figure 4-59 summarize the turbidity samples for all of the counties.

Turbidity levels were highest at the Fresno County stations. The median turbidity was 28 NTU. Panoche-Silver Creek at Belmont Avenue had the highest median turbidity (median 105 NTU), followed by Panoche-Silver Creek at I-5 crossing (median 25 NTU).

Turbidity levels in Madera County were typically lower than the other counties. Madera had the lowest median value (8 NTU). San Joaquin River at Sack Dam (#70 on Figure 4-53) had the highest median value for Madera County (10 NTU), followed by Cottonwood Creek at Road 20 (median 8 NTU, #73 on Figure 4-53).

Mariposa County had only one station monitored (Marshall Road drain near River Road, #38 on Figure 4-53) and while the mean turbidity was high (173 NTU), the median was not (38 NTU).

In Merced County, the median turbidity was 21 NTU. Black Rascal Creek at Yosemite Road (#45 on Figure 4-53) had the highest median turbidity (51 NTU), followed by Poso Slough at Indiana Avenue (#68 on Figure 4-53) (50 NTU).

San Joaquin County had only one station monitored (Sweet Lateral #1 on Figure 4-53) and the median was 16 NTU.

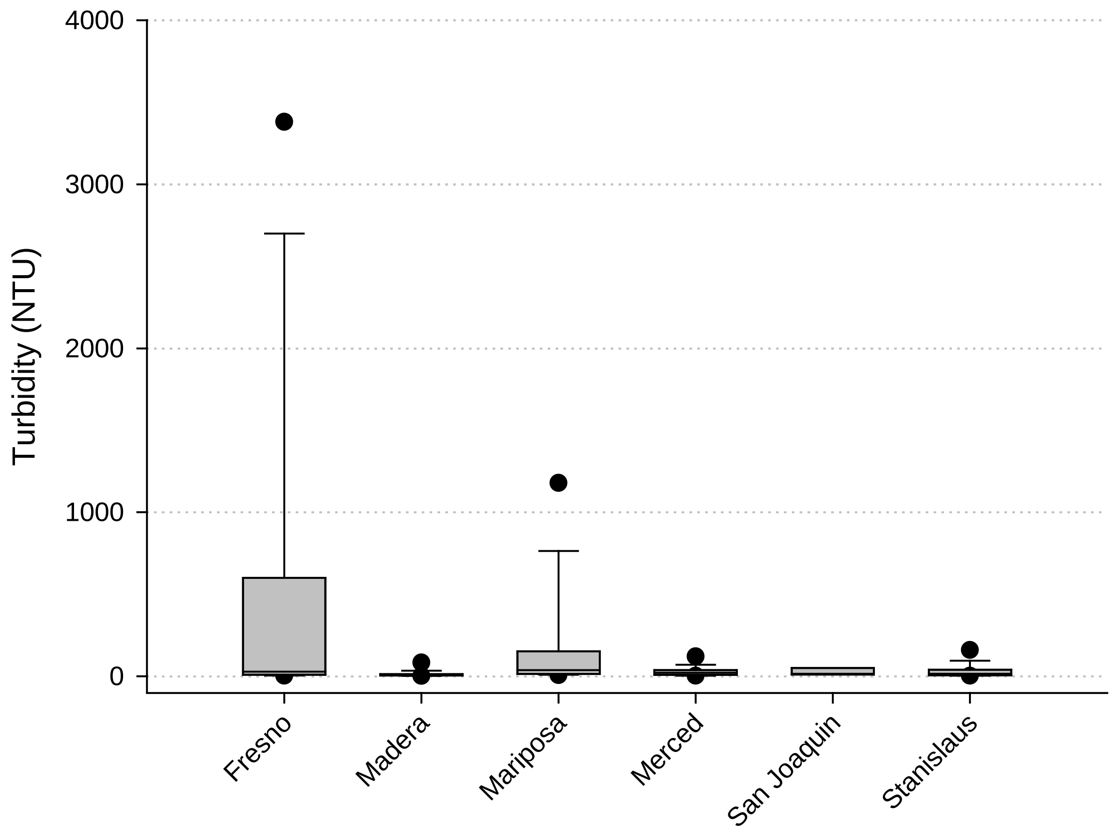
In Stanislaus County, the median turbidity was 15 NTU. Main Drain at DeForest Ranch (#13 on Figure 4-53) had the highest median turbidity (279 NTU), but only two samples were taken. Of the stations with multiple samples, Ingram Creek at River Road (#22 on Figure 4-53) and Hospital Creek at River Road (#21 on Figure 4-53) had the highest median turbidities (86 and 95 NTU).

Table 4-43. Turbidity Summary Statistics for All Counties 2008-2012

County	Turbidity (NTU) Detects/ Samples	Range	Mean	Median
Fresno	23/24	2-3,500	629	28
Madera	115/115	1-680	22	8
Mariposa	32/32	4-1,600	173	38
Merced	781/810	1-1,200	38	21
San Joaquin	6/6	11-61	27	16
Stanislaus	623/637	1-1,300	42	15

Means and Medians are calculated using values at or above the detection limit.

Figure 4-59. Turbidity for All Counties



Confined Animal Facilities (CAFs)

CAFs are defined as any place where cattle, calves, sheep, swine, horses, mules, goats, fowl, or other domestic animals are corralled, penned, tethered, or otherwise enclosed or held, and where feeding is by means other than grazing. California regulations refer to these operations, including concentrated animal feeding operations (CAFOs), as confined animal facilities (CAFs). Approximately 1,300 dairy operations are within the Central Valley, in addition to feedlots. Non-bovine operations include approximately 850 poultry operations (chickens and turkeys), over 500 sheep and lamb farms, and over 150 hog farms (United States Department of Agriculture 2007).

The U.S. Environmental Protection Agency categorizes CAFOs as large, medium, and small based on the number of animals. The categories are further divided by species (Table 4-44). Large CAFOs are automatically subject to regulation under the Clean Water Act. Medium CAFOs must meet one of two "methods of discharge" to be defined or designated as such. Small CAFOs are subject to regulations on a case-by-case basis, unless pollutants are discharged into waterways of the United States through a man-made conveyance, like a ditch.

The number of animal farms varies by county. Using the available 2007 United States Department of Agriculture (USDA) statistics, there were over 7,600 animal farms in the combined five counties (United States Department of Agriculture 2007). Cattle farms are separated into three categories: beef cattle, dairy cows, and stocks of cattle which will become beef cattle or dairy cows. Madera County has the least farms, while Stanislaus County has the most farms. Merced County has the most dairy farms, but Stanislaus County has the most stock cattle, beef cattle, poultry, and hog and pig farms (Table 4-45). Fresno has approximately 410,000 cattle, which includes around 115,000 milk cows. Madera has approximately 190,000 cattle, which includes around 75,000 milk cows. Merced has approximately 530,000 cattle, which includes around 250,000 milk cows. San Joaquin has approximately 235,000 cattle, which includes around 100,000 milk cows. Stanislaus has approximately 410,000 cattle, which includes around 175,000 milk cows (Table 4-46).

The number of total cows on the dairies fluctuated each year. From 2008 to 2012, the number of dairies decreased each year, while the number of cows per dairy increased each year (Table 4-47). Dairy herd size in the San Joaquin Valley is shown in Figure 4-60.

Figure 4-60. Dairy Herd Size in the San Joaquin Valley

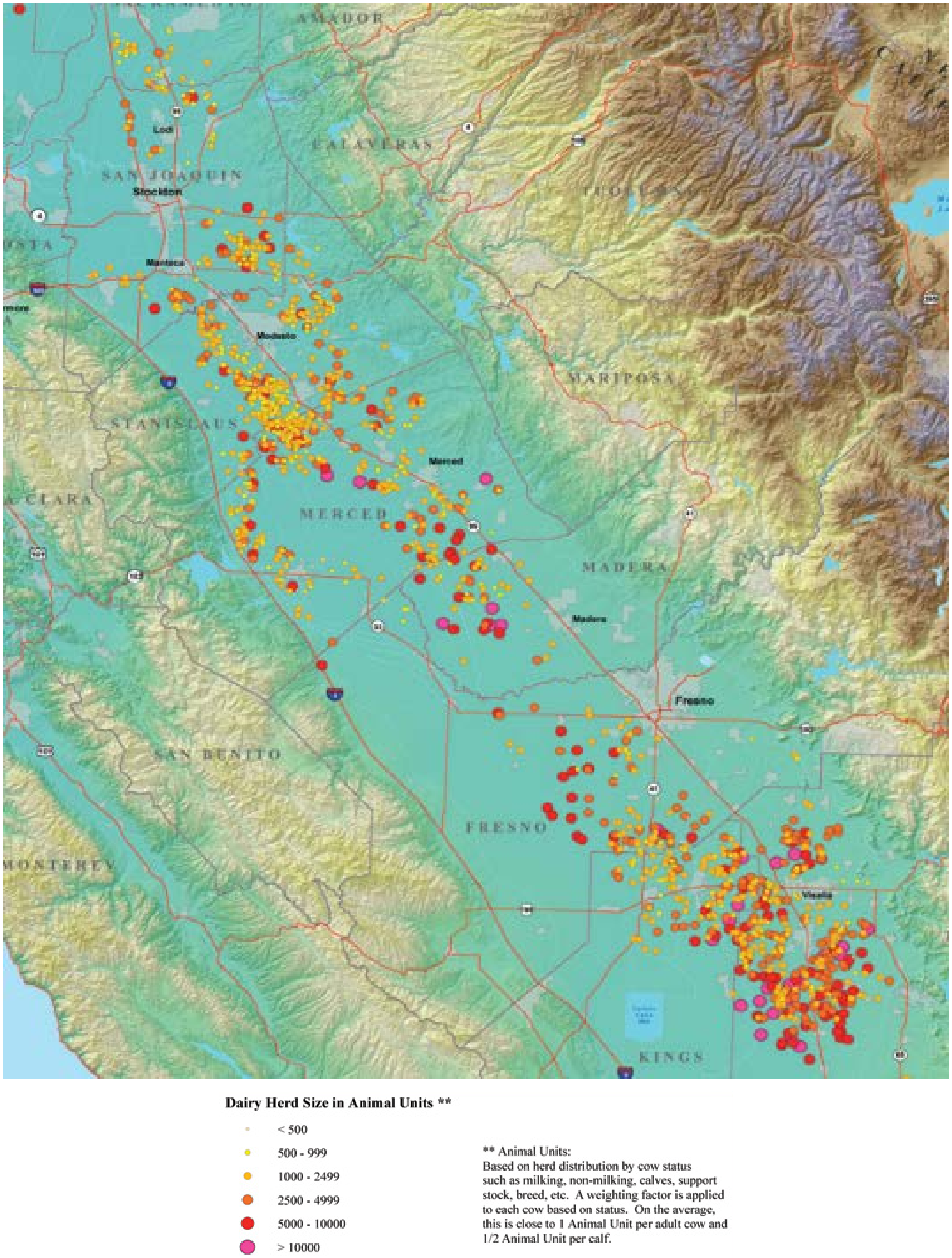


Table 4-44. Size Thresholds for CAFO Classifications

Animal Sector	Large CAFOs	Medium CAFOs	Small CAFOs
Farm cattle or cow/calf pairs	1,000 or more	300–999	less than 300
Mature dairy cattle	700 or more	200–699	less than 200
Turkeys	55,000 or more	16,500–54,999	less than 16,500
Laying hens or broilers (liquid manure handling systems)	30,000 or more	9,000–29,999	less than 9,000
Laying hens (other than a liquid manure handling systems)	82,000 or more	25,000–81,999	less than 25,000
Chickens other than laying hens (other than a liquid manure handling systems)	125,000 or more	37,500–124,999	less than 37,500

Table 4-45. 2007 Data on Cattle, Dairy, Beef, Poultry, and Hog and Pig Farms in the Five Counties

County	Number of Cattle Farms	Number of Dairy Farms	Number of Beef Farms	Number of Poultry Farms	Number of Hog and Pig Farms
Fresno	796	93	531	205	36
Madera	361	56	256	92	23
Merced	686	280	384	80	18
San Joaquin	602	131	374	142	39
Stanislaus	1,169	266	694	274	49
Totals	3,614	1,386	2,239	793	165

Table 4-46. Number of Cows, Dairies, and Cows per Dairy for 2011 and 2012 for the Five Counties

County	Number of Cows 2011	Number of Dairies 2011	Number of cows/dairy 2011	Number of Cows 2012	Number of Dairies 2012	Number of cows/dairy 2012
Fresno	117,534	98	1,199	114,204	86	1,328
Madera	77,110	49	1,595	74,929	46	1,629
Merced	262,131	251	1,044	267,728	243	1,102
San Joaquin	106,012	126	841	101,236	119	851
Stanislaus	180,416	232	778	187,061	216	866
TOTALS	743,203	756	983	745,158	710	1,050

Table 4-47. Cows, Dairies, and Cows per Dairy for the Five Counties Combined for Years 2008-2012

Year	Number of Cows	Number of Dairies	Number of Cows/Dairy
2008	760,316	861	883
2009	748,333	809	925
2010	751,240	795	945
2011	743,203	756	983
2012	745,158	710	1,050

Water Quality

The Central Valley Water Board regulates waste discharges that could affect the State's surface and ground water quality. CAFs represent a significant source of waste discharge with the potential to pollute the state water. Waste includes, but is not limited to, manure, leachate, process wastewater and any water, precipitation, or rainfall runoff that contacts raw materials, products, or byproducts such as manure, compost piles, feed, silage, milk, or bedding. Dairy wastes contain high concentrations of nutrients (organic nitrogen, ammonia, and phosphorus), organic carbon, salts, and pathogens. Accidental and or intentional discharge of animal waste to surface waters or groundwater infiltrations impact water quality. Poor facility design and/or construction, poor management, inadequate waste pond storage, proximity to surface waters, lack of tailwater recovery, and inadequate sump operations can all result in surface water contamination. Waste constituents of concern for CAFOs such as grazing animals, diaries, lagoons, and sludge application to land are listed in Table 4-48.

Table 4-48. Potential Contaminants and Sources from Confined Animal Facilities

Contaminant Source	Potential Contaminants
Confined animal feeding operations	Livestock sewage wastes; nitrates; phosphates; chloride; chemical sprays and dips for controlling insect, bacterial, viral and fungal pests on livestock; coliform and noncoliform bacteria; viruses; protozoa; total dissolved solids
Grazing animals, other animal operations	Livestock sewage wastes; nitrates; phosphates; coliform and noncoliform bacteria; protozoa, viruses; total dissolved solids;
Dairies	Livestock sewage wastes; nitrates; total dissolved solids; salts; phosphates; potassium.
Lagoons	Nitrates; Livestock sewage wastes; salts; pesticides; fertilizers; bacteria
Sludge application to land	Organic and inorganic chemicals, coliform and noncoliform bacteria, viruses, protozoa

Regulations

California regulations governing discharges from confined animal facilities are contained in the Title 27 of the California Code of Regulations (Title 27), at sections 22560 and following sections. See Chapter 2: "Regulations" for more information. The Central Valley Board regulates waste discharges through waste discharge requirement permits such as the Dairy General Order, which implements the relevant water quality control plan.

The Dairy General Order's required plans and reports are:

- Monitoring and Reporting Program: monitor discharges of tailwater from the production area and land application areas, groundwater, and nutrients applied to and removed from land application areas.
- Waste Management Plan: production area is designed, constructed, operated, and maintained; the dairy wastes are managed in compliance with state regulations.
- Nutrient Management Plan: minimizes leaching of nutrients and salts to groundwater and surface water and minimizes nonpoint source pollution runoff to surface water.
- Salinity Report: identifies sources of salt in waste generated, evaluates measures that can be taken to minimize salt, and certifies approved measures to minimize salt.

- Annual Reports: demonstrate dairies are taking specific steps towards complying with all terms and conditions of the General Order.

In 2005, existing milk cow dairies were required to submit a Report of Waste Discharge (ROWD) to the Central Valley Water Board. The Board reported 100% compliance with submittal of the reports. All dairies were then required to submit an existing conditions report, which provided additional information on conditions that were not provided in the ROWD in 2005. A preliminary dairy facility assessment was also required in the report. Nearly all of the dairies statewide are in compliance with surface water quality requirements (per. Comm. Dale Essary and Charleen Herbst).

The Dairy Quality Assurance Program is a voluntary program that assists dairy owners in complying with regulations and improving sanitary conditions at dairies. The California Dairy Quality Assurance Program's efforts have resulted in dairy operators possessing a greater understanding of the need for water quality protection, and over 1,800 dairies have been certified in the Central Valley region (California Dairy Research Foundation 2011).

Before regulations, animal feeding operations caused water quality concerns for surface water. With the improved regulations, dairies were required to implement management plans and upgrades to their facilities. The regulations reduced runoff to surface water, and eliminated animal waste and wastewater from reaching surface water. The regulations lead to better onsite management practices, such as improved wastewater storage. These practices have greatly reduced discharges to surface waters. No discharges to surface water were reported from 2008-2012 (Herbst pers. comm. 2013). While the better onsite management of wastewater has drastically reduced surface water threats, the biggest concern has been shifted to groundwater. It is expected that the new groundwater regulations will result in less degradation of groundwater by dairies and will possibly result in some improvements in groundwater quality.

Violations

Dairies are required to report any spills to the Regional Board and complaints about dairy spills are investigated by Regional Board staff. On average, there are between two and five surface water spills each year, and nearly all are weather related. The majority of the dairies are in compliance with surface water quality regulations. When problems do occur, they are typically weather related (Essary pers. comm. 2013). The number of fines and cases sent to the district attorney for prosecution has decreased in the last five years. The cooperation of farmers, dairy programs, and board staff has helped both the farms and the Regional Board.

The majority of violations found during routine inspections are considered minor. Inspections occur on a rotating cycle, every three to five years. Some administrative violations can become larger violations, if not properly taken care of. These types of violations concern reporting, and development and implementation of management plans.

The California Integrated Water Quality System Project reported only 6 Class I violations at dairies in the five counties during the study period. There were three in Merced County, two in San Joaquin County, and one in Stanislaus County. Class I violations are violations that pose an immediate and substantial threat to water quality and have the potential to cause significant detrimental impacts to human health or the environment. Violations involving recalcitrant parties who deliberately avoid compliance are also considered class I.

There have been some large violations and fines issued by the water board within this study period. However, most are not within the defined watershed of this report. During the study period, there were two instances of large violations reported by the Central Regional Water Control Board. The first occurred in Stanislaus County in May of 2012 in which a farm was fined for failure to implement adequate and effective management practices to protect water quality. The original fine was over $100,000 and was assessed during the 2011 crop season when investigation found sediment-laden irrigation water discharging to a local tributary of the San Joaquin River. The farmer made improvements to the irrigation system and the fine was reduced by more than half. The second violation occurred in Merced County in July 2012 in which a dairy was issued a cleanup and abatement order and fined over $250,000 for violations during a routine inspection. The dairy was found to be illegally disposing cow carcasses, and discharging manure wastewater and septic waste off-property to a drainage canal.

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CHAPTER 5: WATER QUALITY

This chapter discusses the San Joaquin River Watershed's water quality data from water quality stations between the Mendota Pool and Vernalis from 2008 to 2013. Stations were selected along the San Joaquin River to depict water quality changes from upstream to downstream. Table 5-1 includes a list of the stations analyzed, the original station names, and the abbreviated names used in this report.

The Mendota station represents the quality of water in the upper San Joaquin River prior to inputs from the major eastside estuaries and westside streams. The Lander Avenue station is upstream of the Merced River and represents a change in water quality from the Mendota station. The Mud and Salt Slough stations flow to the San Joaquin River and represent mostly agricultural drainage. The Crows Landing station and the Patterson Irrigation District (PID) Pump station are located within close proximity. Together they make up a more robust dataset and represent a change in water quality below the Merced River but upstream of the Tuolumne River. The Vernalis station represents the water quality at the southern boundary of the Delta and is downstream of the Tuolumne and Stanislaus Rivers. See Figure 5-1 for a map of these stations.

Water quality constituents are presented from each station along the San Joaquin River. For each constituent, box plots display the general distribution of data based on the station's dataset. Summary statistics that include range, mean, median, standard deviation, standard error, and 95% confidence intervals describe the general data characteristics. The constituents selected relate to drinking water quality and have the potential to cause adverse health effects.

The potential contaminants of concern discussed in this chapter are briefly described below:

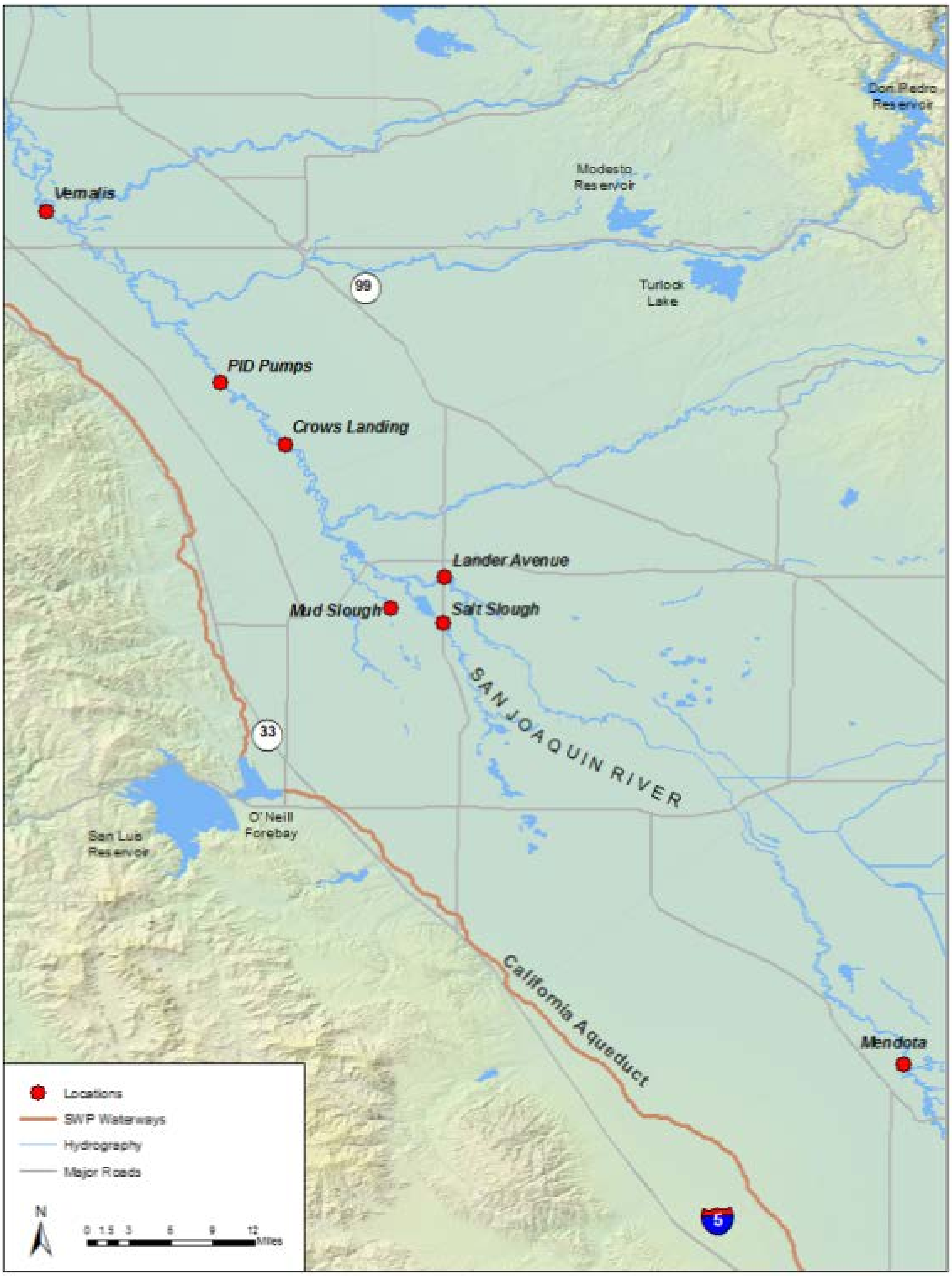
- Organic carbon: Dissolved Organic Carbon (DOC) and Total Organic Carbon (TOC) are discussed in detail because of the ability to form disinfection byproducts (DBPs).
- Salinity: Electrical Conductivity (EC) and Total Dissolved Solids (TDS) can affect drinking water, when found in high levels.
- Bromide is discussed because of its ability to form DBPs.
- Nutrients: Total Nitrogen, Nitrate, Nitrite, Nitrate + Nitrite, Total Kjeldahl Nitrogen (TKN), Ammonia, Orthophosphate, and Total Phosphorus are discussed in terms of proper functioning aquatic ecosystems, but can affect drinking water when in overabundance, leading to algal blooms.
- Turbidity is discussed as a water quality parameter.
- Pathogen indicator organisms: total coliforms, fecal coliforms, and *E. coli* are discussed in terms of their impacts on human health.
- Trace elements and pesticides are included since some have MCLs and may have adverse effects on human health.

Table 5-1. Water Quality Stations Along the San Joaquin River

Original Station Name	Abbreviated Station Name	Station Significance
SJR below Mendota Dam-SJRI_07	Mendota	Upstream location
San Joaquin River at Lander Avenue	Lander Avenue	Upstream of Merced River
Mud Slough Upstream of San Luis Drain	Mud Slough	Importance in agricultural drainage
Salt Slough @ Lander Avenue	Salt Slough	Importance in agricultural drainage
SJR @ Crows Landing	Crows Landing	Upstream of Tuolumne River
San Joaquin River at PID[a] Pumps	PID Pumps	Upstream of Tuolumne River
San Joaquin R. nr. Vernalis (ID:14) [b]	Vernalis	Downstream location

[a] Patterson Irritation District
[b] Data was obtained through the California Department of Water Resources Water Data Library (WDL) and the California Environmental Data Exchange Network (CDEN)

Figure 5-1. Map of the Water Quality Stations on the San Joaquin River



Water Quality Summary

Organic Carbon

Organic carbon reacts with disinfectants in the water treatment process to form disinfection byproducts. Organic carbon occurs in natural waters in both dissolved and particulate forms, usually measured as dissolved organic carbon (DOC: all that passes through a 0.45 µM filter) and total organic carbon (TOC: all organic carbon in an unfiltered sample). Most drinking water treatment plants use coagulation and filtration processes to remove majority of the particulate carbon. TOC exists as particulate organic carbon and 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. 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 in the water treatment process to destroy pathogenic organisms, but also react with organic carbon to produce disinfection byproducts (DBPs) which can cause adverse health effects.

Although TOC is a precursor to many DBPs, DOC is still a constituent of concern to water treatment operators. TOC contains dissolved and particulate matter while DOC is generally a sample that has been filtered through a 0.45 µM filter to remove the particulate matter. DOC is therefore a measurement of dissolved organic carbon plus any particulate matter smaller than the 0.45 µM filter. Most drinking water treatment plants use coagulation and filtration processes removing most of the particulate carbon. With the particulate carbon removed, DOC may be a better indicator of organic carbon that remains available to form DBPs. As both TOC and DOC are important to water treatment operations, they are both included in this analysis for stations that have the available data. Figure 5-3 shows the TOC concentrations for all the stations used in this survey. The summary statistics for TOC can be found in Table 5-2. Figure 5-4 shows the DOC concentrations of the same stations while Table 5-3 shows the summary statistics of DOC.

The TOC and DOC concentrations at Mendota station are relatively low with medians of 2.75 mg/L and 2.85 mg/L, respectively. Concentrations increase between Mendota and the PID Pumps (up to a median of 5.80 mg/L for both TOC and DOC). There are several factors that influence water quality in this stretch of the San Joaquin River. Mud and Salt Slough discharge to the San Joaquin River downstream of the Lander Avenue station. These two sloughs drain wildlife refuges and wetlands in the Grasslands Wildlife Management area which are high in humic substances. In addition, subsurface agricultural drainage is discharged to Mud Slough via the Grasslands Bypass Project. As shown in Figures 5-2 and 5-3, the TOC and DOC concentrations are quite high in Mud Slough (TOC median of 11.50 mg/L and DOC median of 11.00 mg/L). The Merced River is another factor that influences water quality between Mendota and PID Pumps. TOC concentrations in the eastside tributaries are lower than the concentrations in the San Joaquin River. TOC and DOC concentrations at Vernalis (median TOC of 3.60 mg/L and DOC median of 3.00 mg/L) are substantially lower than at the PID Pumps. The high quality Tuolumne and Stanislaus River waters enter the San Joaquin River between these two locations. The TOC and DOC data indicate that water quality improves from upstream to downstream in the portion of the San Joaquin watershed included in this sanitary survey. There are substantial discharges of agricultural runoff and some urban runoff; however, the high quality rivers draining the Sierra Nevada dilute these discharges. The water quality at Vernalis is discussed in more detail in the 2011 Update of the California State Water Project Watershed Sanitary Survey (Archibald et al. 2012).

Figure 5-2. TOC Concentrations in the San Joaquin River

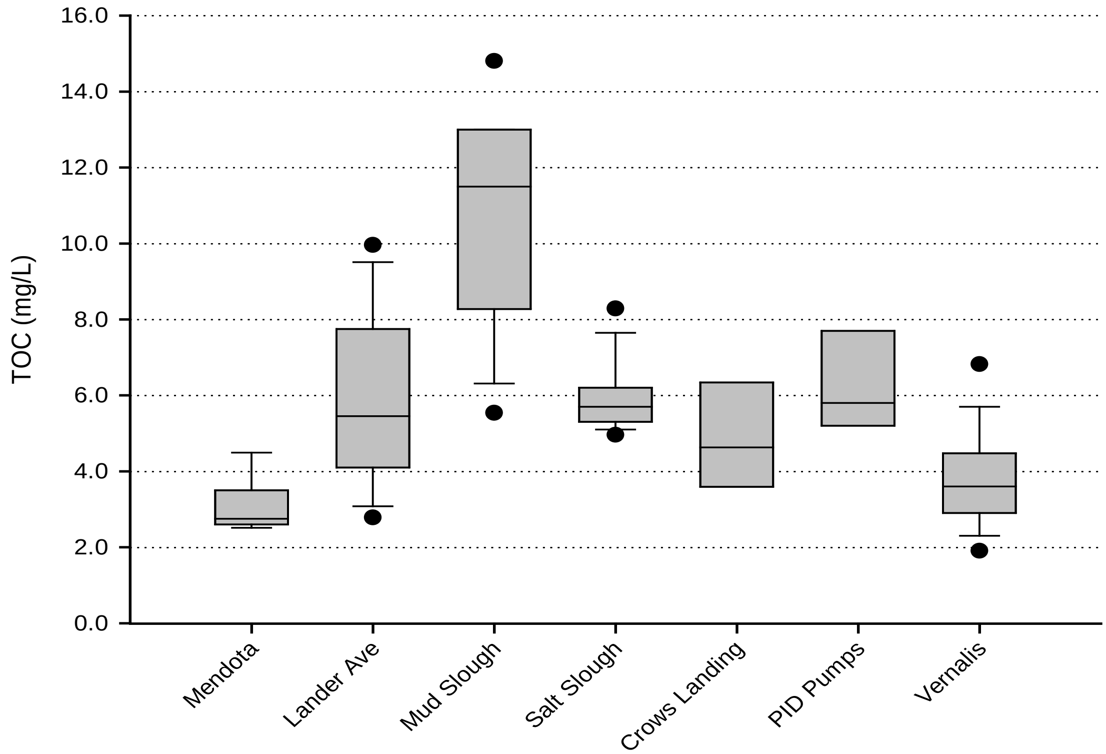


Figure 5-3. DOC Concentrations in the San Joaquin River

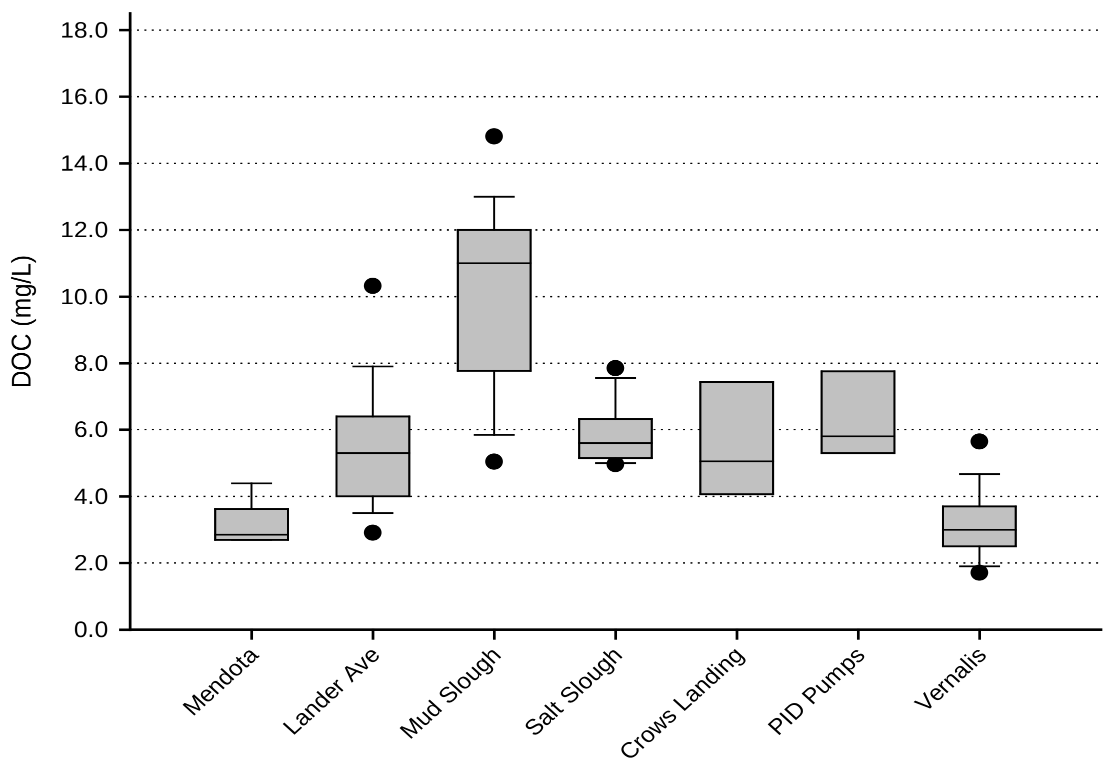


Table 5-2. TOC Summary Statistics (mg/L)

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Mendota	10/09-12/10	10	2.50 – 4.50	3.09	2.75	0.74	0.24	0.53
Lander Ave	7/08-12/12	68	0.96[a] - 10.00	5.94	5.45	2.27	0.27	0.55
Mud Slough	1/09-12/10	30	5.20 – 17.00	10.66	11.50	2.74	0.50	1.02
Salt Slough	1/09-12/10	30	4.90 – 8.50	5.95	5.70	0.91	0.17	0.34
Crows Landing	5/09-11/10	8	1.91 – 6.86	4.67	4.63	1.65	0.58	1.38
PID Pumps	2/09-12/10	5	5.20 – 9.00	6.32	5.80	1.58	0.71	1.96
Vernalis	1/08-12/12	396	1.30 – 11.00	3.83	3.60	1.46	0.07	0.14

[a]the low value of 0.96 could be due to a data entry error. A TOC value of 9600 mg/L was changed to 9.60 at Lander Ave.

Table 5-3. DOC Summary Statistics (mg/L)

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Mendota	10/09-12/10	10	2.70 – 4.40	3.18	2.85	0.66	0.21	0.47
Lander Ave	7/08-12/12	65	2.60 - 11.00	5.53	5.30	1.90	0.24	0.47
Mud Slough	1/09-12/10	30	4.70 – 17.00	10.20	11.00	2.79	0.51	1.04
Salt Slough	1/09-12/10	30	4.90 – 8.00	5.86	5.60	0.87	0.16	0.32
Crows Landing	5/09-11/10	7	3.11 – 13.00	6.17	5.05	3.31	1.25	3.06
PID Pumps	2/09-12/10	5	5.30 – 9.40	6.38	5.80	1.72	0.77	2.14
Vernalis	1/08-12/12	412	1.10 – 9.20	3.19	3.00	1.17	0.06	0.11

Salinity

Salinity in source water is the concentration of dissolved salts in a given volume of an aqueous solution. High levels of salinity can cause an unpleasant taste, making it less suitable for drinking water purposes. In an aqueous solution, dissolved salts exist as charged ionic species and increase the electrical conductivity of water. As a result, the EC of a solution is used as an indirect measure of its salinity. A more direct measure of salinity is the weight of the TDS present in a sample. Secondary MCLs have been established by the USEPA and the DDW. Although the federal guidelines are not enforceable, the California standards are. Table 5-4 lists the secondary MCLs for salinity.

For salinity, similar trends are seen from upstream to downstream as those seen with TOC and DOC. EC was measured at Mendota with a median of 401µS/cm, a relatively low value when being compared to the rest of the stations. Between Mendota and Lander Avenue, EC increases quite significantly with a median of 890 µS/cm. Mud and Salt Slough join the San Joaquin River further downstream of the Lander Avenue station, and as Figure 5-4 shows, have incredibly high EC levels with medians of 1960 µS/cm for Mud Slough and 1344 µS/cm for Salt Slough. It is no surprise then to see that the median EC at Crows Landing (1163 µS/cm) increased from Lander Avenue. The influence of the Merced River can be seen with the decrease of EC between Crows Landing and the PID Pumps (with a median EC of 930 µS/cm). Further downstream at Vernalis (with a median EC of 558 µS/cm) the influences of the Tuolumne and Stanislaus Rivers can be seen as EC decreased again. As Figure 5-5 shows, TDS has a very similar trend to EC, although there are fewer stations with data. Data was not available at Mendota, but the influences of the eastside tributaries as well as the agricultural drainage of the two sloughs can be seen. Median TDS of 455 mg/L at Lander Avenue is relatively low. However, with Mud and Salt Sloughs having a median TDS of 990 mg/L and 755 mg/L respectively, an increase of TDS is expected and seen at the PID Pumps with a median of 675 mg/L. Moving further downstream however, TDS decreases once at Vernalis with a median TDS of 329 mg/L. Tables 5-5 and 5-6 present the summary statistics for EC (5-5) and TDS (5-6).

Table 5-4. Secondary Maximum Contaminant Levels

	Maximum Contaminant Level Ranges		
Constituent	**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

Figure 5-4. EC Concentrations in the San Joaquin River

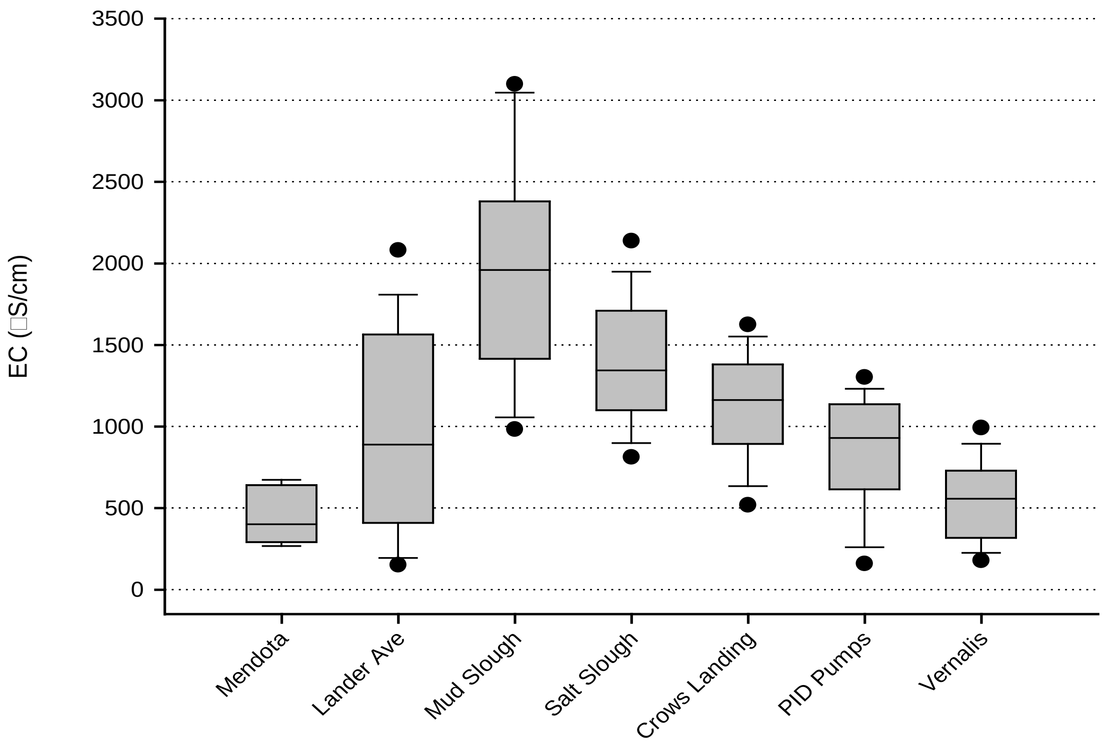


Figure 5-5. **TDS Concentrations in the San Joaquin River**

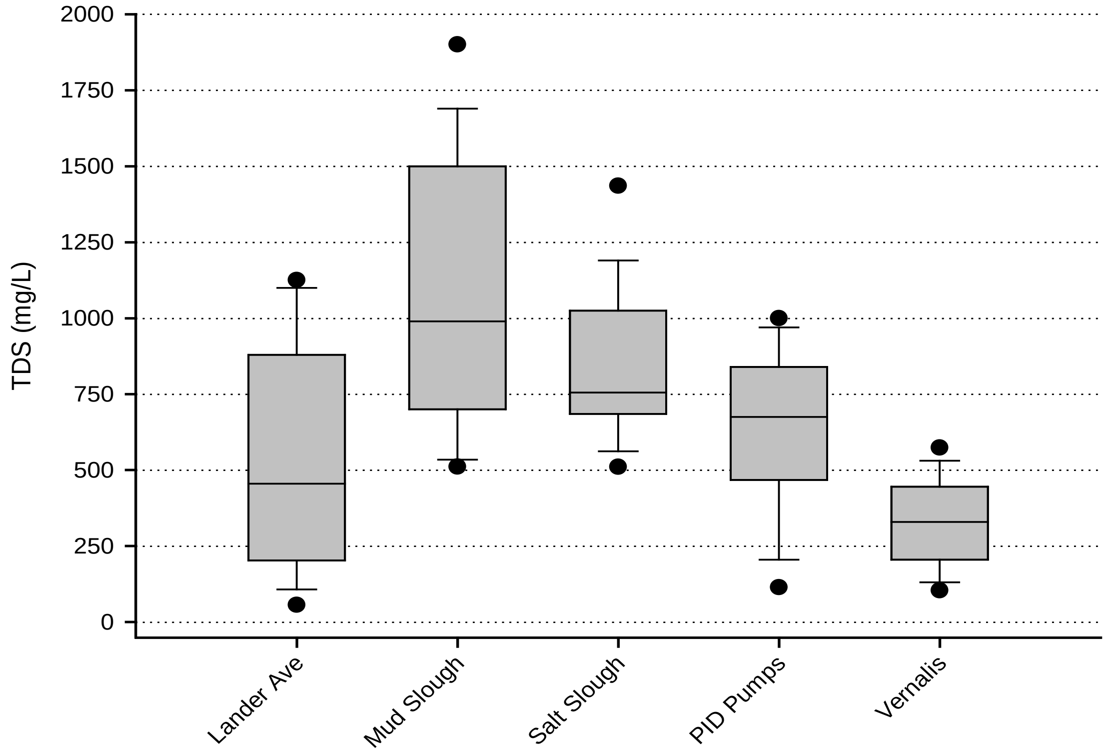


Table 5-5. **EC Summary Statistics (µS/cm)**

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Mendota	11/09-12/10	9	268 – 673	444	401	168	56	129
Lander Ave	1/08-12/12	242	41 - 3186	1002	890	651	42	82
Mud Slough	1/09-12/10	27	93 – 3130	1922	1960	659	127	261
Salt Slough	1/09-12/10	132	12 – 2773	1391	1344	441	38	76
Crows Landing	1/09-12/10	844	242 – 1885	1126	1163	339	12	23
PID Pumps	9/08-2/13	56	131 – 1410	848	930	348	46	93
Vernalis	1/08-12/12	129	134 – 1077	550	558	248	22	43

Table 5-6. TDS Summary Statistics (mg/L)

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Lander Ave	9/08-12/12	54	22 - 1300	522	455	368	50	100
Mud Slough	1/09-12/10	60	88 – 1100	1109	990	417	76	156
Salt Slough	1/09-12/10	30	510 – 1900	84	755	253	46	94
PID Pumps	9/08-2/13	30	460 – 1600	637	675	267	34	69
Vernalis	1/08-12/12	154	80 – 672	336	329	145	12	23

Bromide

Bromide, like organic carbon, is a constituent of concern due to its ability to react with oxidants used in the drinking water treatment process to form DBPs. When chlorine is used as a disinfectant, bromide reacts with chlorine and TOC to form brominated trihalomethanes (THMs) and haloacetic acids (HAA5s). In drinking water distribution systems, the MCLs for THMs and HAA5s are 0.080 mg/L and 0.060 mg/L respectively, calculated as a running annual average. The concentrations are governed by the Stage 1 Disinfectants and Disinfection Byproducts (D/DBP) Rule. Bromide is found in three of the four THMs (bromodichloromethane, dibromochloromethane, and bromoform) and two HAA5s (monobromoacetic acid and dibromoacetic acid). Bromate, another DBP, is formed when ozone is used for disinfection. Bromate has a MCL of 0.010 mg/L. Source waters that contain both bromide and organic carbon can cause problems for drinking water treatment operators. Figure 5-6 presents bromide data for the targeted section of the San Joaquin River. Table 5-7 shows the summary statistics for bromide.

With the exception of Mud Slough, there was limited bromide data at the stations selected for evaluation. The impacts that both Mud and Salt sloughs and the eastside tributaries have on water quality are shown in the bromide data that was available. Lander Avenue is the furthest upstream station that had bromide data with a median of 1.0 mg/L. The bromide concentrations in Mud and Salt sloughs are substantially higher than at Lander Avenue, with a median of 1.60 mg/L and 1.35 mg/L, respectively. Figure 5-6 clearly shows the influences of the Merced, Tuolumne, and Stanislaus Rivers as bromide decreases dramatically with a median of 0.24 mg/L at Vernalis.

Figure 5-6. **Bromide Concentration in the San Joaquin River**

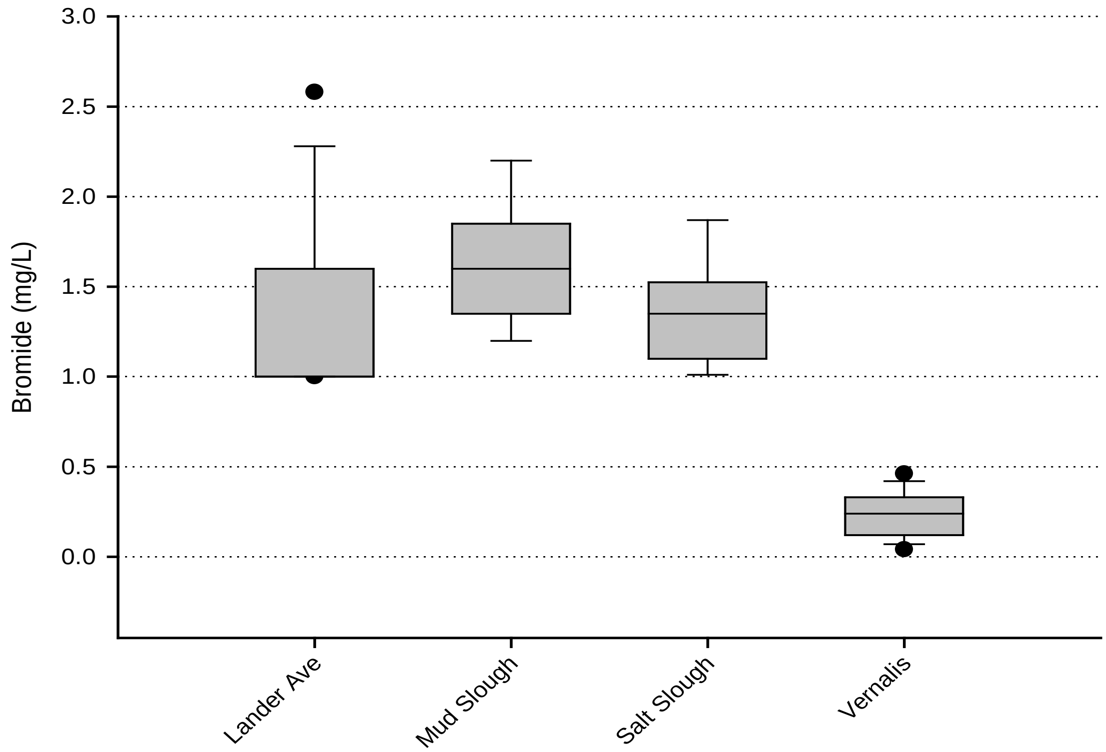


Table 5-7. **Bromide Summary Statistics (mg/L)**

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Lander Ave	9/08-12/12	21	1.00 – 2.60	1.32	1.00	0.48	0.10	0.22
Mud Slough	1/09-12/10	366	1.20 – 2.20	1.63	1.60	0.31	0.10	0.24
Salt Slough	1/09-12/10	9	1.00 – 1.90	1.35	1.35	0.27	0.09	0.19
Vernalis	1/08-12/12	10	0.02 – 0.54	0.24	0.24	0.13	0.01	0.01

Non detects were included in the analysis and reported as the reporting limit of 0.01 mg/L

Nutrients

Although nutrients are necessary for the overall health of an aquatic ecosystem, a number of issues can arise if they are found in drinking water supplies in excess of the natural background levels. Algal growth can lead to concerns regarding taste and odor in drinking water, produce algal toxins, contribute organic carbon, obstruct water conveyance facilities, clog filters, decrease the overall quality of drinking water, and increase the cost of handling solid waste during the treatment process. While ammonia concentrations are generally low in surface water, an excess of algal growth can result in anaerobic conditions when the algae decompose and settle out of the water column. An increase in ammonia concentrations can lead to higher levels of DBPs by impacting the amount of chorine used.

Measuring nutrient concentrations can provide an idea of the potential for algal and vascular plant growth. Nitrogen and phosphorus are the most important required nutrients. Nitrogen in the aquatic environment can be present in several forms, organic nitrogen, ammonia, nitrite, nitrate, and gaseous nitrogen. Total nitrogen (used in this section) includes nitrate, nitrite, ammonia, and organic nitrogen. Gaseous nitrogen is not included in this measurement. Phosphorus can be present in both dissolved and particulate forms, and like nitrogen, phosphorus in large concentrations can lead to algal blooms and accelerated plant growth (Environmental Protection Agency 2012), both of which can lead to complications in the drinking water treatment process. Dissolved orthophosphate (found in dissolved phosphorus) is the only form that can be readily used for algal and plant uptake, but measuring total phosphorus is a better indicator of the system's productivity.

Total Nitrogen

Total nitrogen was calculated as the sum of TKN plus the nitrate + nitrite values. Figure 5-7 presents the total nitrogen data while Table 5-8 shows the summary statistics. Samples were collected for TKN and nitrate + nitrite at all locations except for Crows Landing; data for Crows Landing consisted of nitrate and TKN as shown in Table 5-9.

Figure 5-7 shows that total nitrogen levels along the San Joaquin River showed little variation among the stations. Concentrations increased slightly from Mendota (median 1.24 mg/L) to Lander Avenue (median 1.80 mg/L). Total nitrogen levels in both Mud and Salt Slough were relatively low although Mud Slough concentrations were lower (median 1.54 mg/L) than Salt Slough (median 1.93 mg/L), indicating the agricultural influences from Salt Slough. Total nitrogen concentrations at the PID Pumps increase with a median 5.40 mg/L. Data from the PID Pump station may be skewed due to one total nitrogen value recorded at 29.7 mg/L. Downstream at Vernalis, total nitrogen levels decreased with a median 1.80 mg/L.

Figure 5-7. Total Nitrogen Concentrations in the San Joaquin River

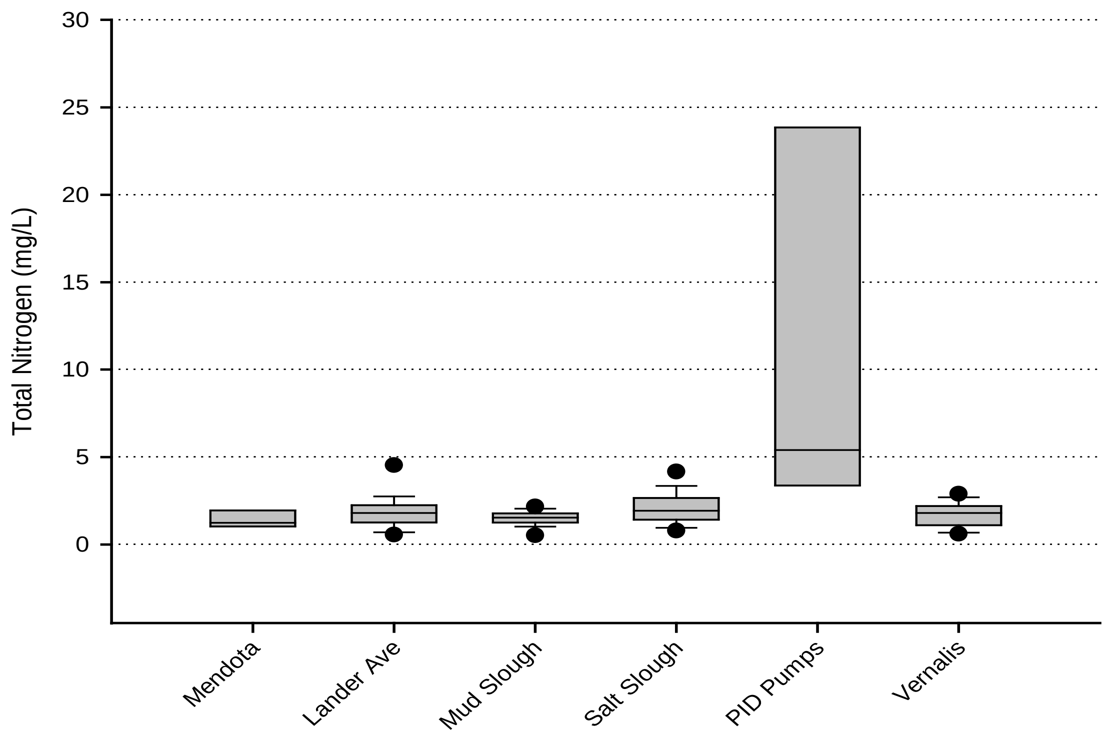


Table 5-8. Total Nitrogen Summary Statistics (mg/L)

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Mendota	10/09-4/10	4	1.02 – 2.14	1.41	1.24	0.51	0.26	0.82
Lander Ave	9/08-12/12	49	0.31 - 7.50	1.90	1.80	1.21	0.17	0.35
Mud Slough	1/09-12/10	25	0.32 – 2.19	1.51	1.54	0.41	0.08	0.17
Salt Slough	1/09-12/10	25	2.99 – 0.36	2.07	1.93	0.90	0.18	0.37
PID Pumps	2/09-12/10	4	2.99 – 29.71	10.88	5.40	12.63	6.31	20.09
Vernalis	1/08-12/12	168	0.36 – 3.80	1.72	1.80	0.72	0.06	0.11

Table 5-9. Crows Landing Nitrate and TKN Summary Statistics (mg/L as N)

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Nitrate	1/09-12/10	36	0.63 – 5.50	1.91	1.80	0.84	.014	0.28
TKN	1/09-11/10	31	0.50 – 1.30	0.78	0.78	0.22	0.04	0.08

Ammonia

Ammonia, as a drinking water constituent, is not regulated by primary or secondary standards. The USEPA recommends, however, that ammonia be considered as a potential source of nitrates in drinking water. Primary sources of ammonia in surface waters are fertilizers, sewage, and livestock manure. Figure 5-8 presents the ammonia data for the stations selected, followed by the summary statistics in Table 5-10.

Figure 5-8 does not show the same trends in ammonia concentrations as the other constituents discussed so far. Since ammonia is not a conservative constituent and it is rapidly converted to nitrate in surface waters containing oxygen, upstream to downstream comparisons do not necessarily reflect accurate concentrations of ammonia in the watershed or dilution effects by higher quality inflows. At Lander Avenue, the median ammonia concentration is 0.14 mg/L. Mud and Salt sloughs both have higher ammonia concentrations than the Lander Avenue station, with medians of 0.29 mg/L and 0.16 mg/L respectively. The ammonia median of 0.15 mg/L at the PID Pumps is similar to the Lander Avenue median concentration. At Vernalis, the ammonia concentrations decrease to a median of 0.01 mg/L.

Figure 5-8. Ammonia Concentrations in the San Joaquin River

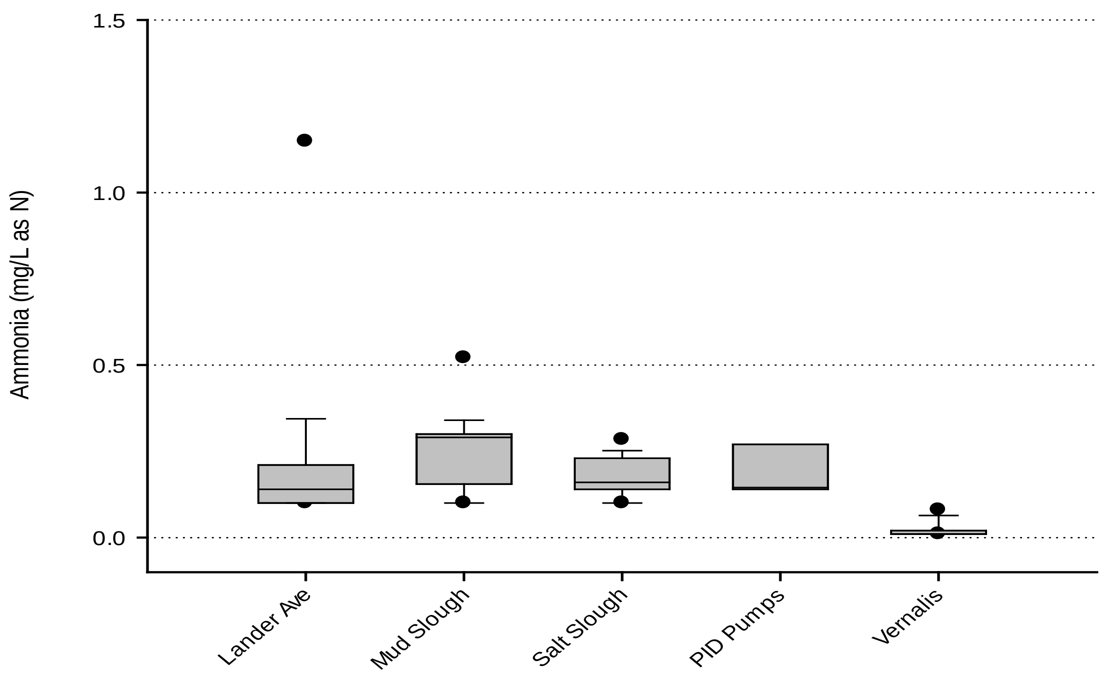


Table 5-10. Ammonia Summary Statistics (mg/L as N)

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Lander Ave	10/08-12/12	65	0.10 – 4.10	0.28	0.14	0.67	0.11	0.11
Mud Slough	1/09-12/10	21	0.10 - 0.54	0.24	0.29	0.11	0.02	0.02
Salt Slough	1/09-12/10	27	0.10 – 0.30	0.18	0.16	0.06	0.01	0.01
PID Pumps	2/09-12/10	4	0.14 – 0.31	0.19	0.15	0.08	0.04	0.04
Vernalis	1/08-12/12	125	0.01 – 0.20	0.02	0.01	0.03	0.00	0.00

Total Phosphorus

Total phosphorus was measured at fewer stations than total nitrogen, and its concentrations can be found in Figure 5-9. The summary statistics are shown in Table 5-11.

Total phosphorus was not measured at Mud and Salt Sloughs. An upstream to downstream trend is seen along the San Joaquin River, as shown in Figure 5-9. Total phosphorus increased downstream at Lander Avenue with a median of 0.18 mg/L. Even though there is no data from Mud and Salt sloughs, their effects are still seen with total phosphorus concentrations increasing further downstream at Crows Landing, with a median of 0.23 mg/L and at the PID Pumps with a median of 0.28 mg/L. Vernalis had a median of 0.14 mg/L due to mixing of the San Joaquin River with the eastside tributaries.

Figure 5-9. Total Phosphorus Concentrations in the San Joaquin River

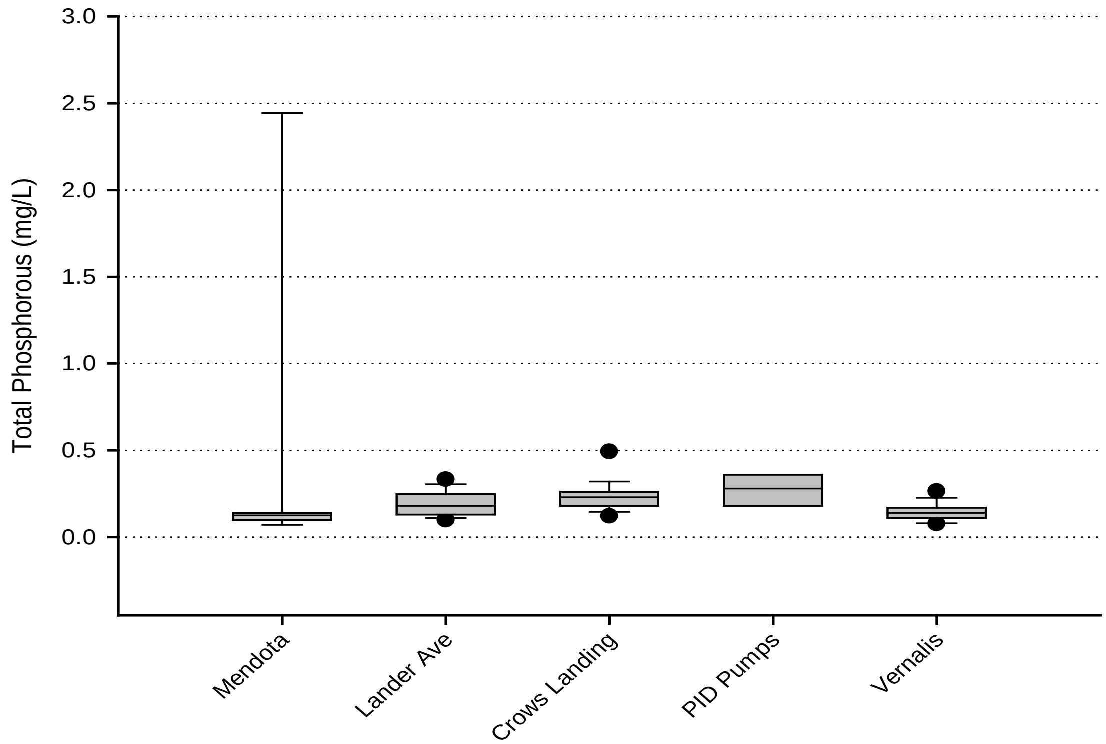


Table 5-11. Total Phosphorus Summary Statistics (mg/L)

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Mendota	10/09-12/10	10	0.07 – 2.70	0.37	0.13	0.82	0.26	0.59
Lander Ave	9/08-12/12	54	0.09 - 0.37	0.19	0.18	0.07	0.01	0.02
Crows Landing	1/09-11/10	35	0.09 – 0.50	0.23	0.23	0.08	0.01	0.03
PID Pumps	2/09-12/10	5	0.18 – 0.40	0.27	0.28	0.09	0.04	0.12
Vernalis	1/08-12/12	132	0.05 – 0.39	0.15	0.14	0.06	0.01	0.01

Turbidity

Turbidity is an optical measurement of the opacity of water. Suspended particulate matter in a body of water impairs the transmission of light through the water. As such, turbidity is a general indirect measurement of the concentration of particulate matter suspended in the water column. Turbidity can limit the growth of algae and cyanobacteria that cause taste and odor (T&O) issues in treated drinking water, by reducing the amount of light penetration. Furthermore, turbidity can assist with water treatment by aiding in attaining efficient flocculation and sedimentation, as well as be an indicator of microbial contamination. The challenges that high turbidity values possess however, are issues with clarifying and disinfecting the water, the expenses related to the treatment chemicals used, and the sludge handling. Figure 5-10 presents the turbidity data while the summary statistics are found in Table 5-12.

Figure 5-10 shows turbidity following the same general trends from upstream to downstream. Turbidity was quite high at Mendota with a median of 10.85 NTU. Between Mendota and Lander Avenue, turbidity increases with a median of 23.00 NTU. Salt Slough's turbidity contribution to the San Joaquin River was greater than Mud Slough, with a median of 21.00 NTU for Mud Slough and 30.00 NTU for Salt Slough. Both sloughs and Crows Landings have relatively high turbidity readings, indicating limited dilution effects from the Merced River on the San Joaquin River. Further downstream at the PID Pumps, the effect the Merced River had on water quality of the San Joaquin River can be seen as the median turbidity at the PID Pumps decreases to 17.00 NTU. The decrease in turbidity at Vernalis could be attributed to the influences of the Tuolumne and the Stanislaus Rivers on the San Joaquin River.

Figure 5-10. Turbidity in the San Joaquin River

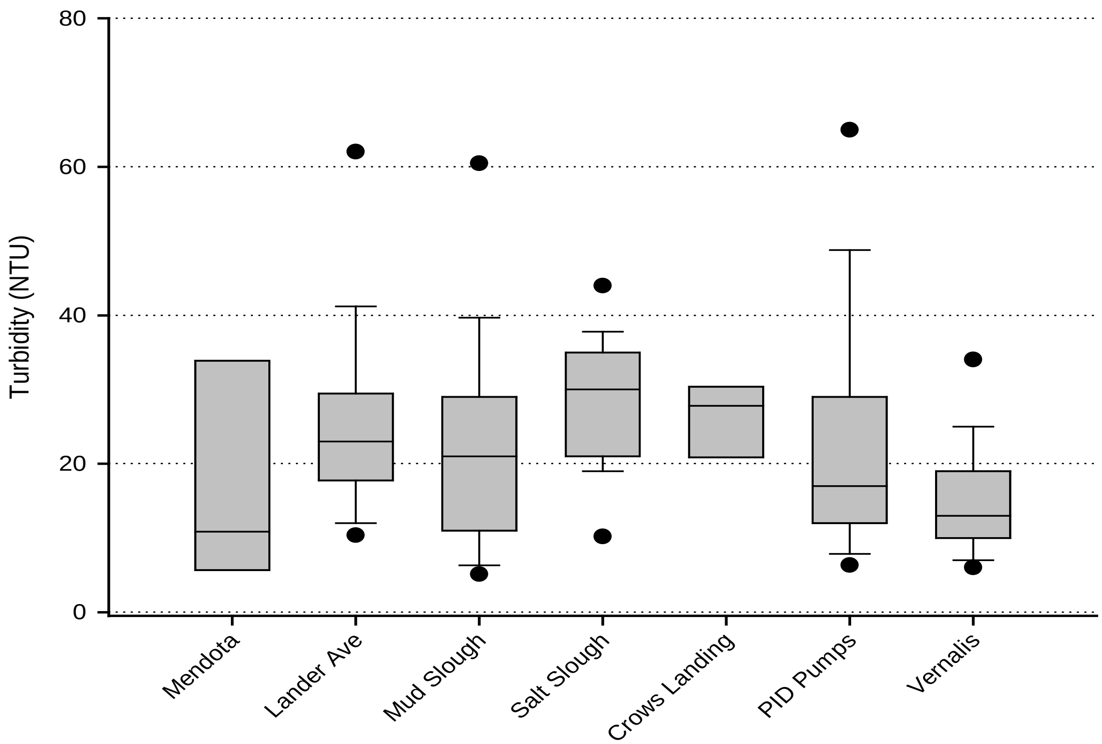


Table 5-12. Turbidity Summary Statistics (NTU)

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Mendota	11/09-6/10	4	4 – 41.50	16.80	10.85	16.78	8.39	26.70
Lander Ave	9/08-12/12	66	4.10 - 70.00	25.56	23.00	13.45	1.66	3.31
Mud Slough	1/09-12/10	30	4.50 – 83.00	22.48	21.00	15.77	2.88	5.89
Salt Slough	1/09-12/10	31	7.40 – 46.90	28.62	30.00	8.54	1.53	3.13
Crows Landing	5/09-11/10	8	15.10 – 37.60	26.58	27.80	6.94	2.45	5.80
PID Pumps	9/08-2/13	60	6.00 – 70.00	22.76	17.00	15.84	2.05	4.09
Vernalis	1/08-12/12	154	6.00 – 116.00	15.87	13.00	11.45	0.92	1.82

Pathogen Indicator Organisms

Pathogenic bacteria, viruses, protozoa, and non-pathogenic naturally occurring microorganisms all may contaminate source waters (Environmental Protection Agency 2013). It is impractical to monitor for all possible pathogens, therefore source water monitoring focuses on indicator bacteria and the regulated pathogenic protozoa *Cryptosporidium* and *Giardia*. DDW staff has historically relied on monthly median total coliform levels as a guide for treatment levels associated with pathogen monitoring. Coliform bacteria is present in the intestines of humans and other warm blooded animals, and are found in large quantities in fecal wastes. Their presence does not automatically indicate fecal contamination as most species occur in the natural aquatic environment. DDW has started to rely upon fecal coliform and *Escherichia coli* (*E. coli*) as specific indicators of mammalian fecal contamination. Trends amongst pathogen indicator organisms are difficult to identify due to limited available data, and sample frequency. Total coliform was sampled more frequently than fecal coliform, but at fewer stations.

Fecal Coliform

Figure 5-11 shows the fecal coliform data collected at the various stations. The summary statistics follows in Table 5-13.

As Figure 5-11 shows there are no clear downstream trends for fecal coliform. Levels for Mendota start off low with a median of 19.5 MPN/100 mL. Unlike the other constituents discussed in this chapter, the levels decrease moving downstream to Lander Avenue with a median of 12.0 MPN/100 mL. Mud and Salt Slough show higher fecal coliform levels with medians of 23.5 and 65.0 MPN/100 mL than the stations located upstream on the San Joaquin River. Downstream, the influence Salt Slough had on fecal coliform levels can be seen with the PID Pumps having a median of 70.0 MPN/100 mL. No data was available at Vernalis.

Figure 5-11. **Fecal Coliform Levels in the San Joaquin River**

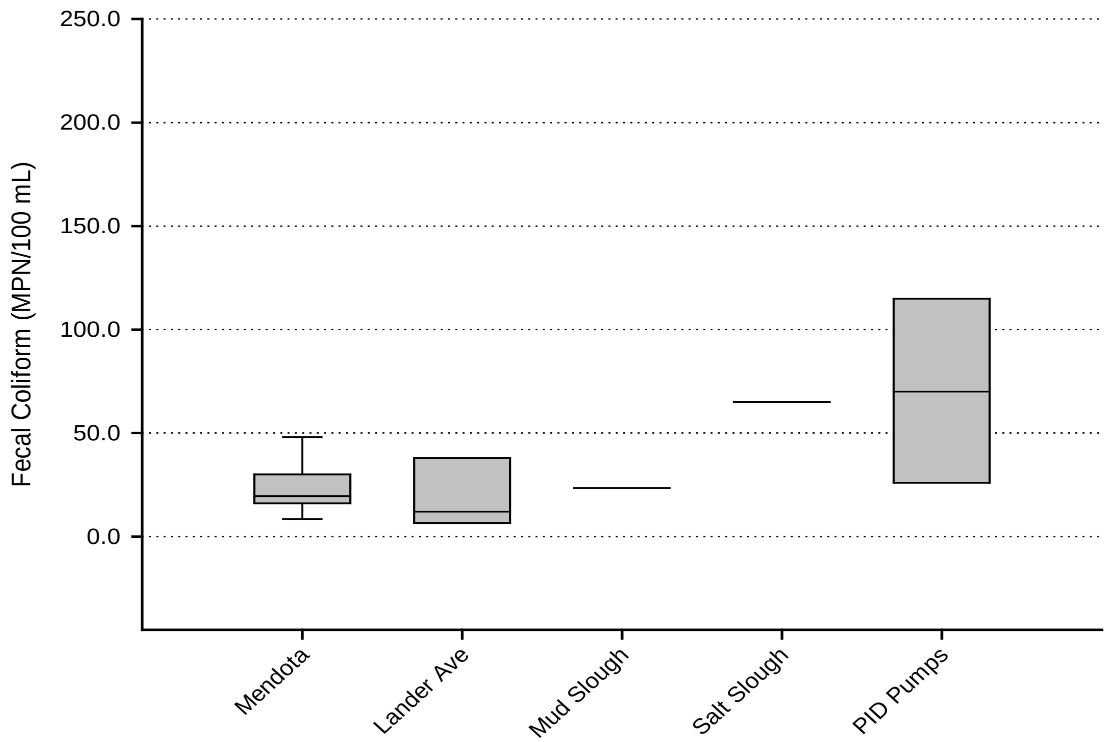


Table 5-13. **Fecal Coliform Summary Statistics (MPN/100 mL)**

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Mendota	10/09-12/10	10	8.0 – 50.0	23.1	19.5	11.9	3.8	8.5
Lander Ave	9/08-2/09	6	2.0 – 2.0	26.3	12.0	41.2	16.8	43.3
Mud Slough	1/09-2/09	2	17.0 – 17.0	23.5	23.5	9.2	6.5	78.2
Salt Slough	1/09-2/09	2	50.0 – 80.0	65.0	65.0	21.2	15.0	180.5
PID Pumps	9/08-2/09	6	14.0 – 220.0	80.7	70.0	73.0	29.8	76.6

Total Coliform

Total coliform was sampled at fewer stations but at a higher frequency. Figure 5-12 presents total coliform levels in the San Joaquin River and Table 5-14 presents the summary statistics.

It is not possible to see the trends associated with total coliform as several of the stations have a consistent recorded value of > 2419.6 MPN/100 mL. Mendota is the only station that measured total coliform with levels well below those of 2419.6 MPN/100 mL with a median of 365.0 MPN/100 mL, but also had the smallest sample size of 10. For the other stations, Lander Avenue had 68 out of 85 samples recorded as > 2419.6 MPN/100 mL, Salt Slough had 43 out of 44, and Crows Landing had 45 out of 50.

Figure 5-12. **Total Coliform Levels in the San Joaquin River**

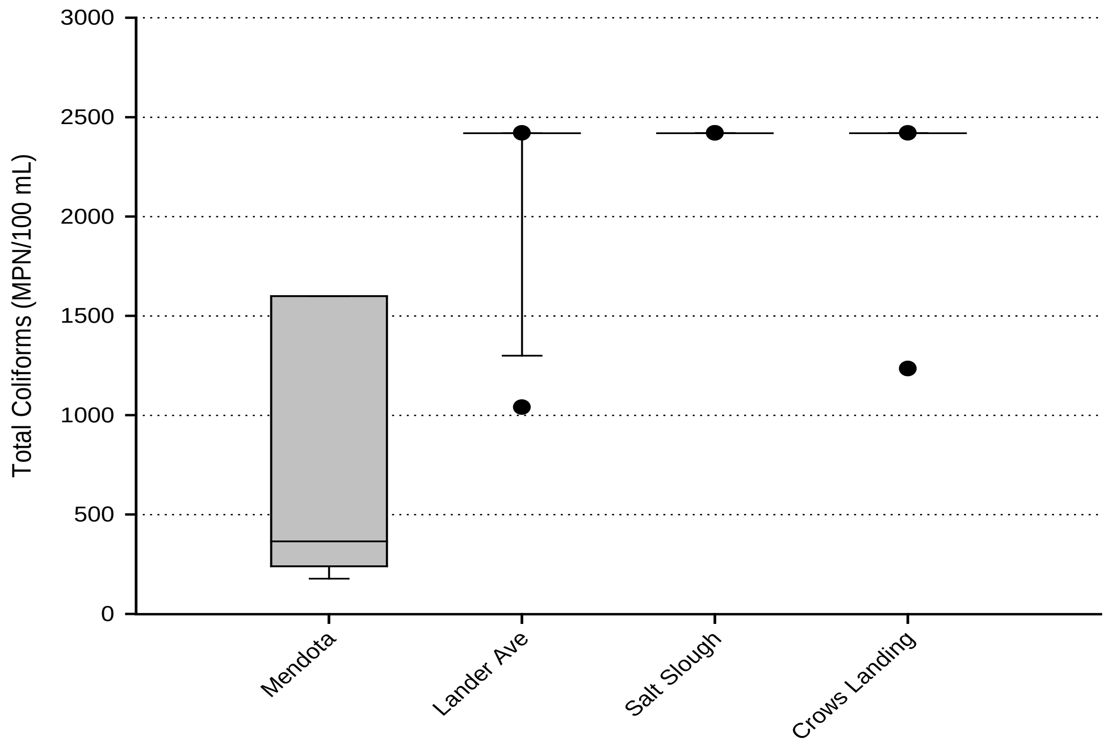


Table 5-14. **Total Coliform Summary Statistics (MPN/100 mL)**

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Mendota	10/09-12/10	10	170.0 – 1600.0	692.0	365.0	634.0	200.5	453.6
Lander Ave	1/08-5/12	85	686.7 – 2419.6	2255.0	2416.6	440.1	48.0	95.5
Mud Slough	1/09-12/10	44	130.8 – 2420.0	2367.6	2419.6	345.1	52.0	104.9
Crows Landing	1/09-12/10	50	1011.2 – 2419.6	2343.1	2419.6	309.3	43.7	87.9

E. coli

Figure 5-13 shows *E. coli* levels in the San Joaquin River. The summary statistics can be found in Table 5-15.

As Figure 5-13 shows, *E. coli* was sampled at all of the locations selected except for Vernalis. Downstream trends for *E. coli* were consistent with the other constituents. Upstream, Mendota had a median level of 15.0 MPN/100 mL, showing an increase in *E. coli* levels further downstream at Lander Avenue which had a median level of 44.9 MPN/100 mL. Mud and Salt sloughs had the highest levels, with Mud Slough having a median of 160.0 MPN/100 mL and Salt Slough having a median of 115.3 MPN/100 mL. The influences of both sloughs can be seen in the *E. coli* levels at Crows Landing, which increased from Lander Avenue, but decreased from Mud and Salt sloughs with a median level of 100.2 MPN/100 mL. At the PID Pumps, the effect of the Merced River on *E. coli* levels can be seen as the median decreases to 54.5 MPN/100 mL. With data being unavailable at Vernalis, effects the Tuolumne and Stanislaus Rivers on *E. coli* levels is unknown.

Figure 5-13. *E. coli* Concentrations in the San Joaquin River

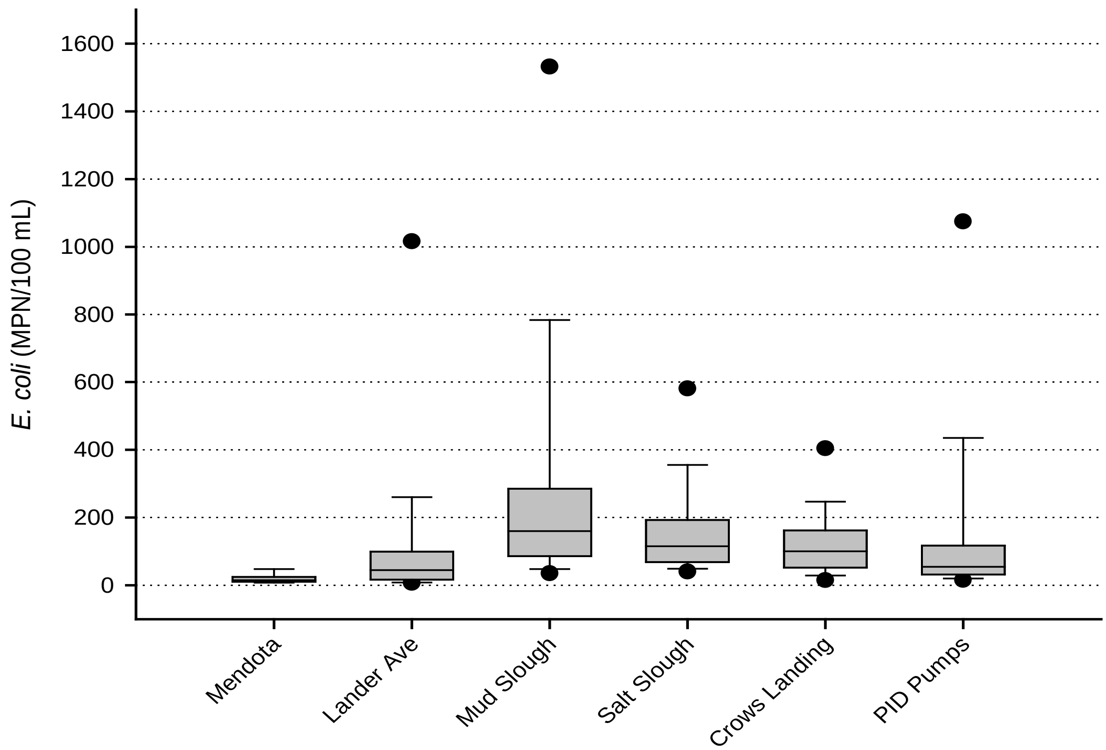


Table 5-15. *E. coli* Summary Statistics (MPN/100 mL)

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Mendota	10/09-12/10	10	8.0 – 50.0	19.5	15.0	4.1	8.39	9.2
Lander Ave	1/08-12/12	138	2.0 – 2419.6	165.9	44.9	35.3	1.66	69.7
Mud Slough	1/09-12/10	30	24.0 – 2400.0	285.2	160.0	81.9	2.88	167.5
Salt Slough	1/09-12/10	73	22.0 – 980.0	175.6	115.3	21.7	1.53	43.3
Crows Landing	1/09-12/10	50	10.9 – 579.4	128.2	100.2	15.8	2.45	31.7
PID Pumps	9/08-2/13	60	12.0 – 2400.0	163.4	54.5	47.5	0.92	95.0

Trace Elements and Pesticides

Arsenic

A number of inorganic chemicals have MCLs; however, most of them are present in surface waters at concentrations well below the MCLs. Arsenic, which has a California MCL of 10 µg/L, is occasionally found at concentrations that exceed the MCL. Figure 5-14 shows the arsenic concentration of the San Joaquin River while the summary statistics can be found in Table 5-16.

As Figure 5-14 shows, arsenic follows the same downstream trends that the other constituents have displayed. Mendota has one of the smaller medians of the stations sampled with a median concentration of 2.10 µg/L. There is an increase in arsenic concentrations downstream at Lander Avenue with a median of 3.60 µg/L. Mud and Salt slough arsenic concentrations are similar to those at Lander Avenue, with medians of 4.20 and 3.40 µg/L respectively and were not expected to cause an increase in arsenic concentrations dowstream. Arsenic concentrations decrease at the PID Pumps with a median of 2.80 µg/L because of dilution influences from the Merced River. Further downstream at Vernalis, the Tuolumne and Stanislaus Rivers have a greater dilution effect on arsenic concentrations as the median decreases further with a value of 1.40 µg/L. Crows Landing data was not included as data was unavailable. The MCL of 10 ug/L was exceed once at Lander Ave with a value of 12.0.

Figure 5-14. Arsenic Concentrations in the San Joaquin River

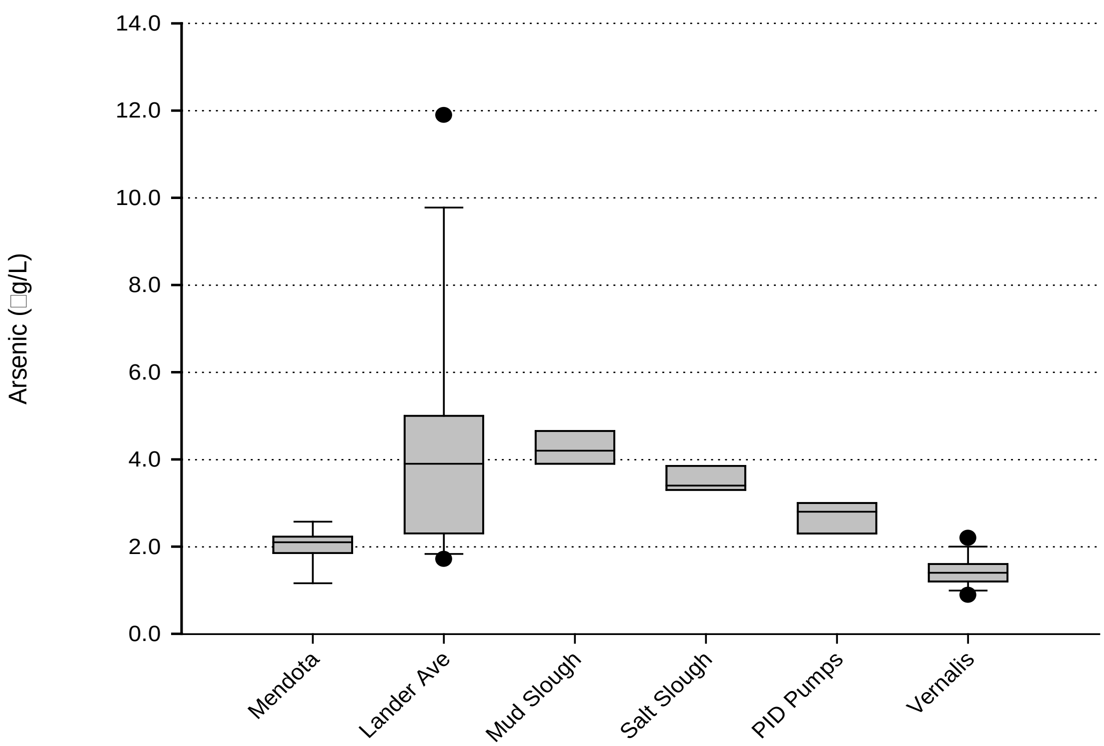


Table 5-16. Arsenic Summary Statistics (μg/L)

Station	Sample Date Range	Samples	Range	Mean	Median	Std. Deviation	Std. Error	95% Confidence
Mendota	10/09-12/10	10	1.10 – 2.60	2.01	2.10	0.40	0.13	0.29
Lander Ave	7/08-9/11	16	1.70 – 12.00	4.41	3.60	3.10	0.77	1.65
Mud Slough	1/09-12/10	5	3.30 – 3.90	4.26	4.20	0.38	0.17	0.47
Salt Slough	1/09-12/10	5	3.30 – 3.90	3.54	3.40	0.29	0.13	0.36
PID Pumps	2/09-1/11	7	1.90 – 3.50	2.66	2.80	0.53	0.20	0.49
Vernalis[a]	1/08-12/12	61	0.81 – 2.70	1.47	1.40	0.39	0.05	0.10

Data was obtained through USGS

Pesticides

The broad category of pesticides includes insecticides, herbicides, fungicides, and various other substances used to control pests. Pesticides derived from both agricultural and urban sources have the potential to impact aquatic life and drinking water sources (Environmental Protection Agency 2014). The DDW has established MCLs for organic chemicals, including pesticides that may pose a risk to human health and drinking water supplies, and these MCLs along with monitoring and compliance and health effects information can be found in the CCR Title 22, Article 5.5, Sections 64444-64468.5. Table 5-17 summarizes data collected for upstream through downstream stations along the San Joaquin River for pesticides that have an associated California MCL. This table, using data from those stations used to collect pesticide information, confirms that there isn't a significant concern with high pesticide concentrations in the San Joaquin River. Of the seven pesticides detected with current California MCLs, none were detected above their respective MCL. Of the pesticides detected with no current California MCLs (Table 5-18), there is no real discernable trend associated with numbers and concentration differences between upstream and downstream. Vernalis has more detected pesticides than the other stations, but this may be due to the USGS having a much more comprehensive sampling program.

Table 5-17. Summary of Pesticides in the San Joaquin River with MCLs (ug/L)

Station	Constituents	Standard	Detects[1] /Sample[2]	Range	Median[3]
PID Pumps	Diazinon	1.0	0/1	-	-
PID Pumps	Simazine	4.0	0/1	-	-
Vernalis[4]	Atrazine	1.0	29/106	0.004-0.015	0.006
Vernalis[4]	Diazinon	1.0	14/105	0.004-0.019	0.006
Vernalis[4]	Glyphosate	700.0	56/61	0.03-1.50	0.12
Vernalis[4]	Metolachlor	44.0	103/105	0.006-0.071	0.15
Vernalis[4]	Simazine	4.0	103/105	0.005-0.998	0.013

[1] Detects = Includes only samples above the reporting limit
[2] Samples = Number of samples collected
[3] Medians are calculated using values above the detection limit
[4] Collected by USGS

Table 5-18. Summary of Pesticides in the San Joaquin River without MCLs (ug/L)

Station	Constituents	Detects[1] /Sample[2]	Range	Median[3]
Lander Ave	Dimethoate	1/1	0.29	0.29
Lander Ave	Diuron	7/13	0.42 - 1.40	0.80
Lander Ave	EPTC	0/1	-	-
Mud Slough	Chlorpyrifos	0/1	-	-
Mud Slough	Diruon	2/5	0.44 - 0.50	0.47
Salt Slough	Chlorpyrifos	4/5	0.019 - 0.045	0.052
Salt Slough	Diruon	10/14	0.60 - 1.80	0.91
Salt Slough	Malathion	0/1	-	-
PID Pumps	Chlorpyrifos	5/5	0.033 - 0.016	0.023
PID Pumps	Dimethoate	2/2	0.26 - 0.70	0.5
PID Pumps	Diuron	1/2	0.61	0.61
PID Pumps	Malathion	0/1	-	-
PID Pumps	Pendimethalin	3/4	0.19 - 0.52	0.26
Vernalis[4]	Chlorpyrifos	58/105	0.003 - 0.018	0.006
Vernalis[4]	Diuron	18/19	0.01 - 0.43	0.03
Vernalis[4]	EPTC	24/105	0.002 - 0.033	0.003
Vernalis[4]	Malathion	8/105	0.007 - 0.63	0.10
Vernalis[4]	Methidathion	3/105	0.019 - 0.007	0.01
Vernalis[4]	Pendimethalin	3/105	0.007 - 0.019	0.01
Vernalis[4]	Hexazinone	95/105	0.001-0.17	0.02
Vernalis[4]	Prometryn	58/105	0.002-0.325	0.02
Vernalis[4]	Prometron	6/105	0.004-0.008	0.006
Vernalis[4]	2,4-D	9/19	0.02-0.63	0.12
Vernalis[4]	Norflurazon	2/19	0.01-0.08	0.45
Vernalis[4]	Metalaxyl	10/105	0.001-0.059	0.019
Vernalis[4]	Myclobutanil	33/105	0.004-0.021	0.009
Vernalis[4]	Oxyfluorfen	15/105	0.001-0.047	0.009
Vernalis[4]	Glufosinate	1/61	0.11	-
Vernalis[4]	Bifenthrin	2/2	0.04-3.3	1.85
Vernalis[4]	Permethrin	2/2	1.3-5.5	3.4
Vernalis[4]	Azoxystrobin	12/16	6.8-39.8	15.19
Vernalis[4]	Desulfinylfipronil	1/16	6.3	-
Vernalis[4]	Propiconzole	1/16	15.3	-
Vernalis[4]	Pyraclostrobin	1/16	20.2	-
Vernalis[4]	Boscalid	15/16	4.9-25.8	10.7
Vernalis[4]	Cyprodinil	1/16	9.2	-
Vernalis[4]	Difenoconazole	1/16	18.2	-
Vernalis[4]	Fenhexamid	1/16	53.4	-
Vernalis[4]	Metribuzin	2/105	0.009-0.014	0.012
Vernalis[4]	Trifluralin	11/105	0.001-0.013	0.004
Vernalis[4]	Ethoprop	2/105	0.012-0.033	0.023
Vernalis[4]	Benfluralin	1/105	0.003	-
Vernalis[4]	DCPA	68/105	0.001-0.013	0.003
Vernalis[4]	Propargite	3/105	0.017-0.044	0.027
Vernalis[4]	3,5-Dichloroaniline	1/105	0.002	-
Vernalis[4]	Desulfinylfipronil	16/105	0.002-0.009	0.005
Vernalis[4]	Aminomethylphosphonic Acid	59/61	0.05-4.4	0.31
Vernalis[4]	2,4-D plus 2,4 D-methyl ester	9/19	0.02-0.92	0.16

Vernalis[4]	3,4 Dichloroaniline	14/16	2.3-8.3	4.59
Vernalis[4]	N-(3,4-Dichorophenyl)-N'methylurea	12/16	4.6-32.3	12.77
Vernalis[4]	2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine	2/19	0.011-0.021	0.016

[1] Detects = Includes only samples above the reporting limit
[2] Samples = Number of samples collected
[3] Medians are calculated using values above the detection limit
[4] Collected by USGS

CHAPTER 6: KEY FINDINGS AND RECOMMENDATIONS

The key findings and recommendations from Chapters 4 and 5 are as follows:

Wastewater Treatment Plants

Within the defined San Joaquin River watershed, there are six wastewater treatment plants that discharge directly to the San Joaquin River or its tributaries. Flows from these wastewater treatment plants are discharged year-round and may pose a continuous threat to human health. Of the six wastewater treatment plants discharging in the San Joaquin River watershed, four have been built or upgraded to tertiary level treatment (Atwater, Manteca, Clovis, and Turlock) with two still remaining at secondary (Modesto and Merced).

Of the constituents of concern in regards to discharge by wastewater treatment plants, the following are the key findings:

- Pathogens such as *Giardia* and *Cryptosporidium* are not measured directly; therefore coliform levels are used as pathogen indicator organisms. Merced's coliform values were over 1600 MPN/100 mL, but only occurred four times in a three year period. The Other WWTPs coliform values were much lower.
- Tertiary treatment plants' process converts ammonia to nitrate. Since Modesto is not a tertiary treatment plant, ammonia concentrations were higher than the other plants. However, nitrate values were consistent among the plants except for Turlock. Turlock's nitrate concentrations ranged from 11.5 to 20.8 mg/L. Nitrite concentrations were consistent among the plants and remained relatively low. Total phosphorus was only collected at two plants (Modesto and Clovis), and the concentrations did not reach over 6.0 mg/L.
- Organic carbon does not have requirements established for effluent limitations. Modesto was the only location where TOC was measured. Based on the values provide by the Central Valley Drinking Water Policy Workgroup for a secondary treatment level, Modesto would not have been out of compliance.
- Salinity had the greatest impact from discharges by wastewater treatment plants. Modesto recorded concentrations over 1400 µmhos/cm while Turlock had concentrations above 1000 µmhos/cm. Manteca, Clovis, and Modesto all reported at least one Category 1 sanitary sewer overflow (SSO). Manteca reported one Category 1 SSOs totaling 1,800 gallons with 88.9% reaching surface water. Clovis reported eight Category 1 SSOs totaling 35,756 gallons with 84.0% reaching surface water. Modesto had 31 Category 1 SSOs totaling 83,277 gallons with 55.3% reaching surface water.

Recommendations

SWPCA and MWQI should use the National Pollutant Discharge Elimination System permits to track any changes being made to the wastewater treatment plants. Changes can include any proposed upgrades to the individual plants and/or changes in effluent limitations. Tracking of updates to Wastewater Treatment Plants may be conducted through periodic reviews of the NPDES permits, including updates in future Sanitary Surveys. In addition, MWQI and SWPCA should continue to contribute comments on waste discharge permit renewals. Lastly, the DDW should be notified by permit holders of any wastewater spills in the San Joaquin River Watershed.

Urban Runoff

Within the defined San Joaquin River watershed, urbanized areas discharge to the San Joaquin River or its tributaries due to generated rainfall and snowmelt events. The amount of monitoring required for urban runoff depends on the size of the municipality and is regulated through Municipal Separate Storm Sewer System (MS4) NPDES permits. Fresno and Modesto fall into Phase I permit holders (population sizes greater than 100,000).

- The City of Fresno's Stormwater Quality Management Programs (SWQMP) monitoring site data showed certain trends during the sampling seasons. There was generally an increase in constituents of concern (nutrients, coliforms, TOC, and salinity) during the wet season, most notably during the first storm event of the season. Sampling during the dry seasons generally reported low concentrations.
- The City of Modesto's Storm Water Management Plan (SWMP) monitoring site data along the Tuolumne River showed an increase in constituent concentrations, most notably coliforms, from upstream to downstream.

Low Impact Development (LID) was already a sustainable practice applied to NPDES permits for Phase I holders, but was also incorporated into the renewals of Phase II permits in 2013. The goal of LID is to use various techniques and practices to reduce the amount of runoff from development areas.

Hydromodification Management is a newer idea incorporated into the 2013 permits. This practice maintains post-project runoff flows to the levels of the pre-project condition.

Recommendations

There are no current recommendations for the management of urban runoff.

Agricultural Discharges

Within the defined San Joaquin River watershed, agricultural discharges affected nutrients and pesticide concentrations, as both exceeded MCLs and beneficial use numeric objectives. Sampling for nutrients and pesticides occurred under the Irrigated Lands Regulation Program. Fresno, Merced, and Stanislaus counties together exceeded the nitrate plus nitrite MCL on 80 occasions, with values ranging from 10 to 43 mg/L. Merced and Stanislaus County combined exceeded the nitrate MCL on 34 occasions, with values ranging from 11 to 35 mg/L. Most of the exceedances occurred in Stanislaus County.

There are 33 pesticides with Maximum Contaminant Levels (MCL)s in California, only 7 with MCL were detected. The seven pesticides detected in the study area were carbofuran, chlordane, endrin, glyphosate, methoxychlor, simazine, and toxaphene. Only simazine had four samples above the MCL of 4 µg/L, in Madera and Merced Counties, with concentrations ranged from 5.1 to 25 µg/L.

Recommendations

There are no current recommendations for the management of nutrients or pesticides.

Confined Animal Facilities

Within the defined San Joaquin River watershed, animal feeding operations in the past were known to impact surface water quality. Since the 2007 Waste Discharge Requirements General Order for Existing Milk Cow Dairies, dairies have been required to implement management plans and upgrade their facilities. Regulations provided a means to reduce runoff and eliminate animal waste from reaching surface waters. Outreach provided by the California Dairy Quality Assurance Program assisted farmers and helped improve sanitary conditions at their facilities. Dairies have reduced surface water quality pollution, and are in compliance for surface water quality standards and regulations. No discharges were reported during the reporting period to surface water. Groundwater is currently the main focus of the Executive Officer.

Recommendations

There are no current recommendations for the management of confined animal facilities.

Water Quality

Within the defined San Joaquin River watershed, various river systems affected changes in water quality from upstream to downstream. Mendota was the furthest upstream location and had the lowest concentrations of the constituents focused on in this report (organic carbon, nutrients, salinity, pathogens, and pesticides). In every case where constituents were measured at both Mendota and Lander Avenue, there was an increase in concentrations. From Lander Avenue to Crows Landing and PID Pumps, many of the constituents continued to increase in concentration, most notably the total phosphorus and salinity concentrations. Vernalis showed some of the lower concentrations of constituents in the study area.

The influences of the eastside tributaries of the San Joaquin River (the Merced River, Tuolumne River, and the Stanislaus River) can be seen as water quality generally improves after the terminus of each river. The data at Vernalis confirms this fact as the station is downstream of all three tributaries.

Alternatively, with the beneficial effects that the eastside tributaries have on water quality in the San Joaquin River, the exact opposite can be said of Mud and Salt sloughs. In cases where data was collected at Mud and Salt sloughs in conjunction with the other stations, the concentrations of constituents were always higher than those of the other stations, and generally Mud Slough had higher concentrations than that of Salt Slough. This is due to the amount of agricultural discharge that flows into the San Joaquin River through Mud and Salt sloughs.

Although the concentrations of constituents are lower at Vernalis than most of the other stations on the San Joaquin River, this does not necessarily mean the water is of high quality. Vernalis still has high concentrations of most of the constituents.

Recommendations

Due to the extensive monitoring efforts currently under taken by MWQI at Vernalis, it is not recommended to pursue any further actions. The amount of data currently collected is sufficient in supplying the State Water Project Contractors with accurate and reliable information regarding the real-time status of San Joaquin River water quality.