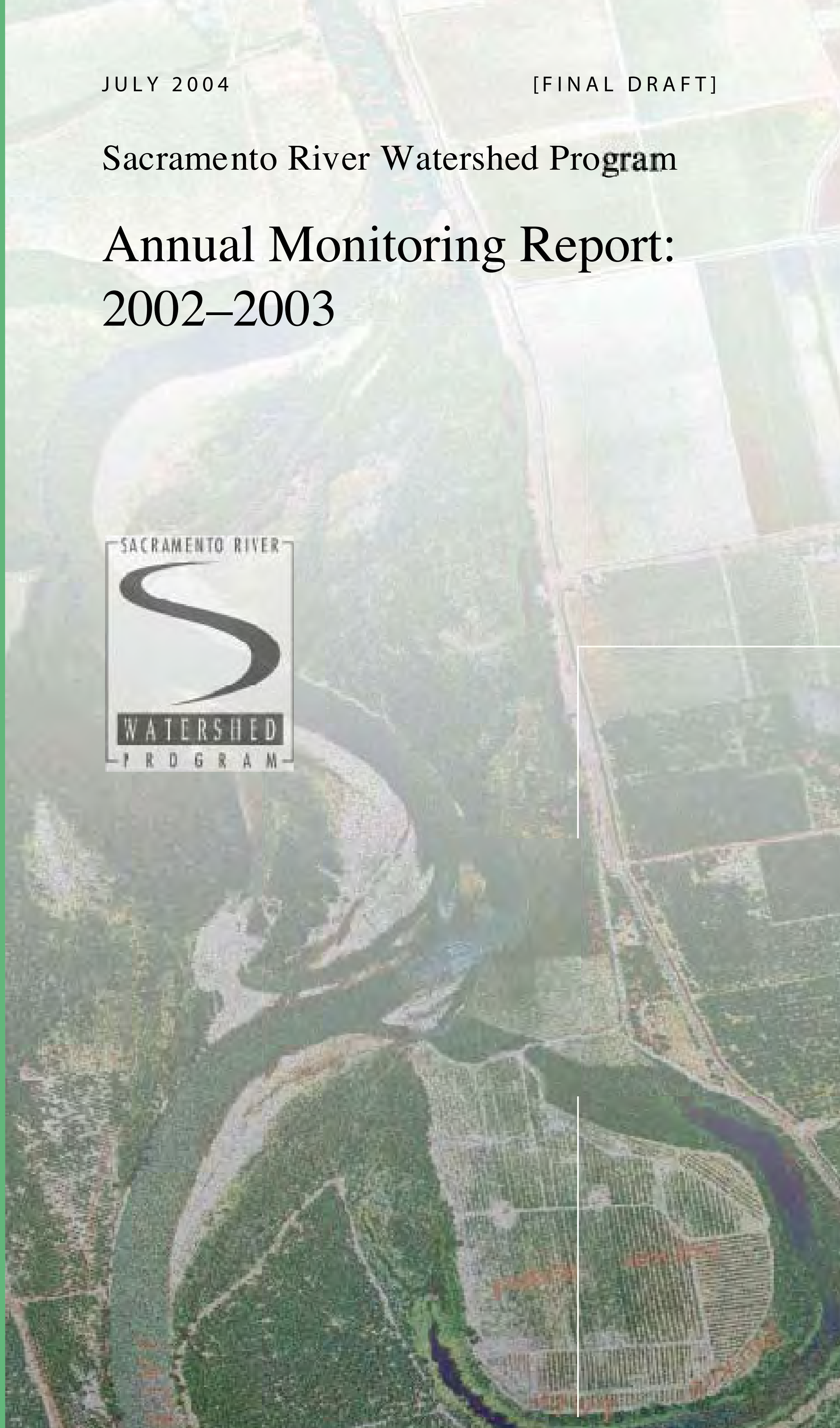
JULY 2004 [FINAL DRAFT]

Sacramento River Watershed Program

Annual Monitoring Report: 2002–2003



REPORT REVIEW PROCESS

The review process and schedule for the 2002-2003 Annual Monitoring Report of the Sacramento River Watershed Program (SRWP) is outlined in the table below. This process includes internal reviews by the SRWP Monitoring, Toxics, and Public Outreach and Education Subcommittees, peer review by outside experts, and review by all SRWP stakeholders and other interested public. The Final Report is also available from the SRWP website,

http://www.sacriver.org.

Comments received for the Public Draft Annual Monitoring Report were compiled and are responded to in Appendix E of this document.

SRWP Annual Monitoring Report (AMR) Review and Submittal Schedule

	Date	**Review Milestones**
☒	4-9-2004	AMR Administrative Draft submitted to Monitoring Subcommittee
☒	5-5-2004	Comments on Administrative Draft Due from Monitoring Subcommittee
☒	5-12-2004	Public draft released for stakeholder and peer review
☒	6-18-2004	Comments on Public Draft due from all reviewers
☒	7-9-2004	Submit Final AMR to SRCSD, Monitoring Subcommittee, and USEPA

ACKNOWLEDGEMENTS

The Sacramento River Watershed Program Monitoring Program and the Annual Monitoring Report are products of the efforts of many people. A great deal of effort has been expended in field, laboratory, and office work to collect and analyze samples, to manage, summarize data, and to interpret the results of the Sacramento River Watershed Program monitoring effort. While the names of all of the individuals involved in the SRWP monitoring program are too numerous to list here, we would like to gratefully acknowledge the assistance of all of the participating members of the Monitoring Subcommittee, the Toxics Subcommittee, the Biological and Habitat Subcommittee, and the Public Outreach and Education Subcommittee. The members of these committees have provided invaluable assistance and advice in developing the monitoring program and in preparing and reviewing this document. We are also grateful for the efforts of the Peer Reviewers of this report. Their insightful comments and recommendations have resulted in substantial improvements to this document.

In additional to the participating SRWP Subcommittee members, the following agencies and contractors have been instrumental in implementing the SRWP monitoring program:

U. S. Environmental Protection Agency (USEPA)

Sacramento Regional County Sanitation District (SRCSD)

Central Valley Regional Water Quality Control Board (CVRWQCB)

and ...

BioVir Laboratories

California Department of Fish and Game (CDFG)

California Department of Water Resources (CDWR)

Larry Walker Associates (LWA)

Moss Landing Marine Lab (MLML)

Office of Environmental Health and Hazard Assessment (OEHHA)

Pacific EcoRisk

San Francisco Estuary Institute (SFEI)

Sierra Foothill Laboratory (SFL)

U. S. Geological Survey (USGS)

University of California Aquatic Toxicology Laboratory (UCD-ATL)

ACRONYMS AND ABBREVIATIONS

CCC	Criterion Continuous Concentration
CDFG	California Department of Fish and Game
CDHS	California Department of Health Services
CDWR	California Department of Water Resources
CDPR	California Department of Pesticide Regulation
CSBP	California Stream Bioassessment Procedure
CTR	California Toxics Rule
CVRWQCB	Central Valley Regional Water Quality Control Board
D/DB-P	Disinfection/Disinfection By-Product Rule
DDTs	Dichlorodiphenylethane compounds
DOC	Dissolved Organic Carbon
ICR	Information Collection Rule
MCLs	Maximum Contaminant Levels
µg/L	micrograms per liter
mg/L	milligrams per liter
MPN/100 mL	Most Probable Number of Bacteria per 100 mL
MWQI	California Department of Water Resources Municipal Water Quality Investigations Program
NAWQA	National Water Quality Assessment Program
ng/L	nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NTR	National Toxics Rule
NTU	Nephelometric Turbidity units
PBO	Piperonyl Butoxide
PCBs	Polychlorinated Biphenyls
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SRCSD	Sacramento Regional County Sanitation District
TIE	Toxicity Identification Evaluation
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TSS	Total suspended Solids
USEPA	U.S. Environmental Protection Agency

EXECUTIVE SUMMARY

WHAT IS IN THIS REPORT?

This is the fifth Annual Monitoring Report for Sacramento River Watershed Program (SRWP). This document provides a review of the Sacramento River Watershed Program (SRWP) monitoring effort and the data generated by the SRWP and other collaborating water quality monitoring programs (USGS NAWQA, Sacramento River Coordinated Monitoring Program, City of Redding NPDES Monitoring, Department of Water Resources Northern District tributary monitoring program). This report describes data collected from 1997–2003 by the SRWP and from varying periods for programs coordinating with the SRWP. These water chemistry, aquatic toxicity, fish tissue, and bioassessment data are used to evaluate the attainment of beneficial uses and potential impairment in surface waters of the Sacramento River watershed; to assess spatial and temporal distributions of a variety of important water quality characteristics; and to compare the relative contributions of selected parameters to the Sacramento-San Joaquin Delta from different sources.

The categories of water quality data considered in this review are mercury (in water and fish tissue), drinking water parameters of concern, aquatic toxicity, and organochlorine pesticides and PCBs in fish tissue. Locations discussed in this executive summary are illustrated in Figure 1 (page 11) and in the individual sections of the Data Review beginning on page 14. The conclusions of this review of SRWP and other monitoring data are summarized below.

Mercury

Mercury monitoring for 2002-2003 consisted of six total water column sampling events with three of these events focused on Battle, Cottonwood, and Thomes Creek watersheds. One sample event was conducted in Fall 2002 for mercury in fish tissue.

Mercury concentrations in fish tissue collected from 1997 to 2002 from the mainstem Sacramento River below Shasta Reservoir and major tributaries to this section of the river were higher than several of the human health-based and wildlife-based advisory and screening values. Frequent exceedances of the tissue-based water quality criterion for mercury recently developed by the USEPA (0.3 mg/kg) and adopted by the California Office of Health Hazard Assessment (OEHHA), and less frequent exceedance of the previous USEPA screening value (0.6 mg/kg), indicate that there are human health concerns associated with consumption of some fish species from the lower Sacramento River watershed. The current water quality USEPA criterion of 0.3 mg/kg is based on a fish consumption rate of 17.5 g/day (equivalent to 4 quarter-pound servings per month). There is some disagreement whether the available data are adequate to warrant issuing fish consumption advisories — OEHHA has not issued advisories for these waters, while the Central Valley Regional Water Quality Control Board has added a number of waterbodies to California's 303(d) list based on the same available data. Interim Public Health Notices have also been issued by Placer, Yuba, and Nevada counties for eight Sierra foothill waterbodies based on the same data used by the Regional Board. Although there is substantial uncertainty regarding the level of risk posed by these concentrations of mercury in fish, there is agreement that the risks are greatest for small children and pregnant women, and that the risks increase with greater consumption of fish. General consumption guidelines are provided by OEHHA on their web page (http://www.oehha.org), in addition to consumption advisories for specific waterbodies. Concerns over mercury in fish from the lower Sacramento River watershed are being addressed with continuing monitoring performed in 2003 and proposed for 2004, and through special studies of fish consumption being conducted by the Delta Tributaries Mercury Council (DTMC). This shift in focus is in large part a result of coordination and consultation with OEHHA, which has been an active participant in the SRWP, and has provided the SRWP with guidance regarding data needs and study design for evaluation of human health risks related to fish consumption.

Consumption-weighted average mercury concentrations in tissues of fish collected from the Sacramento River mainstem from Keswick to the Delta, in smaller tributaries, and in three agricultural drains were equal to or lower than USEPA human health-based criterion of 0.3 mg/kg. However, in almost all trophic level 4 species collected throughout the watershed, average mercury concentrations were higher than the 0.3 mg/kg criterion, and were frequently two to three times higher than this criterion. [Note: “Trophic level” describes the position of a species in the food chain, determined by the number of energy-transfer steps to that level. Trophic level 3 fish consume primarily zooplankton and benthic invertebrates. Trophic level 4 fish preferentially consume trophic level 3 and lower trophic level fish species, as well as benthic invertebrates.]

Consumption-weighted average mercury concentrations in fish tissue collected from the lower American River and Feather River were higher than USEPA human health-based criterion of 0.3 mg/kg. Exceedance of the criterion indicates that there are potential risks to “average” and higher than average human consumers associated with consumption of fish from these waterbodies.

Total water column mercury concentrations in the Sacramento River from Keswick to River Mile 44 rarely exceeded the CTR mercury criterion of 50 ng/L (USEPA 2000). Total mercury concentrations exceeded the 50 ng/L limit in 33% of Cache Creek samples and 46% of samples from the upper Mill Creek watershed. The Feather and Yuba rivers are significant sources of mercury loads, but water column concentrations of total mercury and methylmercury were not elevated compared to the Sacramento River mainstem in 2000-2003. However, the relatively high concentrations of mercury in fish from the lower Feather River and American River may be due to the similarly high concentrations of methylmercury in particulate matter (suspended solids). Spring Creek in the upper Sacramento River watershed, Battle Creek, Deer Creek, Big Chico Creek, and the American River did not appear to be major sources of total mercury: concentrations were low in these tributaries compared to the Sacramento River and were never observed to exceed the 50 ng/L CTR criterion at these sites. Results from 2001-2003 monitoring indicate that Cottonwood Creek, Battle Creek, and Thomes Creek watersheds may be significant sources of mercury and methylmercury. With the exceptions of Mill Creek and Cache Creek, total mercury concentrations rarely exceeded the 50 ng/L CTR criterion at any site.

Methylmercury concentrations in water column samples exceeded the Great Lakes human health-based criterion of 0.24 ng/L most frequently in samples from Arcade Creek (56% of samples) and from two agricultural drain sites (26% and 37% of samples). Methylmercury concentrations exceeded the Great Lakes wildlife-based criterion of 0.05 ng/L in nearly every sample collected from mainstem locations below Hamilton City, and in all other tributaries and agricultural drains sampled.

The Sacramento River watershed is the major source of total mercury to the Delta. This watershed contributes approximately 90% of the total mercury loads to the Delta. Within the Sacramento River watershed, the Cache Creek drainage is the single largest source for total mercury. Major sources of total mercury loads to the Sacramento River watershed include runoff and erosion from historic gold mining sites, erosion of native soils, and natural mineral springs. Minor mercury sources include treated wastewater, urban runoff, historic mercury mines, and atmospheric mercury deposition from external sources.

Organophosphate, Carbamate, and Triazine Pesticides

Pesticide monitoring for 2002-2003 consisted of six total water column sampling events.

The results of SRWP and other monitoring programs continue to support the focus of the SRWP and of both state and federal regulatory agencies on the management of organophosphate pesticides in surface waters. Diazinon and chlorpyrifos appear to have the greatest potential for impacts on aquatic life uses, with other monitored pesticides appearing to have relatively low to minimal risk of impacts on aquatic life or human health. The potential impacts on beneficial uses from diazinon and chlorpyrifos in drainages dominated by agricultural runoff are being addressed through the Water Quality Management Strategy developed by the Organophosphate Pesticide Focus Group (SRWP 2001), by the TMDL being developed by the Central Valley Regional Water Quality Control Board, and by proposed amendments to the Central Valley Basin Plan to add the CDFG recommended criteria for diazinon (and other provisions related to diazinon). The well-documented problems in urban runoff (exemplified by Arcade Creek) are largely being addressed by regulatory changes banning the use of these products in retail pesticide products.

There are still few data available for the many minor tributaries to the Sacramento River watershed. For smaller tributary watersheds with a substantial proportion of agricultural land use (*e.g.*, Big Chico Creek), there may be a significant potential for pesticides to occasionally reach concentrations of concern in surface waters. Although few pesticides were detected in the limited SRWP monitoring of several smaller tributary watersheds in 2000-2003, the available monitoring data are far too limited to make any reliable assessments regarding the potential impacts of pesticides for these and other tributaries. However, small tributaries with only a small proportion of their total drainage in agricultural land uses (*e.g.*, Deer Creek and Mill Creek) are probably at relatively low risk of pesticide impacts on beneficial uses. Additional pesticide monitoring data (*e.g.*, from CDWR) should be evaluated if they become available, to better characterize the potential risks from pesticides in these watersheds, and additional monitoring should also be considered.

A important source of new information on pesticide use and potential impacts will be the data that result from the extensive monitoring that will be required for the Conditional Waiver of Waste Discharge Requirements for Irrigated Lands (SWRCB 2003). Monitoring efforts by agricultural coalition groups throughout the Central Valley will include tracking of pesticide use patterns, toxicity testing, and analyses for pesticides (and other potential causes of toxicity) in water and sediment. Additionally, the Watershed Evaluation Reports submitted by each coalition (April 2004) are expected to provide valuable information on existing pesticide use patterns, management practices, and potential risks from pesticide use in specific drainages in the Central Valley. Monitoring for this program is projected to begin July 2004.

The shift from use of organophosphate and carbamate pesticides for agricultural and other uses to other pesticides (including but not limited to pyrethroids and pyrethrins) indicates the need for increased monitoring for these pesticides. Both private contract laboratories and public agencies (University of California at Davis, USGS) are developing new sampling and analytical techniques to adequately identify and measure toxic concentrations of pyrethroid pesticides in water, sediment, and tissue. The SRWP has collaborated with Dr. Donald Weston (University of California Berkeley) in a study of the distribution and toxicity of sediment-associated pesticides in the Sacramento River watershed. The study is focused on pyrethroid pesticides, and Dr. Weston has demonstrated the ability to analyze pyrethroids (and other sediment-associated pesticides) at concentrations that cause toxicity in laboratory tests of sediment toxicity. Preliminary results of this study indicate that approximately half of the sites sampled exhibit significant sediment toxicity. Funding for this project is provided by the Pesticide Research and Identification of Source, and Mitigation (PRISM) Grant program administered by the State Water Resources Control Board.

Aquatic Toxicity

Aquatic toxicity monitoring for 2002-2003 consisted of six sampling events. Only *Ceriodaphnia dubia* were tested during this monitoring period, using the short-term chronic 7-day test procedure.

The results of the 2002-2003 monitoring and of previous aquatic toxicity monitoring efforts have confirmed that significant toxicity to test organisms occurs in surface waters throughout the watershed. *Ceriodaphnia dubia* toxicity attributable to organophosphate pesticides in agricultural runoff and urban runoff has been definitively shown by SRWP monitoring and other studies. Widespread mortality observed in September 2001 was not associated with any known causes of toxicity, and suggests a need to continue to monitor for episodic toxicity during a wide range of hydrologic and weather conditions.

Regularly scheduled monitoring conducted from 1998–2000 was valuable in beginning to evaluate the overall frequency and distribution of observed water column toxicity, and for identifying or confirming the causes of some of the observed toxicity. However, spatial and temporal coverage of the watershed by SRWP and other programs is far from comprehensive, and significant questions remain regarding the sources, severity, persistence, and ecological significance of periodic toxicity in surface waters of the Sacramento River watershed. It is clear that definitively addressing all of these questions will require monitoring and studies of much greater scope (and cost) than the current efforts by SRWP and other programs. To address some of these questions, the SRWP aquatic toxicity monitoring effort for 2000-2003 has focused primarily on monitoring specific episodic events (e.g. agricultural dormant spray season, runoff events, high flow events). This strategy resulted in observation of more frequent and severe toxicity in the Arcade Creek urban watershed, but did not result in a notably greater frequency of observed toxicity for other locations. Although the 2000-2001 and 2001-2002 wet seasons both had below-average rainfall, the 2002-2003 wet season had above average precipitation with no apparent increase in frequency (or magnitude) of episodic aquatic toxicity throughout the watershed. Interpretation of these few seasons of monitoring only a handful of episodic events must be cautious because the causes and timing of significant episodic toxicity events may differ greatly in different waterbodies, and the likelihood of missing a particular toxic event is high. Although even a single toxic event of sufficient severity has the potential to have significant adverse ecosystem impacts, there is currently insufficient evidence to either support or rule out such a hypothetical event for most sites monitored.

Other issues that require additional investigation are the causes and ecological significance of the adverse reproductive effects to *Ceriodaphnia* observed to occur sporadically at different sites throughout the watershed. Because these effects manifest at sub-lethal levels and the toxicity is often not persistent in the original samples, determining the causes of these effects has proven difficult with the available TIE and follow-up testing procedures. This is complicated by the unpredictable nature of these sublethal toxic “events”. There is also inadequate information regarding the magnitude and duration of these effects to determine whether this phenomenon detected through laboratory toxicity testing has broader ecological significance. It is expected that the Strategy to Address Toxicity of Unknown Cause (currently being revised by the SRWP Toxicity Focus Group) will provide additional tools to address these questions.

Episodic monitoring of aquatic toxicity by SRWP has been continued for the 2003-2004 monitoring season. This monitoring was expanded to reinstate testing with fathead minnows (*Pimephales*) and algae (*Selenastrum*). Monitoring to be conducted by agricultural coalitions in the Central Valley (beginning 2004) is also expected to use an event-based monitoring approach (with events defined by pesticide applications, irrigation schedules, and wet weather runoff) with toxicity testing and TIEs using *Ceriodaphnia*, *Pimephales*, *Selenastrum*, and *Hyalella*.

Drinking Water Parameters of Concern

Monitoring of drinking water parameters for 2001-2002 consisted of six total water column sampling events.

The Sacramento River and major tributaries provide water supplies for municipal, industrial and agricultural use in the Sacramento River Basin and downstream in the Sacramento-San Joaquin Delta. In addition, the Sacramento River is the primary source of flow to the Sacramento-San Joaquin Delta and the source of drinking water for an additional 20 million people in the Bay Area, Central Coast, and Southern California. The Sacramento River and its major tributaries are generally considered high quality drinking water sources. Although the quality of the Sacramento River is changed as it moves downstream and into the Delta, data collected to date for the best available indicators demonstrate that drinking water beneficial uses are substantially realized in the Sacramento River watershed. Water supply agencies treating Sacramento River and Delta water are currently able to meet drinking water standards and provide safe drinking water to millions of consumers throughout California. However, anticipated future drinking water regulations *may* require agencies treating Delta water to implement additional treatment (at increased costs). Drinking water parameters of potential concern included in the SRWP monitoring program include organic carbon, total dissolved solids, pathogens, turbidity, and nutrients. Organic carbon is of concern primarily due to its role in the creation of carcinogenic trihalomethanes (THMs) and other disinfection by-products during disinfection of source water. Total dissolved solids (TDS) can have an important effect on the taste and palatability of drinking water, and at very high levels, may cause health problems in sensitive individuals. The presence of high levels of TDS may also be objectionable to consumers owing to excessive scaling in water pipes and fixtures, heaters, boilers, and household appliances. TDS concentrations are also a factor limiting use of Delta waters for groundwater recharge, particularly in the Southern San Joaquin Valley. Pathogens such as *Cryptosporidium* and *Giardia* are of concern due to their potential to cause adverse human health effects. The primary concern associated with turbidity is its effect on disinfection processes, because high levels have been shown to protect microorganisms from the action of disinfectants and to increase the levels of chlorine and oxygen needed during treatment. Elevated nutrient concentrations may promote excessive algal growth and consequently contribute to taste and odor problems associated with some species of algae.

The mainstem Sacramento River, and major tributaries (the Yuba, Feather, and American rivers) consistently meet water quality goals and objectives for drinking water-related parameters. Based on the best available indicators, these results suggest that designated beneficial uses of the Sacramento River and tributaries as sources of municipal and agricultural supply water and recreational uses are generally being achieved.

- There was a general trend for concentrations of several parameters (TDS, organic carbon, nutrients) to increase in the mainstem Sacramento River from the upper watershed to the lower watershed. This trend can generally be attributed to a combination of natural and anthropogenic sources, and is moderated by high quality Sierra tributary inflows.

- The highest concentrations of most drinking water parameters of concern were generally observed in agricultural drains (Sacramento Slough and Colusa Basin Drain) and in urban drainages and creeks (Natomas East Main Drain, Arcade Creek).
- The Basin Plan limit for median fecal coliform numbers (200 MPN/100mL) was exceeded at only one site (Natomas East Main Drain), and the maximum limit for single samples (400 MPN/100 mL) was exceeded infrequently in the Sacramento River, the American River, and Cache Slough. Recommended USEPA and CDHS single sample and geometric mean limits for total coliform are also infrequently exceeded at monitored locations. Recommended single sample Basin Plan limits for *E. coli* were exceeded at most locations monitored, but *E. coli* numbers exceeded the geometric mean limit only at Natomas East Main Drain. Note that comparisons for *E. coli* are based on data biased towards episodic events expected to result in elevated bacteria counts.
- TOC concentrations measured in the Sacramento River at Colusa, Verona, and Freeport often exceed the Stage 1 Disinfectant/Disinfection By-Product (D/DBP) Rule treatment threshold of 2 mg/l. The 2 mg/L threshold is significant because exceedance of this threshold may require utilities to remove up to 35% percent of TOC in their source water. It is not necessarily the case that the observed concentrations of organic carbon will result in a requirement for municipal drinking water suppliers to remove *additional* TOC in source water. The Stage 1 D/DBP Rule does not require such treatment if certain treatment technology requirements used, or if other water quality requirements are met in influent or treated water. Additionally, treatment technologies currently in use by many utilities are already able to remove ≥35% of source water TOC from Sacramento River water. Even if additional TOC removal is necessary, this requirement would not limit the water supply use. Available Specific UV Absorbance (SUVA) data suggest that average SUVA in surface waters of the Sacramento River watershed is generally greater than D/DBP alternative criterion (2.0 L/mg-m) and would not provide relief from additional treatment requirements.
- Nitrate and nitrite appear to meet USEPA and CDHS MCLs at all locations monitored in the Sacramento River watershed. Other nitrogen and phosphorus compounds monitored (ammonia, total nitrogen, dissolved orthophosphate) currently have no relevant regulatory thresholds for comparison. Although total nitrogen and total phosphorus concentrations may exceed expected ecoregional nutrient criteria under development by USEPA in many Sacramento River watershed surface waters, these criteria are not currently based on thresholds for protection of beneficial uses.

The parameters of greatest concern for drinking water quality—TOC, TDS, nutrients, and pathogens—are still largely unregulated by the Central Valley Regional Water Quality Control Board (CVRWQCB) and the Water Quality Control Plan (Basin Plan). The combination of existing and future land use changes and the resulting increases in point source and nonpoint source discharges in the Sacramento River watershed have the potential to increase loadings of these largely unregulated parameters of concern. The CVRWQCB is currently implementing a work plan for the development of an effective drinking water policy. This policy is expected to specifically address these parameters and establish water quality objectives for eventual inclusion in the Basin Plan.

PCBs and Organochlorine Pesticides in Fish Tissue

Monitoring for PCBs and organochlorine pesticides in fish tissue consisted of one sample event conducted in fall of 2002.

Based on comparisons to screening values for organochlorine pesticides and PCBs in fish tissue, consumers who eat a variety of fish from different locations appear to be at relatively low risk from these compounds in fish tissue. However, potential risks increase for people selectively consuming a limited number of higher trophic level species (e.g. white catfish, largemouth bass, striped bass), and for individuals consuming more fish than the 21 g/day (about six quarter-pound servings per month) on which the screening values were based.

Consumption-weighted average concentrations of DDTs and dieldrin in fish from agricultural drains, and of PCBs in fish from major tributaries (American River and Feather River) and Delta locations exceeded screening values, but these results were dependent on very limited data for trophic level 3 species. Additional data are needed to adequately assess the potential risks for these waterbodies.

Evaluation of consumption-weighted average and species average concentrations suggests the need to re-evaluate at least one of the waterbodies cited on the 2002 303(d) for impairment due to organochlorine pesticides and PCBs. The results indicate that the Regional Board's listing of the Feather River for "Group A" pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes including lindane, endosulfan, and toxaphene) may not be necessary.

Fish from smaller tributaries throughout the watershed tended to have lower concentrations of most organochlorines than other waterbodies. There was little evidence of other distinct spatial trends in organochlorine concentrations in fish tissue.

Monitoring of organochlorine pesticides and PCBs in fish tissue has been suspended for 2003-2004 due to budgetary constraints. However, samples collected for mercury analyses will be retained for analysis of organochlorine pesticides and PCBs if and when funding becomes available for that purpose. More extensive monitoring of organochlorine pesticides and PCBs in fish has been proposed for future monitoring efforts.

Bioassessment

The focus of the SRWP 2001-2003 bioassessment effort was shifted to developing a process for identifying reference conditions in the Sierra Nevada foothill and the Central Valley regions, in cooperation with the California State Water Resources Control Board and Department of Fish and Game. The Sierra foothill region was selected for the initial focus of this effort because this region is undergoing rapid development and urbanization. Identification of reference sites and conditions are critical for interpreting bioassessment monitoring results and for developing biocriteria. The process developed for identifying and selecting reference sites is expected to have application throughout the watershed and the state. This effort is continuing in 2004.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

PROGRAM OVERVIEW

ORGANIZATION AND FUNDING

The Sacramento River Watershed Program (SRWP) is an association of stakeholders in the Sacramento River watershed. These stakeholders include representatives of local municipalities and districts, state and federal agencies, agriculture, industry, landowners, environmental organizations, universities, technical consultants, and watershed conservancies. The SRWP was formed in 1996 and functions through a series of stakeholder meetings. In 2002, the SRWP elected a Board of Trustees and was incorporated as a not-for-profit California public benefit corporation.

Formation of the SRWP was facilitated by the Sacramento River Toxic Pollutant Control Program (SRTPCP), a locally initiated effort led by Sacramento County and the Sacramento Regional County Sanitation District (SRCSD). The SRTPCP is a watershed-based approach to the management of potentially toxic pollutants in surface waters of the Sacramento River watershed.

Funding for the SRTPCP has been provided primarily by the federal government (a total of $9.7 million since 1996) and is administered by USEPA Region IX. Local matching funds have been provided by the Sacramento Regional County Sanitation District ($509,000 to date), and in-kind services are provided by several participating stakeholders. Additionally, significant public and private support of the program is being provided through the active participation of numerous representatives on the SRWP subcommittees. A portion of the SRTPCP funding was specifically designated to assist in the formation of the broader watershed program.

PROGRAM GOALS AND OBJECTIVES

The goal statement developed by the participating stakeholders for the SRWP in 1996 is as follows:

> *"To ensure that current and potential uses of the watershed's resources are sustained, restored and, where possible, enhanced while promoting the long-term social and economic vitality of the region."*

One of the primary tasks of the SRTPCP and the SRWP is the design and implementation of a water quality monitoring program for the watershed. In early stakeholder meetings, a Monitoring Subcommittee was formed to lead the development of the water quality monitoring program.

Monitoring Program Goals

The Monitoring Subcommittee established the following long-term goal for the SRWP water quality monitoring program:

> **"***In coordination with other subcommittees and the larger stakeholder group, develop a cost-efficient and well-coordinated long term monitoring program within the watershed to identify the causes, effects and extent of constituents of concern that affect the beneficial uses of water and to measure progress as control strategies are implemented."*

The SRWP water quality monitoring program is envisioned by the Subcommittee to be a long-term (e.g., 20 year) effort that provides information to promote the understanding of conditions in surface waters of the watershed and to assess the health of these waters. The monitoring program changes annually as information is accumulated and new information needs are identified. It is projected that the water quality program will be integrated with other resource monitoring activities, including biological communities, habitat, and land use. More in-depth descriptions of the monitoring program are provided in the Phase 1 Monitoring Plan (SRWP 1998a), and the Quality Assurance Project Plans for monitoring conducted from 1998 through 2003 (SRWP 1998b, 1999, 2000, 2001, 2002).

The Monitoring Subcommittee established the following goal for the first year of the monitoring program, and retained this goal for the second year of monitoring:

> *"To assess conditions in the mainstem of the Sacramento River through the collection of baseline information, with an emphasis on examining the degree to which beneficial uses are attained or potentially impaired."*

The SRWP has made substantial progress towards meeting both the long-term and short-term goals for the monitoring program. The monitoring program developed by the SRWP through the stakeholder process is currently coordinating with a number of ongoing monitoring programs managed by federal, state, and regional public agencies. The collection and evaluation of baseline information for water quality parameters of interest to the SRWP is being accomplished directly through SRWP monitoring, and through cooperative data sharing with other monitoring programs conducted by the Department of Water Resources, the Central Valley Regional Water Quality Control Board, the U.S Geological Survey, the Sacramento River Coordinated Monitoring Program, and the City of Redding. Additionally, the program also compiles and reports water quality data generated prior to the initiation of SRWP monitoring in 1998. Evaluating the available information and identifying gaps in the data needed to assess the degree to which beneficial uses are achieved or potentially impaired in the watershed was (and continues to be) an integral part of the development of the monitoring program. The evaluation of water quality monitoring information documented herein is an extension of this ongoing process.

Objectives

The Monitoring Subcommittee also adopted long-term and short-term objectives. The long-term objectives include:

- Identification of available monitoring program elements that will provide information needed to understand the condition of surface waters of the watershed (i.e., to inventory the characteristics of the watershed).
- Identification of an approach for determining the relative health of the watershed (i.e. a means to assess and evaluate the meaning of the above information).

The short-term objectives developed by the Subcommittee include:

- Identification of the monitoring goals and future uses for the data being collected, including: *water quality characterization, biological assessment, long-term trend analysis, and compliance with applicable water quality regulations*
- Identification of data needs and data quality objectives (i.e. to ensure that data collected will be useful, understandable, accessible, manageable, and scientifically valid).
- Coordination with other Subcommittees of the SRWP (e.g. Toxics, Biological and Habitat, Education and Outreach).

ASSESSMENT OF BENEFICIAL USES AND COMPLIANCE WITH WATER QUALITY OBJECTIVES

As stated above, the initial goal for the SWRP monitoring effort includes examining the degree to which beneficial uses are attained or potentially impaired. The existing and potential beneficial uses for the Sacramento River watershed are outlined in the water quality control plan (Basin Plan) for the Central Valley Region. The following are existing beneficial uses in the Sacramento River watershed, as defined in the Central Valley Region Basin Plan (CVRWQCB 1995):

- municipal and domestic water supply
- agriculture (irrigation, stock watering)
- industry (process, service supply, power)
- contact recreation
- non-contact recreation
- freshwater habitat
- migration
- spawning
- wildlife habitat
- navigation

Another purpose of the SRWP monitoring program is the comparison of observed ambient concentrations with adopted water quality objectives and criteria[1]. Numeric and narrative objectives have also been adopted in the Basin Plan (CVRWQCB 1995) for surface waters of the Sacramento River watershed for selected toxic pollutants in California. (Basin Plan objectives are analogous to National water quality criteria.) Water quality criteria for toxic pollutants are also included in the California Toxics Rule (CTR) (USEPA 2000). The CTR criteria are largely the same as the current USEPA recommended national ambient water quality criteria (USEPA 1999).

The Regional Water Quality Control Boards for the Central Valley and San Francisco Bay have developed lists of impaired waters which will not meet water quality objectives after implementation of water quality- and technology-based controls for point sources and best management practices for non-point sources. These lists are required under Section 303(d) of the Clean Water Act. The portions of the lists that address the Sacramento River and its tributaries and the Sacramento-San Joaquin Delta are provided in individual data review sections. Management plans that establish Total Maximum Daily Loads (TMDLs) for listed pollutants must be prepared for all waters contained on the 303(d) lists, and the regulations state that TMDLs must lead to compliance with adopted water quality objectives.

MONITORING PROGRAM DESCRIPTION

The 2002-2003 SRWP monitoring program includes chemical, physical, biological and toxicological monitoring elements. The proposed program augments and coordinates with a number of other monitoring efforts that are ongoing in the watershed, including the USGS National Water Quality Assessment Program (NAWQA), the Sacramento Coordinated Water Quality Monitoring Program (CMP), and monitoring efforts by the Department of Water Resources (CDWR), Department of Pesticide Regulation (DPR), City of Sacramento, and City of Redding.

[1] The SRWP's review and evaluation of designated uses and the criteria developed to protect these uses is consistent with the Water Quality Standards program mandated by the Clean Water Act (33 U.S.C. §§ 1251 *et seq*.), wherein a Standard for a water body is defined by four elements: designated uses of the water body, water quality criteria to protect the designated uses, an antidegradation policy, and general policies addressing implementation issues.

The SRWP Monitoring Program was developed through an interest-based, coordinated approach. Managers of major water quality monitoring activities in the watershed were identified and invited to participate on the Monitoring Subcommittee. Numerous Subcommittee meetings were held to discuss and evaluate considerations in the development of the first year SRWP monitoring program. Existing monitoring programs were described and opportunities for coordination and integration were identified. Parameters of interest, candidate monitoring locations, monitoring frequency, sample collection methods, appropriate analytical methods, quality assurance/quality control, and program costs were evaluated by the Subcommittee.

Several possible monitoring approaches were discussed and evaluated during development of the proposed program design. The approach selected by the Monitoring Subcommittee as the starting point for the SWRP monitoring program was to monitor selected locations and parameters to facilitate an initial evaluation of beneficial use attainment in the watershed, with an emphasis on the mainstem and major tributaries of the Sacramento River. The emphasis on the mainstem Sacramento River was favored to provide a foundation to which other programs and future additions to the SRWP Monitoring Program could be connected. This approach was considered the best available means to achieving SRWP monitoring goals and was chosen to provide the best achievable information using conventional monitoring tools. Monitoring parameters and methods were selected to provide data immediately useful for evaluating beneficial use attainment and potential impairment, and for identification of management issues. Sites were chosen to complement and augment ongoing monitoring, to provide information at the mouths of major tributaries, and to coincide with flow monitoring stations where possible.

Each year, the SRWP monitoring program is evaluated and modified by the Monitoring Subcommittee based on the guidance and recommendations from other SRWP subcommittees and focus groups (Toxics Subcommittee, Delta Tributaries Mercury Council, Biological and Habitat Subcommittee, fish tissue focus group, drinking water focus group, organophosphate pesticides focus group [now inactive], and agricultural issues workgroup). The SRWP monitoring program for 2001-2002 implemented several significant changes to the monitoring program (changes retained for 2002-2003), including modification of sampling locations, parameters, and sampling and analytical contractors. Note that changes made in the monitoring program were always prioritized by considering the goals of the program and the overall approach, even as changes were required by decreases in the monitoring budget. The specific changes to the monitoring program are documented in the Quality Assurance Project Plans (QAPP) (SRWP 2002). The sites monitored, parameters measured, and sampling schedule for the SRWP 2002–2003 monitoring program are discussed in the following sections.

Monitoring Sites

Site selection criteria were developed by the Monitoring Subcommittee to determine the monitoring locations for the SWRP monitoring program. Criteria used for the selection of sites included the following:

- existing sampling station
- flow gauging station
- magnitude of streamflow
- critical habitat area
- predominant land use (e.g., agriculture, municipal, industrial, mining, etc.)
- site access constraints
- sampling access constraints
- available water quality data
- in existing watershed program
- potential water quality impairment, including 303(d) listed waterbodies

After an initial screening using the criteria listed above, the selection was narrowed to include sites along the mainstem of the Sacramento River and at the mouths of major tributaries. Major tributaries were identified using existing streamflow data. Mainstem sites were selected to facilitate coordination with existing programs and to provide information below major reservoirs. Major tributaries were selected based on the magnitude of flow into the mainstem. The three major tributaries into Lake Shasta were included to capture these inputs and large tributary areas.

In addition to the mainstem monitoring, three smaller Sierra Nevada tributaries (Mill Creek, Big Chico Creek, and Deer Creek) were selected for special studies for 1998-2000 monitoring. The Subcommittee included these tributaries on a demonstration basis to encourage monitoring in these areas and to coordinate with the monitoring activities of the Department of Water Resources, Northern District.

For the 2001-2002 and 2002-2003 monitoring years, locations were added for mercury monitoring in Cottonwood Creek watershed (three locations), Battle Creek watershed (three locations), Thomes Creek (three locations), Dry Creek (one site), and Little Chico Creek (one site). All of these locations were added to provide a better understanding of the mercury sources in the Sacramento River Watershed. Cottonwood Creek, Battle Creek, and Thomes Creek are relatively large tributary watersheds for which there are little or no mercury data, and Dry Creek and Little Chico Creek may be affected by significant historical mining operations in those watersheds.

Ceriodaphnia toxicity monitoring was continued at three new locations first monitored by SRWP in the 2001-2002 monitoring year (the Pit River above Shasta, Cottonwood Creek at the mouth, and Cache Creek at Rumsey). The Pit River site was added because it is one of the major sources of flow in the watershed, and sporadic toxicity has been observed in the past. The Cottonwood Creek site was added because mining historically conducted in this watershed and CVRWQCB metals analyses data indicate a significant potential for aquatic toxicity. The Cache Creek site was added because it is on the 303(d) list for toxicity of unknown cause.

Fish tissue monitoring was conducted at only three locations, compared to as many as 15 locations monitored in previous years. The primary reason for the decrease in the number of locations is decreased available budget. The sites selected by the SRWP Fish Tissue Focus Group for monitoring include three previously monitored sites considered to be the highest priority for continued monitoring for tracking of long-term trends in mercury concentrations.

Overall, the 2002-2003 SRWP monitoring program included monitoring at 31 locations in the Sacramento River watershed. Seven of these sites are located on the mainstem of the Sacramento River, from the Sacramento River below Keswick Reservoir to the Sacramento River at River Mile 44. Three sites are located on major tributaries to the Sacramento River, two sites are located on major agricultural drains, and two sites are located in highly urbanized drainages. The remaining sites are located on smaller tributaries to the Sacramento River. The proposed sites cover over 300 miles of the Sacramento River system and represent a drainage area of over 23,000 square miles. Table 1 lists the sampling sites for the SWRP 2002-2003 monitoring program with a description of the location, type of site, and contributing land use percentages. The site locations are illustrated in Figure 1.

Monitoring Parameters

Specific individual parameters measured by the SRWP 2002-2003 monitoring effort are listed in Table 2. Monitoring performed in 2002-2003 was a continuation of 2001-2002 monitoring program and all of the same parameters were monitored. The rationales for monitoring environmental parameters included in the SRWP monitoring program are discussed below.

Mercury, PCBs, and Chlorinated Pesticides in Fish Tissue

Mercury and certain organic contaminants (including DDT and PCBs) are readily accumulated directly from water or through the food web from low levels in water, resulting in concentrations in fish tissue which may be of concern to humans and wildlife. Monitoring levels of these pollutants in fish provides an effective way to assess potential human health hazards due to contamination of the Sacramento River system. Because fish accumulate contaminants throughout their life span and their habitat, measurements of contaminant concentrations in fish tissue provide an indication of average conditions over space and time. Fish tissue data can be useful in the determination of long term levels and trends of bioaccumulative contaminants (such as mercury, DDT and PCBs) in the watershed. This long-term data set can be used to measure the effectiveness of activities to control these pollutants.

Mercury in Water

As stated above, low concentrations of mercury and methylmercury in water are of potential concern to human health. Several programs are currently planned or under way in the Sacramento River watershed to monitor mercury concentrations at various locations, including the Sacramento Coordinated Water Quality Program, the USGS National Water Quality Assessment for the Sacramento River, and CALFED. SRWP mercury monitoring supplements existing data, and planned and ongoing monitoring efforts, with information for eleven locations. Data obtained will be used to quantify ambient concentrations of mercury and methylmercury in surface waters of the Sacramento River watershed and to study whether these concentrations are causing or contributing to potential human health risks or otherwise adversely affecting beneficial uses.

Pesticides in Water

Low concentrations of pesticides in water can affect the growth, reproduction and/or survival of sensitive aquatic species. The SRWP currently monitors organophosphate (OP), carbamate, and triazine pesticides. These classes of pesticides have been identified as being of potential concern to aquatic life in the Sacramento River system and are responsible for the presence of several Sacramento River watershed waterbodies on the 303(d) list of impaired waterbodies. Several programs are currently under way in the Sacramento River watershed to monitor pesticides at various locations in the Sacramento River watershed, including programs administered by the California Department of Pesticide Regulation (CDPR), the Central Valley Regional Water Quality Control Board (CVRWQCB), and the USGS National Water Quality Assessment for the Sacramento River. SRWP pesticide monitoring will supplement the existing data with information for 10 additional locations. Specific pesticides analyses and locations for monitoring were selected on the basis of documented use of these pesticides upstream from the locations monitored, on pesticide-caused toxicity detected at these streams/rivers, and on inclusion for pesticides on the 303(d) list of impaired water bodies. Data obtained are used to quantify ambient concentrations of pesticides in surface waters of the Sacramento River watershed and to assess whether these concentrations are potentially adversely affecting uses. It should be noted that numerous other pesticides of potential concern to aquatic life and human health (including pyrethroids and legacy organochlorine pesticides) are not being monitored in water by the SRWP.

Toxicity in Water

Ambient samples of water and sediment can be tested in the laboratory for toxicity to provide an indication of the conditions that exist in the natural environment. Standard test species and test procedures are used to provide reliable and comparable results. Toxicity is deemed to occur when test species are significantly adversely affected by exposure to toxicants in ambient water or sediment as compared to laboratory controls. Toxic effects measured for the SRWP in 2002-2003 include reduced reproduction and increased mortality of *Ceriodaphnia dubia*. Effects may occur rapidly over a period of hours to four days (acute toxicity) or may occur over a longer period (chronic toxicity). For SRWP monitoring, the results of toxicity testing are also used to trigger further investigations to determine the cause of observed toxicity. These toxicity identification evaluations (TIEs) include the consideration of a number of factors, including contributing watershed characteristics, chemical characteristics of the water, biology, and additional toxicity testing wherein classes of toxicants are selectively removed or rendered non-toxic. Results from these weight-of-evidence investigations are useful in identifying potential water quality problems in the watershed. Sites for aquatic toxicity monitoring were selected to provide an overall survey of the distribution of toxicity in the watershed, and to coordinate with existing monitoring programs.

Pathogens and Pathogen Indicators

Pathogens are disease-producing organisms (protozoa, bacteria, and viruses) that adversely affect the quality of drinking water and/or may pose human health risks for water contact recreation. Two pathogens of particular concern are *Giardia lamblia* and *Cryptosporidium parvum.* Water treatment agencies are currently required to remove or inactivate at least 99.9% of *Giardia* and effective December 2001, are required to remove 99% of *Cryptosporidium* (Interim Enhanced Surface Water Treatment Rule, USEPA 1998a). Although most facilities utilizing conventional or direct filtration remove at least 2 logs of *Cryptosporidium* (*ibid.)*, this organism is resistant to disinfection with chlorine, and high numbers of *Cryptosporidium* in source waters may require water supply agencies to switch to ozone or other disinfectants. Although some data exist for the Sacramento River near Redding and in the Sacramento River below Sacramento, data on the numbers of these pathogens are otherwise lacking for most of the Sacramento River system. Monitoring efforts by the Department of Water Resources, and the Metropolitan Water District of Southern California in the lower end of the watershed near Sacramento to assess numbers of *Cryptosporidium*, *Giardia*, and coliform organisms (indicators of fecal contamination) were completed in April, 1998, but no final report is expected to be released. The SRWP pathogen monitoring effort extended monitoring for these specific parameters to several additional upstream locations in the Sacramento River watershed. Coliform bacteria are monitored primarily as indicators of fecal contamination and the possible presence of enteric pathogens such as *Cryptosporidium* and *Giardia*. The USEPA recommends monitoring *Escherischia coli* and *Enterococci* as the preferred indicators of pathogen organisms. It was anticipated that SRWP data would be used primarily to determine the magnitude and extent of numbers of these pathogens in the mainstem of the river below major dams.

Monitoring by SRWP for *Cryptosporidium* and *Giardia* was suspended after the 2000-2001 monitoring effort. Although the analytical method used to monitor *Giardia* and *Cryptosporidium* in 1999-2001 is much improved (compared to the ICR method used previously), there remains a high degree of uncertainty associated with data for these pathogens. The results of a recent CDWR study (DiGiorgio *et al.* 2002) found that while recoveries of both organisms are acceptable under low turbidity conditions, recoveries of *Giardia* decrease unacceptably in higher turbidity waters. In addition, there are currently no regulatory limits or meaningful environmental benchmarks for these pathogens in surface waters. Monitoring of coliform indicator bacteria was continued in 2002-2003.

Organic Carbon in Water

The organic content of water (measured as total and dissolved organic carbon) is a parameter important to drinking water suppliers. High concentrations of organic compounds in source waters contributes to the production of disinfection by-products (trihalomethanes and halo-acetic acids) as a result of conventional water treatment. Some of these by-products are carcinogenic and pose human health problems at relatively low concentrations. Additionally, the Stage 1 Disinfectants and Disinfection By-Product Rule (effective January 2002) requires drinking water systems serving at least 10,000 people to meet specified total organic carbon (TOC) removals dependant on source water TOC concentrations. For these reasons, baseline data on typical organic carbon concentrations and seasonal variability of those concentrations in the Sacramento River system are important to the assessment of drinking water uses. SRWP monitoring for organic carbon augments fairly extensive monitoring already performed by the USGS NAWQA program, the City of Sacramento and the California Department of Water Resources (CDWR).

Some organic compounds commonly found in wastewaters and natural surface waters (lignin, humic and fulvic acids, and some aromatic compounds) strongly absorb ultraviolet radiation. Strong correlations have been demonstrated with organic carbon and precursors of trihalomethanes and other disinfection by-products (APHA *et al*. 1998). Ultraviolet absorbance at 254 nm (UVA_{254})is considered to be a useful surrogate measure for the ability of organic compounds to form these disinfection by-products.

General Constituents (Suspended and Dissolved Solids, Turbidity, Alkalinity, Hardness, and Nitrogen and Phosphorus Compounds) in Water

These “conventional” water quality characteristics are important to the evaluation of the attainment of a variety of uses, including drinking water supply, recreation, aesthetics, aquatic habitat, and agricultural supply. Data for these parameters are available from a number of programs, including USGS NAWQA, the Sacramento Coordinating Monitoring Program and the Department of Water Resources. SRWP monitoring augments the ongoing data collection efforts for some of these constituents.

Benthic Invertebrates and Habitat Characterization

Benthic invertebrates are the aquatic insects and other organisms that live along the bottom of streams, lakes, and other waterbodies. Procedures have been developed to standardize the assessment of biological habitat and benthic communities for use as a monitoring tool (Plafkin et al. 1989, CDFG 1996, CDWR 1997). Ideally, information on invertebrate diversity, abundance, species richness, and other community metrics collected at specific sites is compared against expected conditions (or reference stream conditions) to evaluate the relative health of the biological community at that location. This information is used in combination with chemical concentration and toxicity data to assess ecosystem conditions at various locations. Different procedures are used depending on the characteristics of the stream (i.e. wadable versus non-wadable). This monitoring tool has been effectively used by citizen monitoring groups in smaller tributary watersheds. The Department of Water Resources, Department of Fish and Game, and the Central Valley Regional Board continue to work actively with a number of tributary watershed groups to provide education and training regarding the assessment methods. Data from the SRWP monitoring program is intended to supplement and integrate results from projected tributary efforts.

In 2001 the focus of SRWP bioassessment monitoring was shifted to developing a process for identifying reference conditions in the Sierra Nevada foothill region and the valley floor, in cooperation with the California State Water Resources Control Board and Department of Fish and Game. The Sierra foothill region was selected for the initial focus of this effort because this region is undergoing rapid development and urbanization. Identification of reference sites and conditions are critical for interpreting bioassessment monitoring results and for developing biocriteria. The process developed for identifying and selecting reference sites is expected to have application throughout the watershed and the state. No other SRWP monitoring of benthic macroinvertebrates was performed in 2002-2003.

Sampling Frequency and Schedule

The base monitoring frequency for 2002-2003 remained at six events per year (down from nine events per year for 2000-2001, and 12 events in previous years). This change in frequency was made to accommodate a significant decrease in the SRWP monitoring budget for 2001-2002. In order to best satisfy the monitoring goals and priorities of the SRWP and to maintain monitoring at existing station, some reductions in monitoring frequency were considered preferable to discontinuing monitoring for additional parameters or discontinuing existing long-term monitoring locations. The basis for planning sample events was also changed to "episodic" (event-based) for all parameters in 2001-2002. This change was made to allow the program to focus on specific hydrological conditions and other events relevant to water quality (low and high flows, storm events, pesticide application seasons and events, spills, etc.).

Monitoring frequency varied by location and the parameter to be tested. Water quality monitoring for mercury, pesticides, pathogens, organic carbon, general constituents in water, and for aquatic toxicity sampling was "event-based", for a total of six sample events. These sample events were planned to coincide with a range of hydrological conditions and other events expected to significantly affect water quality (e.g. during seasonal pesticide applications, expected periods of agricultural or urban runoff, high and low flows), or conditions that match a previously observed pattern of toxicity or changes in concentrations of parameters. All data represent the results of a single grab sample per event per site (*i.e.*, no composite samples were collected), and analytical results for different parameters are essentially for the same sample (within the limitations of parameter-specific sampling requirements). Fish tissue sampling was conducted once annually (in the fall) for the three sites monitored.

The sample events were typically conducted over a period of three or four days. In 2002-2003, a total of six events, including four wet weather episodic events and two dry weather events, were monitored. Wet weather episodic events included the first significant watershed-wide storm event of the 2002-2003 wet season (early November, 2002), the organophosphate pesticide dormant spray application period (late January 2003), and two late wet season rainfall events (March and April, 2003). One dry weather "episodic" event was scheduled to coincide with late dry season low flows, and one during the rice herbicide application and discharge period (early June, 2003). (Descriptions and dates for specific events are also described later in the Data Review sections of this report.) A breakdown of sampling sites, sampling frequency, and parameters to be analyzed are provided in Table 3.

Table 1. SRWP 2002-2003 Monitoring Sites

			Percent Contributing Land Use				
Site description	Site ID(1)	Site Type	Rangeland	Forest	Agriculture	Urban, Residential	Other(1)
Sacramento River below Keswick	SRBKR	Mainstem	20	70	4.5	0.3	4.9
Sacramento River above Bend Bridge	SRABB	Mainstem	20	71	4.5	0.7	3.9
Sacramento River near Hamilton City	SRHAM	Mainstem	21	69	6.6	0.7	3.4
Sacramento River at Colusa	SRCOL	Mainstem	22	67	7.5	0.8	3.2
Sacramento River at Veterans Bridge	SRVET	Mainstem	18	62	16	1.1	3.0
Sacramento River at Freeport	SRFPT	Mainstem	18	62	15	1.8	3.4
Sacramento River at River Mile 44	SRRMF	Mainstem	18	62	15	1.9	3.4
Yuba River at Marysville	YRMRY	Major Trib	9.9	85	1.0	0.8	3.5
Feather River near Nicolaus	FRNIC	Major Trib	11	77	7.0	1.3	3.4
American River at Discovery Park	ARDPK	Major Trib	12	76	3.1	3.8	5.6
Pit River above Shasta	PRSHA	Tributary	22	67	5.8	0.2	4.7
MF Cottonwood Creek near Ono	CTMON	Tributary	—(2)	—	—	—	—
NF Cottonwood Creek at McCauliffe Road	CTNON	Tributary	—	—	—	—	—
SF Cottonwood Creek at Anderson Canal	CTSCW	Tributary	—	—	—	—	—
Cottonwood Creek near Cottonwood	CTCTW	Tributary	35	61	2.8	0.5	0.2
NF Battle Creek at Manton Road	BANFA	Tributary	—	—	—	—	—
SF Battle Creek at Wildcat Road	BASFA	Tributary	—	—	—	—	—
Battle Creek below Coleman Fish Hatchery	BACTW	Tributary	9.0	89	0.5	0.3	0.8
Mill Creek at Mouth	MCMOU	Tributary	2.5	96	1.1	0.1	0.3
Thomes Creek at Paskenta	THPSK	Tributary	—	—	—	—	—
Thomes Creek at Henleyville	THAPK	Tributary	—	—	—	—	—
Thomes Creek at Rawson Rd Bridge	THRRB	Tributary	33	62	5.3	0.1	0.2
Deer Creek at Mouth	DCMOU	Tributary	4.5	93	2.3	0.0	0.1
Big Chico Creek at Mouth	CHMOU	Tributary	8.4	69	17	5.4	0.2
Dry Creek above Cherokee Canal	DRACC	Tributary	6.4	88	1.1	0.6	3.3
Little Chico Creek at Mouth	LCMOU	Tributary	19	66	8.9	6.1	0.5
Cache Creek near Rumsey	CCHRM	Tributary	37	47	7.4	2.1	6.5
Colusa Basin Drain above KL	COLDR	Ag Drain	18	17	64	1.4	0.2
Sacramento Slough	SACSL	Ag Drain	12	18	63	2.8	3.3
Natomas East Main Drain(3)	NEMDR	Urban	—	—	—	—	—
Arcade Creek at Norwood Ave.	ARCNW	Urban	0.06	.003	14	84	2.1

(1) Includes water, wetlands, snowfields, shrub and brush tundra, and transitional areas.
(2) "—" indicates land use percentages not calculated.
(3) Characteristics of the Natomas East Main Drain drainage are nearly identical to that of Arcade Creek.

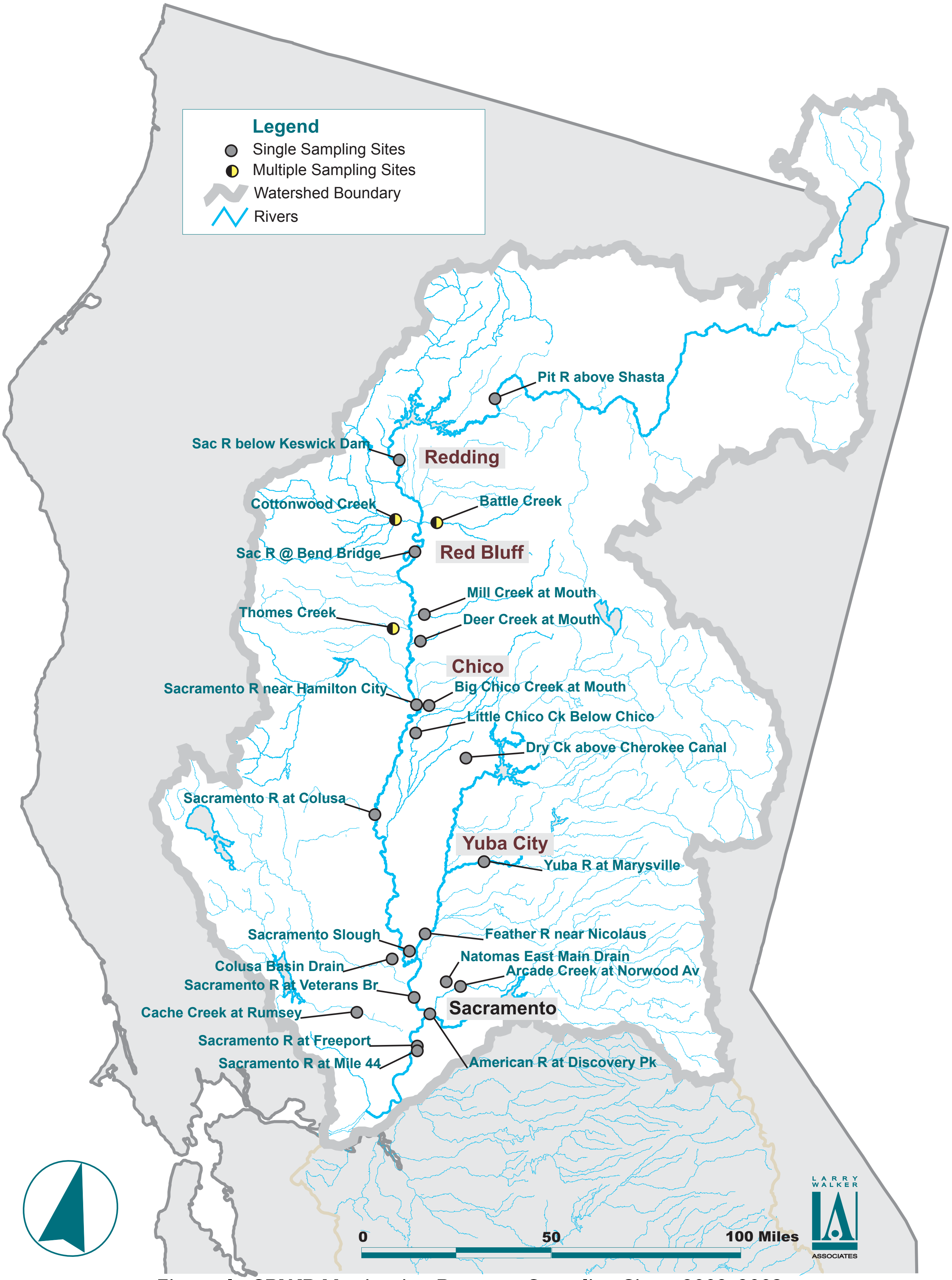


Figure 1. SRWP Monitoring Program Sampling Sites, 2002-2003

Table 2. Parameters Measured for the SRWP 2002-2003 Monitoring Program and Relevant Beneficial Uses.

	Beneficial Uses									
Parameters Monitored	**Municipal and Domestic Water Supply**	**Industrial Water Supply**	**Agricultural Water Supply**	**Non-Contact Recreation (Aesthetic Value)**	**Contact Recreation**	**Sport and Subsistence Fishing**	**Freshwater Habitat and Aquatic Life**	**Spawning**	**Fish Migration**	**wildlife Habitat and Uses**
Physical and Chemical Parameters in Water										
Alkalinity	X	X	X							
Conductivity	X	X	X							
Dissolved Oxygen							X	X	X	
Hardness	X	X	X							
Mercury, Filtered and Unfiltered						X				X
Methylmercury, Filtered and Unfiltered						X				X
Organic Carbon, Total and Dissolved	X									
pH							X			
Temperature							X	X	X	
Total Dissolved Solids (TDS)	X	X	X							
Total Suspended Solids (TSS)							X	X		
Turbidity	X			X			X	X		
Ultraviolet Absorbance at 254 nm	X									
Nitrogen and Phosphorus Compounds in Water										
Ammonia Nitrogen	X			X			X			
Nitrate and Nitrite Nitrogen	X			X			X			
Total Kjeldahl Nitrogen	X			X			X			
Dissolved Orthophosphate and Total Phosphorus	X			X			X			
Pesticides in Water										
OP Pesticides							X			
Carbamate Pesticides							X			
Triazine Pesticides							X			
Molinate and Thiobencarb	X						X			
Microbiological Characteristics in Water										
Escherischia coli Bacteria	X				X					
Total and Fecal Coliform Bacteria	X				X					
Aquatic Toxicity										
Ceriodaphnia dubia (Mortality and Reproduction)							X			
Fish Tissue										
Mercury, PCBs & Organochlorine Pesticides						X				X
Bioassessment										
Benthic Invertebrates Community Metrics							X			
Physical Habitat Assessment				X				X	X	X

Table 3. Summary of Sampling Sites, Sampling Frequency, and Parameters.

	Chemical Characteristics												Pathogens		Aquatic Toxicity		Fish Tissue		Bioassess-ment[b]	
Monitoring Locations [c]	Hg and MeHg (filtered and unfiltered)	TSS	Hardness	Alkalinity	TOC	DOC	UVA 254	TDS	Nitrogen and Phosphorus compounds	OP pesticides	carbamate pesticides	triazines	E. coli	Total, Fecal Coliforms	Ceriodaphnia	WC Tox Followup (a)	Mercury	PCBs & OC pest.	Benthic Invertebrates	Habitat Assessment
Pit R. above Shasta			atox	atox											6	(a)			RB	
Sac. R. below Keswick	5	5	atox	atox				RED							6	(a)				
Cottonwood Ck at mouth			atox	atox											6	(a)				
Cottonwood Creek (3 tributary sites)	12	12																		
Battle Creek (3 tributary sites)	12	12																		
Sac. R. at Bend Br	5	5	atox	atox	6	6	6	6	6				6	6	6	(a)				
Mill Creek @ Los Molinos										3										
Deer Creek										3										
Thomes Creek (3 tributary sites)	12	12																		
Dry Creek (trib to Little Chico Ck)	4	4																		
Little Chico Creek	4	4																		
Big Chico Creek										3										
Sac. R. near Hamilton City	5	5	atox	atox	6	6	6	6	6	6			6	6	6	(a)				
Sac. R. @ Colusa	5	5	atox	atox	6	6	6	6	6	6			6	6	6	(a)				
Sac. Slough	4	4	atox	atox	6	6	6	6	6	6	6		6	6	6	(a)				
Colusa Basin Dr	4	4	atox	atox	6	6	6	6	6	6	6		6	6	6	(a)		(c)		
Yuba R. at Marysville	5	5	atox	atox	6	6	6	6	6	6	6		6	6	6	(a)				
Feather R. near Nicolaus	5	5	atox	atox	6	6	6	6	6	6		4	6	6	6	(a)	4			
Sac. R. at Veterans Br.	CMP	CMP	CMP	6	CMP	CMP	6	6	6	6		4	CMP	CMP						
Arcade Creek	4	4		atox						6	6	6			6	(a)				
Natomas East Main Drain			DWR	DWR	DWR	DWR	DWR	DWR	6				6	6						
American R. at Discovery Pk	CMP	CMP	CMP	atox	CMP	CMP	6	CMP	6	CMP			CMP	CMP	6	(a)	6	2		
Sac. R. at Freeport	CMP	CMP	CMP	GS	CMP	CMP	6	CMP	6	GS	GS	GS	CMP	CMP	6	(a)				
Sac. R. at RM44	CMP	CMP	CMP	6	CMP	CMP	6	CMP	6	CMP			CMP	CMP			4	2		
Cache Creek at Rumsey															6	(a)				

Tabled values indicate number of environmental samples collected annually. All 2002-2003 water quality monitoring was "event-based". "atox" indicates parameter is measured as part of aquatic toxicity monitoring. Other text entries indicate data or samples collected by primary coordinating programs: CMP = Sacramento River Coordinated Monitoring Program; CDWR = Dept. of Water Resources; GS = USGS.

(a) There are no fixed frequencies or locations for aquatic toxicity follow-up.

(b) Monitoring in 2002 consists entirely of supporting efforts to identify reference sites and conditions.

DATA REVIEW PROCESS

The purpose of this data review is to present the results of monitoring performed by the SRWP and coordinating programs, and to present the conclusions of evaluation of these data. This review utilizes data compiled for the period 1994 through 2003, but focuses on SRWP monitoring conducted in 2002-2003. The primary data considered and presented for this review were generated by the following programs:

- The Sacramento River Watershed Program (SRWP) (http://www.sacriver.org)
- The Sacramento River Coordinated Monitoring Program (CMP) (LWA 2003),
- The City of Redding NPDES monitoring program,
- USGS National Assessment of Water Quality (NAWQA) for the Sacramento River (http://water.wr.usgs.gov/sac_nawqa/index.html),
- California Department of Water Resources (Northern District) Intensive Tributary Monitoring Program (http://wwwdpla.water.ca.gov/nd/index.html),
- California Department of Water Resources Municipal Water Quality Investigations (MWQI) Program

The data from the coordinating programs are collected using similar sampling and analytical methods, and were therefore considered compatible with SRWP data. Data from these programs were pooled for subsequent evaluations, presentation of summary data (e.g. summary statistics), and plots of data, unless stated otherwise. For parameters with concentrations reported below analytical detection limits, summary statistics presented in this report were estimated using the robust method of Helsel and Cohn (1988), which uses probabilities adjusted for the proportion of data below detection to calculate unbiased estimates of the typical parametric statistics (mean, standard deviation, etc.). Additionally, selected results were also considered and evaluated from a number of other monitoring studies referenced in following data review sections.

The review of data for parameters measured for the 2002-2003 SRWP monitoring effort is organized into the following general categories:

- Mercury in water and fish tissue
- Pesticides in water
- Aquatic toxicity
- Drinking water parameters of concern (organic carbon, dissolved and suspended solids, nutrients, pathogen indicators)
- Organochlorine pesticides and PCBs in fish tissue

PROCESS FOR DATA EVALUATION

Each evaluation is preceded by an overview of relevant monitoring information. The evaluations presented within each data review category were designed to address specific goals of the SRWP monitoring program. Monitoring data were evaluated for evidence that beneficial uses are attained or impaired, and if these evaluations indicated potential impairment due to a specific monitoring parameter, temporal and spatial trends in water quality were also evaluated and discussed. If the evaluations indicated that a particular parameter is probably not causing impairment, spatial and temporal trends were not evaluated for that parameter. Descriptions of the specific methods used to evaluate attainment of beneficial uses and spatial and temporal trends follow.

Evaluation of Attainment and Potential Impairment of Beneficial Uses

Comparisons with applicable water quality criteria, objectives, and other advisory criteria were performed as a preliminary evaluation of the degree to which beneficial uses of the Sacramento River watershed are attained or potentially impaired. Concentrations in water are compared to California Toxics Rule (CTR) criteria, USEPA Maximum Contaminant Levels (MCLs) for drinking water, and Central Valley Basin Plan objectives (which incorporate California Department of Health Services (CDHS) Maximum Contaminant Levels (MCLs) for drinking water by reference). Concentrations of mercury and organic compounds in fish tissue were compared to various screening values developed by several different state and federal regulatory agencies. As a rule, these regulatory criteria and other limits define what are believed to be “safe levels”, rather than thresholds of adverse effects. Because these limits are conservative by design, individual exceedances are not necessarily predictive of actual impairments of beneficial uses. For the purpose of these evaluations, concentrations that exceed these regulatory limits in water or tissue are considered indicators of potential impairment of beneficial uses. Cases where concentrations clearly do not exceed regulatory limits indicate that beneficial uses are not being impaired by a specific constituent, but do not provide unequivocal evidence that a specific beneficial use is being fully attained. The results of these comparisons to regulatory criteria and other limits were also evaluated for consistency with the State Water Resources Control Board’s 303(d) list of waterbodies which the State considers to be impaired and not attaining beneficial uses. Note that the State Water Resources Control Board is currently developing a “listing policy” that will define how to determine impairment of beneficial uses, including data requirements, numbers of exceedances, and other information needed to qualify a waterbody for inclusion on the 303(d) list.

As discussed previously, water column monitoring frequency was reduced to six events per year in 2001 (from nine events per year for 2000-2001, and 12 events in previous years). Additionally, the monitoring strategy was changed to “event-based” for all water column parameters in 2001-2002. Because the majority of monitoring events are selected to characterize hydrological events expected to result in higher than typical concentrations and loads of pollutants, over time this change in strategy will tend to bias the dataset towards “worst case” water quality conditions. For most monitoring locations with several years of monitoring data, this effect is offset (for a while) by the large majority of unbiased data in the data set. However, for locations monitored for the first time or with relatively short monitoring histories (e.g. many of the smaller tributaries monitored from 2001-2003), this bias can be substantial and immediate. There is no simple cure for this introduced bias. Statistical corrections may be possible in some cases, but they typically rely on complex modeling or data-weighting methods. For the purpose of these assessments, no attempt is made to correct for the bias, other than to make the reader aware and to warn of its potential impact on the evaluations. Assessments based on fish tissue or bioassessment monitoring remain unbiased because they are not affected by these changes in water column monitoring strategy.

Spatial and Temporal Trends

For parameters determined to have the potential to impair beneficial uses, evaluations of spatial and temporal trends were also performed. Evaluation of these trends support the SRWP goal of collecting and evaluating water quality data for the purpose of characterizing baseline conditions in the watershed, and also provide information relevant to identifying sources of pollutants or causes of potential impairment. Due to the limitations of the data (e.g. only a few years of data for most parameters, varying monitoring periods for different programs, high percentages of data below detection for some parameters and programs, and very few data for some sites and parameters), formal statistical analysis of the spatial and temporal trends would be resource-intensive and would provide little additional useful information for the SRWP. The discussions of general trends are qualitative and descriptive and are generally not characterized as statistically significant. Summary statistics and time series plots of chemical, physical, and microbiological water quality characteristics were also prepared and are provided in Appendix A and Appendix B, respectively. Fish tissue data are presented in Appendix C. If appropriate for the specific data category, a semi-quantitative assessment was performed of the relative importance of the loads of selected pollutants to the Delta.

Statement of Data Quality

Data presented in this report have been reviewed and validated as required by the Quality Assurance Project Plan (SRWP 2002). In general, data collected by the SRWP and cooperating programs are adequate for the purposes intended and the evaluations presented in this review. A detailed review of data quality is presented in Appendix D of this report.

MERCURY

Monitoring results for the Sacramento River Watershed Program (SRWP) for the period June 1998 through June 2003 and for primary coordinating programs (USGS NAWQA, Sacramento River Coordinated Monitoring Program, City of Redding NPDES monitoring, and Department of Water Resources) are presented and summarized in this section. Data are compared to adopted water quality objectives and advisory criteria to evaluate attainment and potential impairment of beneficial uses in the watershed. Data are evaluated for spatial and temporal trends, and summary statistics are provided in Appendix A.

BACKGROUND AND AVAILABLE DATA OVERVIEW

The sources of data utilized for this report are summarized in Table 4. The monitoring locations for the primary data considered for this report (USGS NAWQA, Sacramento River Coordinated Monitoring Program, City of Redding NPDES monitoring, the California Department of Water Resources, and the Sacramento River Watershed Program) are illustrated in Figure 2.

Table 4. Mercury Monitoring Programs (Water Column and Fish Tissue), Sacramento River Watershed

Program	Monitoring Period(s)	Parameters	# of Locations & Geographic Reference
SRWP	6/98–6/03 6/00–6/03	▪ Total Hg in water, ▪ Total Hg in fish tissue ▪ Methylmercury in water	3 water column sites: 2 upper watershed, and 1 in lower watershed; 13 fish tissue sites on Sacramento River and major tributaries
SRWP Special Study (USGS)	1/19/00, 2/20/00	▪ TSS, total Hg, and methylmercury in water	Sac. R. at bend Bridge and Woodson Bridge, Antelope Creek, Elder Creek, and Mill Creek
SRWP Special Study (CDFG)	3/01–6/01	▪ TSS, total Hg, and methylmercury in water	11 Sacramento River sites from Hamilton City to Colusa
SRWP Special Study (PER)	4/01	▪ TSS, total Hg, and methylmercury in water	3 sites in Mill Creek drainage
Sacramento River Mercury Control Planning Project (LWA 1997)	3/95–2/96	▪ Total and filtered Hg and MeHg, and TSS in water ▪ Hg and MeHg in benthic invertebrates and fish	7 water column sites on Sacramento River, Feather River, and Yuba River. MeHg at selected sites. 55 benthic invertebrate and 25 fish sites on Sierra tributaries to the Sacramento River.
Sacramento River CMP (SRCSD)	12/92–6/02	▪ Total and dissolved Hg in water	5 sites on Sacramento and American rivers in Sacramento metropolitan area
USGS Mercury Transport Study (Roth et al. 1998)	6/96–5/97	▪ Total, dissolved, and colloidal Hg in water	6 sites on Sacramento River and 7 sites on selected tributaries.
Sacramento River Basin NAWQA (USGS)	1996—2003	▪ Total Hg and MeHg in water ▪ Total Hg in sediments	12 Hg sites (5 MeHg sites), distributed throughout watershed 1996-98. 5 sites 1998-2002.
USGS (Domagalski 2001)	2/96–2/97	▪ Total Hg and MeHg in water ▪ Total Hg in sediments	11 water column and 17 sediment sites on the Sacramento River and major tributaries.
CVRWQCB (Slotton et al. 1997)	Spring, 1996	▪ Hg in benthic invertebrates.	38 sites in the Cache Creek watershed
CVRWQCB (Foe and Croyle 1998)	10/93–4/95, 1996-1998	▪ Total and dissolved Hg, and TSS in water	22 sites in major Delta tributaries, and 10 additional sites in Cache Ck watershed
City of Redding	1/98–5/01	▪ Total Hg in water	1 site at Sacramento River below Keswick Dam
SF Estuary Regional Monitoring Program	1989–1997	▪ Total and dissolved Hg in water ▪ Total Hg in fish tissue	18 Bay-Delta sites, including Sacramento River and San Joaquin River at the Delta terminus
Special Tributary Program (CDWR)	6/98–5/00	▪ Total Hg in water ▪ Total Hg in fish tissue	13 water column sites and 8 fish tissue sites on Mill Creek, Big Chico Creek, and Deer Creek
CALFED Bay-Delta Hg Program	1999—2003	▪ Total Hg and MeHg in water, sediments, fish, clams, bird eggs, benthic invertebrates,	Locations throughout the Bay-Delta Estuary, and Cache Creek watershed. *Data final but not yet available for most projects.*
USGS Hg Bioaccumultion Study (May *et al.* 2000)	1999	▪ Total mercury in fish	22 sites in the South Yuba River, Deer Creek, and Bear River

ATTAINMENT OF BENEFICIAL USES AND POTENTIAL IMPAIRMENT

One of the SRWP monitoring program's primary goals is to assess the degree to which beneficial uses are attained or potentially impaired in surface waters of the watershed. For the purpose of these evaluations, mercury concentrations in water and fish tissue were compared to various regulatory criteria and screening or advisory thresholds. Concentrations that exceed these regulatory limits in water or tissue are considered indicators of potential impairment of beneficial uses, as described previously. Cases where concentrations clearly do not exceed regulatory limits indicate that beneficial uses are not being impaired by a specific constituent, but do not provide unequivocal evidence that a specific beneficial use is being fully attained. The results of these comparisons to regulatory criteria and other limits were also evaluated for consistency with the State Water Resources Control Board's 303(d) list of waterbodies which the State considers to be impaired and not attaining beneficial uses.

Water Column

Human Health Thresholds

Total mercury concentrations in water were compared with a variety of regulatory, screening, and advisory thresholds (Table 5). Adopted total mercury water quality objectives for the Sacramento River watershed include a human health-based water quality objective for drinking water of 2000 ng/L (the drinking water Maximum Contaminant Level or MCL) adopted in the Central Valley Basin Plan, and a human-health-based federal water quality criterion of 50 ng/L (30-day average) adopted in the May 2000 California Toxics Rule (CTR). The CTR criterion reflects the latest USEPA national water quality criterion for total mercury for protection of human health, which superceded the 1985 USEPA national criterion value of 12 ng/L. The CTR criterion does not reflect the approach used in the Great Lakes Initiative, where an objective of 3.1 ng/L was adopted based on use of field-derived bioaccumulation factors (BAFs). The fish consumption-based human health criteria for mercury are intended to protect sensitive individuals (pregnant women, unborn children, infants) and are based on different assumptions of fish consumption rates and bioaccumulation rates.

USEPA re-evaluated and revised its 304(a) national criterion for mercury in 2001 (USEPA 2001a) and has promulgated the human health-based water quality criterion as a fish tissue-based criterion for methylmercury. New human health criteria based on USEPA's 304(a) revisions have not yet been proposed for California.

Wildlife Thresholds

No wildlife-based water quality objectives have been adopted for mercury in California and USEPA has not issued national wildlife-based advisory criteria for mercury in water. A wildlife-protective standard of 1.3 ng/L total mercury has been adopted for the Great Lakes area, based on criteria developed by USEPA. USEPA revised these Great Lakes values for protection of wildlife species in its Mercury Report to Congress (USEPA 1997), an advisory document. Total mercury criterion values presented in the Mercury Report to Congress ranged from 0.6 ng/L to 1.8 ng/L, with an average of 0.9 ng/L for the species considered. The Mercury Report to Congress also identified a methylmercury criterion of 0.05 ng/L in water for protection of wildlife.

Table 5. Regulatory Standards and Other Threshold Values for Mercury in Water

Basis for Limit	Concentration in Water, ng/L	Form of Mercury	Reference
Human Health	2000	Total	Maximum Contaminant Level (MCL) in drinking water (USEPA 1996)
Human Health	50[2]	Total	Federal water quality criterion per California Toxics Rule (May 2000), Recommended National Water Quality Criteria (USEPA 1999)
Human Health	0.24 3.1	Methyl Total	Specific to Great Lakes, federal water quality criterion for Great Lakes (USEPA 1995a)
Wildlife[1]	0.05 0.641 0.91	Methyl Dissolved Total	Mercury Report to Congress, Vol. VI (USEPA 1997)
Wildlife	1.3	Total	Specific to Great Lakes, federal water quality criterion for Great Lakes (USEPA 1995a)

(1) Lowest average criterion, based on the average for all mammalian wildlife species studied in Mercury Report to Congress.

(2) This value represents a 30-day average not to be exceeded more than once in three years.

Comparison with Water Column Threshold Values

Because the mercury objective for protection of human health for drinking water exposure is orders of magnitude higher than fish consumption-based limits, the remaining discussion will focus only on the fish consumption-based values. The percentage of data meeting specific regulatory or advisory thresholds are presented in Table 6.

Total mercury concentrations in the Sacramento River (from Keswick to Greene's Landing) and in the major tributaries were rarely observed to exceed the CTR criterion for mercury (0.9%, or 6 of 666 total samples in the Sacramento River, and in no samples from the American, Feather, and Yuba rivers). Mercury concentrations in Cache Creek exceeded the 50 ng/L limit in 33% of samples. Based on data collected by CDWR and SRWP, mercury concentrations in the Mill Creek exceeded the 50 ng/L limit in 13% of samples collected from the mouth of the creek. Higher concentrations and percent exceedances (46%) were observed in waters of the upper Mill Creek watershed, where the influence from geothermal activity (hot springs) is greatest. CDWR data for Deer Creek and Big Chico Creek indicate that the CTR criterion was met in every sample collected in the Deer Creek watershed, and in all but one sample (of 86) collected in the Big Chico Creek watershed. Mercury concentrations exceeded the CTR criterion in only one sample collected from the two agricultural drains monitored by SRWP (Sacramento Slough and Colusa Basin Drain), but exceeded the criterion in 30% of samples collected in the Yolo Bypass.

In comparison with total mercury advisory criteria in the range from 2–5 ng/L (as indicated by USEPA Region IX staff) for human health protection, or at 1.3 ng/L concentrations (as has been adopted in the Great Lakes for wildlife protection), ambient water column concentrations of total mercury frequently exceed these values at all sites tested throughout the Sacramento River watershed. In comparison with the 3.1 ng/L Great Lakes criterion for the protection of human health, the Sacramento River exceeded this criterion in only 23% of samples (28 of 137) collected from Hamilton City and upstream, while the 3.1 ng/L limit was exceeded in 85% of samples (431 of 535) collected from the Sacramento River from Colusa to Greene's Landing. The 3.1 ng/L limit was exceeded in fewer than 10% of samples from the Deer Creek watershed, in 15% of samples from the Big Chico Creek watershed, and in nearly every sample (87%) from Mill Creek.

The Great Lakes Initiative adopted a human health-based methylmercury criterion of 0.24 ng/L. Methylmercury concentrations measured by SRWP and USGS at eight mainstem Sacramento River sites exceeded 0.24 ng/L in 9% of samples, and methylmercury concentrations in the two agricultural drain sites (Colusa Drain and Sacramento Slough, 1996-1998, 2001-2003) exceeded 0.24 ng/L in 26% and 37% of samples, respectively. Arcade Creek (an urban creek) exhibited the highest percentage of exceedances of the 0.24 ng/L limit (56%, 2000-03 data). Methylmercury concentrations in Cache Creek exceeded 0.24 ng/L in only one of twelve samples collected by USGS in 1999. In comparisons with the 0.05 ng/l wildlife-based methylmercury advisory criterion identified in the Mercury Report to Congress by USEPA, methylmercury concentrations exceeded the limit in approximately 77% of the total samples collected at all sites (438 of 565 samples).

Table 6. Comparison with Water Quality Criteria for Human Health: Percent of Data Meeting Criterion

	Site	Years Monitored	n	Max Value	2000 CTR Criterion, 50 ng/L	1985 USEPA, 12 ng/L	1997 USEPA Great Lakes Criterion, 3.1 ng/L
Mainstem	Sacramento River below Keswick	1998–2003	53	10.4	100.0%	100.0%	92.5%
	Sacramento River above Bend Bridge	1999–2003	28	14.4	100.0%	99.1%	80.8%
	Sacramento River near Hamilton City	1999–2003	28	54.1	99.4%	90.6%	57.7%
	Sacramento River at Colusa	2000–2003	17	68.2	95.4%	77.3%	44.5%
	Sacramento River at Veterans Bridge	1994–2003	137	34.9	100.0%	81.2%	7.5%
	Sacramento River at Freeport	1994–2003	136	96.0	99.5%	78.0%	17.0%
	Sacramento River at River Mile 44	1994–2003	128	73.4	99.7%	78.1%	14.3%
	Sacramento River at Greene's Landing	2000–2001	8	4.0	100.0%	100.0%	65.3%
Major Trib	Yuba River at Marysville	1999–2003	28	40.2	100.0%	90.3%	52.4%
	Feather River near Nicolaus	1999–2003	29	21.4	100.0%	88.1%	36.2%
	American River below Nimbus Dam	1994–2003	134	15.4	100.0%	99.4%	78.1%
	American River at Discovery Park	1994–2003	135	13.3	100.0%	99.0%	66.1%
Tributaries	Spring Creek PP Discharge to Keswick Res.	1998–2000	11	1.7	100.0%	100.0%	100.0%
	MF Cottonwood at Platina Rd	2002–2003	3	19.4	100.0%	66.6%	66.6%
	MF Cottonwood Creek near Ono	2001–2002	2	1.2	100.0%	100.0%	100.0%
	MF Cottonwood Creek near Cox Road	2003–2003	1	0.7	100.0%	100.0%	100.0%
	NF Cottonwood Creek near Ono	2002–2003	3	27.7	100.0%	69.4%	55.1%
	NF Cottonwood Creek at McCauliffe Rd	2001–2002	2	4.0	100.0%	100.0%	50.0%
	NF Cottonwood Creek near Foster Road	2003–2003	1	2.3	100.0%	100.0%	100.0%
	SF Cottonwood Creek at Anderson Canal	2001–2003	5	17.4	100.0%	87.3%	52.9%
	North Fork Battle Creek at Wildcat Road	2001–2003	6	13.9	100.0%	91.3%	72.7%
	South Fork Battle Creek at Manton Road	2001–2003	6	17.1	100.0%	87.2%	71.6%
	Battle Creek below Coleman Fish Hatchery	2001–2003	6	32.8	100.0%	86.4%	68.7%
	Mill Creek at Highway 36	1998–2000	19	1910.0	54.0%	20.2%	4.3%
	Mill Creek at Black Rock	1998–2001	18	110.0	82.5%	47.1%	15.2%
	Mill Creek at Highway 99	1998–2001	8	116.1	73.2%	41.2%	15.4%
	Mill Creek at Mouth	1998–2001	28	485.0	87.2%	54.6%	19.7%
	Thomes Creek at Paskenta	2001–2003	6	48.2	100.0%	67.6%	49.9%
	Thomes Creek at Henleyville	2002–2003	4	56.2	75.0%	49.6%	26.9%
	Thomes Creek at Rawson Rd Bridge	2002–2003	4	50.3	75.0%	23.3%	1.9%
	Deer Creek below Childs Meadows	1998–2000	19	7.0	100.0%	100.0%	93.6%
	Deer Creek at A Line Road	1998–2000	5	8.1	100.0%	100.0%	72.4%
	Deer Creek at Ponderosa Way	1998–1999	12	5.0	100.0%	100.0%	97.7%
	Deer Creek at Upper Diversion Dam	1998–2000	19	9.6	100.0%	100.0%	82.4%
	Deer Creek at Highway 99	1998–2000	6	9.3	100.0%	100.0%	72.1%
	Deer Creek at Mouth	1998–2000	14	6.0	100.0%	100.0%	94.3%
	Big Chico Creek at Hwy 32	1998–2000	19	4.9	100.0%	100.0%	95.8%
	Big Chico Creek above Salmon Hole	1998–2000	16	6.4	100.0%	100.0%	88.5%
	Big Chico Creek at Chico (Rose Ave.)	1998–2000	19	10.0	100.0%	100.0%	92.0%
	Big Chico Creek above Mud Creek	1998–2000	20	10.1	100.0%	100.0%	79.0%
	Mud Creek above Big Chico Creek	1998–2000	11	57.7	99.8%	87.4%	58.5%
	Dry Creek above Cherokee Canal	2001–2003	7	62.7	86.2%	57.7%	25.6%
	Little Chico Creek below Chico	2002–2003	5	27.4	100.0%	48.3%	10.6%
	Cache Creek near Rumsey	1996–1998	33	2247.6	66.1%	35.4%	13.0%
	Cache Slough near Ryers Ferry	1998–2000	11	18.2	100.0%	77.9%	5.2%
Urban	Arcade Creek at Norwood Ave.	1999–2003	27	54.3	95.6%	63.7%	17.6%
Ag Drains	Colusa Basin Drain above KL	1999–2003	27	75.1	98.6%	75.4%	22.8%
	Sacramento Slough	1999–2003	25	19.1	100.0%	84.0%	14.9%
	Yolo Bypass neat Woodland	1997-1998	10	223.7	69.6%	8.8%	0.1%

Fish Tissue

Threshold Values

Mercury concentrations in composite and individual fish tissue samples were compared with several different advisory thresholds and criteria for mercury in fish tissue (all expressed as wet weight) (Table 7). Human health-based limits range from 1.0 mg/kg (the Food and Drug Administration (FDA) Action Level applicable to commercially-caught fish), to 0.30 mg/kg (national ambient water quality criterion for protection of human health; USEPA 2001a), to 0.14 mg/kg (SFBRWQCB 1995). USEPA fish tissue advisory criteria for protection of wildlife in the Great Lakes, as revised in the 1997 Mercury Report to Congress, range from 0.68 mg/kg to 0.028 mg/kg. These criteria and screening values are risk-based advisory values against which tissue concentrations can be compared to determine whether more intensive monitoring, evaluation, or risk management (e.g. consumption advisories) are warranted. Note that these risk-based values are based on assumed fish consumption rates for humans (6.5 g/day to 30 g/day) or for wildlife species. For individuals or populations consuming more or less fish than assumed for a specific limit or screening value, the risk of adverse health effects is correspondingly increased or decreased. Additionally, each criterion or screening value is calculated from a reference dose (RfD) based on a daily intake level estimated not to cause adverse effects, and a safety factor to account for uncertainties in the reference dose. The current USEPA human health-based reference dose incorporates a safety factor of 10, and reference doses for birds and mammalian wildlife range from 2 to 10. The consumption rate and reference dose associated with each limit are also specified in Table 7.

Comparison with Fish Tissue Threshold Values

Fish tissue data from the SRWP monitoring effort at various locations were compared with fish tissue advisory values[2]. The concentrations of mercury accumulated in fish are known to be species specific, with predatory upper trophic level fish (e.g. Trophic Levels 3 and 4) having higher mercury concentrations. Additionally, concentrations of mercury are size- and age-dependent within a given species, with older, larger fish typically having higher mercury concentrations. (The process which produces these conditions is termed “biomagnification”.) To control for these species-, age-, and size-dependent effects, SRWP fish tissue monitoring focused on mercury concentrations in individual fish and composite samples comprised of fish of similar legal catchable size. Where there were sufficient numbers of a particular species, tissue concentrations were plotted against length to illustrate this relationship (Figure 3 and Figure 4, for largemouth bass and white catfish, respectively). Figure 5 presents data for individual samples for other species.

Average mercury concentrations are presented for each species and location in Table 8. Average mercury concentrations are also summarized by waterbody type, species, and trophic level[3] in Table 9, and the consumption-weighted average is provided for each waterbody type. The

[2] All SRWP fish tissue data presented are for edible fillets with skin off.

[3] “Trophic level” describes the position of a species in the food chain, determined by the number of energy-transfer steps to that level. Trophic level 3 fish consume primarily zooplankton and benthic invertebrates. Trophic level 4 fish preferentially consume trophic level 3 and lower trophic level fish species, as well as benthic invertebrates. Larger individuals of some primarily trophic level 3 species (e.g. trout) may be piscivorous and function at trophic level 4.

consumption-weighted average is an estimate of the average concentration of mercury for the total freshwater and estuarine fish consumed, and assumes that a combination of trophic level 3 and trophic level 4 fish are consumed. While the approach has not been adopted as official policy, USEPA Region 4 used this method for a TMDL developed for the Savannah River in Georgia, in which the consumption-weighted average was compared directly to the fish tissue-based water quality criterion for methylmercury (0.3 mg/kg) to evaluate whether a waterbody should be considered impaired (USEPA 2001b). The approach is also consistent with the development of the methylmercury criterion (USEPA 2001a), which also assumes that fish consumed consist of a mix of different trophic level species. The consumption-weighted average mercury concentration is calculated as follows:

Consumption-Weighted Average = (57% x *Trophic Level 3 avg.*) + (43% x *Trophic Level 4 avg.*).

The percentages used for trophic levels 3 and 4 (TL3 and TL4) in this equation are based on assumptions used by USEPA in development of the methylmercury criterion, which assumed consumption of TL2, TL3, and TL4 species in proportions of 21.7%, 45.7%, and 32.6%, respectively (USEPA 2001a). For the purpose of this analysis for the SRWP, it was assumed that no TL2 species were consumed and the TL2 percentage was apportioned equally between TL3 and TL4 species. It should be noted that the USEPA default consumption rates and TL3 and TL4 percentages may not be appropriate for consumers in the Sacramento River watershed, and should ideally be adjusted based on site-specific consumption information. Fish consumption patterns for the Sacramento River watershed are being investigated by the Delta Tributaries Mercury Council of the SRWP. Additionally, although a consumption-weighted average should ideally be calculated separately for each waterbody, there were insufficient data to perform these calculations for each location and waterbody. However, species average concentrations were similar within each defined waterbody category, so grouping the locations within these broad waterbody categories appeared to provide characterizations that were also reasonable for the individual waterbodies.

Comparisons of tissue mercury concentrations to fish tissue advisory values are summarized below.

- A total of 15 fish species are represented in the data set, including seven trophic level 3 species and eight trophic level 4 species (Table 8 and Table 9). The average mercury concentrations for combined trophic level 3 species (0.10–0.27 mg/kg) were lower than the 0.3 mg/kg criterion for all waterbody categories sampled (Ag drains, tributaries, major tributaries, the Sacramento River from Keswick to the I Street Bridge, and Delta sites including Cache Slough and the Sacramento River at Mile 44 below I Street Bridge). Average mercury concentrations calculated individually for each of the seven trophic level 3 species (79 total samples) were also below 0.3 mg/kg for all locations and waterbody categories, with the exception of splittail and smallmouth bass samples (0.37 and 0.57 mg/kg, respectively) collected from Sacramento River at Mile 44.
- The average mercury concentrations for combined trophic level 4 species (0.32–0.85 mg/kg) were greater than the 0.3 mg/kg criterion for every waterbody category sampled. Average mercury concentrations calculated individually for each of the eight trophic level 4 species (217 total samples) were greater than 0.3 mg/kg for most locations and waterbody categories, with the following exceptions: Sacramento pikeminnow in the Sacramento River mainstem from Bend Bridge to River Mile 44, white catfish and crappie in Colusa Basin Drain, white catfish in Natomas East Main Drain and Putah Creek, and smallmouth bass in Chico Creek and Deer Creek all had average mercury concentrations lower than 0.3 mg/kg.
- Average mercury concentrations in fish tissue exceeded the USEPA criterion (0.3 mg/kg) in largemouth bass from all waterbody types and locations sampled, and average concentrations

in white catfish exceeded the USEPA criterion in six of nine sites sampled (Table 8, Figure 3). These two species were collected from lower Sacramento River and Delta sites, agricultural drains, and major and lesser tributaries from Keswick to Cache Slough.

- Most largemouth bass collected also exceeded the USEPA 1996 Screening Value (0.6 mg/kg), and a number of individual largemouth bass collected from the American River, Feather River, the Sacramento River at River Mile 44, and from Cache Slough exceeded the FDA Action Level of 1.0 mg/kg (Figure 4).
- All striped bass sampled (n = 8) exceeded the 0.3 mg/kg criterion (Figure 5). Striped bass exhibited the highest average mercury concentration (1.2 mg/kg) for any species sampled, and included the highest mercury concentration of any sample (3.5 mg/kg) for a single large individual fish (~33 inches long) collected from the Feather River at Nicolaus.
- Consumption-weighted average mercury concentrations were highest (0.51 mg/kg) for the two major tributaries sampled (American River and Feather River), and also exceeded the 0.3 mg/kg criterion for the two Delta locations sampled (0.34 mg/kg, Sacramento River at Mile 44 and Cache Slough). Consumption-weighted averages were lower than the 0.3 mg/kg criterion for smaller tributaries (0.23 mg/kg), the Sacramento River from Keswick to the "I" Street Bridge (0.27 mg/kg), and the two agricultural drains (0.27 mg/kg, Colusa Basin Drain and Sacramento Slough). The single urban drainage (Natomas East Main Drain) was represented by only trophic level four species with an average of 0.57 mg/kg.

Table 7. Criteria and Screening Values for Mercury in Fish Tissue

Basis for Limit	Criterion or Screening Value[1], mg/kg	RfD, µg/kg/day	Body Weight, kg	Consump-tion Rate, kg/day	Reference
Human Health	1.0	0.47	60	0.0284	FDA Action Level[2] (vm.cfsan.fda.gov/~dms/)
	1.0	0.3	60	0.018	ATSDR 1999 (www.atsdr.cdc/gov/press/ma990419.html)
	0.6	0.06	60	0.065	USEPA Screening Value (USEPA 1993)
	0.33	0.1	60	0.018	Mercury Report to Congress, Vol. VI (USEPA 1997)
	0.14	0.06	70	0.030	SFBRWQCB Screening Value (SFBRWQCB 1995)
	0.23	0.1	70	0.030	OEHHA and SFEI Screening Value (OEHHA 1999, SFEI 1999a)
	0.3	0.1	70	0.0175	Ambient Water Quality Criterion for Human Health (USEPA 2001)
Wildlife[4]	0.08 0.34	Hg criterion in trophic level 3 fish Hg criterion in trophic level 4 fish (See USEPA 1997 for calculations)			Mercury Report to Congress, Vol. VI (USEPA 1997)

(1) Expressed as mg/kg wet weight. Values are calculated as (RfD x Body Weight) ÷ Consumption Rate.

(2) The FDA Action Level is intended to apply only to commercially caught fish, and not to locally-caught or sport fish.

(3) The USEPA 2001 criterion also assumes that a specific proportion of 3 trophic levels of fish are consumed—.0038 kg/day Trophic Level 2 (21.7%), .0080 mg/day Trophic Level 3 (45.7%), and .0057 kg/day Trophic Level 4 fish (32.6%).

(4) Lowest average criterion, based on the average for all mammalian wildlife species studied in Mercury Report to Congress.

Table 8. Mercury in Fish Tissue, Concentrations by Species and Location

Type	Location	Hg in Fish Tissue, mg/kg, Wet Weight					
		Species	**n**	**Mean**	**Std Dev**	**Min**	**Max**
Delta	Cache Slough	Carp	1	0.11	–		
		Crappie	1	0.32	–		
		Largemouth Bass	18	0.71	0.290	0.31	1.27
		Sacramento Sucker	1	0.11	–		
		White Catfish	21	0.50	0.193	0.14	1.00
	Sacramento R. at Mile 44	Bluegill	1	0.10	–		
		Largemouth Bass	29	0.87	0.292	0.18	1.37
		Pike Minnow	2	0.15	0.046	0.11	0.18
		Sacramento Sucker	2	0.22	0.008	0.21	0.22
		Smallmouth Bass	1	0.57	–		
		Splittail	1	0.37	–		
		Striped Bass	1	0.34	–		
		White Catfish	30	0.40	0.240	0.16	1.14
Mainstem	Sacramento R. below Keswick	Rainbow Trout	4	0.03	0.016	.003	0.04
	Sacramento R. above Bend Bridge	Pike Minnow	1	0.12	–		
		Rainbow Trout	2	0.04	0.008	0.03	0.04
		Sacramento Sucker	1	0.10	–		
	Sacramento R. near Hamilton City	Pike Minnow	2	0.25	0.052	.22	0.29
		Sacramento Sucker	2	0.03	0.001	.03	0.03
	Sacramento R. at Colusa	Carp	1	0.19	–		
		Pike Minnow	2	0.22	0.108	0.15	0.30
		Sacramento Sucker	1	0.06	–		
		Striped Bass	1	0.30	–		
	Sacramento R. at Veterans Bridge	Largemouth Bass	2	0.89	0.099	0.82	0.96
		Pike Minnow	1	0.25	–		
		Sacramento Sucker	1	0.10	–		
		White Catfish	2	0.38	0.239	0.21	0.55
Major Tributary	American River at Sunrise	Sacramento Sucker	1	0.20	–		
	American R. at J Street	Largemouth Bass	1	0.66	–		
		Pike Minnow	2	0.49	0.084	0.43	0.54
		Sacramento Sucker	2	0.09	0.010	0.08	0.10
	American R. at Discovery Park	Largemouth Bass	6	1.06	0.397	0.45	1.43
		Pike Minnow	4	0.42	0.023	0.40	0.45
		Redear Sunfish	2	0.19	0.159	0.08	0.30
		Sacramento Sucker	4	0.25	0.092	0.13	0.35
		Striped Bass	1	0.28	–		
		White Catfish	2	0.39	0.185	0.26	0.52
	Feather River above Bear River	Redear Sunfish	1	0.10	–		
		Sacramento Sucker	1	0.27	–		
	Feather R. near Nicolaus	Bluegill	1	0.12	–		
		Channel Catfish	1	0.73	–		
		Largemouth Bass	31	0.79	0.488	0.21	2.35
		Pike Minnow	5	0.94	0.350	0.57	1.38
		Redear Sunfish	1	0.22	–		
		Sacramento Sucker	1	0.28	–		
		Striped Bass	5	1.59	1.172	0.32	3.5
		White Catfish	10	0.70	0.315	0.39	1.25

Table 8. Mercury in Fish Tissue, Concentrations by Species and Location
(Continued from previous page)

		Hg in Fish Tissue, mg/kg, Wet Weight					
Type	**Location**	**Species**	**n**	**Mean**	**Std Dev**	**Min**	**Max**
Tributary	Clear Creek at Mouth	Largemouth Bass	1	0.45	–		
		Rainbow Trout	1	0.05	–		
	McCloud R. above Shasta	Rainbow Trout	1	0.05	–		
	Pit R. above Shasta	Rainbow Trout	1	0.05	–		
	Sacramento R. above Shasta	Rainbow Trout	2	0.06	0.004	0.057	0.063
	Clear Cr. at Reading Bar	Rainbow Trout	2	0.03	0.018	0.02	0.05
		Riffle Sculpin	2	0.12	0.051	0.09	0.16
	Clear Cr. above Whiskeytown	Rainbow Trout	2	0.05	0.000	0.05	0.05
		Riffle Sculpin	3	0.14	0.065	0.10	0.21
	Clear Cr. at Hwy 273	Riffle Sculpin	1	0.24	–		
	Mill Cr. at Black Rock	Riffle Sculpin	2	0.34	0.018	0.33	0.35
	Mill Cr. at Hwy 99	Riffle Sculpin	2	0.28	0.006	0.28	0.29
	Deer Cr. below Childs Meadow	Rainbow Trout	2	0.02	0.000	0.02	0.02
		Riffle Sculpin	2	0.03	0.010	0.02	0.03
	Deer Cr. at Hwy 99	Riffle Sculpin	2	0.06	0.028	0.04	0.08
		Smallmouth Bass	2	0.06	0.022	0.04	0.08
	Big Chico Cr. at Hwy 32	Rainbow Trout	3	0.04	0.004	0.037	0.044
	Big Chico Cr. near mouth	Largemouth Bass	1	0.33	–		
		Pike Minnow	1	0.48	–		
	Big Chico Cr. at Hwy 99	Riffle Sculpin	2	0.16	0.025	0.15	0.18
		Smallmouth Bass	2	0.18	0.076	0.12	0.23
	Putah Creek	Bluegill	6	0.12	0.037	0.07	0.16
		Largemouth Bass	17	0.43	0.187	0.10	0.82
		Sacramento Sucker	1	0.19	–		
		White Catfish	1	0.15	–		
	Upper Putah Creek	Brown Trout	1	0.06	–		
Ag Drain	Sacramento Slough	Largemouth Bass	3	0.48	0.034	0.44	0.51
		White Catfish	3	0.51	0.115	0.44	0.64
	Colusa Basin Drain near KL	Carp	4	0.21	0.133	0.11	0.41
		Crappie	1	0.08	–		
		White Catfish	2	0.26	0.066	0.21	0.30
Urban	Natomas East Main Drain	Largemouth Bass	3	0.64	0.041	0.60	0.68
		Striped Bass	1	0.81	–		
		White Catfish	2	0.25	0.053	0.21	0.29

Table 9. Mercury in Fish Tissue, Summarized by Waterbody Type and Trophic Level

Waterbody	Species	Trophic Level[1]	N	Hg concentrations in fish tissue, mg/kg, wet weight: Mean	Std. Dev.	Species-Weighted Trophic Level Average[2]	Consumption-Weighted Average[3]
Ag Drains (Sac. Slough, Colusa Drain)	Carp	3	4	0.215	0.133	0.215	0.268
	Crappie	4	1	0.078	–	0.322	
	Largemouth Bass	4	3	0.480	0.034		
	White Catfish	4	5	0.407	0.162		
Urban (Natomas E. Main Drain)	Largemouth Bass	4	3	0.645	0.041	0.567	0.567
	Striped Bass	4	1	0.808	–		
	White Catfish	4	2	0.248	0.053		
Tributaries (above Shasta, Clear Cr, Mill Cr, Deer Cr, Big Chico Cr, Putah Cr)	Bluegill	3	6	0.118	0.037	0.114	0.234
	Brown Trout	3	1	0.056	–		
	Rainbow Trout	3	14	0.042	0.014		
	Riffle Sculpin	3	16	0.166	0.107		
	Sacramento Sucker	3	1	0.185	–		
	Smallmouth Bass	3	4	0.119	0.082		
	Largemouth Bass	4	19	0.428	0.178	0.353	
	Pike Minnow	4	1	0.484	–		
	White Catfish	4	1	0.146	–		
Major Tributaries (Yuba R, Feather R, American R)	Bluegill	3	1	0.121	–	0.170	0.510
	Redear Sunfish	3	4	0.174	0.106		
	Sacramento Sucker	3	9	0.215	0.092		
	Channel Catfish	4	1	0.729	–	0.850	
	Largemouth Bass	4	38	0.827	0.475		
	Pike Minnow	4	11	0.667	0.341		
	Striped Bass	4	6	1.376	1.177		
	White Catfish	4	12	0.650	0.314		
Lower Mainstem (Keswick to "I" Street Bridge)	Carp	3	1	0.186	–	0.093	0.271
	Rainbow Trout	3	6	0.030	0.014		
	Sacramento Sucker	3	5	0.064	0.035		
	Largemouth Bass	4	2	0.888	0.099	0.449	
	Pike Minnow	4	6	0.221	0.074		
	Striped Bass	4	1	0.303	–		
	White Catfish	4	2	0.384	0.239		
Delta (Sacramento River below "I" Street, Cache Sl.)	Bluegill	3	1	0.103	–	0.265	0.338
	Carp	3	1	0.107	–		
	Sacramento Sucker	3	3	0.179	0.063		
	Smallmouth Bass	3	1	0.568	–		
	Splittail	3	1	0.369	–		
	Crappie	4	1	0.315	–	0.411	
	Largemouth Bass	4	47	0.809	0.299		
	Pike Minnow	4	2	0.147	0.046		
	Striped Bass	4	1	0.343	–		
	White Catfish	4	51	0.442	0.224		

What Do The Results Tell Us About Attainment Of Beneficial Uses And Potential Impairment, And How Does This Compare With Any Relevant 303(d) Listings?

The beneficial uses at greatest potential risk from elevated mercury concentrations are wildlife protection and human health protection related to the consumption of fish, and therefore fish tissue concentrations are considered the best available indicator of potential impairment. An interim sport fish consumption advisory is currently in effect for the San Francisco Bay and Delta Region for elevated concentrations of mercury and other chemicals. Sport fish consumption advisories are also in effect for elevated mercury concentrations in fish in Clear Lake and Lake Berryessa, and more fish consumption advisories have been issued at the County Health Department level for foothill reservoirs on both sides of the watershed. The California Office of Environmental Health and Hazard Assessment (OEHHA) has also issued an interim advisory and consumption guidance for Black Butte Reservoir, in the Stony Creek Watershed. Based on these advisories (which recommend limiting consumption of specific sizes and species of fish), the local sportfishing beneficial use has been described by the Regional Board and SWRCB as impaired in the Bay, in the Delta, and in Clear Lake and Lake Berryessa.

A number of both mainstem and tributary reaches in the Sacramento River watershed are included for mercury on the California 2002 303(d) list (Table 10). It should be noted that the CVRWQCB used a more conservative approach to determine impairment than used by USEPA to develop the methylmercury criterion or the Savannah River TMDL (USEPA 2001a, 2001b). The CVRWQCB compared average concentrations only in trophic level 4 species with the 0.3 mg/kg USEPA criterion, and considered trophic level 3 species only when there were “limited” data for trophic level 4 fish. With only one exception, all of the current and recommended 303(d) listings for mercury are based on elevated concentrations of mercury in fish tissue, and abandoned mines are cited as the major or only source of mercury.

With the exception of Cache Creek, the waterbodies included on the 303(d) list had a fairly high frequency of compliance with the CTR criterion of 50 ng/L (97-100%) and the USEPA 1985 criterion of 12 ng/L (>70%) for total mercury concentrations in water. Conversely, with the exceptions of the Sacramento River at Hamilton City and the American River at Discovery Park, 303(d)-listed waterbodies had relatively low rates of compliance (less than 40%) with the Great Lakes 3.1 ng/L human health objective for total mercury in water (Table 6). Fish tissue data indicated that concentrations of mercury in trophic level 4 species (particularly largemouth bass, white catfish, and striped bass) frequently exceed screening values at a number of locations in the lower watershed. Based on comparisons of consumption-weighted average tissue mercury concentrations to the recently-adopted 0.3 mg/kg USEPA criterion, SRWP fish tissue data generally support the need for fish consumption advisories already in effect for the lower American River, the lower Feather River, and Sacramento Slough, and indicate that advisories should be evaluated for one additional agricultural drain (Colusa Basin Drain) and an urban drainage (Natomas East Main Drain) which also includes the Arcade Creek drainage. These same data also indicate that potential health risks are lower for the Sacramento River mainstem from Keswick to River Mile 44 (which is technically in the Delta) and for most smaller tributaries throughout the watershed, for consumers of a mix of trophic level 3 and 4 fish. Potential health risks are of course higher for individuals consuming higher than average amounts of fish, or for those consuming primarily trophic level 4 species (especially largemouth bass, white catfish, or striped bass). However, because the USEPA criterion for methylmercury includes substantial margins of safety, moderate differences in the rates of consumption and percentages of TL3 and TL4 species would not result in greatly increased risks. Potential risks may also vary significantly for specific waterbodies within each waterbody category, but these differences appear to be relatively small since mercury concentrations were generally similar in fish from the different locations monitored within each category.

Based in part on SRWP fish tissue data, the CVRWQCB's update to the 2002 303(d) list changed the upstream limit of the mercury-impaired reach of the mainstem Sacramento River from Red Bluff to Knight's Landing and reduced the total mercury-impaired length from 30 to 16 miles of river. Based on guidance from OEHHA, the available fish tissue data from the SRWP are not yet sufficient to support additional consumption advice from OEHHA in the Sacramento River watershed. However, SRWP fish tissue data for the lower Sacramento River watershed and the addition of ten waterbodies to the 2002 303(d) list for mercury in fish tissue clearly indicate a need for continued evaluation of potential human health and wildlife concerns in these waterbodies. The SRWP is continuing to investigate these concerns with fish tissue monitoring performed in the fall of 2003. The SRWP and agencies participating in the SRWP are also applying for grant funds to perform more extensive fish tissue monitoring in the Sacramento River watershed for this purpose.

Table 10. Waterbodies Listed For Mercury On the California 2002 303(d) List

Waterbody	Listed Source of Mercury	Area Affected		Fish Advisory
Delta Waterways	Resource Extraction	43,991	Acres	Yes
Clear Lake	Resource Extraction	40,070	Acres	Yes
Berryessa Lake	Resource Extraction	19,083	Acres	Yes
Black Butte Reservoir	Resource Extraction	4,507	Acres	Yes(2)
Camp Far West Reservoir	Resource Extraction	1,945	Acres	IPHN(1)
Rollins Reservoir	Resource Extraction	774	Acres	IPHN(1)
Lake Englebright	Resource Extraction	754	Acres	IPHN(1)
Scotts Flat Reservoir	Resource Extraction	660	Acres	IPHN(1)
Lake Combie	Resource Extraction	362	Acres	IPHN(1)
Davis Creek Reservoir	Resource Extraction	163	Acres	No
Cache Creek	Resource Extraction	96	Miles	No
Feather River, Lower	Resource Extraction	42	Miles	No
Putah Creek, Lower	Resource Extraction	28	Miles	No
American River, Lower	Resource Extraction	27	Miles	No
Sacramento River (Knight's Landing To Delta)	Resource Extraction	16	Miles	No
Bear Creek	Resource Extraction	15	Miles	No
Sulfur Creek	Resource Extraction	14	Miles	No
Bear River, Upper	Resource Extraction	10	Miles	IPHN(1)
James Creek	Resource Extraction	6.3	Miles	No
Harley Gulch	Resource Extraction	6	Miles	No
Little Deer Creek	Resource Extraction	4.1	Miles	IPHN(1)
Humbug Creek	Resource Extraction	2.2	Miles	No
Sacramento Slough	Source Unknown	1.7	Miles	No

(1) Interim Public Health Notification issued by Placer, Nevada, and Yuba counties.

(2) Draft Advisory issued by OEHHA, 2000.

SPATIAL DISTRIBUTIONS AND PATTERNS

This evaluation is based primarily on water quality data collected between 1994 and 2003 by the SRWP and other monitoring programs. The complete data set and specific monitoring periods for each location are summarized in Appendix A (Summary Statistics). Fish tissue data reviewed in this section are also presented in Appendix C.

Water Column

Water column total mercury concentrations in the mainstem Sacramento River generally increased with distance downstream from the Keswick Reservoir discharge (Figure 6). A significant proportion of the increase occurred between Keswick and Colusa, with more than a four-fold increase in median concentrations (from 1.1 ng/L to 5.1 ng/L). Median total mercury concentrations in the mainstem below Colusa increased more moderately to the Sacramento below the confluence with the Feather River (by about 40%), and decreased slightly below the American River confluence (by about 10%). In the Sacramento River below the American River confluence, there was no apparent trend in total mercury concentrations (Sacramento River at Freeport, River Mile 44, and Greene’s Landing).

Total mercury concentrations at the mouth of the Feather River system were midway between those in the Sacramento River at Colusa and Veterans Bridge. Concentrations in the Yuba and American rivers were much lower than either the lower Sacramento or Feather rivers. Total mercury concentrations in Arcade Creek, and the two agricultural drains monitored were substantially higher than concentrations anywhere in the mainstem Sacramento River. Concentrations in Mill Creek were also substantially higher than observed in the Sacramento River upstream from the confluence.

Concentrations of total mercury in particulate matter (expressed as ng of particulate total mercury per gram of suspended solids) were also evaluated using data collected between 2000-2003 (Figure 7). The distribution of mercury concentrations in suspended solids in the mainstem exhibits a similar pattern of increase to that of total mercury. Although concentrations of mercury in particulates are substantially higher in the major tributaries and some lesser tributaries than in the mainstem, the effect of this difference on loads is offset by much lower concentrations of suspended solids. The exceptions to this pattern are Colusa Basin Drain and Sacramento Slough, which had relatively low mercury concentrations in particulates and high concentrations of suspended solids compared to the mainstem.

SRWP special studies conducted in 2000 by USGS (Domagalski 2000) and in 2001 by Pacific Ecorisk to identify potential sources of the observed increase in mercury between Red Bluff and Colusa confirmed that Mill Creek was a significant source of mercury during some storm events. Although Mill Creek discharges at the time of this USGS study were relatively low, discharges as high as 14,000 cfs have been recorded on Mill Creek (January 1997) and could be responsible for much greater loads than demonstrated by earlier monitoring. The USGS study also concluded that there were also other significant sources of mercury in this stretch of the river. It was determined that Elder Creek (on the West side of the valley) and Antelope Creek (on the East side of the valley) were probably not significant sources, but Thomes Creek was identified as a potentially significant source of mercury. Previous monitoring in Thomes Creek and Cottonwood Creek for the USGS NAWQA program indicated that mercury concentrations in bed sediments from these drainages were similar to those in sediments collected in the Sacramento River mainstem above the Feather River confluence (Domagalski *et al.* 2000). The same USGS study concluded that there was no evidence of elevated natural or anthropogenic sources of mercury in the Thomes Creek or Cottonwood Creek watershed. A single SRWP monitoring event collected in 2001-2002 under relatively high flow conditions suggested that Thomes Creek can contribute a substantial proportion of the total mercury load in the Sacramento River above Hamilton City. In subsequent monitoring of wet weather events conducted in 2002-2003, the Thomes Creek drainage contributed an additional 2% to 24% to the loads estimated for the Bend Bridge, and accounted for less than 10% of the increases in from Bend Bridge to Hamilton City for any particular event. Battle Creek and Cottonwood Creek were monitored 2001-2002 (n = 2 events) and in 2002-203 (n = 4 events). Although data are limited, the results suggest that Cottonwood Creek and Battle Creek may be responsible for a substantial proportion of the increase in mercury concentrations observed in the Sacramento River between Keswick and Bend Bridge. For the events monitored, mercury loads from these two drainages accounted for 10% to 70% of the increase in daily loads observed between Keswick and Bend Bridge, with larger percentages estimated for higher flow events. Load estimates for SRWP events conducted from 2001-2003 are presented in Table 11.

Total methylmercury concentrations measured in the mainstem Sacramento River by SRWP in 2000-2002 exhibit a similar spatial distribution pattern to that for total mercury (compare Figure 6 and Figure 8). Median unfiltered methylmercury concentrations in the mainstem Sacramento River also exhibited a dramatic (more than six-fold) increase from less than 0.02 ng/L below Keswick to 0.12 ng/L at Veterans Bridge. An interesting deviation from the pattern observed for total mercury was observed in the Sacramento River below the American River confluence. A similar decrease was observed below the American River confluence for the Sacramento River at Freeport, but methylmercury concentrations appeared to increase substantially between Freeport and River Mile 44, and then decrease again at Greene’s Landing to below concentrations at Freeport. Although the influence of the Sacramento Regional Wastewater Treatment Plant below Freeport may explain some of the increase in methylmercury at River Mile 44, there is no obvious explanation for the observed decrease at Greene’s Landing in 2000-2001 (Greene’s Landing was not monitored by SRWP after 2001). Greene’s Landing data exhibit a lower range of TSS and methylmercury concentrations than the larger data sets for Freeport and River Mile 44. However, methylmercury concentrations were also consistently lower at Greene’s Landing while TSS concentrations were similar at all three sites during the period when all three lower Sacramento River sites were monitored (June 2000 to June 2001).

Methylmercury data for the tributaries to the Sacramento River exhibit patterns that differ somewhat from total mercury concentrations (Figure 6 and Figure 8). Because methylmercury is a non-conservative pollutant (i.e. mass is not necessarily conserved in the form of methylmercury due to methylation and demethylation processes), source assessments based on apparent differences in concentration must be made with caution. However, it is interesting to note that nearly all of the increase observed in Sacramento River mainstem methylmercury concentrations occurs before confluences with the major tributaries. Additionally, methylmercury concentrations observed in the Feather and Yuba Rivers were not high enough to account for increases below the confluence with the Feather River. Methylmercury concentrations in the Yuba and Feather River were similar to those in the Sacramento River above the confluence with the Feather River, while concentrations in the lower American River were still well below concentrations above its confluence with the Sacramento River. In Cottonwood Creek, Battle Creek, Mill Creek and Thomes Creek watersheds (for the few events sampled), there were two notable patterns: (1) methylmercury concentrations increased substantially towards the lower reaches of each watershed, and (2) concentrations were higher in the mouths of these tributaries than in the Sacramento River at each confluence. Concentrations in these tributary drainages also tended to be much more variable than observed in the Sacramento River mainstem or major tributaries.

Methylmercury concentrations were also higher in Sacramento Slough, Colusa Basin Drain, and Arcade Creek (with concentrations approximately 50% to more than 100% higher than those measured in the mainstem). Although the flows from these sources are relatively small compared to the mainstem, these sources may cumulatively account for a substantial proportion of the increase in mainstem methylmercury concentrations and loads. However, the patterns observed in mainstream methylmercury concentrations suggests that increases are due in large part to methylation of instream mercury sources in the Sacramento River.

Concentrations of methylmercury in particulate matter (expressed as ng of particulate methylmercury per gram of suspended solids) in the mainstem exhibit no apparent spatial trend between Hamilton City and Greene's Landing (2000-2003 data, Figure 9). Colusa Basin Drain and Sacramento Slough exhibited methylmercury concentrations in particulates that were similar to the lower mainstem Sacramento River, but with much higher concentrations of suspended solids. Concentrations of methylmercury in particulates were dramatically higher in the major tributaries than in the mainstem. As noted for total mercury, the effect of this difference on loads is offset by much lower concentrations of suspended solids from these drainages. However, this pattern does suggest a mechanism for the high concentrations of mercury observed in fish tissue in the lower American River and Feather River. Assuming that rates of consumption of particulate matter by lower trophic level organisms are similar from drainage to drainage, higher concentrations of methyl mercury in particulate matter would account for the relatively higher rates of bioaccumulation through the food chain at these locations.

Table 11. Total Mercury Loads in the Sacramento River and Tributaries from Keswick to Colusa, SRWP Sampling Events Conducted from 2001-2003

	Estimated Daily Loads of Total Mercury, grams/day						
Event Dates	Sacramento River below Keswick	Battle Creek	Cottonwood Creek	Sacramento River above Bend Bridge	Thomes Creek	Sacramento River near Hamilton City	Sacramento River at Colusa
01/16/01	2.5	—	—	12.4	—	20.3	39.7
02/20/01	16.4	—	—	434.6	—	370.1	132.8
03/20/01	—	—	—	19.8	—	43.9	137.3
04/17/01	11.3	—	—	14.4	—	12.9	32.9
05/15 - 05/16/2001	—	—	—	25.2	—	24.4	22.1
09/24 - 09/25/2001	7.8	—	—	9.2	—	17.9	44.4
10/31/01	7.	—	—	—	—	—	—
11/01 - 11/03/2001	—	0.57	—	8.8	12.1	12.1	6.9
02/18 - 02/21/2002	24.4	0.74	16.7	26.9	140.1	318.7	2399.2
10/01 - 10/02/2002	15.1	—	—	12.4	—	11.7	38.3
11/07 - 11/10/2002	3.2	0.18	0.08	5.8	0.12	2.9	3.3
01/23 - 01/24/2003	—	—	—	—	—	617.9	931.5
02/15 - 02/17/2003	19.7	4.4	5.6	71.5	5.4	—	—
03/13 - 03/16/2003	17.2	48.7	57.8	214.1	53.2	4008.4	5365.2
04/03 - 04/05/2003	13.8	2.1	4.1	22.3	1.2	47.6	—
04/13/03	—	—	—	—	—	—	306.8

Notes: Loads are estimated as Mean Daily Flow (cfs) x Total Hg (ng/L) and converted to grams per day. Load estimates are only valid for the specific date indicated and are not valid for extrapolation to annual loads.

"—" indicates site was not sampled for event.

Fish Tissue

Fish tissue samples (typically consisting of composites of five fish each) were collected from 30 locations ranging from the Sacramento River above Lake Shasta to Cache Slough (near Rio Vista) in the Delta. Fish were collected during the months of September and October from 1997 to 2002. A total of 15 fish species have been sampled, including seven trophic level 3 species and eight trophic level 4 species. It should be noted that mercury concentrations in fish tissue are dependent not only on water column concentrations of bioavailable mercury, but also on the productivity of the waterbody (e.g. oligotrophic vs. eutrophic) and the trophic level, feeding patterns, and age of the fish. For this reason, mercury concentrations in trophic level 3 species (e.g. rainbow trout), should not be directly compared with concentrations in trophic level 4 species (e.g. largemouth bass) as a means of inferring spatial differences in levels of bioavailable mercury. Examination of the average tissue mercury concentrations for each trophic level (Table 9) provides a less biased view of regional patterns in fish tissue concentrations, but ideally, comparisons should be based on a similar size for each species. For this reason, most species were collected within a narrow size range and results are reasonably comparable from site to site. However, white catfish and largemouth bass were collected over a somewhat larger size range than other species, so where possible, potential biases due to the different sizes collected at a site were considered by normalizing to a standard size for each species.

Spatial patterns in average mercury concentrations for each trophic level are generally similar to the patterns discussed previously for consumption-weighted averages. The average tissue mercury concentrations for trophic level 4 species were highest for the two major tributaries (Feather River and American River), and concentrations were lowest in trophic level 4 species from agricultural drains and smaller tributaries. Average tissue mercury concentrations in trophic level 3 species were generally similar in agricultural drains, major tributaries, and the two Delta locations, and were lowest in fish from the lower mainstem and lesser tributaries. Average tissue mercury concentrations in trophic level 4 species were highest in the major tributaries and were lower by about a factor of two in the lower Sacramento River mainstem (from Keswick to the "I" Street Bridge), the two Delta sites (Sacramento River at Mile 44 and Cache Slough), and in the two agricultural drains (Colusa Basin Drain and Sacramento Slough). The one location in an urban drainage (Natomas East Main Drain) was represented only by trophic level 4 species, with average concentrations that were about 30% higher than fish from lower mainstem and Delta locations, and about 66% higher than fish from ag drains and lesser tributaries.

This pattern in fish tissue concentrations exhibits at least one interesting contrast with the spatial pattern observed for the water column mercury and methylmercury concentrations—in 2000-2003 mercury and methylmercury concentrations in the Feather and American rivers were generally lower than or similar to concentrations observed in the mainstem, while average fish tissue mercury concentrations were approximately twice as high in the two tributary locations as in the mainstem Sacramento River. Because the mercury concentrations in fish tissue integrate bioavailable mercury concentrations in water over a period of several years, these results suggest several possibilities: (1) that the pattern observed in water column concentrations of total mercury and methylmercury in 2000-2003 may not be representative of typical conditions over a longer period; (2) that average water column concentrations of total mercury and methylmercury are not the single most important factor controlling fish tissue mercury concentrations. The results of comparisons between concentrations of the particulate fraction of methylmercury and suspended solids suggests a possible cause for this pattern. The relatively high concentrations of particulate methylmercury per unit of suspended solids at the major tributary locations would result in the lower trophic level species (benthic invertebrates and zooplankton) consuming and accumulating greater amounts of methylmercury than at locations with relatively low particulate methylmeurcury concentrations. These organisms are part of the base of the food web and consequently pass on the accumulated methylmercury to higher trophic level fish.

TEMPORAL DISTRIBUTION AND PATTERNS

Unfiltered total mercury concentrations in the water column exhibit strong seasonal patterns in the mainstem Sacramento River and major tributaries. Concentrations of total mercury typically peak following early wet season precipitation and with increased river flows of the early wet season (typically in November-December), and then decrease steadily through the remainder of the year. In general, this pattern is consistent with the seasonal mobilization of fine-grained particulates in river sediments and runoff deposited during the dry season and during lower stream flows. Mercury tends to adsorb to fine grained sediments, leading to the close correlation between sediment transport and mercury transport phenomena. This pattern appears to be consistent at all the mainstem Sacramento River sites monitored between Redding and River Mile 44, and in the major tributaries in the lower watershed (the Feather River, Yuba River, and American River). This pattern is less distinct for total mercury concentrations in the agricultural drainage-dominated Colusa Basin Drain and Sacramento Slough.

Longer term trends in water column and particulate total mercury concentrations were also examined as simple regressions of concentrations over time (1994 – 2003) for the lower Sacramento River and American River (Figure 10 - Figure 14). Regressions for all five locations examined exhibited significant decreasing trends ($p < 0.05$) in filtered and unfiltered total mercury. The rates of decrease in filtered and unfiltered total mercury were similar at all five locations (between 10% to 15% per year). There were also significant decreases in concentrations of particulate total mercury normalized to suspended solids concentrations. These decreases were again similar at the three lower Sacramento River locations (9% - 11% decreases per year), but were steeper at the two American River locations (24% - 26% decreases per year). Although these decreases were significant and dramatic over the period of available data, it can not necessarily be expected that this trend will continue, and there is some evidence that the high concentrations at the beginning of the 1994 – 2003 period may have been anomalous. Four of the five years preceeding this period were very low water years (1990, 1991, 1992, and 1994 were designated as *Critical* in CDWR's water supply index). This may have resulted in a buildup of mercury in soils (e.g., from dry atmospheric deposition) and a simultaneous buildup of finer sediments, especially in stream channel margins due to a lack of precipitation and flows capable of transporting soils and sediments into watershed streams and through the mainstem. This dry period was followed by a series of six *Wet* or *Above Normal* water years with a generally decreasing trend in average and peak flows (1995 – 2000, Figure 15). These conditions may have contributed to higher than normal concentrations of mercury during the higher rainfall amounts and stream flows that occurred from 1995 – 2000. If this were the case, the mercury concentrations observed during the last three or four years may better represent average long term conditions than the longer data set. Unfortunately, the period of record for methylmercury data does not extend back to 1994, so it can not be determined whether there was a similar trend for that parameter. Such a trend may become evident in fish tissue after several more years of monitoring, however.

Methylmercury concentrations exhibited less distinct and more variable seasonal patterns throughout the watershed from 2000 to 2003 (Figure 16). Water column concentrations of unfiltered methylmercury exhibited similar patterns of increases in the major tributaries during this period, but the pattern is not obviously consistent from year to year. The most apparent temporal trend in the 2000-2003 data was a two- to five-fold increase in methylmercury that was observed for spring of 2001 for all three major tributary locations. This did not coincide with a comparable increase in methylmercury concentrations in the lower Sacramento River mainstem, which exhibited an early wet season peak in the fall of 2002, but no notable increase during the spring of 2001. Longer-term patterns in methylmercury concentrations in the lower Sacramento River (at Veterans Bridge, Freeport, and Mile 44) exhibit a somewhat more consistent pattern of increased concentrations in the early wet season with peaks often occurring from January through March, followed by another peak in late spring or early summer. Probable causes of temporal variations in Sacramento River methylmercury include seasonal mobilization of total mercury, increased methylation due to seasonal water temperature changes, or increased inflows of methylmercury from tributaries. Continuing methylmercury monitoring by the SRWP monitoring program and several CALFED-funded projects are expected to provide additional information to address this question.

Longer-term patterns in seasonal variation in unfiltered total mercury and methylmercury concentrations are also illustrated for the Sacramento River at Freeport in Figure 17 for 1996 through 2002. Time series plots of water column mercury and methylmercury concentrations are also presented in Appendix B of this report.

MASS LOAD COMPARISONS

Evaluations of mass load sources within the Sacramento River watershed and from other major Delta tributaries are currently being performed as part of the Strategic Plan being developed by the Delta Tributaries Mercury Council (DTMC) for management of mercury in the Delta and Sacramento River. This information is vital to development of pollutant management strategies and Total Maximum Daily Loads (TMDLs). It should be noted that mass loads are not direct indicators of water quality or predictors of instantaneous concentrations of mercury in water or in fish tissue.

The results of previous assessments of mass load contributions to the Delta (SRWP 2000, 2001) highlighted the dominance of the Sacramento River watershed with respect to total riverine flows and mercury inputs to the Delta—approximately 90% of estimated total average total mercury loads are from the Sacramento River and Yolo Bypass. In years with relatively high annual flows, such as 1998, loads from the Yolo Bypass and the Cache Creek watershed are estimated to exceed the loads from the rest of the Sacramento River watershed. Within the Cache Creek watershed, mercury loads from the Superfund mine site at Clear Lake do not appear to contribute a significant proportion of the total mercury loads from the Cache Creek watershed. Evidence compiled by the Delta Tributaries Mercury Council from their Strategic Plan for Mercury in the Sacramento River Watershed (http://www.sacriver.org/subcommittees/dtmc/documents.html) indicate that erosion of native soils with naturally-elevated mercury concentrations is the predominant source of mercury loads from the highly erosive Cache Creek drainage, which have been estimated to be greater than 200 kg in wet years. On average, only about 5 kg of mercury is estimated to be discharged from Clear Lake annually (CVRWQCB 2001). (See also Domagalski *et al*. 2004 for a synthesis of CALFED studies in the Cache Creek watershed, and Bloom 2003 for methods used to evaluate methylation potentials of Cache Creek sediment). Although the available data for the San Joaquin River and the Mokelumne River are still very limited, the low annual flows (in comparison to the Sacramento River flows) and moderate mercury concentrations in these rivers suggest that these inputs are responsible for a relatively low percentage of total mercury inputs to the Delta (less than 10% for the San Joaquin River and Mokelumne River, combined). These estimates are intended only to provide a semi-quantitative comparison of the relative magnitude of the major Delta inputs, and are not intended to be definitive estimates of actual loads. Because these estimates are based on limited data and long-term average flows, they do not fully account for the seasonal spikes in mass loads that typically occur during peak streamflow events, and may therefore underestimate total mercury loads to the Delta. It should also be noted that estimates of mass loads of total mercury provide little direct information regarding causes of excessive mercury bioaccumulation in the Delta, primarily because total mercury concentrations are not closely related to concentrations of bioavailable mercury.

As part of the Strategic Plan for mercury controls (DTMC and SRWP 2002), the DTMC has analyzed a variety of data sources in addition to mercury concentration and flow data to develop load models for the Sacramento River watershed. In the Strategic Plan, the DTMC evaluated land use characteristics, density of mercury and gold mines, and several other measures of factors useful in relating load estimates for specific sources and tributary watersheds to loads in the Sacramento River mainstem. The goal of this process is to estimate known background loads and source loads, and to compute discrete contributions from controllable sources. Results of the DTMC evaluations indicate that total mercury loads double (approximately) in the mainstem between Hamilton City and Colusa, and double again between Colusa and the Sacramento River below the confluence with the Feather River. The largest increase in methylmercury load in the mainstem Sacramento River is estimated to occur between Hamilton City and Veterans Bridge, increasing the load approximately six-fold in this reach. The Feather River is estimated to represent approximately one-fifth of the methylmercury load at Veterans Bridge. The results of the DTMC evaluations don’t indicate any single outstanding source of mercury or methylmercury loads to the Sacramento River, but instead suggest that loads in mainstem increase throughout the river’s length. This assessment is consistent with the patterns described for spatial variability of total mercury and methylmercury water column concentrations. Major sources of total mercury loads include erosion of native soils, and geothermal springs, which appear to represent significant proportions of the total loads, in addition to the major anthropogenic source (runoff and erosion from historic gold mine sites). Other minor sources of mercury mass loads include treated municipal and industrial wastewater, atmospheric deposition, historic mercury mines, and urban runoff. The Strategic Plan estimates that a substantial proportion (up to 39%) may be from sources as yet unknown.

CONCLUSIONS AND RECOMMENDATIONS

Mercury concentrations in fish tissue collected from 1997 to 2002 from the mainstem Sacramento River below Shasta Reservoir and major tributaries to this section of the river were higher than several of the human health-based and wildlife-based advisory and screening values. Frequent exceedances of the tissue-based water quality criterion for mercury recently developed by the USEPA (0.3 mg/kg) and adopted by the California Office of Health Hazard Assessment (OEHHA), and less frequent exceedance of the previous USEPA screening value of 0.6 mg/kg, indicate that there are human health concerns associated with consumption of some fish species from the lower Sacramento River watershed. The current water quality USEPA criterion of 0.3 mg/kg is based on a fish consumption rate of 17.5 g/day (equivalent to 4 quarter-pound servings per month). There is some disagreement whether the available data are adequate to warrant issuing fish consumption advisories, based on the fact that OEHHA has not issued advisories for these waters, while the Central Valley Regional Water Quality Control Board has added a number of waterbodies to California’s 303(d) list based on the same available data. Interim Public Health Notices have been issued by Placer, Yuba, and Nevada counties for eight Sierra foothill waterbodies based on the same data used by the Regional Board. Although there is substantial uncertainty regarding the level of risk posed by these concentrations of mercury in fish, there is agreement that the risks are greatest for small children and pregnant women, and that the risks increase with greater consumption of fish. General consumption guidelines are provided by OEHHA on their web page (http://www.oehha.org), in addition to more specific consumption advisories developed for some waterbodies. Concerns over mercury in fish from the lower Sacramento River watershed are being addressed with continuing monitoring performed in 2003 and proposed for 2004, and through special studies of fish consumption being conducted by the Delta Tributaries Mercury Council (DTMC). This shift in focus is in large part a result of coordination and consultation with OEHHA, which has been an active participant in the SRWP, and has provided the SRWP with guidance regarding data needs and study design for evaluation of human health risks related to fish consumption.

Other conclusions of this review of mercury monitoring data can be summarized as follows:

Consumption-weighted average mercury concentrations in tissues of fish collected from the Sacramento River mainstem from Keswick to the Delta, in smaller tributaries, and in three agricultural drains were equal to or lower than USEPA human health-based criterion of 0.3 mg/kg. However, in almost all trophic level 4 species collected throughout the watershed, average mercury concentrations were higher than the 0.3 mg/kg criterion, and were frequently two to three times higher than this criterion.

Consumption-weighted average mercury concentrations in fish tissue collected from the lower American River and Feather River were higher than USEPA human health-based criterion of 0.3 mg/kg. Exceedance of the criterion indicates that there are potential risks to “average” and higher than average human consumers associated with consumption of fish from these waterbodies.

Total water column mercury concentrations in the Sacramento River from Keswick to River Mile 44 rarely exceeded the CTR mercury criterion of 50 ng/L (USEPA 2000). Total mercury concentrations exceeded the 50 ng/L limit in 33% of Cache Creek samples and 46% of samples from the upper Mill Creek watershed. The Feather and Yuba rivers are significant sources of mercury loads, but water column concentrations of total mercury and methylmercury were not elevated compared to the Sacramento River mainstem in 2000-2003. However, the relatively high concentrations of mercury in fish from the lower Feather River and American River may be due to the similarly high concentrations of methylmercury in particulate matter (suspended solids). Spring Creek in the upper Sacramento River watershed, Battle Creek, Deer Creek, Big Chico Creek, and the American River did not appear to be major sources of total mercury: concentrations were low in these tributaries compared to the Sacramento River and were never observed to exceed the 50 ng/L CTR criterion at these sites. Results from 2001-2003 monitoring indicate that Cottonwood Creek, Battle Creek, and Thomes Creek watersheds may be significant sources of mercury and methylmercury. Mill Creek also appears to be a potentially significant source of bioavailable mercury under episodic high flow conditions. With the exceptions of Mill Creek and Cache Creek, total mercury concentrations rarely exceeded the 50 ng/L CTR criterion at any site.

Methylmercury concentrations in water column samples exceeded the Great Lakes human health-based criterion of 0.24 ng/L most frequently in samples from Arcade Creek (56% of samples) and from two agricultural drain sites (26% and 37% of samples). Methylmercury concentrations exceeded the Great Lakes wildlife-based criterion of 0.05 ng/L in nearly every sample collected from mainstem locations below Hamilton City, and in all other tributaries and agricultural drains sampled.

The Sacramento River watershed is the major source of total mercury to the Delta. This watershed contributes approximately 90% of the total mercury loads to the Delta. Within the Sacramento River watershed, the Cache Creek drainage is the single largest source for total mercury. Major sources of total mercury loads to the Sacramento River watershed include runoff and erosion from historic gold mining sites, erosion of native soils, and natural mineral springs. Minor mercury sources include treated wastewater, urban runoff, historic mercury mines, and atmospheric mercury deposition from external sources.

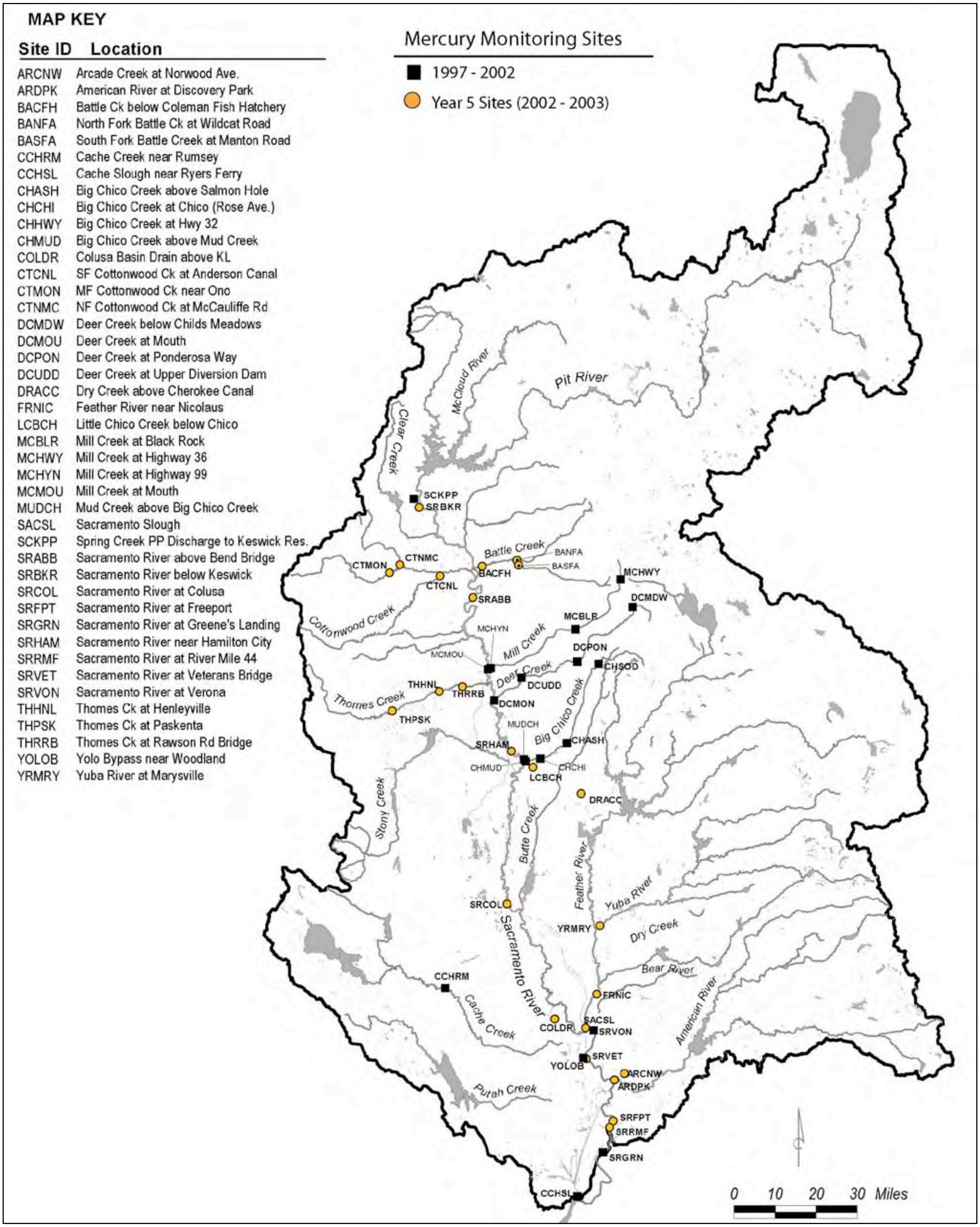


Figure 2. Mercury Monitoring for the Sacramento River Watershed Program

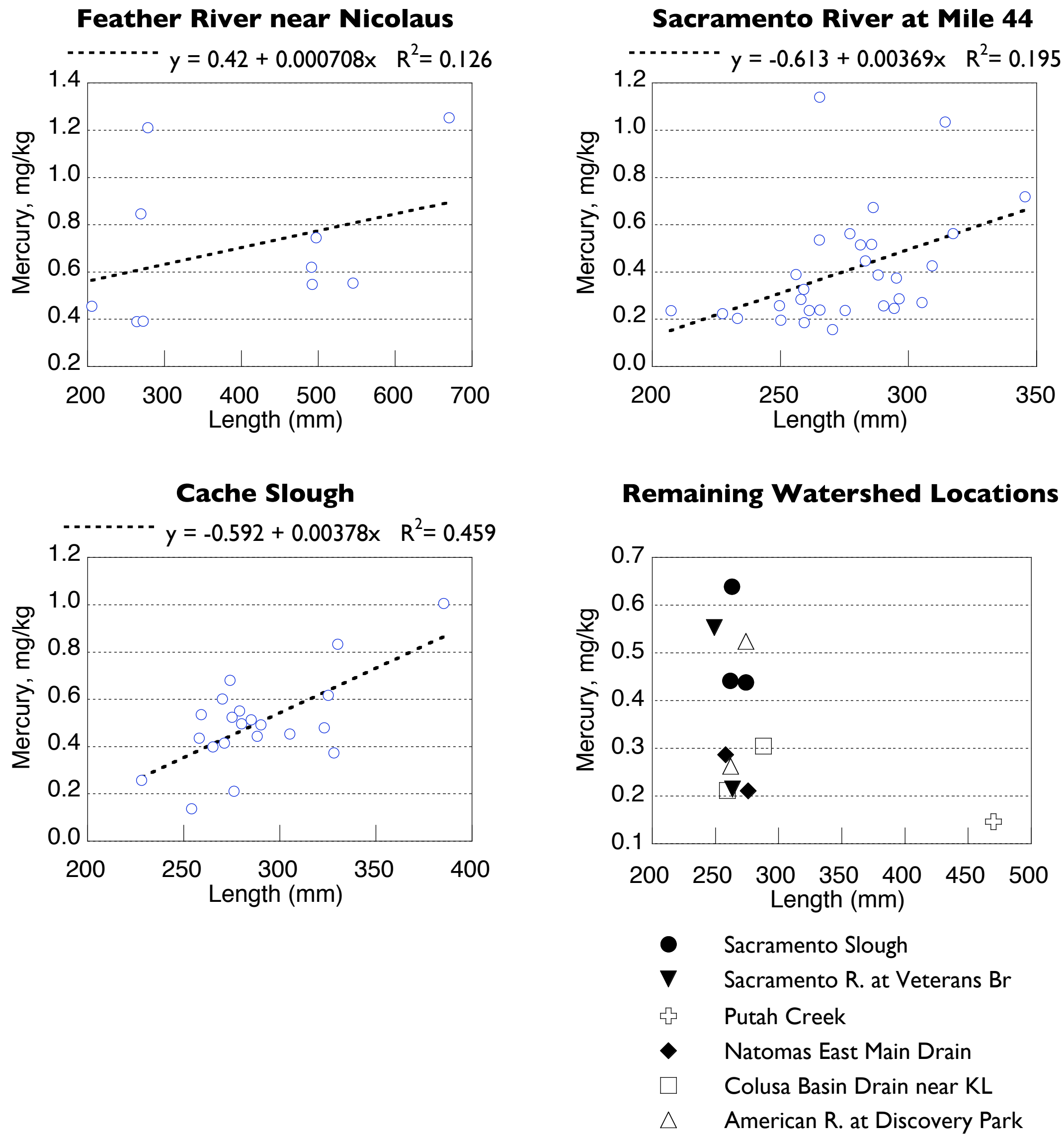


Figure 3. Mercury in White Catfish in the Sacramento River Watershed, 1997–2002 (SRWP Data)

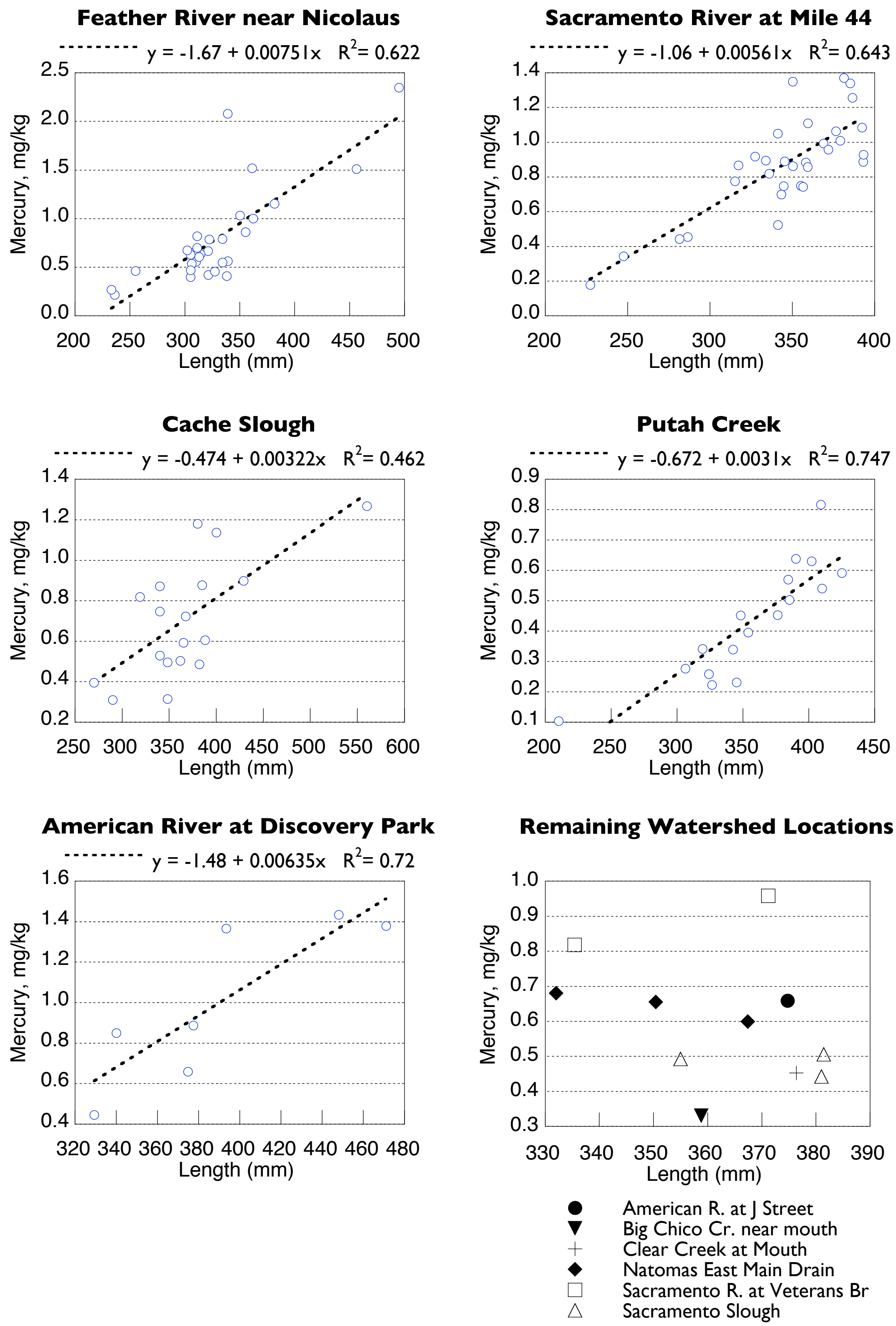


Figure 4. Mercury in Largemouth Bass in the Sacramento River Watershed, 1997–2002 (SRWP and CDWR Data)

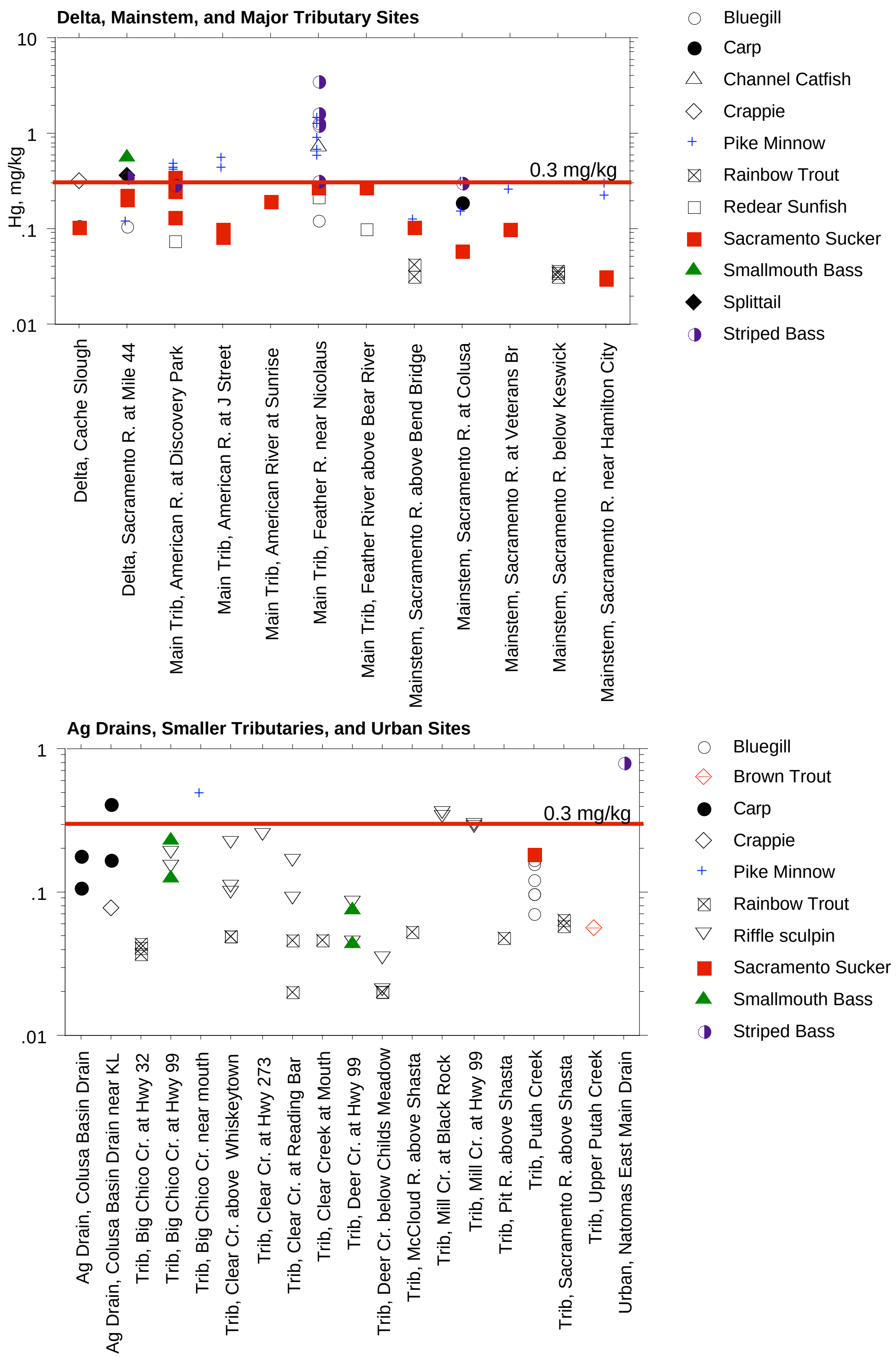


Figure 5. Mercury in Other Fish Species, 1997-2002 (SRWP and CDWR Data)

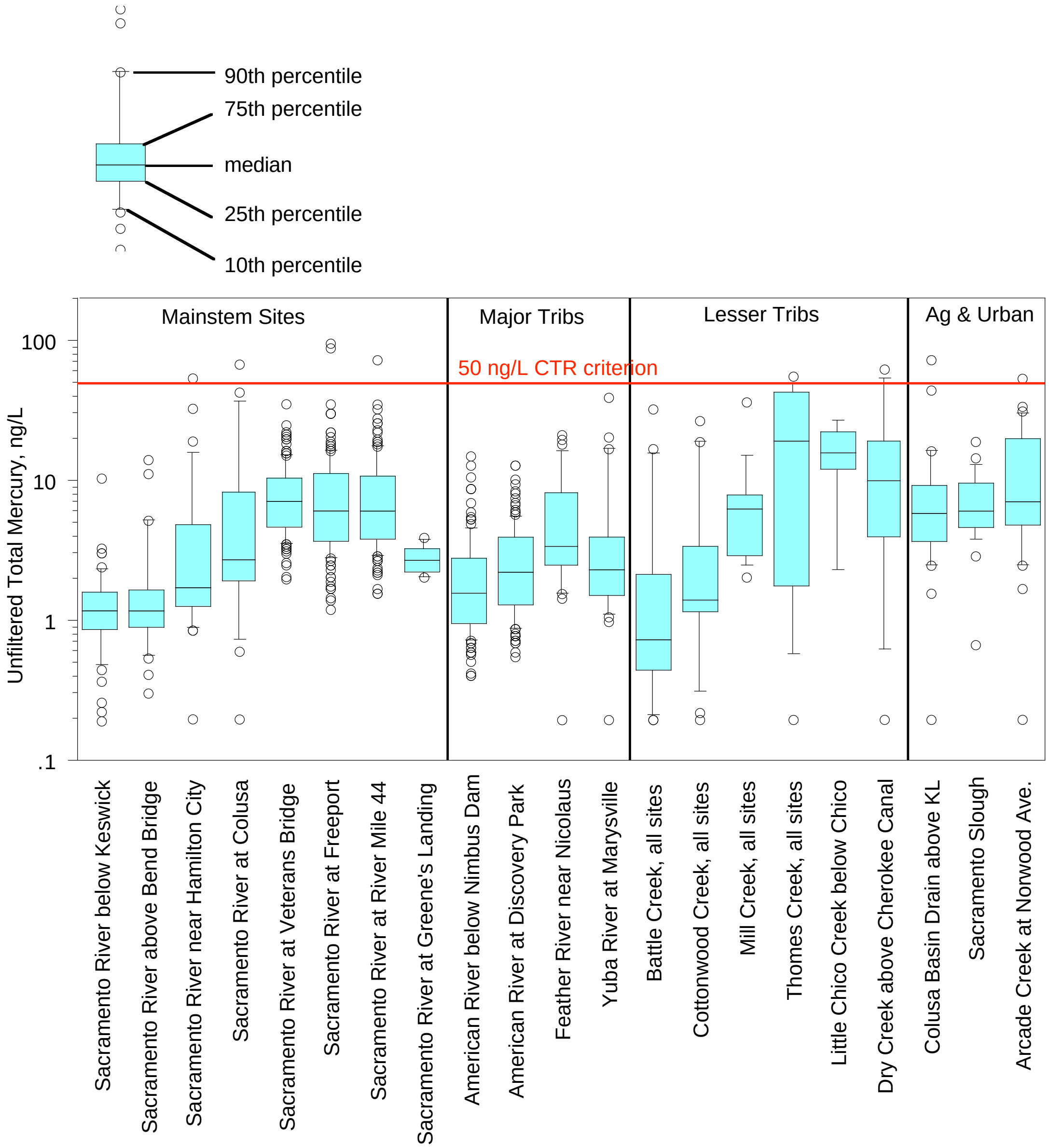


Figure 6. Unfiltered Total Mercury Concentrations, Sacramento River Watershed, 1994-2003

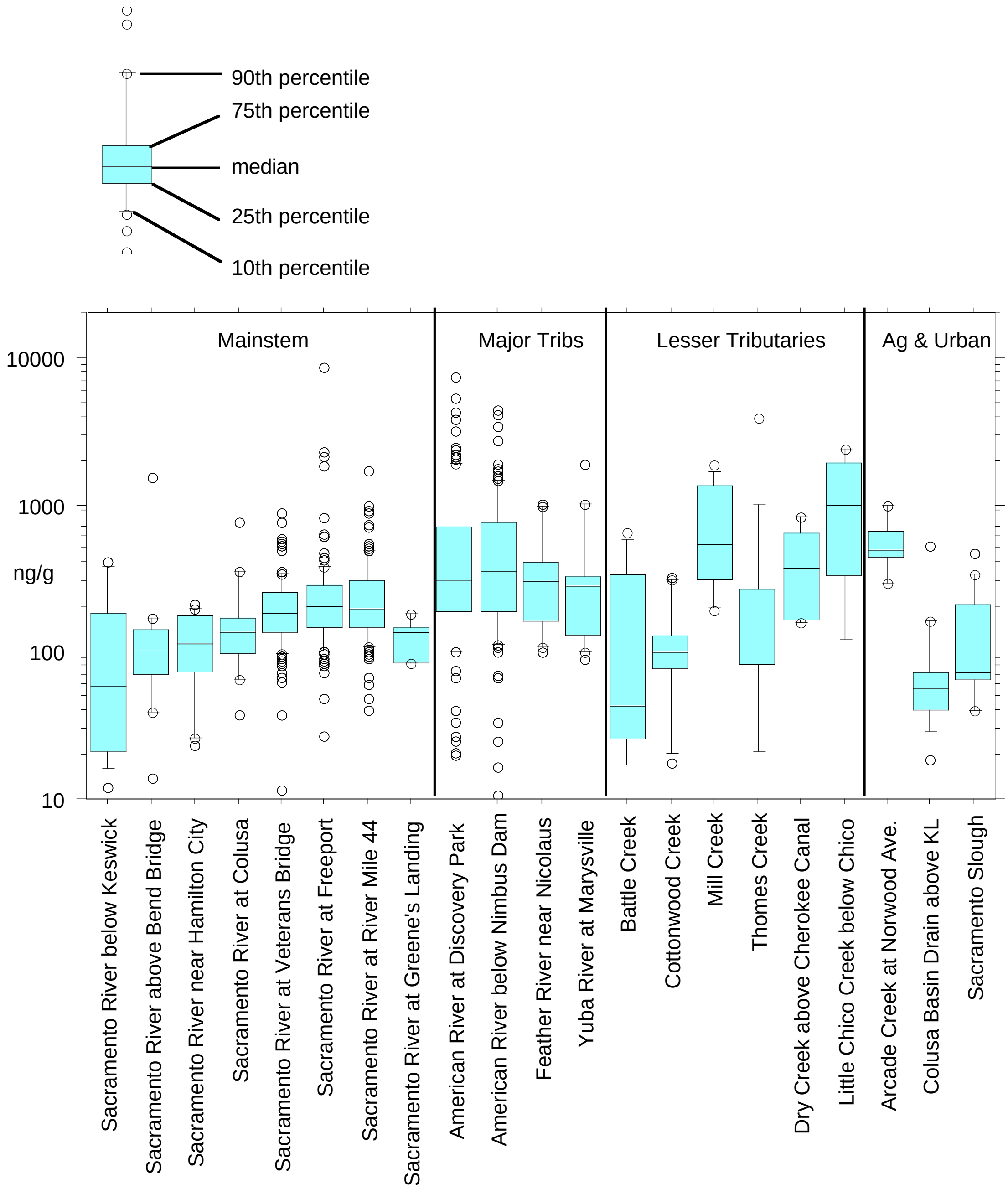


Figure 7. Total Mercury Concentrations in Total Suspended Solids: Particulate Total Mercury in the Sacramento River Watershed, 2000-2003

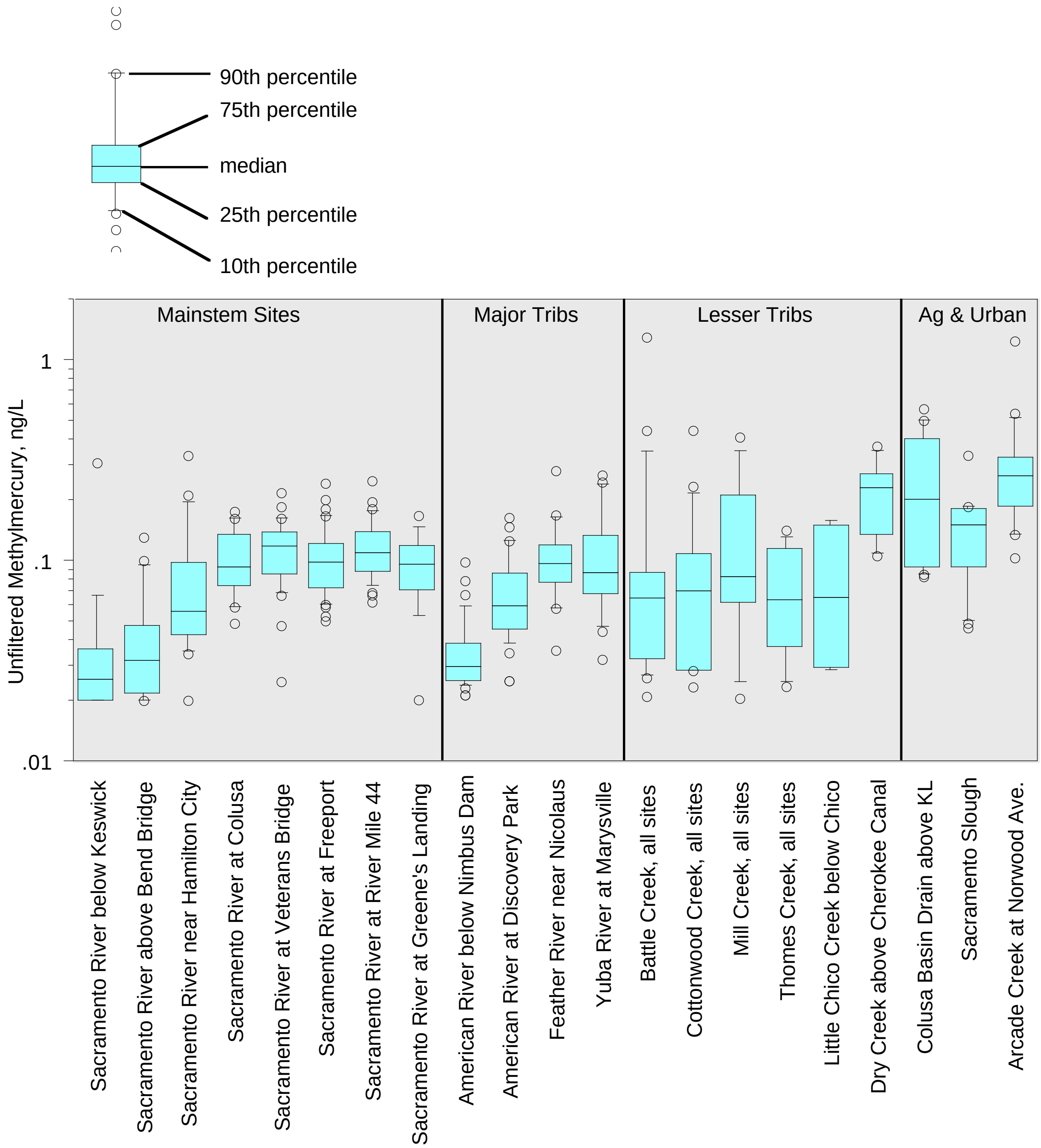


Figure 8. Unfiltered Methylmercury Concentrations, Sacramento River Watershed, 2000-2003

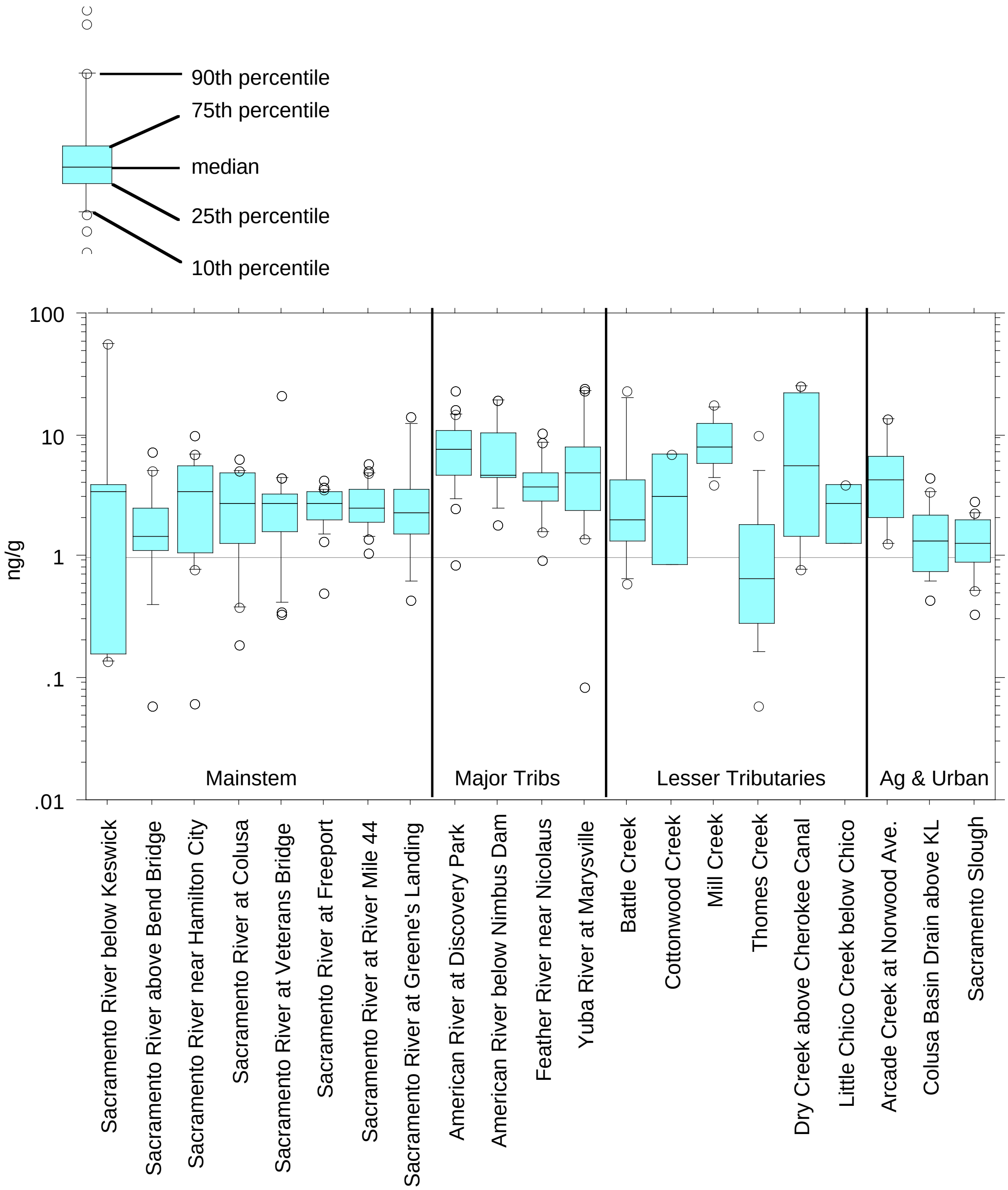
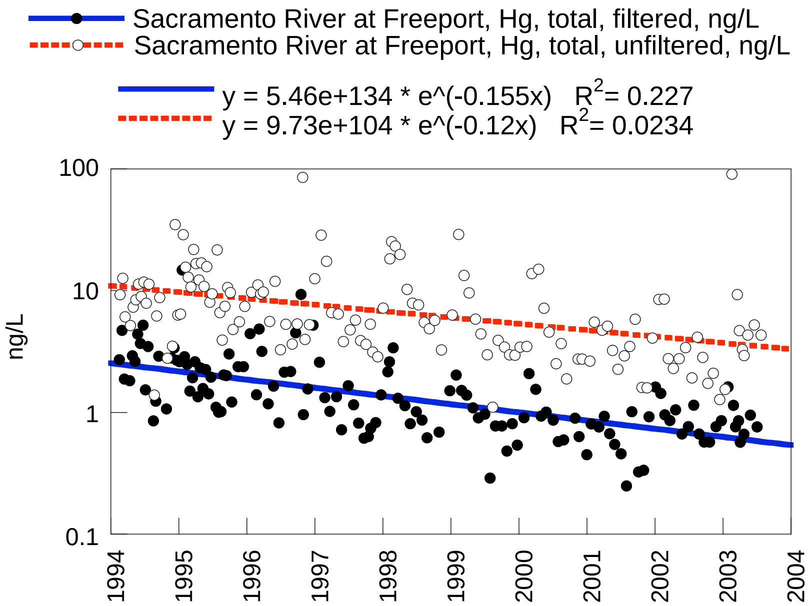


Figure 9. Methylmercury Concentrations in Total Suspended Solids: Particulate Methylmercury in the Sacramento River Watershed, 2000-2003



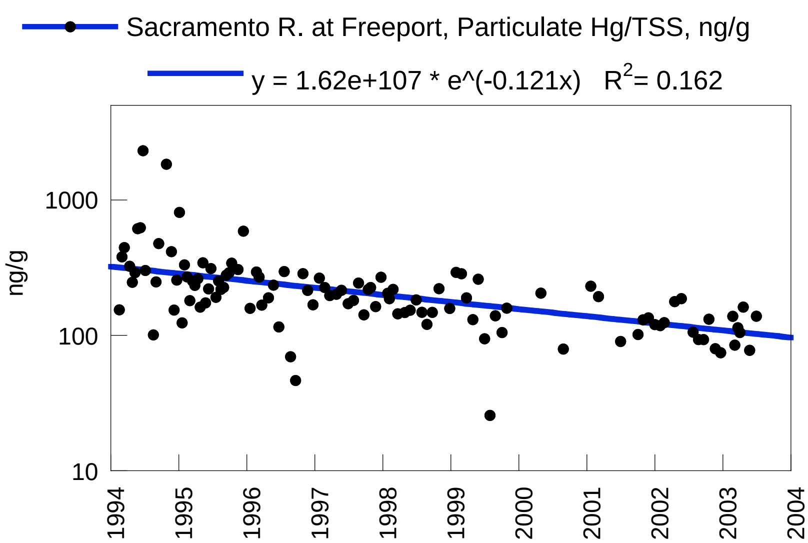
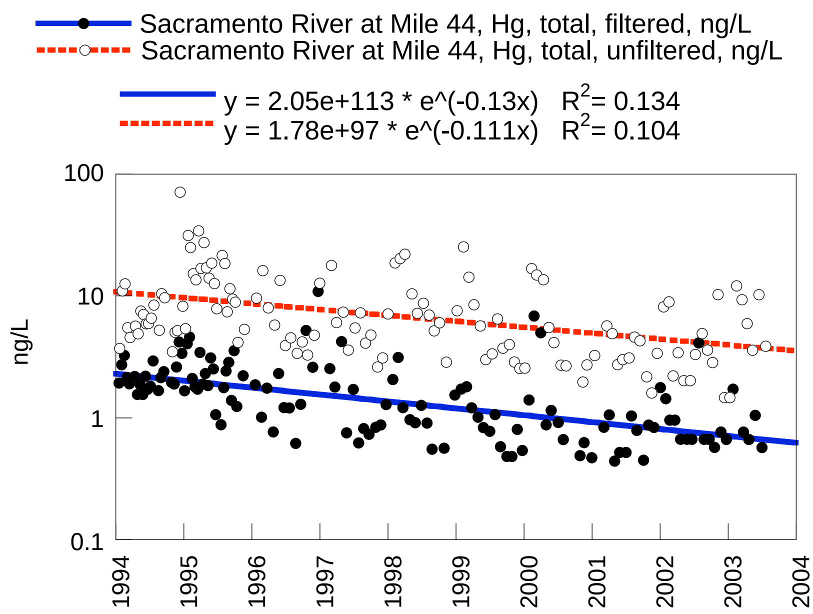


Figure 10. Trends in Water Column and Particulate Total Mercury, Sacramento River at Freeport, 1994 – 2003

(All illustrated trends are statistically significant at $p<0.05$)



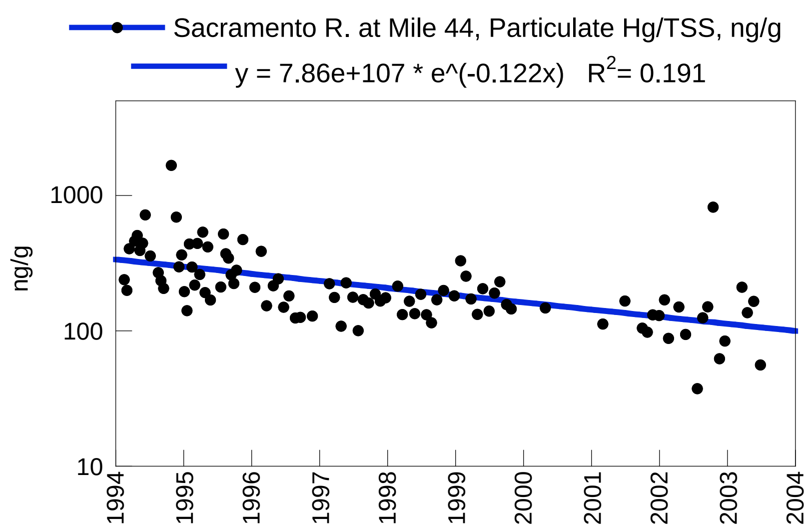
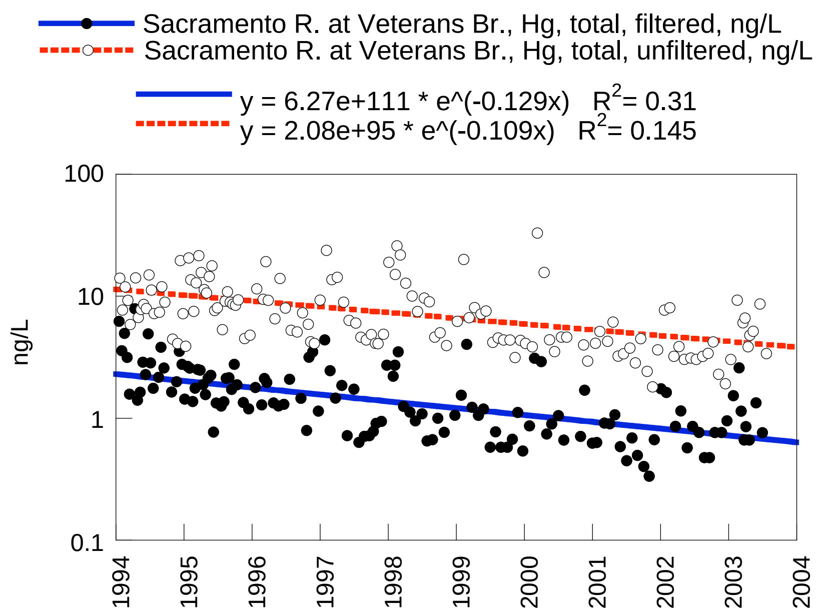


Figure 11. Trends in Water Column and Particulate Total Mercury, Sacramento River at Mile 44, 1994 – 2003

(All illustrated trends are statistically significant at $p<0.05$)



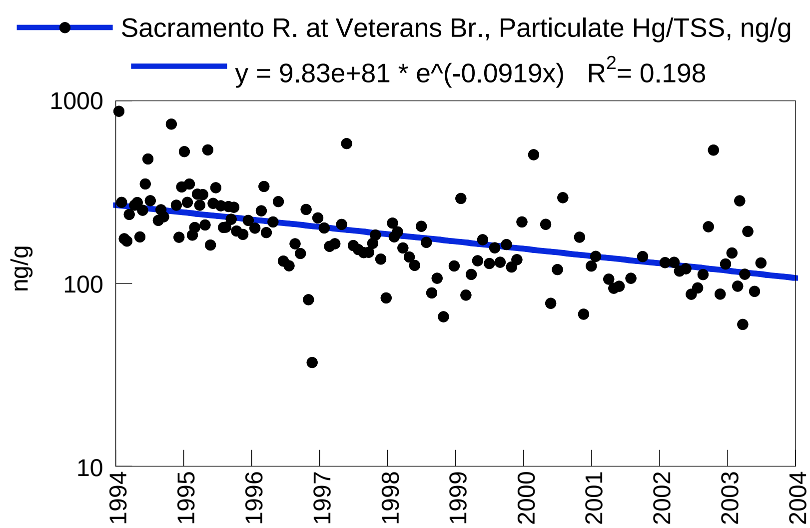
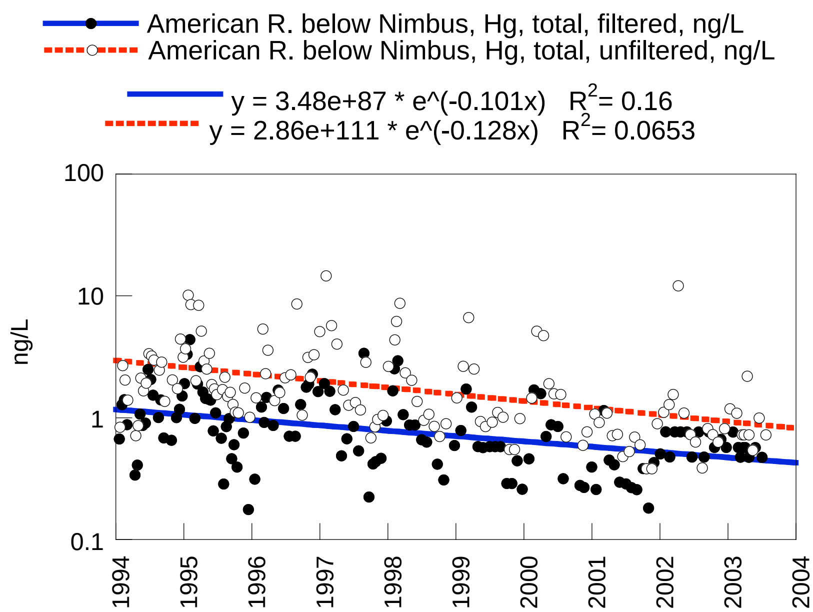


Figure 12. Trends in Water Column and Particulate Total Mercury, Sacramento River at Veterans Bridge, 1994 – 2003

(All illustrated trends are statistically significant at $p<0.05$)



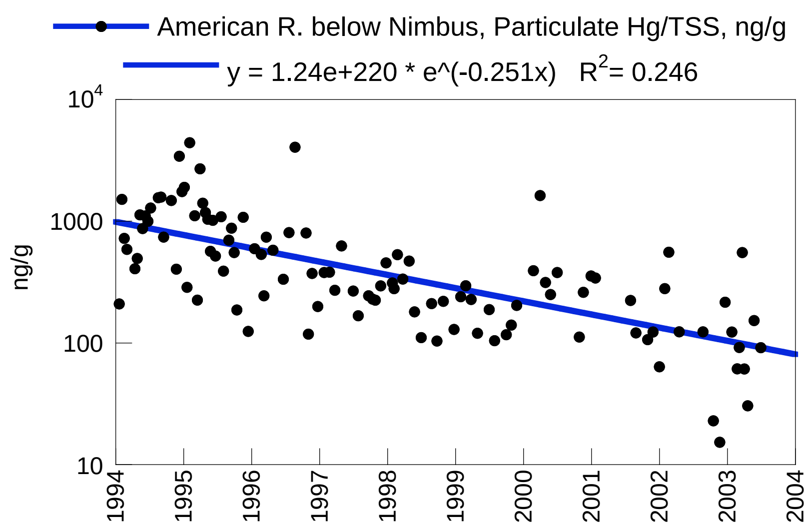
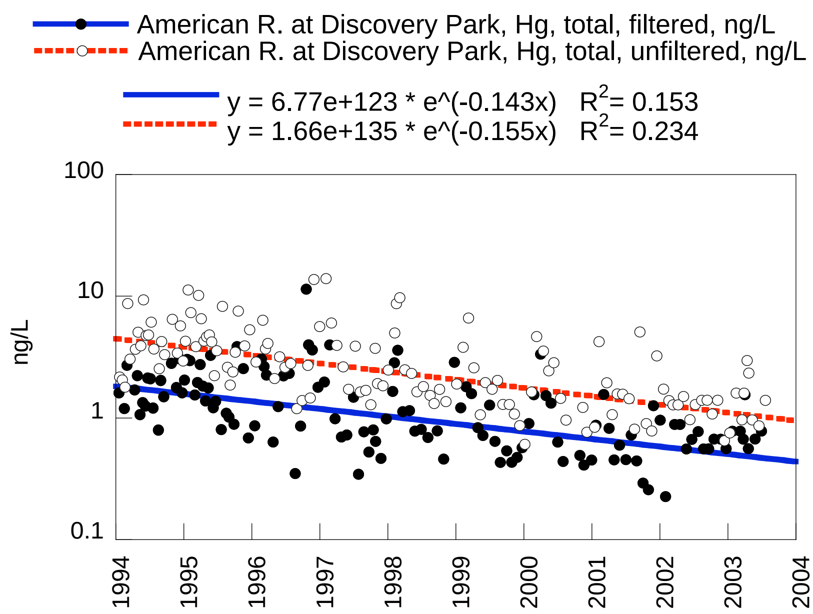


Figure 13. Trends in Water Column and Particulate Total Mercury, American River below Nimbus Dam, 1994 – 2003

(All illustrated trends are statistically significant at p<0.05)



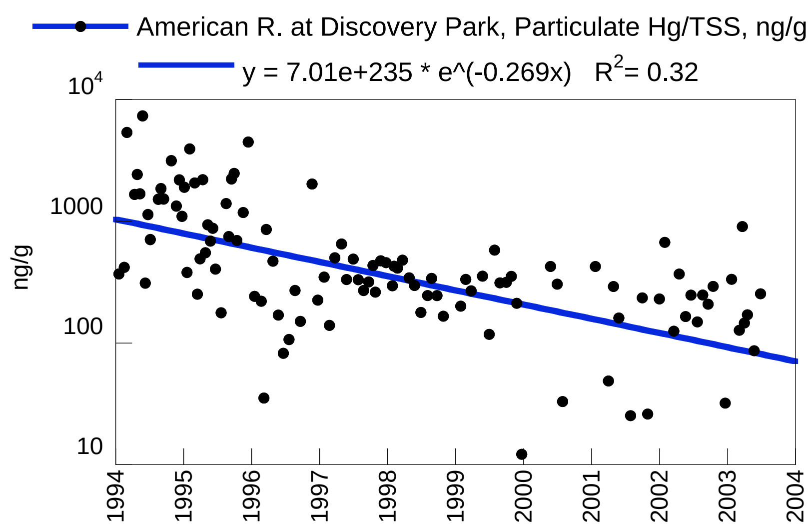


Figure 14. Trends in Water Column and Particulate Total Mercury, American River at Discovery Park, 1994 – 2003

(All illustrated trends are statistically significant at $p<0.05$)

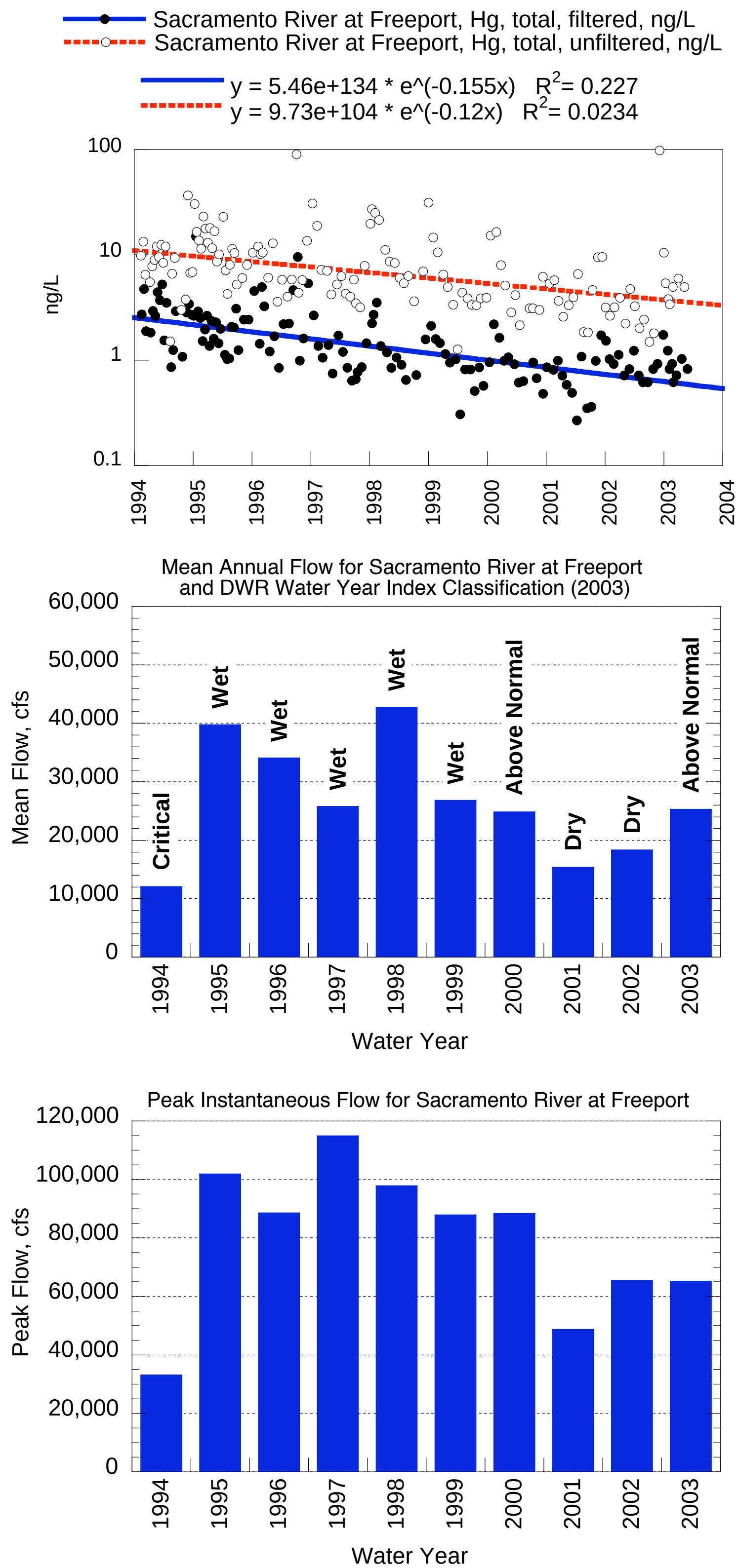


Figure 15. Trends in Total Mercury and Sacramento River Flows, 1994 – 2003

(All illustrated trends are statistically significant at p<0.05)

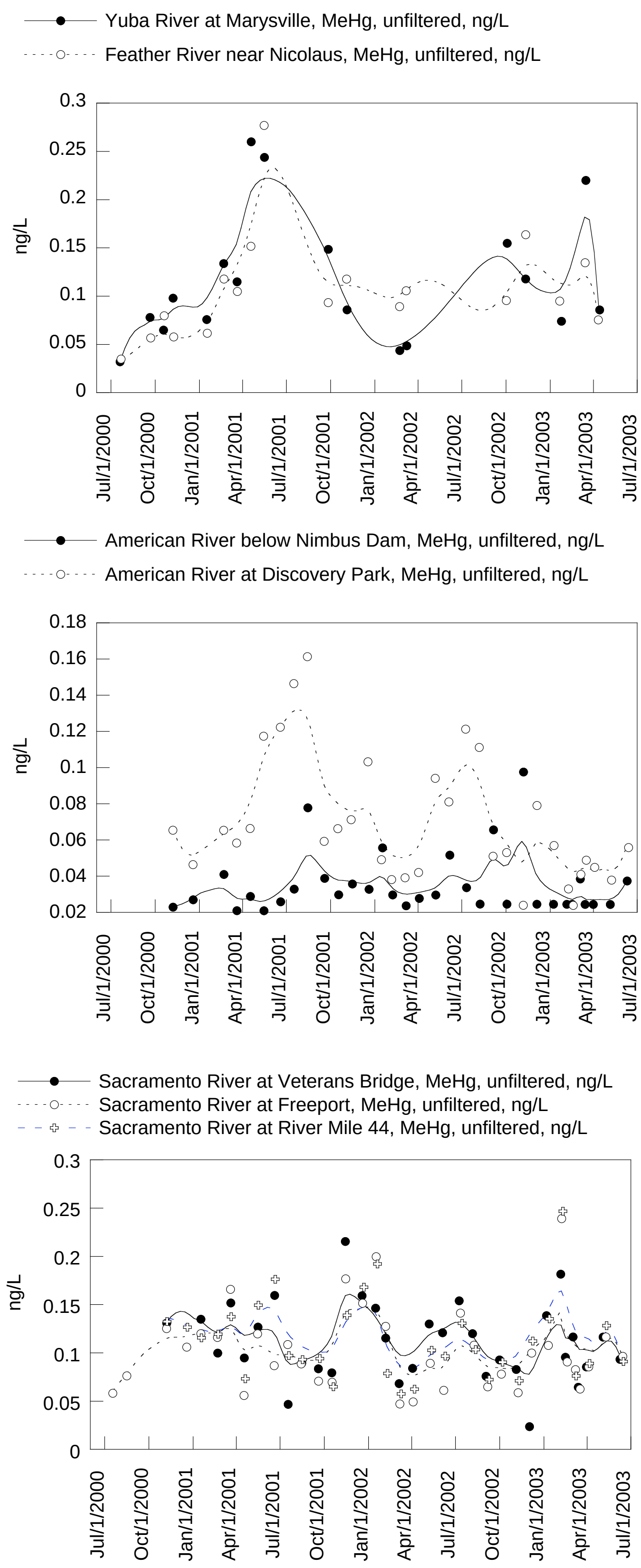


Figure 16. Temporal Patterns in Unfiltered Methylmercury, Lower Sacramento River Watershed, 2000 - 2003

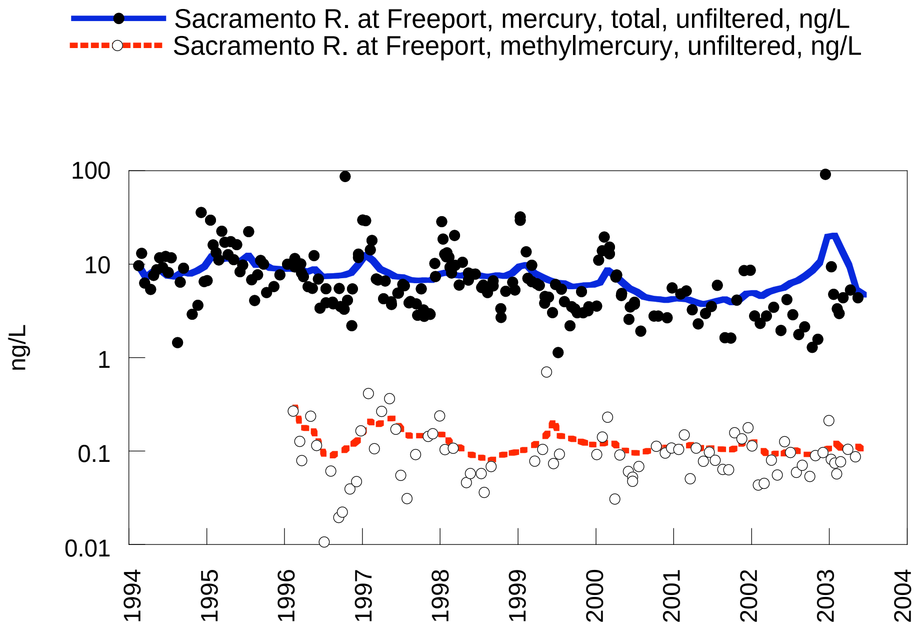


Figure 17. Seasonal Patterns in Mercury and Methylmercury, Sacramento River at Freeport, 1994 – 2003

PESTICIDES

Monitoring results for the Sacramento River Watershed Program (SRWP) for primary coordinating programs (USGS NAWQA, Sacramento River Coordinated Monitoring Program, and California Department of Water Resources), and from the California Department of Pesticide Regulation (CDPR) Surface Water Database are presented and summarized in this section. Data were compared to relevant water quality objectives and toxicity thresholds to evaluate attainment of beneficial uses and potential impairment of these uses in surface waters of the watershed. It should be noted that these evaluations are limited to the pesticides monitored by SRWP, and do not include many other pesticides that have potential to affect beneficial uses. Data were evaluated for spatial and temporal trends if evidence of potential impairment was found. Summary statistics for SRWP, coordinating programs, and other monitoring data in CDPR's Surface Water Database are provided for pesticides detected in 1999-2003 SRWP monitoring (Appendix A).

BACKGROUND AND AVAILABLE DATA OVERVIEW

The sources of data utilized for this report are summarized in Table 12. The majority of non-SRWP data discussed in this report were obtained from CDPR's Surface Water Database (July 15, 2000). The monitoring locations for the primary data considered for this report (USGS NAWQA, California, the Sacramento River Coordinated Monitoring Program, California Department of Pesticide Regulation, and the Sacramento River Watershed Program) are illustrated in Figure 18.

The majority of the pesticide monitoring performed in surface waters of the Sacramento River watershed has been focused on pesticides used in rice cultivation and orchard dormant spray applications, and on pesticides commonly found in urban runoff. Of these, the SRWP monitoring program has focused primarily on organophosphate and carbamate pesticides, with triazine pesticides also monitored at selected locations. "Legacy" organochlorine pesticides (including DDT, aldrin, dieldrin, endrin, heptachlors, chlordanes, endosulfans, toxaphene, and hexachlorocyclohexanes) were not monitored in water. All samples were collected as instantaneous grab samples.

As discussed previously in this document, SRWP monitoring for pesticides was performed on an episodic basis in 2002-2003. A total of six events, including four wet weather episodic events and two dry weather events, were monitored at 11 locations. Wet weather episodic events included the first significant watershed-wide storm event of the 2002-2003 wet season (early November, 2002), the organophosphate pesticide dormant spray application period (late January 2003), and two late wet season rainfall events (March and April, 2003). One dry weather "episodic" event was scheduled to coincide with late dry season low flows, and one during the rice herbicide application and discharge period (early June, 2003). These events are summarized in Table 13. The number of detections and total number of samples analyzed at each site is summarized in Table 14 for pesticides detected in SRWP 2002-2003 monitoring.

Table 12. Pesticide Monitoring in the Sacramento River Watershed

Program	Monitoring Period(s)	Parameters	# of Locations & Geographic Reference
SRWP	6/99–5/01	▪ Organophosphate, carbamate, and triazine pesticides in water	6 sites: 3 Sac. River sites (OPs), 2 Ag. Drain sites (OPs, carbamates), and 1 urban runoff-dominated site (all parameters)
Sacramento River CMP (SRCSD)	12/92–12/01	▪ Diazinon and chlorpyrifos in water	5 sites on Sacramento and American rivers in Sacramento metropolitan area
Sacramento River Basin NAWQA (USGS)	2/96–4/98	▪ Wide range of pesticides, including OPs, carbamates,	5 sites: 1 Sac. River site, 2 Ag. Drainage dominated sites, 1 urban runoff-dominated site, and Yolo Bypass
USGS (Domagalski 1998)	5/98–9/00	▪ Wide range of pesticides, including OPs, carbamates,	Continuation of NAQWA monitoring at Sac. River at Freeport, Arcade Creek, and Sacramento Slough (through 9/04)
Department of Pesticide Regulation (DPR)	1996–2001 (wet season episodic sampling)	▪ Organophosphate, carbamate, and triazine pesticides in water	3 sites: Sacramento River at Veterans Bridge (Alamar) and Sutter Bypass near Karnak, and Wadsworth Canal
DPR	1995–2001	▪ Rice Pesticides	3 sites: Sacramento River at Village Marina, Butte Slough, and Colusa Basin Drain
DPR (Spurlock 2002)	1991-2001	▪ Chlorpyrifos, diazinon ▪ Acute Toxicity	Meta-analysis of 32 surface water and dormant spray studies
CVRWQCB	1/94–3/94	▪ Organophosphate, carbamate, and triazine pesticides in water	21 sites: Sacramento River, Feather River, Yuba River, and multiple ag. drainage-affected sites
Sacramento NPDES Stormwater Monitoring Program (LWA 2003)	1990–2002	▪ Organophosphate and carbamate pesticides in water	13 Sacramento area urban runoff and river sites
SF Estuary Regional Monitoring Program	1989–1998	▪ Pesticides in water	18 Bay-Delta sites, including Sacramento River and San Joaquin River at the Delta terminus
Special Tributary Program (CDWR)	6/98–5/00	▪ Pesticides in water	13 water column sites on Mill Creek, Big Chico Creek, and Deer Creek
Offstream Storage Study (CDWR)	1999 to 2001	▪ Pesticides in water	42 sites: 7 Sac. River sites and 32 tributary sites between Keswick and Colusa, and 3 reservoir sites. *Data not available*
DPR (Gill 2004)	2003	▪ Esfenvalerate	1 BMP study site in Glenn County
CVRWQCB, CALFED	9/00–8/01	▪ 4-day *Selenastrum* toxicity tests ▪ Pesticides in water	7 sites in the Sacramento River watershed
DPR (Bacey, Starner, and Spurlock 2003)	2002–2003 (wet season episodic)	▪ Pyrethroid, organophosphate, and triazine pesticides	2 ag drain sites near Marysville
USGS (Dileanis *et al. 2002)*	2000 wet season	▪ Wide range of pesticides, including OPs, carbamates,	6 ag drain sites in Butte Co.;
USGS (Dileanis *et al. 2003)*	2001 wet season	▪ Wide range of pesticides, including OPs, carbamates,	21 ag and urban sites
USGS (NWIS DB)	1/02–2/02	▪ Wide range of pesticides, including OPs, carbamates,	11 sites (ag drains, urban, mainstem, and tributaries)

Table 13. SRWP Pesticide Monitoring, 2002-2003: Events and Locations

		Mainstem Sacramento River			Major Tributaries		Tributaries			Ag Drains		Urban Creek
Sample Dates	**Event Description**	**S.R. near Hamilton City**	**S.R. at Veterans Bridge**	**S.R. at Colusa**	**Feather River near Nicolaus**	**Yuba River at Marysville**	**Big Chico Creek**	**Deer Creek**	**Mill Creek**	**Colusa Basin Drain**	**Sacramento Slough**	**Arcade Creek**
Oct 02 - Oct 03, 2002	Late dry season, low flows	O	O	O	O	O/C	—	—	—	O/C	O/C	T/O/C
Nov 09 - Nov 12, 2002	First significant storm event of the wet season	O	T/O	O	T/O	O/C	—	—	—	O/C	O/C	T/O/C
Jan 22 - Jan 24, 2003	Rain event following OP pesticide dormant spray application	O	T/O	O	T/O	O/C	O	O	O	O/C	O/C	T/O/C
Mar 15 - Mar 17, 2003	Late wet season storm event	O	T/O	O	T/O	O/C	O	O	O	O/C	C	T/O/C
Apr 12 - Apr 14, 2003	Late wet season storm event	O	T/O	O	T/O	O/C	O	O	O	—	O/C	T/O/C
Jun 09 - Jun 10, 2003	Rice pesticide application and discharge season (dry weather event)	O	R/O	R/O	R/O	O/C	—	—	—	R/O/C	R/O/C	T/O/C

Notes: "O" – Organophosphate Pesticides by EPA 8141A;
"C" – Carbamate Pesticides by EPA 8321;
"T" – Triazine pesticides by EPA 619;
"R" – Rice Pesticides (molinate and thiobencarb) by EPA 507;
"—" indicates site not monitored for event.

Table 14. Numbers of Detections and Total Numbers of Samples for Pesticides Detected in SRWP Monitoring, SRWP Data 2002-2003

		Locations and Numbers of Detections/Total Analyses [1]										
		Mainstem Sacramento River			Major Tributaries		Tributaries			Ag Drains		Urban Creek
Method	**Pesticide**	**S.R. near Hamilton City**	**S.R. at Colusa**	**S.R. at Veterans Bridge**	**Feather River near Nicolaus**	**Yuba River at Marysville**	**Big Chico Creek**	**Deer Creek**	**Mill Creek**	**Colusa Basin Drain**	**Sacramento Slough**	**Arcade Creek**
EPA 8141A	Chlorpyrifos	0/6	0/6	1/6	0/6	0/6	0/3	0/3	0/3	0/6	0/5	0/6
	Diazinon	0/6	0/6	0/6	0/6	0/6	0/3	0/3	0/3	0/6	0/5	5/6
	Prometon	0/5	0/5	0/6	0/6	0/5	0/3	0/3	0/3	0/5	0/4	3/6
	Prowl	0/6	0/6	0/6	0/6	0/6	0/3	0/3	0/3	1/6	0/5	0/6
	Simazine	0/5	0/5	0/6	0/6	0/5	2/2	0/3	0/3	2/4	0/4	0/6
EPA 8321A	Bromacil	—	—	—	—	0/6	—	—	—	0/6	0/6	1/6
	Carbaryl	—	—	—	—	0/6	—	—	—	0/6	0/6	2/6
	Diuron	—	—	—	—	0/6	—	—	—	1/6	1/6	3/6
	Oryzalin	—	—	—	—	0/5	—	—	—	1/5	0/5	2/5
EPA 507	Molinate	—	0/1	0/1	0/1	—	—	—	—	1/1	1/1	—
	Thiobencarb	—	0/1	0/1	0/1	—	—	—	—	1/1	0/1	—

(1) Number of samples in which pesticide was detected versus total number of samples analyzed.

ATTAINMENT OF BENEFICIAL USES AND POTENTIAL IMPAIRMENT

Pesticides monitored by the SRWP include organophosphate and phenoxyurea pesticides, carbamate pesticides, and triazine pesticides (analyzed by USEPA methods 8141, 8321, and 619, respectively). In addition, the rice herbicides molinate and thiobencarb were monitored at six locations for a single event using EPA method 507 (in coordination with the City of Sacramento). Individual pesticides and their respective reporting limits are presented in Table 15. Eleven of these pesticides were detected in SRWP monitoring in 2001-2002. An additional six pesticides detected in 1999-2002 monitoring, but not detected in 2002-2003 (aldicarb, EPTC, malathion, methomyl, propazine, and tebuthiuron), have been discussed in previous Annual Monitoring Reports and are not evaluated again in this document. The concentrations of pesticide detected in 2002-2003 were compared with a variety of regulatory and toxicity thresholds (Table 16) to evaluate potential risks to human health and aquatic life. The frequency that these same pesticides were detected in different waterbody types is summarized for SRWP and coordinating data sources in Table 17. The frequency that concentrations of these pesticides were observed to exceed regulatory and toxicity thresholds in different waterbody types is summarized in Table 18 and Table 19. The regulatory thresholds considered include USEPA aquatic life criteria, USEPA's Maximum Contaminant Levels (MCL) for drinking water, reference doses for drinking water from USEPA's IRIS database, and minimum toxic thresholds from USEPA's Office of Pesticide Programs (OPP) Ecotoxicity database. Also considered were recommended aquatic life criteria developed by the California Department of Fish and Game for diazinon, chlorpyrifos (CDFG 2000), and carbaryl (CDFG 1998). There are no criteria in the adopted California Toxics Rule for any of the pesticides detected in SRWP monitoring. Of the pesticides detected in SRWP monitoring, only chlorpyrifos, diazinon, and malathion have aquatic life criteria developed using USEPA methodology. Of the pesticides detected in 2001-2002, only molinate and thiobencarb have Drinking Water MCLs. No relevant regulatory limits are available for other detected pesticides (carbaryl, diuron, prometon, and prowl). The results of these comparisons provide some perspective regarding potential impacts on beneficial uses. However, these results do not provide definitive or conclusive information regarding such impacts.

Comparisons with Water Quality Criteria and Toxicity Thresholds

Bromacil (a substituted uracil herbicide) was not detected at concentrations exceeding or approaching the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (6.8 μg/L, EC_{50} for aquatic plants), either in SRWP monitoring or data reported in CDPR's Surface Water Database. There are no aquatic life criteria or drinking water MCLs for bromacil.

Carbaryl (a carbamate insecticide) was not detected at concentrations exceeding or approaching the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (1.5 μg/L, LC_{50} for crustacean species), or DFG's recommended Continuous Concentration Criterion (CCC) of 2.53 μg/L, either in SRWP monitoring or data reported in CDPR's Surface Water Database (CDPR 2003).

Chlorpyrifos (an organophosphate insecticide) was detected at greater than DFG's recommended Criterion Continuous Concentration (CCC) of 0.014 μg/L in one of six samples collected from the Sacramento River at Veterans Bridge in 2002-2003 monitoring. The concentration measured in this sample (0.07 μg/L) also exceeded the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (.028 μg/L, LC_{50} for crustacean species) and the recommended Criterion Maximum Concentration (CMC) of 0.02 μg/L. Chlorpyrifos was not detected in any other samples in SRWP 2002-2003 monitoring, and data in the CDPR Surface Water database indicate that chlorpyrifos is infrequently detected the Sacramento River mainstem, major and minor tributaries, and agricultural drains (Table 17). However, many of these results are from analyses with detection limits that are higher than relevant toxicity thresholds and water quality objectives. Given this limitation of the data, it appears that the greatest magnitude and most frequent exceedances of DFG's recommended CCC and CMC occur in urban runoff and creeks.

Diazinon (an organophosphate insecticide) was detected at greater than DFG's recommended Continuous Concentration Criterion (CCC) of 0.050 µg/L in five of six samples collected from Arcade Creek in 2002–2003. Diazinon concentrations from Arcade Creek also exceeded the lowest LC_{50} (0.2 µg/L, for crustacea) reported in the USEPA's OPP Ecotoxicity database in four these samples. Aquatic toxicity testing at this site indicates that metabolically activated toxicants are often the cause of significant mortality and/or reproductive toxicity frequently observed at this site—a pattern that is consistent with diazinon toxicity. Four of the five Arcade Creek samples observed to exceed DFG's recommended CCC also exhibited significant mortality (3 samples) or reproductive inlhibition (1 sample) in toxicity tests with *Ceriodaphnia dubia*. Although diazinon was not detected at greater than the recommended CCC at any other SRWP-monitored site in 2002-2003, data in the CDPR Surface Water database indicate that diazinon concentrations have commonly exceeded this value at nearly every location monitored, including the Sacramento River mainstem, and major and minor tributaries. The greatest magnitude and most frequent exceedances of the recommended CCC have been observed in the numerous waterways most directly affected by agricultural drainage or urban runoff. Based on the data in the CDPR Surface Water database, diazinon concentrations in agricultural drainage-dominated waterways commonly exceed 0.2 µg/L, the lowest LC_{50} (for crustacea) reported in the USEPA's OPP Ecotoxicity database. Although it appears that this concentration is not frequently exceeded in the Sacramento River or major tributaries, other studies have documented cases of significant reproductive effects and mortality to *Ceriodaphnia dubia* due to diazinon, or have observed diazinon concentrations high enough to cause toxicity (Foe and Sheipline 1993, Larsen *et al*. 1998a and b, Holmes *et al*. 1998). Concentrations many times higher than DFG's recommended CCC and other toxicity thresholds have been documented in urban creeks and agricultural drains by numerous researchers and monitoring programs (Ogle and Cooke 2000, Denton 2001, LWA 2001)

Diuron (a urea herbicide) was detected at a concentration greater than the minimum toxicity threshold in USEPA's OPP Ecotoxicity Database (2.4 µg/L, aquatic plant species EC_{50}) in one sample from Arcade Creek in SRWP 2002-2003 monitoring. Data reported in CDPR's Surface Water Database (CDPR 2003) indicate that this threshold was exceeded occasionally in agricultural drainage, urban runoff, and urban creeks, sometimes by more than an order of magnitude. It was not exceeded in any samples reported for the Sacramento River. There are no aquatic life criteria or human health-based MCLs for diuron.

Molinate (a selective thiocarbamate herbicide) was not detected at concentrations exceeding or approaching the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (220 µg/L, aquatic plant species EC_{50}), either in SRWP monitoring or data reported in CDPR's Surface Water Database. Concentrations detected in Colusa Basin Drain (2.1 µg/L) and Sacramento Slough (3.7 µg/L) were well below the USEPA MCL (20 µg/L) and the IRIS RfD (14 µg/L) for molinate. Concentrations exceeding the MCL and the RfD have often been reported in USEPA's OPP Ecotoxicity Database for two agricultural drains (Colusa Basin Drain and Butte Slough), but not for Sacramento River mainstem or the Feather River sites.

Oryzalin (a selective pre-emergent herbicide) was not was not detected at concentrations exceeding or approaching the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (15.4 µg/L, aquatic plant species EC_{50}), either in SRWP monitoring or data reported in CDPR's Surface Water Database. There are no aquatic life criteria or human health-based MCLs for oryzalin.

Prometon (a non-selective triazine herbicide) was not detected at concentrations exceeding or approaching the lowest toxicity threshold reported in USEPA's OPP Ecotoxicity Database (98 µg/L, aquatic plant species EC_{50}), either in SRWP monitoring or data reported in CDPR's Surface Water Database. There are no aquatic life criteria or human health-based MCLs for prometon.

Pendimethalin (a selective herbicide) was not detected at concentrations exceeding or approaching the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (5.2 µg/L, aquatic plant species EC_{50}), either in SRWP monitoring or data reported in CDPR's Surface Water Database. There are no aquatic life criteria or human health-based MCLs for pendimethalin.

Simazine (a selective triazine herbicide) was not detected at concentrations exceeding or approaching the lowest toxicity threshold reported in USEPA's OPP Ecotoxicity Database (36 µg/L, aquatic plant species EC_{50}) or the California MCL (4 µg/L), either in SRWP monitoring or data reported in CDPR's Surface Water Database.

Thiobencarb (a thiocarbamate herbicide) was not detected at concentrations exceeding the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (2 µg/L, crustacean species LOEC for *Daphnia magna*; no NOEC was reported). The concentration detected in one sample from Colusa Basin Drain approached but did not exceed the secondary taste and odor-based MCL of 1 µg/L. In CDPR's Surface Water Database, thiobencarb has been reported to exceed this toxicity threshold frequently in two agricultural drains (Colusa Basin Drain and Butte Slough), but never in the Sacramento River mainstem or the Feather River sites.

No pesticides were detected at concentrations exceeding drinking water reference doses (RfD) reported in USEPA's IRIS database.

Table 15. Pesticides Monitored by the Sacramento River Watershed Program

Analyte	RL, µg/L[1]	Analyte	RL, µg/L[1]
Organophosphate pesticides by EPA Method 8141a			
Azinphosmethyl	1.0	Fenthion	0.10
Bolstar	0.10	Malathion	0.10
Chlorpyrifos	0.05	Merphos	0.10
Coumaphos	0.20	Mevinphos	0.70
Def	0.10	Naled	0.50
Demeton-S	0.20	Parathion, ethyl	0.10
Diazinon	0.05	Parathion, methyl	0.10
Dichlorovos	0.20	Phorate	0.10
Dimethoate	0.10	Prowl	0.10
Disulfoton	0.10	Ronnel	0.10
EPN	0.10	Stirophos	0.10
EPTC	0.10	Tokuthion	0.10
Ethion	0.10	Trichloronate	0.10
Ethoprop	0.10	Trifluralin	0.10
Fensulfotion	0.50		
Carbamate pesticides by EPA Method 8321			
Aldicarb	0.8	Linuron	0.8
Aminocarb	0.8	Methiocarb	0.8
Barban	7.0	Methomyl	7.0
Benomyl (Carbendazim)	0.8	Mexacarbate	0.8
Bromacil	0.8	Monuron	0.8
Carbaryl	0.14	Neburon	0.8
Carbofuran	0.14	Oxamyl	7.0
Chloropropham	7.0	Propachlor	7.0
Chloroxuron	0.8	Propoxur	0.8
Diuron	0.8	Siduron	0.8
Fenuron	0.8	Tebuthiuron	0.8
Fluometuron	0.8		
Triazine pesticides by EPA Method 619			
Ametryn	0.5	Propazine	0.5
Atraton	0.5	Simetryn	0.5
Atrazine	0.5	Simazine	0.5
Cyanazine	0.5	Terbuthylazine	0.5
Prometon	0.5	Terbutryn	0.5
Prometryn	0.5		
EPA Method 507			
Molinate	0.5	Thiobencarb	0.5

(1) Reporting Limit

Table 16. Advisory Criteria and Other Threshold Values for Pesticides Detected in SRWP 2002–2003 Monitoring

	Units = µg/L			
Pesticide	**Chronic Aquatic Life Criterion (CCC)**	**MCL**	**IRIS RFd**	**Minimum Toxicity Thresholds (1) (threshold type, taxonomic class)**
Bromacil	—	—	90	6.8 (minimum EC_{50}, aquatic plants)
Carbaryl	2.53(2)	—	700	1.5 (minimum LC_{50}, crustacea)
Chlorpyrifos	0.014 (3)	—	21	0.028 (minimum LC_{50}, crustacea) 0.01 (LOEC, crustacea)
Diazinon	0.05 (3)	—	—	0.2 (minimum LC_{50}, crustacea)
Diuron	—	—	14	2.4 (minimum EC_{50}, aquatic plants)
Molinate	13	20	14	220 (minimum EC_{50}, aquatic plants)
Oryzalin	—	—	35	15.4 (minimum EC_{50}, aquatic plants)
Prometon	—	—	100	98 (minimum EC_{50}, aquatic plants)
Pendimethalin (Prowl)	—	—	280	5.2 (minimum EC_{50}, aquatic plants) 9.8 (LOEC, crustacea)
Simazine	10.0(4)	4	3.5	36 (minimum EC_{50}, aquatic plants)
Thiobencarb	3.1	70 (1° MCL) 1 (2° MCL)	70	17 (minimum EC_{50}, aquatic plants) 2 (LOEC, crustacea)

(1) From U.S. EPA's Environmental Fate and Effects Division of the Office of Pesticide Programs Pesticide Ecotoxicity Database, (USEPA 2003).
(2) CDFG 1998
(3) CDFG 2000
(4) U.S. Environmental Protection Agency, *Water Quality Criteria, 1972* (1973) [*The Blue Book*]

Table 17. Percent Detections and Total Number (n) of Analyses, Pesticides Detected in SRWP Monitoring, 1991-2003

Pesticide	Mainstem		Major Tributaries (American, Feather, Yuba)		Tributaries		Ag Drains		Urban Creek		Urban Runoff	
Aldicarb	0.0%	(128)	0.0%	(45)	0.0%	(5)	1.1%	(87)	0.0%	(62)	0.0%	(10)
Bromacil	1.9%	(208)	0.0%	(45)	0.0%	(5)	6.5%	(278)	6.3%	(63)	0.0%	(10)
Carbaryl	0.0%	(284)	4.2%	(72)	0.0%	(5)	1.1%	(261)	27.4%	(62)	53.3%	(15)
Carbofuran	0.0%	(386)	8.8%	(80)	33.3%	(9)	32.2%	(695)	0.0%	(62)	10.0%	(10)
Chlorpyrifos	1.9%	(519)	0.0%	(146)	0.0%	(36)	3.4%	(320)	36.5%	(63)	55.6%	(27)
Diazinon	19.0%	(683)	18.0%	(327)	31.6%	(57)	66.1%	(576)	92.1%	(63)	27.8%	(79)
Diuron	38.5%	(208)	4.4%	(45)	20.0%	(5)	37.4%	(278)	48.4%	(62)	86.7%	(15)
EPTC	1.1%	(181)	0.0%	(121)	0.0%	(27)	26.5%	(102)	3.8%	(53)	0.0%	(12)
Malathion	0.0%	(602)	0.0%	(186)	0.0%	(36)	7.1%	(630)	25.4%	(63)	2.1%	(96)
Methomyl	0.0%	(128)	0.0%	(45)	0.0%	(5)	1.2%	(86)	0.0%	(62)	0.0%	(10)
Molinate	31.2%	(154)	27.0%	(37)	66.7%	(3)	85.1%	(498)	3.3%	(30)	—	—
Oryzalin	2.8%	(36)	0.0%	(16)	—	—	7.1%	(14)	19.4%	(36)	—	—
Prometon	0.0%	(280)	3.8%	(53)	0.0%	(37)	3.5%	(287)	40.0%	(95)	8.3%	(24)
Propazine	0.0%	(19)	0.0%	(13)	0.0%	(5)	0.0%	(3)	6.3%	(32)	—	—
Prowl	2.5%	(204)	1.0%	(103)	0.0%	(32)	1.6%	(64)	6.1%	(33)	—	—
Simazine	13.2%	(302)	19.6%	(97)	12.2%	(41)	40.5%	(395)	23.2%	(95)	45.8%	(24)
Tebuthiuron	0.0%	(76)	2.1%	(47)	0.0%	(5)	13.3%	(120)	15.9%	(63)	0.0%	(10)
Thiobencarb	10.6%	(160)	3.4%	(29)	—	—	60.5%	(448)	0.0%	(30)	—	—

Notes: Data are from SRWP monitoring, Sacramento River Coordinated Monitoring Program, USGS NAWQA, and Other Studies contained in CDPR's Surface Water Database, 1991-2003.
"—" indicates category not monitored for parameter.

Table 18. Detected Exceedances of Aquatic Life Criteria, Percent and Number (n) of Total Analyses

Analyte	Minimum Aquatic Life Criterion, ug/L	Sacramento River Mainstem Sites		Major Tributaries		Tributaries		Ag Drains		Urban Creek		Urban Runoff	
Carbaryl	2.53	0.0%	(284)	0.0%	(72)	0.0%	(5)	0.0%	(261)	0.0%	(62)	0.0%	(15)
Carbofuran	0.5	0.0%	(386)	0.0%	(80)	0.0%	(9)	6.3%	(695)	0.0%	(62)	0.0%	(10)
Chlorpyrifos	0.014	1.9%	(519)	0.0%	(146)	0.0%	(36)	1.3%	(320)	17.5%	(63)	55.6%	(27)
Diazinon	0.05	10.4%	(683)	11.0%	(327)	17.5%	(57)	55.6%	(576)	92.1%	(63)	27.8%	(79)
Malathion	0.43	0.0%	(602)	0.0%	(186)	0.0%	(36)	2.4%	(630)	1.6%	(63)	1.0%	(96)
Simazine	10	0.0%	(302)	0.0%	(97)	0.0%	(41)	0.0%	(395)	0.0%	(95)	0.0%	(24)
Thiobencarb	3.1	0.0%	(160)	0.0%	(29)	—		17.4%	(448)	0.0%	(30)	—	

Notes: Data are from SRWP monitoring, Sacramento River Coordinated Monitoring Program, USGS NAWQA, and Other Studies contained in CDPR's Surface Water Database, 1991-2003.
"—" indicates category not monitored for parameter.

Table 19. Detected Exceedances of Minimum Toxicity Thresholds, Percent and Number (n) of Total Analyses

Analyte	Minimum Toxicity Threshold, ug/L (EC_{50} or LC_{50})	Sacramento River Mainstem Sites	Major Tributaries	Tributaries	Ag Drains	Urban Creek	Urban Runoff
Aldicarb	12	0.0% (128)	0.0% (45)	0.0% (5)	0.0% (87)	0.0% (62)	0.0% (10)
Bromacil	6.8	0.0% (208)	0.0% (45)	0.0% (5)	0.0% (278)	0.0% (63)	0.0% (10)
Carbaryl	1.5	0.0% ()	0.0% (72)	0.0% (5)	0.0% (261)	0.0% (62)	0.0% (15)
Carbofuran	4.6	0.0% (386)	0.0% (80)	0.0% (9)	0.0% (695)	0.0% (62)	0.0% (10)
Chlorpyrifos	0.028	1.7% (519)	0.0% (146)	0.0% (36)	0.3% (320)	6.3% (63)	55.6% (27)
Diazinon	0.2	2.5% (683)	2.8% (327)	1.8% (57)	24.0% (576)	65.1% (63)	22.8% (79)
Diuron	2.4	0.0% (208)	0.0% (45)	0.0% (5)	0.0% (278)	3.2% (62)	26.7% (15)
EPTC	630	0.0% (181)	0.0% (121)	0.0% (27)	0.0% (102)	0.0% (53)	0.0% (12)
Malathion	0.5	0.0% (602)	0.0% (186)	0.0% (36)	2.1% (630)	1.6% (63)	1.0% (96)
Methomyl	7.6	0.0% (128)	0.0% (45)	0.0% (5)	0.0% (86)	0.0% (62)	0.0% (10)
Molinate	220	0.0% (154)	0.0% (37)	0.0% (3)	0.0% (498)	0.0% (30)	—
Oryzalin	15.4	0.0% (36)	0.0% (16)	—	0.0% (14)	0.0% (36)	—
Prometon	98	0.0% (280)	0.0% (53)	0.0% (37)	0.0% (287)	0.0% (95)	0.0% (24)
Propazine	25	0.0% (19)	0.0% (13)	0.0% (5)	0.0% (3)	0.0% (32)	—
Prowl	5.2	0.0% (204)	0.0% (103)	0.0% (32)	0.0% (64)	0.0% (33)	—
Simazine	36	0.0% (302)	0.0% (97)	0.0% (41)	0.0% (395)	0.0% (95)	0.0% (24)
Tebuthiuron	50	0.0% (76)	0.0% (47)	0.0% (5)	0.0% (120)	0.0% (63)	0.0% (10)
Thiobencarb	17	0.0% (160)	0.0% (29)	—	0.0% (448)	0.0% (30)	—

Notes: Data are from SRWP monitoring, Sacramento River Coordinated Monitoring Program, USGS NAWQA, and Other Studies contained in CDPR's Surface Water Database, 1991-2003.
"—" indicates category not monitored for parameter.

What Do These Results Say About Attainment of Beneficial Uses and Potential Impairment, and How Does This Compare with Relevant 303(D) Listings for Parameter and Sites?

Waterbodies in the Sacramento River watershed that are included on California's 2002 303(d) list due to elevated pesticide concentrations are presented in Table 20.

As stated previously, it should be noted that comparisons with advisory criteria and toxicity thresholds do not provide conclusive evidence of attainment or impairment of beneficial uses. However, for the purpose of these evaluations, repeated significant exceedances of these values are considered as an indication of potential impairment of beneficial uses. In general, regulatory agency advisory criteria (*e.g.*, USEPA aquatic life criteria or drinking water MCLs) are given the most weight in these evaluations. However, because most of the pesticides detected do not have any adopted regulatory limits, detected concentrations were compared to available toxicity threshold data as an initial screen for potential impairment of beneficial uses. These were considered the best available indicators of potential impairment. As previously noted, these evaluations are limited to the pesticides monitored by SRWP, and do not include many other pesticides that have the potential to affect beneficial uses.

The beneficial uses at greatest potential risk from elevated pesticide concentrations in surface water are "Cold Freshwater and Estuarine Habitat", "Commercial and Sport Fishing", and

"Municipal and Domestic Water Supply" (as defined in the Central Valley Region Basin Plan, CVRWQCB 1995). The most direct effects are likely to be on aquatic plants and crustacea, taxonomic groups which include the species most sensitive to the most widely used insecticides and herbicides. Based on data from the SRWP and other monitoring efforts, there may be significant potential for localized impacts on these beneficial uses due to elevated concentrations of some pesticides in some surface waters of the Sacramento River watershed. Based on findings of elevated concentrations and documented toxicity in surface waters ranging from small urban creeks and agricultural drains to the Sacramento River mainstem and Delta waterways, diazinon appears to pose the greatest and most extensive risks. The Central Valley Regional Board has concluded that beneficial uses are impaired by diazinon, and has cited diazinon as the primary reason for including numerous waterbodies on the 2002 303(d) list of impaired waterbodies (Table 20). Direct effects of elevated diazinon concentrations are likely to be limited to sensitive zooplankton species. These invertebrate species are also important food sources for higher trophic level organisms in the ecosystem, and reduction of zooplankton populations during critical periods could also impact populations of higher trophic level organisms (*e.g.*, fish) (Ogle and Cooke 2000).

Although less frequently detected at toxic concentrations in the mainstem Sacramento River, elevated chlorpyrifos concentrations appear to pose similar risks. Because of its toxic mode of action is the same as diazinon, chlorpyrifos will also contribute to organophosphate toxicity even at concentrations below its single-chemical toxicity threshold (Bailey *et al.* 1996). The available pesticide concentration data agree well with the California 303(d) list of impaired waterbodies. Chlorpyrifos and diazinon are responsible for the greatest number of the individual listings on the California 303(d) list of impaired waterbodies, with diazinon alone responsible for the listing of 16 Sacramento River miles and 42 Feather River miles, 24,917 acres of Delta waterways, hundreds of thousands of acres in the Sacramento-San Joaquin Delta and San Francisco Bay Estuary. Diazinon is also responsible for numerous listings in urban creeks in the Sacramento metropolitan area, as well as in other urban areas in California (*e.g.*, the San Francisco Bay area). Based on a weight of evidence approach, it has been determined that these two organophosphate pesticides have a high potential for impairment of aquatic life and related beneficial uses in surface waters of the Sacramento River watershed. It should be noted that a Department of Pesticide Regulation meta-analysis of data from 32 surface water and dormant spray application studies (Spurlock 2002) found that the use and frequency of detections and the maximum concentrations of both of these pesticides has decreased substantially over the period studied (1991-2001), suggesting that risks to beneficial uses may be decreasing as well.

There appears to be some potential for localized impacts on aquatic life in specific waters in the watershed due to occasionally elevated concentrations of malathion and carbofuran, primarily in waterways dominated by agricultural drainage. As with diazinon and chlorpyrifos, direct toxic effects of these insecticides are likely to be limited to sensitive aquatic invertebrate species. There appears to be little risk of beneficial use impairment from these pesticides in the Sacramento River and larger tributaries, however. The available data appear to support the single 303(d) listing for malathion in the Sacramento River watershed (Colusa Basin Drain), although the number of detections and potential impacts of both carbofuran and malathion have been substantially reduced in recent years by changes in rice farming practices. There are no 303(d) listings in the Sacramento River watershed due specifically to carbofuran.

There appears to be some potential for localized impacts on aquatic life due to occasionally elevated concentrations of diuron, primarily in urban creeks and other waterways affected by urban runoff. There appears to be little risk of beneficial use impairment in the Sacramento River and larger tributaries from this herbicide. Direct toxic effects of diuron are probably limited to sensitive aquatic plant species. There are no 303(d) listings due specifically to diuron.

For the locations monitored, there appears to be little to no significant potential for impairment of aquatic life uses due to elevated concentrations of other pesticides monitored by the SRWP. Although the potential certainly exists for impairment due to synergistic effects from exposure to multiple pesticides, based on the available data there is yet little evidence of this phenomenon at the locations monitored, with the specific exception of organophosphate pesticides (discussed previously). Beneficial uses related to human health concerns (drinking water supply, and contact and non-contact recreational use) do not appear to be at risk from any of the pesticides monitored by the SRWP.

Table 20. Waterbodies in the Sacramento River Watershed Listed for Pesticides on the California 2002 303(d) List

Pesticide	Waterbody	Area Affected		Cited Sources
Azinphos-methyl, diazinon, malathion, methyl parathion, molinate	Colusa Drain	49	Miles	Agriculture
Chlordane, DDT, diazinon, dieldrin,	Sacramento-San Joaquin Delta	41,736	Acres	Nonpoint Source
Chlorpyrifos	Delta Waterways(2)	24,917	Acres	Agriculture; Urban Runoff
	Elder Creek	11	Miles	Urban Runoff
	Arcade Creek	9.9	Miles	Urban Runoff
	Chicken Ranch Slough(3)	8	Miles	Urban Runoff
	Strong Ranch Slough(3)	6.4	Miles	Urban Runoff
DDT	Delta Waterways(2)	24,917	Acres	Agriculture
Diazinon	Delta Waterways(2)	24,917	Acres	Agriculture; Urban Runoff
	Feather River, Lower	42	Miles	Agriculture; Urban Runoff
	Sac. R. (Red Bluff To Delta)	16	Miles	Agriculture
	Lower Bear River	21	Miles	Agriculture
	Morrison Creek	21	Miles	Agriculture; Urban Runoff
	Sutter Bypass	19	Miles	Agriculture
	Jack Slough	14	Miles	Agriculture
	Elder Creek(3)	11	Miles	Agriculture; Urban Runoff
	Arcade Creek	9.9	Miles	Agriculture; Urban Runoff
	Chicken Ranch Slough(3)	8	Miles	Agriculture; Urban Runoff
	Elk Grove Creek	6.9	Miles	Agriculture
	Strong Ranch Slough(3)	6.4	Miles	Agriculture; Urban Runoff
	Natomas E. Main Drain	3.5	Miles	Agriculture; Urban Runoff
	Sacramento Slough(3)	1.7	Miles	Agriculture; Urban Runoff
Diazinon, molinate	Butte Slough	8.9	Miles	Agriculture
Dieldrin, chlordane	SF Bay/Delta Estuary	292,520	Acres	Nonpoint Source
Group A pesticides(4)	Delta Waterways	24,917	Acres	Agriculture
	Colusa Drain	49	Miles	Agriculture
	Feather River, Lower	42	Miles	Agriculture

(1) Recommended for removal from 303(d) list in 2002 (CVRWQCB 2003)

(2) Sum of acreage for Western and Eastern Delta waterways

(3) Area Affected was increased in 2002 update (CVRWQCB 2003)

(4) "Group A" pesticides are aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, chlordanes, endosulfans, toxaphene, and hexachlorocyclohexanes)

SPATIAL DISTRIBUTIONS AND PATTERNS

Spatial distributions and patterns of detection were evaluated for pesticides determined to have a reasonable potential to cause impairment of beneficial uses (chlorpyrifos, diazinon, malathion, and diuron). As with other pollutants, the ability to evaluate spatial distribution patterns is highly dependent on the sites selected for monitoring. SRWP monitoring was performed at sites selected to complement monitoring performed by USGS NAWQA and the Department of Pesticide Regulation. Most of the data available are from monitoring performed in water bodies dominated by agricultural drainage or urban runoff, and for the mainstem Sacramento River. There are relatively few data available for the major tributaries to the Sacramento River (Feather River, Yuba River, and American River), and even fewer currently available for the greater number of minor tributaries to the Sacramento River. Within these limitations, there are still a number of general patterns discernible in the available data.

General Patterns

As expected, the frequency of detection and maximum concentrations detected are generally highest in waterbodies dominated by agricultural drainage or urban runoff, and lowest in the mainstem Sacramento River and tributaries.

In the Sacramento River, the frequency of detection and maximum values are generally lower upstream of the major agricultural production areas in the watershed. As an example, in SRWP monitoring, no organophosphate pesticides were detected in any samples collected from the Sacramento River near Hamilton City and Colusa sites, or from several smaller tributaries (Mill Creek, Deer Creek, and Big Chico Creek), which are above the region of the most intensive agricultural use of organophosphate pesticides for dormant spray applications. No pesticides were detected in 21 samples from the Feather River or the 11 samples from the Yuba River collected in 2000-2003, and there were few detections in the lower American River. When the larger combined dataset is considered, the Feather River had the highest percentage of detected pesticides (15%, n = 570 analyses from two locations). The percentages of detected pesticides was much lower in the Yuba River (2.4%, n = 170 analyses from one location near Marysville) and American River (2.2%, n = 767 analyses from three locations from Nimbus Dam to Discovery Park).

In SRWP monitoring, the greatest number of different pesticides (13 of the 18 different pesticides detected, 1999-2003) were observed at Colusa Basin Drain. The most frequent detections were observed at Arcade Creek (13%, n = 555 total analyses for 33 samples) This pattern is consistent with results of USGS NAWQA monitoring performed 1996-1998.

Organophosphate Pesticides

Organophosphate pesticides have been monitored at 14 locations by the SRWP. Of the 29 pesticides analyzed in the organophosphate pesticide scan (EPA Method 8141), seven were detected in SRWP monitoring conducted 1999-2003. These were chlorpyrifos, diazinon, EPTC, malathion, pendimethalin, prometon, and simazine.

Diazinon has been a widely used organophosphate insecticide. Its pattern of detection reflects its use in a variety of agricultural and urban/residential settings. In SRWP monitoring, it was the most frequently detected organophosphate pesticide, detected at seven of 14 sites monitored (Colusa Basin Drain, Sacramento Slough, Sacramento River at at Veterans Bridge and Freeport, Arcade Creek, American River at Discovery Park, and Cache Slough). Of these SRWP sites, diazinon was detected most frequently (28 of 33 samples) in Arcade Creek, an urban creek affected by both urban runoff and aerial deposition from nearby agricultural areas. In studies contained in the CDPR Surface Water database, diazinon was frequently detected (and concentrations were highest) in both urban runoff and waterways dominated by agricultural runoff. Diazinon was less frequently detected in the Sacramento River mainstem and tributaries monitored. Reporting limits for most of the data ranged from 0.002 μg/L for the USGS NAWQA program, to 0.01-0.05 μg/L for most of the other studies in the CDPR Surface Water database.

Chlorpyrifos was most frequently detected in urban runoff, never detected in the Sacramento River mainstem, and was rarely detected in other water bodies in the studies contained in the CDPR Surface Water database. Chlorpyrifos was detected in three SRWP samples (on each from Arcade Creek, Colusa Basin Drain, and Sacramento River at Veterans Bridge). Reporting limits for most of the data ranged from 0.004 μg/L for the USGS NAWQA program, to 0.03-0.05 μg/L for most of the other studies in the CDPR Surface Water database.

Malathion was detected in only two SRWP samples, from Sacramento Slough and Colusa Basin Drain. In studies contained in the CDPR Surface Water database, malathion was most frequently detected in waterways dominated by agricultural drainage, and it has been less frequently detected in urban runoff and urban creeks. Malathion was not reported at detectable concentrations for any of the hundreds of results reported for the Sacramento River in the CDPR Surface Water database. Reporting limits for most of the data ranged from 0.005 μg/L for the USGS NAWQA program, to 0.03-0.1 μg/L for most of the other studies in the CDPR Surface Water database.

Carbamate Pesticides

Carbamate pesticides were monitored at eight locations by the SRWP (one urban creek, two agricultural drainage dominated waterways, the Yuba and American rivers, and three Sacramento River sites). Pesticides analyzed in the carbamate pesticide scan (EPA Method 8321) includes both herbicides and insecticides, eight of which have been detected in SRWP monitoring conducted in 1999-2003. Of the pesticides detected, only diuron appears to have a significant potential to impair beneficial uses, and potential impacts from diuron appear limited to urban creeks and agricultural drains.

Diuron is an herbicide commonly used for weed control on public rights of way and for landscape maintenance, with significant amounts also used for alfalfa and citrus crops. In SRWP monitoring, diuron has been detected in Arcade Creek, Colusa Basin Drain and Sacramento Slough, the American River at Discovery Park, Cache Slough, and the Sacramento River at Freeport. In CDPR's Surface Water database, diuron was commonly detected at nearly every location monitored, including the Sacramento River mainstem, urban creeks, urban runoff, and in many waterways dominated by agricultural drainage. The highest concentrations were reported in smaller agricultural drains. Concentrations approaching toxic levels were not reported in the mainstem and major tributaries. Reporting limits for most of these studies ranged from 0.003–0.07 μg/L.

Triazine Pesticides

Triazine pesticides were monitored by the SRWP in Arcade Creek, the Feather River, and the Sacramento River at Veterans Bridge. Of the pesticides analyzed in the triazine pesticide scan (EPA Method 619), only prometon and propazine were detected in SRWP monitoring conducted

1999-2003. Neither of these two pesticides was considered to have significant potential for beneficial use impairment.

Pesticides detected in SRWP 2002-2003 monitoring are listed in Table 21, along with their primary uses and pounds reported applied for 1999–2002 in the Sacramento River watershed. Summary statistics for pesticides detected in SRWP monitoring (1999-2003) are presented in Appendix A.

TEMPORAL DISTRIBUTION AND PATTERNS

Most of the available monitoring data are focused on the periods of greatest use of particular pesticides or categories of pesticides (e.g. rice pesticide monitoring in late spring and organophosphate pesticide monitoring during the dormant spray application season). Although the episodic monitoring conducted by the SRWP from 2000-2003 is intended to monitor conditions most likely to result in pesticide detections, pesticides were infrequently detected at any location other than Arcade Creek. It should be noted that these three years of monitoring represents only a few samples for each specific type of episodic "event", and therefore no definitive conclusions regarding temporal patterns can be reached based solely on SRWP monitoring. Additionally, this focused approach to monitoring provides relatively little information about other periods or seasons. However, in combination with the available data from other programs, these results generally confirm that the pattern of detections and greatest concentrations reflects patterns of pesticide use. Specific examples include:

- The highest concentrations and highest frequency of diazinon detections occurred in the months of January (55%) and February (54%) throughout the watershed (Figure 19). This period coincides with the dormant spray application season.
- The highest concentrations of carbofuran, malathion, and molinate have been observed in May and June, coincident with the release of water from rice fields.
- The percentage of carbofuran detections reported for the Sacramento River watershed in CDPR's Surface Water Database decreased from approximately 66% in 1994, to 2.5% in 2000, and no detected carbofuran was reported in 2001-2003 monitoring. A similar pattern was observed for malathion. These decreases correspond to changes made by the rice farming industry to pesticide application practices and in holding times for irrigation water after pesticide application. Granular formulations of carbofuran were also banned in 1994 to protect wildlife.

Overall use of cholinesterase-inhibiting organophosphate and carbamate insecticides has declined over the last several years (DPR 2000a, Spurlock 2002). In contrast, over the same period, the total number of acres planted in fruit and vegetable crops and the total pounds of all varieties of pesticides applied has increased in California (DPR 2000a). This suggests that there may be a general shift from organophosphate and carbamate insecticides to other categories of pesticides, possibly in response to economic pressures, patterns of pest pressures, and pesticide resistance. It has been suggested that pyrethroid pesticides are increasingly being used in place of organophosphate and carbamate pesticides for many crops, and the Department of Pesticide Regulation documented an increase in the number of pyrethroid applications from 1991 to 1996 and a corresponding decrease in the number of organophosphate pesticide applications during this period (DPR 1999). On the basis of total pounds applied, applications of the five pyrethroids accounting for 93% of the total pyrethroid use in California in 1999 (bifenthrin, cyfluthrin, cypermethrin, esfenvalerate, and permethrin) appeared to have stabilized in counties in the Sacramento River watershed (based on published pesticide use reports from DPR). However, there has also been a shift in the use patterns to more effective pesticides (*i.e.*, more toxic per pound of chemical) within the pyrethroid class. Use of bifenthrin, cyfluthrin, cypermethrin, deltamethrin, and other other pyrethroids has increased in 2001 and 2002, while applications of esfenvalerate, permethrin, and cyhalothrin has decreased. To better evaluate the trend in pyrethroid use, the total pounds of each pyrethroid applied were “normalized” to permethrin-equivalent pounds by multiplying by the ratio of each pesticide’s 10^{th} percentile LC_{50} to the permethrin 10^{th} percentile LC_{50} values (Solomon *et al*. 2001, Weston *et al.* 2004). Although actual total pounds of pyrethroids applied in the Sacramento River watershed have only increased by about 20% from 1999 to 2002, applications increased by 71% when evaluated based on toxicity-normalized values (Figure 20).

Pyrethroids are also replacing organophosphate pesticides (diazinon and chlorpyrifos) in popular retail pesticide products since their ban for these uses. Other means of pest control, including biopesticides (*e.g.*, bacteria, naturally-occurring compounds, and pheromones), reduced-risk pesticides, and non-chemical pest management practices have also increased dramatically since 1995 (*ibid*.). Given the extremely low toxicity thresholds of some of these pesticides (e.g. pyrethrins and pyrethroids, Table 22), the lack of monitoring data has been recognized as significant information gap. In response to this need, the University of California Davis, Department of Entomology is developing new analytical and monitoring methods for monitoring pyrethroid pesticides, and USGS has also been funded by CALFED to develop analytical methods. The SRWP is also collaborating with Dr. Donald Weston (University of California Berkeley) in a study of the distribution and toxicity of sediment-associated pesticides in the Sacramento River watershed. The study is focused on pyrethroids and other sediment-associated pesticides. Preliminary results of this study indicate that approximately half of the sites sampled exhibit significant sediment toxicity.

The Department of Pesticide Regulation has also documented an increase in the number of detections of thiobencarb in Colusa Basin Drain (1994-2000) and the number of exceedances of the performance goal of 1.5 μg/L and the USEPA criterion of 6.2 μg/L (Newhart 2000). The increasing number and magnitude of detected concentrations are due in part to the increased use of thiobencarb. Increased use of this rice pesticide is attributed to an increase in acreage planted in rice in Glenn and Colusa counties, the geographical spread of rice weeds, and the development of herbicide resistance in rice weeds.

There were generally insufficient detected SRWP pesticide data to generate meaningful time series plots.

MASS LOAD COMPARISONS

Average mass loads of pesticides to the Delta can not be reliably estimated from the available data, due primarily to relatively infrequent monitoring and even less frequent detection of pesticides in most waterbodies monitored. Also needed for reliable load estimates for agricultural drains are accurate flow data and characterizations of the relationship between pesticide concentrations in water and event hydrographs. Some of this information is expected to be developed as part of the conditional agricultural waiver monitoring programs being implemented in the Central Valley in 2004.

Table 21. Most Frequently Monitored Pesticides (CDPR Surface Water Database, January 2004) and Pesticides Detected in SRWP Monitoring, 2000-2003: Major Uses and Total Watershed Applications.

Pesticide	Use Category	Top uses in Sac. River watershed[1] (lbs applied x 1,000)	Total use reported for Sac. River watershed[1] (lbs x 1000) 1999	2000	2001	2002	Detection by SRWP 2002-03[4]
Atrazine	Herbicide	Corn (4.6), sudan grass (4.3), forest trees (1.8), sorghum (0.078)	18	14	11	12	ND
Bromacil	Herbicide	Rights of way (4.9), citrus (0.086), landscape maintenance (0.043), nuts (0.023), structural pest control[3] (0.0016)	4.6	5.4	5.0	3.7	Detected
Carbaryl	Insecticide	Rice (7.5), stonefruit[2] (6.6), melons (4.9), tomatoes (2.1) corn (1.8), apples (0.68), almonds (0.66), grapes (0.42),	37	58	27	17	Detected
Carbofuran	Insecticide	Alfalfa (2.9), cotton (2.2)	33	19	5.1	5.1	ND
Chlorpyrifos	Insecticide	Walnuts (62), pest control[3] (27), Alfalfa (13), almonds (12), cotton (4.6), stonefruit[2] (1.9), landscape maintenance (1.5), pears (1.1)	156	136	127	128	Detected
Diazinon	Insecticide	Stonefruit[2] (30), pest control[3] (14), almonds (8.6), tomatoes (4.9), pears (4.3), walnuts (3.7), landscape maintenance (1.4)	99	93	68	92	Detected
Diuron	Herbicide	Rights of way (45), alfalfa (17), walnuts (9.2), landscape maintenance (2.3), grapes (1.8), olives (1.7)	96	112	79	134	Detected
Fonofos	Insecticide	None reported in Sacramento River watershed in 2001	0.68	0.20	0	0	NM
Malathion	Insecticide	Pest control[3] (22), walnut (16), Alfalfa (14), rice (1.9), landscape maintenance (1.2)	47	27	58	83	ND
Methidathion	Insecticide	Stonefruit2 (3.7), almonds (1.2), walnuts (0.8), pears (0.4), apples (0.3), kiwi (0.3)	14	14	7.3	6.9	ND
Methyl parathion	Insecticide	Walnut (10.8), corn (0.1) pears (.005), apples (.005)	39	10	11	8.6	ND
Molinate	Herbicide	Rice (673)	851	951	673	829	Detected
Prometon	Herbicide	Rights of way (.00075)	0	2.5	.0075		Detected
Pendimethalin (Prowl)	Herbicide	Rice (4.5), walnuts (3.4), landscape maintenance (2.8), cotton (2.4), rights of way (1.9), sunflowers (1.8), almonds (1.6), beans (1.4), onions (0.8)	21	23	22	26	Detected
Simazine	Herbicide	Walnut (11), grapes (7.5), almonds (4.1), pears (2.6), olives (1.7), rights of way (0.29), pest control[3] (0.16)	29	40	27	41	Detected
Thiobencarb	Herbicide	Rice (618)	703	993	619	824	Detected
Trifluralin	Herbicide	Alfalfa (35), tomatoes (21), safflower (13), cotton (2.9), sunflowers (1.6)	112	320	81	99	ND

(1) Total pounds of active ingredient applications reported in 2001 for major agricultural counties in Sacramento River watershed (Butte, Sutter, Colusa, Yolo, Yuba, Glenn, Sacramento, and Tehama) (DPR 2002). The DPR Pesticide Use database available for this report was characterized as "preliminary" by DPR.

(2) Apricot, nectarines, peaches, plums, prunes

(3) Public health and structural pest control

(4) Indicates whether detected in 2002-03 monitoring. "ND" = Not Detected, "NM" = Not Monitored

Table 22. Toxicity Threshold Values for the Pyrethroid Pesticides

Pyrethroid	Minimum LC_{50} Values Reported in OPP Database, µg/L (threshold type, taxonomic class) [1]	10th centile LC_{50} [2]	Permethrin equivalent factor [3]
Bifenthrin	0.004 (LC_{50}, crustacea) 0.15 (LC_{50}, fish)	0.015	12
Cyfluthrin	0.0024 (LC_{50}, crustacea) 0.3 (LC_{50}, fish)	0.012	15
Cypermethrin	0.0047 (LC_{50}, crustacea) 0.73 (LC_{50}, fish)	0.01	18
Deltamethrin	0.0017 (LC_{50}, crustacea) 0.25 (LC_{50}, fish)	0.009	20
Esfenvalerate and Fenvalerate	0.15 (LC_{50}, crustacea) 0.07 (LC_{50}, fishes)	0.037	4.9
Fenpropathrin	0.021 (LC_{50}, crustacea) 2.2 (LC_{50}, fishes)	0.24	0.75
Lambda-Cyhalothrin	0.0041 (LC_{50}, crustacea) 0.21 (LC_{50}, fishes)	0.01	18
Permethrin	0.019 (LC_{50}, crustacea) 0.79 (LC_{50}, fishes)	0.18	1
Tralomethrin	0.039 (LC_{50}, crustacea) 1.6 (LC_{50}, fishes)	<0.31	0.6

(1) From U.S. EPA's Office of Pesticide Programs Pesticide Ecotoxicity Database, (USEPA 2003).

(2) The average LC_{50} for the lower 10th centile species tested. As reported in Solomon *et al.* 2001.

(3) Calculated as permethrin 10th centile LC_{50} ÷ 10th centile LC_{50} for pesticide.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions of this review of pesticide monitoring data can be summarized as follows:

- The results of SRWP and other monitoring programs continue to support the focus of the SRWP and of both state and federal regulatory agencies on the management of organophosphate pesticides in surface waters. Diazinon and chlorpyrifos appear to have the greatest potential for impacts on aquatic life uses, with other monitored pesticides appearing to have relatively low to minimal risk of impacts on aquatic life or human health. The potential impacts on beneficial uses from diazinon and chlorpyrifos in drainages dominated by agricultural runoff are being addressed through the Water Quality Management Strategy developed by the Organophosphate Pesticide Focus Group (SRWP 2001), by the TMDL being developed by the Central Valley Regional Water Quality Control Board, and by proposed amendments of the Central Valley Basin Plan to add the CDFG recommended criteria for diazinon (and other provisions related to diazinon). The well-documented problems in urban runoff (exemplified by Arcade Creek) are largely being addressed by regulatory changes banning the use of these products in retail pesticide products.
- There are still few data available for the many minor tributaries to the Sacramento River watershed. For smaller tributary watersheds with a substantial proportion of agricultural land use (e.g. Big Chico Creek), there may be a significant potential for pesticides to occasionally reach concentrations of concern in surface waters. Although few pesticides were detected in the limited SRWP monitoring of several smaller tributary watersheds in 2000-2003, the available monitoring data are far too limited to make any reliable assessments regarding the potential impacts of pesticides for these and other tributaries. However, small tributaries with only a small proportion of their total drainage in agricultural land uses (e.g. Deer Creek and Mill Creek) are probably at relatively low risk of pesticide impacts on beneficial uses. Additional

pesticide monitoring data (*e.g.*, from CDWR) should be evaluated for these watersheds if they become available, to better characterize the potential risks from pesticides in these watersheds, and additional monitoring should also be considered.

- A important source of new information on pesticide use and potential impacts will be the data that result from the extensive monitoring that will be required for the Conditional Waiver of Waste Disharge Requirements for Irrigated Lands (SWRCB 2003). Monitoring efforts by agricultural coalition groups throughout the Central Valley will include tracking of pesticide use patterns, toxicity testing, and analyses for pesticides (and other potential causes of toxicity) in water and sediment. Additionally, the Watershed Evaluation Reports submitted by each coalition (April 2004) are expected to provide valuable information on existing pesticide use patterns, management practices, and potential risks from pesticide use in specific drainages in the Central Valley. Monitoring for this program is projected to begin July 2004.
- The shift from use of organophosphate and carbamate pesticides for agricultural and other uses to other pesticides (including but not limited to pyrethroids and pyrethrins) indicates the need for increased monitoring for these pesticides. Both private contract laboratories and public agencies (University of California at Davis, USGS) are developing new sampling and analytical techniques to adequately identify and measure toxic concentrations of pyrethroid pesticides in water, sediment, and tissue. The SRWP has collaborated with Dr. Donald Weston (University of California Berkeley) in a study of the distribution and toxicity of sediment-associated pesticides in the Sacramento River watershed. The study is focused on pyrethroid pesticides, and Dr. Weston has demonstrated the ability to analyze pyrethroids (and other sediment-associated pesticides) at concentrations that cause toxicity in laboratory tests of sediment toxicity. Prelininary results of this study indicate that approximately half of the sites sampled exhibit significant sediment toxicity. Funding for this project is provided by the Pesticide Research and Identification of Source, and Mitigation (PRISM) Grant program administered by the State Water Resources Control Board.

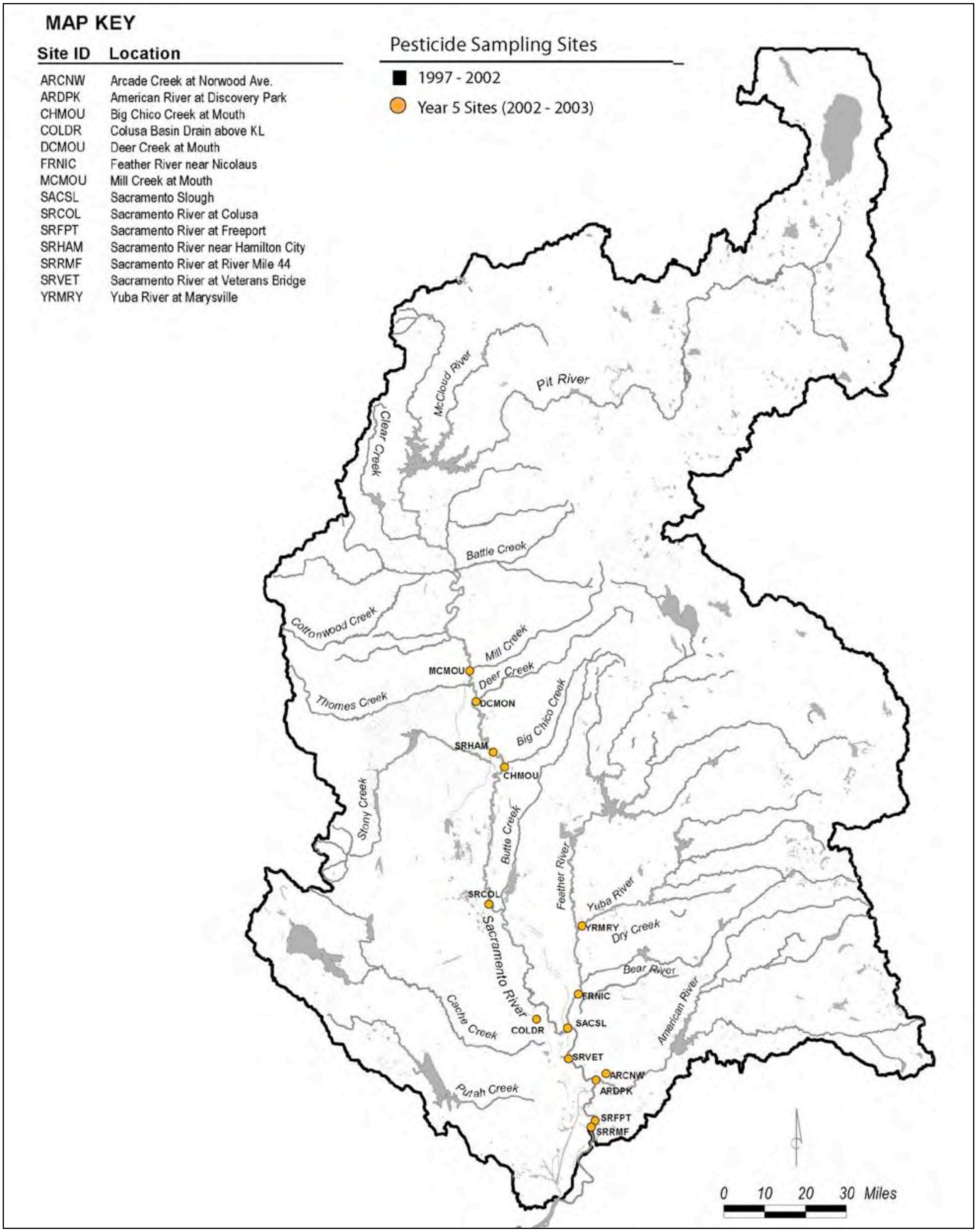


Figure 18. Pesticide Monitoring for the Sacramento River Watershed Program, Historical and 2002-2003 Monitoring Locations

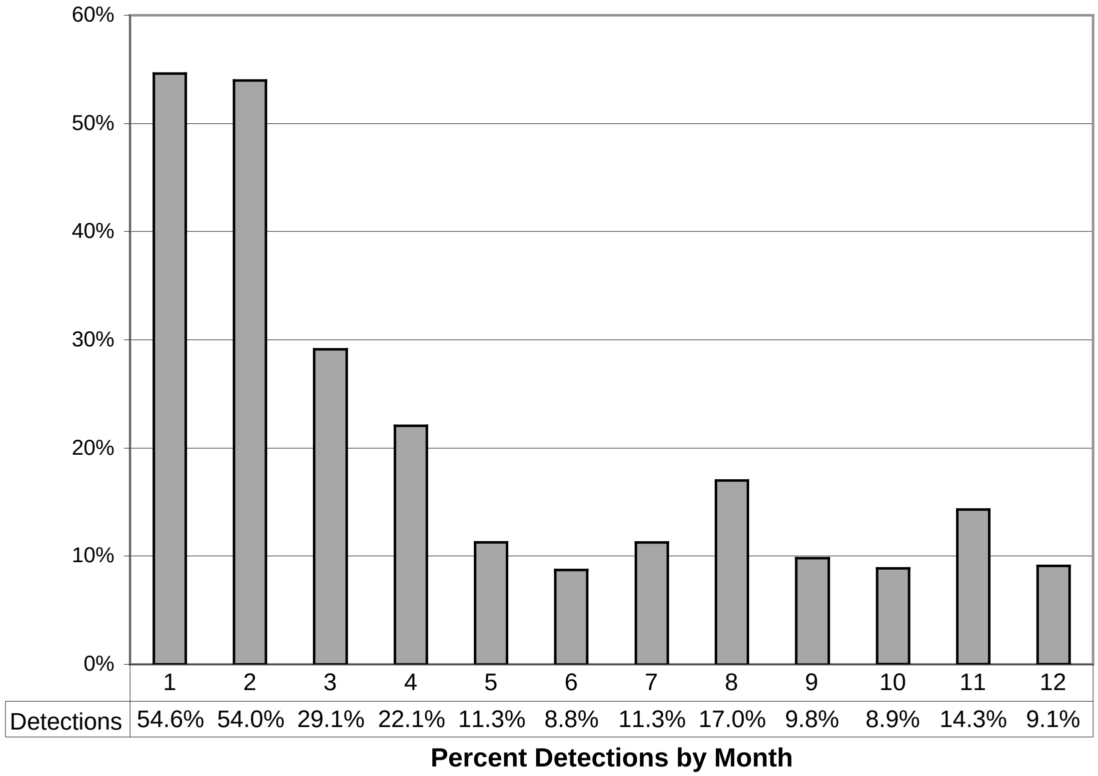
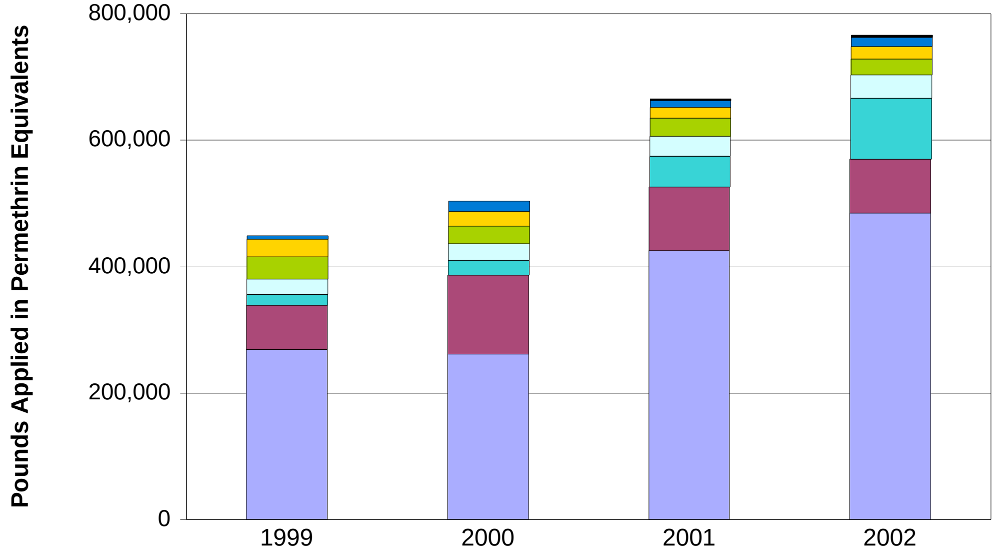


Figure 19. Diazinon Detection Frequency, Percentage of Total Analyses per Month, SRWP and CDPR Surface Water Database Data, 1991 - 2003



	1999	2000	2001	2002
OTHER PYRETHROIDS	1.1	0.3	2,122	3,913
DELTAMETHRIN	5,276	16,404	11,471	14,432
PERMETHRIN	27,620	23,432	17,030	19,309
ESFENVALERATE + FENVALERATE	34,948	27,981	28,288	25,594
BIFENTHRIN	24,902	25,800	32,240	36,944
CYFLUTHRIN	17,112	23,001	48,645	95,917
LAMBDA-CYHALOTHRIN	70,038	125,388	99,900	86,116
CYPERMETHRIN	268,902	261,951	426,087	484,661

Figure 20. Trends in Pyrethroid Pesticide Use in the Sacramento River Watershed

(Total Pounds Applied, as Permethrin Toxicity Equivalents, DPR Pesticide Use Reporting Data, 1999 – 2002

AQUATIC TOXICITY

BACKGROUND AND OVERVIEW OF AVAILABLE DATA

Aquatic toxicity monitoring in the mainstem Sacramento River and its tributaries was undertaken by the SRWP to characterize the spatial and temporal distribution of toxicity in surface waters of the watershed, and to identify potential sources and causes of toxicity. Laboratory toxicity tests were performed using USEPA procedures and the standard freshwater test organism, *Ceriodaphnia dubia* (water flea), seven-day reproduction and survival test to assess water quality. Tests using the fathead minnow (*Pimephales promelas*) and the algae *Selenastrum capricornutum* were performed in previous monitoring years and are not reported in this document. Determination of significant toxicity for each test endpoint was accomplished using hypothesis testing statistical procedures described in the method documents for the specific tests[4] (USEPA 1994). Toxicity Identification Evaluations (TIEs) (USEPA 1991, 1992, 1993) were performed on selected samples to attempt to identify the toxicants responsible for repeated adverse effects in toxicity tests. The toxicity monitoring program (implemented in 1996 and continuing to present) was designed to assess the success of implemented pollution control programs (e.g. for rice pesticides), as well as to identify toxicity concerns in the study area.

Aquatic toxicity monitoring conducted in 2002–2003 was performed at 14 locations throughout the watershed. Sites monitored for aquatic toxicity monitoring were selected to provide an overall survey of the distribution of toxicity in the watershed and to coordinate with existing monitoring programs, and were located on the Pit River, the Sacramento mainstem, three major tributaries, two agricultural drainage-dominated sites, and one urban runoff-dominated site. In previous years, monitoring has also been performed on eight smaller tributaries (Sacramento River above Shasta, McCloud River, Mill Creek, Deer Creek, Big Chico Creek, Clear Creek, and Butte Creek). The locations of the SRWP 2002-2003 monitoring sites are illustrated in Figure 21.

A total of six events, including four wet weather episodic events and two dry weather events, were monitored at the 14 locations. Wet weather episodic events included the first significant watershed-wide storm event of the 2002-2003 wet season (early November, 2002), the organophosphate pesticide dormant spray application period (late January 2003), and two late wet season rainfall events (March and April, 2003). One dry weather “episodic” event was scheduled to coincide with late dry season low flows, and one during the rice herbicide application and discharge period (early June, 2003). (Note: These events are also summarized in Table 13 in the previous section.)

[4] Although the hypothesis testing procedures described in the USEPA 1994 document refer specifically to testing for differences between several treatments and a control, the methods are equally applicable to testing for differences between ambient water samples and a control. The specific statistical methods used for a particular sample depend on the results of each test and include both parametric t-tests and non-parametric tests.

A summary of a number of other relevant studies of aquatic toxicity in the Sacramento River watershed is provided in Table 23 (and are also summarized in more detail in de Vlaming *et al.* 2000). The critical results of these studies may be briefly summarized as follows:

Foe 1998—This study identified diazinon as the responsible toxicant in each of ten samples (out of 33) exhibiting toxicity from Orestimba Creek, San Joaquin River at Vernalis, and Sacramento Slough. Samples from the Sacramento River at Greene's Landing were not toxic to *Ceriodaphnia* (three samples, January 1997). Samples were collected following precipitation events of 0.5 inches or more.

DPR (Nordmark et al. 1998-2000, Gill 2002)—This five-year study by the Department of Pesticide Regulation is focused on the occurrence of toxicity attributable to detections of dormant-spray pesticides in a small agricultural drainage (Wadsworth Canal), the Sutter Bypass, and in the Sacramento River. Preliminary results reported from this ongoing study indicate that significant chronic toxicity was rarely observed in samples from the Sacramento River (one sample in 1998-99 monitoring, and one sample in 1999-00 monitoring). At the Sutter Bypass location, only acute toxicity to *Ceriodaphnia* was monitored, and no significant toxicity was observed (1996-1998). Acute toxicity monitoring was changed to the Wadsworth Canal location for 1998-99 monitoring, and multiple occurrences of acute toxicity to *Ceriodaphnia* were observed in 1998-99 and 1999-00 monitoring. The authors stated that occurrences of acute toxicity generally corresponded with diazinon concentrations of approximately 0.2 µg/L. Diazinon and methidathion were the most commonly detected pesticides, with occasional detections of carbaryl, diuron, simazine, bromacil, and hexazinone also reported. The highest concentrations and most frequent detections were reported for Wadsworth Canal. Results from monitoring in winter 2000-2001 were not available in time for inclusion in this report.

SFEI 1999b—The Regional Monitoring Program for Trace Substances aquatic toxicity results for the Sacramento River: one of two samples caused significant toxicity to *Mysidopsis bahia* (shrimp), zero of two samples caused significant toxicity to *Mytilus edulis* (mussel) larvae.

DPR 1998—Studies performed by the Department of Pesticide Regulation have concluded that aquatic toxicity attributed to pesticides in rice field drainage has been greatly reduced, due to changes in farming practices and extended holding times for applied pesticides.

CVRWQCB 2000—Sacramento River Watershed Program aquatic toxicity data for 1998-1999 have also been compiled and reported in a separate report prepared by the Central Valley Regional Water Quality Control Board.

CVRWQCB 2002—This one-year study used modified USEPA testing protocols and TIE procedures to investigate potential causes of toxicity to the single-cell green algae, *Selenastrum capricornutum*, at seven sites in the Sacramento River watershed and 6 sites in the San Joaquin River watershed. Toxicity (inhibition of algal cell growth) was observed for several ag drains, an urban creek site, and the mainstem Sacramento River. Nineteen of the 95 samples collected (20%) in the Sacramento River watershed exhibited significant toxicity to *Selenastrum*. In 16 of the 19 toxic samples (84%), the toxicity was removed by a C8 solid phase extraction column, indicating that toxicity was due to non-polar organic compounds (such as herbicides and other pesticides). The study concluded that diuron the primary toxicant in approximately 13 of the 54 (24%) samples with observed toxicity. Specific causes of toxicity were not determined for the majority of samples.

Table 23. Selected Aquatic Toxicity Monitoring Programs in the Sacramento River Watershed

Program	Monitoring Period and (Frequency)	Parameters	Number of Sampling Locations & Geographic Reference
SRWP	8/96–5/00 (monthly); 7/00–5/02 (episodic)	▪ 7-day *Ceriodaphnia* toxicity tests ▪ 4-day *Selenastrum* toxicity tests ▪ 7-day *Pimephales* toxicity tests ▪ Toxicity Identification Evaluations	21 sampling sites throughout the Sacramento River watershed (*Selenastrum* testing limited to 3 sites after 5/98; *Pimephales* testing discontinued after 5/99)
Regional Board/CalFed	6/99–5/00 (monthly)	▪ 7-day *Pimephales* toxicity tests	24 sampling sites throughout the Sacramento River watershed
CUWA	2/98–3/99 (monthly)	▪ *Pimephales* toxicity tests with SRWP samples split with UCD Aquatic Toxicology Lab	6 SRWP sites: 5 mainstem Sacramento River sites and one Feather River site
CDWR Special Tributary Monitoring	6/98–5/00 (monthly)	▪ 7-day *Ceriodaphnia* and 10-day*Pimephales* toxicity tests ▪ Toxicity Identification Evaluations	27 (*Cerio.*) sampling sites in Sac River tributaries (Clear Ck, Mill Ck, Deer Ck, Big Chico Ck)
SF Bay Regional Monitoring Program (SFEI 1999b)	1994–1997 (episodic storm events)	▪ 48-hour *Mytilus* and *Crassostrea* toxicity tests, and 7-day *Mysidopsis* bahia toxicity tests ▪ Dissolved and particulate diazinon and chlorpyrifos in water	10-13 Bay-Delta sampling sites, including the Sacramento River and San Joaquin River at the Delta terminus
CVRWQCB (Foe *et al.* 1998)	1996 and 1997 wet seasons	▪ 7-day *Ceriodaphnia* toxicity tests ▪ Toxicity Identification Evaluations ▪ Dormant-spray pesticides in water	4 sampling sites: Sac Slough and Sac River at Greene's Landing; Orestimba Ck, and San Joaquin River at Vernalis
DPR (Nordmark *et al.* 1998-00)	1996–00, weekly during dormant spray season	▪ 96-hour and 7-day *Ceriodaphnia* toxicity tests ▪ Dormant-spray pesticides, herbicides in water	2 Sutter Bypass sampling sites, Wadsworth Canal, 1 sampling site at Sacramento River at Bryte *or* Alamar
DPR (Spurlock 2002)	1991-2001	▪ Chlorpyrifos, diazinon ▪ Acute Toxicity	Meta-analysis of 32 surface water and dormant spray studies
Rice Pesticide Monitoring (DPR 1995-98)	1995-1999 (episodic discharge events)	▪ 96-hour *Ceriodaphnia* toxicity tests ▪ Rice pesticides in water	4 sampling sites: Colusa Basin Drain, Butte Slough, and Sacramento River at Village Marina and near Bryte
CVRWQCB, CALFED	9/00–8/01 (monthly)	▪ 4-day *Selenastrum* toxicity tests, TIEs ▪ Pesticides in water	7 sites in the Sacramento River watershed
DPR (Bacey, Starner, and Spurlock 2003)	2002–2003 (wet season episodic)	▪ 96-hour *Ceriodaphnia* toxicity tests ▪ Pyrethroid, organophosphate, and triazine pesticides	2 ag drain sites near Marysville (Jack Slough and Wadsworth Canal)

ATTAINMENT OF BENEFICIAL USES AND POTENTIAL IMPAIRMENT

Comparisons with water quality criteria and 303(d) listings: What do the data say about attainment of beneficial uses and potential impairment? Toxicity to aquatic organisms in surface waters outside designated mixing zones[5] is prohibited by the Basin Plan's enforceable narrative water quality objective:

> *"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 effect of multiple substances. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests of appropriate duration or other methods as specified by the Regional Water Board."*

The results of SRWP monitoring and other studies have documented that water collected from streams and rivers throughout the watershed have episodically caused toxicity to zooplankton, fish larvae, and algal test organisms (*Ceriodaphnia*, *Pimephale*s, and *Selenastrum*, respectively). The magnitude of statistically significant effects observed on test organisms ranged from small decreases in growth or reproduction to 100% mortality of the test organisms. This observed toxicity to test organisms may be of ecological significance, *e.g.*, if it translates to significant decreases in instream populations of resident species. Studies have established that there is a statistically significant relationship between ecosystem effects and mortality in laboratory tests, most clearly for highly toxic point source discharges (de Vlaming *et al.* 2000, de Vlaming and Norberg-King 1999). Probabilistic risk assessments have been proposed as an alternative method for evaluating the likelihood and ecological significance of the potential toxic effects (*e.g.*, that conducted by Giddings *et al*. (2000) for diazinon in the Sacramento-San Joaquin system). The relationship between ecosystem impairment and statistically significant sublethal chronic effects (such as inhibition of reproduction) in laboratory toxicity tests has not been well established by either of these methods, but for the purpose of the evaluations performed herein, it is assumed that significant toxicity to test organisms is an indication of potential impairment to aquatic species and ecosystems.

As stated previously, toxicity in surface waters is prohibited by the Basin Plan, and violations of this prohibition have resulted in waterbodies being included on the 303(d) list of impaired waterbodies. A number of sites have been included on California's 2002 303(d) list of impaired waterbodies for toxicity of unknown cause (Table 24) and for organophosphate pesticides, which have been identified as causes of observed toxicity in the watershed. The observed toxicity attributed to diazinon and chlorpyrifos in Arcade Creek samples is consistent with the 303(d) listings of this and several other waterbodies for toxicity due to these pesticides. The Sacramento River mainstem from Shasta to the Delta, the lower Feather River, and the American River are all listed for toxicity of unknown causes(s), and some samples from each of these reaches have caused toxicity to test organisms in previous monitoring years. The specific causes of observed toxicity at these locations has not yet been determined. Members of the Toxicity Focus Group of

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[5] The Central Valley Basin Plan states that mixing zones *may* be allowed and that objectives *may* not apply within designated mixing zones, but will apply at the edge of designated mixing zones (CVRWQCB 1995). If granted, mixing zones are generally designated in NPDES permits for specific point source discharges. None of the locations monitored by the SRWP are within designated mixing zones.

the SRWP have developed a strategy to address toxicity of unknown causes in 2001 and are currently revising the strategy (Larsen *et al*. 2001).

Table 24. Waterbodies Cited for Toxicity of Unknown Cause and Organophosphate Pesticides on California's 2002 303(d) List

Waterbody	Cause for Listing	Source	Area Affected	Units
Delta Waterways (Western and Eastern Portions)	Unknown Toxicity(1)	Source Unknown	43,039	Acres
Sacramento River (Keswick to Delta)	Unknown Toxicity	Source Unknown	129	Miles
Cache Creek	Unknown Toxicity	Source Unknown	96	Miles
Colusa Basin Drain	Unknown Toxicity	Agriculture	49	Miles
Feather River, Lower	Unknown Toxicity	Source Unknown	42	Miles
American River, Lower	Unknown Toxicity	Source Unknown	27	Miles
Delta Waterways	Chlorpyrifos, Diazinon	Agriculture, Urban Runoff	43,039	Acres
Elder Creek	Chlorpyrifos	Urban Runoff	11	Miles
Arcade Creek	Chlorpyrifos, Diazinon	Agriculture, Urban Runoff	9.9	Miles
Chicken Ranch Slough	Chlorpyrifos, Diazinon	Agriculture, Urban Runoff	8	Miles
Feather River, Lower	Diazinon	Agriculture, Urban Runoff	42	Miles
Morrison Creek	Diazinon	Agriculture, Urban Runoff	21	Miles
Lower Bear River	Diazinon	Agriculture	21	Miles
Sutter Bypass	Diazinon	Agriculture	19	Miles
Sacramento River, Knight's Landing - Delta	Diazinon	Agriculture	16	Miles
Jack Slough	Diazinon	Agriculture	14	Miles
Elder Creek	Diazinon	Agriculture, Urban Runoff	11	Miles
Butte Slough	Diazinon, Molinate	Agriculture	8.9	Miles
Elk Grove Creek	Diazinon	Agriculture, Urban Runoff	6.9	Miles
Strong Ranch Slough	Diazinon	Agriculture, Urban Runoff	6.4	Miles
Natomas East Main Drain	Diazinon	Agriculture, Urban Runoff	3.5	Miles
Sacramento Slough	Diazinon	Agriculture, Urban Runoff	1.7	Miles

SPATIAL AND TEMPORAL PATTERNS

Toxicity testing results from 2002–2003 monitoring are summarized in Table 25 and Table 26. It should be noted that the spatial and temporal coverage of the watershed by SRWP and other monitoring efforts are not adequate to completely characterize and evaluate the incidence and significance of aquatic toxicity throughout the watershed. However, the results available so far have demonstrated some consistent temporal and spatial patterns discussed below.

The results of 2002–2003 aquatic toxicity monitoring can be summarized as follows:

Summary of toxicity results:

- 3 cases of significant mortality were observed at Arcade Creek, with significant mortality removed by 100 ppb piperonyl butoxide (PBO). In 2 of these cases, some significant reproductive toxicity remained. In the third, all significant toxicity was removed by PBO, indicating that the cause was primarily or solely due to metabolically activated organophophate pesticides. One case of significant reproductive toxicity was also observed during a separate late wet season rain event. The reproductive toxicity was not removed by PBO treatment.
- Significant mortality was also observed in the Sacramento River above Bend Bridge and near Hamilton City during a late wet season rain event. The original samples were retested and

toxicity was found to be persistent at least three to four days after the samples were collected. Significant reproductive toxicity was also observed in the Sacramento River at Freeport during this event. The toxicity in the Freeport sample was removed by SPE, filtration, and cation exchange treatments, and was persistent in the original sample when retested four days after collection. The specific toxicant was not identified.

- Significant reproductive toxicity was observed for 4 of 6 samples collected from the Sacramento River at Keswick.

Mortality

- Five of 81 samples collected (6%) caused significant mortality[6] to *Ceriodaphnia*. Three of the samples causing significant mortality were collected from Arcade Creek during three different rain events. The remaining two samples causing mortality were collected from Sacramento River mainstem sites at Bend Bridge and Hamilton City during the same rain event in March 2003. No samples collected during the late dry season or during rice pesticide application and discharge period caused significant mortality.
- Significant mortality was not observed in any samples from the two agricultural drainage-dominated sites (Colusa Basin Drain and Sacramento Slough) in monitoring conducted 2002-2003. Only one case of significant mortality was observed in the previous monitoring periods (1999-2002). Monitoring performed prior to 1996 reported 100% *Ceriodaphnia* mortality in samples collected from these sites during the spring, when rice field runoff was present in surface waters (Connor *et al.* 1993). The long-term decrease in toxicity at these locations has been attributed largely to the effectiveness of changes in pesticide application practices and longer holding times implemented by the rice farming industry for rice flood water to allow for degradation of pesticides.
- Three of the six samples collected in 2002-2003 from Arcade Creek at Norwood Avenue caused severe mortality (70-100%) to *Ceriodaphnia*. Each of these samples was treated with piperonyl butoxide (PBO), which prevents metabolic activation of organophosphate pesticides. PBO eliminated mortality and reproductive toxicity in all three samples, indicating that the primary toxicant was a metabolically activated toxicants such as diazinon or chlorpyrifos.
- Samples collected from the Sacramento River at Bend Bridge and Hamilton City during a late season rain event caused 100 mortality to *Ceriodaphnia*. These samples were retested to evaluate persistence of toxicity in the samples. In both retests, mortality was found not to be significant. However, reproduction was still significantly reduced in both samples, indicating that toxicity was persistent in the original sample three to five days after the sample was collected, but at a reduced level.

Reproductive Toxicity

- Significant adverse reproductive effects to *Ceriodaphnia* have been observed at nearly every location monitored in the Sacramento River watershed during the past four years. In 2002–2003 monitoring, 5 of 29 samples (17%) collected from five Sacramento River mainstem sites from Redding to Freeport caused significant decreases in reproduction (reductions of greater than or equal to 20% compared to controls). Four of these five samples were collected from the Sacramento River below Keswick.
- None of the 17 samples collected from the major tributary sites (American River, Yuba River, and Feather River) also caused significant adverse reproductive effects.

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[6] Significant mortality is defined as ≥20% mortality that is significantly different from controls at a 95% statistical confidence level.

- Four of the 12 total samples causing reproductive toxicity were collected during the rice field discharge event, but three of the four sites exhibiting toxicity were outside of the areas expected to be impacted by these sources. In all of these cases, the specific causes of observed reproductive toxicity have not been determined. In 2002-2003 monitoring, one of five samples from Colusa Basin Drain and one of five samples from Sacramento Slough caused significant adverse reproductive effects.
- In the three severely toxic Arcade Creek samples treated with PBO, the treatment removed all significant mortality and reproductive toxicity. In one additional sample exhibiting reproductive toxicity, PBO treatments did not remove toxicity.

The watershed-wide pattern of reproductive toxicity to *Ceriodaphnia* observed in the months of January and February of 1997-2000 and February 2002, was not evident in 2003. This period typically coincides with seasonal high flows and application of dormant-spray pesticide applications. The 2002-2003 water year was an above average rainfall year in the watershed with normal precipitation in January and February, and normal seasonal high flows in the Sacramento River mainstem and the major tributaries. Although there were no strong seasonal patterns observed in the incidence of significant toxicity to *Ceriodaphnia* in 1998-2003 monitoring (Figure 22 and Figure 23), the results of the SRWP and other monitoring programs support the conclusion that significant adverse effects on test organisms (at most locations) tend to be associated with specific episodic events. The episodic events most commonly associated with observed toxicity are the application and subsequent runoff of dormant-spray pesticides from agricultural areas, and seasonal hydrologic events such as first-flush storms in areas affected by urban runoff. However, in 2002-2003 monitoring, the most severe toxicity observed in the mainstem Sacramento River occurred during a late wet season rainfall event, and only one other site (Arcade Creek) exhibited significant mortality during any events.

CONCLUSIONS AND RECOMMENDATIONS

Samples collected from Arcade Creek at Norwood Avenue continue to exhibit a higher frequency and severity of toxicity than all other tributaries and mainstem Sacramento River sites sampled.

The results of the 2002-2003 monitoring and previous SRWP aquatic toxicity monitoring efforts have confirmed that significant toxicity to test organisms occurs in surface waters throughout the watershed. *Ceriodaphnia dubia* toxicity attributable to organophosphate pesticides in agricultural runoff and urban runoff has been definitively shown by SRWP monitoring and other studies. Widespread mortality observed in September 2001 was not associated with any known causes of toxicity, and suggests a need to continue to monitor for episodic toxicity during a wide range of hydrologic and weather conditions.

Regularly scheduled monitoring conducted from 1998–2000 was valuable in beginning to evaluate the overall frequency and distribution of observed water column toxicity, and for identifying or confirming the causes of some of the observed toxicity. However, spatial and temporal coverage of the watershed by SRWP and other programs is far from comprehensive, and significant questions remain regarding the sources, severity, persistence, and ecological significance of periodic toxicity in surface waters of the Sacramento River watershed. It is clear that definitively addressing all of these questions will require monitoring and studies of much greater scope (and cost) than the current efforts by SRWP and other programs. To address some of these questions, the SRWP aquatic toxicity monitoring effort for 2000-2003 has focused primarily on monitoring specific episodic events (e.g. agricultural dormant spray season, runoff events, high flow events). This strategy resulted in observation of more frequent and severe toxicity in the Arcade Creek urban watershed, but did not result in a notably greater frequency of observed toxicity for other locations. Although the 2000-2001 and 2001-2002 wet seasons both had below-average rainfall, the 2002-2003 wet season had above average precipitation with no apparent increase in frequency (or magnitude) of episodic aquatic toxicity throughout the watershed. Interpretation of the results of a handful of episodic events for these few seasons of monitoring must be cautious because the causes and timing of significant episodic toxicity events may differ greatly in different waterbodies, and the likelihood of missing a particular toxic event is high. Although even a single toxic event of sufficient severity has the potential to have significant adverse ecosystem impacts, there is currently insufficient evidence to either support or rule out such a hypothetical event for most sites monitored.

Other issues that require additional investigation are the causes and ecological significance of the adverse reproductive effects to *Ceriodaphnia* observed to occur sporadically at different sites throughout the watershed. Because these effects manifest at sub-lethal levels and the toxicity is often not persistent in the original samples, determining the causes of these effects has proven difficult with the available TIE and follow-up testing procedures. This is complicated by the unpredictable nature of these sub-lethal toxic “events”. These sub-lethal toxic effects need to be further evaluated through additional testing to quantify potential frequency and magnitude of toxicity at these sites. It is expected that the Strategy to Address Toxicity of Unknown Cause (currently being revised by the SRWP Toxicity Focus Group) will provide additional tools to address these questions.

Episodic monitoring of aquatic toxicity by SRWP has been continued for the 2003-2004 monitoring season. This monitoring was expanded to reinstate testing with fathead minnows (*Pimephales*) and algae (*Selenastrum*). Monitoring to be conducted by agricultural coalitions in the Central Valley (beginning 2004) is also expected to use an event-based monitoring approach with toxicity testing and TIEs using *Ceriodaphnia*, *Pimephales*, *Selenastrum,* and *Hyalella*.

Table 25. Summary of 2002-2003 Toxicity Monitoring Results: Samples Exhibiting Significant Toxicity to *Ceriodaphnia dubia*

Site	Total Samples Collected	Significant Mortality(1)		Significant Reduction in Reproduction(1)		Significant Mortality *or* Reproductive Toxicity(1)	
	n	n	%	n	%	n	%
Sacramento River below Keswick	6	0	0%	4	67%	4	67%
Sacramento River above Bend Bridge	6	1	17%	1	17%	2	33%
Sacramento River near Hamilton City	6	1	17%	0	0%	1	17%
Sacramento River at Colusa	6	0	0%	0	0%	0	0%
Sacramento River at Freeport	5	0	0%	2	40%	2	40%
Feather River at Nicolaus	6	0	0%	1	17%	1	17%
Yuba River at Marysville	6	0	0%	0	0%	0	0%
American River at Discovery	5	0	0%	1	20%	1	20%
Pit River above Shasta	6	0	0%	1	17%	1	17%
Cottonwood Creek near Cottonwood	6	0	0%	0	0%	0	0%
Cache Creek at Rumsey	5	0	0%	2	40%	2	40%
Arcade Creek at Norwood Ave.	6	3	50%	1	17%	4	67%
Colusa Basin Drain	6	0	0%	2	33%	2	33%
Sacramento Slough	6	0	0%	2	33%	2	33%
Total	81	5	6%	12 (2)	15%	17 (2)	21%

(1) Significant toxicity is defined as mortality or decreased reproduction (≥20%) that is significantly different from controls at the 95% confidence level.

(2) Four additional samples exhibited a reduction of reproduction compared to control that was statistically significant but less than 20%.

Table 26. SRWP 2002-2003 Toxicity Monitoring Results: Reproduction and Mortality Endpoints for *Ceriodaphnia dubia*

Event Type and Date:	Late Dry Season, Low Flows	First Significant Storm Event OF Season	Rain Event, OP Pesticide Dormant Spray Application	Sig't Rain Event	Late Wet Season Rain Events		Rice Field Discharge Season (Dry Weather Event)
	10/1-4/02	11/7-12/02	1/22-24/03	2/15/03	3/13-18/03	4/3-5/03, 4/13-14/03	6/8-10/03
Toxicity Testing Endpoints[1]:	Mean Percent Mortality (Days to 100% Mortality) / Reproduction, Mean Neonates/Adult						
Lab Control Results[2]	0-20	0	0	10	0-20	0-30	0-10
	19.2-27.2	*21.4-38.1*	*21.1-36.7*	*26*	*21.1-27.4*	*9-29.1*	*17.8-31.4*
Sacramento River below Keswick	10	0		40	33	0	10
	13.9	*28.6*		*7.3*	*13.4*	*26.6*	*13*
Sacramento River above Bend Bridge	0	20		10	100 (day 6)	0	0
	27	*28.8*		*21.9*	*4.4*	*30.6*	*18.6*
Sacramento River near Hamilton City	20	0	20		100 (day 6)	0	0
	21.9	*28.9*	*31.3*		*0*	*31.4*	*19.6*
Sacramento River at Colusa	0	0	0		22	0	0
	24.5	*22.7*	*28.5*		*19.4*	*38.4*	*19.6*
Sacramento River at Freeport	0	0			40	0	0
	24.7 (3)	*35.8*			*12*	*29.4*	*19.1*
Feather River at Nicolaus	0	10	0		0	0	10
	27.1	*30.2 (3)*	*19.4*		*20.2*	*28.4*	*23.9*
Yuba River at Marysville	0	0	0		0	0	0
	28.2	*17.5*	*32.4*		*26.2*	*37.8*	*18.4*
American River at Discovery	0	0			0	10	0
	23.4	*33.3 (3)*			*26.7*	*24.5*	*20.6*
Pit River above Shasta	0	0		0	10	0	0
	22.4	*25.1*		*35.5*	*30.4*	*33.5*	*17.4*
Cottonwood Creek near Cottonwood	0	0		0	0	0	0
	26.2	*32.8*		*35.1*	*27.7*	*31.8*	*19.6*
Cache Creek at Rumsey	20	0			0	0(4)	10
	26.7	*33.8*			*27.5*	*17.4 (3)*	*9.3*
Arcade Creek at Norwood Ave.	0	100 (day 5)	70		10	100 (day 7)(4)	10
	24.7	*0.4*	*8.8*		*15.6*	*7.6 (4)*	*22.5*
Colusa Basin Drain	10	0	0		0	0	10
	28.7	*27.8*	*19.5*		*23.2*	*50.7*	*25.9 (3)*
Sacramento Slough	0	0	0		20	0	0
	29	*32.5 (3)*	*19.6*		*20.8*	*45*	*17.2*

(1) Shaded rows are mortality results. Unshaded rows are reproduction results. Outlined tabled values indicate a statistically significant ($p<0.05$) increase in mortality (≥20%) or reduction in reproduction compared to the laboratory control.

(2) Laboratory controls meeting EPA criteria for test acceptability

(3) Reduction of reproduction compared to control was statistically significant but less than 20%.

(4) Results of retest due to control failure

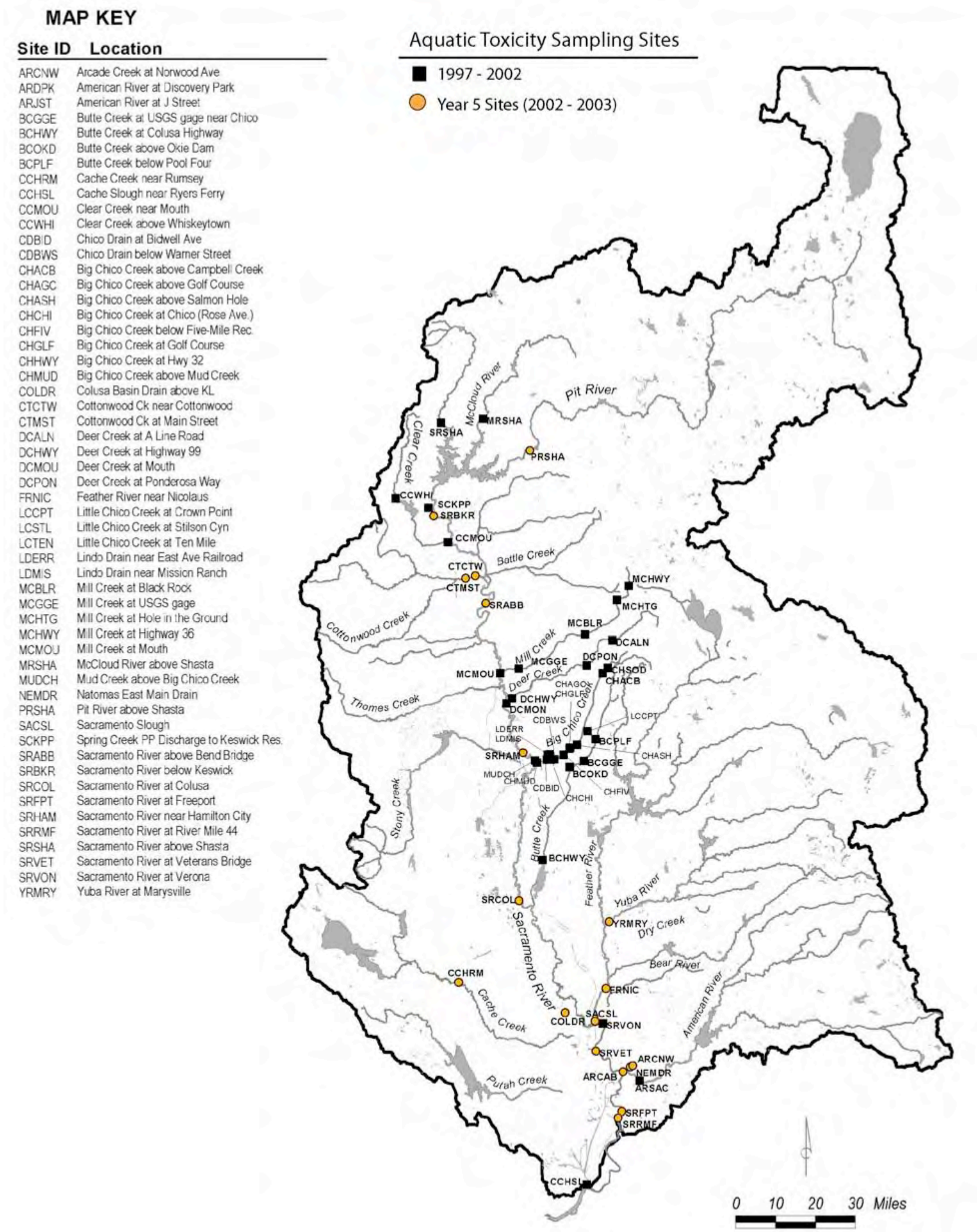

Figure 21. Aquatic Toxicity Monitoring, Sacramento River Watershed Program: Historical and 2002-2003 Monitoring Sites

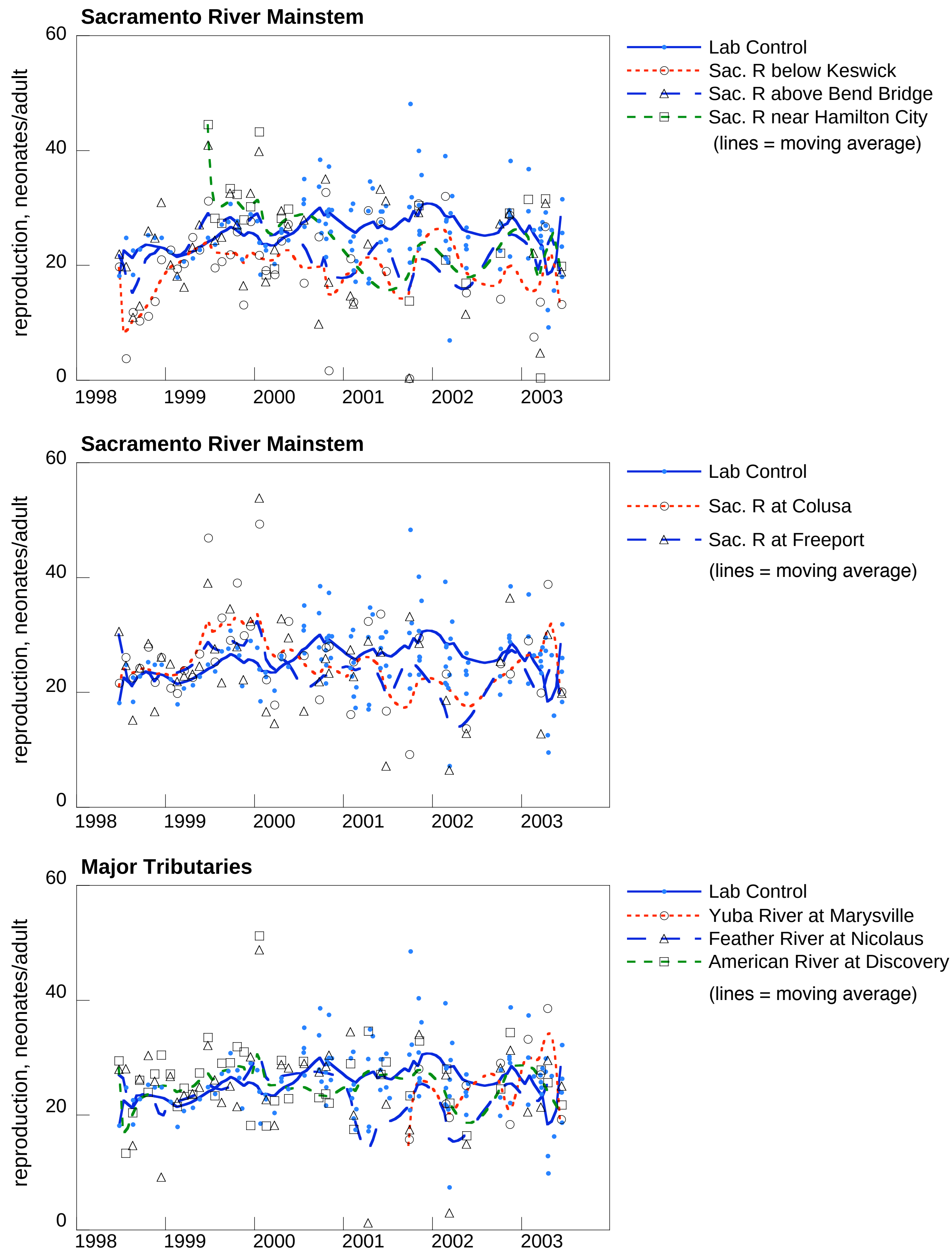

Figure 22. Ceriodaphnia Reproduction: Mainstem Sacramento River and Major Tributaries, 1998-2003

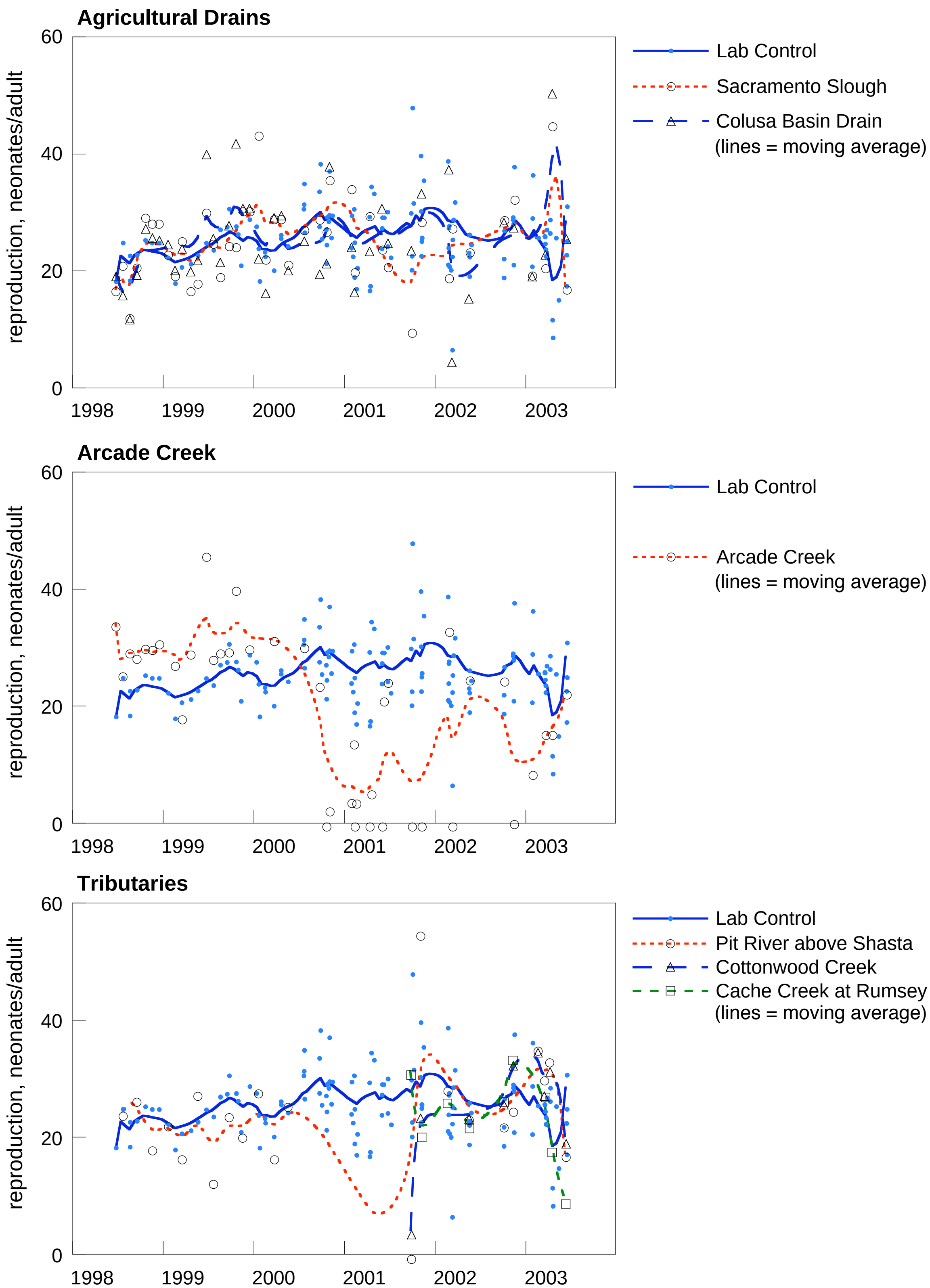

Figure 23. Ceriodaphnia Reproduction: Ag Drains, Arcade Creek, and Other Tributaries, 1998-2003

DRINKING WATER PARAMETERS

BACKGROUND AND AVAILABLE DATA OVERVIEW

For the purposes of this analysis, drinking water parameters are grouped into four categories: total dissolved solids, organic carbon and ultraviolet absorbance, nitrogen and phosphorus compounds, and bacterial pathogen indicators. Minerals and pathogenic organisms (*Cryptosporidium* and *Giardia*) are also considered parameters relevant to drinking water beneficial uses, but were not monitored in 2002-2003. The parameters included within each category are discussed below in terms of their attainment of beneficial uses, and spatial and temporal distributions, if additional evaluation was warranted. For selected parameters, relative contribution to mass loads within the Sacramento-San Joaquin Delta are also discussed. General spatial distribution patterns, when considered, are described in terms of mean or median concentrations, as appropriate. Summary statistics for all parameters discussed are provided in Appendix A.

The sources of data utilized for this report are summarized in Table 27. The monitoring locations for the primary data considered for this report (USGS NAWQA, Sacramento River Coordinated Monitoring Program, City of Redding NPDES monitoring, the California Department of Water Resources, and the Sacramento River Watershed Program) are illustrated in Figure 24.

Table 27. Selected Programs Monitoring Drinking Water Constituents in the Sacramento River Watershed

Program	Monitoring Period(s)	Parameters	# of Sampling Locations & Geographic Reference
NAWQA (USGS)	2/96–4/98 (through 2002 for Sacramento River at Freeport)	▪ Total Dissolved Solids in water ▪ Total and Dissolved Organic Carbon in water ▪ Nutrients in water: nitrite as N; nitrate as N; ammonia as N organic nitrogen as N; dissolved orthophosphate as P; total phosphorus as P ▪ General Minerals in water: total alkalinity; sodium; chloride; sulfate; calcium; dissolved magnesium, manganese, potassium, iron, silica as SiO_2	12 sampling sites distributed throughout the Sacramento River watershed
SRWP	6/98–6/02	▪ Total Dissolved Solids in water ▪ Organic carbon and UVA_{254} in water ▪ Nutrients in water: nitrite as N nitrate as N; ammonia as N dissolved orthophosphate as P total phosphorus as P ▪ General Minerals in water: Total Alkalinity; Sodium; Chloride; Sulfate; Calcium; Total Magnesium, Manganese, Potassium, Iron ▪ Total and Fecal Coliform and E. coli in water ▪ *Giardia* and *Cryptosporidium* in water	12 sampling sites on Sacramento River and major tributaries
MWQIP (CDWR)	3/86–3/98 (1/96–3/98 considered for present analysis)	▪ Total Dissolved Solids in water ▪ Dissolved Organic Carbon in water ▪ Nutrients in water: Nitrate as N; Ammonia as N ▪ General Minerals in water: Total Alkalinity; Sodium; Chloride; Sulfate; Calcium; Dissolved Magnesium, Potassium ▪ Fecal Coliform in water	19 sampling sites distributed throughout the Sacramento-San Joaquin Delta (5 sites considered for present analysis)
CMP (SRCSD)	12/92–6/02 (10/96–6/02 considered for present analysis)	▪ Total Dissolved Solids in water ▪ Organic carbon and UVA_{254} in water ▪ Nutrients in water: nitrite as N nitrate as N; ammonia as N dissolved orthophosphate as P total phosphorus as P ▪ Total and Fecal Coliform and E. coli in water ▪ *Giardia* and *Cryptosporidium* in water	5 sites on Sacramento and American rivers in Sacramento metropolitan area
City of Redding	1/98–5/01	▪ Total Dissolved Solids in water	1 site at Sacramento River below Keswick Dam

ATTAINMENT OF BENEFICIAL USES AND POTENTIAL IMPAIRMENT

Comparisons with Relevant Water Quality Objectives

The Central Valley Basin Plan has adopted by reference California Title 22 of the California Code of Regulations Maximum Contaminant Levels (MCLs) for drinking water, as Basin Plan objectives. Specifically, the Basin Plan states:

> *"At a minimum, water designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs) specified in the following provisions of Title 22 of the California Code of Regulations, which are incorporated by reference into this plan: Tables 64431-A (Inorganic Chemicals) and 64431-B. "*

Note that these drinking water MCLs are originally intended to apply to finished tap water, rather than to untreated sources of drinking water. Comparisons of surface water characteristics with MCLs clearly indicate that there is no impairment due to a specific parameter when the MCL for that parameter is not exceeded. Exceedances of MCLs in untreated source water indicate that there is some potential for increased treatment costs or for exceedances of the MCL in the treated drinking water, but are not definitive evidence that the use is impaired. For the purpose of these evaluations, it is assumed that waters that comply with MCLs are achieving the designated use as sources of drinking water, and that exceedance of MCLs indicate potential impairment of this use.

Existing applicable water quality objectives and goals for the parameters included within three drinking water categories (TDS and conductivity, TOC and DOC, nutrients, and pathogens) are listed in Table 28. The results of comparisons with these numeric thresholds are presented in Table 29and are summarized below.

Total dissolved solids (TDS) concentrations in surface waters monitored in the Sacramento River watershed have been observed to exceed CDHS and USEPA's Secondary Drinking Water Standard Maximum Contaminant Level (MCL) of 500 mg/L once in Sacramento Slough and twice in Colusa Basin Drain. Long-term median concentrations were well below the 500 mg/L MCL at both sites, and compliance with the TDS limit is estimated to be greater than 88% for Colusa Basin Drain and 98% for Sacramento Slough. TDS concentrations were not observed to exceed the 500 mg/L MCL at any other sites. Concentrations were not observed to exceed 500 mg/L at any site, although frequency of compliance estimated from distributional statistics was approximately 95% for Natomas East Main Drain below the confluence with Arcade Creek. The Central Valley Basin Plan also includes a site-specific objective for TDS in the American River (125 mg/L as a 90th percentile) from Folsom Dam to the Sacramento River. This objective was exceeded in only 1 of 108 samples collected from the American River. TDS concentrations in the Sacramento River watershed are also illustrated in Figure 25.

There are site-specific and seasonal objectives for *specific conductivity (at 25˚C)* in the Central Valley Basin Plan. Relevant site-specific objectives are expressed as conductivities not to be exceeded by the 50th and 90th percentile of data in the Sacramento River at Knight's Landing (230 µmhos/cm and 235 µmhos/cm, respectively) and at the I Street Bridge (240 µmhos/cm and 340 µmhos/cm, respectively), and in the Feather River (150 µmhos/cm as a 90th percentile). There are also seasonal- and water year-specific objectives for the Sacramento River at Emmaton, which range from 450 µmhos/cm in wet years to 2,780 in critical dry years. None of these site-specific objectives were exceeded at any sites where they might reasonably apply.

Total organic carbon (TOC) concentrations were compared to the 2 mg/L and 4 mg/L TOC treatment threshold included in the Stage 1 Disinfectants/Disinfection By-products (D/DBP) Rule. This regulation is designed to limit precursors to disinfection byproducts such as trihalomethanes, which are human carcinogens. In cases where the running annual average TOC in source water (measured at water treatment plant intakes) is 2.0–4.0 mg/L, water utilities may be required to remove up to 35% of the TOC (depending on source water alkalinity) unless they meet other specific quality or treatment technology requirements[7]. If the running average source water TOC is greater than 4 mg/L, water utilities may be required to remove up to 45% of the TOC in their influent. Total organic carbon concentrations occasionally exceeded the D/DBP 2 mg/L goal at all sites evaluated (Table 29). TOC concentrations measured in Sacramento Slough and the Colusa Basin Drain exceeded the 2 mg/L D/DBP treatment threshold in almost every sample analyzed, and exceeded the 4 mg/L threshold in more than 70% of samples collected. TOC in the Natomas East Main Drain (a primarily urban drainage) also exceeded the 2 mg/L threshold in virtually every sample, and exceeded the 4 mg/L threshold in approximately 85% of samples. The percentage of TOC concentrations in the mainstem Sacramento River exceeding the 2 mg/L D/DBP threshold value increased from Keswick to River Mile 44, but there was no apparent trend in compliance with the 4 mg/L treatment threshold. The Yuba, Feather, and American rivers all exhibit TOC concentrations above the 2 mg/L treatment threshold, with percent exceedances ranging from 30% (in the Yuba River at Marysville) to 55% (in the Feather River near Nicolaus). Concentrations of TOC in all of these major tributaries were below the 4 mg/L threshold at least 95% of the time. Long-term average TOC concentrations were greater than 2.0 mg/L at most locations monitored, with the exception of the Yuba River, the American River, the Sacramento River above Bend Bridge, and several smaller tributaries. The distribution of TOC concentrations in the Sacramento River watershed is illustrated in Figure 26.

Included in the D/DBP Rule is a provision that utilities would not have to meet these removal requirements if the average *Specific UV Absorbance (SUVA)* is less than 2.0 L/mg-m in source water *or* treated water. SUVA is defined as the ratio of ultraviolet absorbance at 254 nm to the dissolved organic carbon concentration (UVA_{254}/DOC), and is used as a measure of the ability of organic carbon to react with disinfectants and form trihalomethanes and other disinfection by-products. UVA_{254} has been measured in a total of 11 events 2001-2003 by the SRWP, and in several more events by the Sacramento Coordinated Monitoring Program, and by CDWR for the Natomas East Main Drain. These preliminary results indicate that average SUVA is greater than the 2.0 L/mg-m D/DBP threshold in Sacramento River watershed surface waters monitored for this parameter (the Sacramento River mainstem and three major tributaries, two agricultural drains, and one urban drainage). SUVA data are also illustrated in Figure 27.

Fecal coliform bacteria numbers were evaluated in comparison to the Basin Plan water quality objective of 200 Most Probable Number (MPN) per 100 milliliters (ml) as a geometric mean value and a maximum value of 400 MPN/100 ml. Long-term geometric mean fecal coliform numbers exceeded the 200 MPN/100 ml objective only at Natomas East Main Drain, which also exceeded the 400 MPN/100 ml objective in 6 of 9 samples collected in 2001-2003. Maximum fecal coliform numbers were observed to exceed the 400 MPN/100 ml objective in the

[7] Utilities would not have to meet these removal requirements if they meet one of several possible conditions, including: (1) average TOC in their treated water less than 2.0 mg/L; (2) average levels of haloacetic acids and trihalomethanes below 30 µg/L and 40 µg/L, respectively, or a clear commitment to implement treatment to meet these levels by June 2005; or (3) average Specific UV Absorbance (SUVA) less than 2.0 L/mg-m in source water or treated water.

Sacramento River (in 21 of 313 total samples from the mainstem), in the American River (in 8 of 81 samples at Discovery Park and in 3 of 81 samples from below Nimbus), in the Yuba River (3 of 10 samples), and Feather River (3 of 33 samples), and in Cache Slough (in 3 of 12 samples). Fecal coliform data are also illustrated in Figure 28.

Total and fecal coliform data are also relevant to another important beneficial use, contact recreation. Although USEPA has identified as a priority the transition to using *E. coli* and *Enterococcus* bacteria (instead of total and fecal coliform bacteria) as indicators of microbial contamination (Action Plan for Beaches and Recreational Waters; EPA/600/R-98/079, March 1999), in this same document, USEPA reaffirmed commitment to the limits established in the 1986 criteria document (*Ambient Water Criteria for Bacteria—1986*), which include specific limits for total and fecal coliform bacteria. The 1986 criteria document is also referenced in USEPA's *National Recommended Water Quality Criteria* (USEPA 1999). The California Department of Health Services (CDHS) *Guidance for Freshwater Beaches* (Draft, February 11, 2000) recommends limits and testing for total and fecal coliform bacteria, as well as *E. coli* or *Enterococcus*. The non-regulatory CDHS *Guidance* also cites the numbers of bacteria at which closing and posting beaches is recommended. These recommended limits are identical to the limits cited by USEPA in the 1986 criteria document (*Ambient Water Criteria for Bacteria—1986*). In 2002, CVRWQCB Staff recommended adopting the recommended limits for *E. coli* in the Basin Plan for the Central Valley (CVRWQCB 2002). This amendment to the Basin Plan is still awaiting final approval from the Office of Administrative Law and the US Environmental Protection Agency.

For the purpose of evaluating achievement and potential impairment of contact recreational uses, total and fecal coliform and *E. coli* data were compared to the limits recommended by CVRWQCB staff, USEPA, and CDHS. The recommended limits for total coliform are 1,000 MPN/100 mL as a 5-sample 30-day geometric mean and 10,000 MPN/100 mL as a single sample maximum. The single sample limit for total coliform bacteria was exceeded in 5 of 82 samples collected from the American River at Discovery Park, and in 2 of 83 samples from the Sacramento River at Veterans Bridge. The 10,000 MPN/100 mL limit was not exceeded at any other sites sampled. The long-term geometric mean was below the 1,000 MPN/100 mL limit at all locations monitored. The limits for fecal coliform bacteria are essentially the same values adopted in the Central Valley Basin Plan (200 MPN/100 mL as a geometric mean and 400 MPN/100 mL as a single sample maximum). Comparisons to fecal coliform limits are provided in previous paragraphs.

The recommended limits for *E. coli* are 126 MPN/100 mL as a 5-sample 30-day geometric mean and 235 MPN/100 mL as a single sample maximum. The single sample limit for *E. coli* was exceeded at nearly every site, but long-term geometric means exceeded the 126 MPN/100 mL recommended objective only in Natomas East Main Drain. These high concentrations reported by DWR for Natomas East Main Drain are similar to those observed in urban runoff monitoring conducted by the Sacramento Stormwater Monitoring Program (LWA 2003). It should be noted that SRWP began monitoring *E. coli* in 2001-2002 and that these data are biased by the focus on episodic rainfall events, which are expected to result in elevated bacteria counts in surface waters. This also applies to other total and fecal coliform data, but to a lesser degree, since these data sets have longer and less biased monitoring histories. The data used in this evaluation are also presented in Figure 29.

Of the six nitrogen and phosphorus compounds monitored by the SRWP, only nitrite and nitrate currently have relevant water quality objectives. Nitrite and nitrate (as N) were not observed to exceed their MCLs (1 mg/L and 10 mg/L as N) at any site. Median concentrations of both constituents were well below their CDHS and USEPA MCL at all sites. Nitrate distribution in the watershed is illustrated in Figure 30.

Although excessive nutrient concentrations in source waters can be a factor in increased algal growth (and consequently taste and odor problems and increased treatment costs for domestic water suppliers), the effect of nutrient concentrations is generally not easily separated from the effects of storage and transport (e.g. increased temperature and sunlight exposure), and no specific limits for nutrients in source water have been developed to address or evaluate these problems. Although there are currently no relevant objectives for ammonia, organic nitrogen, dissolved orthophosphate, or total phosphorus, U.S. EPA is in the process of developing Ecoregional nutrient criteria. As part of this process, U.S. EPA will attempt to establish critical nutrient levels based on conditions in minimally impacted waterbodies ("reference" conditions), or on empirical data for waterbodies in each ecoregion if no appropriate reference conditions can be identified. The current generic guidelines provided in U.S. EPA guidance are 0.01 mg/L total phosphorus and 0.15 mg/L total nitrogen, but U.S. EPA expects that these values will be refined to be specific for each ecoregion or sub-ecoregion. Criteria for the Central Valley sub-ecoregion have not yet been published, but recommended criteria based on data for the ecoregion which contains the Central Valley (Ecoregion III, "the Xeric West") have been released (USEPA 2000). These recommended criteria (0.022 mg/L total phosphorus, and 0.377 mg/L total nitrogen) are not based on reference conditions, but instead are empirically derived as the lower 25th percentile concentrations for data available for the ecoregion. Average total phosphorus and total nitrogen concentrations are expected to exceed these levels in many waterbodies in the Sacramento River watershed.

Table 28. Water Quality Objectives Relevant to Drinking Water Parameters

Parameter	Units	Threshold Values	Basis
TDS	mg/L	500 125	CDHS and USEPA Secondary Drinking Water Standard MCL [1] Basin Plan Site-specific Objective
Specific Conductivity	µmhos/cm at 25°C	150 – 2,780	CVRWQCB Basin Plan Site-specific objectives
TOC	mg/L	2 4	D/DBP Rule Treatment Thresholds
Nitrite, as N	mg/L	1	CDHS and USEPA Primary Drinking Water Standard MCL
Nitrate, as N	mg/L	10	CDHS and USEPA Primary Drinking Water Standard MCL
Sulfate	mg/L	250	CDHS and USEPA Secondary Drinking Water Standard MCL
Fecal coliforms	MPN/100 mL	200, geo.mean[2] 400, maximum[3]	CVRWQCB Basin Plan, CDHS Recommended Limits (CDHS 2000), and USEPA Recommended Criteria (USEPA 1999)
Total coliforms	MPN/100 mL	1,000, geo.mean[2] 10,000, maximum[3]	CDHS Recommended Limits (CDHS 2000), USEPA Recommended Criteria (USEPA 1999),
E. coli	MPN/100 mL	126, geo.mean[2] 235, maximum[3]	CVRWQCB Basin Plan Amendment (CVRWQCB 2002)

(1) Primary and Secondary Drinking Water Standard MCLs have been adopted by reference in the Central Valley Basin Plan.
(2) This limit is intended to be applied to a 30-day geometric mean consisting of 5 samples.
(3) This limit is applied as a one-sample maximum.

Table 29. Comparisons with Drinking Water and Recreational Water Quality Goals: Percent of Data Meeting Limits

	Site	NH_3, mg/L as N (variable)	Fecal Coliform, 400 MPN/100 mL	Total Coliform, 10,000 MPN/100 mL	E. coli, 235 MPN/100 mL	NO_3, 10 mg/L as N	NO_2, 1.0 mg/L as N	TOC, 2 mg/L	TOC, 4 mg/L	TDS, 500 mg/L
Main-stem	Sacramento River below Keswick	100%	100%	100%	—	—	—	—		100%
	Sacramento River above Bend Bridge	100%	96.8%	100%	96.5%	100%	100%	77.5%	99.1%	100%
	Sacramento River near Hamilton City	100%	77.1%	100%	56.7%	100%	100%	56.6%	91.7%	100%
	Sacramento River at Colusa	100%	89.4%	100%	71.0%	100%	100%	58.0%	95.0%	100%
	Sacramento River at Veterans Bridge	100%	96.6%	98.4%	99.7%	100%	100%	41.5%	90.7%	100%
	Sacramento River at Freeport	100%	93.6%	100%	95.6%	100%	100%	42.9%	91.7%	100%
	Sacramento River at River Mile 44	97.7%	100%	100%	—	100%	100%	37.0%	90.9%	100%
Major Trib-utaries	Yuba River at Marysville	100%	69.9%	100%	64.6%	100%	100%	71.5%	100%	100%
	Feather River near Nicolaus	100%	94.6%	100%	79.5%	100%	100%	45.3%	95.1%	100%
	American River below Nimbus Dam	100%	97.6%	100%	97.5%	100%	100%	71.1%	99.9%	100%
	American River at Discovery Park	100%	88.8%	97.5%	87.2%	100%	100%	53.1%	99.0%	98.1%(1)
Lesser Trib-utaries	Big Chico Creek above Mud Creek	100%	88.6%	—	—	—	—	92.0%	100%	100%
	Big Chico Creek above Salmon Hole	100%	100%	—	—	—	—	—	—	100%
	Big Chico Creek at Chico (Rose Ave.)	100%	100%	—	—	—	—	—	—	100%
	Big Chico Creek at Hwy 32	100%	100%	—	—	—	—	—	—	100%
	Butte Creek at Colusa Highway	100%	—	—	—	100%	100%	—	—	100%
	Cache Creek near Rumsey	100%	—	—	—	—	100%	87.6%	100%	99.7%
	Cache Slough near Ryers Ferry	100%	88.9%	100%	—	100%	100%	—	—	100%
	Deer Creek at A Line Road	100%	100%	—	—	—	—	—	—	—
	Deer Creek at Highway 99	100%	100%	—	—	—	—	—	—	100%
	Deer Creek at Mouth	100%	100%	—	—	—	—	100%	100%	100%
	Deer Creek at Ponderosa Way	100%	100%	—	—	—	—	—	—	—
	Deer Creek at Upper Diversion Dam	100%	100%	—	—	—	—	—	—	—
	Deer Creek below Childs Meadows	100%	100%	—	—	—	—	—	—	—
	McCloud River above Shasta	100%	—	—	—	100%	100%	—	—	100%
	Mud Creek above Big Chico Creek	100%	100%	—	—	—	—	42.2%	100%	100%
	Pit River above Shasta	100%	—	—	—	100%	100%	—	—	100%
	Sacramento River above Shasta	—	—	—	—	—	—	—	—	100%
	Spring Cr. PP Discharge to Keswick Res.	100%	—	—	—	100%	100%	—	—	100%
Ag Drains	Colusa Basin Drain above KL	100%	82.4%	100%	78.1%	100%	100%	0.0%	3.1%	87.8%
	Sacramento Slough	100%	100%	100%	100%	100%	100%	1.2%	28.1%	98.0%
	Yolo Bypass near Woodland	—	—	—	—	—	—	—	—	100%
Urban	Natomas East Main Drain	100%	34.1%	100%	27.5%	100%	100%	0.1%	14.7%	94.5%
	Arcade Creek at Norwood Ave.	100%	—	—	—	100%	100%	—	—	100%
	Arcade Creek in Del Paso Park	—	—	—	—	—	—	—	—	100%

(1) Compared to Basin Plan Site-specific objective of 125 mg/L.

What Do These Results Say About Attainment of Beneficial Uses and Potential Impairment, and How Does This Compare with Relevant 303(D) Listings for Parameter and Sites?

The California 2002 303(d) list does not consider all of the contaminants of concern to drinking water supply, and few waterbodies in the Sacramento River watershed are cited on the 303(d) list for pollutants relevant to drinking water and recreational use concerns (Table 30). The Pit River and Clear Lake are the only waterbodies in the Sacramento River watershed listed for impairment due to nutrients. Four waterbodies in the Sacramento River watershed are included in the 2002 303(d) list for impairments due to fecal coliform (South Cow Creek, Clover Creek, Clover Creek, and Whiskeytown Reservoir. The Western portion of the Delta is on the 2002 303(d) list for impairment due to specific conductance. It is clear however, that the Sacramento River and major tributaries generally provide water that is of very high quality for municipal and agricultural supply. Comparisons of drinking water parameters with relevant water quality goals and objectives for the Sacramento River watershed show that the mainstem Sacramento River, and major tributaries (the Yuba, Feather, and American rivers) consistently meet water quality goals and objectives, suggesting that these waterbodies achieve their beneficial uses as sources of municipal and agricultural supply water and contact recreation, as designated by the Central Valley Region Basin Plan (CVRWQCB 1995). Analyses by USGS (Saleh *et al*. 2003) concluded that DOC concentrations even decreased significantly from 1990 and 2000 in the Sacramento River at Freeport and the lower American River. Although the TOC concentrations measured in the Sacramento River from Bend Bridge to the Delta often exceeded the 2 mg/l goal, it is not clear that these concentrations of organic carbon will result in a requirement for additional treatment for municipal drinking water suppliers to remove additional TOC in source water. The Stage 1 D/DBP Rule does not require such treatment if certain treatment technologies are used, or if other water quality requirements are met (e.g. for specific ultraviolet absorbance in source or treated water, TOC <2.0 mg/L in treated water, or trihalomethanes and haloacetic acids less than specified concentrations in treated water). Additionally, treatment technologies currently in use by many utilities are already able to remove ≥35% of TOC from Sacramento River water. If additional TOC removal is necessary, this requirement would increase treatment costs, but would not otherwise limit the water supply use. Additionally, comparisons of coliform bacteria data to limits recommended by USEPA, California Department of Health Services, and the CVRWQCB indicate that these limits are infrequently exceeded and suggest that recreational uses protected by these limits are generally well-supported in the mainstem Sacramento River and its major tributaries.

Table 30. Waterbodies Cited for Drinking Water-Related Parameters on California's 2002 303(d) List.

Waterbody	Cause for Listing	Source	Area	Units
Clear Lake	Nutrients	Unknown	40,070	Acres
Delta Waterways (Western portion)	Electrical Conductivity	Agriculture	22,904	Acres
Delta Waterways (Stockton Ship Channel)	Organic Enrichment, Low DO	Municipal point sources, urban runoff, storm drains	952	Acres
Pit River	Nutrients, Organic Enrichment, Low DO	Agriculture, Grazing	123	Miles
Whiskeytown Reservoir	Coliform bacteria	Septage disposal	98	Acres
Wolf Creek	Fecal coliform bacteria	Urban runoff, recreation, agriculture	23	Miles
Clover Creek	Fecal coliform bacteria	Human and livestock sources	11	Miles
South Cow Creek	Fecal coliform bacteria	Human and livestock sources	7.9	Miles

SPATIAL AND TEMPORAL DISTRIBUTION PATTERNS AND MASS LOADS

Because drinking water and recreational beneficial uses generally appear to be adequately supported for the Sacramento River watershed locations monitored by the SRWP, and the parameters monitored were not considered likely to impair these uses, spatial and temporal distributions were not evaluated for any of the drinking water-related parameters monitored in 2002-2003. Based on the same criterion, mass loads were also not evaluated for these parameters. Spatial and temporal trends and mass loading have been considered in previous Annual Monitoring Reports (SRWP 2000, 2001) for results of SRWP monitoring conducted 1998-2000 and from other major monitoring efforts.

CONCLUSIONS AND RECOMMENDATIONS

The mainstem Sacramento River, and major tributaries (the Yuba, Feather, and American rivers) consistently meet water quality goals and objectives for drinking water-related parameters. Based on the best available indicators, these results suggest that designated beneficial uses of the Sacramento River and tributaries as sources of municipal and agricultural supply water and recreational uses are generally being achieved.

- There was a general trend for concentrations of several parameters (TDS, organic carbon, nutrients) to increase in the mainstem Sacramento River from the upper watershed to the lower watershed. This trend can generally be attributed to a combination of natural and anthropogenic sources, and is moderated by high quality Sierra tributary inflows.
- The highest concentrations of most drinking water parameters of concern were generally observed in agricultural drains (Sacramento Slough and Colusa Basin Drain) and in urban drainages and creeks (Natomas East Main Drain, Arcade Creek). Natomas East Main Drain has also been identified as a “site of concern” in the CALFED Drinking Water Quality Program Plan (CALFED 2000).
- The Basin Plan limit for median fecal coliform numbers (200 MPN/100mL) was exceeded at only one site (Natomas East Main Drain), and the maximum limit for single samples (400 MPN/100 mL) was exceeded infrequently in the Sacramento River, the American River, and Cache Slough. Recommended USEPA and CDHS single sample and geometric mean limits for total coliform are also infrequently exceeded at monitored locations. Recommended single sample Basin Plan limits for *E. coli* were exceeded at most locations monitored, but *E. coli* numbers exceeded the geometric mean limit only at Natomas East Main Drain. Note that comparisons for *E. coli* are based on data biased towards episodic events expected to result in elevated bacteria counts.
- TOC concentrations measured in the Sacramento River at Colusa, Verona, and Freeport often exceed the Stage 1 Disinfectant/Disinfection By-Product (D/DBP) Rule treatment threshold of 2 mg/l. The 2 mg/L threshold is significant because exceedance of this threshold may require utilities to remove up to 35% percent of TOC in their source water. It is not necessarily the case that the observed concentrations of organic carbon will result in a requirement for municipal drinking water suppliers to remove *additional* TOC in source water. The Stage 1 D/DBP Rule does not require such treatment if certain treatment technology requirements used, or if other water quality requirements are met in influent or treated water. Additionally, treatment technologies currently in use by many utilities are already able to remove ≥35% of source water TOC from Sacramento River water. Even if additional TOC removal is necessary, this requirement would not limit the water supply use. Available Specific UV Absorbance (SUVA) data suggest that average SUVA in surface waters of the Sacramento River watershed is generally greater than D/DBP alternative criterion (2.0 L/mg-m) and would not provide relief from additional treatment requirements.

- Nitrate and nitrite appear to meet USEPA and CDHS MCLs at all locations monitored in the Sacramento River watershed. Other nitrogen and phosphorus compounds monitored (ammonia, total nitrogen, dissolved orthophosphate) currently have no relevant regulatory thresholds for comparison. Although total nitrogen and total phosphorus concentrations may exceed expected ecoregional nutrient criteria under development by USEPA in many Sacramento River watershed surface waters, these criteria are not currently based on thresholds for protection of beneficial uses.

Water from the Sacramento River from Hood and upstream is considered to be of high quality for drinking water supply. However, the quality of water in the Central and Southern Sacramento-San Joaquin Delta is often marginal for drinking water supply and compliance with increasingly stringent drinking water objectives is becoming more difficult. The Sacramento River alone provides up to 75% of the water entering the Delta, including a large portion of seasonal organic carbon and TDS mass loads. Although the Sacramento River therefore has a substantial effect on the quality of Delta drinking water supply source water, there are also significant internal sources of TOC and TDS within the Delta and from the San Joaquin River. Assessing the variety of sources and loads of Delta TOC is in fact one of the primary goals of the CALFED water quality program. As stated previously, the parameters of primary concern for drinking water quality—TOC, TDS, nutrients, and pathogens—are currently largely unregulated by the CVRWQCB and the Water Quality Control Plan (Basin Plan). Expected changes in Sacramento River watershed land uses (e.g. increased urbanization and development) have the potential to increase regulated point source discharges and (relatively) unregulated non-point source discharges, and therefore to increase loads of TOC, TDS, and pathogens to the Delta. In order to address these and other drinking water concerns, the CVRWQCB is implementing a work plan for the development of an effective drinking water policy. This policy is expected to address these parameters and to establish water quality objectives for eventual inclusion in the revised Basin Plan.

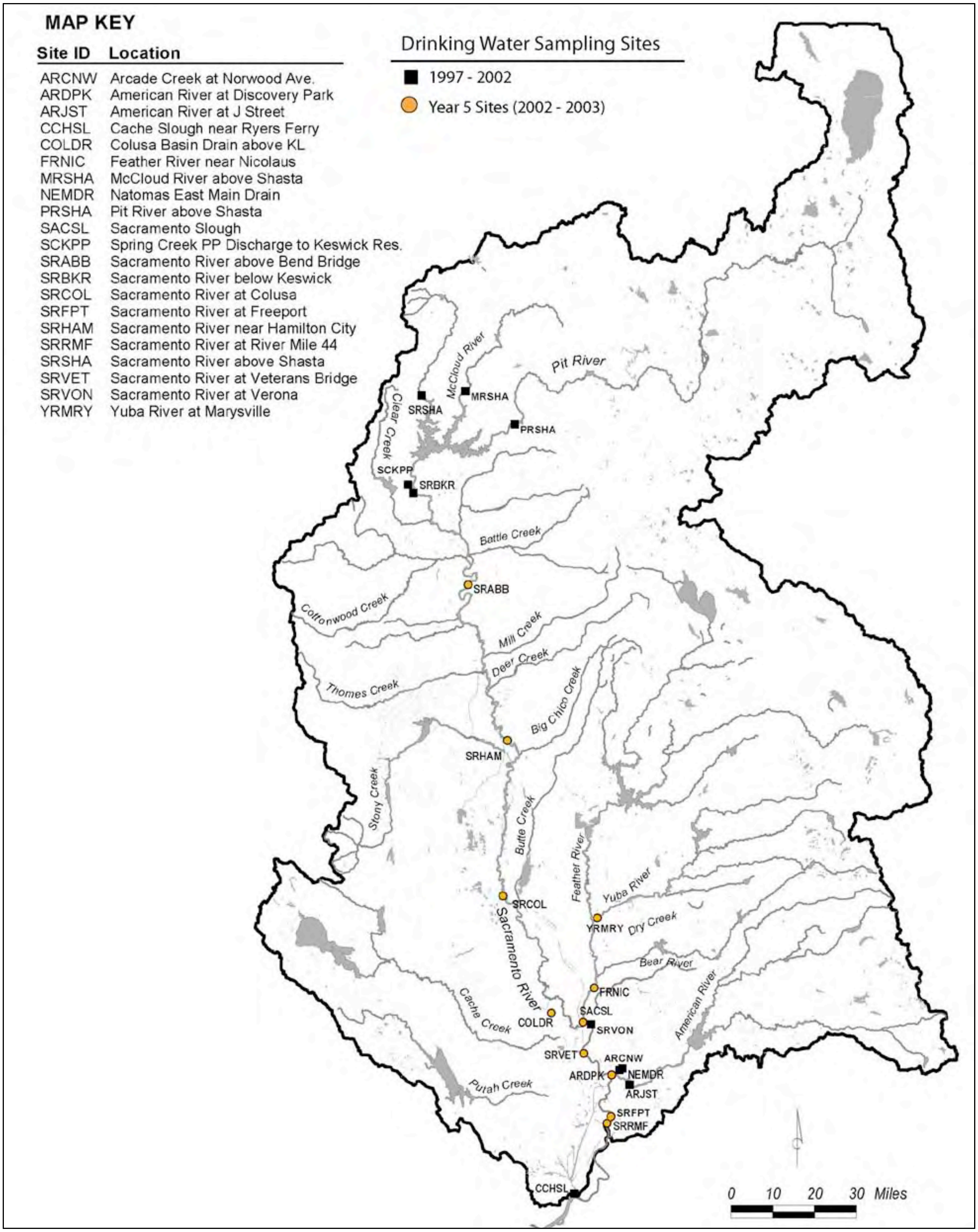

Figure 24. Drinking Water Constituent Monitoring for the Sacramento River Watershed Program: Historical and 2002-2003 Monitoring Sites

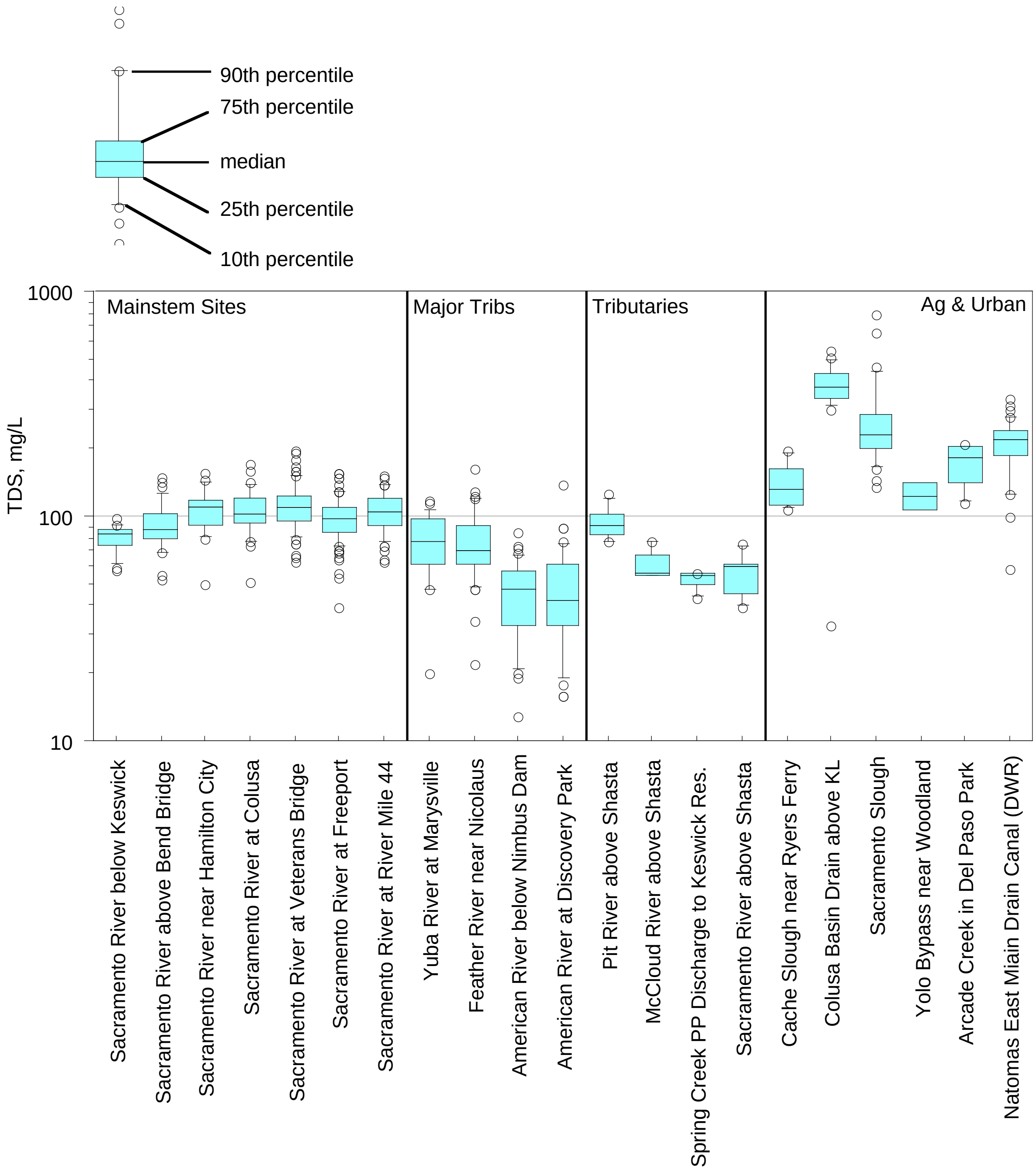

Figure 25. Total Dissolved Solids (TDS) Distribution, Sacramento River Watershed, 1998-2003 Data

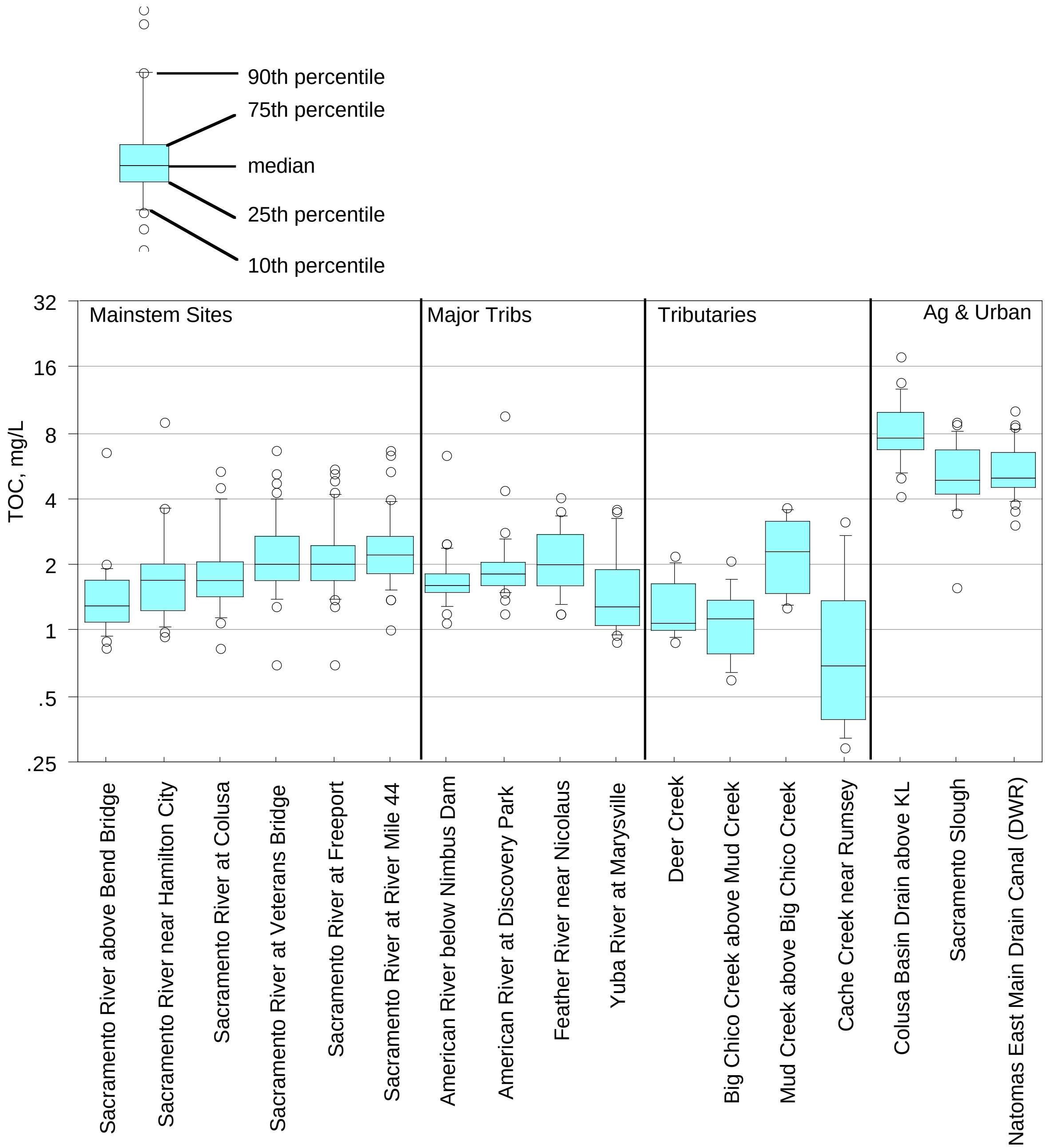

Figure 26. Total Organic Carbon (TOC) Distribution, Sacramento River Watershed, 1998-2003 Data

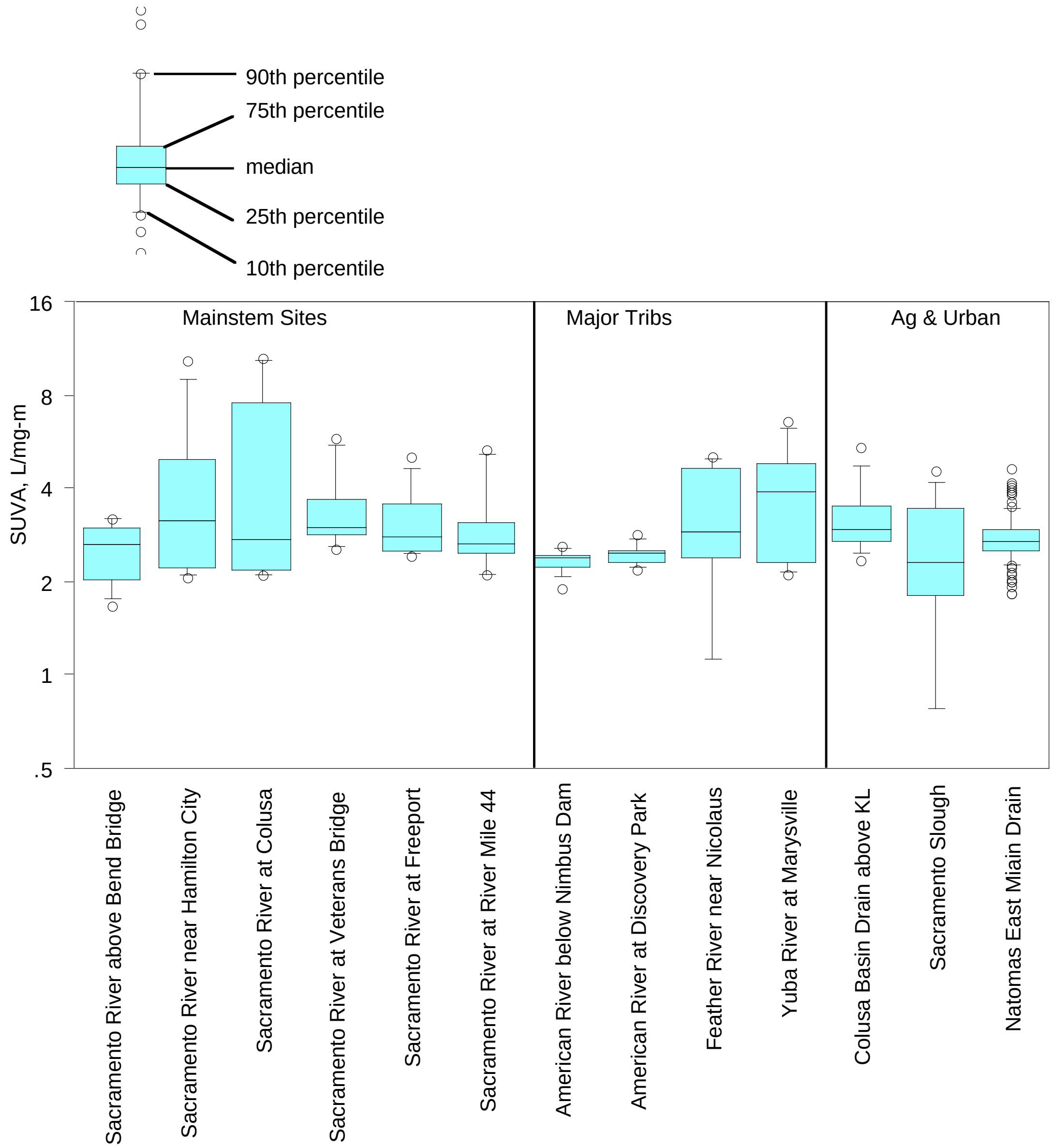

Figure 27. Specific Ultraviolet Absorbance (SUVA) at 254 nm Distribution, Sacramento River Watershed

(1988-2000 data for Natomas East Main Drain;
2002-2003 Data for All Other Locations)

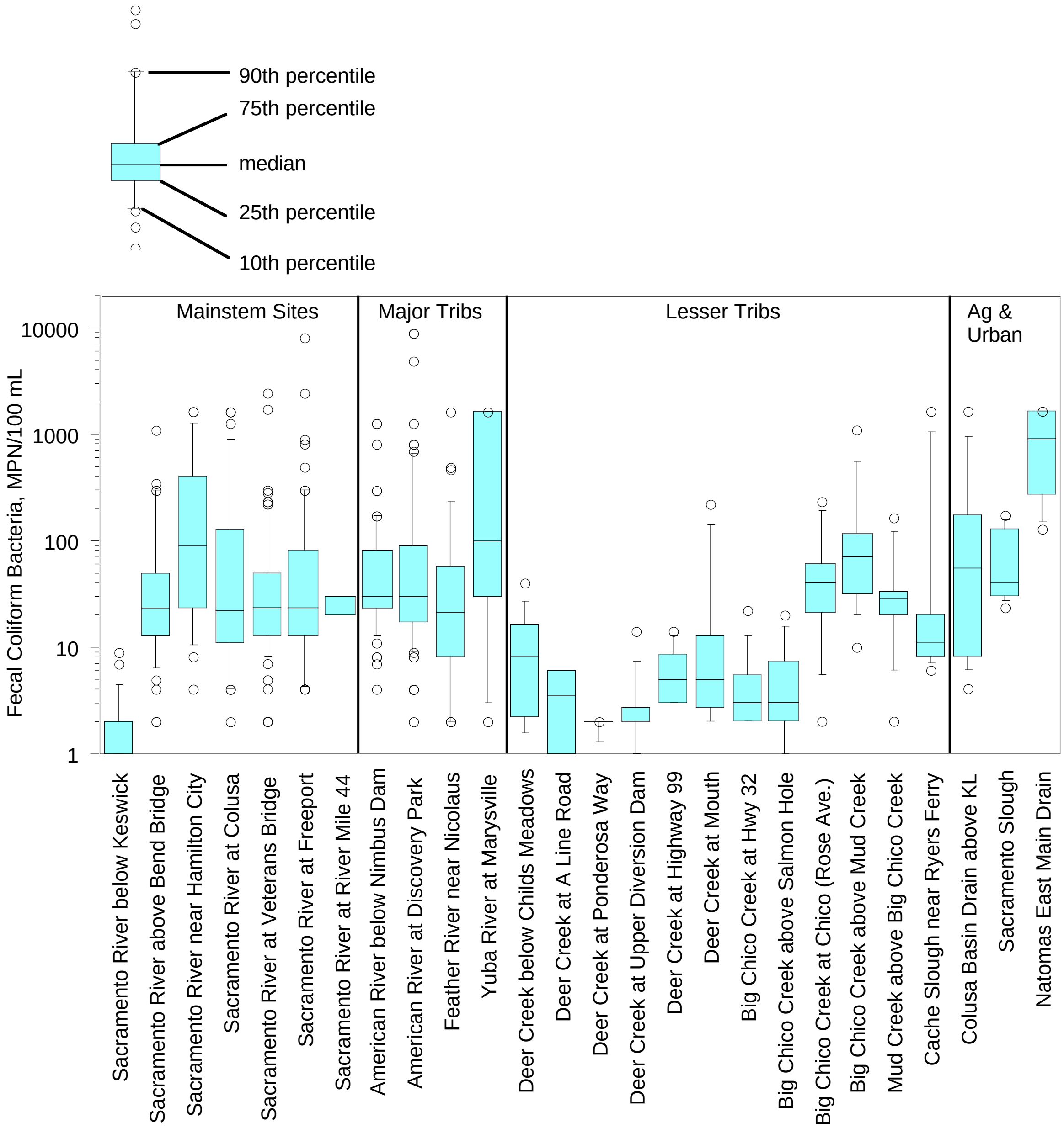

Figure 28. Fecal Coliform Bacteria Distribution, Sacramento River Watershed, 1998-2003

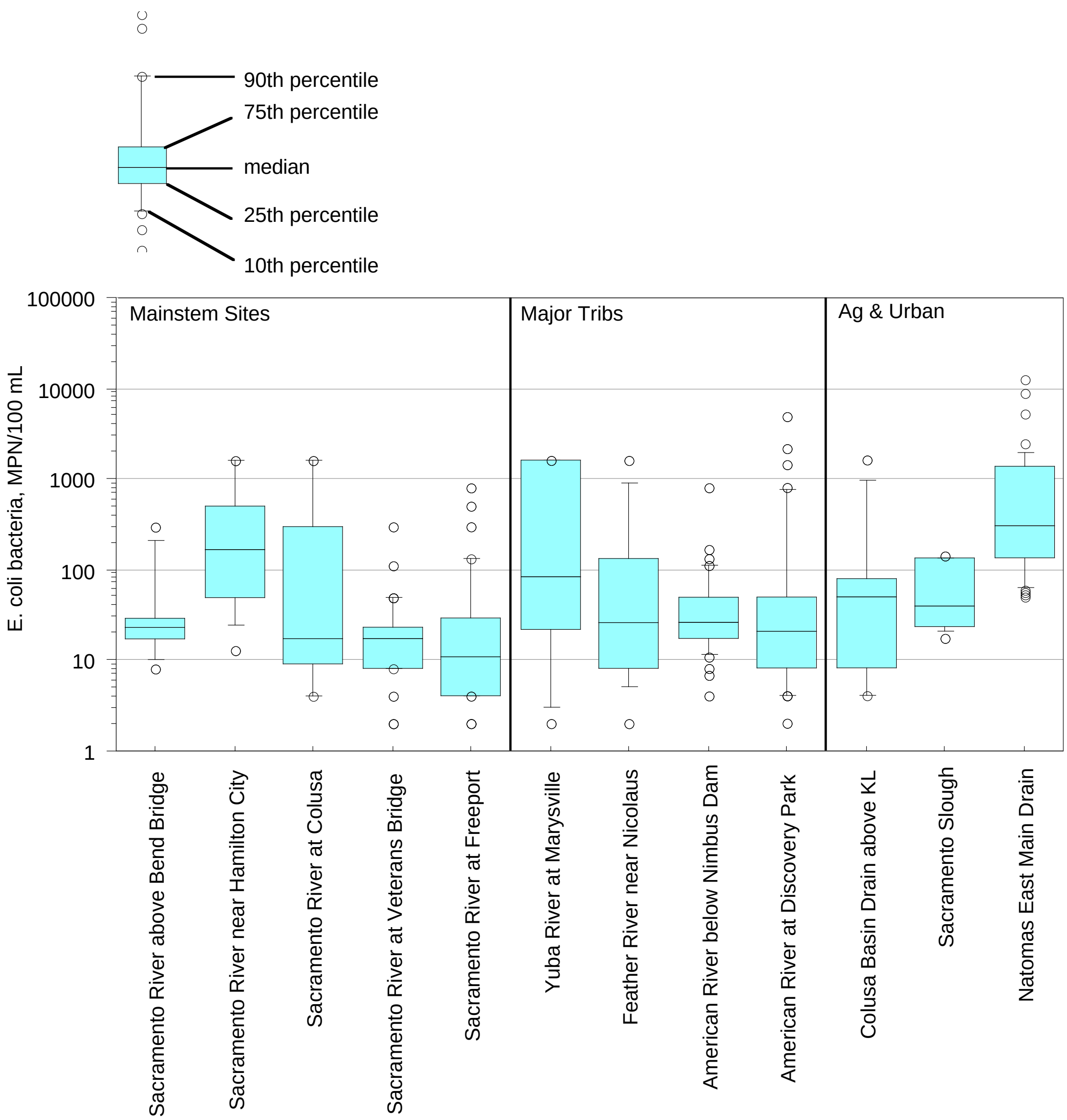

Figure 29. ***Escherischia coli*** **Distribution, Sacramento River Watershed, 2000-2003**

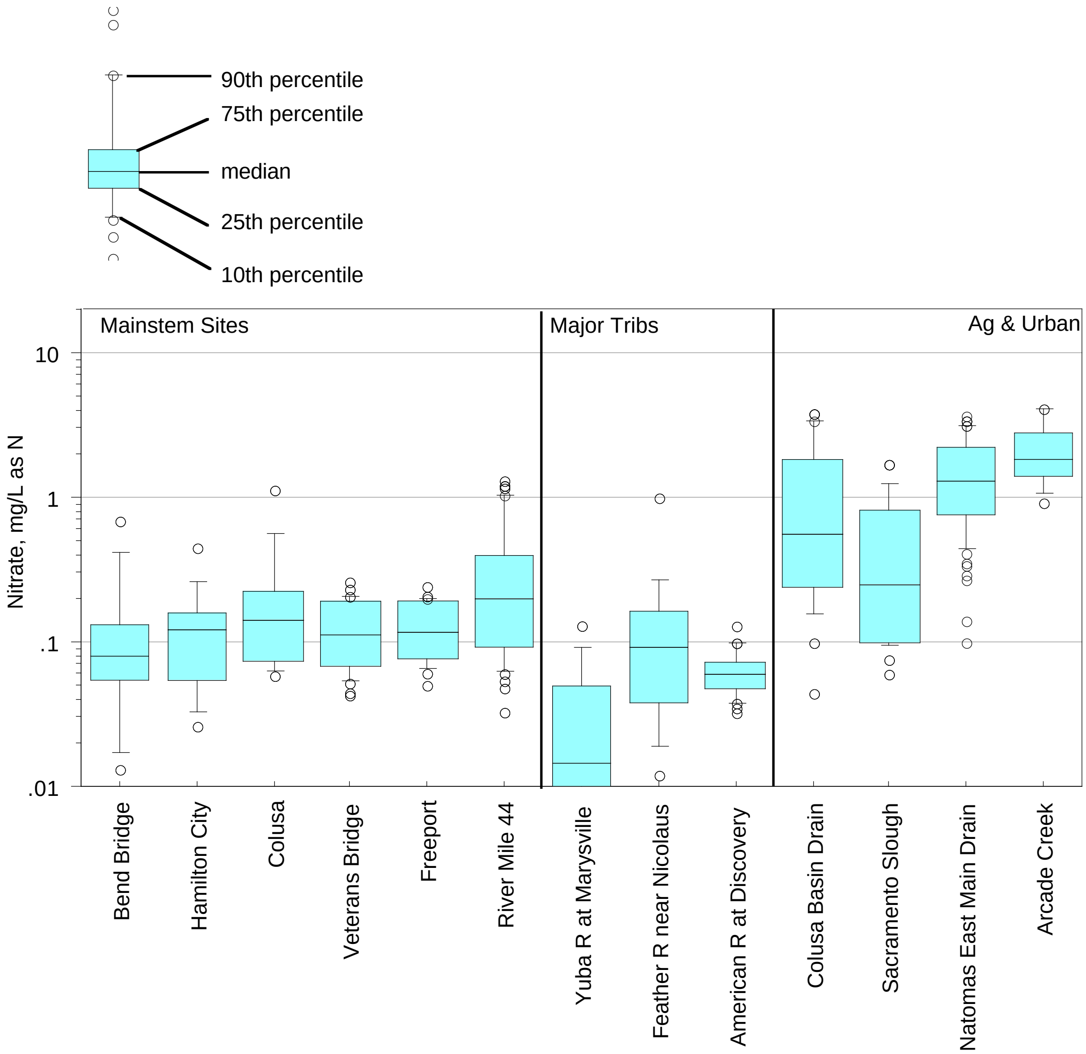

Figure 30. Nitrate Distribution, Sacramento River Watershed

(1990-2003 data for Natomas East Main Drain;
1999-2003 data for all other locations)

ORGANOCHLORINE PESTICIDES AND PCBs

BACKGROUND AND AVAILABLE DATA OVERVIEW

In September and October of 1997-2002, the SRWP monitoring program has collected fish from 18 locations and analyzed tissue for concentrations of organochlorine pesticides (DDTs, chlordanes, aldrin, dieldrin, endrin, hexachlorocyclohexanes, hexachlorobenzene, endosulfans, methoxychlor, mirex, and oxadiazinon) and PCB compounds. Monitoring in the Sacramento River watershed for these compounds in fish tissue has been performed previously by the Toxic Substances Monitoring Program (administered by the State Water Resources Control Board) between 1977 and 1996. Organochlorine pesticides and PCBs have also been analyzed in fish collected as part of CDWR's tributary monitoring program (1999). Studies of these pollutants in fish tissue were also performed in San Francisco Bay in 1994 and 1997 (Table 31).

The locations of sites monitored in 1997–2002 by the SRWP are illustrated in Figure 31.

Table 31. Programs Monitoring PCB and Organochlorine Pesticides in Fish in the Sacramento River Watershed

Program	Monitoring Period	Parameters	Total # of Locations & Geographic Reference
SRWP	Sep-Oct, 1997-2002	♦ Organochlorine pesticides and PCBs in edible fish tissue	17 fish tissue sites, distributed throughout the watershed
TSMP (SWRCB)	1977–1999	♦ Metals, organics, and pesticides in fish	Many sites distributed throughout the watershed
SFBRWQCB	1994	♦ Mercury and organochlorines in fish	San Francisco Bay
SF Estuary RMP (SFEI 1999a)	1997	♦ Mercury and organochlorines in fish	San Francisco Bay
CDWR	1999	♦ Organochlorine pesticides and PCBs in edible fish tissue	Deer Creek, Mill Creek, Big Chico Creek, and Clear Creek watersheds

ATTAINMENT OF BENEFICIAL USES AND POTENTIAL IMPAIRMENT

Comparisons with fish tissue screening values and 303(d) listings: What do the data say about attainment of beneficial uses and potential impairment? Concentrations of organochlorine pesticides and PCBs in fish tissue were compared primarily to California Office of Environmental Health Hazard Assessment screening values (OEHHA 1999; SFEI 1998b), and to USEPA national screening values (SFBRWQCB *et al*. 1995, USEPA 1993, USEPA 1998b) adjusted for a fish consumption rate of 30 g/day and an updated PCB cancer slope factor (SFEI 1999a). Exceedance of screening values is considered an indication that more intensive site-specific monitoring or evaluation of human health risks should be conducted (SFEI 1998). Note that these risk-based human health limits are based on assumptions of specific fish consumption rates that are typically averages for the general population. For individuals or populations consuming more fish than assumed for a specific limit or screening value (e.g. sport fisherman or some ethnic populations), the risk of adverse health effects is increased.

Based on comparisons to OEHHA's screening values, the overall risks from organochlorine pesticides in fish tissue appear to be low. However, some individual samples and some species averages exceeded screening values. PCB concentrations in striped bass (34 ng/g, n=1) white catfish (27 ng/g, n=19) were greater than OEHHA's 20 ng/g screening value. In carp (n=4), average concentrations of DDTs (295 ng/g) and dieldrin (6.8 ng/g) exceeded screening values (100 ng/g, and 2.0 ng/g, respectively), but three of the four samples for this species were from one ag drain location (Colusa Basin Drain). Consumption-weighted averages also exceeded screening values for DDTs and dieldrin in fish from agricultural drains, but these exceedances were also strongly influenced by the average for one trophic level 3 species (carp in Colusa Basin Drain) with very high concentrations of these pesticides. Consumption-weighted averages also exceeded screening values for PCBs in fish from Delta locations, but this exceedance was also strongly influenced by the results for one trophic level 3 species caught for one Delta location (Sacramento sucker from Sacramento River at Mile 44, n=2). Review of the maximum ranges for consumption-weighted averages (based on substitution of zero and the detection limit for concentrations below detection) revealed that evaluations for dieldrin are the most sensitive to the substitution method used. Approximately 81% of the dieldrin results were below the reporting limit of 2.0 ng/g, and the reporting limit is equal to the OEHHA screening value for this pesticide. Based on the low percentage of concentrations detected above 2 ng/g, it is unlikely that average concentrations exceed the screening except in fish from agricultural drains.

Consumption-weighted average organochlorine concentrations were calculated by waterbody category. The consumption-weighted average is an estimate of the average concentration in tissue for the total freshwater and estuarine fish consumed, and assumes that a combination of trophic level 3 and trophic level 4 fish are consumed. Although not adopted as official policy, USEPA Region 4 used this approach in a TMDL developed in Georgia, and compared the consumption-weighted average directly to the fish tissue-based water quality criterion for methylmercury to evaluate whether a waterbody should be considered impaired (USEPA 2001b). The approach is also consistent with the development of the fish tissue-based criterion for methylmercury (USEPA 2001), which assumes that fish consumed consist of a mix of different trophic level species. The consumption-weighted average concentration is calculated as:

$$CWA = (56.6\% \times \textit{Trophic Level 3 avg.}) + (43.4\% \times \textit{Trophic Level 4 avg.}).$$

Consumption-weighted averages, and averages for individual species and trophic levels were all compared to screening values. In all cases where concentrations were below detection, the average concentration was calculated with the tissue concentration set equal to one half the detection limit. The possible range for the average was also calculated by substituting zero and the detection limit for data below detection. Comparisons with screening values were made using the "best estimate" average values (based on the one half detection limit substitution) for the entire data set and for waterbodies grouped by the following categories:

- Lower Sacramento River mainstem, from Keswick to the "I" Street Bridge in Sacramento),
- Delta locations (Sacramento River below "I" Street Bridge, and Cache Slough),
- Major tributaries (Feather River and American River),
- Smaller tributaries, from above Shasta to Putah Creek,
- Agricultural drains (Colusa Basin Drain, and Sacramento Slough)
- Urban drainage (Natomas East Main Drain).

Summaries of these evaluations are provided inTable 32 and Table 33. Consumption-weighted averages are summarized in Table 34, and results for individual samples and trophic level 3 and 4 species are illustrated in Figure 32 and Figure 33. The data used for these evaluations are also presented in Appendix A.

There are four waterbodies included on the 2002 California 303(d) list for impairment due to organochlorine pesticides and PCBs (Table 35). Evaluation of consumption-weighted average concentrations suggests the need to re-evaluate at least one of these 303(d) listings. Concentrations of dieldrin and chlordane in SRWP fish samples (n=7) from the Feather River are all below the OEHHA Screening Value, suggesting that concentrations of these chemicals may not be sufficiently high in fish tissue to warrant 303(d) listing at this site for Group A pesticides. Average concentrations of all PCBs and organochlorine pesticides were lower in Feather River fish than in American River fish. The Central Valley Regional Board removed the lower American River from the 303(d) list on the based in part on these SRWP data, and because the original 303(d) listing for the lower American River was inappropriate because it was based on exceedance of a non-regulatory National Academy of Sciences "criterion" (Lee and Jones-Lee 2002). Concentrations of PCBs in trophic level 4 fish from Natomas East Main Drain support the 303(d) listing for PCBs at this site. Additional data are still needed to evaluate the high consumption-weighted average concentrations of DDT and dieldrin estimated for agricultural drains and the 303(d) listing for Colusa Basin Drain. Results more extensive monitoring proposed for 2004 should provide additional data needed to adequately evaluate these results.

SPATIAL AND TEMPORAL DISTRIBUTION & PATTERNS

Concentrations of organochlorines accumulated in fish tissue are dependent on a number of factors in addition to exposure to these compounds, including species and trophic level, age, size, and tissue lipid concentrations. The species and size of fish analyzed for this study varied by location, and it is difficult to describe purely spatial variation independent of these factors. For this reason, concentrations in trophic level 3 species (e.g. rainbow trout), should not be directly compared with concentrations in trophic level 4 species (e.g. largemouth bass) as a means of inferring spatial differences in concentrations of bioavailable oganochlorine pesticides and PCBs. Examination of the consumption-weighted average organochlorine concentrations for each waterbody category (Table 34) provides a relatively unbiased biased view of broad regional patterns in fish tissue concentrations. These results suggest that concentrations of organochlorines are generally low in fish from smaller tributaries. Although consumption-weighted average PCBs were highest for the Delta and major tributary locations, and DDTs and dieldrin were highest in the fish from agricultural drains, these values were very dependent on high concentrations in a very limited number of samples or species. Considering only the two species collected from the most sites (white catfish and largemouth bass), there were no distinct or consistent differences in average concentrations for different waterbody categories.

Consumption weighted averages of organochlorine concentrations in fish tissue are summarized in Table 34 by waterbody category. Concentrations in individual species are illustrated for each location sampled in Figure 34 and Figure 35.

There are currently insufficient data available to assess long-term temporal trends in the concentrations of organochlorines in fish tissue.

CONCLUSIONS AND RECOMMENDATIONS

- Based on comparisons to screening values for organochlorine pesticides and PCBs in fish tissue, consumers who eat a variety of fish from different locations appear to be at relatively low risk from these compounds in fish tissue. However, potential risks increase for people selectively consuming a limited number of higher trophic level species (e.g. white catfish, largemouth bass, striped bass), and for individuals consuming more fish than the 21 g/day (about six quarter-pound servings per month) on which the screening values were based.
- Consumption-weighted average concentrations of DDTs and dieldrin in fish from agricultural drains, and of PCBs in fish from major tributaries (American River and Feather River) and Delta locations exceeded screening values, but these results were dependent on very limited data for trophic level 3 species. Additional data are needed to adequately assess the potential risks for these waterbodies.
- Evaluation of consumption-weighted average and species average concentrations suggests the need to re-evaluate at least one of the waterbodies cited on the 2002 303(d) for impairment due to organochlorine pesticides and PCBs. The results indicate that the Regional Board's listing of the Feather River for "Group A" pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes including lindane, endosulfan, and toxaphene) may not be necessary.
- Fish from smaller tributaries throughout the watershed tended to have lower concentrations of most organochlorines than other waterbodies. There was little evidence of other distinct spatial trends in organochlorine concentrations in fish tissue.
- Monitoring of organochlorine pesticides and PCBs in fish tissue has been suspended for 2003-2004 due to budgetary constraints. However, samples collected for mercury analyses will be retained for analysis of organochlorine pesticides and PCBs if and when funding becomes available for that purpose. More extensive monitoring of organochlorine pesticides and PCBs in fish has been proposed for future monitoring efforts.

Table 32. Organochlorine Pesticides and PCB in Fish Tissue: Regulatory Limits, Screening Values, and Summary of SRWP Data (1997-2000)

	PCBs (as Aroclors)	Sum of Chlordanes	Sum Of DDTs	Dieldrin
Updated USEPA Screening Values(1) (SFBRWQCB *et al.* 1995)	23 ng/g	18 ng/g	69 ng/g	1.5 ng/g
OEHHA Screening Values(2) (OEHHA 1999, SFEI 1998)	20 ng/g	30 ng/g	100 ng/g	2 ng/g
FDA Action Levels(3)	2000 ng/g	300 ng/g	5000 ng/g	300 ng/g
Total number of samples analyzed (1997 – 2001)	109	109	109	109
Number of samples exceeding OEHHA screening value	28	0	5	13
Percent of samples exceeding OEHHA screening value	25.6%	0%	4.6%	12%
Species(4) exceeding OEHHA screening values	CC, LMB, PM, RT, SB, SS, WC	—	CP, WC, SS	CC, CP, LMB, PM, SMB, SS, WC
Sites(5) exceeding OEHHA screening value in at least one sample	ARDPK ARJST ARSNR COLDR FRABR NEMDR SACSL SRBKR SRCOL SRRMF SRVET	—	COLDR SRRMF SRVET	ARDPK CCHSL COLDR SACSL SRRMF
Sites(5) exceeding no OEHHA screening values in any sample	CCHWY, CCMOU, CCRBR, CCWHI, CHHWY, CHMOU, CHSYC, DCHWY, DCMDW, FRNIC, MCBLK, MCHWY, PUTAH, PUTAU, SRABB, SRASH, SRHAM			

(1) Screening value is based on a consumption rate of 30 g/day.

(2) Screening value is based on a consumption rate of 21 g/day.

(3) FDA Action Level is based on a consumption rate of 6.5 g/day.

(4) BT–Brown trout, CP–Carp, RT–Rainbow trout, LMB–Largemouth bass, PM–Sacramento pikeminnow, RS–Riffle sculpin, SB–Striped bass, SMB–Smallmouth bass, SS–Sacramento sucker, WC–White catfish, CC–Channel catfish

(5) Mainstem sites in downstream order: SRBKR–Sac. River below Keswick; SRABB–Sac. River at Bend Bridge; SRHAM–Sac. River at Hamilton City; SRCOL–Sac. River at Colusa; SRVET–Sac. River at Vets Bridge;
Major tributary sites: FRNIC—Feather River near Nicolaus; FRABR—Feather River above Bear River; ARSNR–American River at Sunrise; ARJST–Amercian River at J Street; ARDPK–American River at Discovery Park;
Delta sites: SRRMF–Sac. River at Mile 44; CCHSL–Cache Slough near Ryers Ferry
Ag drain sites: COLDR–Colusa Basin Drain; SACSL–Sacramento Slough;
Urban sites: NEMDR–Natomas East Main Drain;
Tributary sites: CCHWY–Clear Ck @ Hwy 273 ; CCMOU–Clear Creek at Mouth; CCRBR–Clear Ck @ Reading Bar ; CCWHI–Clear Ck above Whiskeytown; CHHWY–Big Chico Ck @ Hwy 32; CHMOU–Big Chico Ck near mouth; CHSYC–Big Chico Ck @ Hwy 99; DCHWY–Deer Ck @ Hwy 99 ; DCMDW–Deer Ck below Childs Meadow; MCBLK–Mill Ck at Black Rock; MCHWY–Mill Ck at Hwy 99; PUTAH–Putah Creek; PUTAU–Upper Putah Creek,

Table 33. Comparisons To Screening Values for Fish Tissue Data, 1997-2002

PCBs as Sum of Aroclors (OEHHA Screening Value[1] = 20 ng/g)	
Species averages	♦ Overall species averages for striped bass (n=1), white catfish (n=19), and Sacramento sucker (n=17) exceeded the Screening Value (SV). ♦ Species average concentrations were above the SV in white catfish and striped bass (n=1) for the lower Sacramento River mainstem, in white catfish and Sacramento sucker (n=1) for Delta locations, in white catfish, pikeminnow, and Sacramento sucker for major tributaries, in white catfish in Natomas East Main Drain (NEMDR), and in channel catfish (n=1) in ag drains ♦ All species averages for smaller tributaries were below the SV.
Trophic Level (TL) averages	♦ Overall TL3 average concentration was greater than the SV (note: biased by large Sacramento suckers from Feather River and American River) ♦ Overall TL4 average concentration was lower than the SV. ♦ Trophic level 3 average was above the SV for the Delta and major tributary locations (based only on Sacramento sucker data). ♦ Trophic Level 4 average was above the SV for major tributaries and the lower Sacramento River mainstem
Consumption-weighted avg (CWA)	♦ CWA above Screening Value for Delta locations and major Tributaries (result dependent on high TL3 Sacramento sucker samples) ♦ CWA below Screening Value for other waterbody categories.
Summary of potential risks	♦ Potential risk is highest at Delta locations (Sac. River at Mile 44 and Cache Slough) and major tributaries (lower Feather and American rivers), and low at other locations. Risk may be biased by reliance on single TL3 species.
Sum of Chlordanes (OEHHA Screening Value = 30 ng/g)	
Species averages	♦ All species averages were below the SV.
Trophic Level (TL) avg.	♦ All were below the SV.
Consumption-weighted avg (CWA)	♦ Below the SV for all waterbody categories
Summary of potential risks	♦ Risk appears to be very low for all waterbody categories sampled (Lower Sac. River mainstem, Delta, major tributaries, smaller tribs, ag drains, urban).
Sum of DDTs (OEHHA Screening Value = 100 ng/g)	
Species averages	♦ The overall average (n=4) and the ag drain average (n=3) for Carp exceeded the SV. The Delta average (n=2) for Sacramento sucker exceeded the SV. ♦ All other overall species averages were below the SV.
Trophic Level (TL) averages	♦ 4 of 43 TL3 samples and 1 of 66 TL4 samples were above the SV. ♦ Overall Trophic Level 3 and 4 average concentrations were lower than the SV. ♦ Trophic level 3 average was above the SV for Ag drains and Delta locations, but based on only one species for each category (Carp in Ag drains, n=3; Sacramento sucker in the Delta, n=2).
Consumption-weighted avg (CWA)	♦ CWA was above the SV for Ag drains, but dependent on only one TL3 species (Carp, n=3). CWA was below the SV for all other waterbody categories.
Summary of potential risks	♦ Some potential risks for fish from ag drains, but risk may be overestimated due to reliance on single TL3 species. Overall risk appears low.
Dieldrin (OEHHA Screening Value = 2 ng/g)	
Species averages	♦ The overall average (n=4) and the ag drain average (n=3) for Carp exceeded the SV. The average for smallmouth bass (n=1) exceeded the SV. Other overall and waterbody category averages were below the SV.
Trophic Level (TL) averages	♦ 4 of 43 TL3 samples and 9 of 66 TL4 samples were above the SV. ♦ Overall TL3 and TL4 averages were below the SV
Consumption-weighted avg (CWA)	♦ CWA was above the SV for Ag drains, but dependent on only one TL3 species (Carp, n=3). CWA was below the SV for all other waterbody categories.
Summary of potential risks	♦ There may be some potential risks for fish from ag drains, but risk may be overestimated due to reliance on single TL3 species. Overall risks appear low .

(1) OEHHA screening values are based on a consumption rate of 21 g/day (OEHHA 1999)

Table 34. Consumption-Weighted Average Concentrations in Fish: PCBs and Organochlorine Pesticides

				Consumption-weighted Avg(2), ng/g			
Site Category	**Species**	**Trophic Level(1)**	**Count**	**Aroclors**	**Chlordanes**	**DDTs**	**Dieldrin**
Lower Sac. R. Mainstem (Keswick to "I" Street Bridge)	Carp	3	1	12.8 (10.2–15.4) *52% Det*	1.1 (0.8–1.4) *39% Det*	31.0 (30.9–31.0) *96% Det*	1.0 (0.1–1.9) *9% Det*
	Rainbow trout	3	5				
	Sacramento sucker	3	5				
	Largemouth bass	4	2				
	Pikeminnow	4	6				
	Striped bass	4	1				
	White catfish	4	2				
Delta (Sac. River below "I" Street Bridge, and Cache Slough)	Sacramento sucker	3	2	47.2 (45.8–48.7) *70% Det*	4.6 (4.5–4.7) *35% Det*	79.0 *100% Det*	1.8 (1.3–2.4) *30% Det*
	Largemouth bass	4	8				
	Pikeminnow	4	1				
	White catfish	4	10				
Major tributaries (Feather River and American River)	Sacramento sucker	3	9	56.8 (55.6–58.1) *75% Det*	4.4 (3.2–4.6) *63% Det*	30.4 *100% Det*	1.1 (0.4–1.9) *21% Det*
	Largemouth bass	4	6				
	Pikeminnow	4	6				
	White catfish	4	3				
Tributaries (Sac. R. above Shasta, Pit River, McCloud River, Clear Ck, Mill Ck, Deer Ck, Big Chico Ck, Putah Ck)	Brown trout	3	1	7.1 (2.9–11.3) *8% Det*	0.8 (0.4–1.1) *8% Det*	18.1 (17.4–18.1) *44% Det*	1.0 (0–2.0) *0% Det*
	Rainbow trout	3	7				
	Riffle sculpin	3	8				
	Sacramento sucker	3	1				
	Largemouth bass	4	4				
	Pikeminnow	4	1				
	Smallmouth bass	4	3				
Ag Drains(3) (Sac. Slough, Colusa Basin Drain)	Carp	3	2	10.7 (8.1–13.3) *30% Det*	1.3 (0.8–1.5) *50% Det*	231.9 *100% Det*	5.6 (5.4–5.8) *70% Det*
	Largemouth bass	4	6				
	White catfish	4	4				
		USEPA Screening Values		*23 ng/g*	*18 ng/g*	*69 ng/g*	*1.5 ng/g*
		OEHHA Screening Values		*20 ng/g*	*30 ng/g*	*100 ng/g*	*2.0 ng/g*

(1) Trophic level 3 fish consume primarily zooplankton and benthic invertebrates. Trophic level 4 fish preferentially consume trophic level 3 and lower trophic level fish species, as well as benthic invertebrates. Larger individuals of some primarily trophic level 3 species (e.g. trout) may be piscivorous and function at trophic level 4.

(2) The average concentration for total fish consumed, as described USEPA 2001b. The consumption-weighted average is calculated as: (56.6% x *Trophic Level 3 avg.*) + (43.4% x *Trophic Level 4 avg.*). Averages are calculated by substituting 1/2 the reporting limit for concentrations below detection. Maximum ranges for averages based on substitution of zero and the reporting limit are presented in parentheses. Percent detected concentrations are shown in italics.

(3) Natomas East Main Drain, which was previously included in this group, is primarily an urban drainage. There were no trophic level 3 fish caught at this location, so no Consumption weighted average was calculated for this category and site.

Table 35. California 2002 303(d) List Waterbodies Cited for PCBs and Organochlorine Pesticides

Water Body	Cause for 303(d) Listing	Source of Pollution	Size Affected	Unit
Delta Waterways (Western and Eastern portions)	DDT, Group A Pesticides(1)	Agriculture	43,039	Acres
Colusa Basin Drain	Group A Pesticides	Agriculture	49	Miles
Feather River, Lower	Group A Pesticides	Agriculture	42	Miles
Natomas East Main Drain	PCBs	Industrial Point Sources, Urban Runoff, Agriculture	15.5	Miles

(1) Group A pesticides are comprised of aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan, and toxaphene

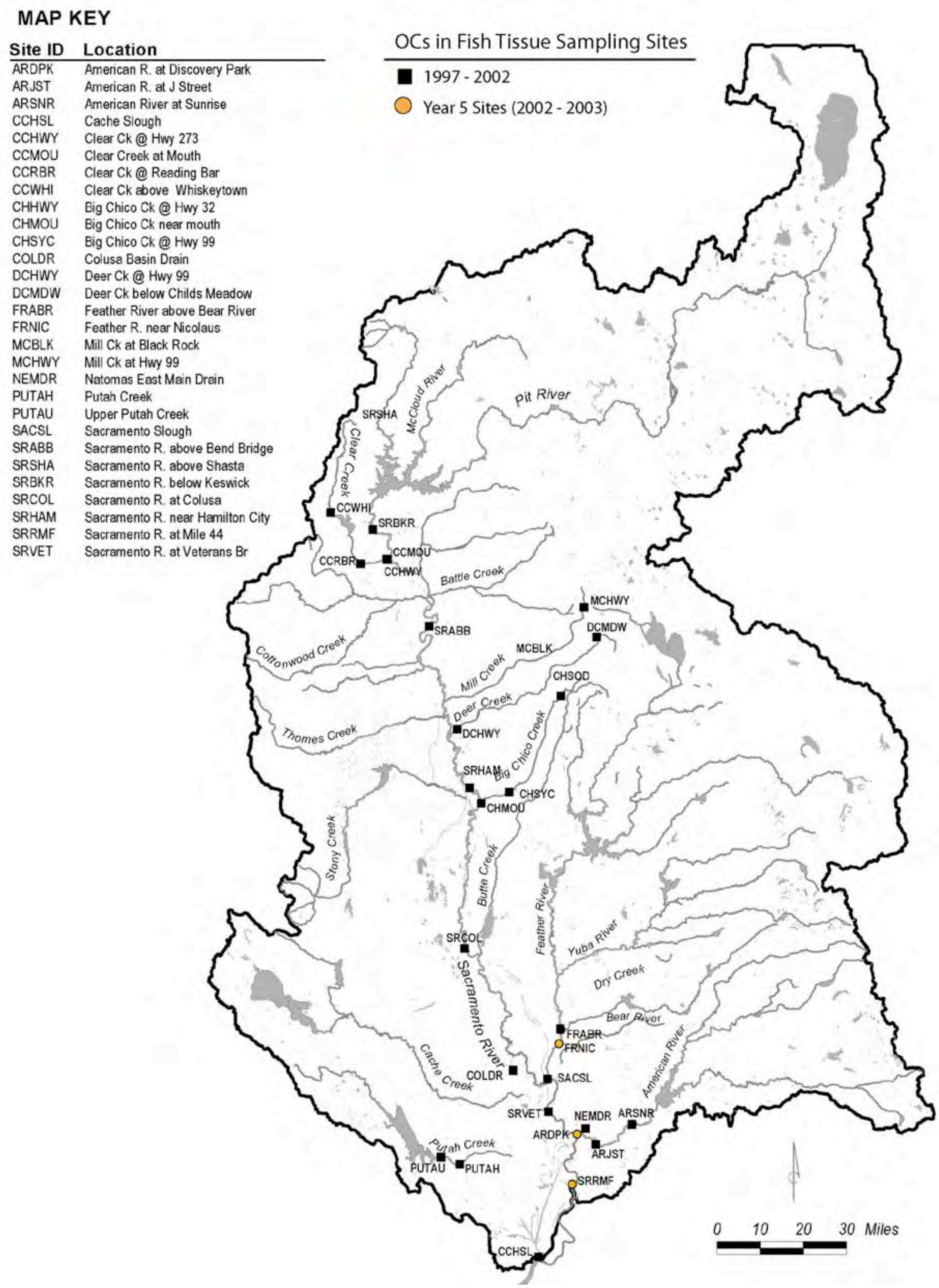

Figure 31. Organochlorine Pesticides and PCBs in Fish Tissue: SRWP Monitoring Locations

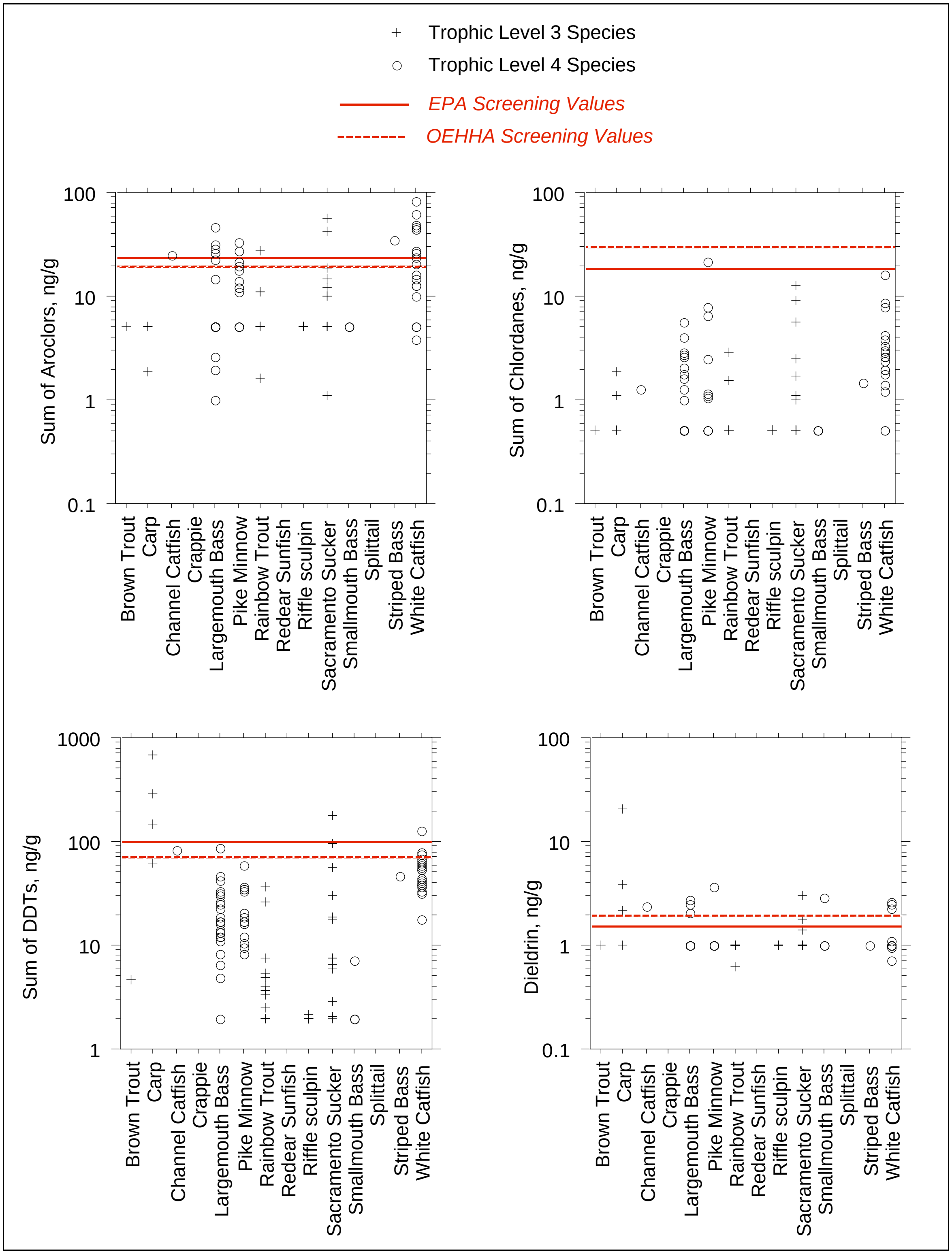

Figure 32. PCBs and Organochlorine Pesticides in Fish Tissue, by Species

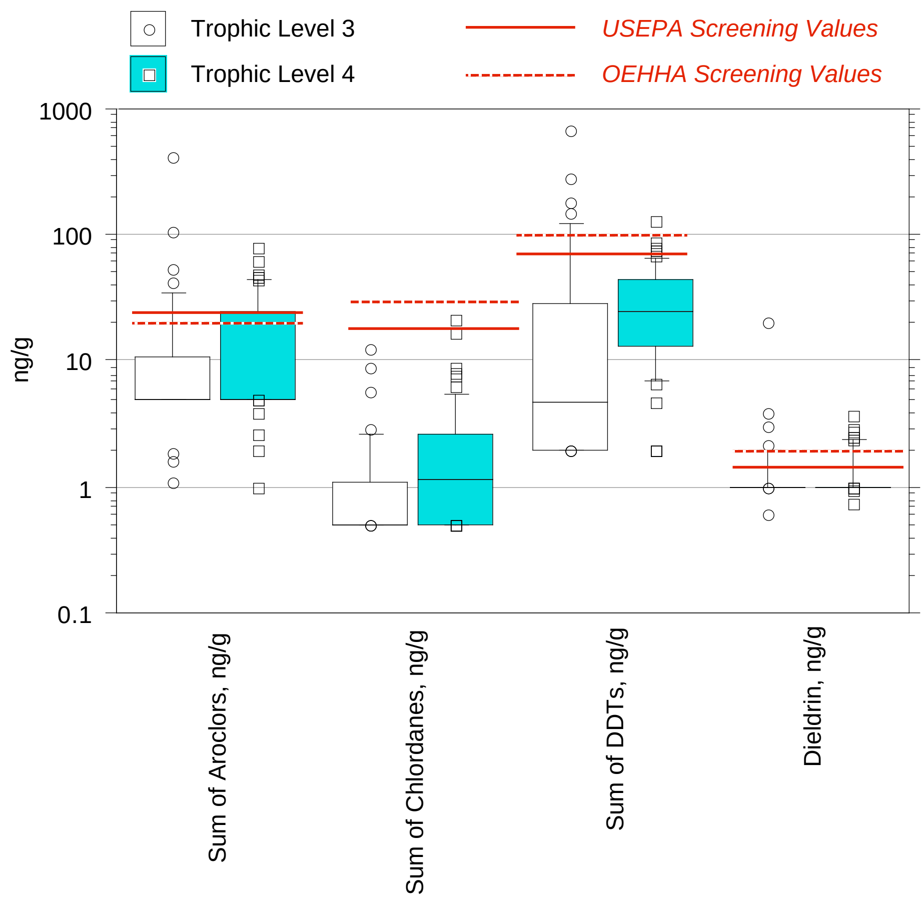

Figure 33. PCBs and Organochlorine Pesticides in Fish Tissue, Summarized by Trophic Level

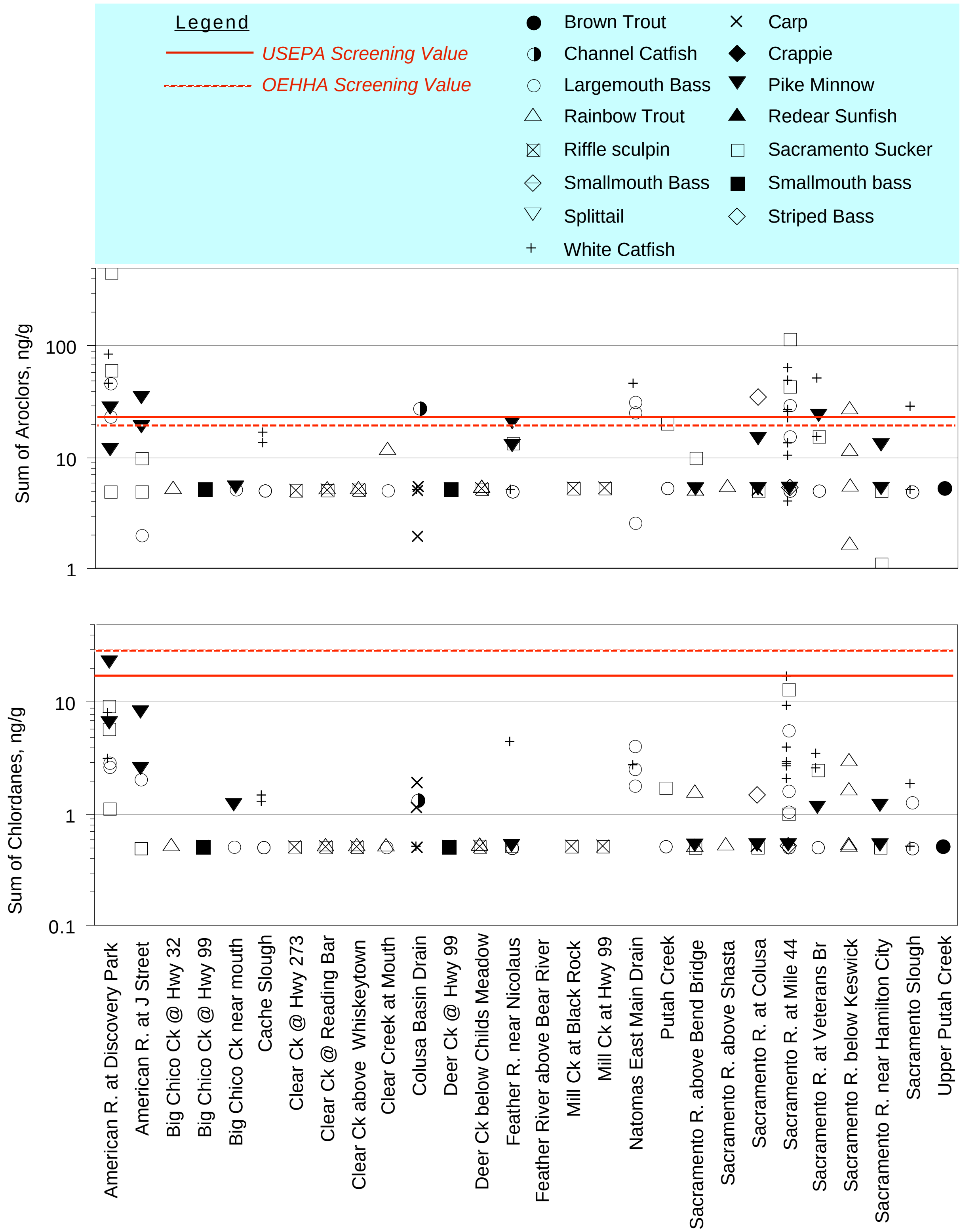

Figure 34. PCBs as Aroclors and Chlordanes in Fish Tissue, 1997 – 2002 SRWP data

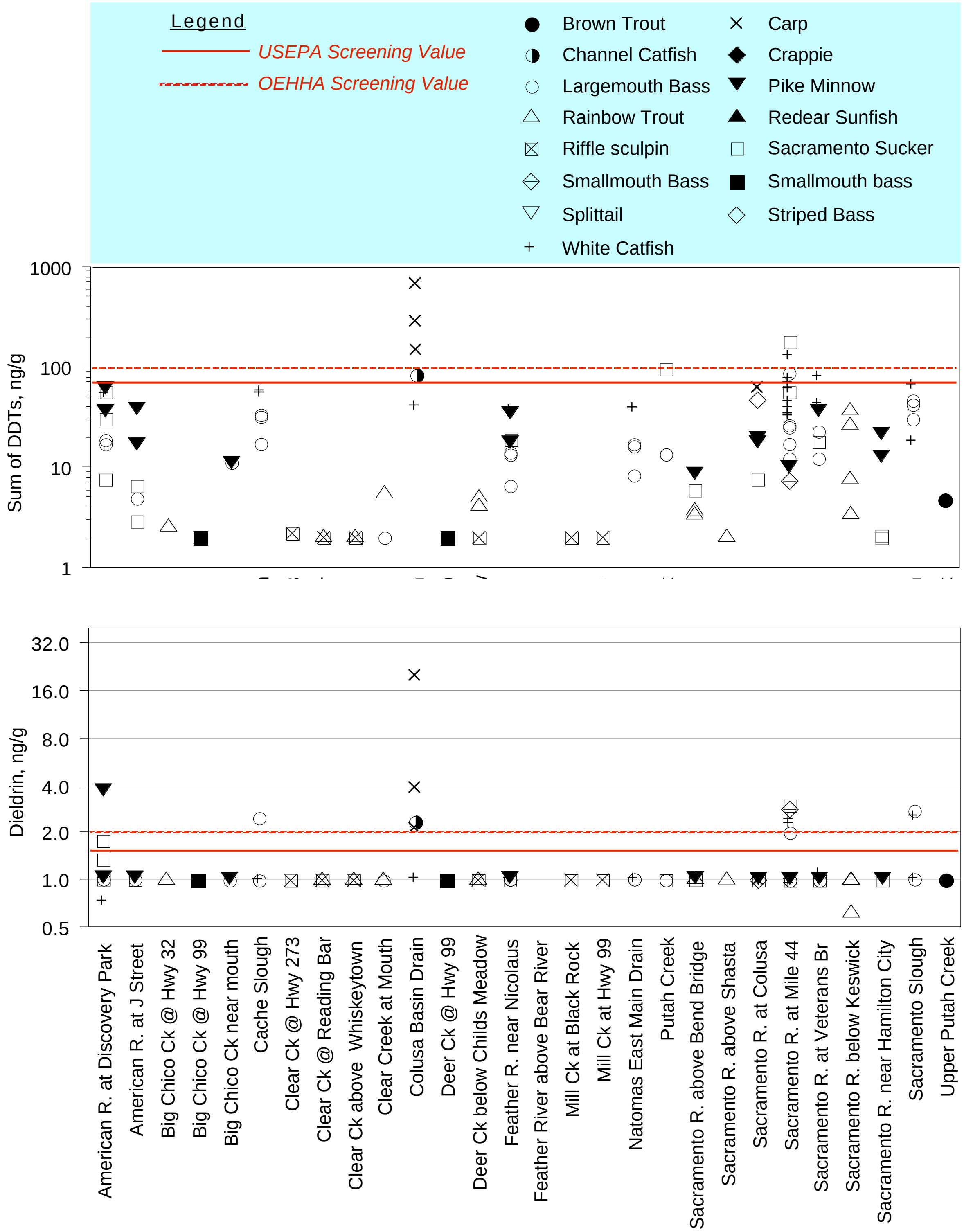

Figure 35. DDTs and Dieldrin in Fish Tissue, 1997 – 2002 SRWP data

YEAR 6 AND 7 MONITORING

The Year 6 monitoring effort is a significantly reduced effort designed primarily to maintain a continuous record for key indicator paramters at the core SRWP monitoring locations. The major changes implemented for the Year 6 program are a reduced frequency of monitoring (4 events), suspension in monitoring of some parameters (nitrogen and phosphorus compounds, carbamate and triazine pesticides, and organochlorine pesticides and PCBs in fish), and reinstatement of previously suspended toxicity test species (*Pimephales* and *Selenastrum*). Otherwise, the Year 6 monitoring approach is largely a continuation of the monitoring performed in Year 5, with a primary focus on supporting the management strategies for mercury and organophosphate pesticides. The ongoing Year 6 monitoring is being conducted primarily on an event-based schedule, and included elements in the following categories:

- Mercury and methylmercury in water
- Organophosphate pesticides in water
- Parameters related to drinking water uses and issues, including coliform bacteria, organic carbon, and selected "conventional" and physical parameters in water
- Causes and sources of aquatic toxicity (*Ceriodaphnia*, *Pimephales*, and *Selenastrum* toxicity testing and Toxicity Identification Evaluations)
- Mercury in fish tissue
- Support for continued development of bioassessment reference conditions in the Sierra foothill and Central Valley regions

As with the previous two years of monitoring, monitoring events will be conducted on an "episodic" basis, with events defined to coincide with specific hydrological or other conditions considered to potentially impact water quality. No special studies are planned for Year 6 monitoring. The Year 6 monitoring plan approved by the SRWP Monitoring Subcommittee is summarized in Table 36.

The SRWP has also submitted a proposal for funding for program development and an expanded monitoring effort through the State Water Resources Control Board's Consolidated Grants program. The proposal has made it through the initial review process and the final decision for funding is currently pending. If funded, monitoring for supported by the grant may begin in late 2004 or early 2005. At the time this document was produced, no other Year 7 SRWP monitoring has been planned for 2004-2005.

Table 36. SRWP Monitoring for 2002-2003: Locations, Analytes, and Numbers of Sample Events

	Chemical Characteristics				Pathogen Indicators	Aquatic Toxicity			Fish Tissue
Monitoring Locations (c)	**Total Hg and MeHg (Filtered and Unfiltered)**	**TSS**	**TOC, DOC, UVA_{254}, TDS**	**OP Pesticides**	**E. coli, Total & Fecal Coliform Bacteria**	***Ceriodaphnia, Pimephales, Selenastrum***	**Hardness, Alkalinity**	**WC Tox Followup (1)**	**Mercury in Fish**
Sac. R. below Keswick	RED	RED	RED	—	—	4	4	E	DFG(2)
Cottonwood Ck at mouth									
Sac. R. at Bend Br	4	4	4	—	4	4	4	E	—
Sac. R. near Hamilton City	4	4	4	4	4	4	4	E	—
Sac. R. @ Colusa	4	4	4	4	4	4	4	E	—
Sac. Slough	4	4	4	4	4	4	4	E	—
Colusa Basin Dr	4	4	4	4	4	4	4	E	—
Yuba R. at Marysville	4	4	4	4	4	4	4	E	—
Feather R. near Nicolaus	4	4	4	4	4	4	4	E	2
Sac. R. at Veterans Br.	CMP	CMP	CMP	4	CMP	—	—	—	—
Arcade Creek	4	4	4	4	4	4	4	E	—
Natomas East Main Drain	—	—	4	4	4	—	—	—	—
American R. at Discovery Pk	CMP	CMP	CMP	CMP	CMP	4	4	E	2
Sac. R. at Freeport	CMP	CMP	CMP	CMP	CMP	4	4	E	—
Sac. R. at RM44	CMP	CMP	CMP	CMP	CMP				4
Cache Creek at Rumsey									
Number of Sites	8	8	9	9	9	11	11	(a)	3
Number of Regular Analyses	32	32	36	36	36	44	44	(a)	8
Additional QC Analyses	8	4	4	8	4	4	4	(a)	0

(1) A fixed budget of $40,000 is allocated for Toxicity follow-up consisting of chemistry, TIE testing, and additional sampling that has no fixed frequency.

(2) Two rainbow trout samples will be collected and analyzed by CDFG.

Note: Tabled values indicate number of environmental samples collected annually. Additional samples are collected for Quality Assurance. Text entries indicate data or samples collected by primary coordinating programs: CMP = Sacramento River Coordinated Monitoring Program, RED = City of Redding NPDES monitoring; DFG = Department of Fish and Game

DATABASE AND DATA ACCESS

Larry Walker Associates (LWA) is responsible for both data management and database development for the Sacramento River Watershed Program. All data collected by the SRWP is currently stored in a normalized, relational database (Microsoft Access) designed by LWA and the Department of Water Resources (Interagency Ecological Program) to house water chemistry and toxicity test data. The sampling crews and laboratories contracted to collect and analyze the Program's monitoring data provide the data manager (LWA) with electronic and hard copy data that are then imported into the SRWP Database. These data are then validated and qualified according to the protocols described in the SRWP Quality Assurance Project Plan (QAPP).

SRWP data In addition to the results reported in SRWP Annual Monitoring Reports, final qualified data are also being made available through the Department of Water Resources Bay Delta and Tributaries (BDAT) database. This database also contains results from many monitoring programs and is accessible to the public through the BDAT website: http://baydelta.ca.gov/

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APPENDIX A:

SUMMARY STATISTICS FOR WATER QUALITY DATA

The following acronyms and abbreviations are used in the presentation of summary statistics:

n	Total number of data
% Det	Percent detected data
n Det	Number of detected data
Min Det	*Minimum Detected* concentration or value (*ND* if not detected)
Max Det	*Maximum Detected* concentration or value (*ND* if not detected)
Min RL	*Minimum Reporting Limit*. (Not reported for 100% detected data.)
Mean	Arithmetic average of the reported data
Std Dev	*Standard Deviation* of the reported data
Median	*Median* of the reported data
IQR	*Interquartile Range* of the data (distance between 75^{th} and 25^{th} percentiles)
IDD	*Insufficient Detected Data*. Indicates that there were too few detected data to estimate statistic
ND	*Not Detected.* Indicates no detected concentrations were reported.

Summary Statistics: Trace Inorganics (Mercury and Methylmercury)

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Mercury, total, filtered, ng/L	Ag Drains	Colusa Basin Drain above KL	07/21/00	04/13/03	16	94%	15	0.21	16.71	0.2	2.09	4.16	0.88	1.65
Mercury, total, filtered, ng/L	Ag Drains	Sacramento Slough	07/21/00	04/13/03	16	94%	15	0.28	28.18	0.2	2.75	6.84	0.929	1.94
Mercury, total, filtered, ng/L	Mainstem	Sacramento River below Keswick	07/19/00	04/03/03	14	79%	11	0.34	1.86	0.2	0.526	0.423	0.429	0.415
Mercury, total, filtered, ng/L	Mainstem	Sacramento River above Bend Bridge	07/19/00	04/04/03	17	76%	13	0.21	3.32	0.2	0.733	0.901	0.433	0.734
Mercury, total, filtered, ng/L	Mainstem	Sacramento River near Hamilton City	07/20/00	04/05/03	17	88%	15	0.43	6.17	0.2	1.11	1.41	0.738	0.982
Mercury, total, filtered, ng/L	Mainstem	Sacramento River at Colusa	07/20/00	04/13/03	17	94%	16	0.22	14.66	0.2	1.69	3.46	0.713	1.4
Mercury, total, filtered, ng/L	Mainstem	Sacramento River at Veterans Bridge	01/18/94	06/10/03	134	99%	132	0.35	7.96	0.03	1.65	1.19	1.34	1.21
Mercury, total, filtered, ng/L	Mainstem	Sacramento River at Freeport	02/15/94	06/11/03	134	99%	133	0.26	14.92	0.03	1.72	1.72	1.31	1.3
Mercury, total, filtered, ng/L	Mainstem	Sacramento River at River Mile 44	01/18/94	06/11/03	126	98%	124	0.46	11.1	0.03	1.71	1.43	1.35	1.27
Mercury, total, filtered, ng/L	Mainstem	Sacramento River at Greene's Landing	07/21/00	05/17/01	9	100%	9	0.3	2.32	100% det	0.889	0.605	0.744	0.781
Mercury, total, filtered, ng/L	Major Tributary	Yuba River at Marysville	07/20/00	04/13/03	18	100%	18	0.392	22.97	100% det	2.79	5.26	1.35	2.24
Mercury, total, filtered, ng/L	Major Tributary	Feather River near Nicolaus	07/21/00	04/13/03	18	100%	18	0.22	17.13	100% det	2.08	4.	1.01	1.51
Mercury, total, filtered, ng/L	Major Tributary	American River below Nimbus Dam	01/19/94	06/11/03	134	95%	127	0.19	4.43	0.03	0.944	0.689	0.753	0.731
Mercury, total, filtered, ng/L	Major Tributary	American River at Discovery Park	01/18/94	06/10/03	129	95%	123	0.07	11.3	0.03	1.32	1.26	0.976	1.1
Mercury, total, filtered, ng/L	Tributary	MF Cottonwood Ck at Platina Rd	11/07/02	03/14/03	3	100%	3	0.43	2.59	100% det	1.27	1.16	0.958	1.96
Mercury, total, filtered, ng/L	Tributary	MF Cottonwood Ck near Ono	11/01/01	02/18/02	2	100%	2	0.769	0.79	100% det	IDD	IDD	IDD	IDD
Mercury, total, filtered, ng/L	Tributary	MF Cottonwood Ck near Cox Road	04/04/03	04/04/03	1	100%	1	0.82	0.82	100% det	IDD	IDD	IDD	IDD
Mercury, total, filtered, ng/L	Tributary	NF Cottonwood Ck near Ono	11/07/02	03/14/03	3	100%	3	0.26	3.3	100% det	1.51	1.59	0.941	3.09
Mercury, total, filtered, ng/L	Tributary	NF Cottonwood Ck at McCauliffe Rd	11/01/01	02/19/02	2	100%	2	1.47	1.62	100% det	IDD	IDD	IDD	IDD
Mercury, total, filtered, ng/L	Tributary	NF Cottonwood Ck near Foster Road	04/04/03	04/04/03	1	100%	1	0.73	0.73	100% det	IDD	IDD	IDD	IDD
Mercury, total, filtered, ng/L	Tributary	SF Cottonwood Ck at Anderson Canal	10/31/01	04/04/03	5	100%	5	0.358	2.11	100% det	1.11	0.703	0.931	1.22
Mercury, total, filtered, ng/L	Tributary	North Fork Battle Ck at Wildcat Road	11/01/01	04/04/03	6	83%	5	0.226	5.53	0.2	1.37	2.09	0.514	1.85
Mercury, total, filtered, ng/L	Tributary	South Fork Battle Creek at Manton Road	11/01/01	04/04/03	6	67%	4	0.384	2.75	0.2	0.931	1.01	0.507	1.27
Mercury, total, filtered, ng/L	Tributary	Battle Ck below Coleman Fish Hatchery	11/01/01	04/04/03	6	83%	5	0.478	1.38	0.2	0.742	0.418	0.652	0.646
Mercury, total, filtered, ng/L	Tributary	Mill Creek at Black Rock	04/06/01	04/06/01	1	100%	1	5.18	5.18	100% det	IDD	IDD	IDD	IDD
Mercury, total, filtered, ng/L	Tributary	Mill Creek at Highway 99	04/06/01	04/07/01	4	100%	4	1.13	5.34	100% det	3.08	2.23	2.41	3.78
Mercury, total, filtered, ng/L	Tributary	Mill Creek at Mouth	07/19/00	05/15/01	9	100%	9	0.59	2.24	100% det	1.4	0.539	1.3	0.896
Mercury, total, filtered, ng/L	Tributary	Thomes Ck at Paskenta	11/02/01	04/04/03	6	100%	6	0.607	23.83	100% det	6.02	9.07	2.45	7.6
Mercury, total, filtered, ng/L	Tributary	Thomes Ck at Henleyville	02/20/02	04/04/03	4	100%	4	0.86	16.5	100% det	7.14	6.66	4.57	12.4
Mercury, total, filtered, ng/L	Tributary	Thomes Ck at Rawson Rd Bridge	02/20/02	04/04/03	4	100%	4	1.35	20.66	100% det	8.69	8.86	5.23	14.9
Mercury, total, filtered, ng/L	Tributary	Dry Creek above Cherokee Canal	11/03/01	04/12/03	7	100%	7	0.28	23.99	100% det	5.38	8.32	2.48	6.61
Mercury, total, filtered, ng/L	Tributary	Little Chico Creek below Chico	02/20/02	04/12/03	4	100%	4	2.58	17.4	100% det	6.49	7.28	4.47	7.
Mercury, total, filtered, ng/L	Urban Creek	Arcade Creek at Norwood Ave.	07/21/00	04/14/03	16	100%	16	0.23	18.	100% det	3.7	4.12	2.49	3.72
Mercury, total, unfiltered, ng/L	Ag Drains	Colusa Basin Drain above KL	03/06/96	04/13/03	53	98%	52	1.59	75.1	0.2	9.76	11.1	7.39	7.15
Mercury, total, unfiltered, ng/L	Ag Drains	Sacramento Slough	02/12/96	04/13/03	50	100%	50	0.69	30.8	100% det	9.01	5.2	7.71	6.45
Mercury, total, unfiltered, ng/L	Ag Drains	Yolo Bypass near Woodland	01/07/97	03/31/98	10	100%	10	17.86	223.71	100% det	48.2	62.4	33.6	36.1
Mercury, total, unfiltered, ng/L	Mainstem	Sacramento River below Keswick	01/20/98	04/03/03	53	100%	53	0.193	10.4	100% det	1.44	1.43	1.13	1.11
Mercury, total, unfiltered, ng/L	Mainstem	Sacramento River above Bend Bridge	02/13/96	04/04/03	56	100%	56	0.3	32.56	100% det	3.42	5.02	2.03	2.83
Mercury, total, unfiltered, ng/L	Mainstem	Sacramento River near Hamilton City	06/23/99	04/05/03	28	96%	27	0.87	54.11	0.2	5.99	11.6	2.45	4.44
Mercury, total, unfiltered, ng/L	Mainstem	Sacramento River at Colusa	02/28/96	04/13/03	46	98%	45	0.604	105.16	0.2	10.9	19.1	5.14	8.99
Mercury, total, unfiltered, ng/L	Mainstem	Sacramento River at Verona	02/22/96	05/20/98	28	100%	28	2.457	39.8	100% det	8.57	7.56	6.86	6.26
Mercury, total, unfiltered, ng/L	Mainstem	Sacramento River at Veterans Bridge	01/18/94	06/10/03	135	100%	135	1.98	34.9	100% det	8.41	5.37	7.1	5.72
Mercury, total, unfiltered, ng/L	Mainstem	Sacramento River at Freeport	02/15/94	06/11/03	191	100%	191	1.2	96.	100% det	8.9	10.7	6.48	6.68
Mercury, total, unfiltered, ng/L	Mainstem	Sacramento River at River Mile 44	01/18/94	06/11/03	127	100%	127	1.6	73.41	100% det	8.99	8.73	6.76	6.99
Mercury, total, unfiltered, ng/L	Mainstem	Sacramento River at Greene's Landing	07/21/00	05/17/01	8	100%	8	2.06	4.	100% det	2.83	0.705	2.76	1.1
Mercury, total, unfiltered, ng/L	Major Tributary	Yuba River at Marysville	02/27/96	04/13/03	55	98%	54	1.	46.66	0.2	6.31	9.21	3.47	5.09
Mercury, total, unfiltered, ng/L	Major Tributary	Feather River near Nicolaus	02/23/96	04/13/03	56	98%	55	1.49	46.19	0.2	7.22	7.6	5.15	5.89
Mercury, total, unfiltered, ng/L	Major Tributary	American River below Nimbus Dam	01/19/94	06/11/03	132	100%	132	0.42	15.4	100% det	2.33	2.37	1.69	1.82
Mercury, total, unfiltered, ng/L	Major Tributary	American River at J Street	02/21/96	04/16/98	27	100%	27	0.87	18.51	100% det	2.77	3.48	1.98	2.01
Mercury, total, unfiltered, ng/L	Major Tributary	American River at Discovery Park	01/18/94	06/10/03	133	100%	133	0.56	13.3	100% det	2.94	2.33	2.28	2.29

Summary Statistics: Trace Inorganics (Mercury and Methylmercury)

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Mercury, total, unfiltered, ng/L	Tributary	Spring Creek PP Discharge to Keswick Res.	06/24/98	04/18/00	11	100%	11	0.51	1.65	100% det	1.15	0.374	1.09	0.621
Mercury, total, unfiltered, ng/L	Tributary	MF Cottonwood at Platina Rd	11/07/02	03/14/03	3	67%	2	1.39	19.43	0.2	IDD	IDD	IDD	IDD
Mercury, total, unfiltered, ng/L	Tributary	MF Cottonwood Ck near Ono	11/01/01	02/18/02	2	100%	2	1.05	1.2	100% det	IDD	IDD	IDD	IDD
Mercury, total, unfiltered, ng/L	Tributary	MF Cottonwood Ck near Cox Road	04/04/03	04/04/03	1	100%	1	0.68	0.68	100% det	IDD	IDD	IDD	IDD
Mercury, total, unfiltered, ng/L	Tributary	NF Cottonwood Ck near Ono	11/07/02	03/14/03	3	100%	3	0.22	27.65	100% det	9.7	15.6	1.95	21.7
Mercury, total, unfiltered, ng/L	Tributary	NF Cottonwood Ck at McCauliffe Rd	11/01/01	02/19/02	2	100%	2	1.87	4.03	100% det	IDD	IDD	IDD	IDD
Mercury, total, unfiltered, ng/L	Tributary	NF Cottonwood Ck near Foster Road	04/04/03	04/04/03	1	100%	1	2.32	2.32	100% det	IDD	IDD	IDD	IDD
Mercury, total, unfiltered, ng/L	Tributary	SF Cottonwood Ck at Anderson Canal	10/31/01	04/04/03	5	100%	5	1.32	17.37	100% det	5.01	6.95	2.82	5.44
Mercury, total, unfiltered, ng/L	Tributary	North Fork Battle Ck at Wildcat Road	11/01/01	04/04/03	6	100%	6	0.264	13.92	100% det	3.1	5.39	1.06	3.2
Mercury, total, unfiltered, ng/L	Tributary	South Fork Battle Creek at Manton Road	11/01/01	04/04/03	6	83%	5	0.335	17.06	0.2	3.5	6.68	0.786	3.82
Mercury, total, unfiltered, ng/L	Tributary	Battle Ck below Coleman Fish Hatchery	11/01/01	04/04/03	6	83%	5	0.591	32.77	0.2	6.07	13.1	1.05	4.45
Mercury, total, unfiltered, ng/L	Tributary	Mill Creek at Highway 36	06/23/98	04/17/00	19	100%	19	4.38	1910.	100% det	155.	429.	42.8	104.
Mercury, total, unfiltered, ng/L	Tributary	Mill Creek at Black Rock	06/23/98	04/06/01	18	100%	18	2.	110.	100% det	27.	33.3	13.3	29.4
Mercury, total, unfiltered, ng/L	Tributary	Mill Creek at Highway 99	06/23/98	04/07/01	8	100%	8	3.3	116.1	100% det	37.5	41.6	17.5	49.4
Mercury, total, unfiltered, ng/L	Tributary	Mill Creek at Mouth	06/23/98	05/15/01	28	100%	28	2.04	485.	100% det	34.3	92.1	10.2	22.2
Mercury, total, unfiltered, ng/L	Tributary	Thomes Ck at Paskenta	11/02/01	04/04/03	6	83%	5	0.631	48.2	0.2	16.	22.	3.11	22.5
Mercury, total, unfiltered, ng/L	Tributary	Thomes Ck at Henleyville	02/20/02	04/04/03	4	100%	4	1.73	56.2	100% det	26.8	27.3	12.3	53.
Mercury, total, unfiltered, ng/L	Tributary	Thomes Ck at Rawson Rd Bridge	02/20/02	04/04/03	4	100%	4	8.11	50.32	100% det	30.	17.3	25.	36.5
Mercury, total, unfiltered, ng/L	Tributary	Deer Creek below Childs Meadows	06/24/98	04/17/00	19	100%	19	0.16	7.	100% det	1.16	1.56	0.735	1.
Mercury, total, unfiltered, ng/L	Tributary	Deer Creek at A Line Road	01/19/99	04/17/00	5	100%	5	0.53	8.1	100% det	2.43	3.18	1.46	2.8
Mercury, total, unfiltered, ng/L	Tributary	Deer Creek at Ponderosa Way	06/24/98	11/08/99	12	100%	12	0.15	5.	100% det	0.838	1.34	0.5	0.655
Mercury, total, unfiltered, ng/L	Tributary	Deer Creek at Upper Diversion Dam	06/24/98	04/17/00	19	100%	19	0.22	9.6	100% det	1.96	2.84	0.89	1.83
Mercury, total, unfiltered, ng/L	Tributary	Deer Creek at Highway 99	01/19/99	02/14/00	6	100%	6	0.45	9.3	100% det	2.56	3.48	1.29	3.07
Mercury, total, unfiltered, ng/L	Tributary	Deer Creek at Mouth	06/24/98	04/17/00	14	100%	14	0.32	6.	100% det	1.19	1.46	0.828	0.983
Mercury, total, unfiltered, ng/L	Tributary	Big Chico Creek at Hwy 32	06/23/98	04/17/00	19	95%	18	0.18	4.9	3.	0.912	1.06	0.615	0.827
Mercury, total, unfiltered, ng/L	Tributary	Big Chico Creek above Salmon Hole	06/23/98	02/14/00	16	94%	15	0.2	6.4	3.	1.44	1.82	0.808	1.34
Mercury, total, unfiltered, ng/L	Tributary	Big Chico Creek at Chico (Rose Ave.)	06/23/98	04/17/00	19	100%	19	0.23	10.	100% det	1.39	2.24	0.78	1.11
Mercury, total, unfiltered, ng/L	Tributary	Big Chico Creek above Mud Creek	06/23/98	04/17/00	20	95%	19	0.33	10.1	0.2	2.11	2.67	1.1	2.16
Mercury, total, unfiltered, ng/L	Tributary	Mud Creek above Big Chico Creek	06/23/98	04/17/00	11	100%	11	0.4	57.7	100% det	7.38	16.8	2.21	5.64
Mercury, total, unfiltered, ng/L	Tributary	Dry Creek above Cherokee Canal	11/03/01	04/12/03	7	86%	6	2.35	62.72	0.2	17.	21.2	8.81	22.8
Mercury, total, unfiltered, ng/L	Tributary	Little Chico Creek below Chico	02/20/02	04/12/03	5	100%	5	2.32	27.42	100% det	16.3	9.18	12.6	20.9
Mercury, total, unfiltered, ng/L	Tributary	Cache Creek near Rumsey	02/09/96	04/14/98	36	100%	36	2.68	2247.62	100% det	141.	390.	23.6	72.8
Mercury, total, unfiltered, ng/L	Tributary	Cache Slough near Ryers Ferry	06/25/98	02/16/00	11	100%	11	3.09	18.2	100% det	8.62	4.22	7.77	6.07
Mercury, total, unfiltered, ng/L	Urban Creek	Arcade Creek at Norwood Ave.	03/05/96	04/14/03	53	98%	52	1.06	54.3	0.2	11.6	11.4	7.93	10.3
Methylmercury, filtered, ng/L	Ag Drains	Colusa Basin Drain above KL	07/21/00	04/13/03	16	100%	16	0.024	0.316	100% det	0.109	0.097	0.075	0.107
Methylmercury, filtered, ng/L	Ag Drains	Sacramento Slough	07/21/00	04/13/03	16	94%	15	0.021	0.142	0.0278	0.0593	0.0368	0.05	0.0464
Methylmercury, filtered, ng/L	Mainstem	Sacramento River below Keswick	07/19/00	04/03/03	14	29%	4	0.0207	0.0396	0.02	0.0164	0.00946	0.0141	0.0122
Methylmercury, filtered, ng/L	Mainstem	Sacramento River above Bend Bridge	07/19/00	04/04/03	17	35%	6	0.0207	0.0935	0.02	0.0206	0.0234	0.0123	0.0211
Methylmercury, filtered, ng/L	Mainstem	Sacramento River near Hamilton City	07/20/00	04/05/03	17	71%	12	0.02	0.0599	0.02	0.0305	0.0162	0.0265	0.0221
Methylmercury, filtered, ng/L	Mainstem	Sacramento River at Colusa	07/20/00	04/13/03	17	82%	14	0.021	0.081	0.02	0.0399	0.0203	0.0354	0.0277
Methylmercury, filtered, ng/L	Mainstem	Sacramento River at Veterans Bridge	10/17/00	06/10/03	32	81%	26	0.026	0.113	0.025	0.0451	0.0209	0.0409	0.0263
Methylmercury, filtered, ng/L	Mainstem	Sacramento River at Freeport	10/17/00	06/11/03	33	82%	27	0.009	0.094	0.025	0.0431	0.0219	0.0374	0.0297
Methylmercury, filtered, ng/L	Mainstem	Sacramento River at River Mile 44	10/17/00	06/11/03	33	85%	28	0.023	0.752	0.025	0.0728	0.126	0.0479	0.0496
Methylmercury, filtered, ng/L	Mainstem	Sacramento River at Greene's Landing	07/21/00	05/17/01	9	89%	8	0.022	0.092	0.02	0.041	0.0234	0.0359	0.0326
Methylmercury, filtered, ng/L	Major Tributary	Yuba River at Marysville	07/20/00	04/13/03	17	88%	15	0.03	0.145	0.02	0.0686	0.0355	0.0603	0.0502
Methylmercury, filtered, ng/L	Major Tributary	Feather River near Nicolaus	07/21/00	04/13/03	18	89%	16	0.03	0.196	0.02	0.0595	0.0409	0.0503	0.0447
Methylmercury, filtered, ng/L	Major Tributary	American River below Nimbus Dam	10/17/00	06/11/03	32	38%	12	0.008	0.075	0.004	0.0167	0.0165	0.0125	0.0137
Methylmercury, filtered, ng/L	Major Tributary	American River at Discovery Park	10/17/00	06/10/03	32	72%	23	0.021	0.073	0.018	0.035	0.0145	0.0321	0.0194
Methylmercury, filtered, ng/L	Tributary	MF Cottonwood at Platina Rd	11/07/02	03/14/03	3	100%	3	0.0306	0.0518	100% det	0.0406	0.0107	0.0397	0.0211
Methylmercury, filtered, ng/L	Tributary	MF Cottonwood Ck near Ono	11/01/01	02/18/02	2	50%	1	0.0343	0.0343	0.0278	IDD	IDD	IDD	IDD

Summary Statistics: Trace Inorganics (Mercury and Methylmercury)

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Methylmercury, filtered, ng/L	Tributary	MF Cottonwood Ck near Cox Road	04/04/03	04/04/03	1	0%	0	ND	ND	0.0228	IDD	IDD	IDD	IDD
Methylmercury, filtered, ng/L	Tributary	NF Cottonwood Ck near Ono	11/07/02	03/14/03	3	100%	3	0.0373	0.0529	100% det	0.0431	0.00856	0.0425	0.0149
Methylmercury, filtered, ng/L	Tributary	NF Cottonwood Ck at McCauliffe Rd	11/01/01	02/19/02	2	50%	1	0.0482	0.0482	0.0278	IDD	IDD	IDD	IDD
Methylmercury, filtered, ng/L	Tributary	NF Cottonwood Ck near Foster Road	04/04/03	04/04/03	1	0%	0	ND	ND	0.0228	IDD	IDD	IDD	IDD
Methylmercury, filtered, ng/L	Tributary	SF Cottonwood Ck at Anderson Canal	10/31/01	04/04/03	5	80%	4	0.0307	0.179	0.0278	0.0598	0.0684	0.0373	0.0751
Methylmercury, filtered, ng/L	Tributary	North Fork Battle Ck at Wildcat Road	11/01/01	04/04/03	6	33%	2	0.0382	0.0525	0.0207	IDD	IDD	IDD	IDD
Methylmercury, filtered, ng/L	Tributary	South Fork Battle Creek at Manton Road	11/01/01	04/04/03	6	50%	3	0.0356	0.168	0.0207	0.0458	0.0634	0.018	0.0594
Methylmercury, filtered, ng/L	Tributary	Battle Ck below Coleman Fish Hatchery	11/01/01	04/04/03	6	67%	4	0.036	0.295	0.0228	0.0982	0.117	0.043	0.138
Methylmercury, filtered, ng/L	Tributary	Mill Creek at Black Rock	04/06/01	04/06/01	1	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Methylmercury, filtered, ng/L	Tributary	Mill Creek at Highway 99	04/06/01	04/07/01	4	100%	4	0.025	0.045	100% det	0.0328	0.00881	0.0319	0.0151
Methylmercury, filtered, ng/L	Tributary	Mill Creek at Mouth	07/19/00	05/15/01	9	100%	9	0.029	0.315	100% det	0.108	0.0958	0.0793	0.11
Methylmercury, filtered, ng/L	Tributary	Thomes Ck at Paskenta	11/02/01	04/04/03	6	67%	4	0.0211	0.0655	0.0228	0.0345	0.0184	0.0306	0.0262
Methylmercury, filtered, ng/L	Tributary	Thomes Ck at Henleyville	02/20/02	04/04/03	4	75%	3	0.0247	0.0307	0.0278	0.027	0.00261	0.0268	0.0043
Methylmercury, filtered, ng/L	Tributary	Thomes Ck at Rawson Rd Bridge	02/20/02	04/04/03	4	50%	2	0.0263	0.0272	0.0278	IDD	IDD	IDD	IDD
Methylmercury, filtered, ng/L	Tributary	Dry Creek above Cherokee Canal	11/03/01	04/12/03	7	100%	7	0.0666	0.182	100% det	0.117	0.05	0.107	0.0791
Methylmercury, filtered, ng/L	Tributary	Little Chico Creek below Chico	02/20/02	04/12/03	5	40%	2	0.0512	0.0536	0.0278	IDD	IDD	IDD	IDD
Methylmercury, filtered, ng/L	Urban Creek	Arcade Creek at Norwood Ave.	07/21/00	04/14/03	16	100%	16	0.0303	1.183	100% det	0.197	0.287	0.117	0.17
Methylmercury, unfiltered, ng/L	Ag Drains	Colusa Basin Drain above KL	03/06/96	04/13/03	41	100%	41	0.021	0.888	100% det	0.232	0.17	0.18	0.202
Methylmercury, unfiltered, ng/L	Ag Drains	Sacramento Slough	02/12/96	04/13/03	39	100%	39	0.045	1.18	100% det	0.207	0.212	0.153	0.164
Methylmercury, unfiltered, ng/L	Mainstem	Sacramento River below Keswick	07/19/00	04/03/03	14	43%	6	0.0215	0.305	0.02	0.0365	0.0787	0.0111	0.0315
Methylmercury, unfiltered, ng/L	Mainstem	Sacramento River above Bend Bridge	07/19/00	04/04/03	17	82%	14	0.0207	0.13	0.02	0.0414	0.0321	0.0327	0.0363
Methylmercury, unfiltered, ng/L	Mainstem	Sacramento River near Hamilton City	07/20/00	04/05/03	17	94%	16	0.034	0.333	0.02	0.0848	0.0789	0.0648	0.0696
Methylmercury, unfiltered, ng/L	Mainstem	Sacramento River at Colusa	02/28/96	04/13/03	46	98%	45	0.046	1.265	0.025	0.16	0.197	0.115	0.117
Methylmercury, unfiltered, ng/L	Mainstem	Sacramento River at Verona	02/22/96	04/22/98	27	100%	27	0.006	1.977	100% det	0.222	0.378	0.122	0.195
Methylmercury, unfiltered, ng/L	Mainstem	Sacramento River at Veterans Bridge	11/07/00	06/10/03	33	97%	32	0.047	0.216	0.025	0.113	0.0383	0.107	0.0541
Methylmercury, unfiltered, ng/L	Mainstem	Sacramento River at Freeport	02/20/96	06/11/03	78	99%	77	0.012	0.78	0.025	0.126	0.11	0.1	0.0962
Methylmercury, unfiltered, ng/L	Mainstem	Sacramento River at River Mile 44	11/07/00	06/11/03	32	100%	32	0.062	0.251	100% det	0.117	0.0415	0.111	0.0539
Methylmercury, unfiltered, ng/L	Mainstem	Sacramento River at Greene's Landing	07/21/00	06/14/01	15	93%	14	0.052	0.164	0.02	0.0937	0.0354	0.088	0.0511
Methylmercury, unfiltered, ng/L	Major Tributary	Yuba River at Marysville	07/20/00	04/13/03	19	100%	19	0.032	0.26	100% det	0.11	0.0664	0.0937	0.0826
Methylmercury, unfiltered, ng/L	Major Tributary	Feather River near Nicolaus	07/21/00	04/13/03	18	100%	18	0.035	0.277	100% det	0.107	0.0541	0.096	0.0678
Methylmercury, unfiltered, ng/L	Major Tributary	American River below Nimbus Dam	11/07/00	06/11/03	33	58%	19	0.021	0.098	0.025	0.0321	0.0183	0.0283	0.0192
Methylmercury, unfiltered, ng/L	Major Tributary	American River at Discovery Park	11/07/00	06/10/03	33	94%	31	0.034	0.162	0.025	0.0697	0.0349	0.0625	0.0436
Methylmercury, unfiltered, ng/L	Tributary	MF Cottonwood at Platina Rd	11/07/02	03/14/03	3	100%	3	0.0648	0.227	100% det	0.12	0.0927	0.1	0.134
Methylmercury, unfiltered, ng/L	Tributary	MF Cottonwood Ck near Ono	11/01/01	02/18/02	2	50%	1	0.0536	0.0536	0.0278	IDD	IDD	IDD	IDD
Methylmercury, unfiltered, ng/L	Tributary	MF Cottonwood Ck near Cox Road	04/04/03	04/04/03	1	0%	0	ND	ND	0.0228	IDD	IDD	IDD	IDD
Methylmercury, unfiltered, ng/L	Tributary	NF Cottonwood Ck near Ono	11/07/02	03/14/03	3	100%	3	0.0756	0.159	100% det	0.106	0.0461	0.1	0.0761
Methylmercury, unfiltered, ng/L	Tributary	NF Cottonwood Ck at McCauliffe Rd	11/01/01	02/19/02	2	50%	1	0.0686	0.0686	0.0278	IDD	IDD	IDD	IDD
Methylmercury, unfiltered, ng/L	Tributary	NF Cottonwood Ck near Foster Road	04/04/03	04/04/03	1	100%	1	0.0463	0.0463	100% det	IDD	IDD	IDD	IDD
Methylmercury, unfiltered, ng/L	Tributary	SF Cottonwood Ck at Anderson Canal	10/31/01	04/04/03	5	80%	4	0.0274	0.433	0.0278	0.145	0.169	0.0831	0.187
Methylmercury, unfiltered, ng/L	Tributary	North Fork Battle Ck at Wildcat Road	11/01/01	04/04/03	6	67%	4	0.0258	0.0663	0.0207	0.0369	0.0224	0.0314	0.0312
Methylmercury, unfiltered, ng/L	Tributary	South Fork Battle Creek at Manton Road	11/01/01	04/04/03	6	100%	6	0.0283	0.129	100% det	0.0635	0.0388	0.0546	0.0582
Methylmercury, unfiltered, ng/L	Tributary	Battle Ck below Coleman Fish Hatchery	11/01/01	04/04/03	6	100%	6	0.0476	1.28	100% det	0.337	0.484	0.157	0.401
Methylmercury, unfiltered, ng/L	Tributary	Mill Creek at Black Rock	04/06/01	04/06/01	1	100%	1	0.02	0.02	100% det	IDD	IDD	IDD	IDD
Methylmercury, unfiltered, ng/L	Tributary	Mill Creek at Highway 99	04/06/01	04/07/01	4	100%	4	0.03	0.067	100% det	0.0558	0.0174	0.0531	0.033
Methylmercury, unfiltered, ng/L	Tributary	Mill Creek at Mouth	07/19/00	05/15/01	9	100%	9	0.025	0.403	100% det	0.18	0.131	0.135	0.204
Methylmercury, unfiltered, ng/L	Tributary	Thomes Ck at Paskenta	11/02/01	04/04/03	6	100%	6	0.0245	0.136	100% det	0.0755	0.0481	0.0621	0.0791
Methylmercury, unfiltered, ng/L	Tributary	Thomes Ck at Henleyville	02/20/02	04/04/03	4	75%	3	0.0579	0.11	0.0228	0.0729	0.0339	0.0673	0.0565
Methylmercury, unfiltered, ng/L	Tributary	Thomes Ck at Rawson Rd Bridge	02/20/02	04/04/03	4	100%	4	0.0339	0.113	100% det	0.063	0.0361	0.0561	0.0584
Methylmercury, unfiltered, ng/L	Tributary	Dry Creek above Cherokee Canal	11/03/01	04/12/03	7	100%	7	0.103	0.364	100% det	0.214	0.091	0.197	0.154
Methylmercury, unfiltered, ng/L	Tributary	Little Chico Creek below Chico	02/20/02	04/12/03	5	60%	3	0.0629	0.154	0.0278	0.0836	0.0605	0.0654	0.089
Methylmercury, unfiltered, ng/L	Urban Creek	Arcade Creek at Norwood Ave.	07/21/00	04/14/03	16	100%	16	0.0989	1.213	100% det	0.31	0.261	0.255	0.227

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Aldicarb, ug/L	Ag Drains	Colusa Basin Drain above KL	02/13/94	06/10/03	55	2%	1	0.7	0.7	0.016	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Ag Drains	Sacramento Slough	02/23/00	02/23/00	32	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Mainstem	Sacramento River near Hamilton City	08/18/99	08/18/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Mainstem	Sacramento River at Colusa	06/24/99	06/09/03	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Mainstem	Sacramento River 2.5 mi below Verona	06/05/02	02/05/03	52	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Mainstem	Sacramento River at Veterans Bridge	11/15/93	11/07/94	18	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Mainstem	Sacramento River at Freeport	08/26/91	06/11/03	42	0%	0	ND	ND	0.016	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Mainstem	Sacramento River at River Mile 44	12/01/97	04/13/03	12	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Major Tributary	Yuba River at Marysville	06/22/99	06/11/03	10	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Major Tributary	Feather River near Nicolaus	09/25/01	06/09/03	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Major Tributary	American River below Nimbus Dam	02/23/96	01/19/00	17	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Major Tributary	American River at Discovery Park	06/22/99	06/10/03	17	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	62	0%	0	ND	ND	0.016	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	01/20/96	04/01/96	4	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	01/20/96	04/01/96	3	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Aldicarb, ug/L	Urban Runoff	Sump 111, drains to American River	01/20/96	04/01/96	3	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Ag Drains	Jack Slough at Doc Adams Road	02/09/94	03/08/00	18	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Bromacil, ug/L	Ag Drains	Sutter Bypass at Karnak Pumping Sta.	01/04/94	02/18/94	51	10%	5	0.053	0.155	0.05	IDD	IDD	IDD	IDD
Bromacil, ug/L	Ag Drains	Sutter Bypass at Kirkville Road	02/25/00	02/25/00	38	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Bromacil, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	12/07/98	03/08/00	42	17%	7	0.114	0.729	0.05	IDD	IDD	IDD	IDD
Bromacil, ug/L	Ag Drains	Wadsworth Canal at South Butte Road	01/26/94	01/26/94	42	5%	2	0.061	0.09	0.05	IDD	IDD	IDD	IDD
Bromacil, ug/L	Ag Drains	Colusa Basin Drain above KL	01/05/94	06/10/03	55	7%	4	0.2	0.5	0.035	IDD	IDD	IDD	IDD
Bromacil, ug/L	Ag Drains	Sacramento Slough	02/21/00	03/06/02	32	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Mainstem	Sacramento River near Hamilton City	06/23/99	06/09/03	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Mainstem	Sacramento River at Colusa	11/16/99	11/16/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Mainstem	Sacramento River at Veterans Bridge	02/18/94	02/21/94	150	3%	4	0.05	0.09	0.05	IDD	IDD	IDD	IDD
Bromacil, ug/L	Mainstem	Sacramento River at Freeport	12/17/96	06/11/03	42	0%	0	ND	ND	0.035	IDD	IDD	IDD	IDD
Bromacil, ug/L	Mainstem	Sacramento River at River Mile 44	06/22/99	06/10/03	12	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Major Tributary	Yuba River at Marysville	09/19/00	06/10/03	10	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Major Tributary	Feather River near Nicolaus	09/25/01	06/09/03	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Major Tributary	American River below Nimbus Dam	01/12/94	01/19/00	17	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Major Tributary	American River at Discovery Park	06/22/99	06/10/03	17	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	63	6%	4	0.4	1.3	0.035	IDD	IDD	IDD	IDD
Bromacil, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	01/20/96	04/01/96	4	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Bromacil, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	01/20/96	04/01/96	3	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Bromacil, ug/L	Urban Runoff	Sump 111, drains to American River	01/20/96	04/01/96	3	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Ag Drains	Butte Slough at Lower Pass Road	11/07/96	06/09/03	1	0%	0	ND	ND	0.046	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Ag Drains	Sutter Bypass at Karnak Pumping Sta.	02/08/94	02/21/94	57	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Ag Drains	Sutter Bypass at Kirkville Road	02/09/94	02/09/94	45	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	12/04/00	03/06/02	45	2%	1	0.098	0.098	0.046	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Ag Drains	Wadsworth Canal at South Butte Road	02/08/94	02/20/94	24	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Ag Drains	Colusa Basin Drain above KL	06/22/99	06/10/03	56	2%	1	0.04	0.04	0.003	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Ag Drains	Sacramento Slough	01/04/94	02/20/94	33	3%	1	0.14	0.14	0.046	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Mainstem	Sacramento River at Vina at Woodson Bridge	06/23/99	02/05/03	1	0%	0	ND	ND	0.046	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Mainstem	Sacramento River near Hamilton City	02/18/94	04/05/03	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Mainstem	Sacramento River at Colusa	05/15/02	06/09/03	2	0%	0	ND	ND	0.046	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Mainstem	Sacramento River 2.5 mi below Verona	06/04/02	06/10/03	52	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Mainstem	Sacramento River at Veterans Bridge	12/02/96	03/07/97	147	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Mainstem	Sacramento River at Bryte	11/16/99	11/16/99	24	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Mainstem	Sacramento River at Freeport	11/15/96	01/11/01	43	0%	0	ND	ND	0.003	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Mainstem	Sacramento River at River Mile 44	05/15/02	06/10/03	12	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Major Tributary	Feather River at Yuba City	04/20/99	06/11/03	1	0%	0	ND	ND	0.046	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Major Tributary	Yuba River at Marysville	09/19/00	06/11/03	10	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Major Tributary	Feather River near Nicolaus	02/21/00	06/09/03	28	11%	3	0.043	0.3102	0.041	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Major Tributary	American River below Nimbus Dam	02/23/96	06/10/03	16	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Major Tributary	American River at Discovery Park	06/22/99	06/10/03	17	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	62	27%	17	0.05	0.5	0.003	0.0707	0.101	0.0316	0.0686
Carbaryl, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	03/02/95	04/01/96	6	83%	5	0.07	0.33	0.01	0.145	0.108	0.114	0.16
Carbaryl, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	12/11/95	04/01/96	4	75%	3	0.08	0.15	0.07	IDD	IDD	IDD	IDD
Carbaryl, ug/L	Urban Runoff	Sump 111, drains to American River	03/08/95	04/01/96	5	0%	0	ND	ND	0.01	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Ag Drains	Butte Slough at Lower Pass Road	11/07/96	06/09/03	125	26%	32	0.04	1.04	0.044	0.13	0.203	0.0569	0.108
Carbofuran, ug/L	Ag Drains	Jack Slough at Marysville	01/22/97	03/08/00	11	100%	11	0.068	0.37	100% det	0.233	0.103	0.208	0.177
Carbofuran, ug/L	Ag Drains	Main Drainage Canal at Colusa Hwy (trib to Cherokee CN)	08/18/99	08/18/99	10	100%	10	0.045	0.94	100% det	0.261	0.351	0.143	0.229
Carbofuran, ug/L	Ag Drains	Obanion Outfall at DWR PP on Obanion Road	02/25/00	02/25/00	8	88%	7	0.028	0.069	0.044	0.0446	0.0172	0.0416	0.0251
Carbofuran, ug/L	Ag Drains	Sacramento Outfall (Gilsizer Slough)	01/04/94	02/20/94	10	100%	10	0.13	0.29	100% det	0.207	0.0582	0.199	0.0919
Carbofuran, ug/L	Ag Drains	Sutter Bypass at Karnak Pumping Sta.	05/16/95	07/05/02	56	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Ag Drains	Sutter Bypass at Kirkville Road	02/21/00	02/22/00	44	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	01/04/94	02/21/94	54	20%	11	0.024	0.062	0.044	0.0353	0.00879	0.0342	0.0121
Carbofuran, ug/L	Ag Drains	Wadsworth Canal at South Butte Road	01/04/94	02/20/94	24	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Ag Drains	Colusa Basin Drain above KL	01/04/94	06/10/03	290	40%	116	0.023	3.6	0.003	0.211	0.428	0.0598	0.169
Carbofuran, ug/L	Ag Drains	Sacramento Slough	02/25/00	02/25/00	63	43%	27	0.021	0.11	0.044	0.0561	0.0145	0.054	0.0203
Carbofuran, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Mainstem	Sacramento River near Hamilton City	08/18/99	08/18/99	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Carbofuran, ug/L	Mainstem	Sacramento River at Colusa	06/24/99	04/13/03	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Mainstem	Sacramento River 2.5 mi below Verona	12/14/99	09/20/00	52	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Mainstem	Sacramento River at Veterans Bridge	02/18/94	02/18/94	148	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Mainstem	Sacramento River at Bryte	02/17/94	11/16/99	26	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Mainstem	Sacramento River at Village Marina/Crawdads Cantina	06/23/99	02/05/03	99	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Mainstem	Sacramento River at Freeport	05/17/00	05/17/00	44	0%	0	ND	ND	0.003	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Mainstem	Sacramento River at River Mile 44	06/23/99	02/05/03	13	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Major Tributary	Yuba River at Marysville	08/26/91	06/11/03	10	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Major Tributary	Feather River near Nicolaus	01/04/94	06/09/03	34	21%	7	0.021	0.0427	0.031	0.0251	0.00569	0.0245	0.00809
Carbofuran, ug/L	Major Tributary	American River below Nimbus Dam	01/04/94	06/10/03	18	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Major Tributary	American River at Discovery Park	04/20/99	06/10/03	18	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Tributary	Bear River at Berry Road	01/04/94	01/24/94	2	100%	2	0.082	0.11	100% det	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Tributary	Honcut Creek at Chandler Road	01/04/94	01/24/94	2	50%	1	0.094	0.094	0.044	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	62	0%	0	ND	ND	0.003	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	01/20/96	04/01/96	4	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	01/20/96	04/01/96	3	33%	1	0.08	0.08	0.07	IDD	IDD	IDD	IDD
Carbofuran, ug/L	Urban Runoff	Sump 111, drains to American River	01/20/96	04/01/96	3	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Butte Slough at Lower Pass Road	02/08/94	06/09/03	3	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Cherokee Canal at Gridley Road	01/05/94	06/09/03	1	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Gilsizer Slough at Bogue Road	01/14/98	03/08/00	1	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Gilsizer Slough at Richland	01/26/94	01/26/94	1	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Jack Slough at Doc Adams Road	12/04/00	03/14/01	20	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Main Drainage Canal at Colusa Hwy (trib to Cherokee CN)	06/23/99	06/09/03	1	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Obanion Outfall North (Gilsizer Slough)	02/23/00	02/23/00	1	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Obanion Outfall South (Gilsizer Slough)	02/21/00	02/21/00	2	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Sacramento Outfall (Gilsizer Slough)	01/04/94	02/20/94	5	20%	1	0.01	0.01	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Sutter Bypass at Karnak Pumping Sta.	02/21/00	02/21/00	62	0%	0	ND	ND	0.04	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Sutter Bypass at Kirkville Road	12/02/96	03/12/01	46	0%	0	ND	ND	0.04	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	01/24/94	02/20/94	44	0%	0	ND	ND	0.04	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Wadsworth Canal at South Butte Road	01/04/94	07/18/02	43	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Colusa Basin Drain above KL	06/22/99	06/10/03	59	17%	10	0.005	0.7	0.004	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Ag Drains	Sacramento Slough	01/04/94	02/21/94	31	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Mainstem	Sacramento River near Hamilton City	06/22/99	06/10/03	31	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Mainstem	Sacramento River at Colusa	11/16/99	10/30/00	36	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Mainstem	Sacramento River 2.5 mi below Verona	08/18/99	06/11/03	104	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Mainstem	Sacramento River at Veterans Bridge	10/25/91	02/10/92	209	0.5%	1	0.07	0.07	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Mainstem	Sacramento River at Bryte	11/16/99	11/16/99	24	0%	0	ND	ND	0.04	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Mainstem	Sacramento River at Freeport	08/18/99	06/11/03	65	0%	0	ND	ND	0.004	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Mainstem	Sacramento River at River Mile 44	11/15/93	11/07/94	36	0%	0	ND	ND	0.03	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Mainstem	Sacramento River near Sherman Island	04/20/99	06/11/03	12	75%	9	0.018	1.416	0.0001	0.344	0.482	0.0717	0.375
Chlorpyrifos, ug/L	Major Tributary	Feather River at Yuba City	04/20/99	06/11/03	3	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Chlorpyrifos, ug/L	Major Tributary	Yuba River at Marysville	08/26/91	02/10/92	12	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Major Tributary	Feather River near Nicolaus	09/25/01	06/09/03	52	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Major Tributary	American River below Nimbus Dam	01/19/00	01/19/00	40	0%	0	ND	ND	0.03	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Major Tributary	American River at Discovery Park	04/20/99	06/10/03	39	0%	0	ND	ND	0.03	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	Bear River at Berry Road	02/22/00	02/24/00	2	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	Mill Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	6	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	Butte Creek at Gridley Road	02/22/00	02/24/00	2	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Chlorpyrifos, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	63	37%	23	0.0048	0.0445	0.004	0.0138	0.0127	0.00924	0.0135
Chlorpyrifos, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	03/02/95	04/01/96	8	75%	6	0.06	0.53	0.05	0.122	0.171	0.0655	0.133
Chlorpyrifos, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	03/02/95	04/01/96	8	75%	6	0.04	0.08	0.05	0.0521	0.0144	0.0505	0.0209
Chlorpyrifos, ug/L	Urban Runoff	Sump 111, drains to American River	03/02/95	04/01/96	11	27%	3	0.03	0.22	0.05	0.0483	0.0588	0.0323	0.0425
Diazinon, ug/L	Ag Drains	Butte Slough at Lower Pass Road	01/05/94	06/09/03	50	90%	45	0.03	1.	0.02	0.179	0.197	0.12	0.165
Diazinon, ug/L	Ag Drains	Cherokee Canal at Gridley Road	03/07/02	06/09/03	1	100%	1	0.065	0.065	100% det	IDD	IDD	IDD	IDD
Diazinon, ug/L	Ag Drains	Gilsizer Slough at Bogue Road	12/07/98	03/08/00	1	100%	1	0.178	0.178	100% det	IDD	IDD	IDD	IDD
Diazinon, ug/L	Ag Drains	Gilsizer Slough at Richland	12/02/96	03/14/01	1	100%	1	0.115	0.115	100% det	IDD	IDD	IDD	IDD
Diazinon, ug/L	Ag Drains	Jack Slough at Doc Adams Road	01/04/94	06/26/01	22	95%	21	0.084	0.162	0.04	0.118	0.0235	0.116	0.0336
Diazinon, ug/L	Ag Drains	Jack Slough at Marysville	01/04/94	02/20/94	20	100%	20	0.032	1.25	100% det	0.332	0.274	0.257	0.291
Diazinon, ug/L	Ag Drains	Main Drainage Canal at Colusa Hwy (trib to Cherokee CN)	01/05/94	04/13/03	20	95%	19	0.057	2.9	0.03	0.898	0.875	0.52	1.04
Diazinon, ug/L	Ag Drains	Obanion Outfall at DWR PP on Obanion Road	02/21/00	02/22/00	18	100%	18	0.03	0.76	100% det	0.283	0.208	0.204	0.305
Diazinon, ug/L	Ag Drains	Obanion Outfall North (Gilsizer Slough)	02/23/00	02/23/00	1	100%	1	0.028	0.028	100% det	IDD	IDD	IDD	IDD
Diazinon, ug/L	Ag Drains	Obanion Outfall South (Gilsizer Slough)	01/04/94	02/24/00	2	100%	2	0.081	0.103	100% det	IDD	IDD	IDD	IDD
Diazinon, ug/L	Ag Drains	Sacramento Outfall (Gilsizer Slough)	01/04/94	02/18/94	24	100%	24	0.055	2.8	100% det	0.461	0.64	0.253	0.433
Diazinon, ug/L	Ag Drains	Sutter Bypass at Karnak Pumping Sta.	02/08/94	02/24/00	57	42%	24	0.04	0.132	0.04	0.0401	0.0273	0.0325	0.0311
Diazinon, ug/L	Ag Drains	Sutter Bypass at Kirkville Road	01/20/97	03/08/00	46	26%	12	0.041	0.104	0.04	0.0362	0.024	0.0295	0.0278
Diazinon, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	02/19/02	03/06/02	64	81%	52	0.042	4.8	0.04	0.591	0.938	0.232	0.558
Diazinon, ug/L	Ag Drains	Wadsworth Canal at South Butte Road	01/24/94	02/20/94	44	45%	20	0.04	1.32	0.04	0.105	0.23	0.0238	0.0812
Diazinon, ug/L	Ag Drains	Colusa Basin Drain above KL	01/05/94	06/10/03	114	52%	59	0.005	0.42	0.002	0.0551	0.0882	0.0231	0.0493
Diazinon, ug/L	Ag Drains	Sacramento Slough	02/21/00	02/22/00	91	67%	61	0.03	1.5	0.05	0.223	0.323	0.0978	0.205
Diazinon, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River above Bend Bridge	02/17/94	05/16/00	2	50%	1	0.08	0.08	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River at Bend Ferry Rd Bridge	03/22/00	03/22/00	3	0%	0	ND	ND	0.03	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River at Vina at Woodson Bridge	11/15/96	09/15/98	6	83%	5	0.065	0.29	0.03	0.157	0.0919	0.132	0.153
Diazinon, ug/L	Mainstem	Sacramento River near Hamilton City	12/01/97	06/10/03	36	14%	5	0.03	0.23	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River at Ord Bend Rd Bridge	07/20/99	06/10/03	4	75%	3	0.036	0.1	0.03	0.0606	0.0407	0.0492	0.0677
Diazinon, ug/L	Mainstem	Sacramento River at Butte City at Hwy 162 bridge	11/16/99	11/16/99	2	100%	2	0.064	0.155	100% det	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River at Colusa	06/24/99	06/09/03	87	38%	33	0.017	0.22	0.02	0.0374	0.0361	0.0278	0.0292
Diazinon, ug/L	Mainstem	Sacramento River 2.5 mi below Verona	02/18/94	02/18/94	52	4%	2	0.07	0.11	0.05	IDD	IDD	IDD	IDD

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Diazinon, ug/L	Mainstem	Sacramento River at Veterans Bridge	02/17/94	02/21/94	233	10%	24	0.011	0.171	0.01	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River at Bryte	06/24/99	06/09/03	24	17%	4	0.061	0.065	0.04	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River at Village Marina/Crawdads Cantina	11/15/93	11/07/94	10	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River at Tower Bridge	01/03/94	02/26/94	41	63%	26	0.03	0.253	0.03	0.055	0.0603	0.0335	0.0532
Diazinon, ug/L	Mainstem	Sacramento River at Miller Park	12/01/97	04/13/03	10	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River at Freeport	11/15/96	01/11/01	101	12%	12	0.005	0.14	0.002	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River at River Mile 44	06/23/99	02/05/03	59	3%	2	0.015	0.039	0.01	IDD	IDD	IDD	IDD
Diazinon, ug/L	Mainstem	Sacramento River near Sherman Island	02/09/94	08/06/97	12	92%	11	1.2	46.629	0.0001	11.4	16.	4.38	12.3
Diazinon, ug/L	Major Tributary	Feather River at Yuba City	02/21/00	02/23/00	40	38%	15	0.036	0.171	0.02	0.0524	0.0426	0.0384	0.0464
Diazinon, ug/L	Major Tributary	Yuba River at Marysville	02/21/00	02/23/00	25	8%	2	0.048	0.19	0.008	IDD	IDD	IDD	IDD
Diazinon, ug/L	Major Tributary	Feather River near Nicolaus	09/25/01	06/09/03	95	29%	28	0.02	0.9778	0.02	0.077	0.188	0.0103	0.044
Diazinon, ug/L	Major Tributary	American River below Nimbus Dam	02/23/96	06/10/03	77	3%	2	0.012	0.09	0.01	IDD	IDD	IDD	IDD
Diazinon, ug/L	Major Tributary	American River at Watt Avenue Bridge	09/25/01	06/09/03	10	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Diazinon, ug/L	Major Tributary	American River at Discovery Park	10/25/91	06/10/03	80	15%	12	0.013	0.1	0.01	IDD	IDD	IDD	IDD
Diazinon, ug/L	Tributary	Bear River at Berry Road	01/04/94	02/24/00	12	67%	8	0.02	0.203	0.03	0.0696	0.0662	0.045	0.0712
Diazinon, ug/L	Tributary	Honcut Creek at Chandler Road	01/04/94	02/20/94	11	64%	7	0.04	0.2	0.03	0.0746	0.0597	0.0545	0.0776
Diazinon, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Tributary	Mill Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	6	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Tributary	Butte Creek at Gridley Road	02/22/00	02/24/00	2	100%	2	0.025	0.029	100% det	IDD	IDD	IDD	IDD
Diazinon, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	100%	1	0.03	0.03	100% det	IDD	IDD	IDD	IDD
Diazinon, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	63	92%	58	0.06	1.38	0.05	0.325	0.263	0.25	0.27
Diazinon, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	10/25/91	04/01/96	17	53%	9	0.21	1.1	0.1	0.475	0.309	0.384	0.396
Diazinon, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	10/25/91	04/01/96	16	38%	6	0.19	0.96	0.1	0.246	0.236	0.168	0.278
Diazinon, ug/L	Urban Runoff	Sump 111, drains to American River	10/25/91	04/01/96	26	19%	5	0.1	0.77	0.05	IDD	IDD	IDD	IDD
Diazinon, ug/L	Urban Runoff	Sump 34, drains to Sacramento River upstream of Freeport	10/25/91	02/10/92	10	20%	2	1.1	2.4	0.1	IDD	IDD	IDD	IDD
Diazinon, ug/L	Urban Runoff	Urban runoff site btwn Riley and Wool streets, Folsom	10/25/91	02/10/92	10	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Diuron, ug/L	Ag Drains	Jack Slough at Doc Adams Road	01/04/94	02/20/94	18	72%	13	0.05	2.22	0.05	0.759	0.71	0.305	0.866
Diuron, ug/L	Ag Drains	Sutter Bypass at Karnak Pumping Sta.	02/23/00	02/23/00	51	49%	25	0.053	0.269	0.05	0.0684	0.0553	0.0522	0.0577
Diuron, ug/L	Ag Drains	Sutter Bypass at Kirkville Road	02/21/00	02/24/00	38	5%	2	0.103	0.158	0.05	IDD	IDD	IDD	IDD
Diuron, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	01/04/94	02/20/94	42	67%	28	0.053	1.13	0.05	0.161	0.221	0.0853	0.156
Diuron, ug/L	Ag Drains	Wadsworth Canal at South Butte Road	02/08/94	02/08/94	42	26%	11	0.05	0.291	0.05	0.0409	0.0679	0.014	0.0372
Diuron, ug/L	Ag Drains	Colusa Basin Drain above KL	06/22/99	06/10/03	55	40%	22	0.04	0.9	0.02	0.204	0.216	0.123	0.203
Diuron, ug/L	Ag Drains	Sacramento Slough	12/02/96	03/14/01	32	9%	3	0.4	0.8	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Mainstem	Sacramento River near Hamilton City	12/01/97	06/10/03	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Mainstem	Sacramento River at Colusa	01/25/94	04/13/03	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Mainstem	Sacramento River at Veterans Bridge	01/20/97	06/11/03	150	49%	74	0.05	1.42	0.05	0.104	0.179	0.0518	0.0931
Diuron, ug/L	Mainstem	Sacramento River at Freeport	11/15/96	06/11/03	42	14%	6	0.06	1.1	0.02	IDD	IDD	IDD	IDD
Diuron, ug/L	Mainstem	Sacramento River at River Mile 44	12/02/96	03/07/97	12	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Major Tributary	Yuba River at Marysville	06/22/99	06/11/03	10	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Diuron, ug/L	Major Tributary	Feather River near Nicolaus	02/21/00	06/09/03	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Major Tributary	American River below Nimbus Dam	02/23/96	06/10/03	17	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Major Tributary	American River at Discovery Park	06/22/99	06/10/03	17	12%	2	0.3	0.6	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Diuron, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	100%	1	0.9	0.9	100% det	IDD	IDD	IDD	IDD
Diuron, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	62	48%	30	0.12	6.3	0.02	0.475	0.877	0.218	0.426
Diuron, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	03/02/95	04/01/96	6	83%	5	0.8	12.	0.01	4.78	5.03	2.34	7.2
Diuron, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	12/11/95	04/01/96	4	100%	4	0.4	0.8	100% det	0.6	0.183	0.579	0.342
Diuron, ug/L	Urban Runoff	Sump 111, drains to American River	03/08/95	04/01/96	5	80%	4	0.6	6.	0.01	1.66	2.45	0.741	2.11
EPTC, ug/L	Ag Drains	Butte Slough at Lower Pass Road	01/26/94	06/09/03	9	44%	4	0.007	0.023	0.005	0.00877	0.00787	0.00586	0.00956
EPTC, ug/L	Ag Drains	Obanion Outfall at DWR PP on Obanion Road	12/02/96	03/12/01	1	100%	1	0.005	0.005	100% det	IDD	IDD	IDD	IDD
EPTC, ug/L	Ag Drains	Sacramento Outfall (Gilsizer Slough)	01/04/94	02/20/94	7	86%	6	0.005	0.013	0.005	0.00623	0.00337	0.00565	0.00411
EPTC, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	01/24/94	02/18/94	5	20%	1	0.008	0.008	0.005	IDD	IDD	IDD	IDD
EPTC, ug/L	Ag Drains	Colusa Basin Drain above KL	06/22/99	06/10/03	52	19%	10	0.0059	0.716	0.002	IDD	IDD	IDD	IDD
EPTC, ug/L	Ag Drains	Sacramento Slough	01/20/97	03/08/00	28	18%	5	0.007	0.01	0.005	IDD	IDD	IDD	IDD
EPTC, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Mainstem	Sacramento River near Hamilton City	12/01/97	06/10/03	20	5%	1	0.12	0.12	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Mainstem	Sacramento River at Colusa	11/16/99	11/16/99	21	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Mainstem	Sacramento River at Veterans Bridge	02/09/94	08/06/97	52	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Mainstem	Sacramento River at Freeport	08/18/99	08/18/99	58	2%	1	0.0221	0.0221	0.002	IDD	IDD	IDD	IDD
EPTC, ug/L	Mainstem	Sacramento River at River Mile 44	06/23/99	02/05/03	29	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Major Tributary	Yuba River at Marysville	06/04/02	06/10/03	11	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Major Tributary	Feather River near Nicolaus	09/25/01	06/09/03	47	0%	0	ND	ND	0.044	IDD	IDD	IDD	IDD
EPTC, ug/L	Major Tributary	American River below Nimbus Dam	01/19/00	01/19/00	32	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Major Tributary	American River at Discovery Park	08/26/91	06/10/03	31	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Tributary	Mill Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	6	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	53	4%	2	0.0062	0.0135	0.002	IDD	IDD	IDD	IDD
EPTC, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	03/02/95	02/18/96	4	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	03/02/95	12/11/95	3	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
EPTC, ug/L	Urban Runoff	Sump 111, drains to American River	03/02/95	12/11/95	5	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Butte Slough at Lower Pass Road	01/04/94	06/09/03	117	3%	4	0.05	0.639	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Cherokee Canal at Gridley Road	01/27/94	04/13/03	1	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Gilsizer Slough at Bogue Road	12/04/00	03/06/02	1	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Gilsizer Slough at Richland	01/20/97	03/08/00	1	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Jack Slough at Doc Adams Road	01/04/94	02/20/94	20	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Jack Slough at Marysville	01/04/94	03/08/00	1	0%	0	ND	ND	0.014	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Main Drainage Canal at Colusa Hwy (trib to Cherokee CN)	01/05/94	06/09/03	3	33%	1	0.026	0.026	0.014	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Obanion Outfall at DWR PP on Obanion Road	01/20/97	03/08/00	1	100%	1	0.02	0.02	100% det	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Obanion Outfall North (Gilsizer Slough)	02/21/00	03/06/02	1	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Obanion Outfall South (Gilsizer Slough)	02/23/00	02/23/00	2	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Malathion, ug/L	Ag Drains	Sacramento Outfall (Gilsizer Slough)	01/04/94	02/21/94	4	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Sutter Bypass at Karnak Pumping Sta.	02/23/00	02/23/00	57	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Sutter Bypass at Kirkville Road	12/07/98	03/08/00	46	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	12/01/97	03/14/01	44	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Wadsworth Canal at South Butte Road	02/09/94	02/09/94	43	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Colusa Basin Drain above KL	01/05/94	06/10/03	257	15%	38	0.006	6.	0.005	IDD	IDD	IDD	IDD
Malathion, ug/L	Ag Drains	Sacramento Slough	01/04/94	02/24/00	31	3%	1	0.1	0.1	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River near Hamilton City	12/01/97	06/10/03	31	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River at Colusa	05/15/02	06/09/03	36	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River 2.5 mi below Verona	12/14/99	09/20/00	52	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River at Veterans Bridge	10/25/91	02/10/92	207	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River at Bryte	01/04/94	06/09/03	24	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River at Village Marina/Crawdads Cantina	11/15/96	08/13/98	126	0%	0	ND	ND	0.03	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River at Miller Park	03/21/00	04/13/03	13	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River at Freeport	08/18/99	08/18/99	77	0%	0	ND	ND	0.005	IDD	IDD	IDD	IDD
Malathion, ug/L	Mainstem	Sacramento River at River Mile 44	11/15/93	11/07/94	34	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Major Tributary	Feather River at Yuba City	10/25/91	06/11/03	3	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Major Tributary	Yuba River at Marysville	06/05/02	06/11/03	12	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Major Tributary	Feather River near Nicolaus	03/07/02	06/09/03	52	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Major Tributary	American River below Nimbus Dam	01/12/94	06/10/03	51	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Major Tributary	American River at Watt Avenue Bridge	09/25/01	06/09/03	13	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Major Tributary	American River at Discovery Park	06/22/99	06/10/03	55	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	Bear River at Berry Road	02/22/00	02/24/00	2	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	Mill Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	6	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	Butte Creek at Gridley Road	02/22/00	02/24/00	2	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Malathion, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	63	25%	16	0.012	0.634	0.005	0.0346	0.0833	0.0117	0.0291
Malathion, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	08/26/91	04/01/96	20	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	08/26/91	04/01/96	20	5%	1	0.09	0.09	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Urban Runoff	Sump 111, drains to American River	08/26/91	04/01/96	30	3%	1	0.52	0.52	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Urban Runoff	Sump 34, drains to Sacramento River upstream of Freeport	08/26/91	02/10/92	13	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Malathion, ug/L	Urban Runoff	Urban runoff site btwn Riley and Wool streets, Folsom	08/26/91	02/10/92	13	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Methomyl, ug/L	Ag Drains	Colusa Basin Drain above KL	03/08/02	06/10/03	54	2%	1	0.19	0.19	0.017	IDD	IDD	IDD	IDD
Methomyl, ug/L	Ag Drains	Sacramento Slough	01/04/94	03/08/00	32	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Mainstem	Sacramento River near Hamilton City	01/20/97	06/10/03	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Mainstem	Sacramento River at Colusa	12/17/96	06/11/03	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD

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Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Methomyl, ug/L	Mainstem	Sacramento River 2.5 mi below Verona	02/17/94	02/18/94	52	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Methomyl, ug/L	Mainstem	Sacramento River at Veterans Bridge	11/15/93	11/07/94	18	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Mainstem	Sacramento River at Freeport	08/18/99	08/18/99	42	0%	0	ND	ND	0.017	IDD	IDD	IDD	IDD
Methomyl, ug/L	Mainstem	Sacramento River at River Mile 44	02/18/94	02/18/94	12	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Major Tributary	Yuba River at Marysville	11/16/99	01/11/01	10	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Major Tributary	Feather River near Nicolaus	09/25/01	04/13/03	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Major Tributary	American River below Nimbus Dam	01/19/00	04/13/03	17	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Major Tributary	American River at Discovery Park	09/21/99	01/11/01	17	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	62	0%	0	ND	ND	0.017	IDD	IDD	IDD	IDD
Methomyl, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	01/20/96	04/01/96	4	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	01/20/96	04/01/96	3	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Methomyl, ug/L	Urban Runoff	Sump 111, drains to American River	01/20/96	04/01/96	3	0%	0	ND	ND	0.07	IDD	IDD	IDD	IDD
Molinate, ug/L	Ag Drains	Butte Slough at Lower Pass Road	11/07/96	06/09/03	146	77%	112	0.072	23.7	0.11	4.68	5.3	1.64	4.82
Molinate, ug/L	Ag Drains	Jack Slough at Marysville	12/04/00	03/14/01	11	100%	11	0.04	0.42	100% det	0.275	0.107	0.241	0.215
Molinate, ug/L	Ag Drains	Main Drainage Canal at Colusa Hwy (trib to Cherokee CN)	01/05/94	06/09/03	10	100%	10	0.15	0.24	100% det	0.177	0.0283	0.175	0.0398
Molinate, ug/L	Ag Drains	Obanion Outfall at DWR PP on Obanion Road	02/08/94	02/24/00	8	100%	8	0.053	0.96	100% det	0.217	0.309	0.125	0.211
Molinate, ug/L	Ag Drains	Sacramento Outfall (Gilsizer Slough)	02/19/02	03/06/02	10	100%	10	0.26	0.475	100% det	0.347	0.0703	0.34	0.109
Molinate, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	01/14/98	03/08/00	12	92%	11	0.041	0.09	0.11	0.0601	0.015	0.0585	0.0238
Molinate, ug/L	Ag Drains	Colusa Basin Drain above KL	06/22/99	04/13/03	268	85%	229	0.009	44.09	0.11	7.94	9.48	2.18	8.03
Molinate, ug/L	Ag Drains	Sacramento Slough	02/23/00	03/06/02	33	100%	33	0.053	3.7	100% det	0.298	0.792	0.121	0.122
Molinate, ug/L	Mainstem	Sacramento River at Colusa	12/17/96	06/11/03	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Molinate, ug/L	Mainstem	Sacramento River at Veterans Bridge	02/17/94	02/21/94	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Molinate, ug/L	Mainstem	Sacramento River at Village Marina/Crawdads Cantina	04/14/95	07/18/02	125	26%	33	0.95	3.21	0.5	0.827	0.54	0.686	0.6
Molinate, ug/L	Mainstem	Sacramento River at Freeport	08/18/99	08/18/99	25	60%	15	0.006	1.57	0.004	0.138	0.343	0.0105	0.072
Molinate, ug/L	Major Tributary	Feather River near Nicolaus	09/25/01	06/09/03	37	27%	10	0.022	0.902	0.06	0.0733	0.15	0.0366	0.0585
Molinate, ug/L	Tributary	Bear River at Berry Road	01/04/94	01/24/94	2	50%	1	0.055	0.055	0.11	IDD	IDD	IDD	IDD
Molinate, ug/L	Tributary	Honcut Creek at Chandler Road	01/04/94	01/04/94	1	100%	1	0.038	0.038	100% det	IDD	IDD	IDD	IDD
Molinate, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	04/23/98	30	3%	1	0.0535	0.0535	0.004	IDD	IDD	IDD	IDD
Oryzalin, ug/L	Ag Drains	Colusa Basin Drain above KL	11/16/99	05/16/02	7	14%	1	0.5	0.5	0.4	IDD	IDD	IDD	IDD
Oryzalin, ug/L	Ag Drains	Sacramento Slough	02/19/02	03/06/02	7	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Oryzalin, ug/L	Mainstem	Sacramento River at Veterans Bridge	06/23/99	02/05/03	5	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Oryzalin, ug/L	Mainstem	Sacramento River at Freeport	06/23/99	06/09/03	29	3%	1	0.1	0.1	0.019	IDD	IDD	IDD	IDD
Oryzalin, ug/L	Mainstem	Sacramento River at River Mile 44	12/04/96	03/07/97	2	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Oryzalin, ug/L	Major Tributary	Yuba River at Marysville	02/08/94	02/09/94	6	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Oryzalin, ug/L	Major Tributary	American River below Nimbus Dam	01/19/00	04/13/03	5	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Oryzalin, ug/L	Major Tributary	American River at Discovery Park	09/21/99	09/21/99	5	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Oryzalin, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	36	19%	7	0.08	1.51	0.019	IDD	IDD	IDD	IDD
Prometon, ug/L	Ag Drains	Jack Slough at Doc Adams Road	01/04/94	02/18/94	18	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Prometon, ug/L	Ag Drains	Obanion Outfall at DWR PP on Obanion Road	12/07/98	03/08/00	1	100%	1	0.009	0.009	100% det	IDD	IDD	IDD	IDD
Prometon, ug/L	Ag Drains	Sutter Bypass at Karnak Pumping Sta.	02/21/00	03/06/02	51	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Prometon, ug/L	Ag Drains	Sutter Bypass at Kirkville Road	02/23/00	03/06/02	38	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Prometon, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	01/04/94	02/20/94	42	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Prometon, ug/L	Ag Drains	Wadsworth Canal at South Butte Road	01/04/94	02/20/94	42	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Prometon, ug/L	Ag Drains	Colusa Basin Drain above KL	06/22/99	06/10/03	63	14%	9	0.058	0.32	0.018	IDD	IDD	IDD	IDD
Prometon, ug/L	Ag Drains	Sacramento Slough	12/01/97	03/14/01	32	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	2	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	2	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Mainstem	Sacramento River near Hamilton City	12/01/97	06/10/03	31	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Mainstem	Sacramento River at Colusa	11/15/96	06/11/03	35	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Mainstem	Sacramento River at Veterans Bridge	09/20/00	06/11/03	177	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Prometon, ug/L	Mainstem	Sacramento River at Freeport	02/17/94	06/09/03	31	0%	0	ND	ND	0.018	IDD	IDD	IDD	IDD
Prometon, ug/L	Mainstem	Sacramento River at River Mile 44	04/21/99	02/05/03	2	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Major Tributary	Feather River at Yuba City	10/25/91	02/10/92	2	100%	2	0.009	0.011	100% det	IDD	IDD	IDD	IDD
Prometon, ug/L	Major Tributary	Yuba River at Marysville	08/17/99	06/11/03	10	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Major Tributary	Feather River near Nicolaus	01/05/94	04/13/03	32	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Major Tributary	American River below Nimbus Dam	01/19/00	06/10/03	4	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Major Tributary	American River at Discovery Park	08/17/99	06/10/03	5	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	2	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	2	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	2	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Tributary	Mill Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	6	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	2	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	2	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	95	40%	38	0.0297	0.524	0.018	0.108	0.0871	0.0851	0.083
Prometon, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	03/02/95	04/01/96	7	14%	1	0.1	0.1	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	03/02/95	04/01/96	6	17%	1	0.24	0.24	0.1	IDD	IDD	IDD	IDD
Prometon, ug/L	Urban Runoff	Sump 111, drains to American River	03/02/95	04/01/96	11	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Propazine, ug/L	Ag Drains	Colusa Basin Drain above KL	01/17/94	04/13/03	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Ag Drains	Sacramento Slough	01/14/98	03/08/00	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Mainstem	Sacramento River near Hamilton City	05/16/00	06/10/03	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Mainstem	Sacramento River at Colusa	11/15/96	06/11/03	3	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Mainstem	Sacramento River at Veterans Bridge	12/02/96	03/07/97	12	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Mainstem	Sacramento River at Freeport	08/18/99	08/18/99	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Major Tributary	Feather River near Nicolaus	09/25/01	06/09/03	12	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Major Tributary	American River at Discovery Park	09/21/99	01/11/01	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Propazine, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	06/10/03	32	6%	2	1.1	2.	0.5	IDD	IDD	IDD	IDD
Prowl, ug/L	Ag Drains	Colusa Basin Drain above KL	01/25/94	06/10/03	33	3%	1	0.22	0.22	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Ag Drains	Sacramento Slough	12/07/98	03/08/00	31	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Prowl, ug/L	Mainstem	Sacramento River near Hamilton City	12/01/97	06/10/03	31	3%	1	0.18	0.18	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Mainstem	Sacramento River at Colusa	11/15/96	06/11/03	33	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Mainstem	Sacramento River at Veterans Bridge	08/26/91	02/10/92	69	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Mainstem	Sacramento River at Freeport	04/18/00	06/09/03	37	5%	2	0.11	0.2	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Mainstem	Sacramento River at River Mile 44	04/14/95	06/26/01	32	6%	2	0.13	0.19	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Major Tributary	Yuba River at Marysville	11/16/99	01/11/01	11	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Major Tributary	Feather River near Nicolaus	06/22/99	06/11/03	21	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Major Tributary	American River below Nimbus Dam	01/04/94	04/13/03	36	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Major Tributary	American River at Discovery Park	06/22/99	06/10/03	35	3%	1	0.11	0.11	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Tributary	Mill Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	6	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Prowl, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	06/10/03	33	6%	2	0.1	0.47	0.1	IDD	IDD	IDD	IDD
Simazine, ug/L	Ag Drains	Butte Slough at Lower Pass Road	01/05/94	06/09/03	17	94%	16	0.011	0.44	0.06	0.177	0.114	0.124	0.199
Simazine, ug/L	Ag Drains	Jack Slough at Doc Adams Road	12/02/96	03/14/01	18	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Simazine, ug/L	Ag Drains	Jack Slough at Marysville	02/21/00	02/23/00	11	100%	11	0.019	1.348	100% det	0.46	0.393	0.296	0.589
Simazine, ug/L	Ag Drains	Main Drainage Canal at Colusa Hwy (trib to Cherokee CN)	06/22/99	06/10/03	8	100%	8	0.011	0.21	100% det	0.056	0.0649	0.0369	0.0609
Simazine, ug/L	Ag Drains	Obanion Outfall at DWR PP on Obanion Road	02/23/00	03/06/02	7	86%	6	0.16	0.72	0.06	0.282	0.235	0.216	0.287
Simazine, ug/L	Ag Drains	Sacramento Outfall (Gilsizer Slough)	02/09/94	02/09/94	10	100%	10	0.033	1.2	100% det	0.531	0.375	0.355	0.686
Simazine, ug/L	Ag Drains	Sutter Bypass at Karnak Pumping Sta.	02/08/94	02/08/94	51	14%	7	0.065	0.126	0.05	IDD	IDD	IDD	IDD
Simazine, ug/L	Ag Drains	Sutter Bypass at Kirkville Road	01/04/94	07/18/02	38	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Simazine, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	01/24/94	03/08/00	53	53%	28	0.047	0.64	0.05	0.148	0.137	0.0986	0.14
Simazine, ug/L	Ag Drains	Wadsworth Canal at South Butte Road	01/24/94	02/18/94	42	14%	6	0.06	0.214	0.05	IDD	IDD	IDD	IDD
Simazine, ug/L	Ag Drains	Colusa Basin Drain above KL	01/05/94	06/10/03	82	54%	44	0.0064	0.98	0.005	0.172	0.25	0.0522	0.158
Simazine, ug/L	Ag Drains	Sacramento Slough	12/04/00	03/06/02	58	41%	24	0.008	0.28	0.008	0.132	0.118	0.0861	0.137
Simazine, ug/L	Mainstem	Sacramento River below Keswick	03/22/00	03/22/00	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Mainstem	Sacramento River at Vina at Woodson Bridge	04/14/95	07/18/02	2	100%	2	0.075	0.13	100% det	IDD	IDD	IDD	IDD
Simazine, ug/L	Mainstem	Sacramento River near Hamilton City	06/22/99	06/10/03	32	3%	1	0.078	0.078	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Mainstem	Sacramento River at Butte City at Hwy 162 bridge	05/16/00	06/09/03	1	100%	1	0.11	0.11	100% det	IDD	IDD	IDD	IDD
Simazine, ug/L	Mainstem	Sacramento River at Colusa	10/25/91	06/11/03	52	31%	16	0.01	0.75	0.06	0.195	0.171	0.129	0.194
Simazine, ug/L	Mainstem	Sacramento River at Veterans Bridge	04/21/99	06/11/03	178	4%	7	0.054	0.078	0.05	IDD	IDD	IDD	IDD
Simazine, ug/L	Mainstem	Sacramento River at Freeport	06/23/99	06/09/03	31	42%	13	0.0059	0.0196	0.005	0.00676	0.00446	0.00552	0.00573
Simazine, ug/L	Mainstem	Sacramento River at River Mile 44	11/15/93	11/07/94	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Major Tributary	Feather River at Yuba City	01/04/94	02/23/00	5	80%	4	0.022	0.075	0.008	0.0443	0.0264	0.0372	0.0451
Simazine, ug/L	Major Tributary	Yuba River at Marysville	01/04/94	02/09/94	13	15%	2	0.009	0.055	0.06	IDD	IDD	IDD	IDD
Simazine, ug/L	Major Tributary	Feather River near Nicolaus	06/22/99	06/11/03	70	19%	13	0.014	0.329	0.022	IDD	IDD	IDD	IDD
Simazine, ug/L	Major Tributary	American River below Nimbus Dam	01/28/94	01/19/00	4	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Major Tributary	American River at Discovery Park	01/19/00	01/19/00	5	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Tributary	Bear River at Berry Road	01/04/94	01/24/94	2	100%	2	0.066	0.132	100% det	IDD	IDD	IDD	IDD
Simazine, ug/L	Tributary	Honcut Creek at Chandler Road	01/04/94	01/04/94	1	100%	1	0.021	0.021	100% det	IDD	IDD	IDD	IDD

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Simazine, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Tributary	Mill Creek at Mouth	01/26/01	04/12/03	9	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	6	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	10	20%	2	1.2	1.5	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Simazine, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	95	23%	22	0.0083	0.191	0.005	0.0362	0.0514	0.017	0.0358
Simazine, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	03/02/95	04/01/96	6	83%	5	0.6	4.2	0.01	2.1	1.52	1.54	2.6
Simazine, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	12/11/95	04/01/96	4	75%	3	0.55	1.9	0.01	0.794	0.765	0.557	1.02
Simazine, ug/L	Urban Runoff	Sump 111, drains to American River	03/08/95	04/01/96	14	21%	3	0.55	6.1	0.01	0.806	1.9	0.0224	0.262
Tebuthiuron, ug/L	Ag Drains	Butte Slough at Lower Pass Road	05/16/95	06/09/03	1	0%	0	ND	ND	0.015	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Ag Drains	Jack Slough at Marysville	02/21/00	02/21/00	3	0%	0	ND	ND	0.015	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Ag Drains	Sacramento Outfall (Gilsizer Slough)	12/01/97	03/14/01	8	88%	7	0.025	1.	0.015	0.186	0.333	0.0704	0.197
Tebuthiuron, ug/L	Ag Drains	Colusa Basin Drain above KL	02/19/02	03/06/02	70	9%	6	0.0127	0.07	0.01	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Ag Drains	Sacramento Slough	01/04/94	02/17/94	38	8%	3	0.025	0.11	0.015	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Mainstem	Sacramento River below Keswick	11/16/99	11/16/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Mainstem	Sacramento River above Bend Bridge	05/16/00	05/16/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Mainstem	Sacramento River near Hamilton City	05/15/02	06/10/03	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Mainstem	Sacramento River at Colusa	12/17/96	06/11/03	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Mainstem	Sacramento River at Veterans Bridge	08/26/91	07/05/02	18	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Mainstem	Sacramento River at Freeport	08/18/99	08/18/99	43	0%	0	ND	ND	0.01	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Mainstem	Sacramento River at River Mile 44	12/02/96	03/07/97	11	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Major Tributary	Yuba River at Marysville	06/22/99	06/11/03	10	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Major Tributary	Feather River near Nicolaus	06/22/99	06/11/03	3	33%	1	0.052	0.052	0.015	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Major Tributary	American River below Nimbus Dam	02/23/96	06/10/03	17	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Major Tributary	American River at Discovery Park	01/19/00	01/19/00	17	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.4	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	06/10/03	63	16%	10	0.0134	3.	0.01	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Urban Runoff	Chicken/Strong Ranch Slough, drains to American River.	01/20/96	04/01/96	4	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Urban Runoff	Sump 104, drains to Sacramento River	01/20/96	04/01/96	3	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Tebuthiuron, ug/L	Urban Runoff	Sump 111, drains to American River	01/20/96	04/01/96	3	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Thiobencarb, ug/L	Ag Drains	Butte Slough at Lower Pass Road	11/07/96	06/09/03	139	35%	49	0.008	6.	0.008	0.556	0.915	0.133	0.443
Thiobencarb, ug/L	Ag Drains	Jack Slough at Marysville	02/24/00	02/24/00	1	0%	0	ND	ND	0.008	IDD	IDD	IDD	IDD
Thiobencarb, ug/L	Ag Drains	Main Drainage Canal at Colusa Hwy (trib to Cherokee CN)	06/22/99	06/10/03	4	0%	0	ND	ND	0.008	IDD	IDD	IDD	IDD
Thiobencarb, ug/L	Ag Drains	Obanion Outfall at DWR PP on Obanion Road	01/04/94	02/23/00	1	0%	0	ND	ND	0.008	IDD	IDD	IDD	IDD
Thiobencarb, ug/L	Ag Drains	Sacramento Outfall (Gilsizer Slough)	01/14/98	03/08/00	9	100%	9	0.011	0.042	100% det	0.024	0.0104	0.0219	0.0163
Thiobencarb, ug/L	Ag Drains	Wadsworth Canal at Franklin Rd	12/04/00	03/06/02	5	0%	0	ND	ND	0.008	IDD	IDD	IDD	IDD
Thiobencarb, ug/L	Ag Drains	Colusa Basin Drain above KL	12/01/97	03/14/01	274	77%	212	0.009	16.9	0.002	2.28	2.98	0.521	2.19
Thiobencarb, ug/L	Ag Drains	Sacramento Slough	02/09/94	02/09/94	15	7%	1	0.009	0.009	0.008	IDD	IDD	IDD	IDD

Summary Statistics: Pesticides Detected in SRWP Monitoring

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Thiobencarb, ug/L	Mainstem	Sacramento River at Colusa	11/15/96	06/11/03	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Thiobencarb, ug/L	Mainstem	Sacramento River at Veterans Bridge	11/15/93	11/07/94	2	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Thiobencarb, ug/L	Mainstem	Sacramento River at Village Marina/Crawdads Cantina	12/17/96	06/11/03	129	5%	6	0.5	0.9	0.5	IDD	IDD	IDD	IDD
Thiobencarb, ug/L	Mainstem	Sacramento River at Freeport	06/23/99	04/05/03	27	41%	11	0.01	0.165	0.002	0.0173	0.0373	0.00366	0.0134
Thiobencarb, ug/L	Major Tributary	Feather River near Nicolaus	02/08/94	02/08/94	29	3%	1	0.167	0.167	0.038	IDD	IDD	IDD	IDD
Thiobencarb, ug/L	Urban Creek	Arcade Creek at Norwood Ave.	11/26/96	04/23/98	30	0%	0	ND	ND	0.002	IDD	IDD	IDD	IDD

Summary Statistics: Nitrogen and Phosphorus Compounds

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Ammonia + Organic Nitrogen, filtered, mg/L as N	Tributary	Cache Creek near Rumsey	02/21/99	08/18/99	11	100%	11	0.079	0.363	100% det	0.184	0.09	0.165	0.132
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Ag Drains	Colusa Basin Drain above KL	02/07/96	04/15/98	29	100%	29	0.49	1.3	100% det	0.818	0.199	0.796	0.28
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Ag Drains	Sacramento Slough	02/12/96	09/18/02	43	98%	42	0.11	0.9	0.2	0.494	0.157	0.467	0.233
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Ag Drains	Yolo Bypass near Woodland	01/07/97	02/22/01	10	100%	10	0.24	0.99	100% det	0.454	0.23	0.412	0.298
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Mainstem	Sacramento River below Shasta Dam	07/12/96	08/01/00	6	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Mainstem	Sacramento River below Keswick	07/11/96	02/20/98	8	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Mainstem	Sacramento River above Bend Bridge	02/13/96	05/14/98	26	23%	6	0.1	0.3	0.1	0.111	0.0608	0.0967	0.0744
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Mainstem	Sacramento River at Colusa	02/28/96	09/16/98	33	48%	16	0.11	0.79	0.2	0.226	0.177	0.18	0.168
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Mainstem	Sacramento River at Verona	02/22/96	05/20/98	28	57%	16	0.15	0.6	0.2	0.217	0.103	0.198	0.115
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Mainstem	Sacramento River at Tower Bridge	01/12/93	01/25/93	12	100%	12	0.4	1.3	100% det	0.567	0.246	0.535	0.234
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Mainstem	Sacramento River at Freeport	01/10/90	09/18/02	105	73%	77	0.11	0.7	0.1	0.228	0.127	0.202	0.134
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Major Tributary	Yuba River at Marysville	02/27/96	06/24/02	39	36%	14	0.05	0.41	0.1	0.0971	0.0742	0.0808	0.0662
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Major Tributary	Feather River near Nicolaus	02/23/96	04/20/98	27	26%	7	0.12	0.39	0.1	0.137	0.0913	0.112	0.108
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Major Tributary	American River at Sacramento	02/21/96	04/16/98	27	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Tributary	Cache Creek near Rumsey	02/09/96	02/21/01	51	94%	48	0.137	2.	0.2	0.476	0.35	0.398	0.331
Ammonia + Organic Nitrogen, unfiltered, mg/L as N	Urban Creek	Arcade Creek in Del Paso Park	02/06/96	09/20/02	53	100%	53	0.17	4.	100% det	0.992	0.61	0.885	0.53
Ammonia, unfiltered, mg/L as N	Ag Drains	Colusa Basin Drain above KL	06/23/99	06/09/03	23	30%	7	0.141	0.638	0.1	0.144	0.163	0.0896	0.138
Ammonia, unfiltered, mg/L as N	Ag Drains	Sacramento Slough	06/22/99	06/10/03	22	32%	7	0.104	1.19	0.1	0.174	0.295	0.0689	0.163
Ammonia, unfiltered, mg/L as N	Mainstem	Sacramento River below Keswick	01/20/98	01/18/00	25	4%	1	0.11	0.11	0.1	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Mainstem	Sacramento River above Bend Bridge	09/24/01	06/09/03	10	0%	0	ND	ND	0.2	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Mainstem	Sacramento River near Hamilton City	08/18/99	06/09/03	11	9%	1	0.109	0.109	0.2	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Mainstem	Sacramento River at Colusa	11/16/99	06/09/03	11	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Mainstem	Sacramento River at Veterans Bridge	01/11/01	06/10/03	25	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Mainstem	Sacramento River at Freeport	02/15/90	06/11/03	36	33%	12	0.02	0.06	0.1	0.0382	0.015	0.0354	0.0233
Ammonia, unfiltered, mg/L as N	Mainstem	Sacramento River at River Mile 44	06/23/98	06/11/03	43	63%	27	0.1	0.955	0.1	0.175	0.174	0.13	0.142
Ammonia, unfiltered, mg/L as N	Major Tributary	Yuba River at Marysville	09/25/01	06/09/03	11	9%	1	0.23	0.23	0.2	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Major Tributary	Feather River near Nicolaus	01/19/00	06/10/03	12	8%	1	0.37	0.37	0.1	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Major Tributary	American River below Nimbus Dam	01/11/01	06/11/03	14	7%	1	0.2	0.2	0.1	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Major Tributary	American River at Discovery Park	09/21/99	06/10/03	25	8%	2	0.1	0.23	0.1	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Deer Creek below Childs Meadows	06/24/98	05/18/99	12	17%	2	0.01	0.02	0.01	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Deer Creek at A Line Road	01/19/99	03/15/99	2	100%	2	0.02	0.02	100% det	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Deer Creek at Ponderosa Way	06/24/98	05/18/99	8	13%	1	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Deer Creek at Upper Diversion Dam	06/24/98	05/18/99	12	17%	2	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Deer Creek at Highway 99	01/19/99	03/15/99	2	50%	1	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Deer Creek at Mouth	06/24/98	05/18/99	10	10%	1	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Big Chico Creek at Hwy 32	06/23/98	05/20/99	12	25%	3	0.01	0.05	0.01	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Big Chico Creek above Salmon Hole	06/23/98	05/20/99	12	42%	5	0.01	0.02	0.01	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Big Chico Creek at Chico (Rose Ave.)	06/23/98	05/20/99	12	25%	3	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Big Chico Creek above Mud Creek	06/23/98	05/20/99	12	50%	6	0.01	0.02	0.01	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Mud Creek above Big Chico Creek	06/23/98	05/20/99	8	63%	5	0.01	0.02	0.01	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	100%	1	0.333	0.333	100% det	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Cache Creek near Rumsey	02/21/99	08/18/99	11	9%	1	0.021	0.021	0.02	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	10%	1	0.54	0.54	0.2	IDD	IDD	IDD	IDD
Ammonia, unfiltered, mg/L as N	Urban	Natomas East Main Drain Canal (DWR)	03/25/91	02/22/99	14	100%	14	0.04	0.21	100% det	0.0979	0.0432	0.12	0.0901
Ammonia, unfiltered, mg/L as N	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	05/17/00	11	64%	7	0.124	0.522	0.1	0.196	0.177	0.132	0.213
Nitrate + Nitrite, filtered, mg/L as N	Ag Drains	Colusa Basin Drain above KL	02/07/96	04/15/98	29	100%	29	0.07	1.5	100% det	0.478	0.362	0.362	0.439

Summary Statistics: Nitrogen and Phosphorus Compounds

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Nitrate + Nitrite, filtered, mg/L as N	Ag Drains	Sacramento Slough	02/12/96	09/18/02	43	84%	36	0.05	0.58	0.05	0.156	0.113	0.122	0.132
Nitrate + Nitrite, filtered, mg/L as N	Ag Drains	Yolo Bypass near Woodland	01/07/97	02/22/01	10	100%	10	0.13	0.61	100% det	0.242	0.144	0.215	0.164
Nitrate + Nitrite, filtered, mg/L as N	Mainstem	Sacramento River below Shasta Dam	07/12/96	08/01/00	6	100%	6	0.09	0.13	100% det	0.112	0.0204	0.11	0.0323
Nitrate + Nitrite, filtered, mg/L as N	Mainstem	Sacramento River below Keswick	07/11/96	02/20/98	8	100%	8	0.08	0.13	100% det	0.103	0.0191	0.101	0.0308
Nitrate + Nitrite, filtered, mg/L as N	Mainstem	Sacramento River above Bend Bridge	02/13/96	05/14/98	26	100%	26	0.07	0.25	100% det	0.122	0.0457	0.115	0.0558
Nitrate + Nitrite, filtered, mg/L as N	Mainstem	Sacramento River at Colusa	02/28/96	09/16/98	33	100%	33	0.05	0.34	100% det	0.154	0.0712	0.14	0.0905
Nitrate + Nitrite, filtered, mg/L as N	Mainstem	Sacramento River at Verona	02/22/96	05/20/98	28	100%	28	0.06	0.26	100% det	0.133	0.0544	0.123	0.0753
Nitrate + Nitrite, filtered, mg/L as N	Mainstem	Sacramento River at Tower Bridge	01/12/93	01/25/93	12	100%	12	0.26	1.4	100% det	0.488	0.347	0.419	0.302
Nitrate + Nitrite, filtered, mg/L as N	Mainstem	Sacramento River at Freeport	01/10/90	09/18/02	105	93%	98	0.04	0.47	0.05	0.133	0.0772	0.116	0.087
Nitrate + Nitrite, filtered, mg/L as N	Major Tributary	Yuba River at Marysville	02/27/96	06/24/02	39	64%	25	0.03	0.24	0.05	0.0616	0.0431	0.0508	0.0454
Nitrate + Nitrite, filtered, mg/L as N	Major Tributary	Feather River near Nicolaus	02/23/96	04/20/98	27	93%	25	0.05	1.63	0.05	0.156	0.303	0.0936	0.104
Nitrate + Nitrite, filtered, mg/L as N	Major Tributary	American River at Sacramento	02/21/96	04/16/98	27	52%	14	0.06	0.2	0.05	0.0784	0.0421	0.0685	0.0541
Nitrate + Nitrite, filtered, mg/L as N	Tributary	Cache Creek near Rumsey	02/09/96	02/21/01	40	80%	32	0.06	0.92	0.05	0.146	0.177	0.0955	0.127
Nitrate + Nitrite, filtered, mg/L as N	Urban Creek	Arcade Creek in Del Paso Park	02/06/96	09/20/02	53	100%	53	0.12	2.3	100% det	0.713	0.474	0.591	0.533
Nitrate + Nitrite, unfiltered, mg/L as N	Ag Drains	Colusa Basin Drain above KL	10/03/02	10/03/02	1	100%	1	0.16	0.16	100% det	IDD	IDD	IDD	IDD
Nitrate + Nitrite, unfiltered, mg/L as N	Ag Drains	Sacramento Slough	10/03/02	10/03/02	1	100%	1	0.061	0.061	100% det	IDD	IDD	IDD	IDD
Nitrate + Nitrite, unfiltered, mg/L as N	Mainstem	Sacramento River at Freeport	12/12/90	10/03/02	9	89%	8	0.065	0.49	0.05	0.206	0.176	0.145	0.232
Nitrate + Nitrite, unfiltered, mg/L as N	Mainstem	Sacramento River at River Mile 44	10/03/02	10/03/02	1	100%	1	0.068	0.068	100% det	IDD	IDD	IDD	IDD
Nitrate + Nitrite, unfiltered, mg/L as N	Major Tributary	Feather River near Nicolaus	10/03/02	10/03/02	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Nitrate + Nitrite, unfiltered, mg/L as N	Major Tributary	American River at Discovery Park	10/03/02	10/03/02	1	0%	0	ND	ND	0.05	IDD	IDD	IDD	IDD
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Deer Creek below Childs Meadows	06/24/98	05/18/99	12	25%	3	0.02	0.04	0.01	0.0124	0.0119	0.00829	0.0127
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Deer Creek at A Line Road	01/19/99	03/15/99	2	100%	2	0.02	0.04	100% det	IDD	IDD	IDD	IDD
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Deer Creek at Ponderosa Way	06/24/98	05/18/99	8	50%	4	0.01	0.04	0.01	0.0124	0.0146	0.00612	0.015
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Deer Creek at Upper Diversion Dam	06/24/98	05/18/99	12	42%	5	0.02	0.2	0.01	0.0264	0.056	0.00571	0.0226
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Deer Creek at Highway 99	01/19/99	03/15/99	2	50%	1	0.03	0.03	0.01	IDD	IDD	IDD	IDD
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Deer Creek at Mouth	06/24/98	05/18/99	10	90%	9	0.03	0.32	0.01	0.111	0.108	0.0735	0.12
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Big Chico Creek at Hwy 32	06/23/98	05/20/99	12	17%	2	0.02	0.06	0.01	IDD	IDD	IDD	IDD
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Big Chico Creek above Salmon Hole	06/23/98	05/20/99	12	50%	6	0.01	0.02	0.01	IDD	IDD	IDD	IDD
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Big Chico Creek at Chico (Rose Ave.)	06/23/98	05/20/99	12	25%	3	0.03	0.04	0.01	IDD	IDD	IDD	IDD
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Big Chico Creek above Mud Creek	06/23/98	05/20/99	12	42%	5	0.01	0.15	0.01	0.0235	0.0436	0.00425	0.021
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Mud Creek above Big Chico Creek	06/23/98	05/20/99	8	100%	8	0.02	2.	100% det	0.411	0.656	0.181	0.494
Nitrate + Nitrite, unfiltered, mg/L as N	Tributary	Cache Creek near Rumsey	02/21/99	08/18/99	11	73%	8	0.059	0.11	0.05	0.0789	0.0214	0.0764	0.0322
Nitrate + Nitrite, unfiltered, mg/L as N	Urban	Natomas East Main Drain	10/03/02	10/03/02	1	100%	1	1.7	1.7	100% det	IDD	IDD	IDD	IDD
Nitrate, unfiltered, mg/L as N	Ag Drains	Colusa Basin Drain above KL	06/23/99	06/09/03	23	83%	19	0.099	3.9	0.05	1.13	1.24	0.593	1.22
Nitrate, unfiltered, mg/L as N	Ag Drains	Sacramento Slough	06/22/99	06/10/03	22	77%	17	0.061	1.71	1.	0.498	0.531	0.285	0.501
Nitrate, unfiltered, mg/L as N	Mainstem	Sacramento River above Bend Bridge	09/24/01	06/09/03	10	80%	8	0.054	0.68	0.05	0.137	0.196	0.0784	0.14
Nitrate, unfiltered, mg/L as N	Mainstem	Sacramento River near Hamilton City	08/18/99	06/09/03	11	82%	9	0.055	0.443	0.05	0.136	0.115	0.103	0.132
Nitrate, unfiltered, mg/L as N	Mainstem	Sacramento River at Colusa	11/16/99	06/09/03	11	100%	11	0.058	1.12	100% det	0.234	0.306	0.152	0.215
Nitrate, unfiltered, mg/L as N	Mainstem	Sacramento River at Veterans Bridge	01/11/01	06/10/03	28	64%	18	0.064	0.26	0.05	0.128	0.0641	0.112	0.0904
Nitrate, unfiltered, mg/L as N	Mainstem	Sacramento River at Freeport	01/11/01	06/11/03	27	67%	18	0.065	0.24	0.1	0.127	0.0562	0.115	0.0796
Nitrate, unfiltered, mg/L as N	Mainstem	Sacramento River at River Mile 44	06/23/98	06/11/03	44	66%	29	0.062	1.3	0.1	0.345	0.362	0.211	0.327
Nitrate, unfiltered, mg/L as N	Major Tributary	Yuba River at Marysville	09/25/01	06/09/03	11	27%	3	0.05	0.13	0.05	0.0317	0.0398	0.0156	0.035
Nitrate, unfiltered, mg/L as N	Major Tributary	Feather River near Nicolaus	01/19/00	06/10/03	12	75%	9	0.05	1.	0.05	0.166	0.269	0.0848	0.163
Nitrate, unfiltered, mg/L as N	Major Tributary	American River below Nimbus Dam	01/11/01	06/11/03	17	6%	1	1.1	1.1	0.1	IDD	IDD	IDD	IDD
Nitrate, unfiltered, mg/L as N	Major Tributary	American River at Discovery Park	09/21/99	06/10/03	28	21%	6	0.07	0.13	0.05	0.0642	0.0228	0.0603	0.031
Nitrate, unfiltered, mg/L as N	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	1.	IDD	IDD	IDD	IDD
Nitrate, unfiltered, mg/L as N	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	1.	IDD	IDD	IDD	IDD
Nitrate, unfiltered, mg/L as N	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	1.	IDD	IDD	IDD	IDD
Nitrate, unfiltered, mg/L as N	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Nitrate, unfiltered, mg/L as N	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	100%	1	2.3	2.3	100% det	IDD	IDD	IDD	IDD

Summary Statistics: Nitrogen and Phosphorus Compounds

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Nitrate, unfiltered, mg/L as N	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	100%	10	0.53	3.1	100% det	1.59	0.813	1.4	1.28
Nitrate, unfiltered, mg/L as N	Urban	Natomas East Main Drain Canal (DWR)	01/23/90	10/02/00	63	98%	62	0.13548	3.68054	0.1	1.56	0.975	1.8	1.23
Nitrate, unfiltered, mg/L as N	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	05/17/00	11	36%	4	2.58	4.1	0.1	2.19	1.1	1.95	1.51
Nitrite, filtered, mg/L as N	Ag Drains	Colusa Basin Drain above KL	02/07/96	04/15/98	29	93%	27	0.01	0.06	0.01	0.0265	0.0143	0.0229	0.0194
Nitrite, filtered, mg/L as N	Ag Drains	Sacramento Slough	02/12/96	09/18/02	43	60%	26	0.003	0.025	0.006	0.0096	0.00605	0.0079	0.00733
Nitrite, filtered, mg/L as N	Ag Drains	Yolo Bypass near Woodland	01/07/97	02/22/01	10	30%	3	0.01	0.024	0.01	0.00611	0.00726	0.00332	0.00675
Nitrite, filtered, mg/L as N	Mainstem	Sacramento River below Shasta Dam	07/12/96	08/01/00	6	0%	0	ND	ND	0.01	IDD	IDD	IDD	IDD
Nitrite, filtered, mg/L as N	Mainstem	Sacramento River below Keswick	07/11/96	02/20/98	8	25%	2	0.01	0.011	0.01	IDD	IDD	IDD	IDD
Nitrite, filtered, mg/L as N	Mainstem	Sacramento River above Bend Bridge	02/13/96	05/14/98	26	15%	4	0.01	0.02	0.01	IDD	IDD	IDD	IDD
Nitrite, filtered, mg/L as N	Mainstem	Sacramento River at Colusa	02/28/96	09/16/98	33	27%	9	0.01	0.029	0.01	0.0072	0.00647	0.00506	0.00662
Nitrite, filtered, mg/L as N	Mainstem	Sacramento River at Verona	02/22/96	05/20/98	28	36%	10	0.01	0.035	0.01	0.00798	0.00839	0.00508	0.00776
Nitrite, filtered, mg/L as N	Mainstem	Sacramento River at Tower Bridge	01/12/93	01/25/93	12	100%	12	0.02	0.09	100% det	0.0342	0.0207	0.0302	0.0214
Nitrite, filtered, mg/L as N	Mainstem	Sacramento River at Freeport	01/10/90	09/18/02	105	25%	26	0.003	0.03	0.006	0.00657	0.00482	0.00532	0.00483
Nitrite, filtered, mg/L as N	Major Tributary	Yuba River at Marysville	02/27/96	06/24/02	39	21%	8	0.01	0.192	0.006	0.00857	0.0311	0.00068	0.00365
Nitrite, filtered, mg/L as N	Major Tributary	Feather River near Nicolaus	02/23/96	04/20/98	27	33%	9	0.01	0.032	0.01	0.00786	0.0074	0.00537	0.00743
Nitrite, filtered, mg/L as N	Major Tributary	American River at Sacramento	02/21/96	04/16/98	27	30%	8	0.01	0.02	0.01	IDD	IDD	IDD	IDD
Nitrite, filtered, mg/L as N	Tributary	Cache Creek near Rumsey	02/09/96	02/21/01	40	38%	15	0.007	0.064	0.01	0.0115	0.0129	0.00714	0.0108
Nitrite, filtered, mg/L as N	Urban Creek	Arcade Creek in Del Paso Park	02/06/96	09/20/02	53	96%	51	0.004	0.09	0.01	0.0277	0.0196	0.0216	0.0233
Nitrite, unfiltered, mg/L as N	Ag Drains	Colusa Basin Drain above KL	06/23/99	06/09/03	23	4%	1	0.035	0.035	0.02	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Ag Drains	Sacramento Slough	06/22/99	06/10/03	22	5%	1	0.1	0.1	0.02	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Mainstem	Sacramento River above Bend Bridge	09/24/01	06/09/03	10	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Mainstem	Sacramento River near Hamilton City	08/18/99	06/09/03	11	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Mainstem	Sacramento River at Colusa	11/16/99	06/09/03	11	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Mainstem	Sacramento River at Veterans Bridge	01/11/01	06/10/03	28	4%	1	0.22	0.22	0.02	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Mainstem	Sacramento River at Freeport	12/12/90	06/11/03	35	20%	7	0.01	0.03	0.01	0.0121	0.00779	0.00994	0.0102
Nitrite, unfiltered, mg/L as N	Mainstem	Sacramento River at River Mile 44	06/23/98	06/11/03	44	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Major Tributary	Yuba River at Marysville	09/25/01	06/09/03	11	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Major Tributary	Feather River near Nicolaus	01/19/00	06/10/03	12	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Major Tributary	American River below Nimbus Dam	01/11/01	06/11/03	17	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Major Tributary	American River at Discovery Park	09/21/99	06/10/03	28	0%	0	ND	ND	0.02	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	1.	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	1.	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	1.	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Tributary	Cache Creek near Rumsey	02/21/99	08/18/99	11	0%	0	ND	ND	0.01	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	1.	IDD	IDD	IDD	IDD
Nitrite, unfiltered, mg/L as N	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	40%	4	0.023	0.16	0.02	0.0279	0.0485	0.0082	0.0286
Nitrite, unfiltered, mg/L as N	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	05/17/00	11	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Ag Drains	Colusa Basin Drain above KL	06/23/99	06/09/03	23	70%	16	0.26	1.6	0.5	0.733	0.409	0.626	0.558
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Ag Drains	Sacramento Slough	06/22/99	06/10/03	22	27%	6	0.203	1.1	0.2	0.289	0.293	0.182	0.29
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Mainstem	Sacramento River above Bend Bridge	09/24/01	06/09/03	10	10%	1	1.7	1.7	0.5	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Mainstem	Sacramento River near Hamilton City	08/18/99	06/09/03	11	9%	1	0.86	0.86	0.5	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Mainstem	Sacramento River at Colusa	09/25/01	06/09/03	10	20%	2	0.58	1.1	0.5	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Mainstem	Sacramento River at Veterans Bridge	01/11/01	06/10/03	27	19%	5	0.3	0.67	0.45	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Mainstem	Sacramento River at Freeport	01/11/01	06/11/03	24	17%	4	0.3	0.73	0.45	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Mainstem	Sacramento River at River Mile 44	06/23/98	06/11/03	39	36%	14	0.21	1.3	0.2	0.368	0.282	0.282	0.313
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Major Tributary	Yuba River at Marysville	09/25/01	06/09/03	11	27%	3	0.56	1.	0.5	0.363	0.287	0.275	0.341
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Major Tributary	Feather River near Nicolaus	01/19/00	06/10/03	12	17%	2	0.78	3.09	0.5	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Major Tributary	American River below Nimbus Dam	01/11/01	06/11/03	15	13%	2	0.2	0.76	0.45	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Major Tributary	American River at Discovery Park	09/21/99	06/10/03	26	8%	2	0.2	0.45	0.45	IDD	IDD	IDD	IDD

Summary Statistics: Nitrogen and Phosphorus Compounds

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	100%	1	2.	2.	100% det	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	100%	10	0.55	1.6	100% det	1.12	0.366	1.35	1.06
Nitrogen, Total Kjeldahl, unfiiltered, mg/L as N	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	05/17/00	11	82%	9	0.519	1.59	0.5	0.95	0.441	0.855	0.661
Orthophosphate, filtered, mg/L as P	Ag Drains	Colusa Basin Drain above KL	02/07/96	06/09/03	52	77%	40	0.02	0.19	0.5	0.103	0.0376	0.0949	0.0588
Orthophosphate, filtered, mg/L as P	Ag Drains	Sacramento Slough	02/12/96	06/10/03	64	83%	53	0.025	0.223	0.01	0.0866	0.0374	0.0781	0.0549
Orthophosphate, filtered, mg/L as P	Ag Drains	Yolo Bypass near Woodland	01/07/97	02/22/01	10	100%	10	0.02	0.14	100% det	0.044	0.0344	0.0377	0.0264
Orthophosphate, filtered, mg/L as P	Mainstem	Sacramento River below Shasta Dam	07/12/96	08/01/00	6	100%	6	0.01	0.03	100% det	0.025	0.00837	0.0233	0.015
Orthophosphate, filtered, mg/L as P	Mainstem	Sacramento River below Keswick	07/11/96	02/20/98	8	75%	6	0.02	0.03	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Mainstem	Sacramento River above Bend Bridge	02/13/96	06/09/03	36	83%	30	0.01	0.035	0.01	0.0195	0.00611	0.0186	0.00791
Orthophosphate, filtered, mg/L as P	Mainstem	Sacramento River near Hamilton City	08/18/99	06/09/03	11	82%	9	0.012	0.031	0.01	0.0195	0.00735	0.0183	0.012
Orthophosphate, filtered, mg/L as P	Mainstem	Sacramento River at Colusa	02/28/96	06/09/03	43	95%	41	0.01	0.04	0.01	0.0222	0.00833	0.0207	0.0116
Orthophosphate, filtered, mg/L as P	Mainstem	Sacramento River at Verona	02/22/96	05/20/98	28	89%	25	0.02	0.04	0.01	0.0233	0.00689	0.0225	0.00823
Orthophosphate, filtered, mg/L as P	Mainstem	Sacramento River at Veterans Bridge	09/26/01	06/10/03	21	52%	11	0.011	0.071	0.1	0.0271	0.0145	0.0241	0.0194
Orthophosphate, filtered, mg/L as P	Mainstem	Sacramento River at Tower Bridge	01/12/93	01/25/93	12	100%	12	0.05	0.24	100% det	0.0875	0.0631	0.0748	0.0535
Orthophosphate, filtered, mg/L as P	Mainstem	Sacramento River at Freeport	01/10/90	06/11/03	124	89%	110	0.01	0.07	0.01	0.025	0.0117	0.0223	0.015
Orthophosphate, filtered, mg/L as P	Mainstem	Sacramento River at River Mile 44	06/23/98	06/11/03	43	26%	11	0.03	0.12	0.1	0.0565	0.0225	0.0522	0.0332
Orthophosphate, filtered, mg/L as P	Major Tributary	Yuba River at Marysville	02/27/96	06/09/03	50	12%	6	0.01	0.02	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Major Tributary	Feather River near Nicolaus	02/23/96	06/10/03	39	62%	24	0.01	0.03	0.01	0.011	0.00604	0.00965	0.00732
Orthophosphate, filtered, mg/L as P	Major Tributary	American River below Nimbus Dam	07/10/02	06/11/03	10	0%	0	ND	ND	0.1	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Major Tributary	American River at Sacramento	02/21/96	04/16/98	27	22%	6	0.01	0.02	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Major Tributary	American River at Discovery Park	09/21/99	06/10/03	21	14%	3	0.011	0.025	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Pit River above Shasta	09/22/99	09/22/99	1	0%	0	ND	ND	5.	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	McCloud River above Shasta	01/18/00	01/18/00	1	0%	0	ND	ND	5.	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	10/20/99	1	0%	0	ND	ND	5.	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Deer Creek below Childs Meadows	06/24/98	05/18/99	12	8%	1	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Deer Creek at A Line Road	01/19/99	03/15/99	2	50%	1	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Deer Creek at Ponderosa Way	06/24/98	05/18/99	8	13%	1	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Deer Creek at Upper Diversion Dam	06/24/98	05/18/99	12	25%	3	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Deer Creek at Highway 99	01/19/99	03/15/99	2	50%	1	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Deer Creek at Mouth	06/24/98	05/18/99	10	0%	0	ND	ND	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Big Chico Creek at Hwy 32	06/23/98	05/20/99	12	0%	0	ND	ND	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Big Chico Creek above Salmon Hole	06/23/98	05/20/99	12	17%	2	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Big Chico Creek at Chico (Rose Ave.)	06/23/98	05/20/99	12	8%	1	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Big Chico Creek above Mud Creek	06/23/98	05/20/99	12	25%	3	0.01	0.01	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Mud Creek above Big Chico Creek	06/23/98	05/20/99	8	0%	0	ND	ND	0.01	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Tributary	Cache Creek near Rumsey	02/09/96	02/21/01	51	53%	27	0.01	0.05	0.01	0.0125	0.0101	0.00929	0.0108
Orthophosphate, filtered, mg/L as P	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	0%	0	ND	ND	5.	IDD	IDD	IDD	IDD
Orthophosphate, filtered, mg/L as P	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	100%	10	0.18	1.9	100% det	0.52	0.506	0.401	0.436
Orthophosphate, filtered, mg/L as P	Urban Creek	Arcade Creek in Del Paso Park	02/06/96	09/20/02	53	96%	51	0.04	0.28	0.01	0.134	0.0701	0.115	0.097
Orthophosphate, filtered, mg/L as P	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	05/17/00	11	0%	0	ND	ND	0.5	IDD	IDD	IDD	IDD
Phosphorus, total, filtered, mg/L as P	Tributary	Cache Creek near Rumsey	02/21/99	08/18/99	11	100%	11	0.006	0.023	100% det	0.0126	0.00546	0.0116	0.0079
Phosphorus, total, unfiltered, mg/L as P	Ag Drains	Colusa Basin Drain above KL	02/07/96	06/09/03	44	100%	44	0.11	0.57	100% det	0.24	0.0828	0.227	0.108
Phosphorus, total, unfiltered, mg/L as P	Ag Drains	Sacramento Slough	02/12/96	06/10/03	57	100%	57	0.03	0.34	100% det	0.167	0.0577	0.154	0.0915
Phosphorus, total, unfiltered, mg/L as P	Ag Drains	Yolo Bypass near Woodland	01/07/97	02/22/01	10	100%	10	0.07	0.35	100% det	0.144	0.0822	0.129	0.0942
Phosphorus, total, unfiltered, mg/L as P	Mainstem	Sacramento River below Shasta Dam	07/12/96	08/01/00	6	83%	5	0.02	0.03	0.01	0.0226	0.00622	0.022	0.00924
Phosphorus, total, unfiltered, mg/L as P	Mainstem	Sacramento River below Keswick	07/11/96	02/20/98	8	63%	5	0.01	0.02	0.01	IDD	IDD	IDD	IDD

Summary Statistics: Nitrogen and Phosphorus Compounds

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Phosphorus, total, unfiltered, mg/L as P	Mainstem	Sacramento River above Bend Bridge	02/13/96	06/09/03	36	89%	32	0.01	0.23	0.01	0.0414	0.0418	0.0305	0.034
Phosphorus, total, unfiltered, mg/L as P	Mainstem	Sacramento River near Hamilton City	09/25/01	06/09/03	10	100%	10	0.027	0.4	100% det	0.0864	0.115	0.0548	0.0744
Phosphorus, total, unfiltered, mg/L as P	Mainstem	Sacramento River at Colusa	02/28/96	06/09/03	43	100%	43	0.01	5.4	100% det	0.206	0.819	0.061	0.0903
Phosphorus, total, unfiltered, mg/L as P	Mainstem	Sacramento River at Verona	02/22/96	05/20/98	28	100%	28	0.01	0.17	100% det	0.0582	0.0309	0.0512	0.0397
Phosphorus, total, unfiltered, mg/L as P	Mainstem	Sacramento River at Veterans Bridge	01/11/01	06/10/03	22	59%	13	0.04	0.95	0.1	0.119	0.188	0.0824	0.0725
Phosphorus, total, unfiltered, mg/L as P	Mainstem	Sacramento River at Tower Bridge	01/12/93	01/25/93	12	100%	12	0.11	0.45	100% det	0.172	0.091	0.159	0.0779
Phosphorus, total, unfiltered, mg/L as P	Mainstem	Sacramento River at Freeport	01/10/90	06/11/03	126	90%	114	0.01	0.27	0.01	0.06	0.0353	0.0523	0.0379
Phosphorus, total, unfiltered, mg/L as P	Mainstem	Sacramento River at River Mile 44	06/23/98	06/11/03	36	81%	29	0.04	1.09	0.02	0.115	0.171	0.0843	0.0732
Phosphorus, total, unfiltered, mg/L as P	Major Tributary	Yuba River at Marysville	02/27/96	06/09/03	50	64%	32	0.003	0.11	0.01	0.0181	0.0251	0.0101	0.016
Phosphorus, total, unfiltered, mg/L as P	Major Tributary	Feather River near Nicolaus	02/23/96	06/10/03	38	84%	32	0.01	0.23	0.01	0.0345	0.0375	0.0246	0.0297
Phosphorus, total, unfiltered, mg/L as P	Major Tributary	American River below Nimbus Dam	01/11/01	06/11/03	11	9%	1	0.11	0.11	0.1	IDD	IDD	IDD	IDD
Phosphorus, total, unfiltered, mg/L as P	Major Tributary	American River at Sacramento	02/21/96	04/16/98	27	52%	14	0.01	0.09	0.01	0.0176	0.0216	0.0095	0.0177
Phosphorus, total, unfiltered, mg/L as P	Major Tributary	American River at Discovery Park	01/11/01	06/10/03	21	10%	2	0.027	0.033	0.02	IDD	IDD	IDD	IDD
Phosphorus, total, unfiltered, mg/L as P	Tributary	Deer Creek below Childs Meadows	06/24/98	05/18/99	12	83%	10	0.01	0.04	0.01	0.0184	0.0117	0.015	0.0163
Phosphorus, total, unfiltered, mg/L as P	Tributary	Deer Creek at A Line Road	01/19/99	03/15/99	2	100%	2	0.01	0.18	100% det	IDD	IDD	IDD	IDD
Phosphorus, total, unfiltered, mg/L as P	Tributary	Deer Creek at Ponderosa Way	06/24/98	05/18/99	8	75%	6	0.01	0.04	0.01	0.0174	0.0126	0.0135	0.018
Phosphorus, total, unfiltered, mg/L as P	Tributary	Deer Creek at Upper Diversion Dam	06/24/98	05/18/99	12	83%	10	0.01	0.03	0.01	0.017	0.00817	0.0152	0.0118
Phosphorus, total, unfiltered, mg/L as P	Tributary	Deer Creek at Highway 99	01/19/99	03/15/99	2	100%	2	0.01	0.02	100% det	IDD	IDD	IDD	IDD
Phosphorus, total, unfiltered, mg/L as P	Tributary	Deer Creek at Mouth	06/24/98	05/18/99	10	100%	10	0.01	1.	100% det	0.123	0.308	0.0344	0.0612
Phosphorus, total, unfiltered, mg/L as P	Tributary	Big Chico Creek at Hwy 32	06/23/98	05/20/99	12	75%	9	0.01	0.04	0.01	0.0169	0.00928	0.0149	0.0117
Phosphorus, total, unfiltered, mg/L as P	Tributary	Big Chico Creek above Salmon Hole	06/23/98	05/20/99	12	83%	10	0.01	0.03	0.01	0.0163	0.00703	0.0149	0.00995
Phosphorus, total, unfiltered, mg/L as P	Tributary	Big Chico Creek at Chico (Rose Ave.)	06/23/98	05/20/99	12	75%	9	0.01	0.02	0.01	IDD	IDD	IDD	IDD
Phosphorus, total, unfiltered, mg/L as P	Tributary	Big Chico Creek above Mud Creek	06/23/98	05/20/99	12	92%	11	0.01	0.05	0.01	0.0188	0.0121	0.016	0.0145
Phosphorus, total, unfiltered, mg/L as P	Tributary	Mud Creek above Big Chico Creek	06/23/98	05/20/99	8	88%	7	0.01	0.03	0.01	0.0183	0.00897	0.0163	0.014
Phosphorus, total, unfiltered, mg/L as P	Tributary	Cache Creek near Rumsey	02/09/96	02/21/01	51	92%	47	0.007	0.53	0.004	0.102	0.11	0.0632	0.101
Phosphorus, total, unfiltered, mg/L as P	Tributary	Cache Slough near Ryers Ferry	02/16/00	02/16/00	1	100%	1	0.151	0.151	100% det	IDD	IDD	IDD	IDD
Phosphorus, total, unfiltered, mg/L as P	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	100%	10	0.34	2.3	100% det	0.683	0.587	0.566	0.457
Phosphorus, total, unfiltered, mg/L as P	Urban Creek	Arcade Creek in Del Paso Park	02/06/96	09/20/02	54	100%	54	0.021	1.16	100% det	0.25	0.173	0.213	0.166
Phosphorus, total, unfiltered, mg/L as P	Urban Creek	Arcade Creek at Norwood Ave.	02/16/00	05/17/00	4	100%	4	0.178	0.28	100% det	0.228	0.0512	0.224	0.0912

Summary Statistics: Pathogens and Indicators

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Coliform Bacteria, fecal, MPN/100 mL	Ag Drains	Colusa Basin Drain above KL	09/25/01	06/09/03	10	100%	10	4.	1600.	100% det	233.	490.	49.8	214.
Coliform Bacteria, fecal, MPN/100 mL	Ag Drains	Sacramento Slough	09/26/01	06/10/03	10	100%	10	23.	170.	100% det	76.3	58.4	57.2	72.7
Coliform Bacteria, fecal, MPN/100 mL	Mainstem	Sacramento River below Keswick	07/22/98	05/16/00	20	40%	8	1.	9.	1.	1.46	2.37	0.511	1.42
Coliform Bacteria, fecal, MPN/100 mL	Mainstem	Sacramento River above Bend Bridge	06/24/98	06/09/03	42	90%	38	4.	1100.	2.	84.5	186.	26.1	60.9
Coliform Bacteria, fecal, MPN/100 mL	Mainstem	Sacramento River near Hamilton City	06/24/99	06/09/03	20	100%	20	4.	1600.	100% det	323.	500.	93.	326.
Coliform Bacteria, fecal, MPN/100 mL	Mainstem	Sacramento River at Colusa	06/24/98	06/09/03	40	98%	39	4.	1600.	2.	212.	457.	35.	121.
Coliform Bacteria, fecal, MPN/100 mL	Mainstem	Sacramento River at Veterans Bridge	11/18/96	06/10/03	83	98%	81	2.	2400.	2.	128.	408.	31.2	67.6
Coliform Bacteria, fecal, MPN/100 mL	Mainstem	Sacramento River at Freeport	04/10/90	06/11/03	103	100%	103	2.	8000.	100% det	190.	824.	35.2	91.5
Coliform Bacteria, fecal, MPN/100 mL	Mainstem	Sacramento River at River Mile 44	12/15/92	08/18/99	5	100%	5	4.	30.	100% det	17.8	12.1	13.7	22.9
Coliform Bacteria, fecal, MPN/100 mL	Major Tributary	Yuba River at Marysville	09/25/01	06/09/03	10	90%	9	4.	1600.	2.	525.	743.	95.7	594.
Coliform Bacteria, fecal, MPN/100 mL	Major Tributary	Feather River near Nicolaus	06/23/98	06/10/03	33	97%	32	2.	1600.	20.	110.	292.	21.3	66.7
Coliform Bacteria, fecal, MPN/100 mL	Major Tributary	American River below Nimbus Dam	11/18/96	06/11/03	81	100%	81	4.	1300.	100% det	99.1	217.	45.6	73.5
Coliform Bacteria, fecal, MPN/100 mL	Major Tributary	American River at Discovery Park	11/18/96	06/10/03	81	100%	81	2.	9000.	100% det	421.	1524.	54.9	147.
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Deer Creek below Childs Meadows	06/24/98	05/17/99	11	91%	10	1.	41.	2.	10.7	11.9	5.84	12.9
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Deer Creek at A Line Road	12/15/98	01/19/99	2	100%	2	1.	6.	100% det	IDD	IDD	IDD	IDD
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Deer Creek at Ponderosa Way	06/24/98	05/17/99	8	25%	2	1.	2.	2.	IDD	IDD	IDD	IDD
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Deer Creek at Upper Diversion Dam	06/24/98	05/17/99	11	64%	7	1.	14.	2.	2.7	3.84	1.64	2.36
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Deer Creek at Highway 99	06/24/98	01/19/99	7	100%	7	3.	14.	100% det	6.43	4.16	5.41	5.72
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Deer Creek at Mouth	06/24/98	05/17/99	9	100%	9	2.	224.	100% det	30.8	72.7	7.45	19.5
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Big Chico Creek at Hwy 32	06/23/98	04/20/99	11	82%	9	2.	22.	2.	4.75	6.06	2.91	4.89
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Big Chico Creek above Salmon Hole	06/23/98	05/20/99	12	92%	11	1.	20.	2.	5.57	6.06	3.37	5.89
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Big Chico Creek at Chico (Rose Ave.)	06/23/98	05/20/99	11	91%	10	8.	233.	2.	62.4	70.	37.	72.5
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Big Chico Creek above Mud Creek	06/23/98	05/20/99	12	100%	12	10.	1119.	100% det	169.	309.	72.5	160.
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Mud Creek above Big Chico Creek	06/23/98	05/20/99	8	88%	7	16.	162.	2.	41.3	49.6	28.4	38.1
Coliform Bacteria, fecal, MPN/100 mL	Tributary	Cache Slough near Ryers Ferry	06/23/98	02/16/00	12	100%	12	6.	1600.	100% det	258.	506.	31.7	120.
Coliform Bacteria, fecal, MPN/100 mL	Urban	Natomas East Main Drain	09/26/01	06/10/03	9	100%	9	130.	1600.	100% det	933.	670.	646.	1124.
Coliform Bacteria, total, MPN/100 mL	Ag Drains	Colusa Basin Drain above KL	09/25/01	06/09/03	11	100%	11	30.	1600.	100% det	694.	626.	410.	909.
Coliform Bacteria, total, MPN/100 mL	Ag Drains	Sacramento Slough	09/26/01	06/10/03	11	100%	11	110.	1600.	100% det	557.	560.	368.	582.
Coliform Bacteria, total, MPN/100 mL	Mainstem	Sacramento River below Keswick	07/22/98	05/16/00	20	95%	19	1.	62.	1.	14.9	15.6	8.06	17.7
Coliform Bacteria, total, MPN/100 mL	Mainstem	Sacramento River above Bend Bridge	06/24/98	06/09/03	41	98%	40	1.	1700.	2.	282.	419.	116.	298.
Coliform Bacteria, total, MPN/100 mL	Mainstem	Sacramento River near Hamilton City	06/24/99	06/09/03	21	100%	21	17.	2400.	100% det	561.	710.	221.	585.
Coliform Bacteria, total, MPN/100 mL	Mainstem	Sacramento River at Colusa	06/24/98	06/09/03	41	100%	41	11.	2200.	100% det	355.	529.	148.	334.
Coliform Bacteria, total, MPN/100 mL	Mainstem	Sacramento River at Veterans Bridge	10/29/96	06/10/03	83	100%	83	17.	16000.	100% det	1421.	2807.	572.	1181.
Coliform Bacteria, total, MPN/100 mL	Mainstem	Sacramento River at Freeport	10/26/96	06/11/03	82	100%	82	13.	9000.	100% det	1128.	1730.	505.	1038.
Coliform Bacteria, total, MPN/100 mL	Mainstem	Sacramento River at River Mile 44	08/19/97	07/20/99	4	100%	4	130.	240.	100% det	193.	51.9	187.	97.8
Coliform Bacteria, total, MPN/100 mL	Major Tributary	Yuba River at Marysville	09/25/01	06/09/03	11	100%	11	21.	1600.	100% det	556.	676.	253.	660.
Coliform Bacteria, total, MPN/100 mL	Major Tributary	Feather River near Nicolaus	06/23/98	06/10/03	34	100%	34	3.	1600.	100% det	485.	593.	161.	523.
Coliform Bacteria, total, MPN/100 mL	Major Tributary	American River below Nimbus Dam	10/29/96	06/11/03	82	100%	82	13.	3000.	100% det	417.	664.	167.	359.
Coliform Bacteria, total, MPN/100 mL	Major Tributary	American River at Discovery Park	10/29/96	06/10/03	82	100%	82	17.	50000.	100% det	2042.	6380.	400.	1083.
Coliform Bacteria, total, MPN/100 mL	Tributary	Cache Slough near Ryers Ferry	06/23/98	02/16/00	12	100%	12	30.	1600.	100% det	345.	466.	154.	385.
Coliform Bacteria, total, MPN/100 mL	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	100%	10	900.	1600.	100% det	IDD	IDD	IDD	IDD
E. coli bacteria, MPN/100 mL	Ag Drains	Colusa Basin Drain above KL	09/25/01	06/09/03	10	100%	10	4.	1600.	100% det	219.	493.	41.2	178.
E. coli bacteria, MPN/100 mL	Ag Drains	Sacramento Slough	09/26/01	06/10/03	10	100%	10	17.	140.	100% det	68.3	52.2	50.4	69.6
E. coli bacteria, MPN/100 mL	Mainstem	Sacramento River above Bend Bridge	09/24/01	06/09/03	10	100%	10	8.	300.	100% det	56.4	90.4	28.6	49.5
E. coli bacteria, MPN/100 mL	Mainstem	Sacramento River near Hamilton City	09/25/01	06/09/03	9	100%	9	13.	1600.	100% det	481.	653.	168.	602.
E. coli bacteria, MPN/100 mL	Mainstem	Sacramento River at Colusa	09/25/01	06/09/03	9	100%	9	4.	1600.	100% det	403.	685.	50.	321.
E. coli bacteria, MPN/100 mL	Mainstem	Sacramento River at Veterans Bridge	06/20/00	06/10/03	39	95%	37	4.	300.	2.	28.6	48.8	17.	22.9
E. coli bacteria, MPN/100 mL	Mainstem	Sacramento River at Freeport	07/19/00	06/11/03	36	97%	35	2.	800.	2.	64.3	158.	15.5	40.1
E. coli bacteria, MPN/100 mL	Major Tributary	Yuba River at Marysville	09/25/01	06/09/03	10	90%	9	4.	1600.	2.	519.	748.	79.3	550.
E. coli bacteria, MPN/100 mL	Major Tributary	Feather River near Nicolaus	09/26/01	06/10/03	10	100%	10	2.	1600.	100% det	207.	493.	37.3	160.
E. coli bacteria, MPN/100 mL	Major Tributary	American River below Nimbus Dam	06/20/00	06/11/03	38	100%	38	4.	800.	100% det	60.8	129.	31.4	47.1

Summary Statistics: Pathogens and Indicators

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
E. coli bacteria, MPN/100 mL	Major Tributary	American River at Discovery Park	06/20/00	06/10/03	38	100%	38	2.	5000.	100% det	277.	895.	28.1	91.2
E. coli bacteria, MPN/100 mL	Urban	Natomas East Main Drain	09/26/01	06/10/03	9	100%	9	50.	1600.	100% det	902.	701.	549.	1217.
E. coli bacteria, MPN/100 mL	Urban	Natomas East Main Drain Canal (DWR)	11/13/97	10/02/00	34	100%	34	52.	12033.	100% det	1215.	2553.	2073.	360.

Summary Statistics: Physical and Conventional Parameters

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Alkalinity, total, mg/L as CaCO3	Ag Drains	Lindo Drain near Mission Ranch	10/27/99	01/11/00	2	100%	2	16.	24.	100% det	IDD	IDD	IDD	IDD
Alkalinity, total, mg/L as CaCO3	Ag Drains	Lindo Drain near East Ave Railroad	10/27/99	01/11/00	2	100%	2	23.	40.	100% det	IDD	IDD	IDD	IDD
Alkalinity, total, mg/L as CaCO3	Ag Drains	Chico Drain at Bidwell Ave	10/27/99	01/11/00	2	100%	2	20.	24.	100% det	IDD	IDD	IDD	IDD
Alkalinity, total, mg/L as CaCO3	Ag Drains	Chico Drain below Warner Street	10/27/99	01/11/00	2	100%	2	21.	42.	100% det	IDD	IDD	IDD	IDD
Alkalinity, total, mg/L as CaCO3	Ag Drains	Colusa Basin Drain above KL	02/07/96	06/09/03	75	100%	75	60.	480.	100% det	188.	57.5	180.	75.3
Alkalinity, total, mg/L as CaCO3	Ag Drains	Sacramento Slough	02/12/96	06/10/03	85	100%	85	50.	294.	100% det	134.	42.5	126.	59.9
Alkalinity, total, mg/L as CaCO3	Ag Drains	Yolo Bypass near Woodland	01/07/97	02/22/01	8	100%	8	41.	180.	100% det	96.5	50.9	85.2	78.3
Alkalinity, total, mg/L as CaCO3	Mainstem	Sacramento River below Shasta Dam	07/12/96	08/01/00	6	100%	6	45.	56.	100% det	50.5	4.59	50.3	7.86
Alkalinity, total, mg/L as CaCO3	Mainstem	Sacramento River below Keswick	07/11/96	06/09/03	49	100%	49	30.	62.	100% det	48.9	6.23	48.5	8.93
Alkalinity, total, mg/L as CaCO3	Mainstem	Sacramento River above Bend Bridge	02/13/96	06/09/03	70	100%	70	30.	62.	100% det	50.3	5.91	49.9	8.42
Alkalinity, total, mg/L as CaCO3	Mainstem	Sacramento River near Hamilton City	06/23/99	06/09/03	22	100%	22	31.	66.	100% det	54.2	8.02	53.5	12.2
Alkalinity, total, mg/L as CaCO3	Mainstem	Sacramento River at Colusa	10/24/95	06/09/03	98	100%	98	36.	72.	100% det	55.9	7.3	55.4	10.4
Alkalinity, total, mg/L as CaCO3	Mainstem	Sacramento River at Verona	03/19/96	05/20/98	27	100%	27	24.	73.	100% det	53.6	9.6	52.6	14.5
Alkalinity, total, mg/L as CaCO3	Mainstem	Sacramento River at Veterans Bridge	06/24/98	06/10/03	34	100%	34	16.	84.	100% det	62.5	13.6	60.5	21.8
Alkalinity, total, mg/L as CaCO3	Mainstem	Sacramento River at Freeport	01/10/90	06/10/03	146	100%	146	21.	85.	100% det	56.5	11.7	55.2	16.5
Alkalinity, total, mg/L as CaCO3	Mainstem	Sacramento River at River Mile 44	06/23/98	06/10/03	41	100%	41	36.1	130.	100% det	58.	15.5	56.4	18.1
Alkalinity, total, mg/L as CaCO3	Major Tributary	Yuba River at Marysville	02/27/96	06/09/03	45	100%	45	16.	43.	100% det	30.6	5.91	30.	8.76
Alkalinity, total, mg/L as CaCO3	Major Tributary	Feather River near Nicolaus	11/01/95	06/10/03	72	100%	72	22.	51.	100% det	38.6	6.02	38.1	8.46
Alkalinity, total, mg/L as CaCO3	Major Tributary	American River at Sacramento	11/03/95	04/16/98	28	100%	28	16.	27.	100% det	19.6	2.75	19.5	3.85
Alkalinity, total, mg/L as CaCO3	Major Tributary	American River at Discovery Park	06/23/98	06/10/03	43	100%	43	10.	74.	100% det	24.5	9.12	23.4	8.77
Alkalinity, total, mg/L as CaCO3	Tributary	Sacramento River above Shasta	07/22/98	05/16/00	12	100%	12	39.	64.	100% det	52.4	9.43	51.6	14.4
Alkalinity, total, mg/L as CaCO3	Tributary	Pit River above Shasta	07/22/98	06/08/03	22	100%	22	46.	220.	100% det	73.2	35.3	68.9	25.6
Alkalinity, total, mg/L as CaCO3	Tributary	McCloud River above Shasta	07/22/98	05/16/00	16	100%	16	36.	72.	100% det	52.1	9.87	51.2	15.1
Alkalinity, total, mg/L as CaCO3	Tributary	Spring Creek PP Discharge to Keswick Res.	06/24/98	04/18/00	12	100%	12	24.	78.	100% det	42.8	13.1	41.3	16.8
Alkalinity, total, mg/L as CaCO3	Tributary	Clear Creek above Whiskeytown	06/23/98	08/17/99	15	100%	15	24.	47.	100% det	35.2	7.01	34.5	10.9
Alkalinity, total, mg/L as CaCO3	Tributary	Clear Creek above Acid Canal	06/23/98	08/18/98	3	100%	3	40.	46.	100% det	42.7	3.06	42.6	5.96
Alkalinity, total, mg/L as CaCO3	Tributary	Clear Creek near Mouth	10/28/99	10/28/99	1	100%	1	75.	75.	100% det	IDD	IDD	IDD	IDD
Alkalinity, total, mg/L as CaCO3	Tributary	Clear Creek near Mouth	09/15/98	08/17/99	12	100%	12	24.	50.	100% det	38.6	6.64	38.	10.6
Alkalinity, total, mg/L as CaCO3	Tributary	Cottonwood Ck at Main Street	10/31/01	06/09/03	8	100%	8	68.	110.	100% det	91.4	16.	90.1	26.4
Alkalinity, total, mg/L as CaCO3	Tributary	Cottonwood Ck near Cottonwood	10/12/95	10/01/02	3	100%	3	74.	102.	100% det	84.	15.6	83.1	26.8
Alkalinity, total, mg/L as CaCO3	Tributary	Mill Creek at Highway 36	11/08/99	01/19/00	2	100%	2	23.	26.	100% det	IDD	IDD	IDD	IDD
Alkalinity, total, mg/L as CaCO3	Tributary	Mill Creek at Hole in the Ground	10/28/99	10/28/99	1	100%	1	21.	21.	100% det	IDD	IDD	IDD	IDD
Alkalinity, total, mg/L as CaCO3	Tributary	Mill Creek at Black Rock	06/23/98	04/17/00	17	100%	17	24.	46.	100% det	34.4	6.81	33.8	10.3
Alkalinity, total, mg/L as CaCO3	Tributary	Mill Creek at USGS gage	10/28/99	01/19/00	3	100%	3	38.	51.	100% det	43.3	6.81	43.	12.7
Alkalinity, total, mg/L as CaCO3	Tributary	Mill Creek at Mouth	06/23/98	04/17/00	20	100%	20	24.	53.	100% det	39.1	8.32	38.2	12.4
Alkalinity, total, mg/L as CaCO3	Tributary	Deer Creek below Childs Meadows	06/24/98	05/18/99	12	100%	12	20.	37.	100% det	28.3	4.85	27.9	7.65
Alkalinity, total, mg/L as CaCO3	Tributary	Deer Creek at A Line Road	06/24/98	04/17/00	13	100%	13	24.	57.	100% det	39.5	9.54	38.4	14.6
Alkalinity, total, mg/L as CaCO3	Tributary	Deer Creek at Ponderosa Way	06/24/98	11/08/99	24	100%	24	28.	64.	100% det	47.4	12.	45.9	17.8
Alkalinity, total, mg/L as CaCO3	Tributary	Deer Creek at Upper Diversion Dam	06/24/98	05/18/99	12	100%	12	33.	66.	100% det	48.8	10.8	47.7	16.7
Alkalinity, total, mg/L as CaCO3	Tributary	Deer Creek at Highway 99	06/24/98	02/14/00	25	100%	25	32.	88.	100% det	58.5	18.	55.8	26.2
Alkalinity, total, mg/L as CaCO3	Tributary	Deer Creek at Mouth	06/24/98	04/17/00	13	100%	13	34.	81.	100% det	55.3	15.6	53.2	23.9
Alkalinity, total, mg/L as CaCO3	Tributary	Big Chico Creek above Campbell Creek	09/14/99	09/14/99	1	100%	1	94.	94.	100% det	IDD	IDD	IDD	IDD
Alkalinity, total, mg/L as CaCO3	Tributary	Big Chico Creek below Campbell Creek	06/22/99	07/23/99	2	100%	2	82.	87.	100% det	IDD	IDD	IDD	IDD
Alkalinity, total, mg/L as CaCO3	Tributary	Big Chico Creek at Hwy 32	06/23/98	01/19/00	16	100%	16	47.	86.	100% det	69.2	12.6	68.	19.6
Alkalinity, total, mg/L as CaCO3	Tributary	Big Chico Creek below Higgins Hole (Flow)	06/23/98	07/23/99	14	100%	14	31.	98.	100% det	63.8	19.3	60.8	31.
Alkalinity, total, mg/L as CaCO3	Tributary	Big Chico Creek above Salmon Hole	06/23/98	08/17/99	29	100%	29	38.	92.	100% det	66.8	18.2	64.3	26.5
Alkalinity, total, mg/L as CaCO3	Tributary	Lindo Channel below Five-Mile Rec.	06/23/98	04/22/99	6	100%	6	29.	56.	100% det	42.	11.6	40.7	19.4
Alkalinity, total, mg/L as CaCO3	Tributary	Big Chico Creek at Chico (Rose Ave.)	06/23/98	04/17/00	34	100%	34	30.	92.	100% det	66.3	19.4	63.2	28.8
Alkalinity, total, mg/L as CaCO3	Tributary	Big Chico Creek above Golf Course	09/14/99	04/17/00	6	100%	6	29.	90.	100% det	73.7	23.9	68.9	44.3

Summary Statistics: Physical and Conventional Parameters

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Alkalinity, total, mg/L as CaCO3	Tributary	Big Chico Creek at Golf Course above Five-Mile Rec.	06/23/98	01/11/00	16	100%	16	33.	98.	100% det	68.5	19.5	65.4	31.5
Alkalinity, total, mg/L as CaCO3	Tributary	Big Chico Creek below Five-Mile Rec.	06/23/98	10/27/99	15	100%	15	33.	98.	100% det	66.4	20.4	63.1	32.8
Alkalinity, total, mg/L as CaCO3	Tributary	Big Chico Creek above Mud Creek	06/23/98	04/17/00	35	100%	35	28.	90.	100% det	68.3	19.4	65.1	29.2
Alkalinity, total, mg/L as CaCO3	Tributary	Mud Creek above Big Chico Creek	06/23/98	04/17/00	19	100%	19	37.	82.	100% det	56.3	12.8	54.9	19.3
Alkalinity, total, mg/L as CaCO3	Tributary	Little Chico Creek at Ten Mile	10/28/99	01/19/00	3	100%	3	49.	79.	100% det	64.7	15.	63.5	30.6
Alkalinity, total, mg/L as CaCO3	Tributary	Little Chico Creek at Stilson Cyn	09/14/99	01/19/00	4	100%	4	57.	92.	100% det	82.3	16.9	80.7	28.5
Alkalinity, total, mg/L as CaCO3	Tributary	Little Chico Creek at Crown Point	09/14/99	09/14/99	1	100%	1	82.	82.	100% det	IDD	IDD	IDD	IDD
Alkalinity, total, mg/L as CaCO3	Tributary	Butte Creek below Pool Four	09/14/99	01/19/00	4	100%	4	36.	55.	100% det	44.3	8.88	43.6	15.9
Alkalinity, total, mg/L as CaCO3	Tributary	Butte Creek at USGS gage near Chico	06/24/98	04/19/00	12	100%	12	22.	64.	100% det	44.2	12.	42.6	19.2
Alkalinity, total, mg/L as CaCO3	Tributary	Butte Creek above Okie Dam	09/14/99	01/19/00	4	100%	4	43.	59.	100% det	53.	6.98	52.6	12.7
Alkalinity, total, mg/L as CaCO3	Tributary	Butte Creek at Colusa Highway	06/24/98	04/19/00	12	100%	12	43.	110.	100% det	79.1	22.3	76.	35.9
Alkalinity, total, mg/L as CaCO3	Tributary	Cache Creek near Rumsey	02/09/96	06/08/03	67	100%	67	65.	268.	100% det	141.	42.1	136.	50.
Alkalinity, total, mg/L as CaCO3	Tributary	Cache Slough near Ryers Ferry	06/25/98	04/18/00	12	100%	12	60.	100.	100% det	71.3	11.5	70.6	16.
Alkalinity, total, mg/L as CaCO3	Urban	Natomas East Main Drain	02/05/01	06/06/01	4	100%	4	77.	110.	100% det	100.	15.6	99.2	26.1
Alkalinity, total, mg/L as CaCO3	Urban	Natomas East Main Drain Canal (DWR)	01/23/90	10/02/00	102	100%	102	28.	326.	100% det	154.	72.7	168.	136.
Alkalinity, total, mg/L as CaCO3	Urban Creek	Arcade Creek at Auburn Blvd	02/05/01	06/06/01	4	100%	4	54.	74.	100% det	62.8	9.84	62.2	17.4
Alkalinity, total, mg/L as CaCO3	Urban Creek	Arcade Creek in Del Paso Park	11/06/95	09/20/02	57	100%	57	19.	110.	100% det	68.4	21.1	64.2	33.5
Alkalinity, total, mg/L as CaCO3	Urban Creek	Arcade Creek at Norwood Ave.	06/23/98	06/10/03	48	100%	48	25.	116.	100% det	66.2	28.7	59.8	39.3
Alkalinity, total, mg/L as CaCO3	Urban Creek	Arcade Creek at Mouth	02/05/01	06/06/01	4	100%	4	57.	96.	100% det	70.	18.	68.5	28.6
Dissolved Oxygen, mg/L	Ag Drains	Colusa Basin Drain above KL	06/23/99	06/09/03	38	100%	38	2.	12.6	100% det	7.92	2.59	7.35	4.26
Dissolved Oxygen, mg/L	Ag Drains	Sacramento Slough	06/22/99	06/10/03	37	100%	37	2.3	13.8	100% det	8.56	2.36	8.19	3.62
Dissolved Oxygen, mg/L	Mainstem	Sacramento River below Keswick	06/24/98	04/03/03	35	100%	35	6.56	13.8	100% det	10.7	1.45	10.6	2.07
Dissolved Oxygen, mg/L	Mainstem	Sacramento River above Bend Bridge	06/24/98	06/09/03	44	100%	44	4.86	12.9	100% det	10.4	1.58	10.3	2.31
Dissolved Oxygen, mg/L	Mainstem	Sacramento River near Hamilton City	06/23/99	06/09/03	48	100%	48	2.5	14.7	100% det	9.92	2.35	9.5	3.76
Dissolved Oxygen, mg/L	Mainstem	Sacramento River at Colusa	06/24/98	06/09/03	47	100%	47	4.15	16.06	100% det	10.1	1.68	9.9	2.32
Dissolved Oxygen, mg/L	Mainstem	Sacramento River at Veterans Bridge	07/21/98	06/10/03	48	100%	48	6.6	14.2	100% det	9.56	1.46	9.45	1.96
Dissolved Oxygen, mg/L	Mainstem	Sacramento River at Freeport	07/22/98	06/10/03	40	100%	40	6.9	11.5	100% det	9.07	0.954	9.03	1.34
Dissolved Oxygen, mg/L	Mainstem	Sacramento River at River Mile 44	07/22/98	06/10/03	40	100%	40	6.7	12.2	100% det	8.94	1.07	8.88	1.48
Dissolved Oxygen, mg/L	Mainstem	Sacramento River at Greene's Landing	07/21/00	06/14/01	17	100%	17	7.2	12.8	100% det	9.81	1.54	9.69	2.35
Dissolved Oxygen, mg/L	Major Tributary	Yuba River at Marysville	06/24/99	06/09/03	30	100%	30	4.57	13.6	100% det	10.	1.74	9.84	2.65
Dissolved Oxygen, mg/L	Major Tributary	Feather River near Nicolaus	06/23/98	06/10/03	50	100%	50	4.11	13.6	100% det	9.91	1.55	9.77	2.25
Dissolved Oxygen, mg/L	Major Tributary	American River at Discovery Park	09/26/01	06/10/03	10	100%	10	7.8	10.9	100% det	9.39	1.	9.34	1.62
Dissolved Oxygen, mg/L	Tributary	Sacramento River above Shasta	07/22/98	05/16/00	9	100%	9	9.8	12.8	100% det	11.	0.937	11.	1.49
Dissolved Oxygen, mg/L	Tributary	Pit River above Shasta	07/22/98	05/16/00	9	100%	9	9.9	13.	100% det	11.4	0.902	11.3	1.45
Dissolved Oxygen, mg/L	Tributary	McCloud River above Shasta	07/22/98	05/16/00	9	100%	9	8.3	11.7	100% det	10.6	1.32	10.5	2.01
Dissolved Oxygen, mg/L	Tributary	Spring Creek PP Discharge to Keswick Res.	06/24/98	04/18/00	12	100%	12	8.8	11.7	100% det	10.3	0.813	10.2	1.27
Dissolved Oxygen, mg/L	Tributary	MF Cottonwood at Platina Rd	11/07/02	03/14/03	3	100%	3	10.1	11.9	100% det	10.8	0.987	10.7	1.76
Dissolved Oxygen, mg/L	Tributary	MF Cottonwood Ck near Ono	11/01/01	02/18/02	2	100%	2	9.78	10.7	100% det	IDD	IDD	IDD	IDD
Dissolved Oxygen, mg/L	Tributary	MF Cottonwood Ck near Cox Road	04/04/03	04/04/03	1	100%	1	10.93	10.93	100% det	IDD	IDD	IDD	IDD
Dissolved Oxygen, mg/L	Tributary	NF Cottonwood Ck near Ono	11/07/02	03/14/03	3	100%	3	10.9	11.3	100% det	IDD	IDD	IDD	IDD
Dissolved Oxygen, mg/L	Tributary	NF Cottonwood Ck at McCauliffe Rd	11/01/01	02/19/02	2	100%	2	9.55	10.8	100% det	IDD	IDD	IDD	IDD
Dissolved Oxygen, mg/L	Tributary	NF Cottonwood Ck near Foster Road	04/04/03	04/04/03	1	100%	1	10.8	10.8	100% det	IDD	IDD	IDD	IDD
Dissolved Oxygen, mg/L	Tributary	SF Cottonwood Ck at Anderson Canal	10/31/01	04/04/03	5	100%	5	8.19	13.5	100% det	10.6	1.9	10.5	3.22
Dissolved Oxygen, mg/L	Tributary	North Fork Battle Ck at Wildcat Road	11/01/01	04/04/03	6	100%	6	9.66	11.9	100% det	10.7	0.851	10.7	1.47
Dissolved Oxygen, mg/L	Tributary	South Fork Battle Creek at Manton Road	11/01/01	04/04/03	6	100%	6	10.21	12.7	100% det	11.	0.873	11.	1.3
Dissolved Oxygen, mg/L	Tributary	Battle Ck below Coleman Fish Hatchery	11/01/01	04/04/03	6	100%	6	9.59	11.4	100% det	10.5	0.768	10.5	1.29
Dissolved Oxygen, mg/L	Tributary	Mill Creek at Black Rock	04/06/01	04/06/01	1	100%	1	10.1	10.1	100% det	IDD	IDD	IDD	IDD
Dissolved Oxygen, mg/L	Tributary	Mill Creek at Highway 99	04/06/01	04/07/01	4	100%	4	8.1	12.1	100% det	10.4	2.01	10.3	3.62
Dissolved Oxygen, mg/L	Tributary	Mill Creek at Mouth	07/19/00	04/12/03	18	100%	18	6.1	17.4	100% det	10.7	2.31	10.5	3.2
Dissolved Oxygen, mg/L	Tributary	Thomes Ck at Paskenta	11/02/01	04/04/03	6	100%	6	9.39	10.7	100% det	10.4	0.497	10.4	0.729

Summary Statistics: Physical and Conventional Parameters

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Dissolved Oxygen, mg/L	Tributary	Thomes Ck at Henleyville	02/20/02	04/04/03	4	100%	4	9.7	12.2	100% det	10.7	1.06	10.7	1.82
Dissolved Oxygen, mg/L	Tributary	Thomes Ck at Rawson Rd Bridge	02/20/02	04/04/03	4	100%	4	9.3	11.6	100% det	10.4	0.943	10.3	1.68
Dissolved Oxygen, mg/L	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	100%	3	8.84	12.33	100% det	10.7	1.76	10.6	3.55
Dissolved Oxygen, mg/L	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	6	100%	6	9.4	17.3	100% det	11.6	2.92	11.3	3.9
Dissolved Oxygen, mg/L	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	9	100%	9	9.5	16.6	100% det	11.	2.27	10.8	2.68
Dissolved Oxygen, mg/L	Tributary	Dry Creek above Cherokee Canal	11/03/01	04/12/03	7	100%	7	8.31	11.1	100% det	9.99	0.86	9.96	1.4
Dissolved Oxygen, mg/L	Tributary	Little Chico Creek below Chico	02/20/02	04/12/03	5	100%	5	9.3	10.15	100% det	9.84	0.338	9.83	0.577
Dissolved Oxygen, mg/L	Tributary	Cache Slough near Ryers Ferry	06/23/98	02/16/00	16	100%	16	2.6	10.95	100% det	8.74	2.07	8.38	3.52
Dissolved Oxygen, mg/L	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	100%	10	2.04	10.2	100% det	7.18	2.23	6.68	4.03
Dissolved Oxygen, mg/L	Urban	Natomas East Main Drain Canal (DWR)	04/24/91	12/08/93	35	100%	35	5.2	15.3	100% det	9.04	2.33	9.81	8.76
Dissolved Oxygen, mg/L	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	06/10/03	38	100%	38	0.4	14.4	100% det	7.01	3.48	5.87	5.72
Hardness, total, mg/L as CaCO3	Ag Drains	Lindo Drain near Mission Ranch	10/27/99	01/11/00	2	100%	2	16.	22.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Ag Drains	Lindo Drain near East Ave Railroad	10/27/99	01/11/00	2	100%	2	36.	38.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Ag Drains	Chico Drain at Bidwell Ave	10/27/99	01/11/00	2	100%	2	24.	34.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Ag Drains	Chico Drain below Warner Street	10/27/99	01/11/00	2	100%	2	20.	68.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Ag Drains	Colusa Basin Drain above KL	06/24/98	06/09/03	44	100%	44	48.	372.	100% det	186.	50.	179.	70.7
Hardness, total, mg/L as CaCO3	Ag Drains	Sacramento Slough	06/23/98	06/10/03	43	100%	43	56.	638.	100% det	144.	93.9	129.	76.3
Hardness, total, mg/L as CaCO3	Mainstem	Sacramento River below Keswick	06/24/98	06/09/03	43	100%	43	38.	82.	100% det	47.2	9.11	46.5	10.3
Hardness, total, mg/L as CaCO3	Mainstem	Sacramento River above Bend Bridge	06/24/98	06/09/03	43	100%	43	27.	128.	100% det	49.	14.2	47.7	13.5
Hardness, total, mg/L as CaCO3	Mainstem	Sacramento River near Hamilton City	06/23/99	06/09/03	31	100%	31	41.	68.	100% det	52.	6.27	51.7	8.74
Hardness, total, mg/L as CaCO3	Mainstem	Sacramento River at Colusa	06/24/98	06/09/03	42	100%	42	30.	104.	100% det	55.4	11.7	54.3	14.6
Hardness, total, mg/L as CaCO3	Mainstem	Sacramento River at Veterans Bridge	12/15/92	05/06/03	167	100%	167	28.	97.1	100% det	59.7	12.	58.5	16.3
Hardness, total, mg/L as CaCO3	Mainstem	Sacramento River at Freeport	12/15/92	06/10/03	180	100%	180	26.	127.	100% det	56.8	13.8	55.2	18.1
Hardness, total, mg/L as CaCO3	Mainstem	Sacramento River at River Mile 44	12/15/92	05/07/03	133	100%	133	24.	110.	100% det	58.	13.9	56.3	19.
Hardness, total, mg/L as CaCO3	Major Tributary	Yuba River at Marysville	09/25/01	06/09/03	11	100%	11	33.	57.	100% det	41.4	6.85	40.9	10.
Hardness, total, mg/L as CaCO3	Major Tributary	Feather River near Nicolaus	06/23/98	06/10/03	44	100%	44	28.	98.	100% det	46.1	15.3	44.1	17.7
Hardness, total, mg/L as CaCO3	Major Tributary	American River below Nimbus Dam	01/07/93	05/07/03	138	100%	138	12.	64.	100% det	25.4	8.67	24.2	10.3
Hardness, total, mg/L as CaCO3	Major Tributary	American River at Discovery Park	12/15/92	06/10/03	184	100%	184	14.	103.	100% det	26.1	9.65	24.9	9.59
Hardness, total, mg/L as CaCO3	Tributary	Sacramento River above Shasta	07/22/98	05/16/00	12	100%	12	32.	76.	100% det	46.	11.4	44.9	15.1
Hardness, total, mg/L as CaCO3	Tributary	Pit River above Shasta	07/22/98	06/08/03	22	100%	22	14.	68.	100% det	49.5	9.64	48.	15.
Hardness, total, mg/L as CaCO3	Tributary	McCloud River above Shasta	07/22/98	05/16/00	16	100%	16	32.	94.	100% det	49.4	14.3	47.8	17.6
Hardness, total, mg/L as CaCO3	Tributary	Spring Creek PP Discharge to Keswick Res.	06/24/98	04/18/00	12	100%	12	28.	64.	100% det	39.2	8.84	38.4	10.9
Hardness, total, mg/L as CaCO3	Tributary	Clear Creek above Whiskeytown	06/23/98	08/17/99	15	100%	15	16.	58.	100% det	40.9	11.8	39.	19.6
Hardness, total, mg/L as CaCO3	Tributary	Clear Creek above Acid Canal	06/23/98	08/18/98	3	100%	3	36.	40.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Tributary	Clear Creek near Mouth	10/28/99	10/28/99	1	100%	1	64.	64.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Tributary	Clear Creek near Mouth	09/15/98	08/17/99	12	100%	12	20.	72.	100% det	45.2	13.7	43.1	21.5
Hardness, total, mg/L as CaCO3	Tributary	Cottonwood Ck at Main Street	10/31/01	06/09/03	8	100%	8	76.	122.	100% det	105.	15.4	104.	25.8
Hardness, total, mg/L as CaCO3	Tributary	Cottonwood Ck near Cottonwood	09/24/01	10/01/02	2	100%	2	72.	74.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Tributary	Mill Creek at Highway 36	11/08/99	01/19/00	2	100%	2	38.	72.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Tributary	Mill Creek at Hole in the Ground	10/28/99	10/28/99	1	100%	1	60.	60.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Tributary	Mill Creek at Black Rock	06/23/98	04/17/00	17	100%	17	24.	56.	100% det	38.7	8.74	37.8	13.
Hardness, total, mg/L as CaCO3	Tributary	Mill Creek at USGS gage	10/28/99	01/19/00	3	100%	3	36.	52.	100% det	45.3	8.33	44.8	16.6
Hardness, total, mg/L as CaCO3	Tributary	Mill Creek at Mouth	06/23/98	04/17/00	20	100%	20	24.	72.	100% det	44.	12.8	42.2	19.1
Hardness, total, mg/L as CaCO3	Tributary	Deer Creek at A Line Road	01/20/00	04/17/00	3	100%	3	20.	30.	100% det	26.	5.29	25.6	10.5
Hardness, total, mg/L as CaCO3	Tributary	Deer Creek at Ponderosa Way	06/24/98	11/08/99	16	100%	16	20.	100.	100% det	45.	18.6	41.9	24.6
Hardness, total, mg/L as CaCO3	Tributary	Deer Creek at Highway 99	06/24/98	02/14/00	16	100%	16	28.	76.	100% det	52.1	15.8	49.7	24.6
Hardness, total, mg/L as CaCO3	Tributary	Deer Creek at Mouth	08/18/99	04/17/00	3	100%	3	32.	84.	100% det	57.3	26.	53.2	53.4
Hardness, total, mg/L as CaCO3	Tributary	Big Chico Creek above Campbell Creek	09/14/99	09/14/99	1	100%	1	76.	76.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Tributary	Big Chico Creek at Hwy 32	11/08/99	01/19/00	2	100%	2	52.	56.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Tributary	Big Chico Creek above Salmon Hole	06/23/98	08/17/99	14	100%	14	40.	76.	100% det	62.9	11.9	61.7	18.7

Summary Statistics: Physical and Conventional Parameters

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Hardness, total, mg/L as CaCO3	Tributary	Big Chico Creek at Chico (Rose Ave.)	06/23/98	04/17/00	19	100%	19	20.	88.	100% det	61.2	17.6	58.2	28.3
Hardness, total, mg/L as CaCO3	Tributary	Big Chico Creek above Golf Course	09/14/99	04/17/00	6	100%	6	24.	76.	100% det	63.	20.9	58.7	38.7
Hardness, total, mg/L as CaCO3	Tributary	Big Chico Creek at Golf Course above Five-Mile Rec.	10/28/99	01/11/00	2	100%	2	74.	76.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Tributary	Big Chico Creek below Five-Mile Rec.	10/27/99	10/27/99	1	100%	1	78.	78.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Tributary	Big Chico Creek above Mud Creek	06/23/98	04/17/00	20	100%	20	24.	84.	100% det	58.4	15.3	56.2	24.4
Hardness, total, mg/L as CaCO3	Tributary	Mud Creek above Big Chico Creek	06/23/98	04/17/00	11	100%	11	32.	92.	100% det	54.5	18.	52.1	26.2
Hardness, total, mg/L as CaCO3	Tributary	Little Chico Creek at Ten Mile	10/28/99	01/19/00	3	100%	3	44.	74.	100% det	62.	15.9	60.5	31.8
Hardness, total, mg/L as CaCO3	Tributary	Little Chico Creek at Stilson Cyn	09/14/99	01/19/00	4	100%	4	52.	88.	100% det	75.	15.8	73.6	28.6
Hardness, total, mg/L as CaCO3	Tributary	Little Chico Creek at Crown Point	09/14/99	09/14/99	1	100%	1	72.	72.	100% det	IDD	IDD	IDD	IDD
Hardness, total, mg/L as CaCO3	Tributary	Butte Creek below Pool Four	09/14/99	01/19/00	4	100%	4	32.	56.	100% det	45.5	10.8	44.5	20.6
Hardness, total, mg/L as CaCO3	Tributary	Butte Creek at USGS gage near Chico	06/24/98	04/19/00	12	100%	12	28.	84.	100% det	46.	16.6	43.6	22.4
Hardness, total, mg/L as CaCO3	Tributary	Butte Creek above Okie Dam	09/14/99	01/19/00	4	100%	4	40.	60.	100% det	49.	8.87	48.4	16.3
Hardness, total, mg/L as CaCO3	Tributary	Butte Creek at Colusa Highway	06/24/98	04/19/00	12	100%	12	44.	132.	100% det	78.2	26.2	74.2	39.9
Hardness, total, mg/L as CaCO3	Tributary	Cache Creek near Rumsey	09/23/01	06/08/03	9	100%	9	119.	283.	100% det	176.	52.1	170.	77.8
Hardness, total, mg/L as CaCO3	Tributary	Cache Slough near Ryers Ferry	06/23/98	04/18/00	12	100%	12	60.	104.	100% det	74.3	13.4	73.3	19.7
Hardness, total, mg/L as CaCO3	Urban	Natomas East Main Drain	02/05/01	06/06/01	4	100%	4	92.	114.	100% det	106.	9.43	105.	16.6
Hardness, total, mg/L as CaCO3	Urban	Natomas East Main Drain Canal (DWR)	02/27/90	10/02/00	101	99%	100	27.	324.	1.	164.	74.3	178.	146.
Hardness, total, mg/L as CaCO3	Urban Creek	Arcade Creek at Auburn Blvd	02/05/01	06/06/01	4	100%	4	60.	88.	100% det	74.3	13.4	73.3	24.5
Hardness, total, mg/L as CaCO3	Urban Creek	Arcade Creek at Norwood Ave.	06/23/98	06/10/03	47	100%	47	27.	132.	100% det	73.5	29.	67.5	41.7
Hardness, total, mg/L as CaCO3	Urban Creek	Arcade Creek at Mouth	02/05/01	06/06/01	4	100%	4	65.	104.	100% det	77.5	17.9	76.1	26.7
Organic Carbon, dissolved, mg/L	Ag Drains	Colusa Basin Drain above KL	02/07/96	06/09/03	67	100%	67	2.5	15.	100% det	6.36	2.28	6.	2.9
Organic Carbon, dissolved, mg/L	Ag Drains	Sacramento Slough	02/12/96	06/10/03	60	100%	60	1.4	31.	100% det	4.55	3.78	3.96	2.52
Organic Carbon, dissolved, mg/L	Ag Drains	Yolo Bypass near Woodland	01/07/97	02/22/01	8	100%	8	2.	6.3	100% det	2.99	1.47	2.76	1.65
Organic Carbon, dissolved, mg/L	Mainstem	Sacramento River below Shasta Dam	07/12/96	08/01/00	6	100%	6	0.7	1.2	100% det	1.02	0.183	1.	0.313
Organic Carbon, dissolved, mg/L	Mainstem	Sacramento River below Keswick	07/11/96	05/16/00	16	100%	16	0.9	2.4	100% det	1.16	0.354	1.12	0.339
Organic Carbon, dissolved, mg/L	Mainstem	Sacramento River above Bend Bridge	02/13/96	06/09/03	63	100%	63	0.78	4.3	100% det	1.52	0.591	1.44	0.605
Organic Carbon, dissolved, mg/L	Mainstem	Sacramento River near Hamilton City	09/22/99	06/09/03	27	100%	27	0.82	5.8	100% det	1.82	0.992	1.65	0.986
Organic Carbon, dissolved, mg/L	Mainstem	Sacramento River at Colusa	02/28/96	06/09/03	51	100%	51	0.81	6.4	100% det	1.73	1.02	1.56	0.8
Organic Carbon, dissolved, mg/L	Mainstem	Sacramento River at Verona	02/22/96	05/20/98	28	100%	28	1.3	3.6	100% det	1.85	0.624	1.77	0.708
Organic Carbon, dissolved, mg/L	Mainstem	Sacramento River at Veterans Bridge	12/15/92	06/10/03	96	63%	60	0.7	10.	3.	2.48	1.47	2.19	1.45
Organic Carbon, dissolved, mg/L	Mainstem	Sacramento River at Freeport	12/15/92	06/11/03	165	83%	137	0.3	5.3	0.7	2.06	0.846	1.91	0.953
Organic Carbon, dissolved, mg/L	Mainstem	Sacramento River at River Mile 44	12/15/92	06/11/03	103	63%	65	1.3	38.	0.7	2.85	3.69	2.35	1.55
Organic Carbon, dissolved, mg/L	Major Tributary	Yuba River at Marysville	02/27/96	06/09/03	76	100%	76	0.7	3.6	100% det	1.3	0.621	1.19	0.636
Organic Carbon, dissolved, mg/L	Major Tributary	Feather River near Nicolaus	02/23/96	06/10/03	62	100%	62	1.2	4.2	100% det	1.83	0.693	1.73	0.737
Organic Carbon, dissolved, mg/L	Major Tributary	American River below Nimbus Dam	01/07/93	06/11/03	84	45%	38	0.7	2.	3.	1.45	0.295	1.42	0.422
Organic Carbon, dissolved, mg/L	Major Tributary	American River at Sacramento	02/21/96	04/16/98	27	100%	27	1.1	6.4	100% det	1.72	1.05	1.58	0.671
Organic Carbon, dissolved, mg/L	Major Tributary	American River at Discovery Park	12/15/92	06/10/03	85	46%	39	0.9	3.8	3.	1.78	0.468	1.72	0.605
Organic Carbon, dissolved, mg/L	Tributary	Sacramento River above Shasta	11/15/99	05/16/00	4	100%	4	0.9	1.4	100% det	IDD	IDD	IDD	IDD
Organic Carbon, dissolved, mg/L	Tributary	Pit River above Shasta	11/15/99	05/16/00	4	100%	4	0.9	1.7	100% det	1.28	0.33	1.24	0.609
Organic Carbon, dissolved, mg/L	Tributary	McCloud River above Shasta	11/15/99	05/16/00	4	100%	4	0.5	0.8	100% det	0.65	0.129	0.64	0.244
Organic Carbon, dissolved, mg/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	04/18/00	4	100%	4	1.1	1.2	100% det	IDD	IDD	IDD	IDD
Organic Carbon, dissolved, mg/L	Tributary	Cache Creek near Rumsey	02/09/96	02/21/01	51	100%	51	1.1	4.9	100% det	2.86	0.734	2.77	1.02
Organic Carbon, dissolved, mg/L	Tributary	Cache Slough near Ryers Ferry	10/20/99	02/16/00	3	100%	3	1.7	4.9	100% det	2.87	1.77	2.55	2.83
Organic Carbon, dissolved, mg/L	Urban	Natomas East Main Drain Canal (DWR)	01/23/90	10/02/00	102	100%	102	3.	12.	100% det	5.5	1.57	5.81	5.31
Organic Carbon, dissolved, mg/L	Urban Creek	Arcade Creek in Del Paso Park	02/06/96	09/18/01	37	100%	37	1.2	18.	100% det	7.38	2.5	6.97	3.06
Organic Carbon, dissolved, mg/L	Urban Creek	Arcade Creek at Norwood Ave.	09/21/99	05/17/00	9	100%	9	6.2	12.	100% det	7.8	1.81	7.64	2.43
Organic Carbon, suspended, mg/L	Ag Drains	Colusa Basin Drain above KL	02/07/96	05/16/00	46	100%	46	0.6	2.7	100% det	1.25	0.494	1.16	0.644
Organic Carbon, suspended, mg/L	Ag Drains	Sacramento Slough	02/12/96	05/16/00	39	100%	39	0.3	9.4	100% det	1.02	1.44	0.735	0.717
Organic Carbon, suspended, mg/L	Ag Drains	Yolo Bypass near Woodland	01/07/97	02/22/01	7	100%	7	0.4	6.3	100% det	2.17	2.13	1.43	2.74
Organic Carbon, suspended, mg/L	Mainstem	Sacramento River below Shasta Dam	07/12/96	08/01/00	6	83%	5	0.1	0.4	0.2	0.2	0.109	0.179	0.146

Summary Statistics: Physical and Conventional Parameters

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Organic Carbon, suspended, mg/L	Mainstem	Sacramento River below Keswick	07/11/96	05/16/00	15	47%	7	0.1	2.4	0.1	0.257	0.597	0.0962	0.188
Organic Carbon, suspended, mg/L	Mainstem	Sacramento River above Bend Bridge	02/13/96	05/17/00	44	89%	39	0.1	1.	0.2	0.294	0.201	0.245	0.208
Organic Carbon, suspended, mg/L	Mainstem	Sacramento River near Hamilton City	09/22/99	05/16/00	8	75%	6	0.2	2.3	0.2	0.559	0.797	0.232	0.648
Organic Carbon, suspended, mg/L	Mainstem	Sacramento River at Colusa	02/28/96	09/16/98	30	97%	29	0.2	2.5	0.2	0.513	0.483	0.405	0.373
Organic Carbon, suspended, mg/L	Mainstem	Sacramento River at Verona	02/22/96	05/20/98	25	100%	25	0.2	1.2	100% det	0.468	0.244	0.417	0.298
Organic Carbon, suspended, mg/L	Mainstem	Sacramento River at Freeport	02/20/96	09/18/02	72	99%	71	0.2	1.4	0.2	0.475	0.293	0.404	0.323
Organic Carbon, suspended, mg/L	Mainstem	Sacramento River at River Mile 44	09/22/99	05/17/00	9	100%	9	0.3	0.8	100% det	0.489	0.196	0.458	0.267
Organic Carbon, suspended, mg/L	Major Tributary	Yuba River at Marysville	02/27/96	06/24/02	56	68%	38	0.1	1.2	0.2	0.248	0.212	0.19	0.197
Organic Carbon, suspended, mg/L	Major Tributary	Feather River near Nicolaus	02/23/96	05/16/00	41	88%	36	0.2	0.8	0.2	0.336	0.166	0.299	0.212
Organic Carbon, suspended, mg/L	Major Tributary	American River at Sacramento	02/21/96	04/16/98	26	88%	23	0.1	1.7	0.1	0.355	0.354	0.261	0.291
Organic Carbon, suspended, mg/L	Tributary	Sacramento River above Shasta	11/15/99	05/16/00	4	0%	0	ND	ND	0.2	IDD	IDD	IDD	IDD
Organic Carbon, suspended, mg/L	Tributary	Pit River above Shasta	11/15/99	05/16/00	4	0%	0	ND	ND	0.2	IDD	IDD	IDD	IDD
Organic Carbon, suspended, mg/L	Tributary	McCloud River above Shasta	11/15/99	05/16/00	4	0%	0	ND	ND	0.2	IDD	IDD	IDD	IDD
Organic Carbon, suspended, mg/L	Tributary	Spring Creek PP Discharge to Keswick Res.	10/20/99	02/15/00	3	33%	1	0.2	0.2	0.2	IDD	IDD	IDD	IDD
Organic Carbon, suspended, mg/L	Tributary	Cache Creek near Rumsey	02/09/96	02/21/01	39	97%	38	0.2	8.3	0.2	1.01	1.39	0.666	0.795
Organic Carbon, suspended, mg/L	Tributary	Cache Slough near Ryers Ferry	10/20/99	02/16/00	3	100%	3	0.2	0.5	100% det	IDD	IDD	IDD	IDD
Organic Carbon, suspended, mg/L	Urban Creek	Arcade Creek in Del Paso Park	02/06/96	09/18/01	37	100%	37	0.2	6.5	100% det	0.992	1.32	0.609	0.793
Organic Carbon, suspended, mg/L	Urban Creek	Arcade Creek at Norwood Ave.	09/21/99	05/17/00	9	100%	9	0.5	3.	100% det	1.17	0.781	0.995	0.946
Organic Carbon, total, mg/L	Ag Drains	Colusa Basin Drain above KL	07/21/00	06/09/03	20	100%	20	4.2	18.	100% det	8.62	3.24	8.12	4.22
Organic Carbon, total, mg/L	Ag Drains	Sacramento Slough	07/21/00	06/10/03	20	100%	20	1.6	9.2	100% det	5.43	1.92	5.08	2.87
Organic Carbon, total, mg/L	Mainstem	Sacramento River above Bend Bridge	07/19/00	06/09/03	19	100%	19	0.83	6.5	100% det	1.64	1.22	1.44	0.851
Organic Carbon, total, mg/L	Mainstem	Sacramento River near Hamilton City	07/20/00	06/09/03	19	100%	19	0.94	8.9	100% det	2.17	1.8	1.82	1.43
Organic Carbon, total, mg/L	Mainstem	Sacramento River at Colusa	07/20/00	06/09/03	19	100%	19	0.83	5.4	100% det	2.03	1.15	1.82	1.2
Organic Carbon, total, mg/L	Mainstem	Sacramento River at Veterans Bridge	12/15/92	06/10/03	90	59%	53	1.3	6.6	0.2	2.43	1.16	2.2	1.36
Organic Carbon, total, mg/L	Mainstem	Sacramento River at Freeport	12/15/92	06/11/03	85	68%	58	1.3	6.8	0.7	2.39	1.19	2.16	1.31
Organic Carbon, total, mg/L	Mainstem	Sacramento River at River Mile 44	12/15/92	06/11/03	89	58%	52	1.	6.6	0.2	2.5	1.14	2.3	1.31
Organic Carbon, total, mg/L	Major Tributary	Yuba River at Marysville	07/20/00	06/09/03	20	100%	20	0.9	3.6	100% det	1.69	0.877	1.52	1.01
Organic Carbon, total, mg/L	Major Tributary	Feather River near Nicolaus	07/21/00	06/10/03	19	100%	19	1.2	4.1	100% det	2.22	0.807	2.09	1.11
Organic Carbon, total, mg/L	Major Tributary	American River below Nimbus Dam	01/07/93	06/11/03	81	44%	36	1.1	6.4	3.	1.79	0.682	1.71	0.665
Organic Carbon, total, mg/L	Major Tributary	American River at Discovery Park	12/15/92	06/10/03	84	44%	37	1.2	9.6	3.	2.08	0.996	1.95	0.818
Organic Carbon, total, mg/L	Tributary	Deer Creek at Highway 99	01/19/99	03/15/99	2	100%	2	1.	2.2	100% det	IDD	IDD	IDD	IDD
Organic Carbon, total, mg/L	Tributary	Deer Creek at Mouth	08/18/98	05/18/99	6	100%	6	0.9	1.8	100% det	1.23	0.344	1.2	0.528
Organic Carbon, total, mg/L	Tributary	Big Chico Creek above Mud Creek	08/18/98	05/20/99	10	100%	10	0.6	2.1	100% det	1.15	0.433	1.08	0.646
Organic Carbon, total, mg/L	Tributary	Mud Creek above Big Chico Creek	12/15/98	05/20/99	6	100%	6	1.3	3.7	100% det	2.38	0.954	2.22	1.63
Organic Carbon, total, mg/L	Tributary	Cache Creek near Rumsey	03/15/99	03/15/99	10	100%	10	0.3	3.2	100% det	1.	0.882	0.773	0.904
Organic Carbon, total, mg/L	Urban	Natomas East Main Drain Canal (DWR)	09/01/98	10/02/00	29	100%	29	3.1	10.3	100% det	5.8	1.81	6.46	5.55
Percent solids <0.063 mm	Ag Drains	Colusa Basin Drain above KL	10/30/97	04/15/98	7	100%	7	95.	100.	100% det	98.3	1.6	98.3	2.44
Percent solids <0.063 mm	Ag Drains	Sacramento Slough	10/29/97	09/18/02	23	100%	23	69.	100.	100% det	93.7	7.31	93.3	9.75
Percent solids <0.063 mm	Ag Drains	Yolo Bypass near Woodland	01/20/98	03/18/00	14	100%	14	95.	100.	100% det	99.4	1.4	99.4	1.49
Percent solids <0.063 mm	Mainstem	Sacramento River above Bend Bridge	10/22/97	02/21/00	12	100%	12	39.	100.	100% det	74.4	17.3	72.3	28.7
Percent solids <0.063 mm	Mainstem	Sacramento River at Colusa	10/21/97	09/14/00	36	100%	36	54.	96.	100% det	73.4	10.8	72.6	15.6
Percent solids <0.063 mm	Mainstem	Sacramento River at Verona	10/29/97	05/20/98	8	100%	8	62.	93.	100% det	78.4	10.7	77.7	18.
Percent solids <0.063 mm	Mainstem	Sacramento River at Freeport	01/10/90	09/18/02	180	100%	180	37.	100.	100% det	88.2	11.5	87.3	15.8
Percent solids <0.063 mm	Major Tributary	Yuba River at Marysville	10/20/97	04/06/98	7	100%	7	24.	92.	100% det	68.4	26.7	62.2	49.7
Percent solids <0.063 mm	Major Tributary	Feather River near Nicolaus	10/28/97	04/20/98	7	100%	7	62.	89.	100% det	79.7	12.1	78.9	19.1
Percent solids <0.063 mm	Major Tributary	American River at Sacramento	10/24/97	04/16/98	7	100%	7	74.	100.	100% det	90.4	10.5	89.9	17.3
Percent solids <0.063 mm	Tributary	Cache Creek near Rumsey	10/16/97	06/13/00	36	100%	36	13.	98.	100% det	84.5	18.	80.5	29.6
Percent solids <0.063 mm	Urban Creek	Arcade Creek in Del Paso Park	10/08/97	09/20/02	25	100%	25	52.	100.	100% det	85.	11.5	84.1	17.1
pH, -log[H+]	Ag Drains	Colusa Basin Drain above KL	06/23/99	06/09/03	38	100%	38	6.67	8.59	100% det	7.71	0.456	7.7	0.658
pH, -log[H+]	Ag Drains	Sacramento Slough	06/22/99	06/10/03	37	100%	37	6.68	8.39	100% det	7.67	0.401	7.66	0.58

Summary Statistics: Physical and Conventional Parameters

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
pH, -log[H+]	Mainstem	Sacramento River below Keswick	06/24/98	04/03/03	36	100%	36	6.6	8.92	100% det	7.6	0.515	7.58	0.717
pH, -log[H+]	Mainstem	Sacramento River above Bend Bridge	06/24/98	06/09/03	45	100%	45	6.68	8.52	100% det	7.66	0.366	7.65	0.517
pH, -log[H+]	Mainstem	Sacramento River near Hamilton City	06/23/99	06/09/03	48	100%	48	6.59	9.08	100% det	7.63	0.583	7.61	0.824
pH, -log[H+]	Mainstem	Sacramento River at Colusa	06/24/98	06/09/03	49	100%	49	6.57	8.62	100% det	7.74	0.417	7.73	0.58
pH, -log[H+]	Mainstem	Sacramento River at Veterans Bridge	07/21/98	06/10/03	48	100%	48	6.63	10.5	100% det	7.72	0.559	7.71	0.682
pH, -log[H+]	Mainstem	Sacramento River at Freeport	07/22/98	06/10/03	41	100%	41	6.9	8.75	100% det	7.74	0.385	7.73	0.551
pH, -log[H+]	Mainstem	Sacramento River at River Mile 44	07/22/98	06/10/03	41	100%	41	6.9	8.83	100% det	7.74	0.419	7.73	0.591
pH, -log[H+]	Mainstem	Sacramento River at Greene's Landing	07/21/00	06/14/01	15	100%	15	7.34	8.63	100% det	7.76	0.304	7.76	0.426
pH, -log[H+]	Major Tributary	Yuba River at Marysville	06/24/99	06/09/03	31	100%	31	6.43	8.72	100% det	7.59	0.578	7.57	0.844
pH, -log[H+]	Major Tributary	Feather River near Nicolaus	06/23/98	06/10/03	50	100%	50	6.56	8.49	100% det	7.63	0.401	7.62	0.57
pH, -log[H+]	Major Tributary	American River at Discovery Park	09/21/99	06/10/03	11	100%	11	6.83	8.39	100% det	7.69	0.441	7.67	0.703
pH, -log[H+]	Tributary	Sacramento River above Shasta	07/22/98	05/16/00	9	100%	9	7.4	8.1	100% det	7.81	0.273	7.81	0.414
pH, -log[H+]	Tributary	Pit River above Shasta	07/22/98	05/16/00	10	100%	10	7.3	8.46	100% det	7.96	0.376	7.95	0.591
pH, -log[H+]	Tributary	McCloud River above Shasta	07/22/98	05/16/00	10	100%	10	7.4	8.2	100% det	7.87	0.286	7.86	0.425
pH, -log[H+]	Tributary	Spring Creek PP Discharge to Keswick Res.	06/24/98	04/18/00	13	100%	13	7.2	8.18	100% det	7.41	0.287	7.41	0.32
pH, -log[H+]	Tributary	MF Cottonwood at Platina Rd	11/07/02	03/14/03	3	100%	3	7.7	8.01	100% det	7.83	0.163	7.83	0.309
pH, -log[H+]	Tributary	MF Cottonwood Ck near Ono	11/01/01	02/18/02	2	100%	2	8.	8.53	100% det	IDD	IDD	IDD	IDD
pH, -log[H+]	Tributary	MF Cottonwood Ck near Cox Road	04/04/03	04/04/03	1	100%	1	8.6	8.6	100% det	IDD	IDD	IDD	IDD
pH, -log[H+]	Tributary	NF Cottonwood Ck near Ono	11/07/02	03/14/03	3	100%	3	6.77	7.65	100% det	7.33	0.489	7.32	0.895
pH, -log[H+]	Tributary	NF Cottonwood Ck at McCauliffe Rd	11/01/01	02/19/02	2	100%	2	7.26	8.45	100% det	IDD	IDD	IDD	IDD
pH, -log[H+]	Tributary	NF Cottonwood Ck near Foster Road	04/04/03	04/04/03	1	100%	1	7.94	7.94	100% det	IDD	IDD	IDD	IDD
pH, -log[H+]	Tributary	SF Cottonwood Ck at Anderson Canal	10/31/01	04/04/03	5	100%	5	7.37	8.66	100% det	8.11	0.465	8.1	0.778
pH, -log[H+]	Tributary	North Fork Battle Ck at Wildcat Road	11/01/01	04/04/03	6	100%	6	7.11	8.57	100% det	8.05	0.508	8.04	0.835
pH, -log[H+]	Tributary	South Fork Battle Creek at Manton Road	11/01/01	04/04/03	6	100%	6	6.68	8.52	100% det	7.76	0.652	7.74	1.1
pH, -log[H+]	Tributary	Battle Ck below Coleman Fish Hatchery	11/01/01	04/04/03	6	100%	6	6.95	8.57	100% det	7.85	0.558	7.83	0.958
pH, -log[H+]	Tributary	Mill Creek at Black Rock	04/06/01	04/06/01	1	100%	1	7.64	7.64	100% det	IDD	IDD	IDD	IDD
pH, -log[H+]	Tributary	Mill Creek at Highway 99	04/06/01	04/07/01	4	100%	4	7.28	7.76	100% det	7.53	0.223	7.52	0.41
pH, -log[H+]	Tributary	Mill Creek at Mouth	07/19/00	04/12/03	16	100%	16	6.83	9.17	100% det	7.94	0.562	7.92	0.846
pH, -log[H+]	Tributary	Thomes Ck at Paskenta	11/02/01	04/04/03	6	100%	6	7.65	8.62	100% det	8.23	0.326	8.22	0.541
pH, -log[H+]	Tributary	Thomes Ck at Henleyville	02/20/02	04/04/03	4	100%	4	8.06	8.65	100% det	8.27	0.267	8.26	0.46
pH, -log[H+]	Tributary	Thomes Ck at Rawson Rd Bridge	02/20/02	04/04/03	4	100%	4	8.15	8.58	100% det	8.3	0.203	8.29	0.347
pH, -log[H+]	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	100%	3	6.94	8.12	100% det	7.59	0.599	7.57	1.19
pH, -log[H+]	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	4	100%	4	6.95	8.75	100% det	7.53	0.828	7.5	1.33
pH, -log[H+]	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	8	100%	8	6.51	8.83	100% det	7.82	0.691	7.8	1.13
pH, -log[H+]	Tributary	Dry Creek above Cherokee Canal	11/03/01	04/12/03	7	100%	7	7.15	8.3	100% det	7.72	0.39	7.72	0.631
pH, -log[H+]	Tributary	Little Chico Creek below Chico	02/20/02	04/12/03	5	100%	5	7.27	8.36	100% det	7.82	0.434	7.81	0.78
pH, -log[H+]	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	100%	1	8.51	8.51	100% det	IDD	IDD	IDD	IDD
pH, -log[H+]	Tributary	Cache Slough near Ryers Ferry	06/23/98	02/16/00	18	100%	18	6.87	7.86	100% det	7.32	0.344	7.31	0.506
pH, -log[H+]	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	100%	10	6.93	7.95	100% det	7.46	0.326	7.45	0.525
pH, -log[H+]	Urban	Natomas East Main Drain Canal (DWR)	04/24/91	10/02/00	51	100%	51	6.7	8.6	100% det	7.7	0.433	7.82	7.69
pH, -log[H+]	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	06/10/03	38	100%	38	5.86	8.5	100% det	7.1	0.642	7.07	0.931
Specific Conductivity, umhos/cm at 25˚C	Ag Drains	Colusa Basin Drain above KL	10/30/95	06/09/03	110	100%	110	134.	1283.	100% det	633.	201.	599.	278.
Specific Conductivity, umhos/cm at 25˚C	Ag Drains	Sacramento Slough	02/12/96	06/10/03	122	100%	122	93.7	1477.3	100% det	390.	195.	350.	225.
Specific Conductivity, umhos/cm at 25˚C	Ag Drains	Yolo Bypass near Woodland	01/07/97	02/22/01	16	100%	16	89.	634.	100% det	242.	148.	206.	189.
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River below Shasta Dam	07/12/96	08/01/00	12	100%	12	100.	125.	100% det	112.	7.48	112.	11.5
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River below Keswick	07/11/96	04/03/03	50	100%	50	81.	472.3	100% det	131.	64.6	123.	52.6
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River above Bend Bridge	10/23/95	06/09/03	106	100%	106	62.	361.7	100% det	127.	41.5	123.	42.5
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River near Hamilton City	06/23/99	06/09/03	49	100%	49	84.	332.9	100% det	174.	56.1	166.	73.8
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River at Colusa	10/24/95	06/09/03	146	100%	146	9.	385.	100% det	142.	38.8	136.	51.
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River at Verona	10/26/95	05/20/98	57	100%	57	62.	196.	100% det	133.	28.4	130.	41.9

Summary Statistics: Physical and Conventional Parameters

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River at Veterans Bridge	07/21/98	06/10/03	49	100%	49	72.	351.6	100% det	183.	60.1	174.	80.1
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River at Tower Bridge	02/01/00	02/12/00	7	100%	7	120.	134.	100% det	127.	5.66	127.	9.35
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River at Freeport	01/10/90	06/10/03	305	100%	305	51.	415.9	100% det	145.	38.8	141.	48.6
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River at River Mile 44	07/22/98	06/10/03	41	100%	41	87.	361.5	100% det	171.	61.9	162.	76.6
Specific Conductivity, umhos/cm at 25˚C	Mainstem	Sacramento River at Greene's Landing	07/21/00	06/14/01	17	100%	17	57.	2198.3	100% det	313.	489.	214.	192.
Specific Conductivity, umhos/cm at 25˚C	Major Tributary	Yuba River at Marysville	02/27/96	06/09/03	104	100%	104	22.	326.	100% det	86.9	43.	79.6	43.9
Specific Conductivity, umhos/cm at 25˚C	Major Tributary	Feather River near Nicolaus	11/01/95	06/10/03	123	100%	123	31.9	404.5	100% det	97.	41.5	91.5	39.1
Specific Conductivity, umhos/cm at 25˚C	Major Tributary	American River at Sacramento	11/03/95	04/16/98	55	100%	55	40.	73.	100% det	52.6	7.02	52.2	9.58
Specific Conductivity, umhos/cm at 25˚C	Major Tributary	American River at Discovery Park	09/21/99	06/10/03	11	100%	11	44.	143.1	100% det	93.4	32.6	88.	52.1
Specific Conductivity, umhos/cm at 25˚C	Tributary	Sacramento River above Shasta	07/22/98	05/16/00	9	100%	9	76.	146.	100% det	98.2	24.	96.	32.2
Specific Conductivity, umhos/cm at 25˚C	Tributary	Pit River above Shasta	07/22/98	05/16/00	10	100%	10	121.	140.	100% det	128.	5.31	128.	8.04
Specific Conductivity, umhos/cm at 25˚C	Tributary	McCloud River above Shasta	07/22/98	05/16/00	10	100%	10	77.	135.	100% det	106.	15.6	104.	24.4
Specific Conductivity, umhos/cm at 25˚C	Tributary	Spring Creek PP Discharge to Keswick Res.	06/24/98	04/18/00	13	100%	13	69.	82.	100% det	74.9	3.68	74.8	5.72
Specific Conductivity, umhos/cm at 25˚C	Tributary	MF Cottonwood at Platina Rd	11/07/02	03/14/03	3	100%	3	283.5	373.8	100% det	323.	46.2	321.	89.
Specific Conductivity, umhos/cm at 25˚C	Tributary	MF Cottonwood Ck near Ono	11/01/01	02/18/02	2	100%	2	134.4	465.3	100% det	IDD	IDD	IDD	IDD
Specific Conductivity, umhos/cm at 25˚C	Tributary	MF Cottonwood Ck near Cox Road	04/04/03	04/04/03	1	100%	1	566.5	566.5	100% det	IDD	IDD	IDD	IDD
Specific Conductivity, umhos/cm at 25˚C	Tributary	NF Cottonwood Ck near Ono	11/07/02	03/14/03	3	100%	3	354.9	483.4	100% det	400.	72.	396.	123.
Specific Conductivity, umhos/cm at 25˚C	Tributary	NF Cottonwood Ck at McCauliffe Rd	11/01/01	02/19/02	2	100%	2	199.3	237.9	100% det	IDD	IDD	IDD	IDD
Specific Conductivity, umhos/cm at 25˚C	Tributary	NF Cottonwood Ck near Foster Road	04/04/03	04/04/03	1	100%	1	409.9	409.9	100% det	IDD	IDD	IDD	IDD
Specific Conductivity, umhos/cm at 25˚C	Tributary	SF Cottonwood Ck at Anderson Canal	10/31/01	04/04/03	5	100%	5	254.5	485.7	100% det	412.	96.3	401.	175.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Cottonwood Ck near Cottonwood	10/12/95	07/29/98	5	100%	5	221.	247.	100% det	IDD	IDD	IDD	IDD
Specific Conductivity, umhos/cm at 25˚C	Tributary	North Fork Battle Ck at Wildcat Road	11/01/01	04/04/03	6	100%	6	143.2	417.9	100% det	241.	114.	221.	160.
Specific Conductivity, umhos/cm at 25˚C	Tributary	South Fork Battle Creek at Manton Road	11/01/01	04/04/03	6	100%	6	91.6	241.6	100% det	171.	52.9	163.	95.3
Specific Conductivity, umhos/cm at 25˚C	Tributary	Battle Ck below Coleman Fish Hatchery	11/01/01	04/04/03	6	100%	6	144.9	375.6	100% det	245.	94.5	230.	154.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Mill Creek at Black Rock	04/06/01	04/06/01	1	100%	1	37.	37.	100% det	IDD	IDD	IDD	IDD
Specific Conductivity, umhos/cm at 25˚C	Tributary	Mill Creek at Highway 99	04/06/01	04/07/01	4	100%	4	45.8	210.2	100% det	164.	79.2	140.	166.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Mill Creek at Mouth	07/19/00	04/12/03	18	100%	18	129.4	419.4	100% det	238.	73.1	228.	106.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Thomes Ck at Paskenta	11/02/01	04/04/03	6	100%	6	150.7	603.3	100% det	346.	186.	304.	307.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Thomes Ck at Henleyville	02/20/02	04/04/03	4	100%	4	170.3	372.	100% det	250.	89.6	239.	154.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Thomes Ck at Rawson Rd Bridge	02/20/02	04/04/03	4	100%	4	191.2	302.6	100% det	252.	52.3	248.	97.4
Specific Conductivity, umhos/cm at 25˚C	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	100%	3	92.9	250.8	100% det	149.	88.3	134.	139.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	6	100%	6	134.	341.8	100% det	204.	75.8	194.	111.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	9	100%	9	59.4	374.5	100% det	207.	84.1	189.	142.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Dry Creek above Cherokee Canal	11/03/01	04/12/03	7	100%	7	115.5	298.2	100% det	198.	62.5	189.	104.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Little Chico Creek below Chico	02/20/02	04/12/03	5	100%	5	95.8	198.7	100% det	148.	38.2	144.	69.5
Specific Conductivity, umhos/cm at 25˚C	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	100%	1	216.	216.	100% det	IDD	IDD	IDD	IDD
Specific Conductivity, umhos/cm at 25˚C	Tributary	Cache Creek near Rumsey	02/09/96	02/21/01	75	100%	75	206.	1100.	100% det	390.	215.	355.	168.
Specific Conductivity, umhos/cm at 25˚C	Tributary	Cache Slough near Ryers Ferry	06/23/98	02/16/00	17	100%	17	106.	339.	100% det	229.	69.5	219.	110.
Specific Conductivity, umhos/cm at 25˚C	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	100%	10	281.6	462.1	100% det	384.	63.8	379.	104.
Specific Conductivity, umhos/cm at 25˚C	Urban	Natomas East Main Drain Canal (DWR)	01/23/90	10/02/00	103	100%	103	81.	905.	100% det	490.	174.	524.	457.
Specific Conductivity, umhos/cm at 25˚C	Urban Creek	Arcade Creek in Del Paso Park	11/06/95	09/20/02	106	100%	106	68.	379.	100% det	248.	76.8	232.	119.
Specific Conductivity, umhos/cm at 25˚C	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	06/10/03	40	100%	40	96.	523.9	100% det	289.	117.	265.	167.
Temperature, ˚C	Ag Drains	Colusa Basin Drain above KL	06/23/99	06/09/03	39	100%	39	5.3	30.9	100% det	16.9	6.68	15.6	9.64
Temperature, ˚C	Ag Drains	Sacramento Slough	06/22/99	06/10/03	38	100%	38	7.	30.5	100% det	17.1	5.99	16.1	8.65
Temperature, ˚C	Mainstem	Sacramento River below Keswick	06/24/98	04/03/03	35	100%	35	8.2	16.3	100% det	10.7	1.47	10.6	1.94
Temperature, ˚C	Mainstem	Sacramento River above Bend Bridge	06/24/98	06/09/03	46	100%	46	7.7	15.5	100% det	11.8	1.65	11.7	2.38
Temperature, ˚C	Mainstem	Sacramento River near Hamilton City	06/23/99	06/09/03	50	100%	50	6.4	18.2	100% det	12.9	3.03	12.5	4.47
Temperature, ˚C	Mainstem	Sacramento River at Colusa	06/24/98	06/09/03	49	100%	49	7.2	21.1	100% det	14.7	3.91	14.2	5.74
Temperature, ˚C	Mainstem	Sacramento River at Veterans Bridge	07/21/98	06/10/03	50	100%	50	8.	23.6	100% det	15.	4.4	14.3	6.23
Temperature, ˚C	Mainstem	Sacramento River at Freeport	07/22/98	06/10/03	41	100%	41	8.63	21.5	100% det	15.4	4.08	14.8	5.93

Summary Statistics: Physical and Conventional Parameters

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Temperature, °C	Mainstem	Sacramento River at River Mile 44	07/22/98	06/10/03	41	100%	41	8.69	22.3	100% det	15.6	4.04	15.1	5.88
Temperature, °C	Mainstem	Sacramento River at Greene's Landing	07/21/00	06/14/01	16	100%	16	7.8	21.6	100% det	17.3	4.5	16.6	7.32
Temperature, °C	Major Tributary	Yuba River at Marysville	06/24/99	06/09/03	31	100%	31	8.3	21.1	100% det	13.3	3.41	12.9	4.74
Temperature, °C	Major Tributary	Feather River near Nicolaus	06/23/98	06/10/03	52	100%	52	6.7	29.7	100% det	15.4	4.95	14.6	6.95
Temperature, °C	Major Tributary	American River at Discovery Park	09/21/99	06/10/03	11	100%	11	10.3	19.9	100% det	15.2	3.45	14.8	5.47
Temperature, °C	Tributary	Sacramento River above Shasta	07/22/98	05/16/00	9	100%	9	7.3	17.6	100% det	10.5	3.93	9.93	5.07
Temperature, °C	Tributary	Pit River above Shasta	07/22/98	05/16/00	10	100%	10	7.	18.9	100% det	12.1	4.28	11.4	6.68
Temperature, °C	Tributary	McCloud River above Shasta	07/22/98	05/16/00	10	100%	10	7.7	27.1	100% det	12.	6.33	10.9	6.83
Temperature, °C	Tributary	Spring Creek PP Discharge to Keswick Res.	06/24/98	04/18/00	13	100%	13	7.6	13.5	100% det	11.	1.84	10.8	2.94
Temperature, °C	Tributary	MF Cottonwood at Platina Rd	11/07/02	03/14/03	3	100%	3	6.	10.8	100% det	7.83	2.59	7.57	4.52
Temperature, °C	Tributary	MF Cottonwood Ck near Ono	11/01/01	02/18/02	2	100%	2	7.7	11.	100% det	IDD	IDD	IDD	IDD
Temperature, °C	Tributary	MF Cottonwood Ck near Cox Road	04/04/03	04/04/03	1	100%	1	8.1	8.1	100% det	IDD	IDD	IDD	IDD
Temperature, °C	Tributary	NF Cottonwood Ck near Ono	11/07/02	03/14/03	3	100%	3	8.2	10.5	100% det	9.43	1.16	9.38	2.33
Temperature, °C	Tributary	NF Cottonwood Ck at McCauliffe Rd	11/01/01	02/19/02	2	100%	2	5.5	12.6	100% det	IDD	IDD	IDD	IDD
Temperature, °C	Tributary	NF Cottonwood Ck near Foster Road	04/04/03	04/04/03	1	100%	1	8.3	8.3	100% det	IDD	IDD	IDD	IDD
Temperature, °C	Tributary	SF Cottonwood Ck at Anderson Canal	10/31/01	04/04/03	5	100%	5	9.9	19.	100% det	12.6	3.82	12.2	5.51
Temperature, °C	Tributary	North Fork Battle Ck at Wildcat Road	11/01/01	04/04/03	6	100%	6	8.2	15.4	100% det	10.8	2.51	10.5	3.82
Temperature, °C	Tributary	South Fork Battle Creek at Manton Road	11/01/01	04/04/03	6	100%	6	8.2	14.2	100% det	10.	2.19	9.84	3.13
Temperature, °C	Tributary	Battle Ck below Coleman Fish Hatchery	11/01/01	04/04/03	6	100%	6	9.1	14.8	100% det	11.2	2.27	11.1	3.66
Temperature, °C	Tributary	Mill Creek at Black Rock	04/06/01	04/06/01	1	100%	1	5.7	5.7	100% det	IDD	IDD	IDD	IDD
Temperature, °C	Tributary	Mill Creek at Highway 99	04/06/01	04/07/01	4	100%	4	8.2	10.2	100% det	9.23	0.818	9.2	1.5
Temperature, °C	Tributary	Mill Creek at Mouth	07/19/00	04/12/03	18	100%	18	4.7	32.9	100% det	12.9	7.86	11.2	9.
Temperature, °C	Tributary	Thomes Ck at Paskenta	11/02/01	04/04/03	6	100%	6	6.5	12.2	100% det	9.95	2.11	9.74	3.78
Temperature, °C	Tributary	Thomes Ck at Henleyville	02/20/02	04/04/03	4	100%	4	7.8	12.5	100% det	10.3	2.16	10.1	4.06
Temperature, °C	Tributary	Thomes Ck at Rawson Rd Bridge	02/20/02	04/04/03	4	100%	4	8.8	13.5	100% det	11.3	2.2	11.2	4.09
Temperature, °C	Tributary	Deer Creek at Highway 99	03/06/02	04/12/03	3	100%	3	10.2	10.7	100% det	10.5	0.265	10.5	0.502
Temperature, °C	Tributary	Deer Creek at Mouth	01/26/01	01/23/03	6	100%	6	6.	21.9	100% det	11.1	5.74	10.1	7.92
Temperature, °C	Tributary	Big Chico Creek at Mouth	01/26/01	04/12/03	9	100%	9	6.2	22.	100% det	11.	4.59	10.4	5.95
Temperature, °C	Tributary	Dry Creek above Cherokee Canal	11/03/01	04/12/03	7	100%	7	10.5	15.4	100% det	12.4	1.9	12.3	3.
Temperature, °C	Tributary	Little Chico Creek below Chico	02/20/02	04/12/03	5	100%	5	10.2	14.1	100% det	12.	1.69	11.9	2.96
Temperature, °C	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	100%	1	9.8	9.8	100% det	IDD	IDD	IDD	IDD
Temperature, °C	Tributary	Cache Slough near Ryers Ferry	06/23/98	02/16/00	17	100%	17	8.4	21.5	100% det	14.9	4.95	14.	7.4
Temperature, °C	Urban	Natomas East Main Drain	09/26/01	06/10/03	10	100%	10	12.6	23.2	100% det	17.1	3.67	16.7	5.71
Temperature, °C	Urban	Natomas East Main Drain Canal (DWR)	04/24/91	12/08/93	37	100%	37	7.9	27.8	100% det	19.4	5.11	21.	18.6
Temperature, °C	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	06/10/03	39	100%	39	6.1	27.8	100% det	16.1	6.01	15.	8.62
Total Dissolved Solids (TDS), mg/L	Ag Drains	Colusa Basin Drain above KL	02/07/96	06/09/03	52	100%	52	33.	546.	100% det	365.	86.8	346.	148.
Total Dissolved Solids (TDS), mg/L	Ag Drains	Sacramento Slough	02/12/96	06/10/03	56	100%	56	84.	784.5	100% det	232.	120.	212.	121.
Total Dissolved Solids (TDS), mg/L	Ag Drains	Yolo Bypass near Woodland	01/07/97	03/02/00	8	100%	8	70.	207.	100% det	129.	47.3	121.	74.9
Total Dissolved Solids (TDS), mg/L	Mainstem	Sacramento River below Shasta Dam	07/12/96	02/20/98	5	100%	5	69.	84.	100% det	77.8	6.53	77.6	11.5
Total Dissolved Solids (TDS), mg/L	Mainstem	Sacramento River below Keswick	07/11/96	05/16/00	53	100%	53	51.5	97.5	100% det	75.7	11.1	74.8	16.1
Total Dissolved Solids (TDS), mg/L	Mainstem	Sacramento River above Bend Bridge	02/13/96	06/09/03	68	100%	68	52.5	148.5	100% det	86.8	18.3	85.1	23.3
Total Dissolved Solids (TDS), mg/L	Mainstem	Sacramento River near Hamilton City	08/18/99	06/09/03	20	100%	20	50.	155.	100% det	107.	24.4	104.	37.8
Total Dissolved Solids (TDS), mg/L	Mainstem	Sacramento River at Colusa	02/28/96	06/09/03	73	100%	73	50.5	171.	100% det	98.1	20.	96.2	26.1
Total Dissolved Solids (TDS), mg/L	Mainstem	Sacramento River at Verona	02/22/96	05/20/98	28	100%	28	53.	126.	100% det	89.6	15.9	88.1	23.7
Total Dissolved Solids (TDS), mg/L	Mainstem	Sacramento River at Veterans Bridge	06/24/98	06/10/03	82	100%	82	11.5	196.5	100% det	110.	30.	105.	45.
Total Dissolved Solids (TDS), mg/L	Mainstem	Sacramento River at Freeport	01/10/90	06/11/03	166	100%	166	12.	154.	100% det	94.9	22.7	91.7	33.
Total Dissolved Solids (TDS), mg/L	Mainstem	Sacramento River at River Mile 44	06/23/98	06/11/03	67	100%	67	42.	151.	100% det	103.	23.	100.	33.3
Total Dissolved Solids (TDS), mg/L	Major Tributary	Yuba River at Marysville	02/27/96	06/09/03	47	100%	47	20.	118.	100% det	63.2	20.9	60.	27.7
Total Dissolved Solids (TDS), mg/L	Major Tributary	Feather River near Nicolaus	02/23/96	06/10/03	69	100%	69	22.	164.5	100% det	70.9	24.3	67.4	29.1
Total Dissolved Solids (TDS), mg/L	Major Tributary	American River below Nimbus Dam	01/17/00	06/11/03	40	98%	39	13.	84.	3.	45.6	17.4	42.	26.2

Summary Statistics: Physical and Conventional Parameters

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Total Dissolved Solids (TDS), mg/L	Major Tributary	American River at Sacramento	02/21/96	04/16/98	27	100%	27	24.	52.	100% det	40.	6.78	39.4	10.3
Total Dissolved Solids (TDS), mg/L	Major Tributary	American River at Discovery Park	09/21/99	06/10/03	41	100%	41	16.	140.	100% det	47.8	24.1	42.7	30.5
Total Dissolved Solids (TDS), mg/L	Tributary	Sacramento River above Shasta	07/22/98	05/16/00	10	100%	10	39.	91.	100% det	61.8	15.5	60.	24.6
Total Dissolved Solids (TDS), mg/L	Tributary	Pit River above Shasta	07/22/98	05/16/00	11	100%	11	78.	125.	100% det	93.5	13.5	92.7	18.7
Total Dissolved Solids (TDS), mg/L	Tributary	McCloud River above Shasta	07/22/98	05/16/00	10	100%	10	55.	83.	100% det	65.	11.	64.2	16.
Total Dissolved Solids (TDS), mg/L	Tributary	Spring Creek PP Discharge to Keswick Res.	06/24/98	04/18/00	12	100%	12	43.	59.	100% det	52.2	4.49	52.	7.06
Total Dissolved Solids (TDS), mg/L	Tributary	Cottonwood Ck near Cottonwood	07/29/98	07/29/98	1	100%	1	151.	151.	100% det	IDD	IDD	IDD	IDD
Total Dissolved Solids (TDS), mg/L	Tributary	Deer Creek at Highway 99	03/16/99	03/16/99	1	100%	1	67.	67.	100% det	IDD	IDD	IDD	IDD
Total Dissolved Solids (TDS), mg/L	Tributary	Deer Creek at Mouth	08/18/98	05/18/99	7	100%	7	73.	132.	100% det	101.	24.3	98.	40.2
Total Dissolved Solids (TDS), mg/L	Tributary	Big Chico Creek at Hwy 32	02/14/00	02/14/00	1	100%	1	60.	60.	100% det	IDD	IDD	IDD	IDD
Total Dissolved Solids (TDS), mg/L	Tributary	Big Chico Creek above Salmon Hole	02/14/00	02/14/00	1	100%	1	56.	56.	100% det	IDD	IDD	IDD	IDD
Total Dissolved Solids (TDS), mg/L	Tributary	Big Chico Creek at Chico (Rose Ave.)	02/14/00	02/14/00	1	100%	1	58.	58.	100% det	IDD	IDD	IDD	IDD
Total Dissolved Solids (TDS), mg/L	Tributary	Big Chico Creek above Mud Creek	06/22/99	02/14/00	4	100%	4	58.	134.	100% det	109.	34.4	103.	65.7
Total Dissolved Solids (TDS), mg/L	Tributary	Mud Creek above Big Chico Creek	12/15/98	02/14/00	7	100%	7	1.6	133.	100% det	78.4	40.2	50.1	112.
Total Dissolved Solids (TDS), mg/L	Tributary	Butte Creek at Colusa Highway	12/13/99	12/13/99	1	100%	1	145.	145.	100% det	IDD	IDD	IDD	IDD
Total Dissolved Solids (TDS), mg/L	Tributary	Cache Creek near Rumsey	02/09/96	04/14/98	27	100%	27	131.	572.	100% det	210.	112.	193.	90.2
Total Dissolved Solids (TDS), mg/L	Tributary	Cache Slough near Ryers Ferry	06/25/98	02/16/00	10	100%	10	108.	198.	100% det	139.	30.2	136.	44.3
Total Dissolved Solids (TDS), mg/L	Urban	Natomas East Main Drain Canal (DWR)	01/23/90	10/02/00	102	99%	101	58.	548.	1.	288.	103.	308.	270.
Total Dissolved Solids (TDS), mg/L	Urban Creek	Arcade Creek in Del Paso Park	02/06/96	09/18/01	46	100%	46	58.	237.	100% det	173.	47.5	165.	74.7
Total Dissolved Solids (TDS), mg/L	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	06/22/99	1	100%	1	225.	225.	100% det	IDD	IDD	IDD	IDD
Total Suspended Solids (TSS), mg/L	Ag Drains	Colusa Basin Drain above KL	02/07/96	04/13/03	56	100%	56	21.	468.	100% det	124.	80.6	105.	88.5
Total Suspended Solids (TSS), mg/L	Ag Drains	Sacramento Slough	02/12/96	04/13/03	67	100%	67	14.8	182.	100% det	61.5	31.7	55.4	35.5
Total Suspended Solids (TSS), mg/L	Ag Drains	Yolo Bypass near Woodland	01/07/97	03/18/00	16	100%	16	49.	563.	100% det	187.	130.	152.	159.
Total Suspended Solids (TSS), mg/L	Mainstem	Sacramento River below Keswick	04/21/98	04/03/03	55	42%	23	0.45	13.	0.1	1.75	2.02	1.16	1.57
Total Suspended Solids (TSS), mg/L	Mainstem	Sacramento River above Bend Bridge	03/08/96	04/04/03	59	71%	42	4.	410.	5.	30.8	71.	9.57	24.
Total Suspended Solids (TSS), mg/L	Mainstem	Sacramento River near Hamilton City	06/23/99	04/05/03	28	64%	18	5.2	342.8	5.	42.4	84.6	5.56	27.2
Total Suspended Solids (TSS), mg/L	Mainstem	Sacramento River at Colusa	02/28/96	04/13/03	75	100%	75	10.	593.8	100% det	77.7	112.	46.9	63.
Total Suspended Solids (TSS), mg/L	Mainstem	Sacramento River at Verona	02/22/96	05/20/98	27	100%	27	24.	117.	100% det	61.	29.2	54.5	39.4
Total Suspended Solids (TSS), mg/L	Mainstem	Sacramento River at Veterans Bridge	12/15/92	06/10/03	163	100%	163	3.	200.	100% det	40.2	27.2	33.	30.
Total Suspended Solids (TSS), mg/L	Mainstem	Sacramento River at Freeport	01/10/90	06/11/03	365	100%	364	2.	400.	1.	42.9	51.8	29.9	33.5
Total Suspended Solids (TSS), mg/L	Mainstem	Sacramento River at River Mile 44	12/15/92	06/11/03	152	99%	151	2.	250.	1.	38.2	38.1	26.7	33.1
Total Suspended Solids (TSS), mg/L	Mainstem	Sacramento River at Greene's Landing	07/21/00	05/17/01	9	100%	9	10.	30.7	100% det	16.7	6.15	15.8	8.51
Total Suspended Solids (TSS), mg/L	Major Tributary	Yuba River at Marysville	02/27/96	04/13/03	56	61%	34	1.	153.	5.	17.5	31.8	5.45	14.5
Total Suspended Solids (TSS), mg/L	Major Tributary	Feather River near Nicolaus	02/23/96	04/13/03	56	91%	51	5.	123.	5.	24.4	26.5	15.4	22.3
Total Suspended Solids (TSS), mg/L	Major Tributary	American River below Nimbus Dam	01/07/93	06/11/03	150	57%	85	1.	68.	1.	3.71	7.4	1.6	3.15
Total Suspended Solids (TSS), mg/L	Major Tributary	American River at Sacramento	02/21/96	04/16/98	26	100%	26	2.	116.	100% det	13.9	24.6	6.67	10.8
Total Suspended Solids (TSS), mg/L	Major Tributary	American River at Discovery Park	12/15/92	06/10/03	159	72%	114	1.	41.	1.	5.08	6.67	2.79	4.68
Total Suspended Solids (TSS), mg/L	Tributary	Sacramento River above Shasta	07/22/98	05/16/00	10	10%	1	11.	11.	5.	IDD	IDD	IDD	IDD
Total Suspended Solids (TSS), mg/L	Tributary	Pit River above Shasta	07/22/98	05/16/00	10	30%	3	6.	12.	5.	3.82	3.56	2.61	3.95
Total Suspended Solids (TSS), mg/L	Tributary	McCloud River above Shasta	07/22/98	05/16/00	10	10%	1	10.	10.	5.	IDD	IDD	IDD	IDD
Total Suspended Solids (TSS), mg/L	Tributary	Spring Creek PP Discharge to Keswick Res.	06/24/98	04/18/00	12	8%	1	5.	5.	5.	IDD	IDD	IDD	IDD
Total Suspended Solids (TSS), mg/L	Tributary	MF Cottonwood at Platina Rd	11/07/02	03/14/03	3	67%	2	5.2	216.4	5.	IDD	IDD	IDD	IDD
Total Suspended Solids (TSS), mg/L	Tributary	MF Cottonwood Ck near Ono	11/01/01	02/18/02	2	0%	0	ND	ND	5.	IDD	IDD	IDD	IDD
Total Suspended Solids (TSS), mg/L	Tributary	MF Cottonwood Ck near Cox Road	04/04/03	04/04/03	1	0%	0	ND	ND	5.	IDD	IDD	IDD	IDD
Total Suspended Solids (TSS), mg/L	Tributary	NF Cottonwood Ck near Ono	11/07/02	03/14/03	3	100%	3	12.5	183.3	100% det	69.9	98.2	31.7	113.
Total Suspended Solids (TSS), mg/L	Tributary	NF Cottonwood Ck at McCauliffe Rd	11/01/01	02/19/02	2	50%	1	25.4	25.4	5.	IDD	IDD	IDD	IDD
Total Suspended Solids (TSS), mg/L	Tributary	NF Cottonwood Ck near Foster Road	04/04/03	04/04/03	1	0%	0	ND	ND	5.	IDD	IDD	IDD	IDD
Total Suspended Solids (TSS), mg/L	Tributary	SF Cottonwood Ck at Anderson Canal	10/31/01	04/04/03	5	80%	4	5.1	116.	5.	34.4	48.2	11.1	53.7
Total Suspended Solids (TSS), mg/L	Tributary	North Fork Battle Ck at Wildcat Road	11/01/01	04/04/03	6	67%	4	6.	17.7	5.	7.39	5.58	5.93	7.29
Total Suspended Solids (TSS), mg/L	Tributary	South Fork Battle Creek at Manton Road	11/01/01	04/04/03	6	50%	3	8.1	28.4	5.	11.4	11.9	6.35	14.4

Summary Statistics: Physical and Conventional Parameters

Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Total Suspended Solids (TSS), mg/L	Tributary	Battle Ck below Coleman Fish Hatchery	11/01/01	04/04/03	6	83%	5	5.6	47.9	5.	19.8	21.8	10.5	26.6
Total Suspended Solids (TSS), mg/L	Tributary	Mill Creek at Highway 36	06/23/98	02/14/00	16	100%	16	0.8	130.	100% det	30.2	41.9	10.7	34.6
Total Suspended Solids (TSS), mg/L	Tributary	Mill Creek at Black Rock	06/23/98	04/06/01	12	92%	11	0.2	53.8	5.	14.2	20.1	3.87	14.9
Total Suspended Solids (TSS), mg/L	Tributary	Mill Creek at Highway 99	06/23/98	04/07/01	12	67%	8	0.2	300.	5.	39.7	85.8	3.85	27.3
Total Suspended Solids (TSS), mg/L	Tributary	Mill Creek at Mouth	06/23/98	05/15/01	23	78%	18	0.8	754.	5.	54.3	165.	7.74	23.1
Total Suspended Solids (TSS), mg/L	Tributary	Thomes Ck at Paskenta	11/02/01	04/04/03	6	67%	4	6.3	226.	5.	49.6	88.8	6.58	54.8
Total Suspended Solids (TSS), mg/L	Tributary	Thomes Ck at Henleyville	02/20/02	04/04/03	4	100%	4	8.7	386.	100% det	134.	175.	54.4	254.
Total Suspended Solids (TSS), mg/L	Tributary	Thomes Ck at Rawson Rd Bridge	02/20/02	04/04/03	4	100%	4	7.3	647.	100% det	196.	304.	55.7	345.
Total Suspended Solids (TSS), mg/L	Tributary	Deer Creek below Childs Meadows	09/15/98	02/14/00	13	100%	13	0.2	93.	100% det	9.12	25.3	1.64	5.43
Total Suspended Solids (TSS), mg/L	Tributary	Deer Creek at A Line Road	01/19/99	02/14/00	3	100%	3	0.4	106.	100% det	35.9	60.7	3.71	60.1
Total Suspended Solids (TSS), mg/L	Tributary	Deer Creek at Ponderosa Way	11/16/98	11/08/99	6	100%	6	0.2	5.	100% det	1.47	1.78	0.892	1.85
Total Suspended Solids (TSS), mg/L	Tributary	Deer Creek at Upper Diversion Dam	08/18/98	02/14/00	14	100%	14	0.4	145.	100% det	13.	38.1	2.3	6.29
Total Suspended Solids (TSS), mg/L	Tributary	Deer Creek at Highway 99	03/16/99	02/14/00	4	100%	4	0.2	180.	100% det	45.4	89.8	1.9	22.9
Total Suspended Solids (TSS), mg/L	Tributary	Deer Creek at Mouth	07/21/98	11/18/99	10	100%	10	0.6	29.4	100% det	6.18	9.13	2.77	6.67
Total Suspended Solids (TSS), mg/L	Tributary	Big Chico Creek at Hwy 32	06/23/98	02/14/00	14	100%	14	0.2	46.	100% det	6.81	13.9	1.68	5.07
Total Suspended Solids (TSS), mg/L	Tributary	Big Chico Creek above Salmon Hole	06/23/98	02/14/00	15	100%	15	0.2	91.	100% det	9.48	23.8	1.73	5.43
Total Suspended Solids (TSS), mg/L	Tributary	Big Chico Creek at Chico (Rose Ave.)	06/23/98	02/14/00	15	100%	15	0.2	122.	100% det	12.	31.4	1.99	7.17
Total Suspended Solids (TSS), mg/L	Tributary	Big Chico Creek above Mud Creek	06/23/98	02/14/00	15	100%	15	0.2	97.	100% det	10.7	25.	2.34	8.21
Total Suspended Solids (TSS), mg/L	Tributary	Mud Creek above Big Chico Creek	06/23/98	02/14/00	10	100%	10	0.4	32.8	100% det	7.7	9.83	3.68	9.8
Total Suspended Solids (TSS), mg/L	Tributary	Dry Creek above Cherokee Canal	11/03/01	04/12/03	7	71%	5	12.5	230.4	5.	44.8	82.5	13.9	47.2
Total Suspended Solids (TSS), mg/L	Tributary	Little Chico Creek below Chico	02/20/02	04/12/03	5	100%	5	4.8	78.6	100% det	26.2	31.5	14.5	35.8
Total Suspended Solids (TSS), mg/L	Tributary	Cache Creek near Rumsey	02/09/96	06/13/00	56	100%	56	8.	3820.	100% det	313.	647.	80.4	216.
Total Suspended Solids (TSS), mg/L	Tributary	Cache Slough near Ryers Ferry	06/25/98	02/16/00	8	100%	8	8.	43.	100% det	22.5	13.9	18.8	21.1
Total Suspended Solids (TSS), mg/L	Urban Creek	Arcade Creek in Del Paso Park	02/06/96	09/20/02	52	100%	52	5.	656.	100% det	54.9	109.	25.5	39.2
Total Suspended Solids (TSS), mg/L	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	04/14/03	18	100%	18	6.	265.	100% det	44.7	58.2	29.9	39.5
Turbidity, NTU	Ag Drains	Colusa Basin Drain above KL	06/23/99	05/16/00	12	100%	12	41.4	228.	100% det	106.	59.	92.4	82.4
Turbidity, NTU	Ag Drains	Sacramento Slough	06/22/99	05/16/00	11	100%	11	30.8	87.	100% det	62.7	16.8	60.3	28.5
Turbidity, NTU	Mainstem	Sacramento River below Keswick	06/24/98	05/16/00	23	100%	23	1.27	36.1	100% det	4.35	6.98	3.07	2.55
Turbidity, NTU	Mainstem	Sacramento River above Bend Bridge	06/24/98	05/17/00	40	100%	40	1.38	127.	100% det	14.6	23.7	6.86	11.4
Turbidity, NTU	Mainstem	Sacramento River near Hamilton City	06/23/99	05/17/00	34	100%	34	2.04	213.	100% det	32.	50.9	11.8	26.5
Turbidity, NTU	Mainstem	Sacramento River at Colusa	06/24/98	05/16/00	40	100%	40	2.87	420.	100% det	42.9	75.7	21.6	36.6
Turbidity, NTU	Mainstem	Sacramento River at Veterans Bridge	06/24/98	05/16/00	44	100%	44	3.75	81.2	100% det	26.6	14.6	22.9	19.2
Turbidity, NTU	Mainstem	Sacramento River at Freeport	04/10/90	05/17/00	65	100%	65	2.3	65.5	100% det	19.	14.5	14.4	16.5
Turbidity, NTU	Mainstem	Sacramento River at River Mile 44	06/23/98	05/17/00	42	100%	42	5.1	81.	100% det	25.4	17.1	20.5	20.5
Turbidity, NTU	Major Tributary	Yuba River at Marysville	06/24/99	05/16/00	11	55%	6	0.56	101.	0.01	11.5	29.9	0.722	6.28
Turbidity, NTU	Major Tributary	Feather River near Nicolaus	06/23/98	05/16/00	41	100%	41	1.13	142.	100% det	12.6	23.	7.14	9.91
Turbidity, NTU	Tributary	Sacramento River above Shasta	07/22/98	05/16/00	10	100%	10	0.81	8.35	100% det	2.46	2.52	1.7	2.25
Turbidity, NTU	Tributary	Pit River above Shasta	07/22/98	05/16/00	10	100%	10	1.95	23.9	100% det	6.85	6.98	4.82	6.66
Turbidity, NTU	Tributary	McCloud River above Shasta	07/22/98	05/16/00	10	100%	10	0.54	6.34	100% det	2.26	2.02	1.58	2.42
Turbidity, NTU	Tributary	Spring Creek PP Discharge to Keswick Res.	06/24/98	04/18/00	13	100%	13	0.42	1.94	100% det	1.08	0.544	0.95	0.801
Turbidity, NTU	Tributary	Cache Slough near Ryers Ferry	06/25/98	02/16/00	23	100%	23	2.67	111.	100% det	44.8	29.3	33.7	45.8
Turbidity, NTU	Urban	Natomas East Main Drain Canal (DWR)	01/23/90	10/02/00	102	99%	101	8.	160.	1.	34.5	26.4	39.6	28.2
Turbidity, NTU	Urban Creek	Arcade Creek at Norwood Ave.	06/22/99	05/17/00	12	100%	12	15.7	132.	100% det	60.8	36.5	50.6	54.7
Ultraviolet Absorbance at 254 nm, 1/cm	Ag Drains	Colusa Basin Drain above KL	09/25/01	06/09/03	11	100%	11	0.156	0.352	100% det	0.229	0.0698	0.22	0.101
Ultraviolet Absorbance at 254 nm, 1/cm	Ag Drains	Sacramento Slough	09/26/01	06/10/03	11	100%	11	0.057	0.2	100% det	0.122	0.0442	0.114	0.0717
Ultraviolet Absorbance at 254 nm, 1/cm	Mainstem	Sacramento River above Bend Bridge	09/24/01	06/09/03	10	100%	10	0.023	0.0415	100% det	0.0329	0.00646	0.0323	0.0105
Ultraviolet Absorbance at 254 nm, 1/cm	Mainstem	Sacramento River near Hamilton City	09/25/01	06/09/03	10	100%	10	0.025	0.25	100% det	0.0775	0.0754	0.0554	0.0725
Ultraviolet Absorbance at 254 nm, 1/cm	Mainstem	Sacramento River at Colusa	09/25/01	06/09/03	10	100%	10	0.0259	0.451	100% det	0.121	0.172	0.0602	0.102
Ultraviolet Absorbance at 254 nm, 1/cm	Mainstem	Sacramento River at Veterans Bridge	11/04/01	06/10/03	21	100%	21	0.0347	0.174	100% det	0.0803	0.0406	0.0713	0.0525
Ultraviolet Absorbance at 254 nm, 1/cm	Mainstem	Sacramento River at Freeport	09/27/01	06/11/03	22	100%	22	0.0353	0.4	100% det	0.0816	0.0767	0.0666	0.053

Summary Statistics: Physical and Conventional Parameters

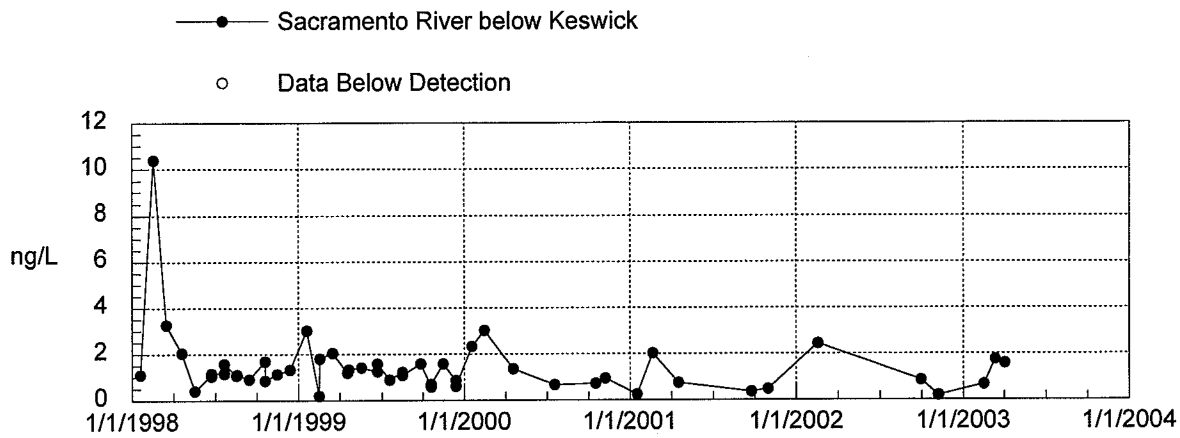
Analyte	Site Category	Site	Start Date	End Date	n	% Det	n Det	Min Det	Max Det	Min RL	Mean	Std Dev	Median	IQR
Ultraviolet Absorbance at 254 nm, 1/cm	Mainstem	Sacramento River at River Mile 44	09/27/01	06/11/03	22	100%	22	0.0377	0.35	100% det	0.0792	0.0669	0.0663	0.0495
Ultraviolet Absorbance at 254 nm, 1/cm	Major Tributary	Yuba River at Marysville	09/25/01	06/09/03	11	100%	11	0.018	0.171	100% det	0.0675	0.0588	0.0484	0.0672
Ultraviolet Absorbance at 254 nm, 1/cm	Major Tributary	Feather River near Nicolaus	09/26/01	06/10/03	11	100%	11	0.015	0.14	100% det	0.0673	0.0407	0.0561	0.0601
Ultraviolet Absorbance at 254 nm, 1/cm	Major Tributary	American River below Nimbus Dam	07/10/02	06/11/03	12	100%	12	0.0295	0.0453	100% det	0.0348	0.00436	0.0346	0.00635
Ultraviolet Absorbance at 254 nm, 1/cm	Major Tributary	American River at Discovery Park	09/26/01	06/10/03	21	100%	21	0.0304	0.072	100% det	0.0432	0.0104	0.0422	0.0131
Ultraviolet Absorbance at 254 nm, 1/cm	Urban	Natomas East Main Drain Canal (DWR)	03/21/90	10/02/00	101	100%	101	0.065	0.372	100% det	0.156	0.0653	0.169	0.145

APPENDIX B:

TIME SERIES PLOTS OF WATER QUALITY DATA

Time Series Plots are provided in the following order:

- Unfiltered and Filtered Mercury
- Unfiltered and Filtered Methylmercury
- Pesticides Detected in SRWP Monitoring (plots include CDPR Surface Water Database data)
- Total Suspended Solids
- Total Dissolved Solids, Alkalinity, Hardness, and Specific Conductance
- Organic Carbon and Ultraviolet Absorbance (UVA_{254})
- Nitrogen and Phosphorus Compounds
- Pathogen Indicator Bacteria


Sacramento River below Keswick
Data Below Detection
ng/L
12
10
8
6
4
2
0
1/1/1998
1/1/1999
1/1/2000
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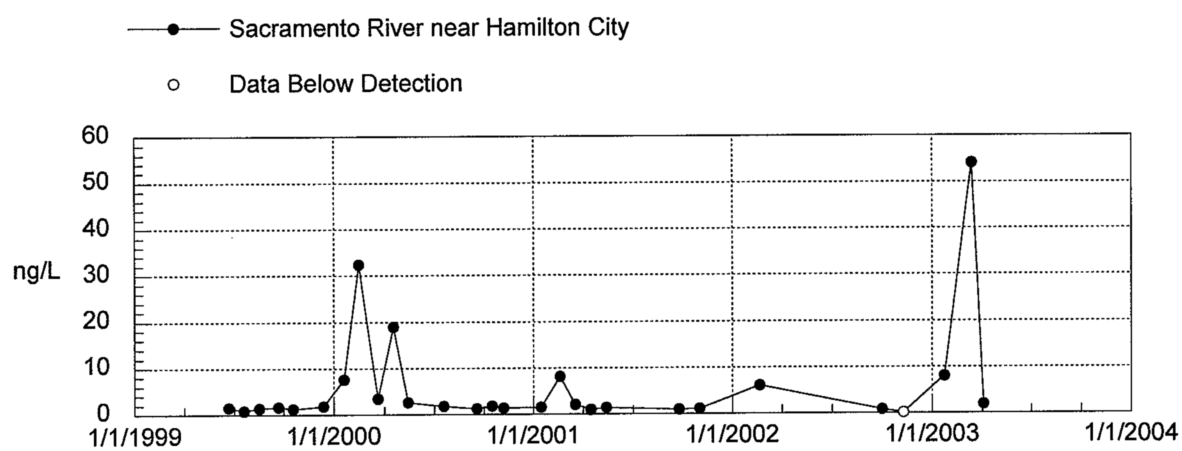
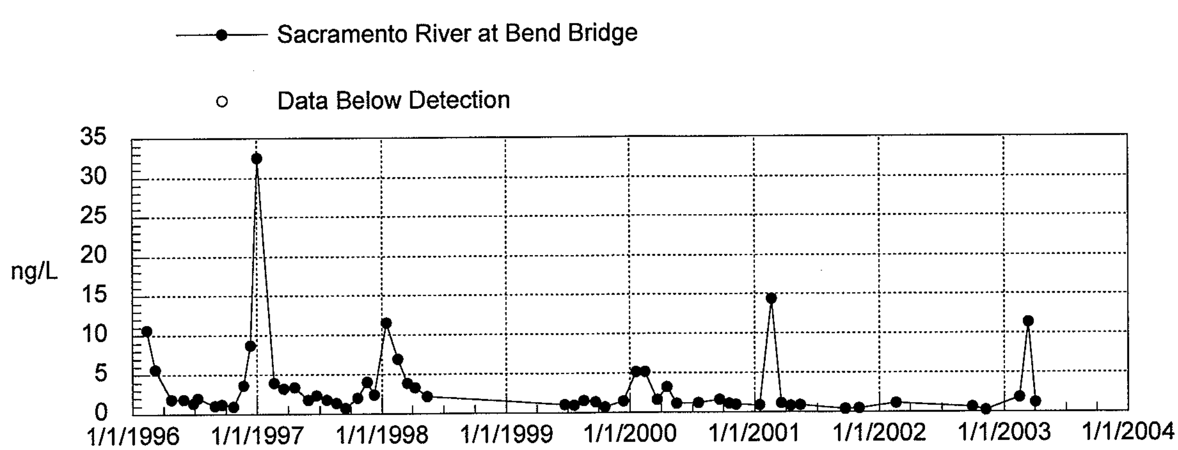
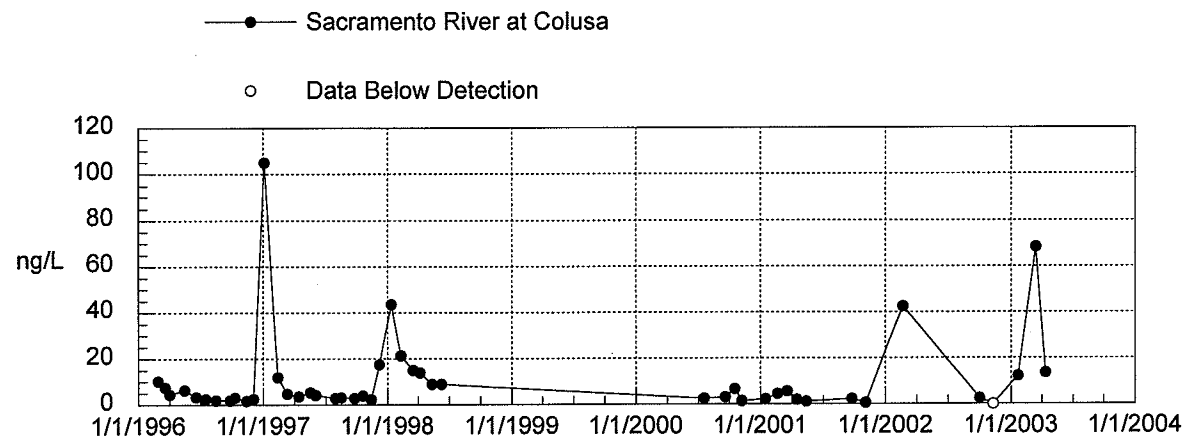
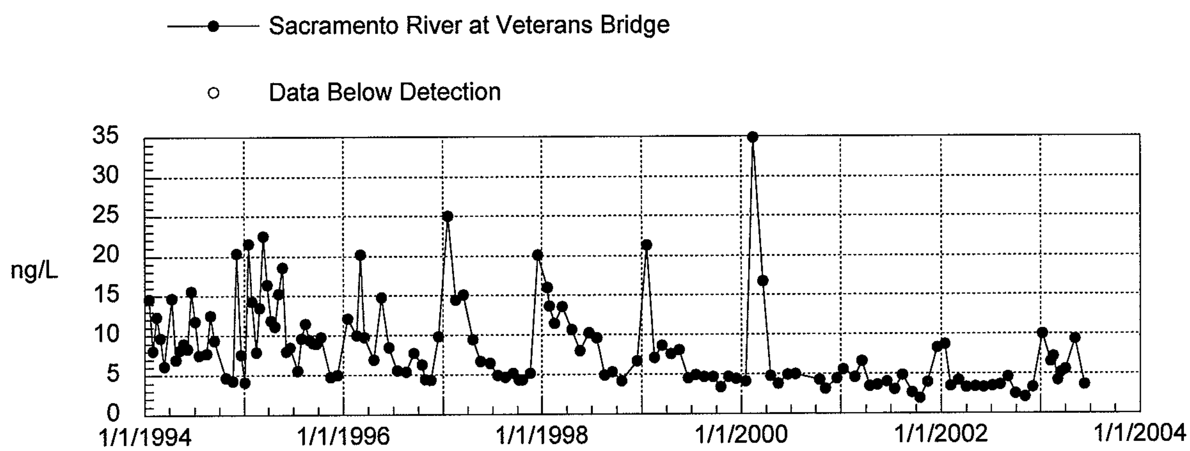
1/1/2002
1/1/2003
1/1/2004

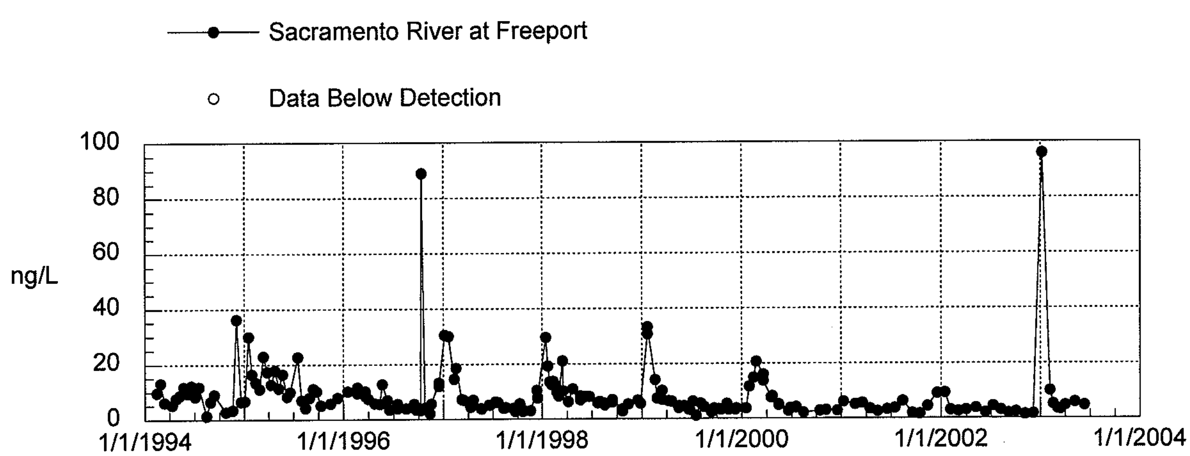

Sacramento River near Hamilton City
Data Below Detection
ng/L
60
50
40
30
20
10
0
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

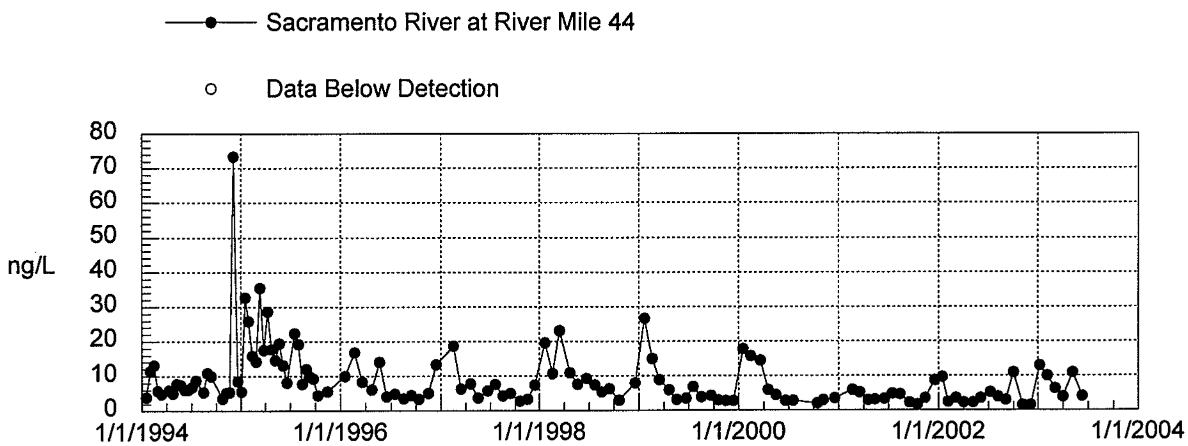

Sacramento River at Bend Bridge
Data Below Detection
ng/L
35
30
25
20
15
10
5
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

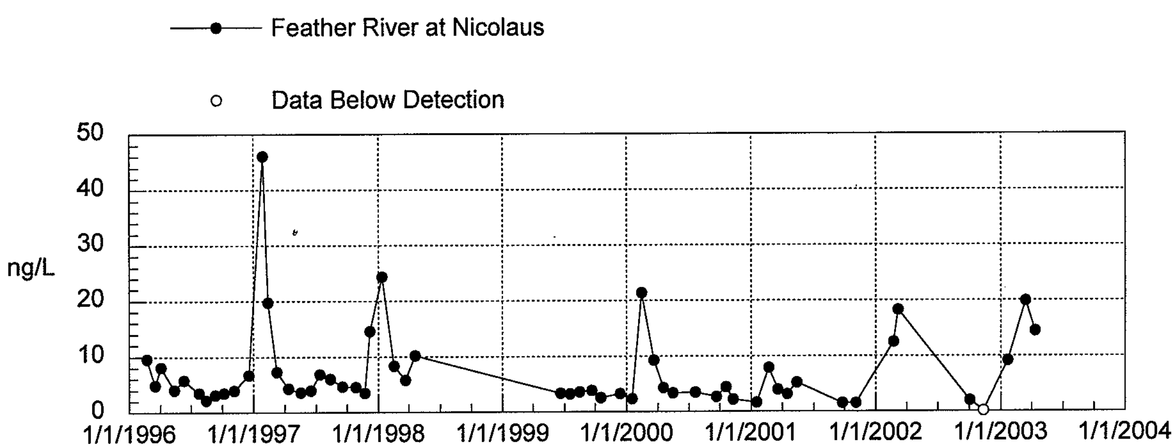
UNFILTERED MERCURY IN WATER








Sacramento River at River Mile 44
Data Below Detection
ng/L
80
70
60
50
40
30
20
10
0
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004


Feather River at Nicolaus
Data Below Detection
ng/L
50
40
30
20
10
0
1/1/1996
1/1/1997
1/1/1998
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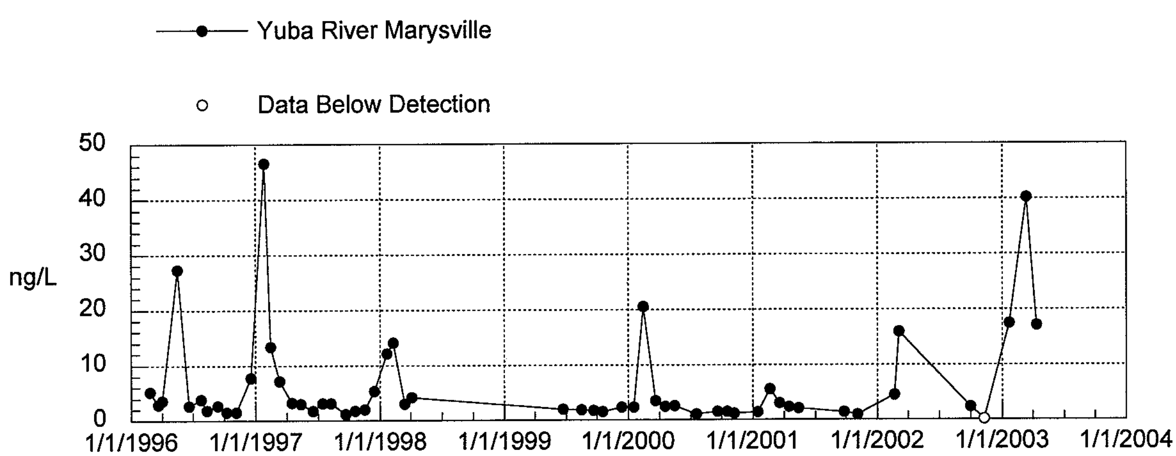
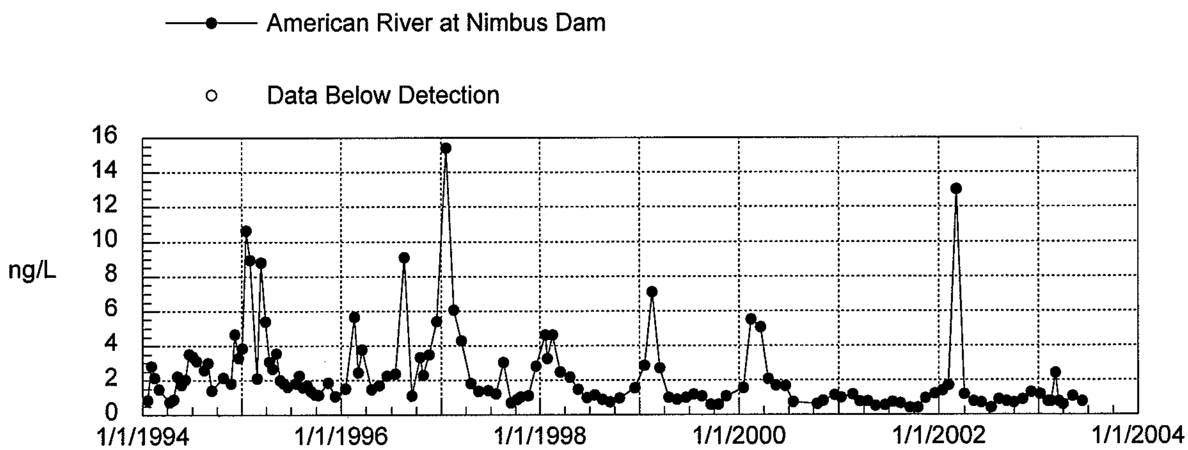
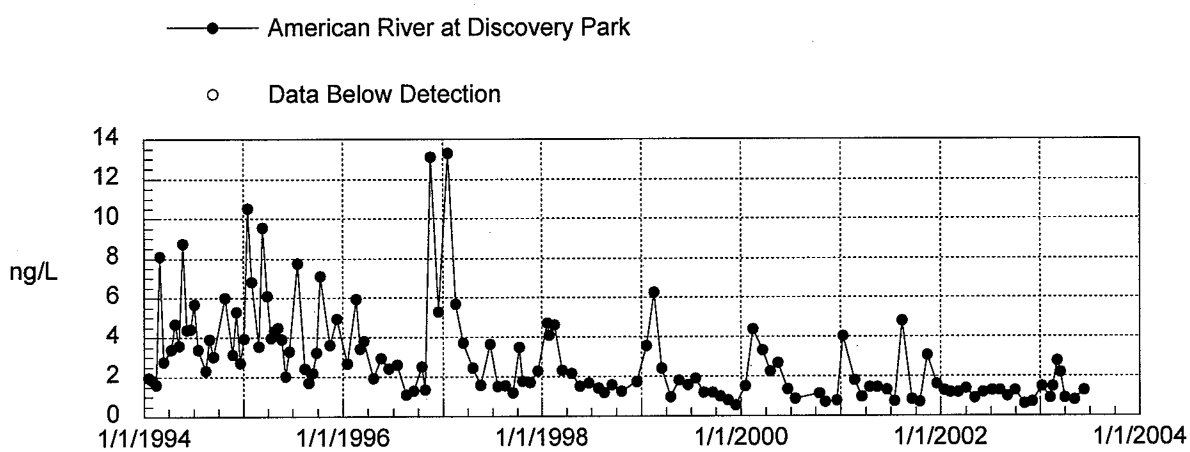
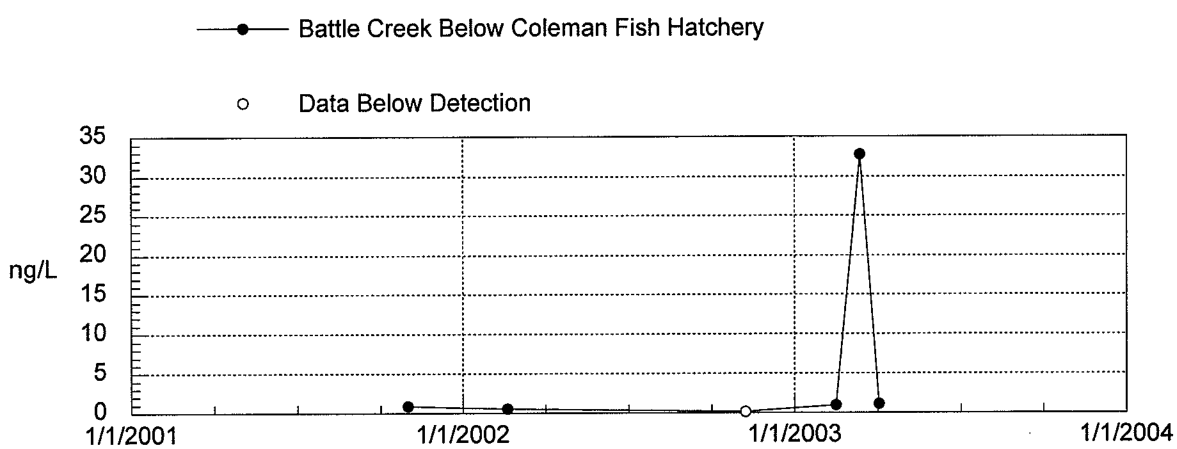
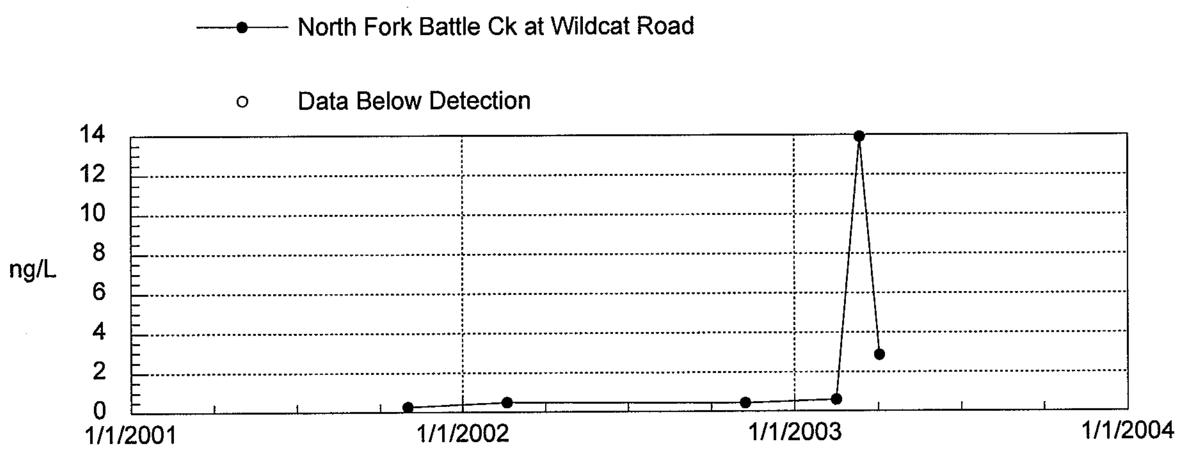
1/1/2003
1/1/2004

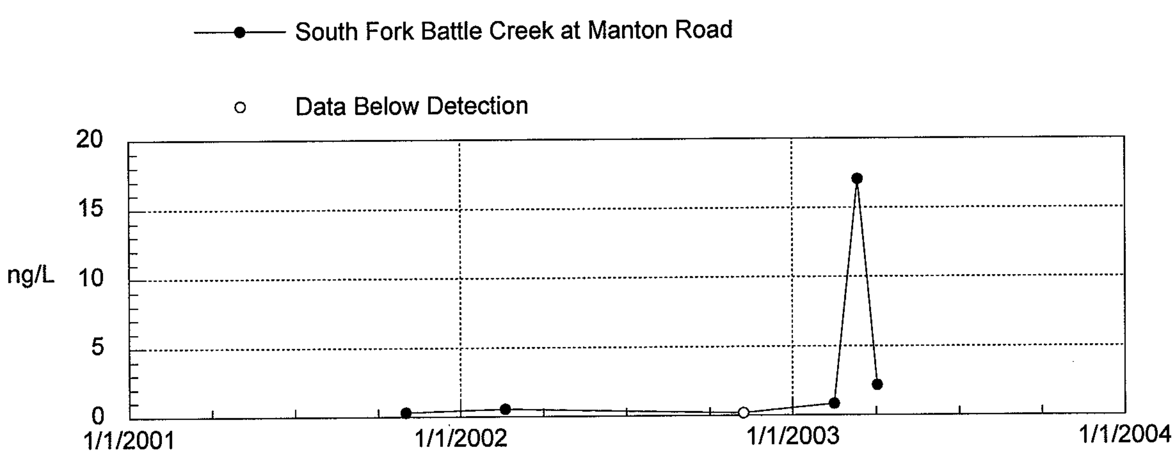

Yuba River Marysville
Data Below Detection
ng/L
50
40
30
20
10
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

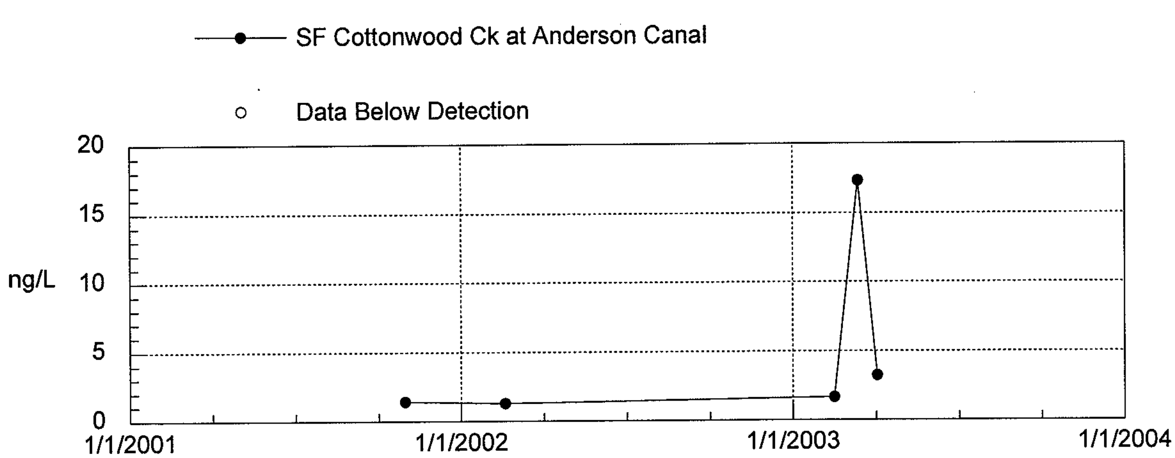

American River at Nimbus Dam
Data Below Detection
ng/L
16
14
12
10
8
6
4
2
0
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

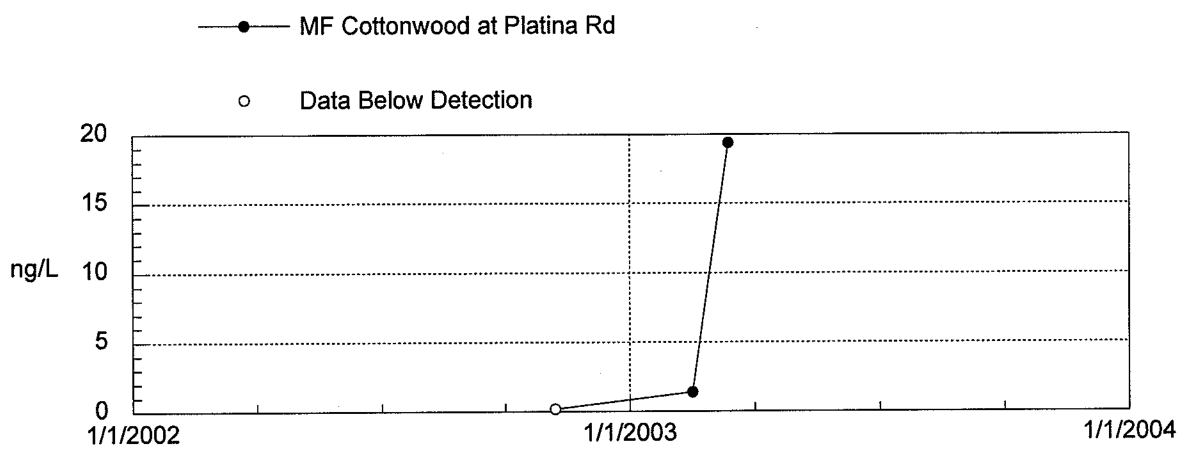

American River at Discovery Park
Data Below Detection
ng/L
14
12
10
8
6
4
2
0
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

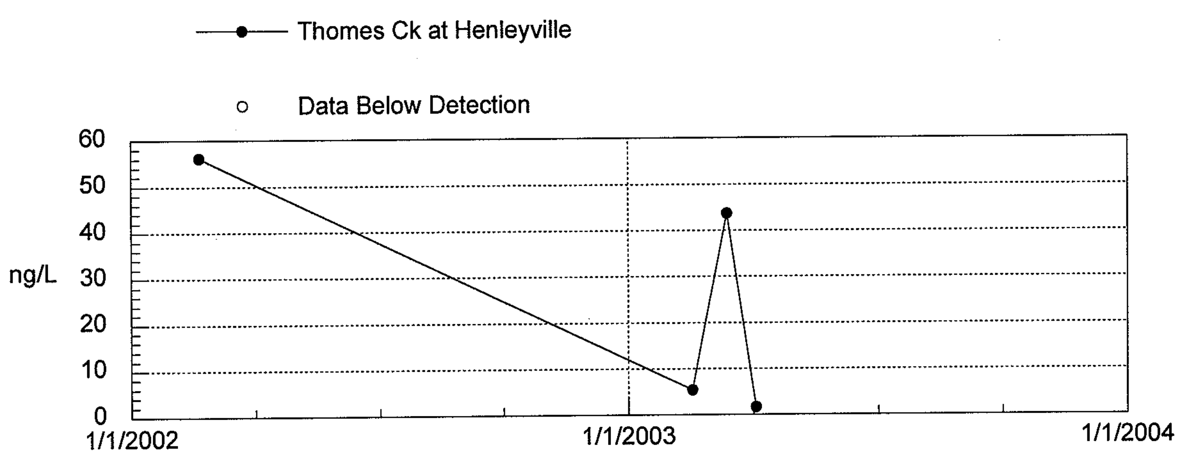

Battle Creek Below Coleman Fish Hatchery
Data Below Detection
ng/L
35
30
25
20
15
10
5
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004

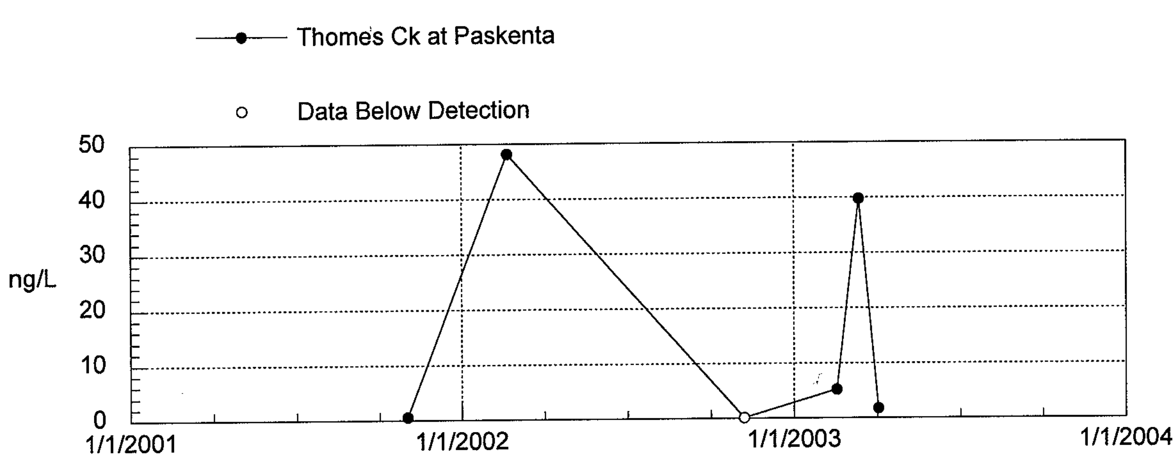

North Fork Battle Ck at Wildcat Road
Data Below Detection
ng/L
14
12
10
8
6
4
2
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004

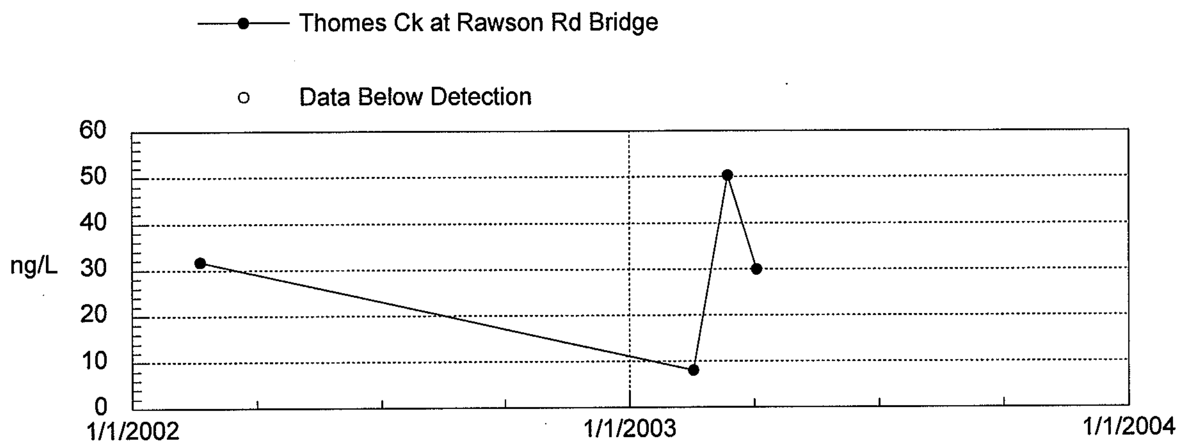

South Fork Battle Creek at Manton Road
Data Below Detection
ng/L
20
15
10
5
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004

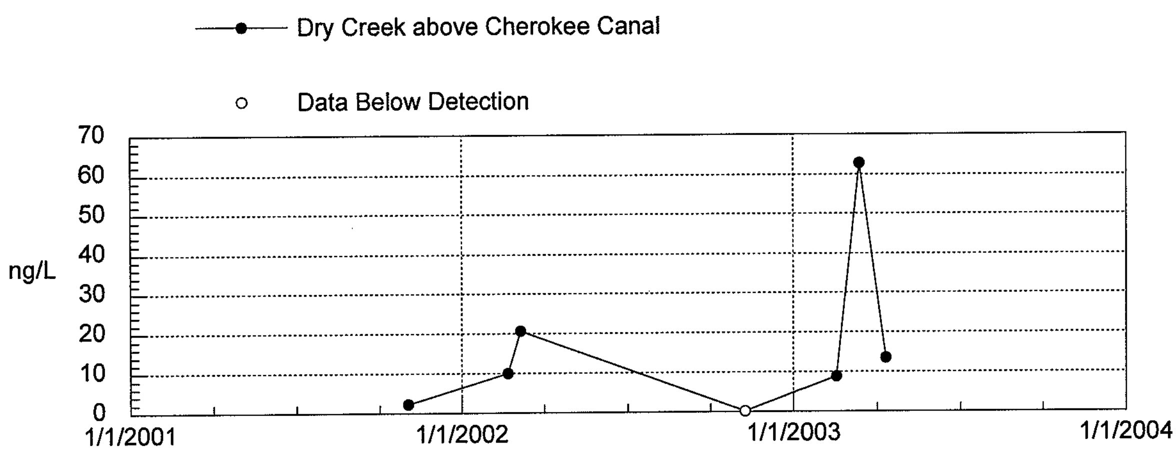

SF Cottonwood Ck at Anderson Canal
Data Below Detection
ng/L
20
15
10
5
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004

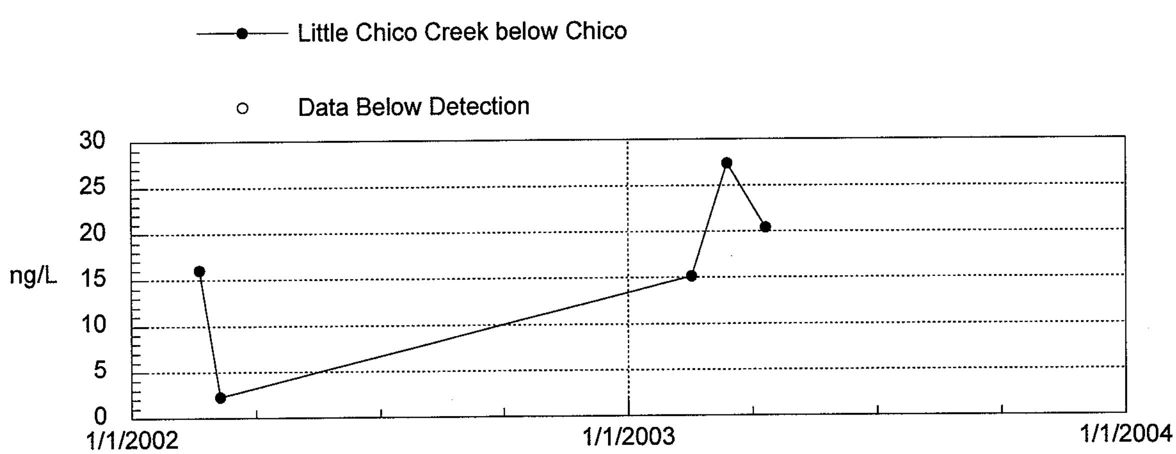

MF Cottonwood at Platina Rd
Data Below Detection
20
15
ng/L 10
5
0
1/1/2002
1/1/2003
1/1/2004


Thomes Ck at Henleyville
Data Below Detection
60
50
40
ng/L 30
20
10
0
1/1/2002
1/1/2003
1/1/2004

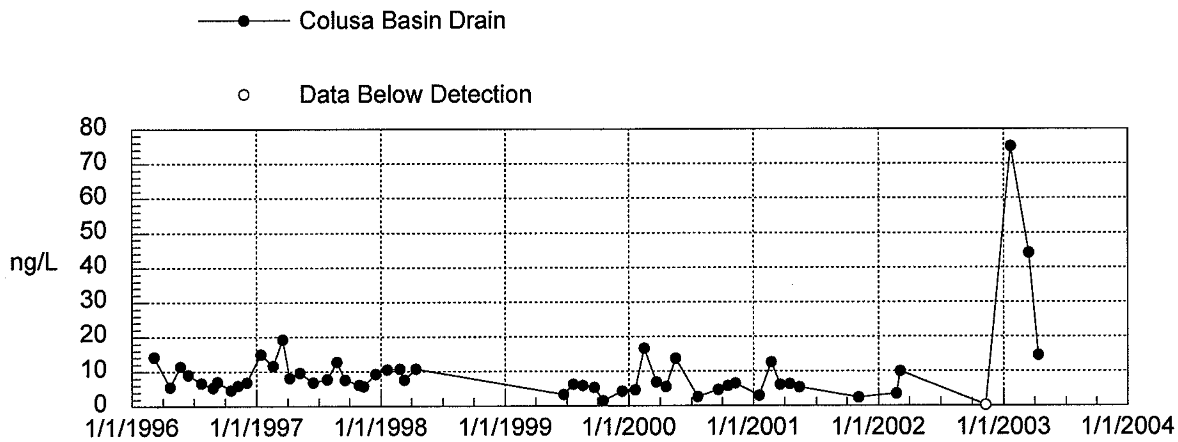

Thomes Ck at Paskenta
Data Below Detection
50
40
30
ng/L
20
10
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004

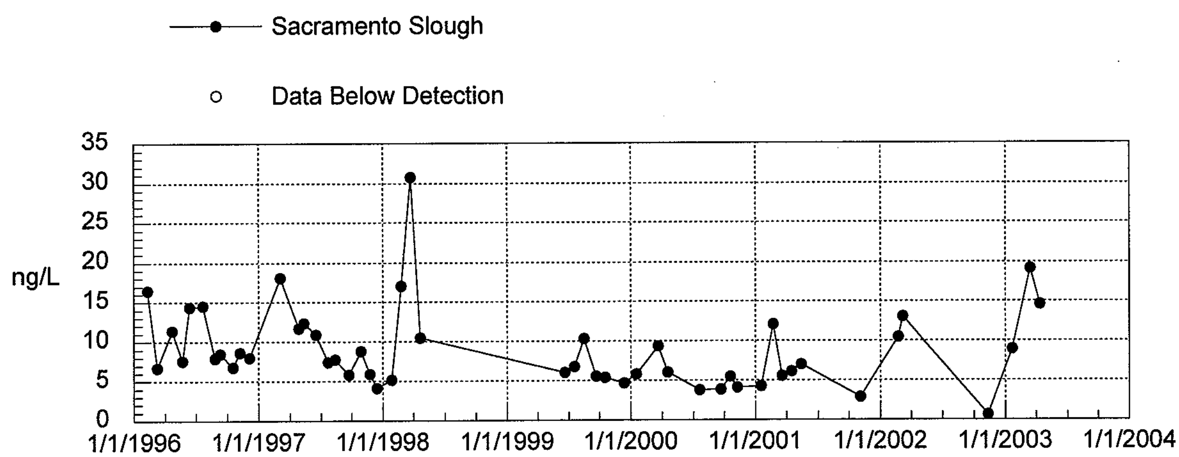

Thomes Ck at Rawson Rd Bridge
Data Below Detection
60
50
40
ng/L
30
20
10
0
1/1/2002
1/1/2003
1/1/2004

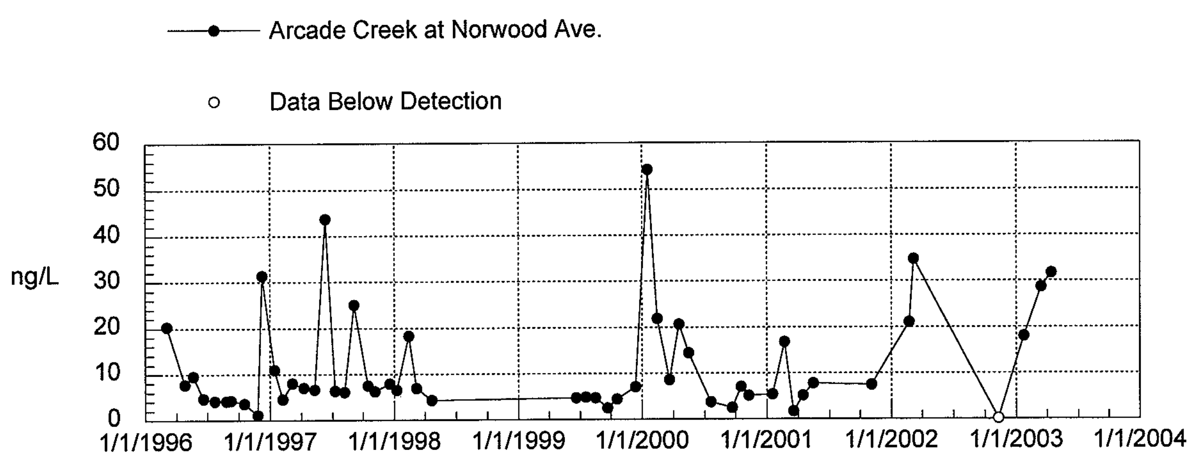

Dry Creek above Cherokee Canal
Data Below Detection
70
60
50
40
ng/L
30
20
10
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Little Chico Creek below Chico
Data Below Detection
30
25
20
ng/L
15
10
5
0
1/1/2002
1/1/2003
1/1/2004

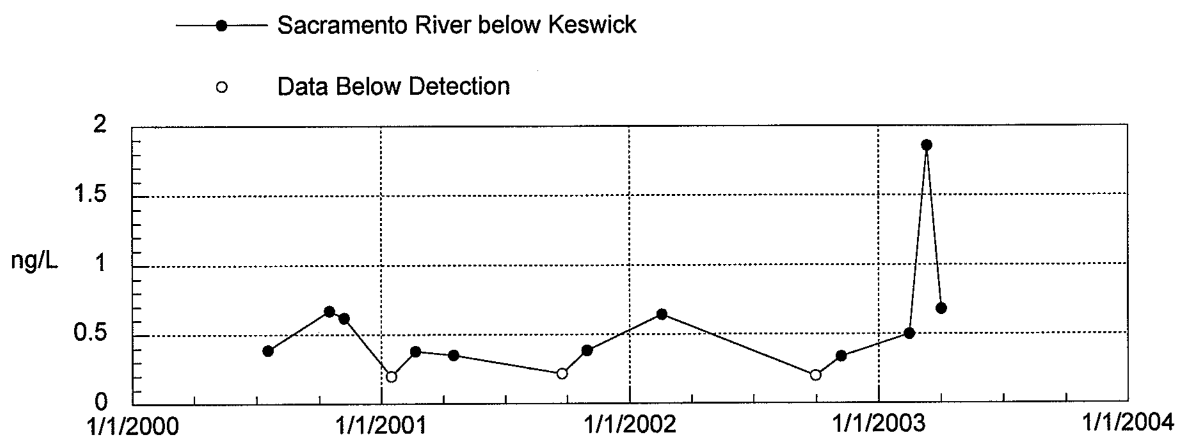
UNFILTERED MERCURY IN WATER

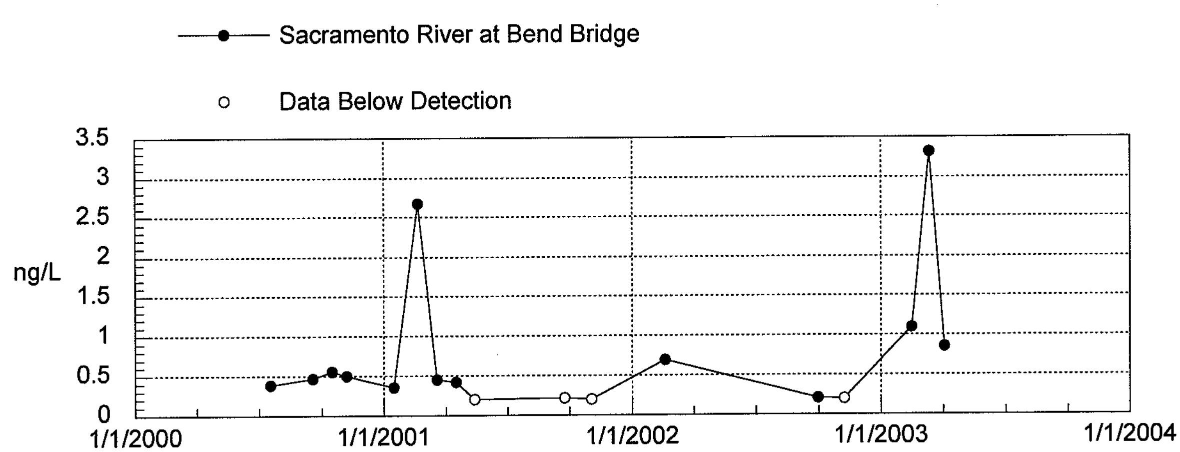


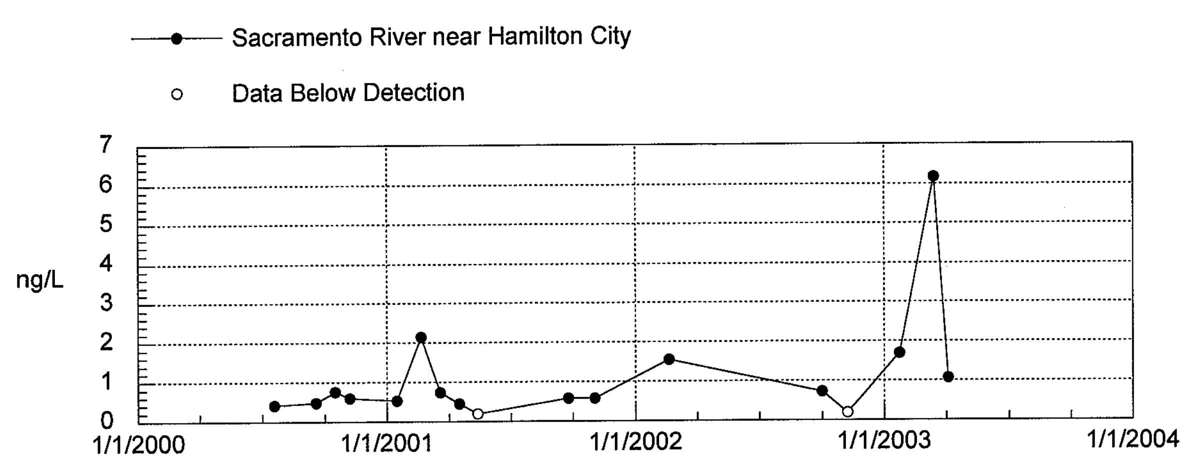




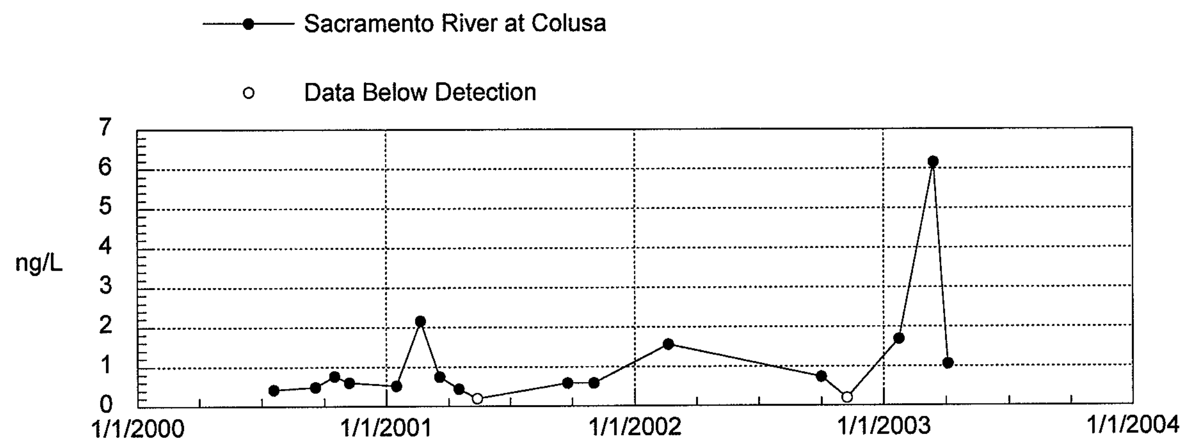
FILTERED MERCURY IN WATER

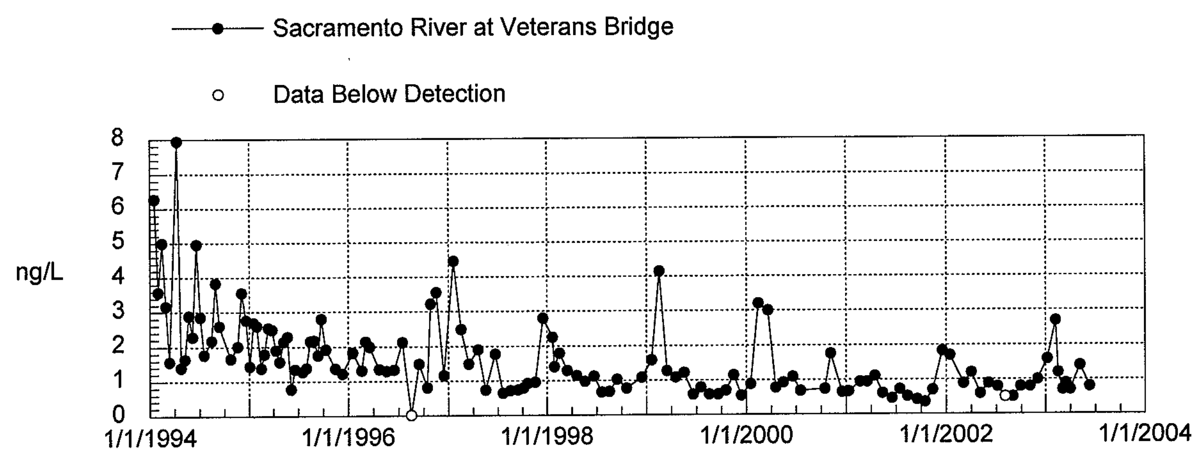


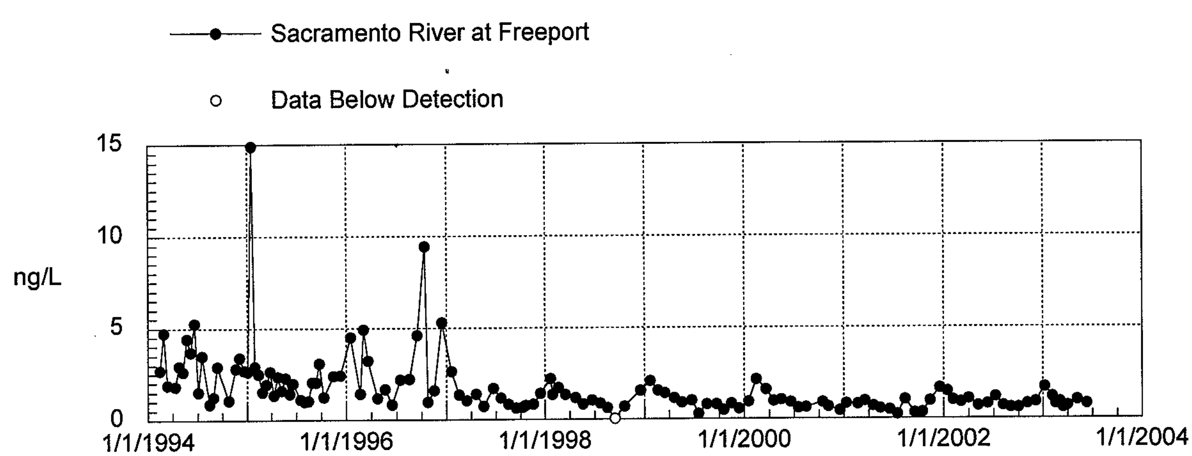


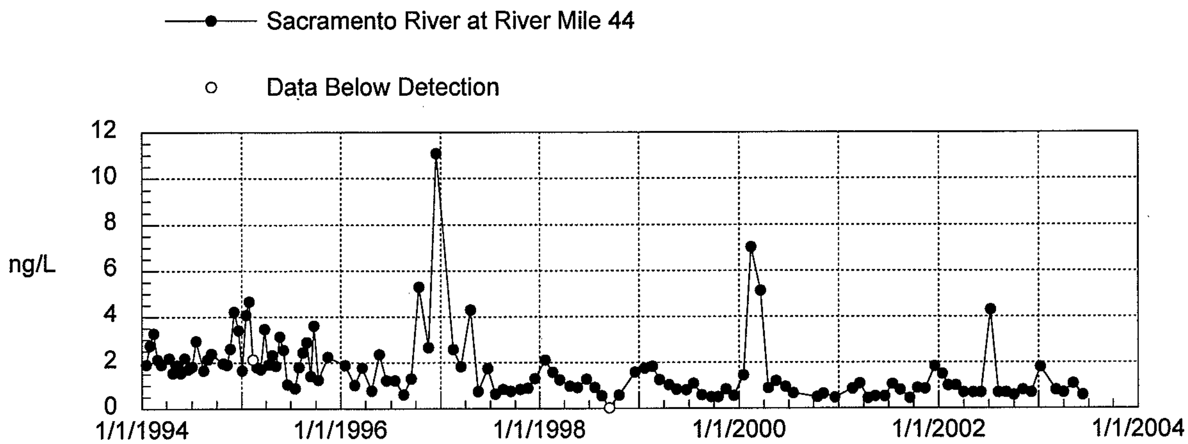


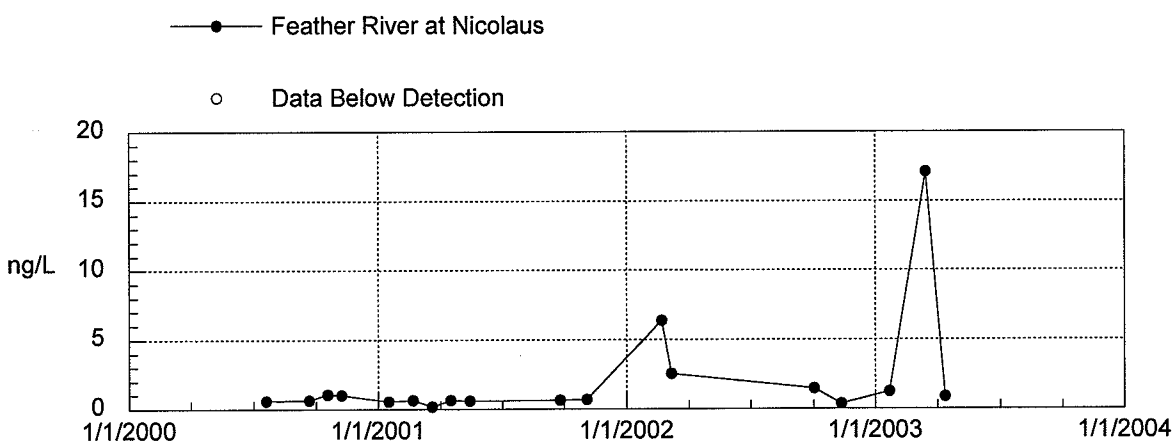
FILTERED MERCURY IN WATER

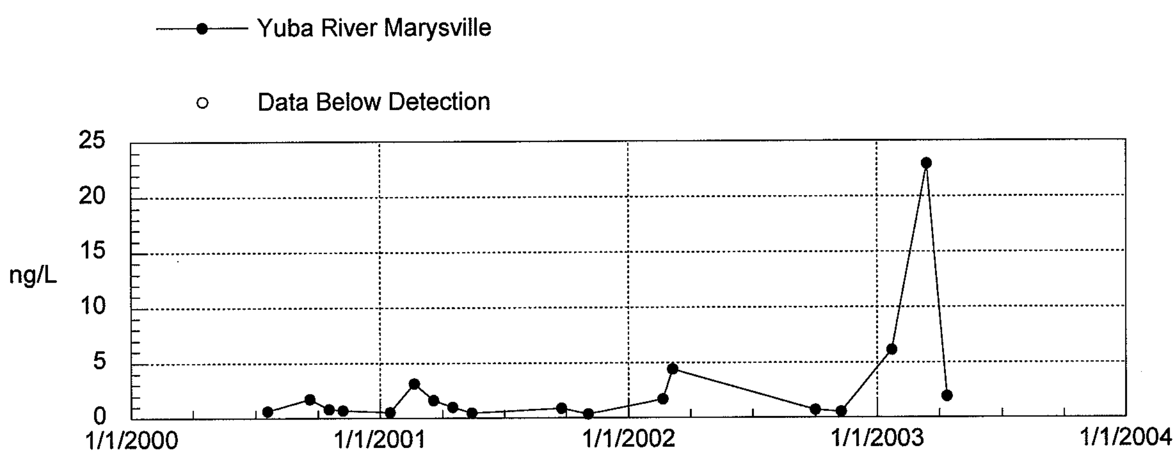


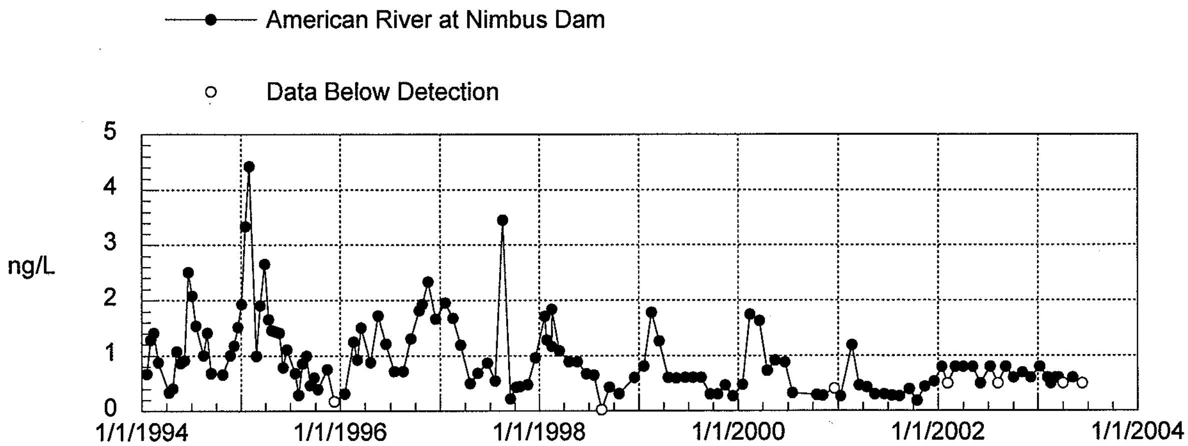




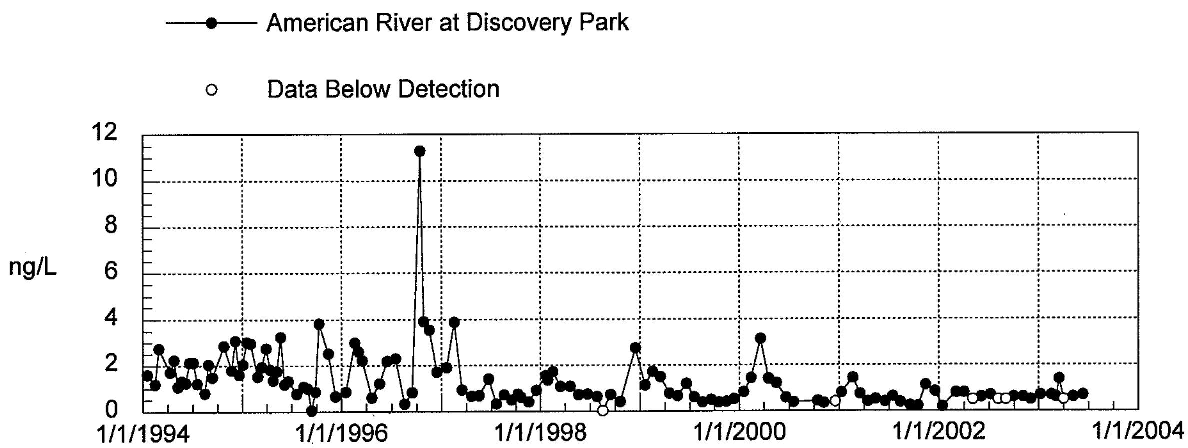

Sacramento River at River Mile 44
Data Below Detection
ng/L
12
10
8
6
4
2
0
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004


Feather River at Nicolaus
Data Below Detection
ng/L
20
15
10
5
0
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

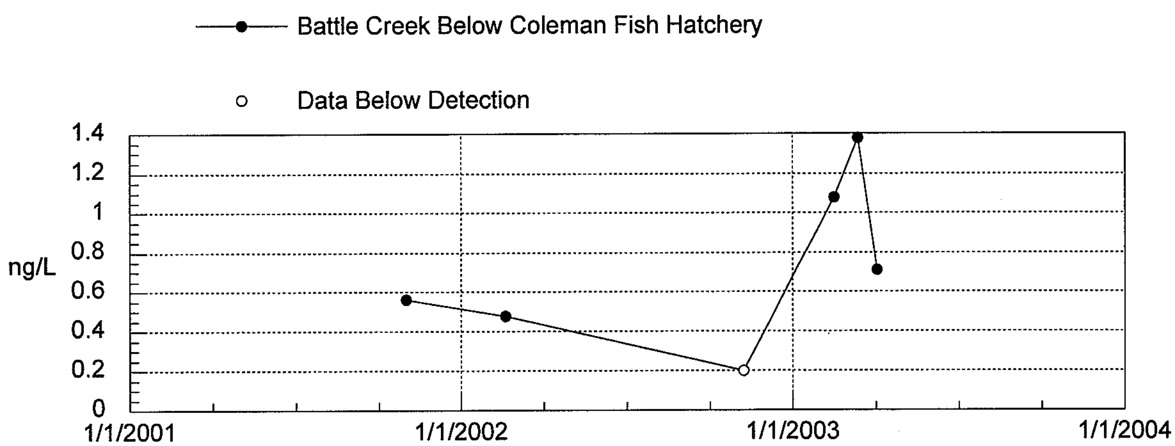

Yuba River Marysville
Data Below Detection
ng/L
25
20
15
10
5
0
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004



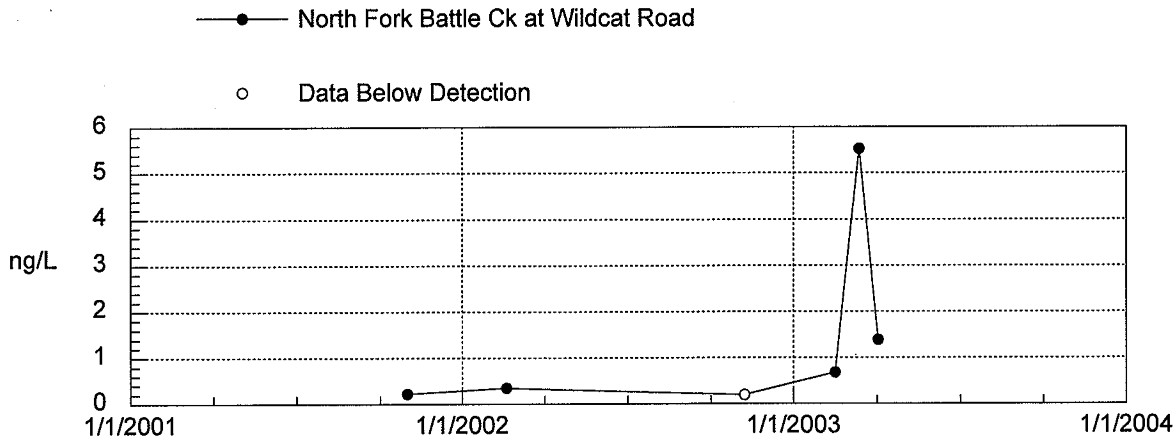
American River at Nimbus Dam
Data Below Detection
ng/L
0
1
2
3
4
5
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

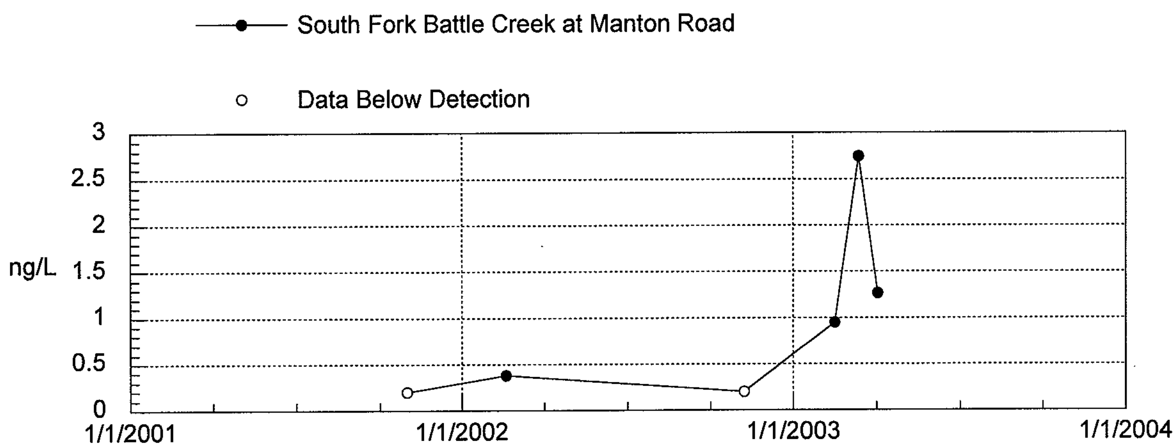


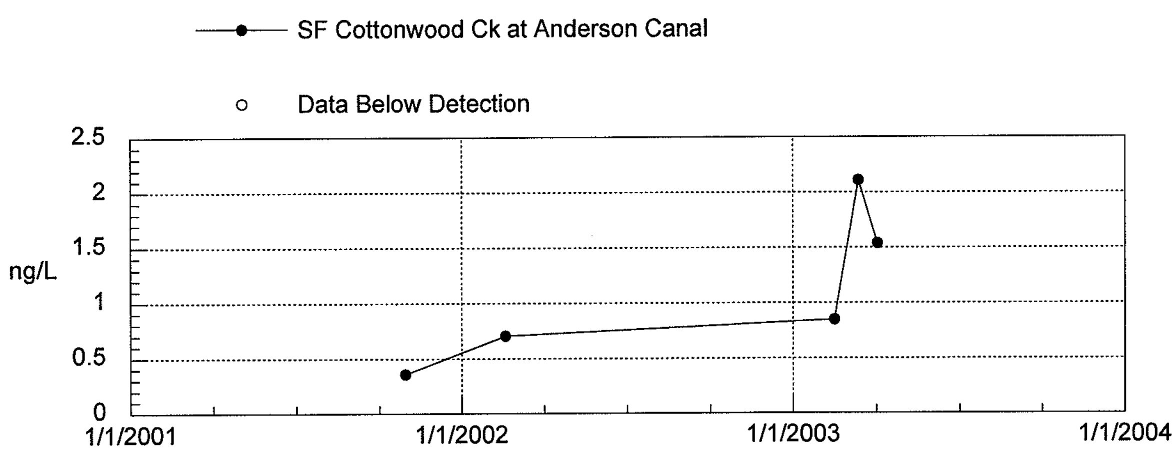
American River at Discovery Park
Data Below Detection
ng/L
0
2
4
6
8
10
12
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

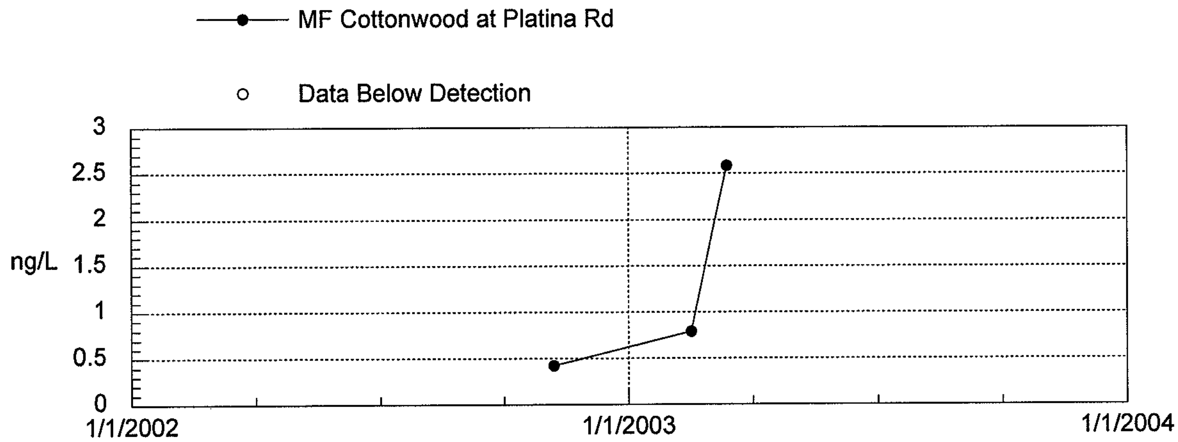


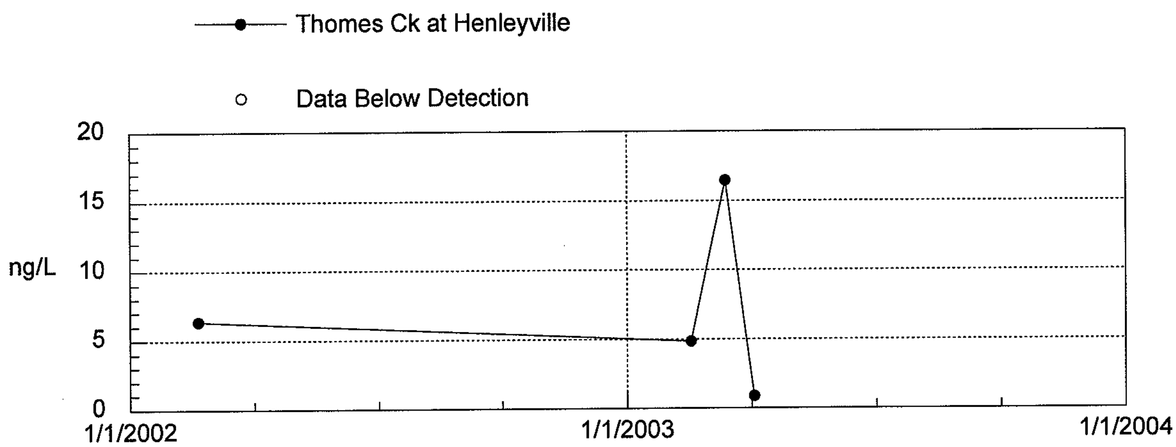
Battle Creek Below Coleman Fish Hatchery
Data Below Detection
ng/L
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1/1/2001
1/1/2002
1/1/2003
1/1/2004

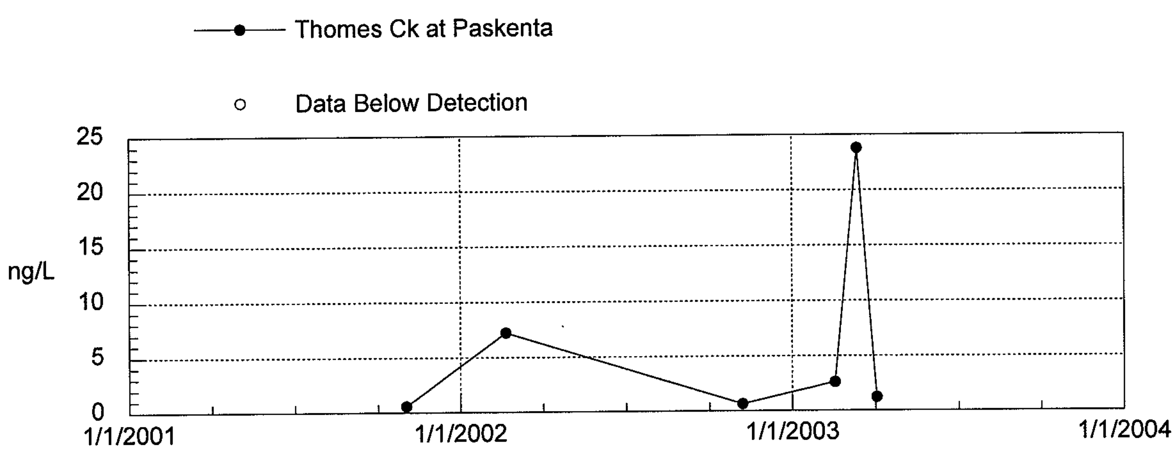

North Fork Battle Ck at Wildcat Road
Data Below Detection
ng/L
6
5
4
3
2
1
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004

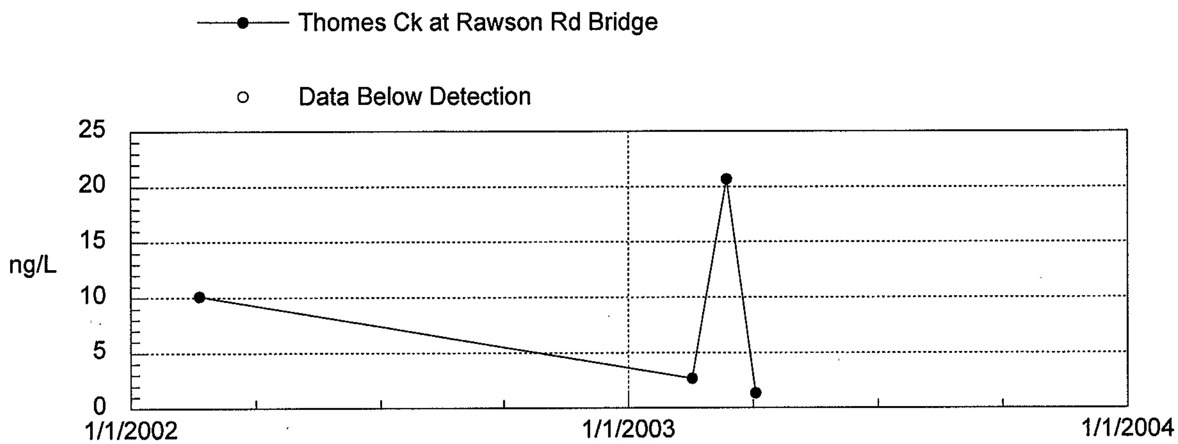

South Fork Battle Creek at Manton Road
Data Below Detection
ng/L
3
2.5
2
1.5
1
0.5
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004


SF Cottonwood Ck at Anderson Canal
Data Below Detection
ng/L
2.5
2
1.5
1
0.5
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004

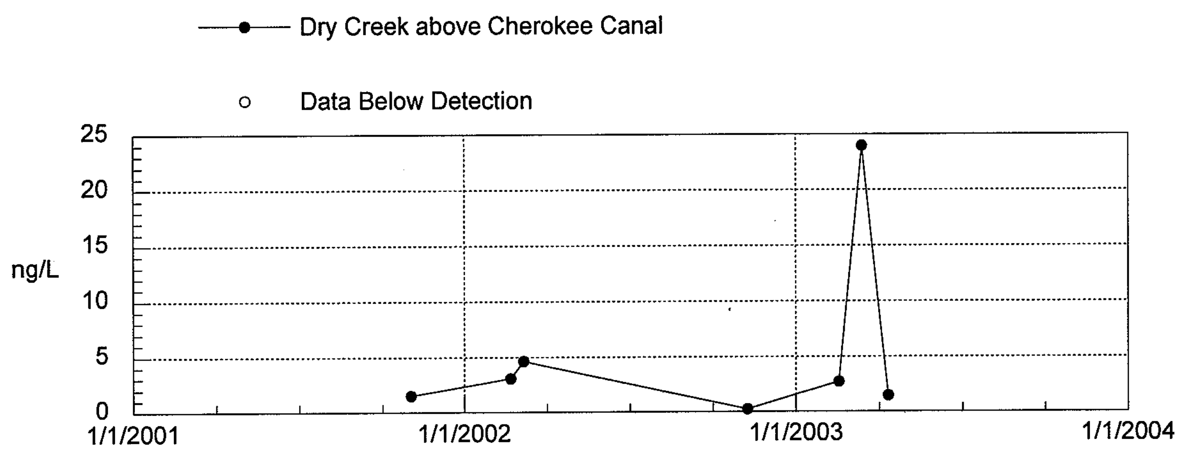

MF Cottonwood at Platina Rd
Data Below Detection
ng/L
3
2.5
2
1.5
1
0.5
0
1/1/2002
1/1/2003
1/1/2004


Thomes Ck at Henleyville
Data Below Detection
ng/L
20
15
10
5
0
1/1/2002
1/1/2003
1/1/2004

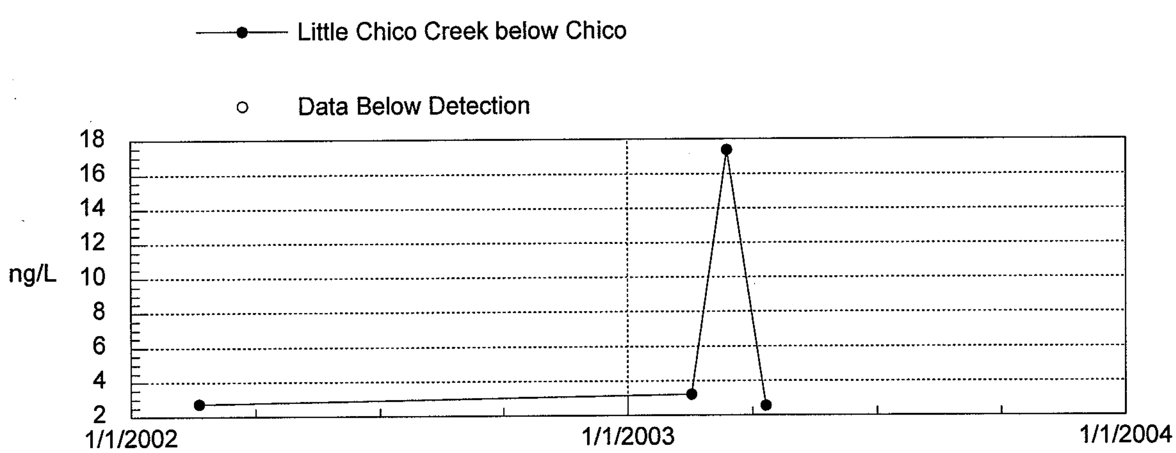

Thomes Ck at Paskenta
Data Below Detection
ng/L
25
20
15
10
5
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004



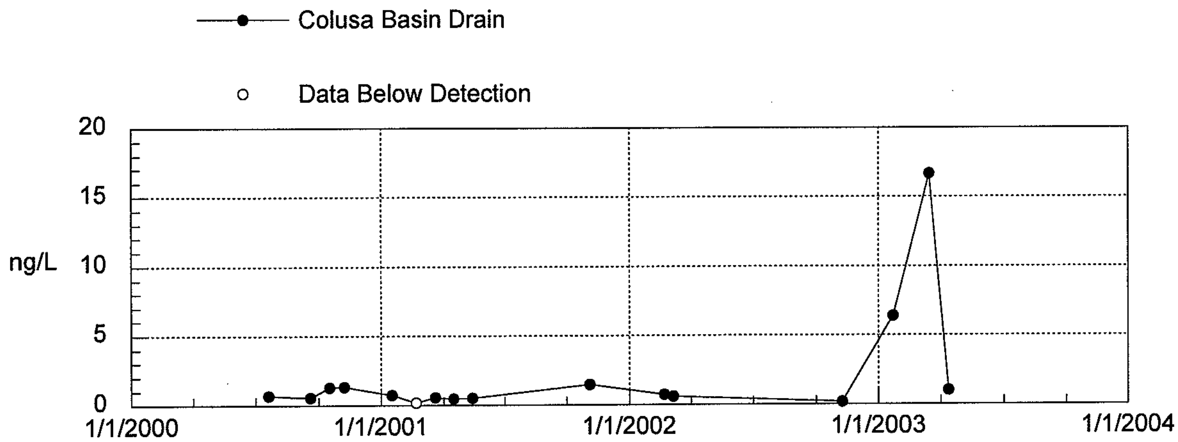
Thomes Ck at Rawson Rd Bridge
Data Below Detection
ng/L
25
20
15
10
5
0
1/1/2002
1/1/2003
1/1/2004

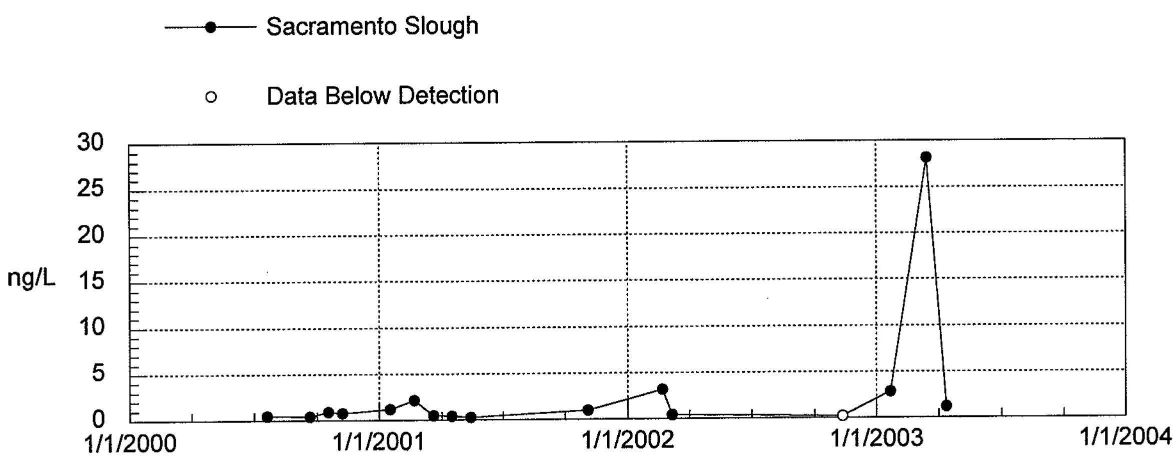


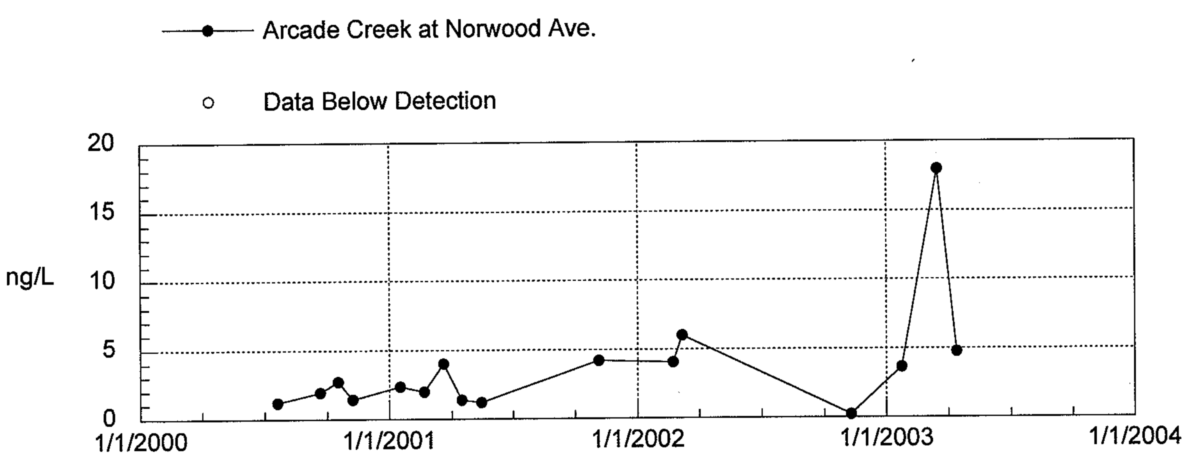
Dry Creek above Cherokee Canal
Data Below Detection
ng/L
25
20
15
10
5
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004



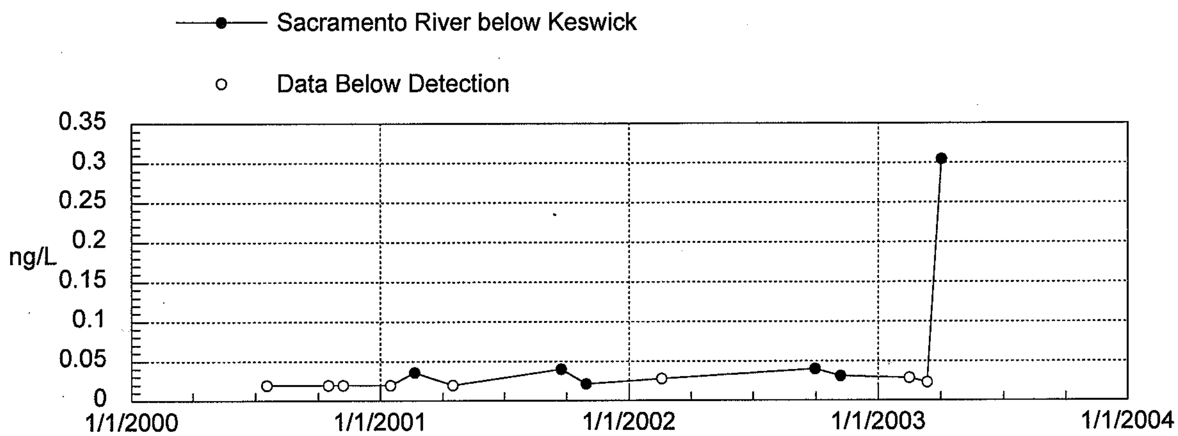
Little Chico Creek below Chico
Data Below Detection
ng/L
18
16
14
12
10
8
6
4
2
1/1/2002
1/1/2003
1/1/2004

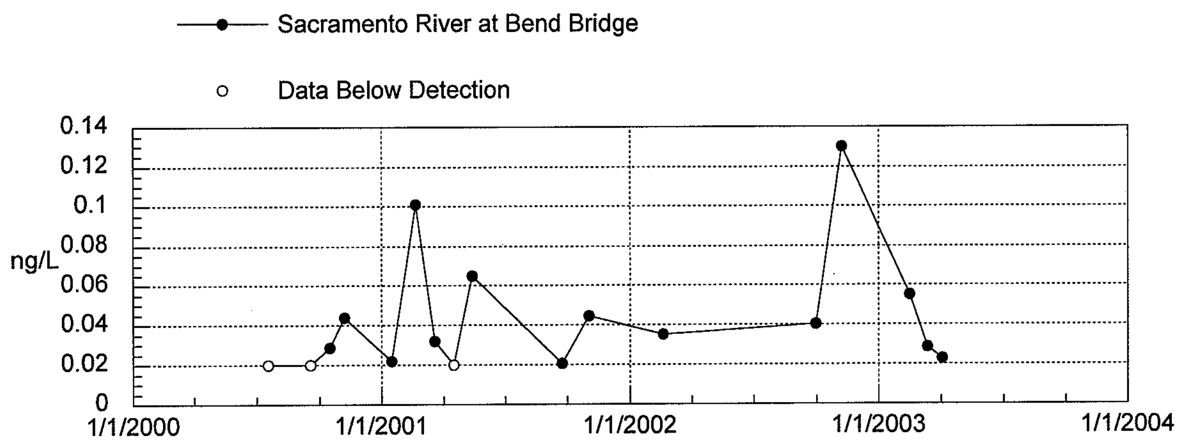

Colusa Basin Drain
Data Below Detection
ng/L
20
15
10
5
0
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

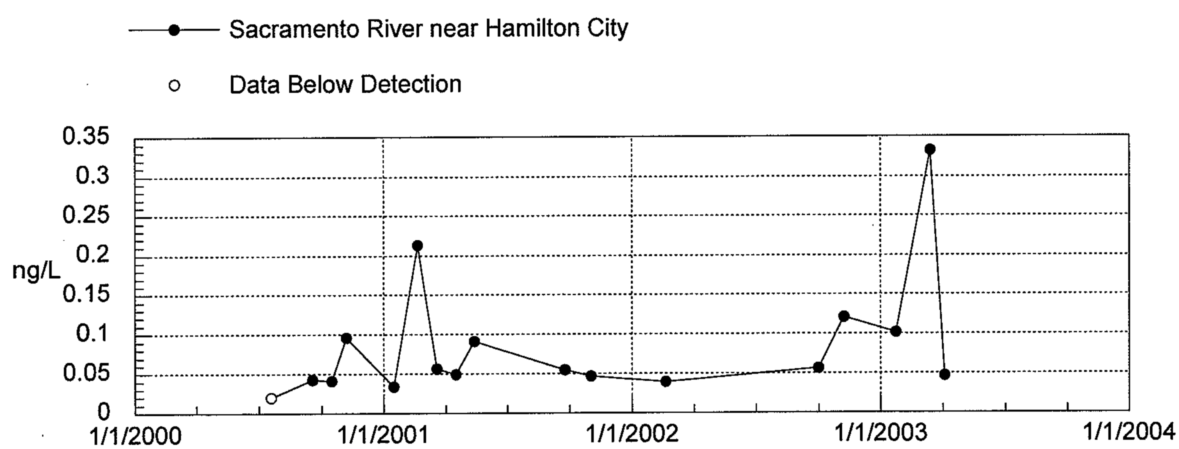

Sacramento Slough
Data Below Detection
ng/L
30
25
20
15
10
5
0
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Arcade Creek at Norwood Ave.
Data Below Detection
ng/L
20
15
10
5
0
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

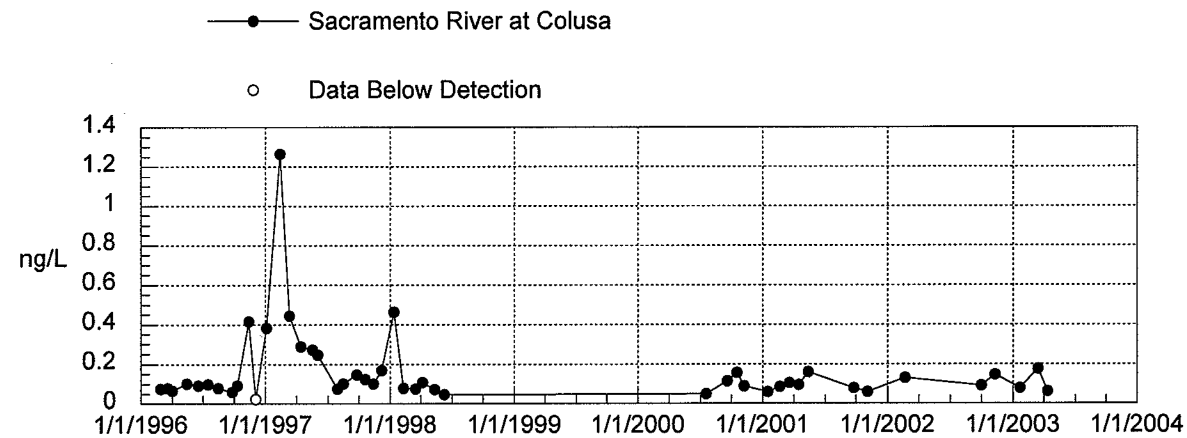
UNFILTERED METHYLMERCURY IN WATER

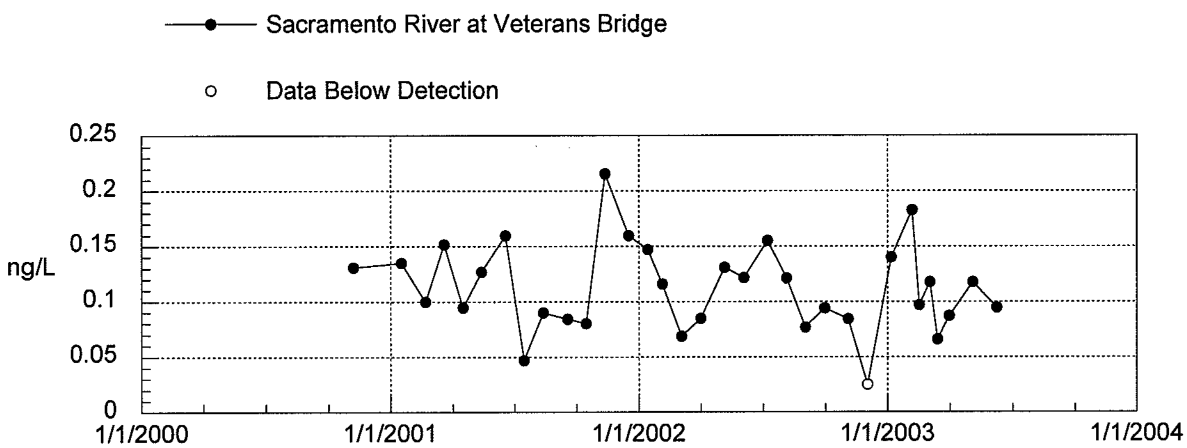


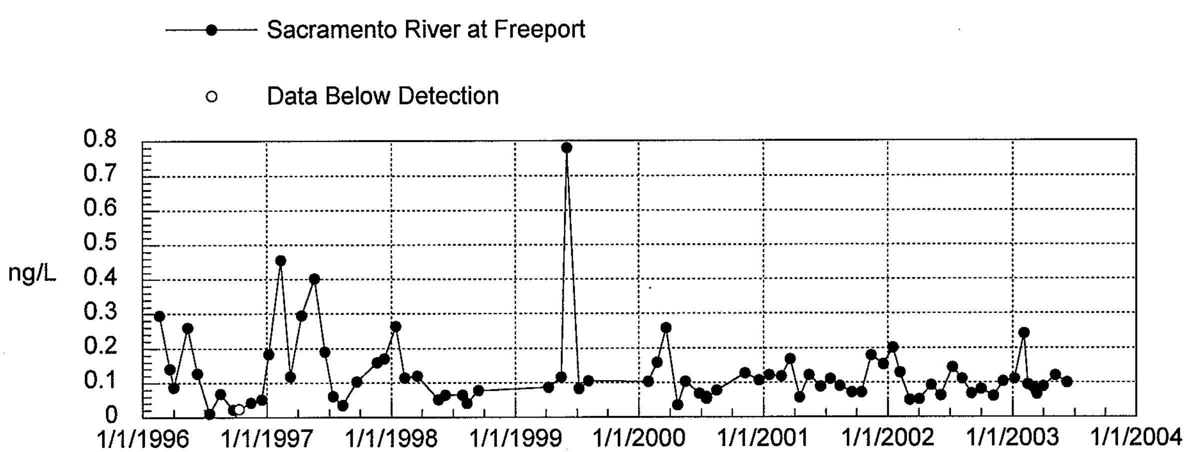




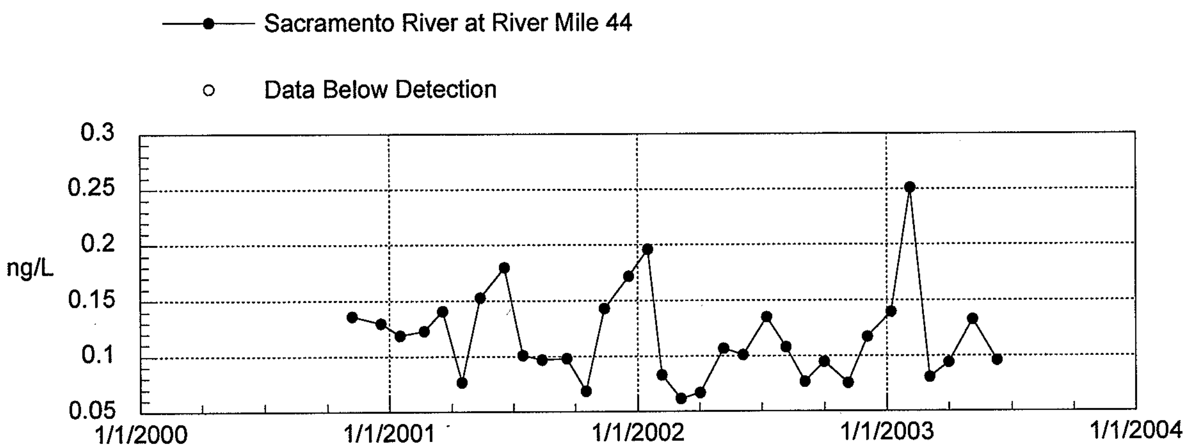
UNFILTERED METHYLMERCURY IN WATER

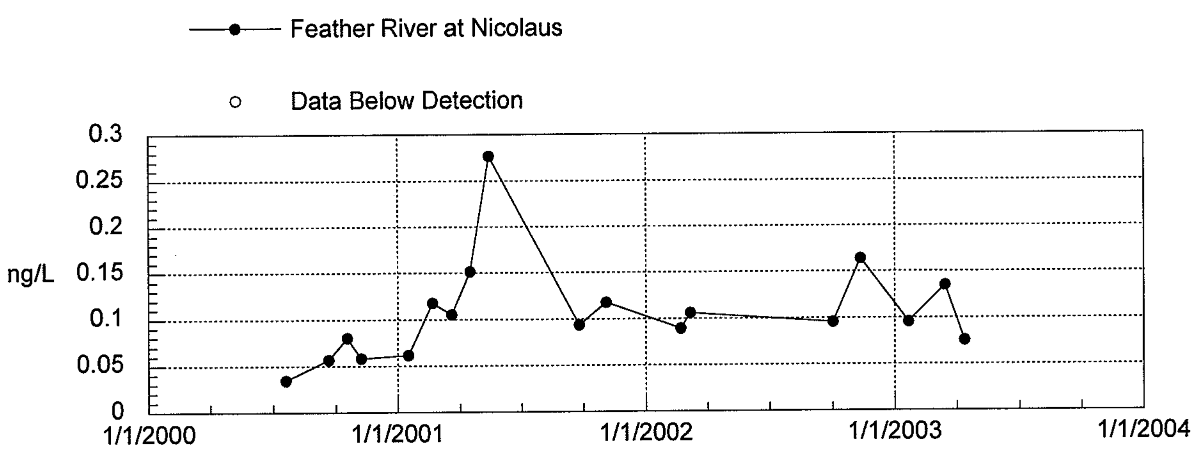


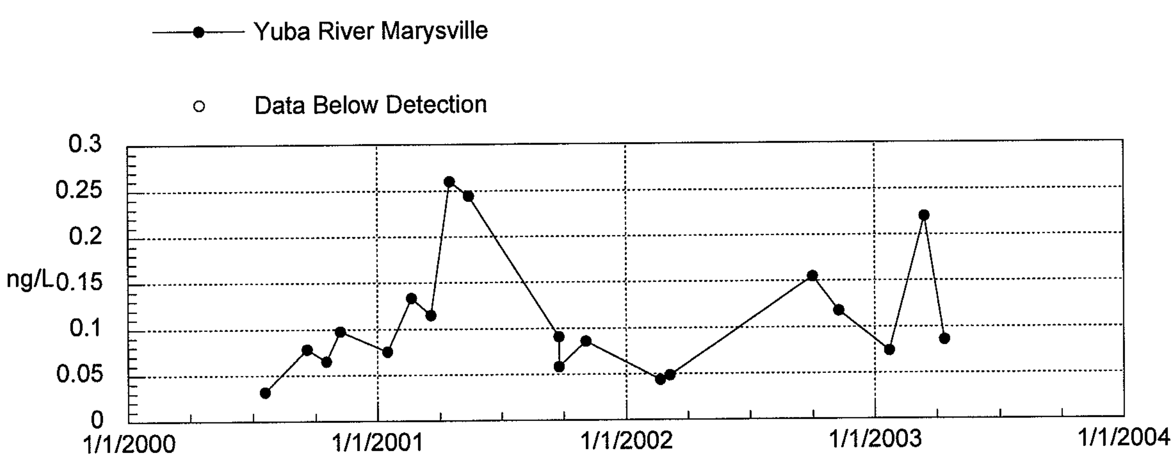




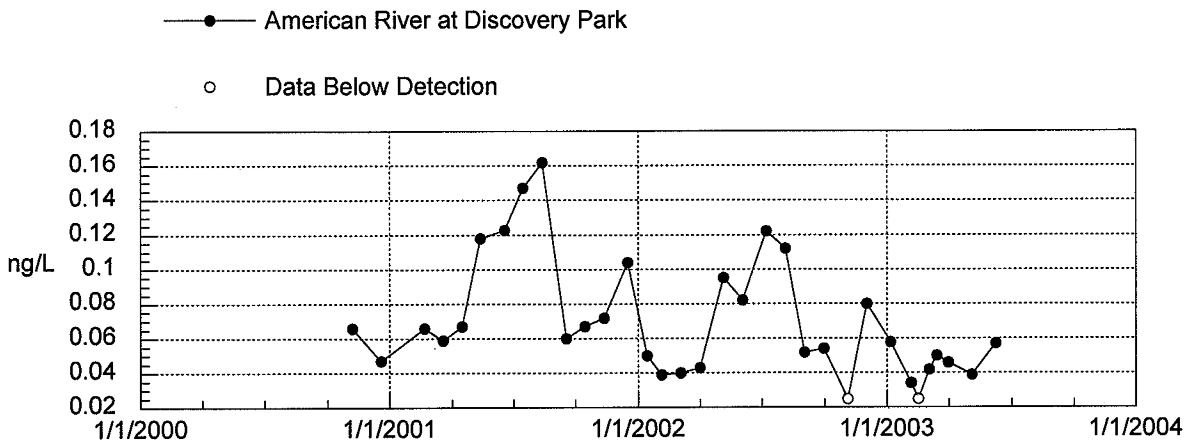
UNFILTERED METHYLMERCURY IN WATER

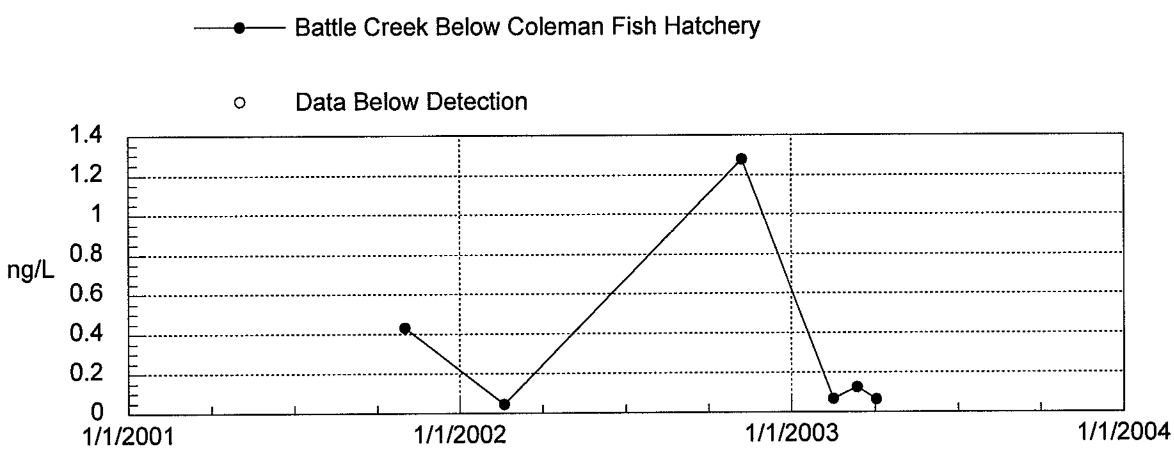


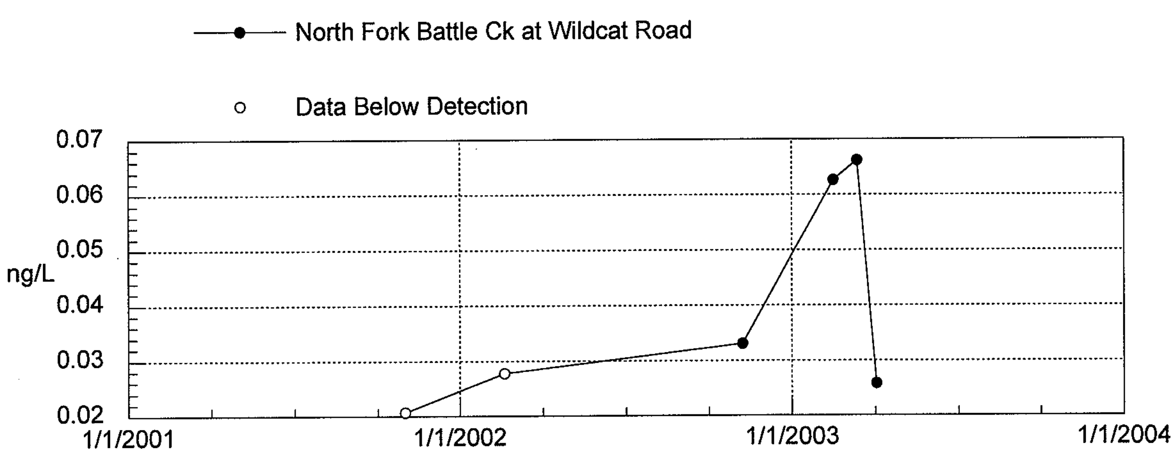




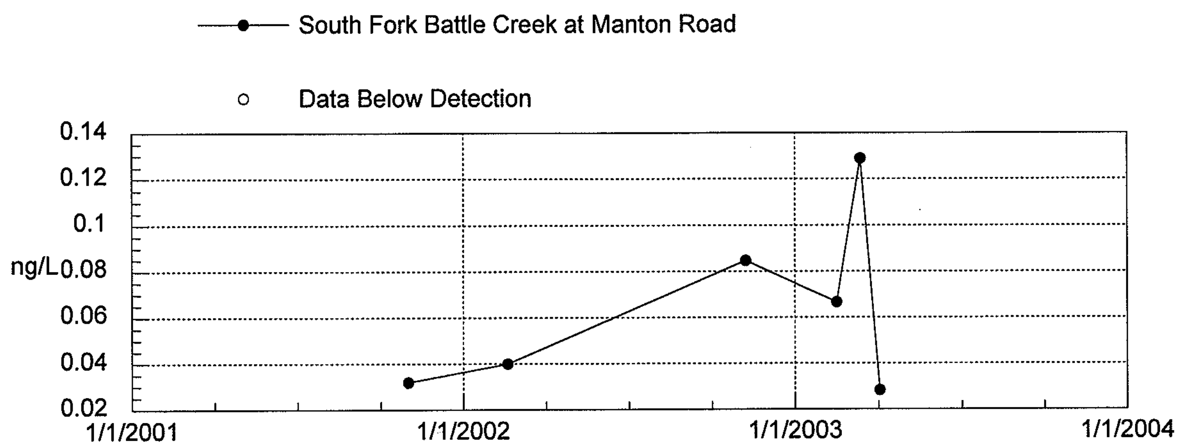
UNFILTERED METHYLMERCURY IN WATER

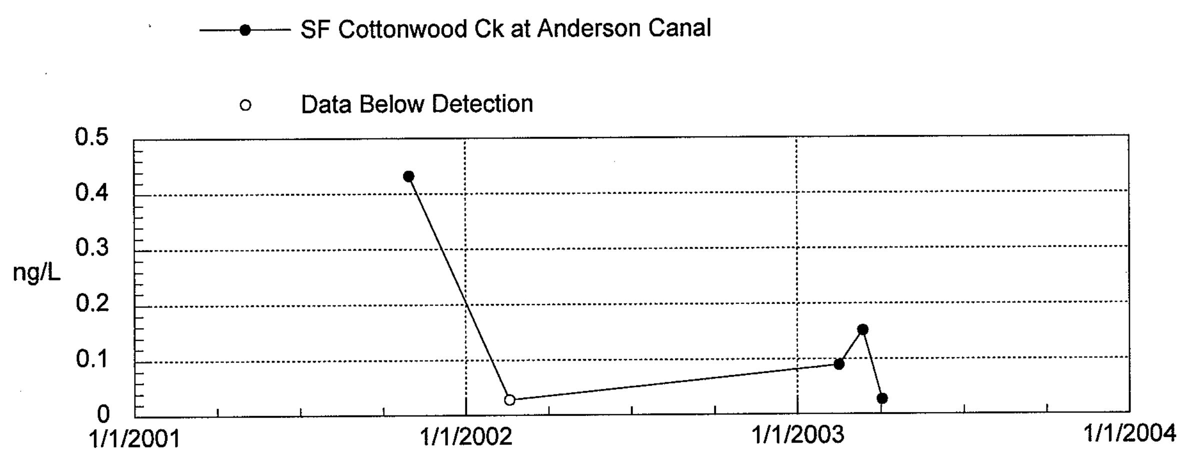


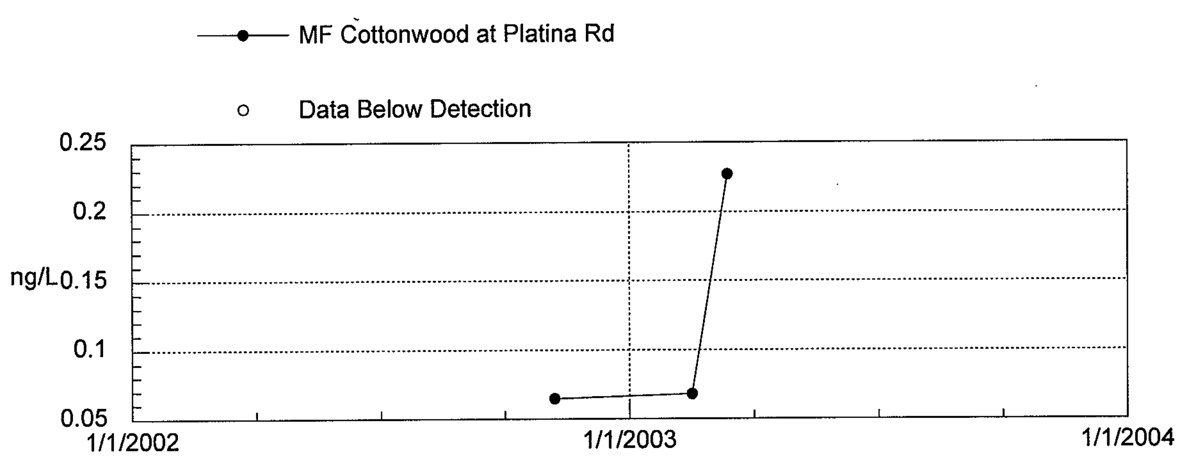




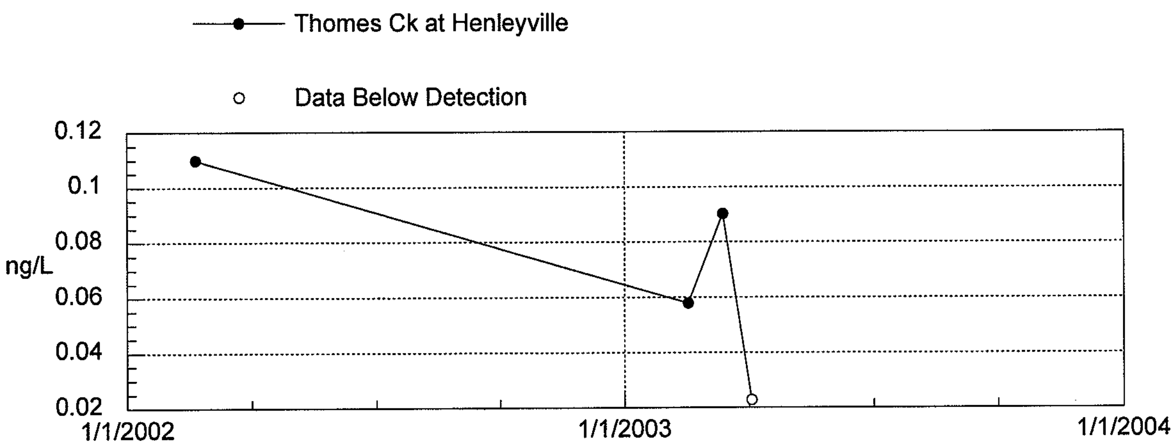
UNFILTERED METHYLMERCURY IN WATER

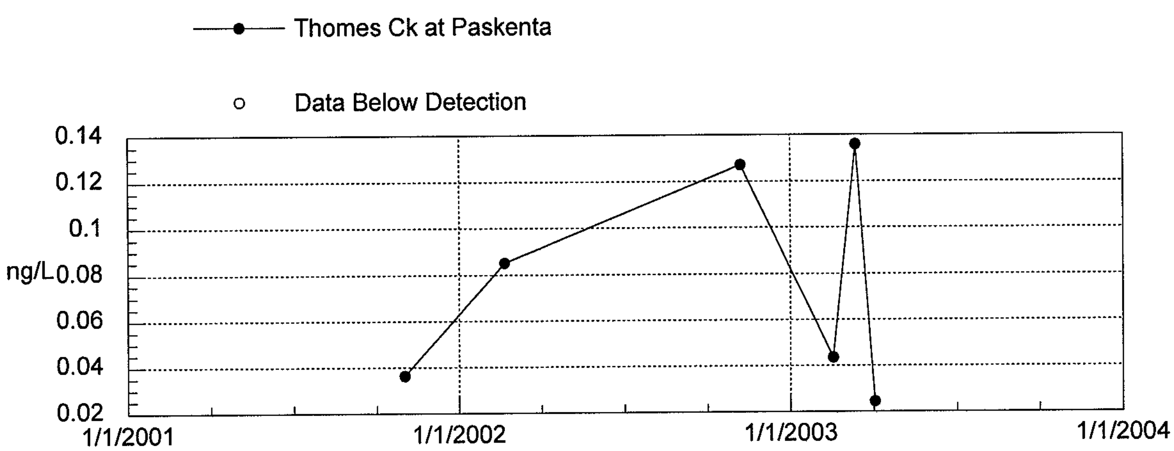


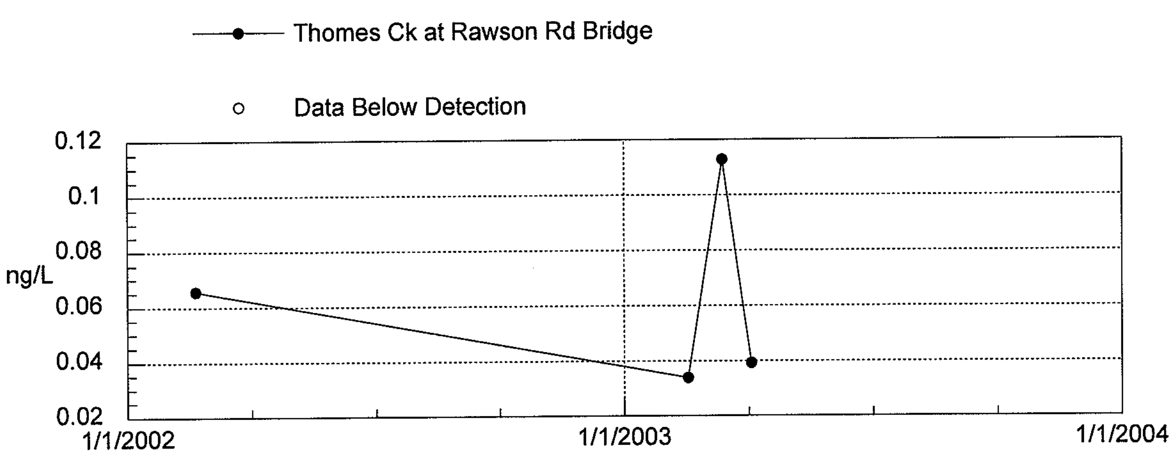




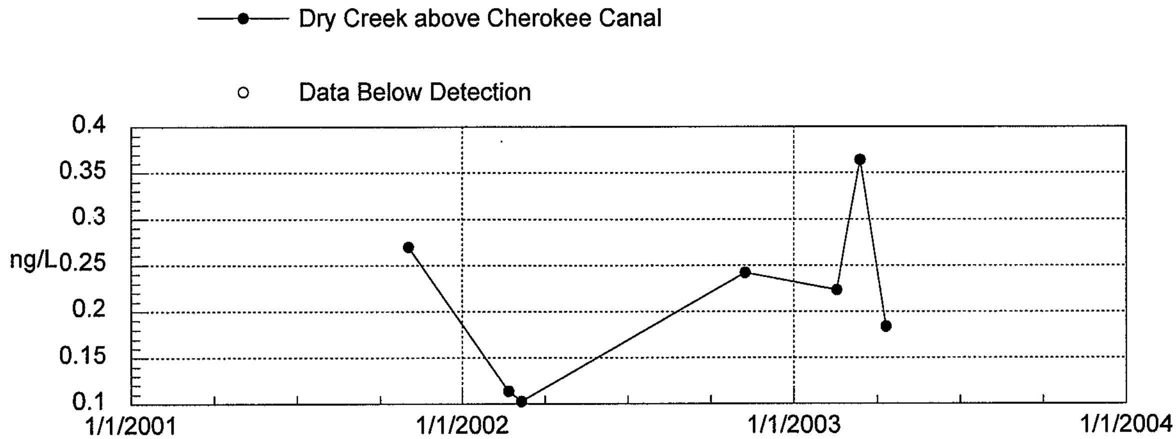
UNFILTERED METHYLMERCURY IN WATER

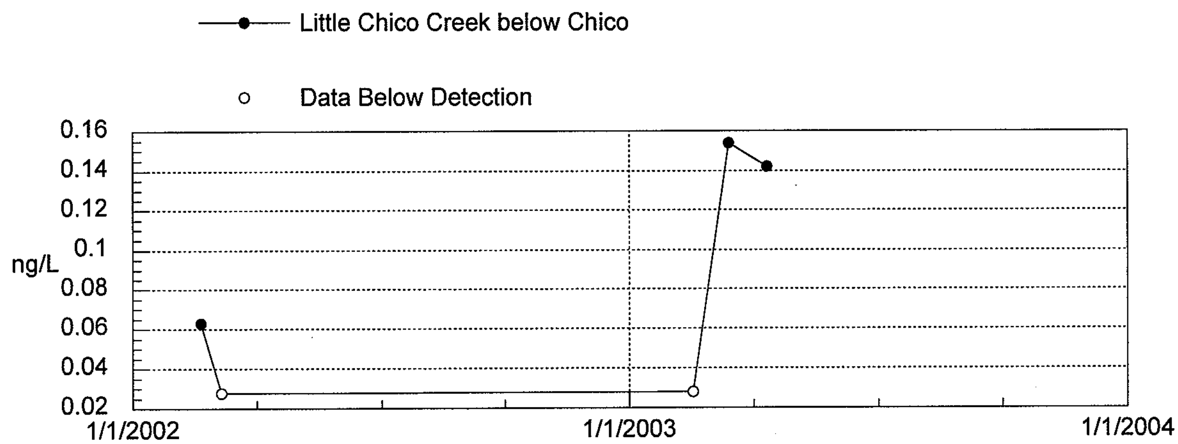


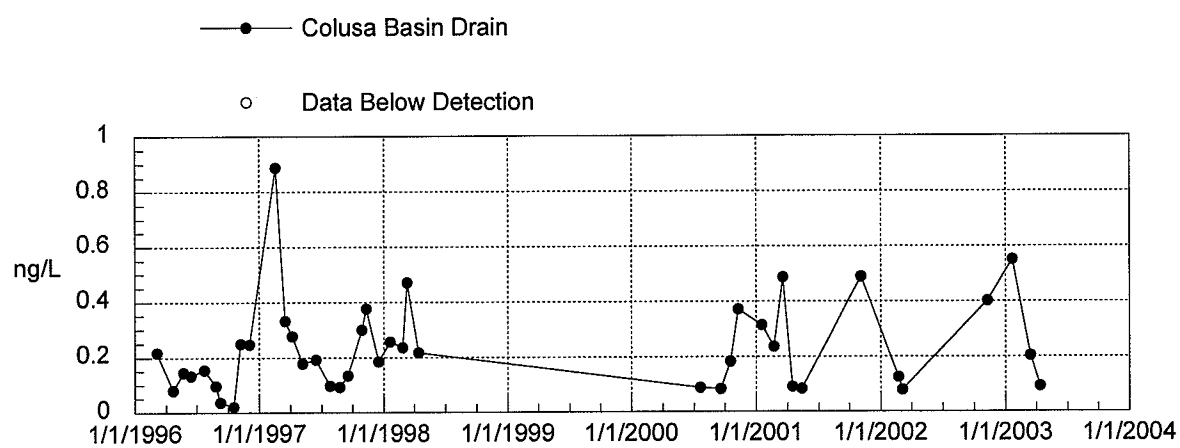




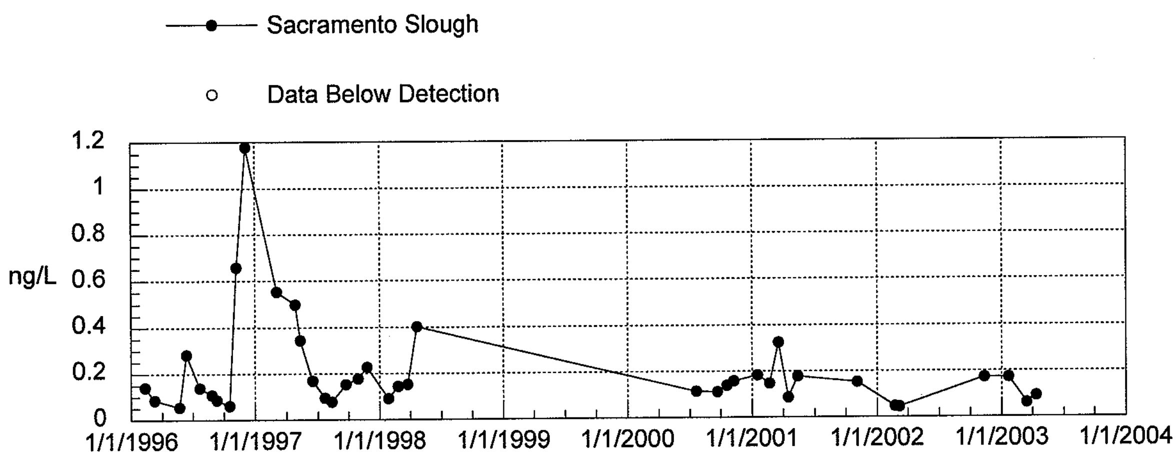
UNFILTERED METHYLMERCURY IN WATER

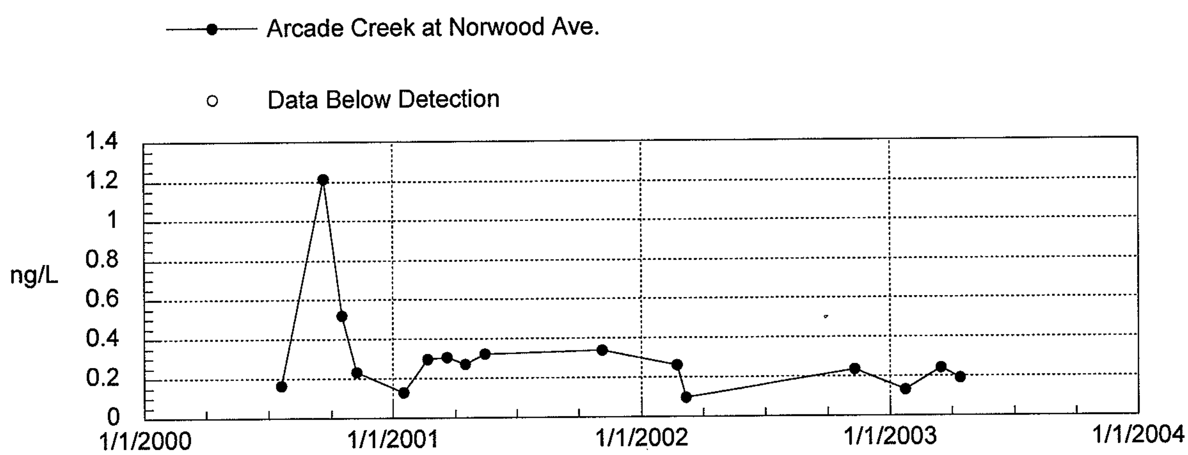




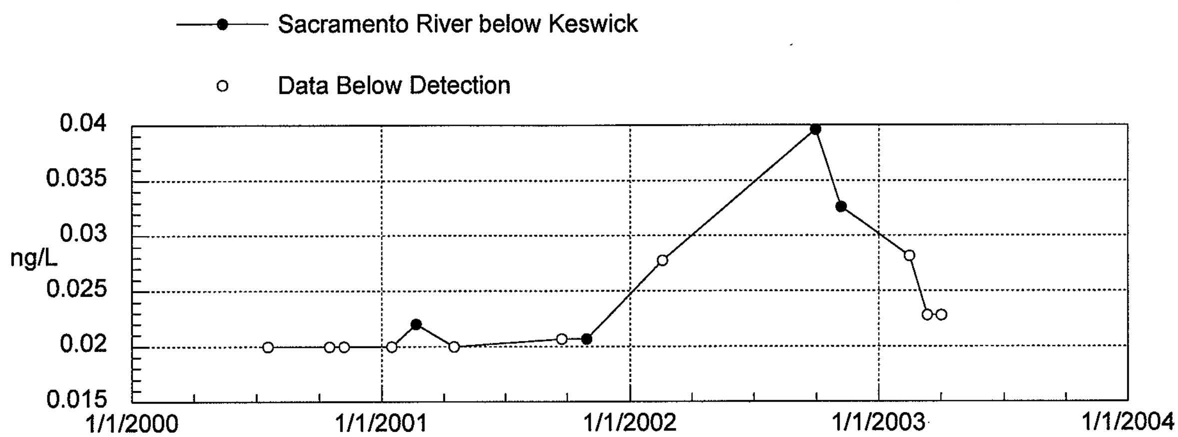


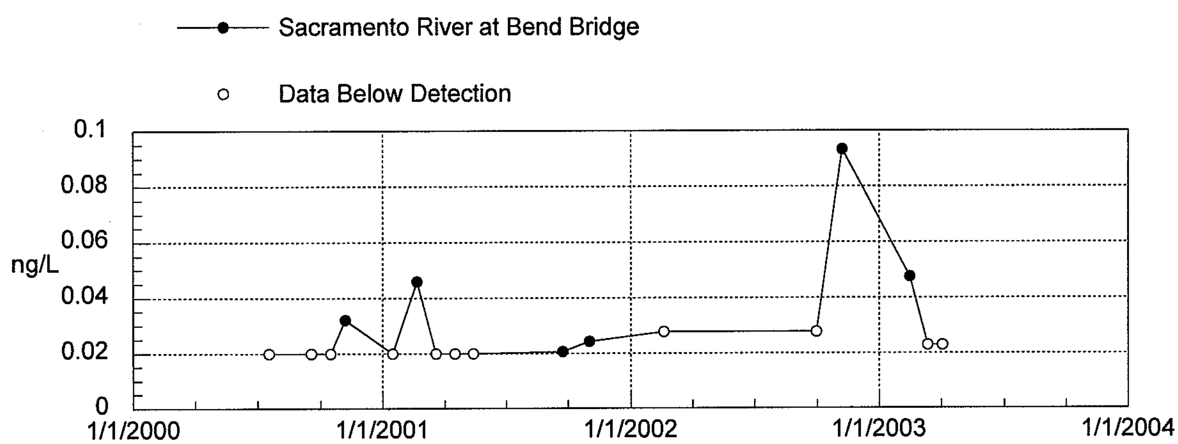
UNFILTERED METHYLMERCURY IN WATER

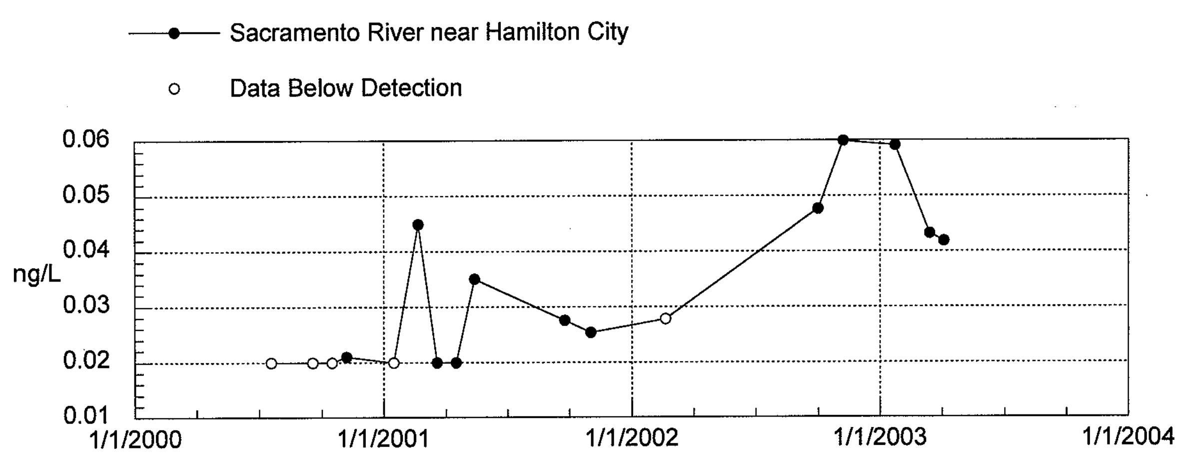




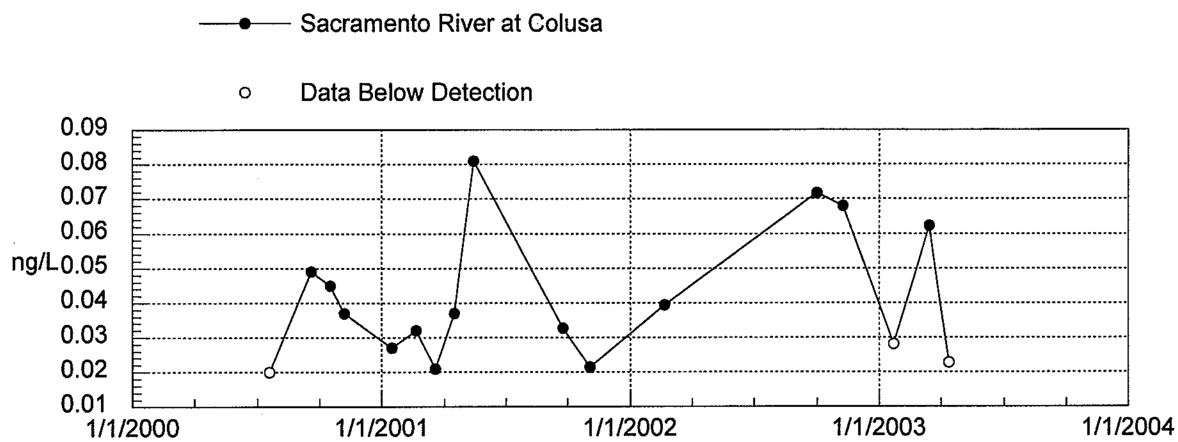
FILTERED METHYLMERCURY IN WATER

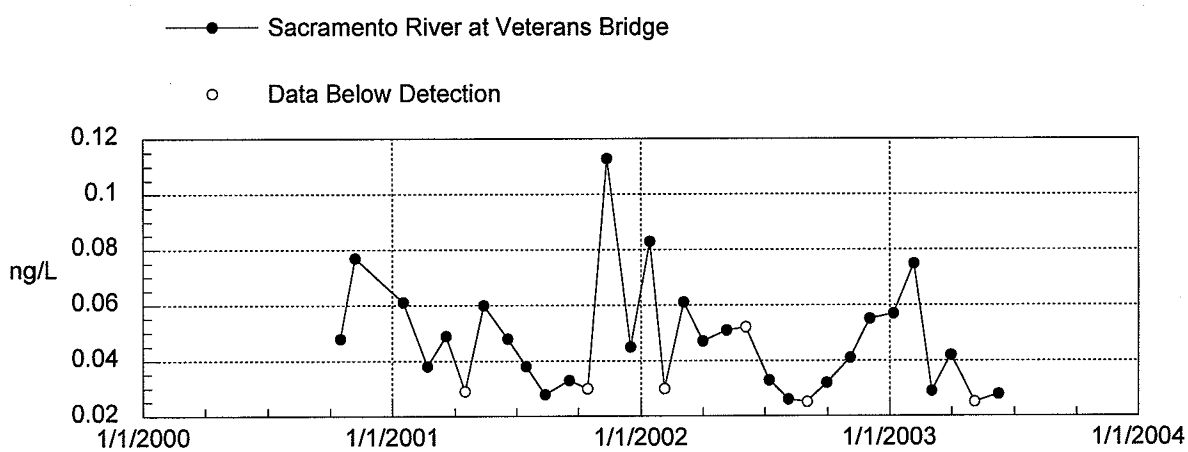


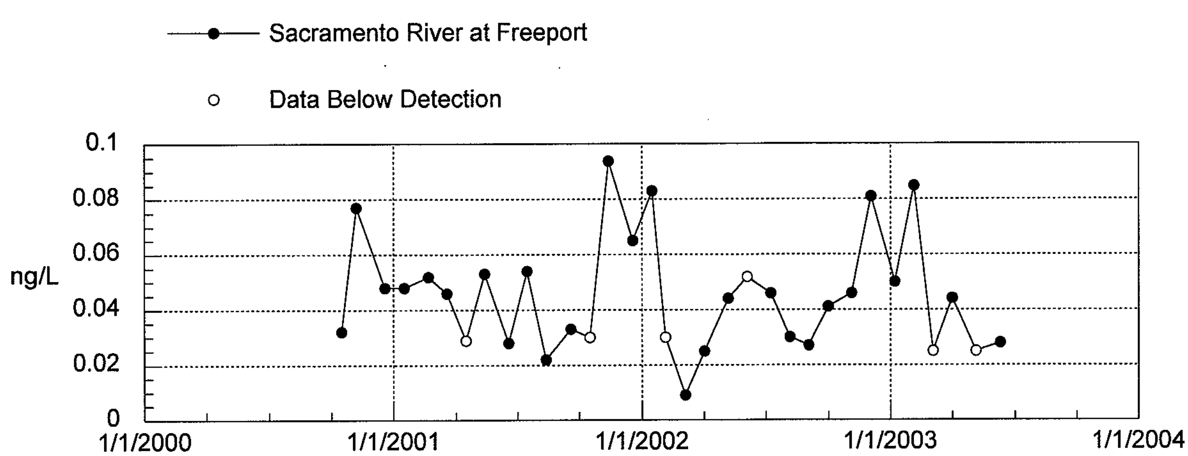




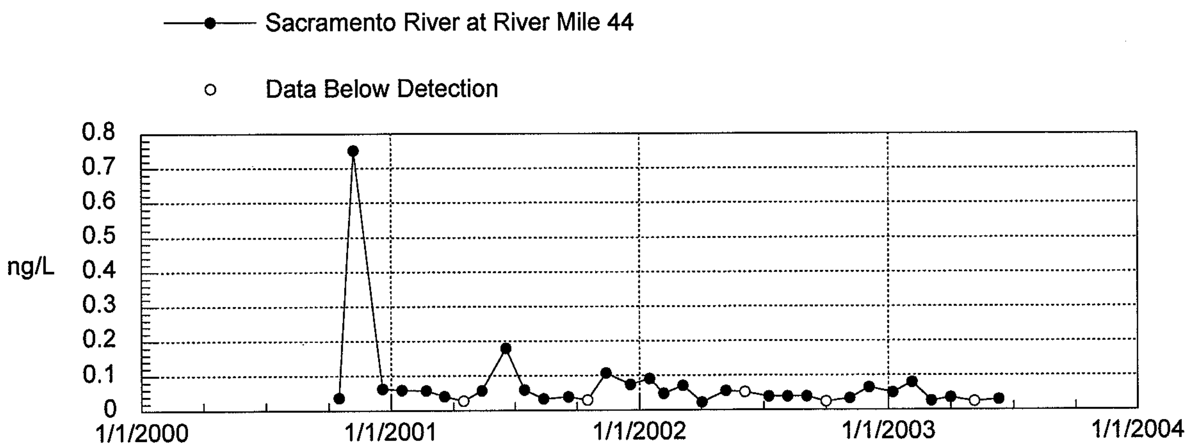
FILTERED METHYLMERCURY IN WATER

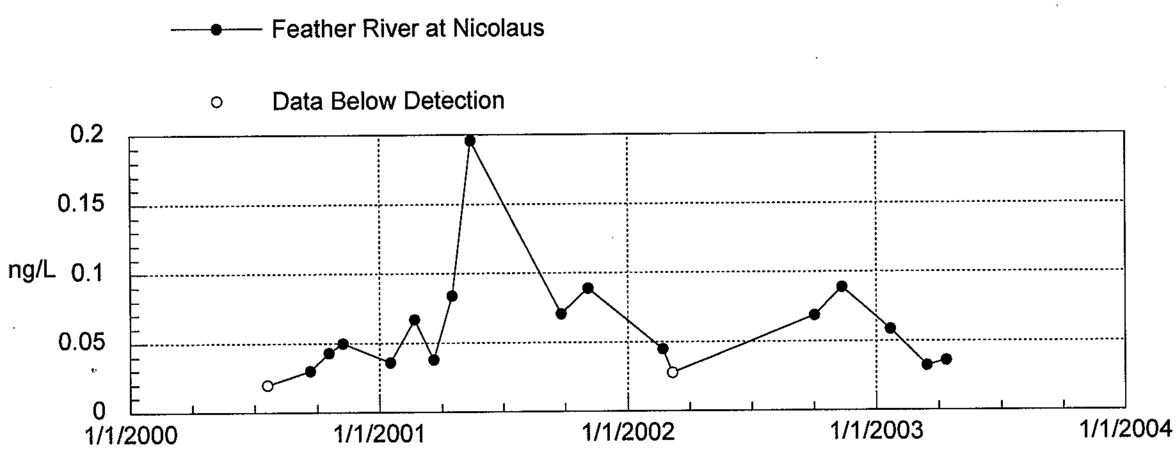


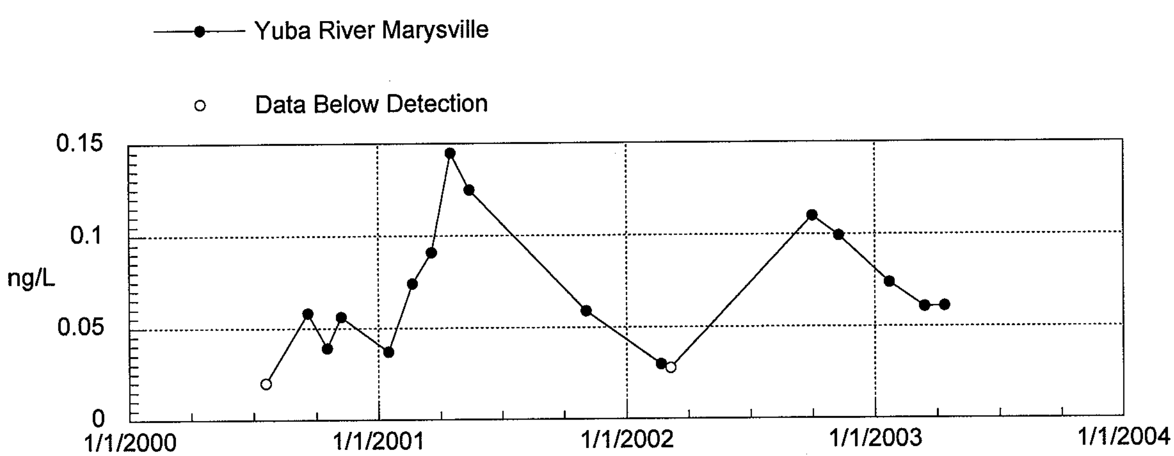




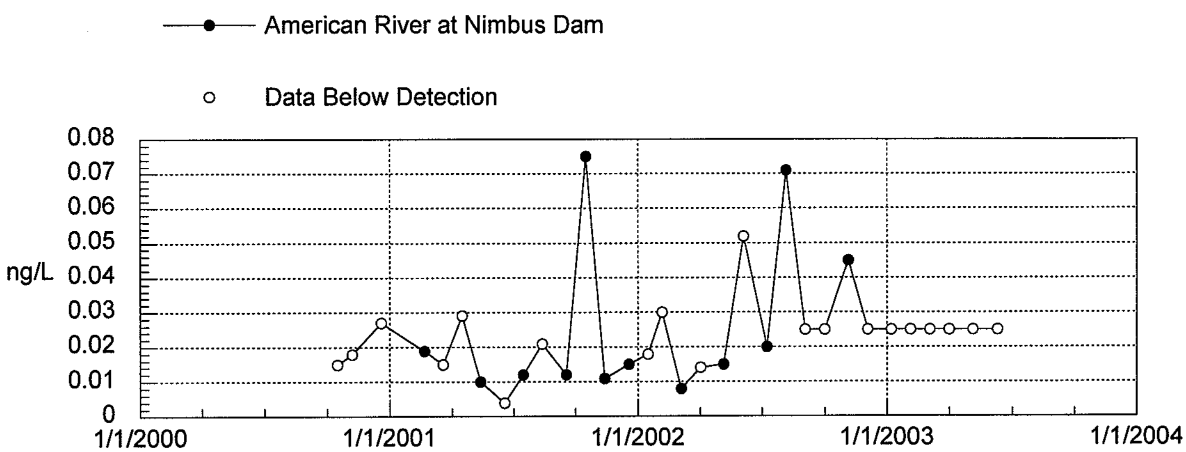
FILTERED METHYLMERCURY IN WATER

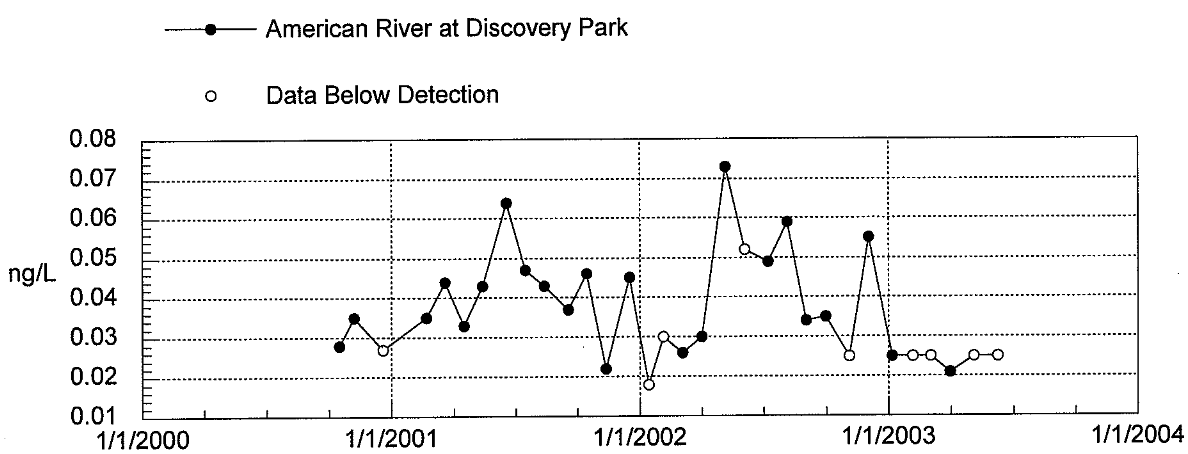


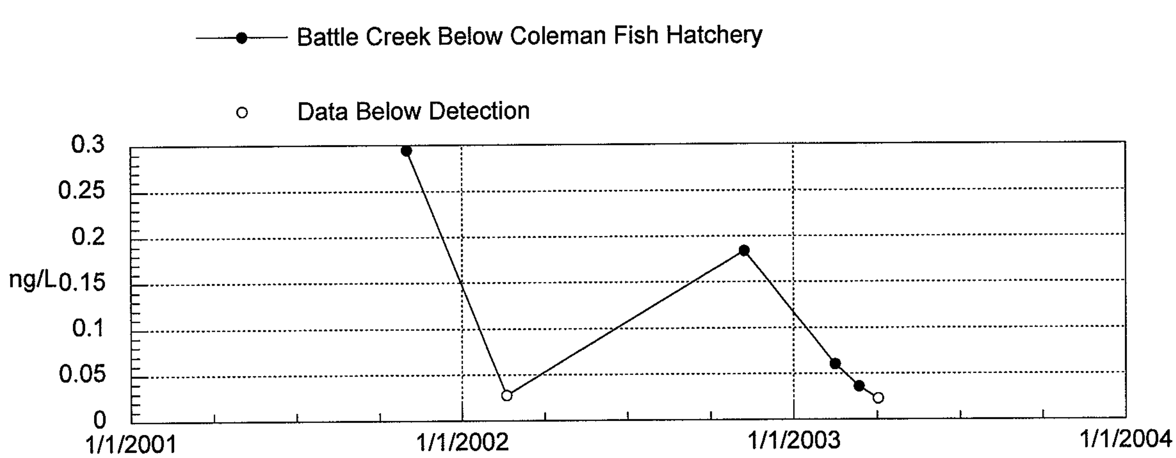




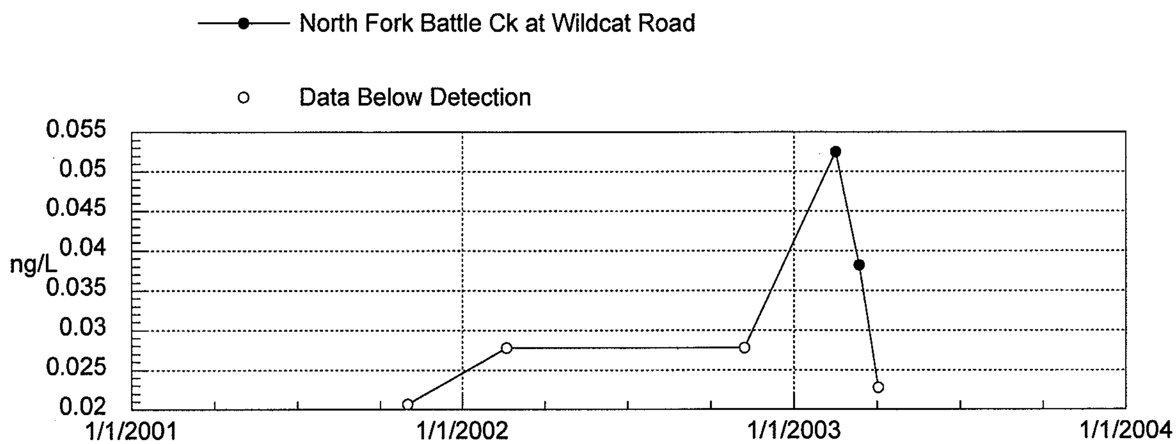
FILTERED METHYLMERCURY IN WATER

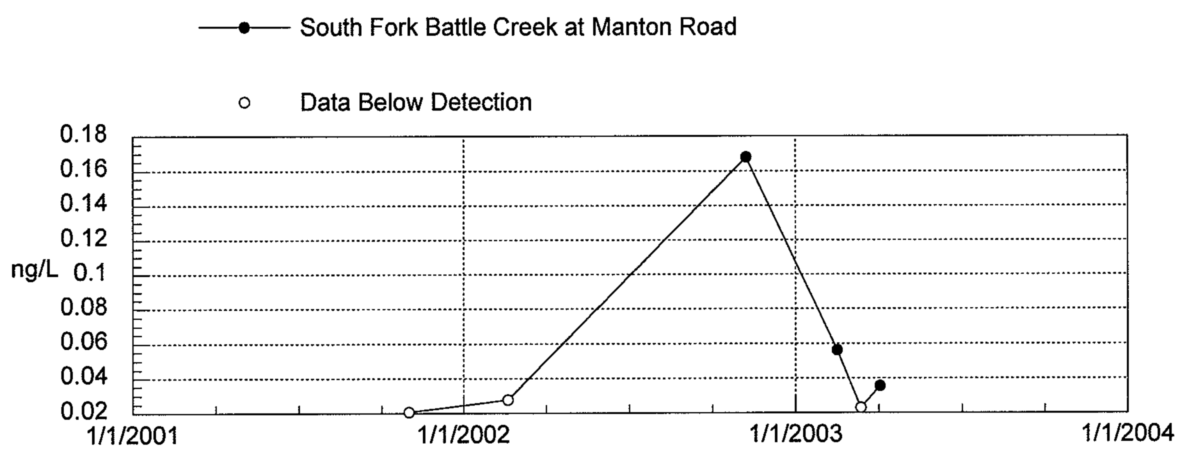


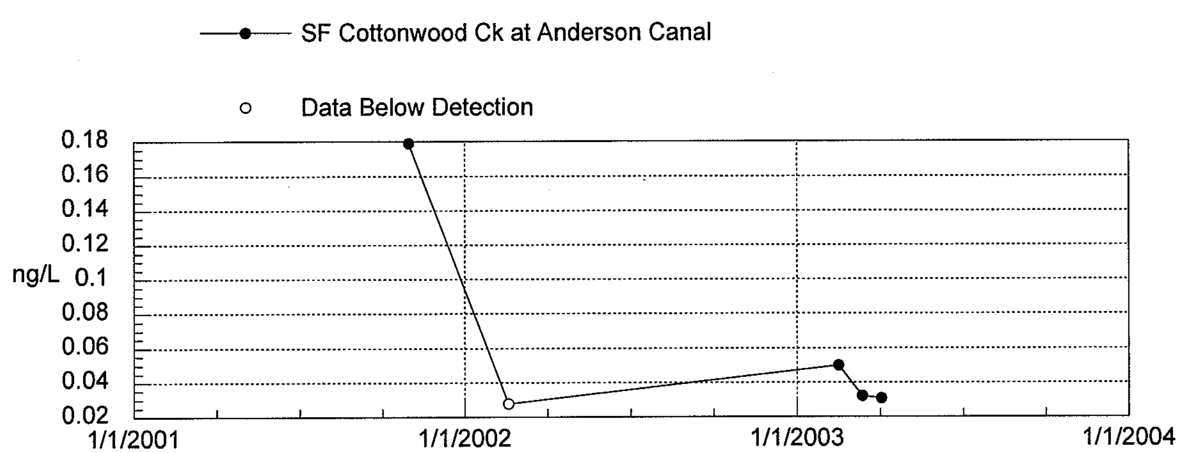




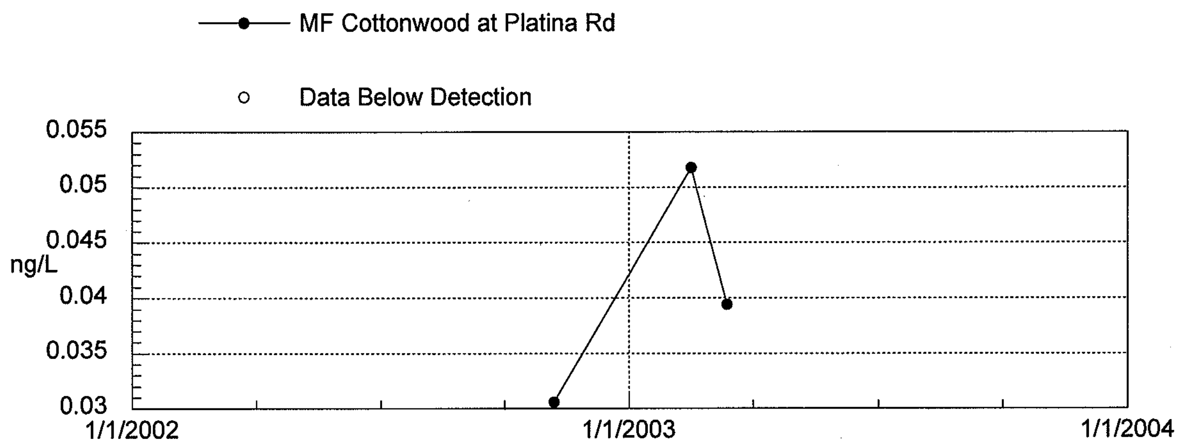
FILTERED METHYLMERCURY IN WATER

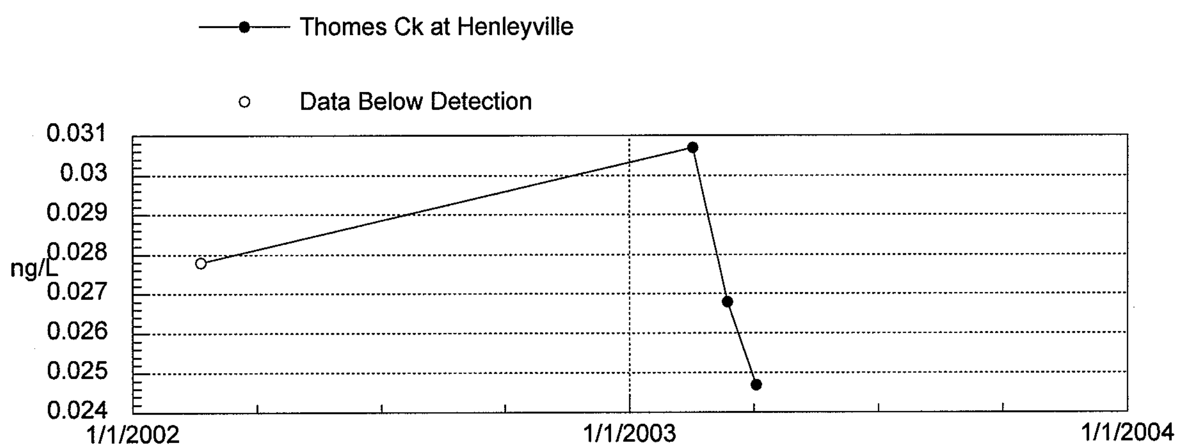


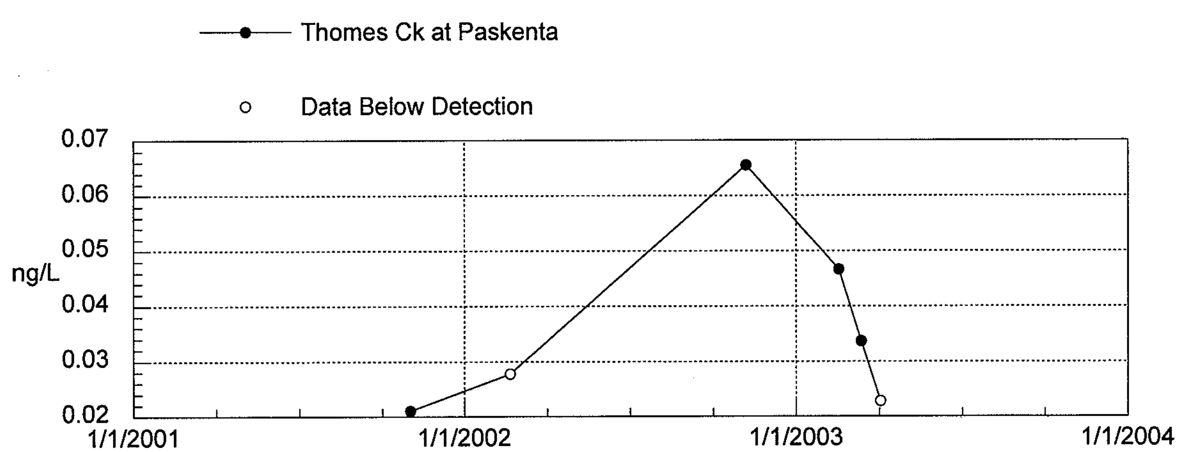




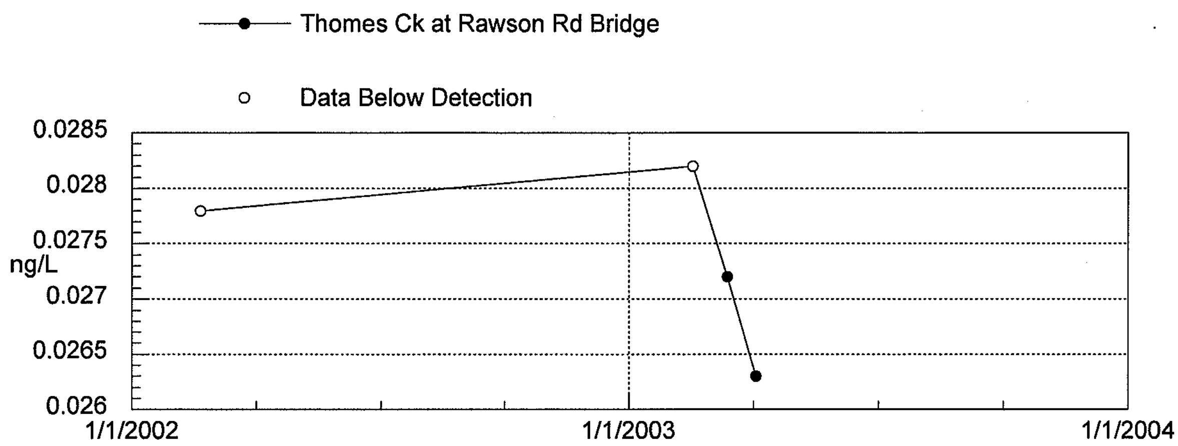
FILTERED METHYLMERCURY IN WATER

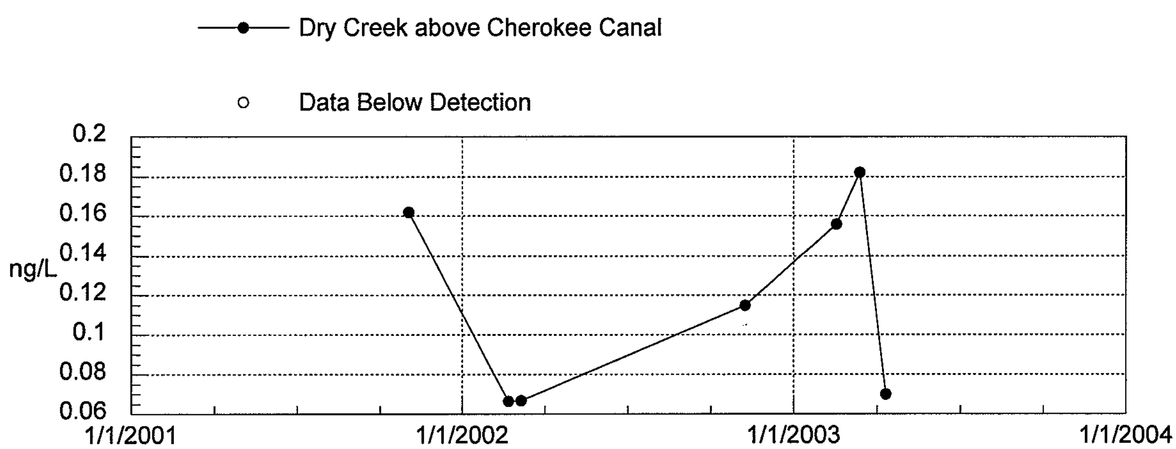


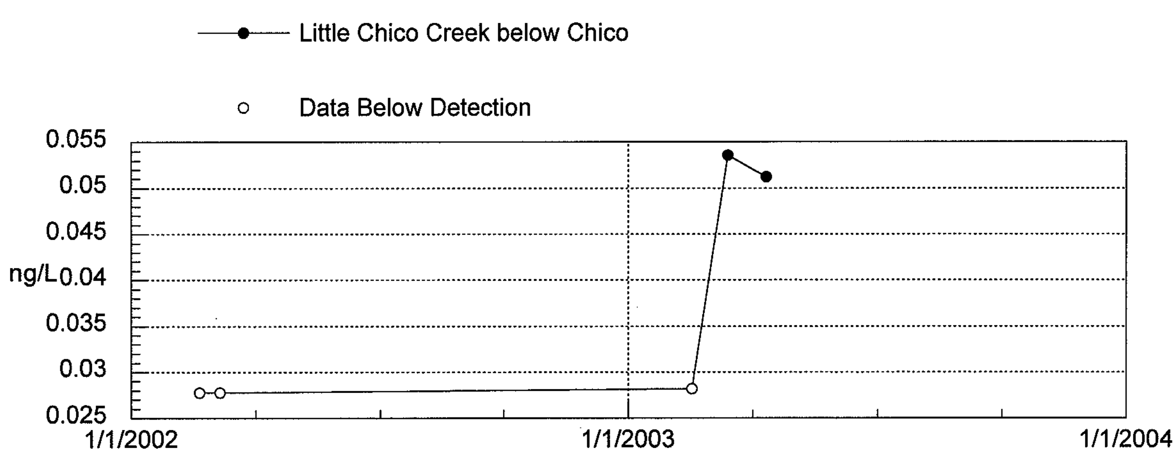




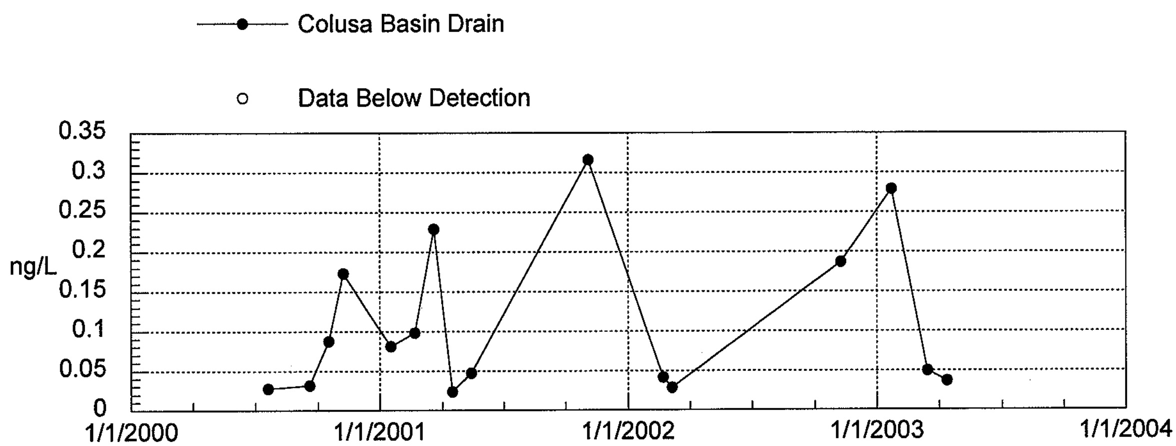
FILTERED METHYLMERCURY IN WATER

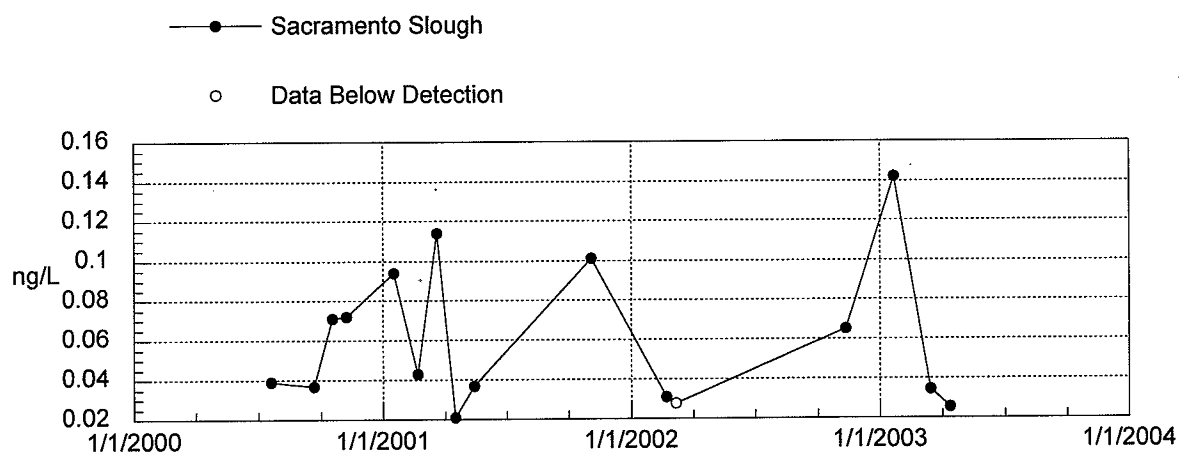


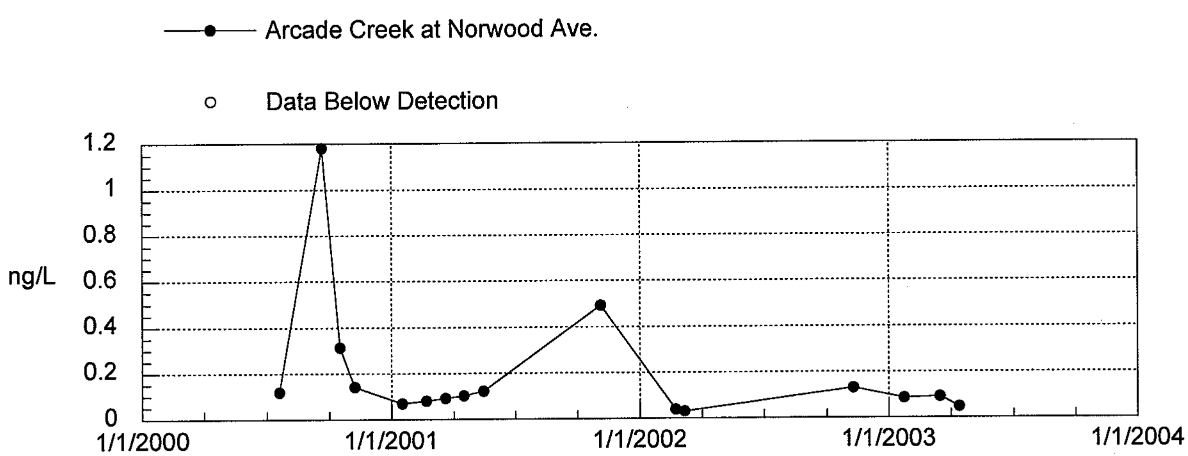


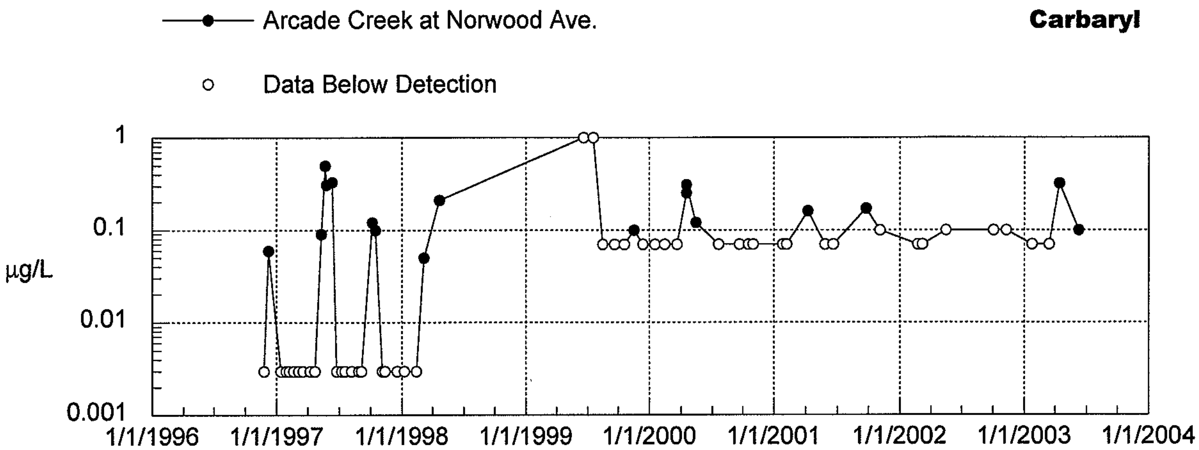


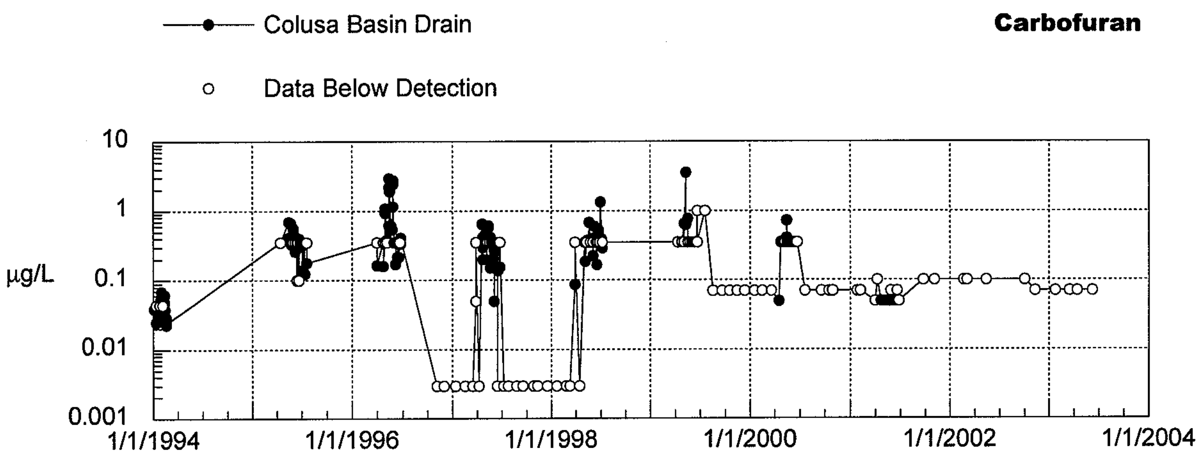
FILTERED METHYLMERCURY IN WATER

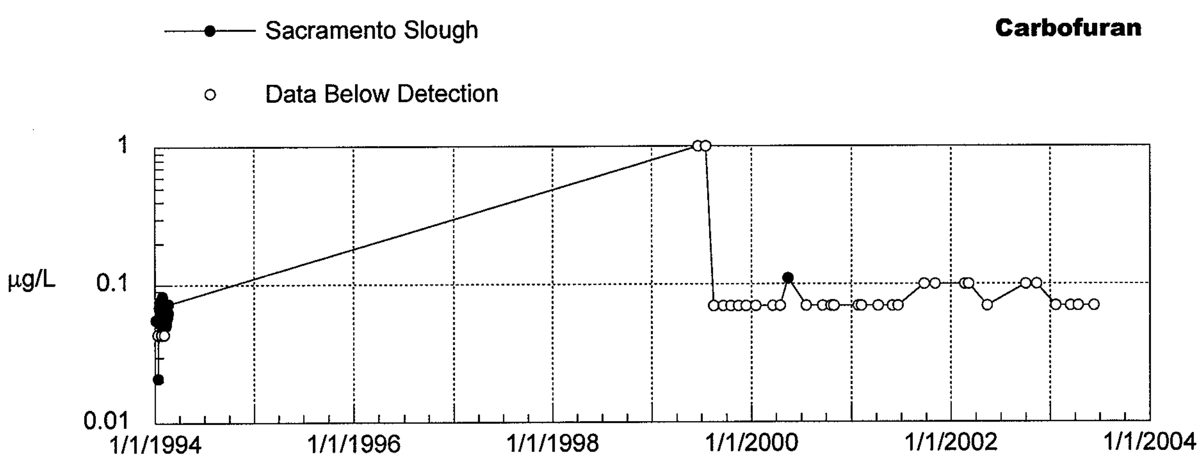


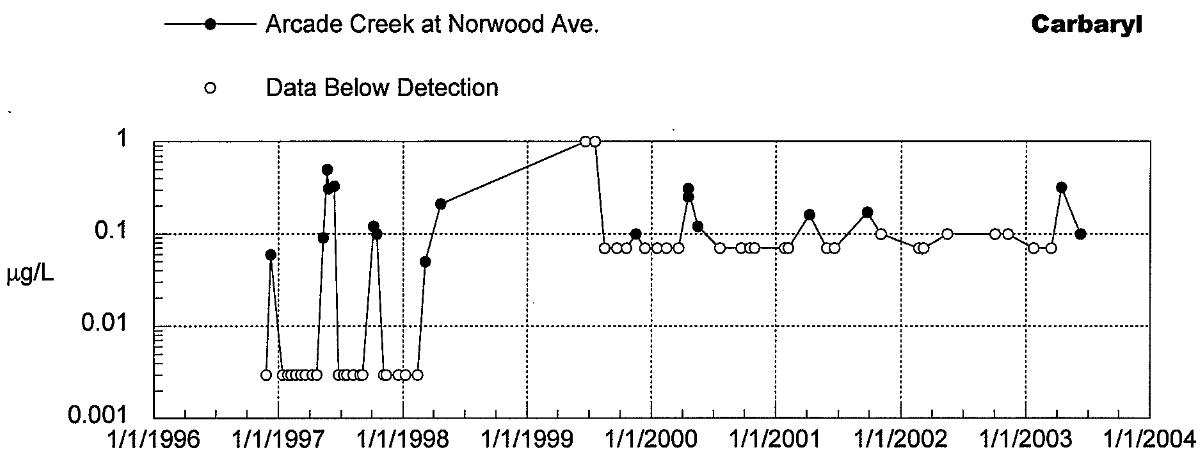


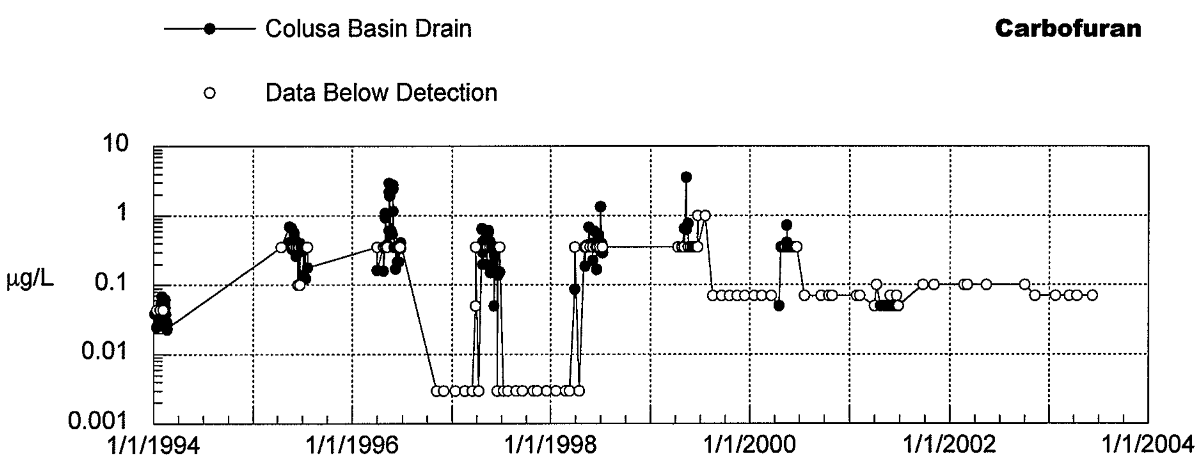


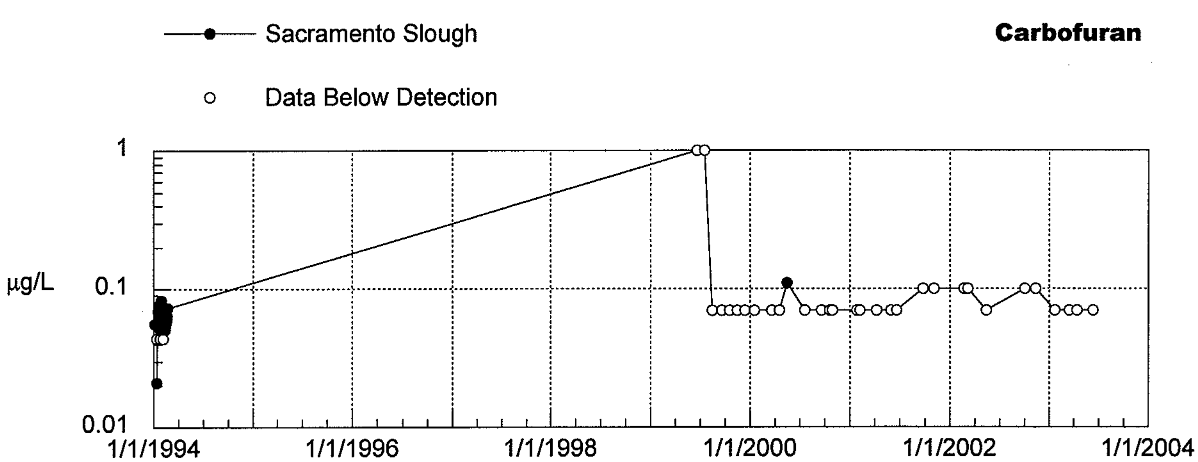

Arcade Creek at Norwood Ave.
Carbaryl
Data Below Detection
µg/L
1
0.1
0.01
0.001
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

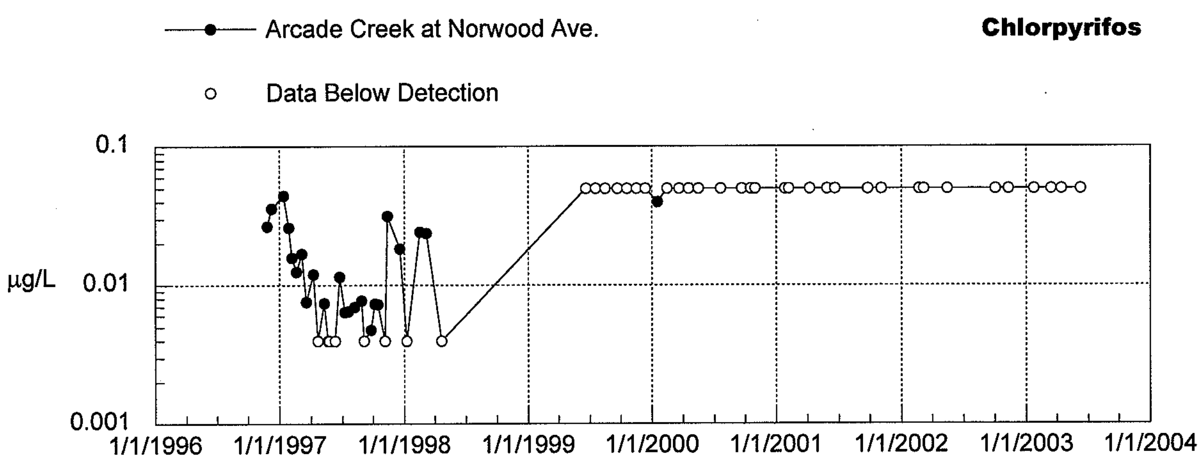

Colusa Basin Drain
Carbofuran
Data Below Detection
µg/L
10
1
0.1
0.01
0.001
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

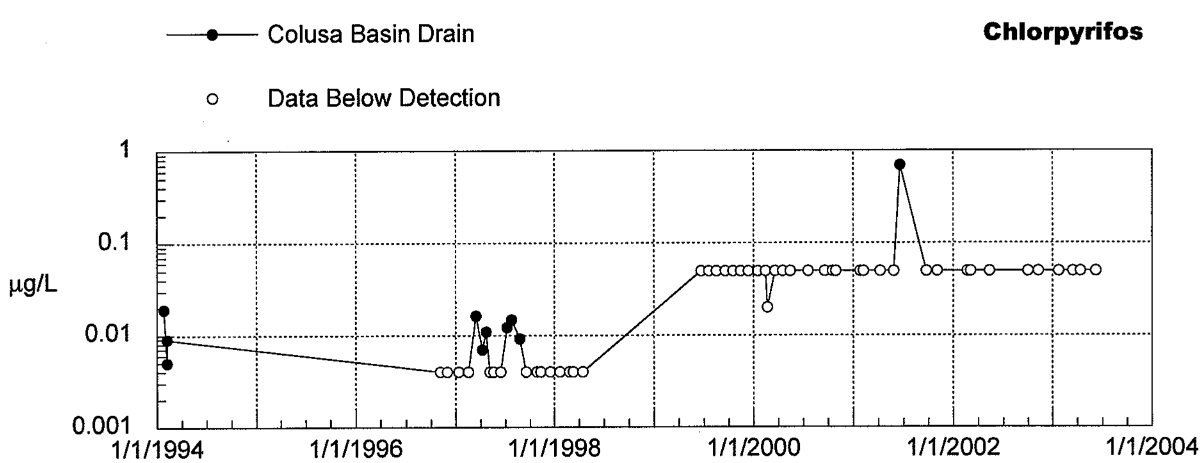

Sacramento Slough
Carbofuran
Data Below Detection
µg/L
1
0.1
0.01
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

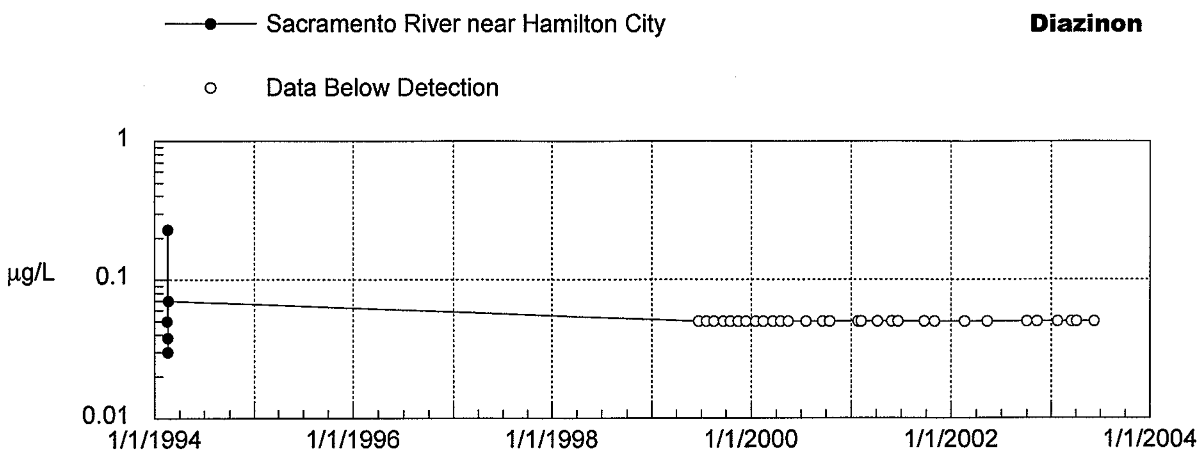

Arcade Creek at Norwood Ave.
Data Below Detection
Carbaryl
µg/L
1
0.1
0.01
0.001
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

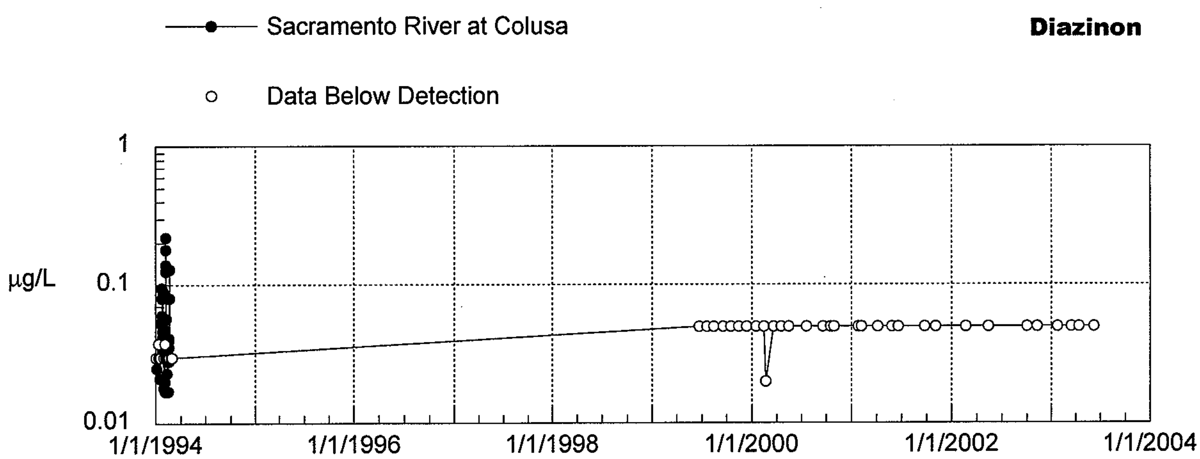

Colusa Basin Drain
Data Below Detection
Carbofuran
µg/L
10
1
0.1
0.01
0.001
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

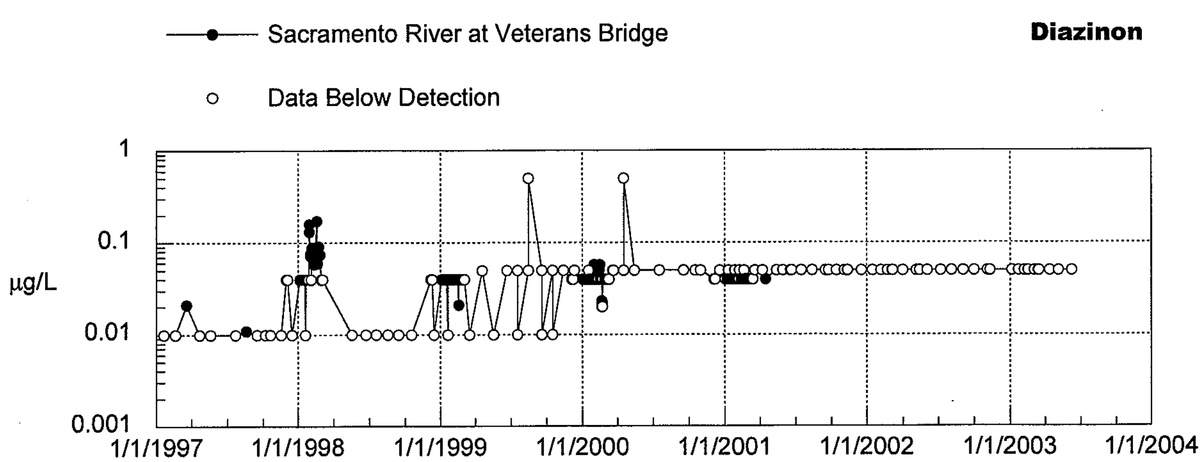

Sacramento Slough
Data Below Detection
Carbofuran
µg/L
1
0.1
0.01
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

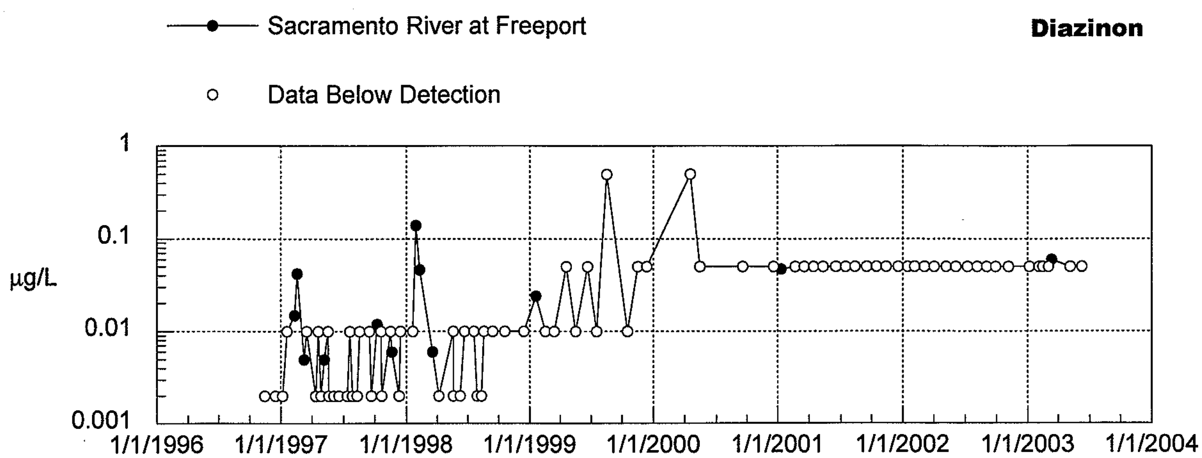

Arcade Creek at Norwood Ave.
Data Below Detection
Chlorpyrifos
µg/L
0.1
0.01
0.001
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

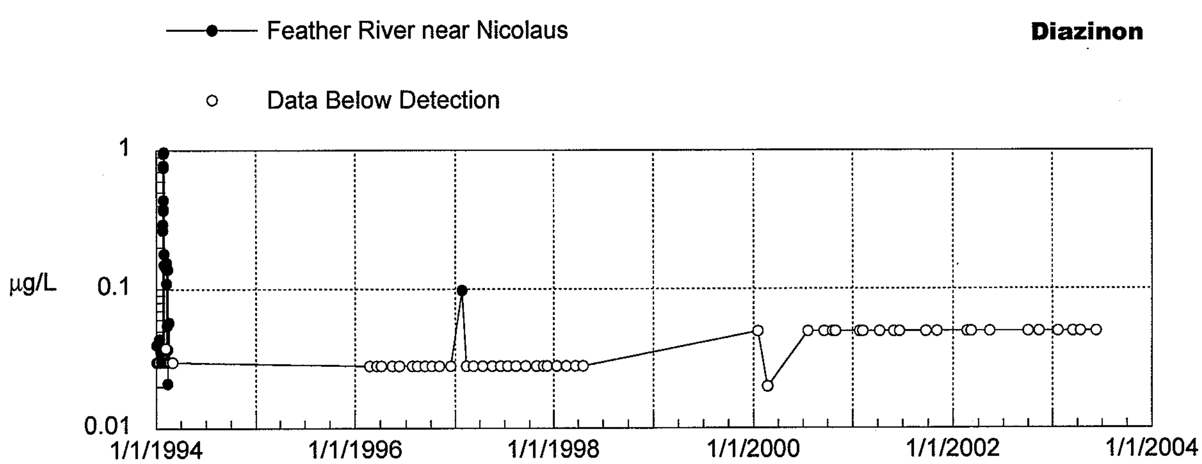

Colusa Basin Drain
Data Below Detection
Chlorpyrifos
µg/L
1
0.1
0.01
0.001
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

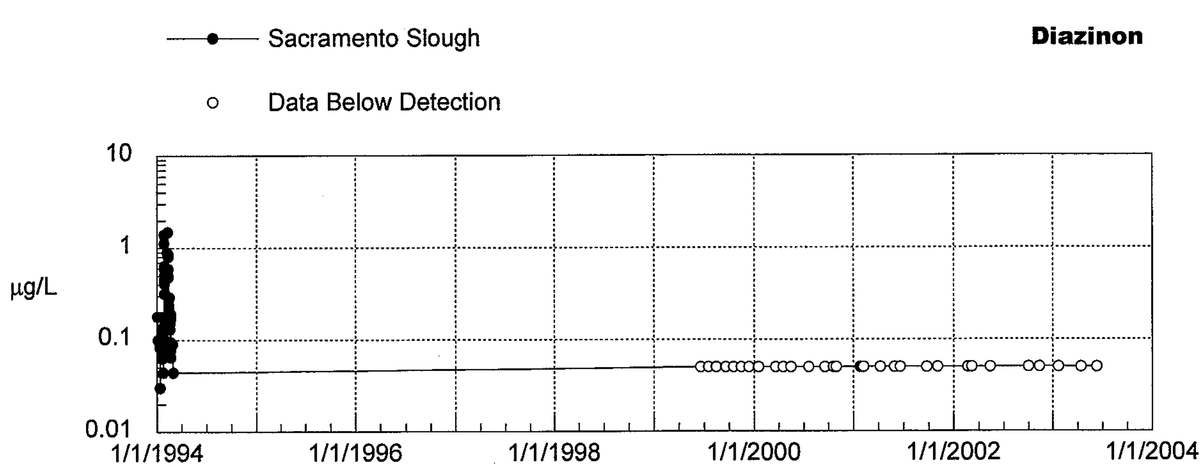

Sacramento River near Hamilton City
Diazinon
Data Below Detection
µg/L
1
0.1
0.01
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

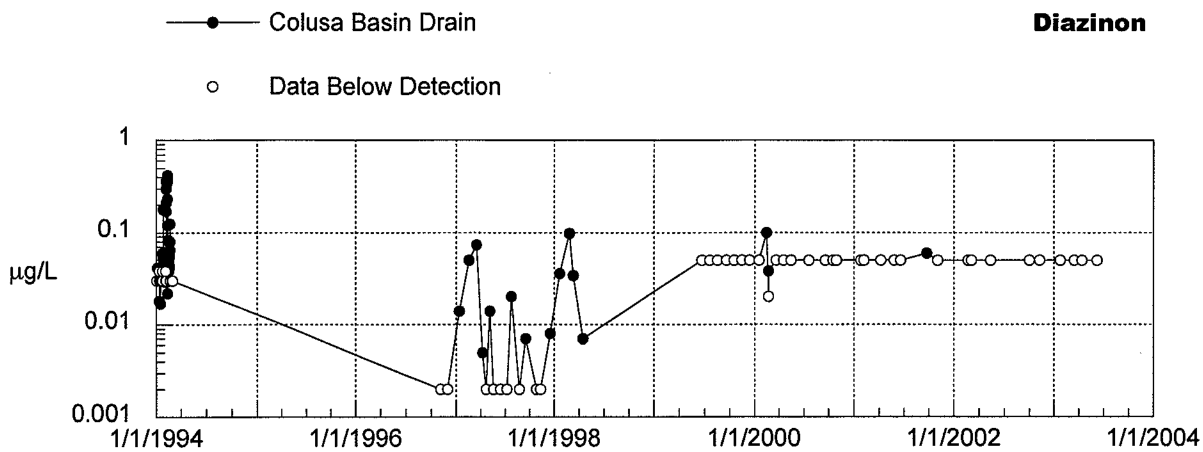

Sacramento River at Colusa
Diazinon
Data Below Detection
µg/L
1
0.1
0.01
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004


Sacramento River at Veterans Bridge
Diazinon
Data Below Detection
µg/L
1
0.1
0.01
0.001
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

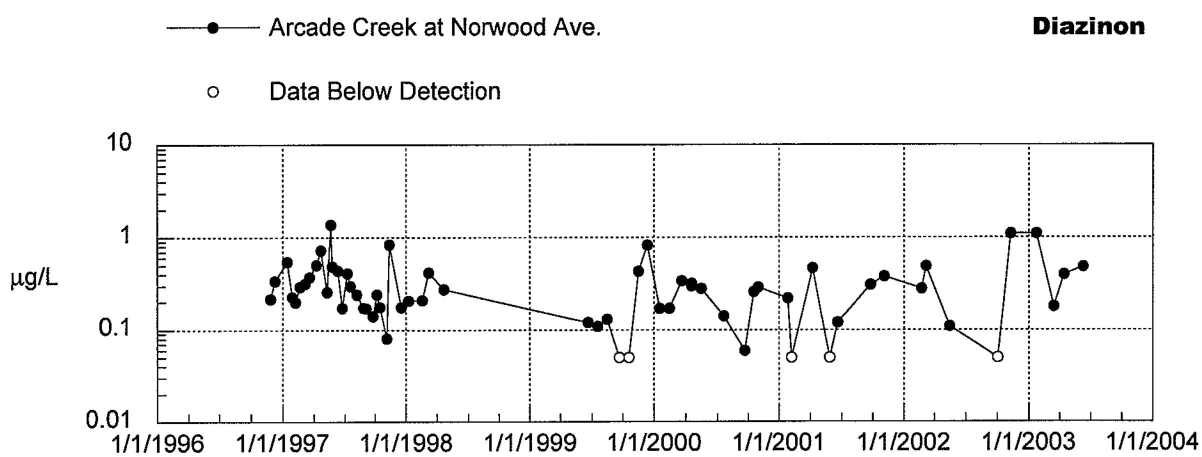

Sacramento River at Freeport
Diazinon
Data Below Detection
1
0.1
µg/L
0.01
0.001
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Feather River near Nicolaus
Diazinon
Data Below Detection
1
µg/L
0.1
0.01
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

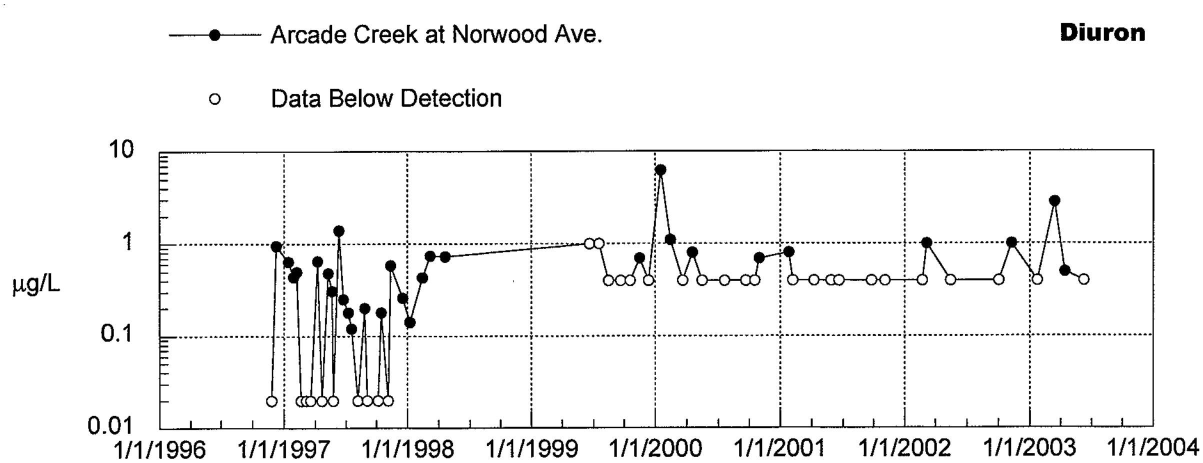

Sacramento Slough
Diazinon
Data Below Detection
10
1
µg/L
0.1
0.01
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004



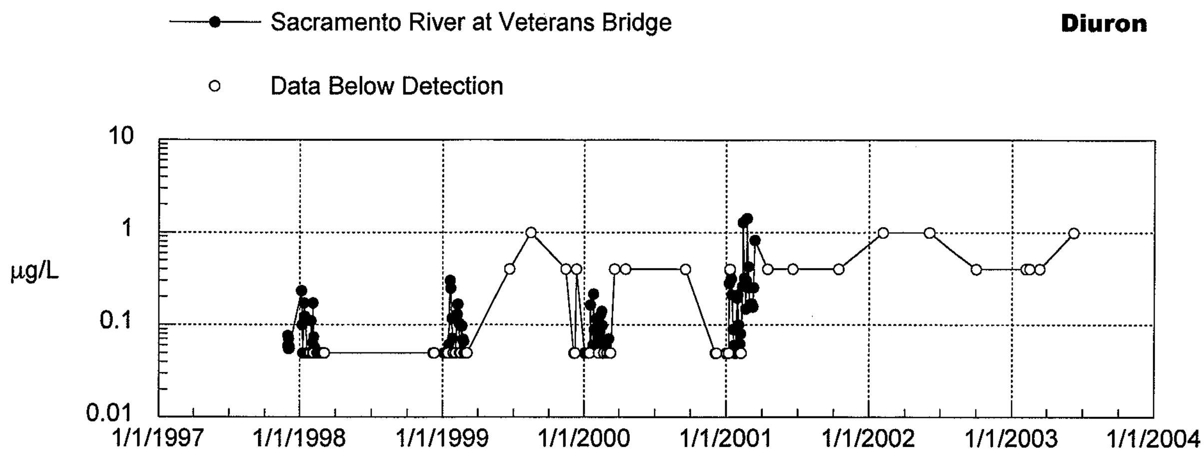
Colusa Basin Drain
Data Below Detection
Diazinon
µg/L
1
0.1
0.01
0.001
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

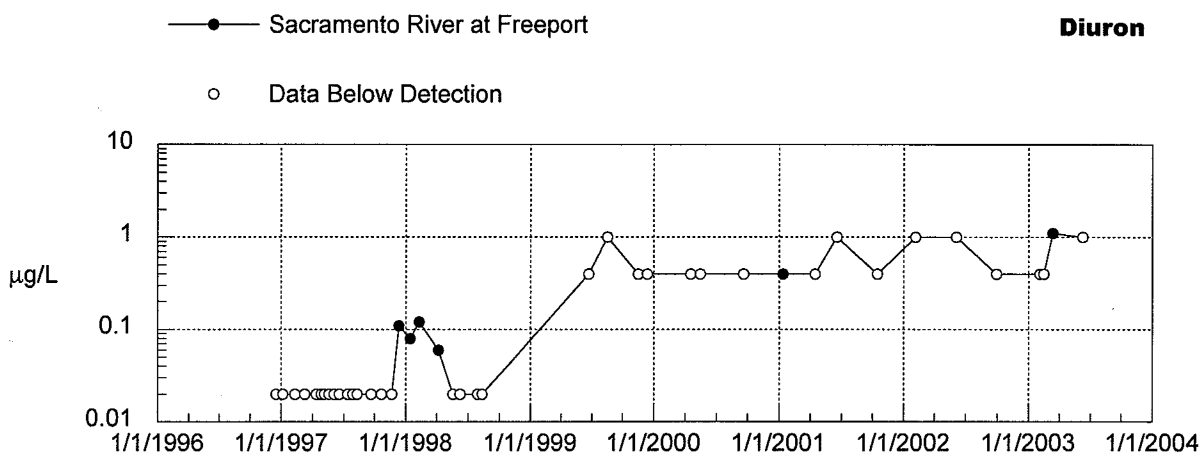


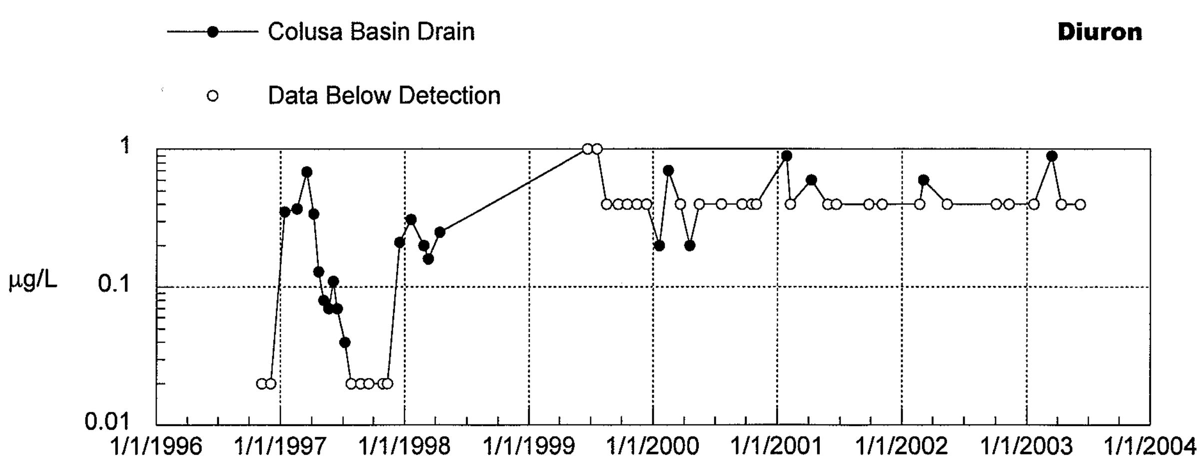
Arcade Creek at Norwood Ave.
Data Below Detection
Diazinon
µg/L
10
1
0.1
0.01
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

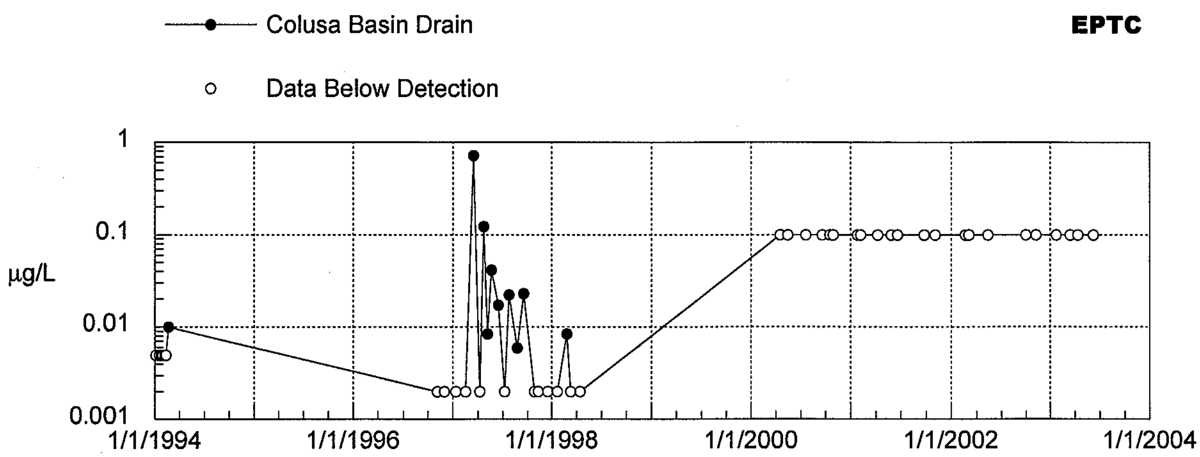


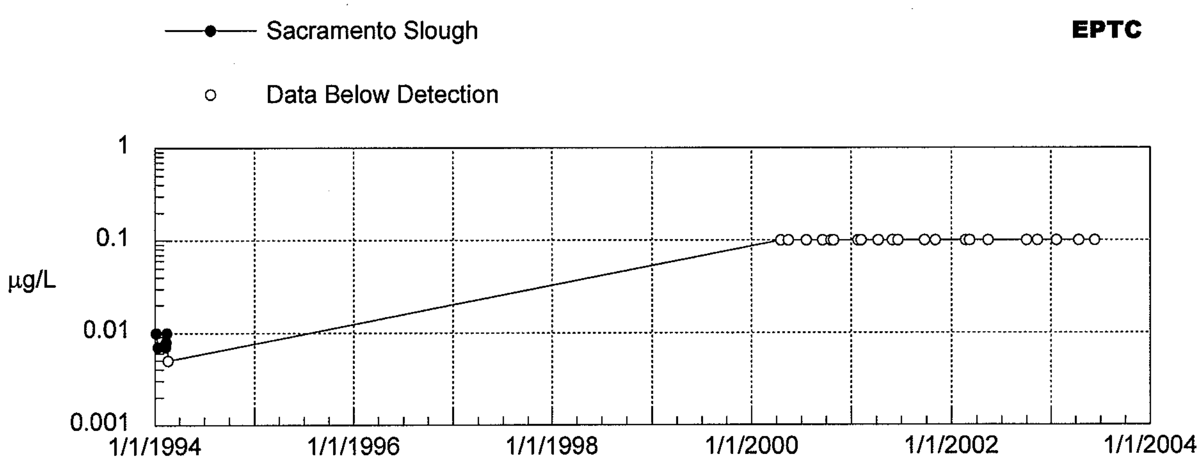
Arcade Creek at Norwood Ave.
Data Below Detection
Diuron
µg/L
10
1
0.1
0.01
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

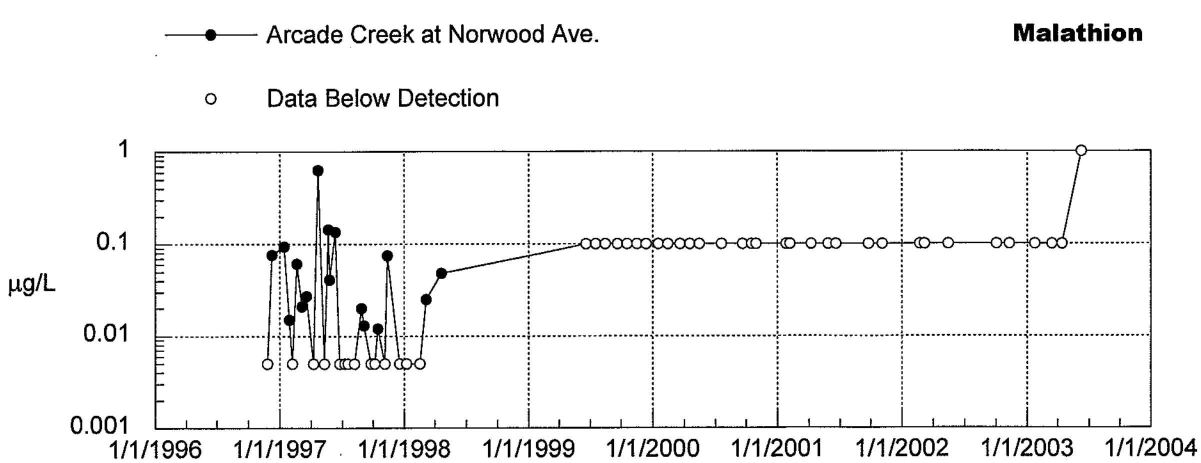

Sacramento River at Veterans Bridge
Diuron
Data Below Detection
10
1
0.1
0.01
µg/L
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

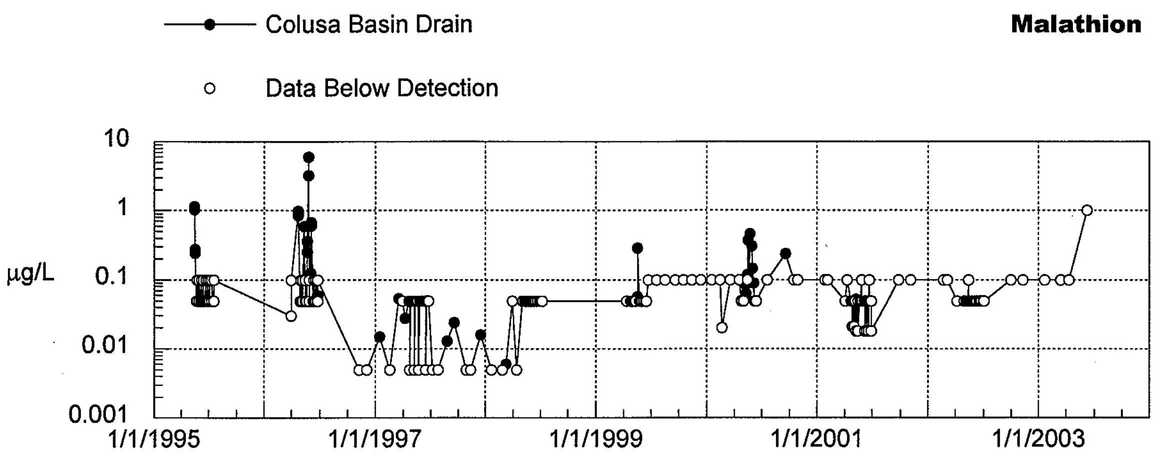

Sacramento River at Freeport
Diuron
Data Below Detection
10
1
0.1
0.01
µg/L
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

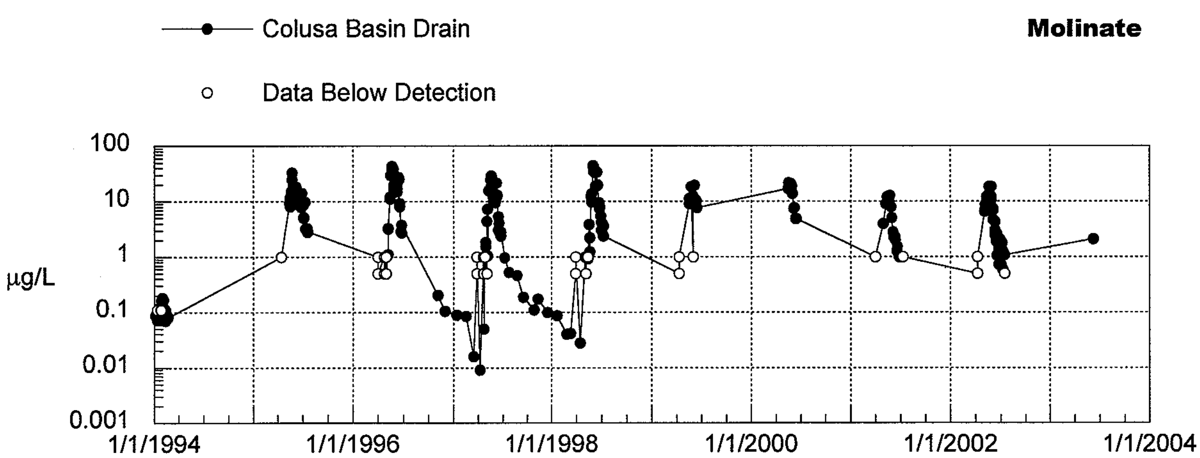

Colusa Basin Drain
Diuron
Data Below Detection
1
0.1
0.01
µg/L
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

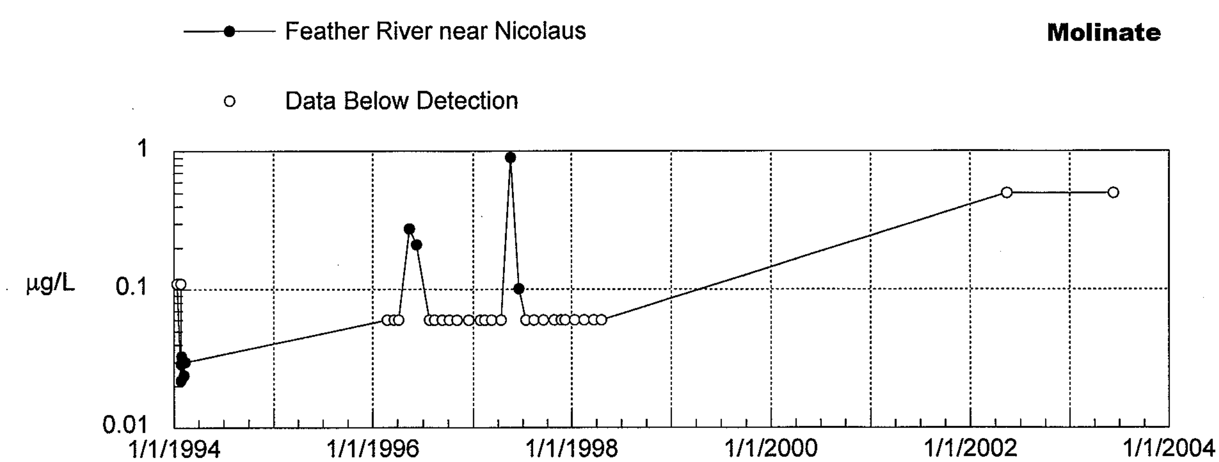

Colusa Basin Drain
Data Below Detection
EPTC
1
0.1
0.01
0.001
µg/L
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

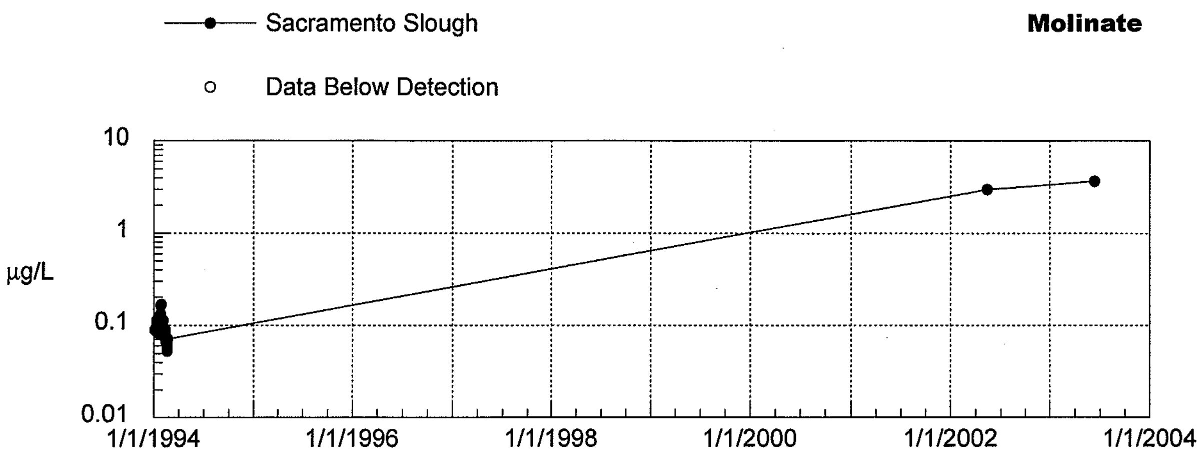

Sacramento Slough
Data Below Detection
EPTC
1
0.1
0.01
0.001
µg/L
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

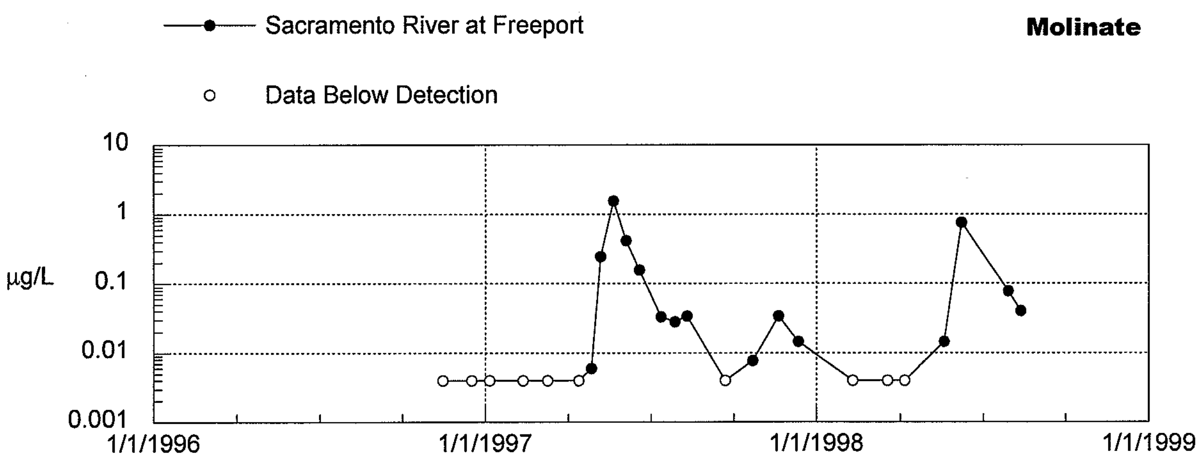

Arcade Creek at Norwood Ave.
Data Below Detection
Malathion
1
0.1
0.01
0.001
µg/L
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

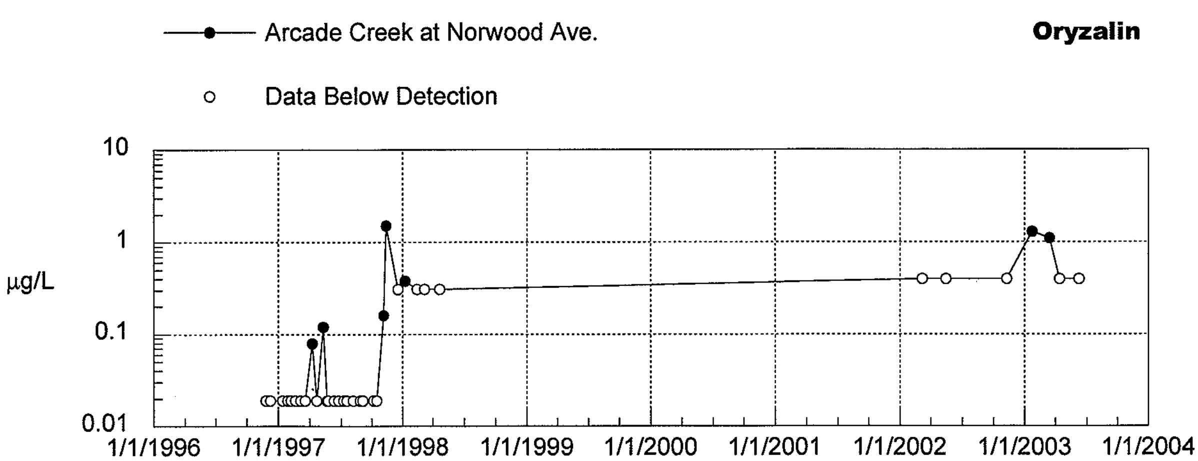

Colusa Basin Drain
Data Below Detection
Malathion
µg/L
10
1
0.1
0.01
0.001
1/1/1995
1/1/1997
1/1/1999
1/1/2001
1/1/2003

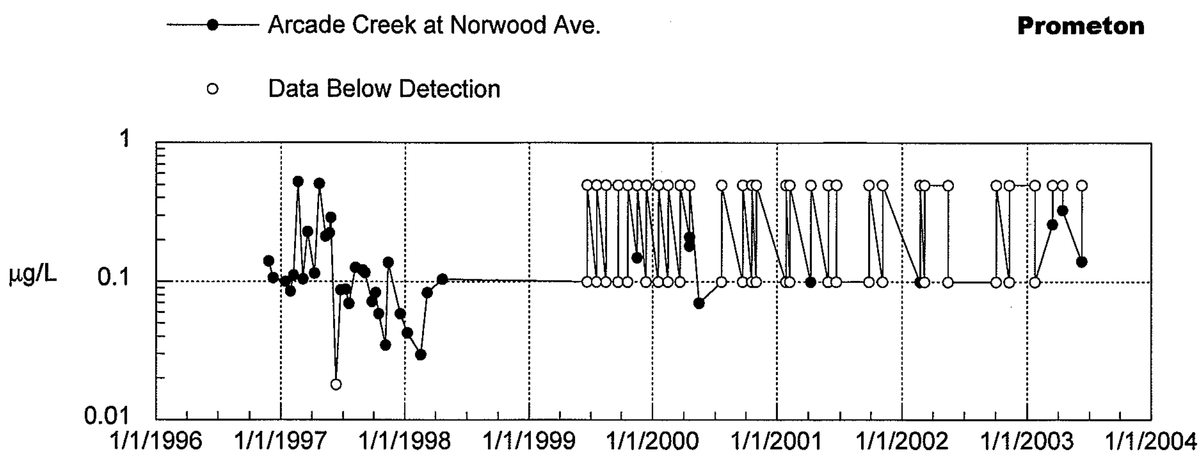

Colusa Basin Drain
Data Below Detection
Molinate
µg/L
100
10
1
0.1
0.01
0.001
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

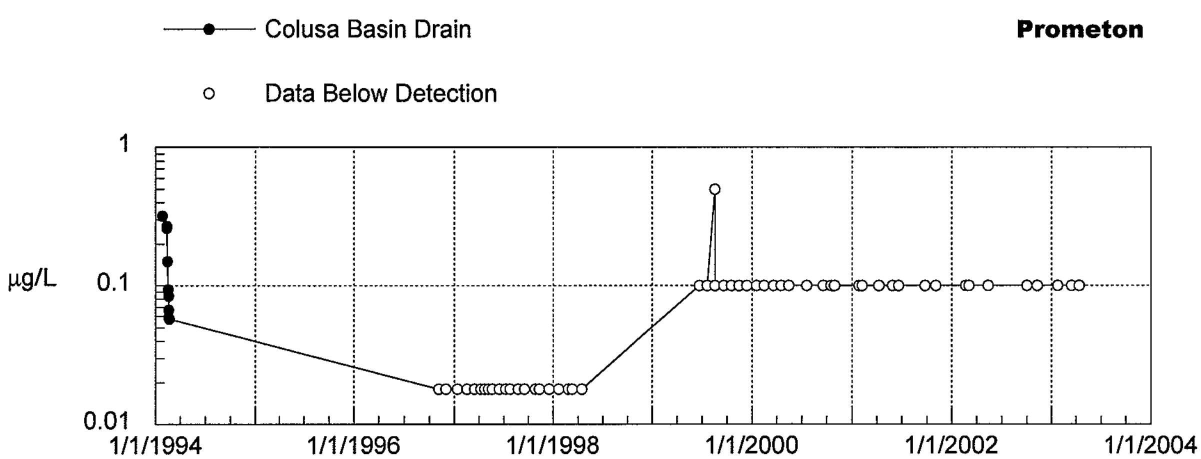

Feather River near Nicolaus
Data Below Detection
Molinate
µg/L
1
0.1
0.01
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

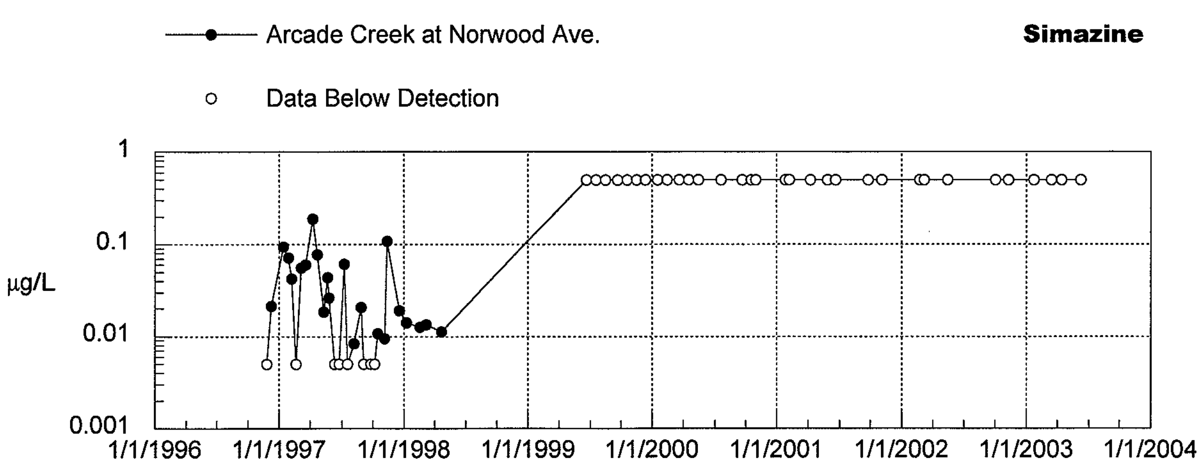

Sacramento Slough
Data Below Detection
Molinate
10
1
0.1
0.01
µg/L
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

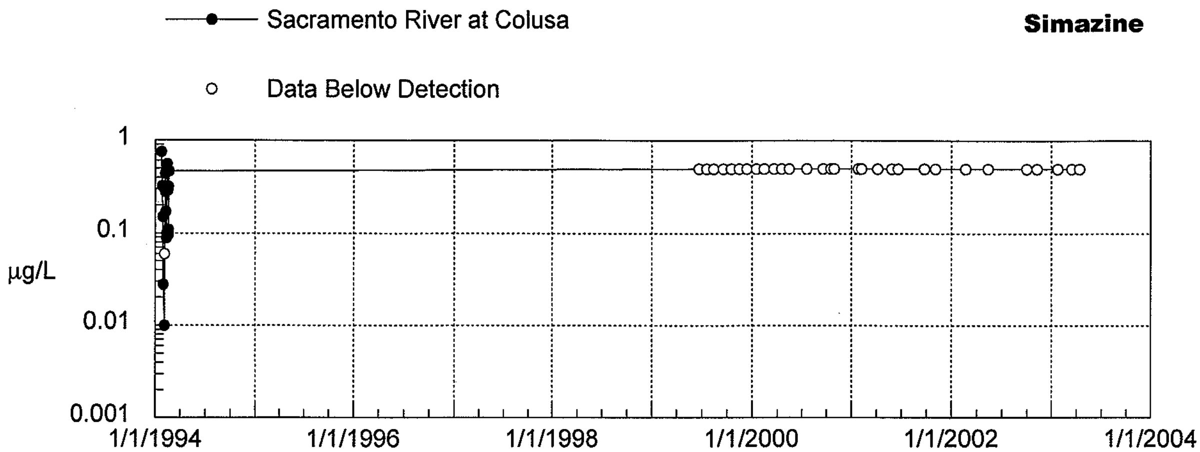

Sacramento River at Freeport
Data Below Detection
Molinate
10
1
0.1
0.01
0.001
µg/L
1/1/1996
1/1/1997
1/1/1998
1/1/1999

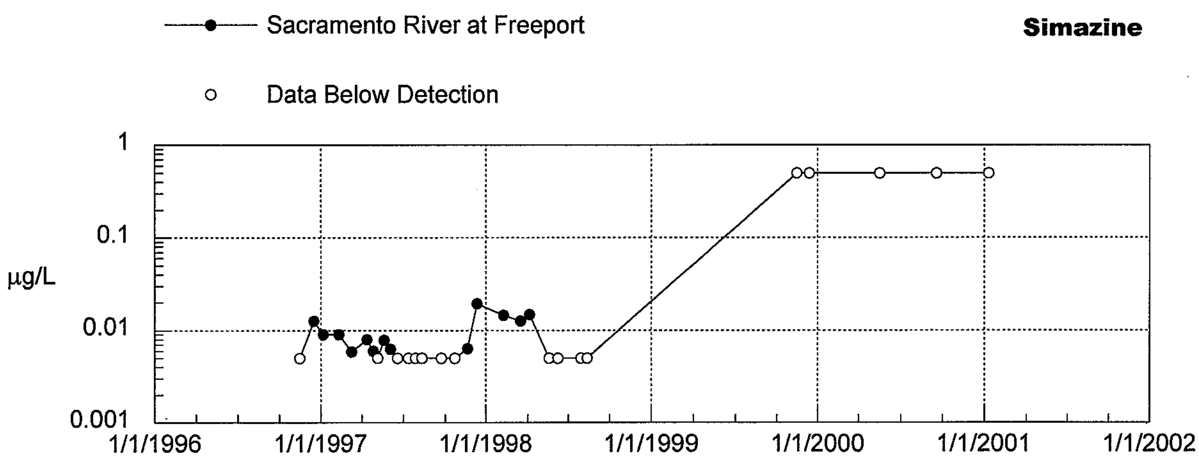

Arcade Creek at Norwood Ave.
Data Below Detection
Oryzalin
10
1
0.1
0.01
µg/L
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

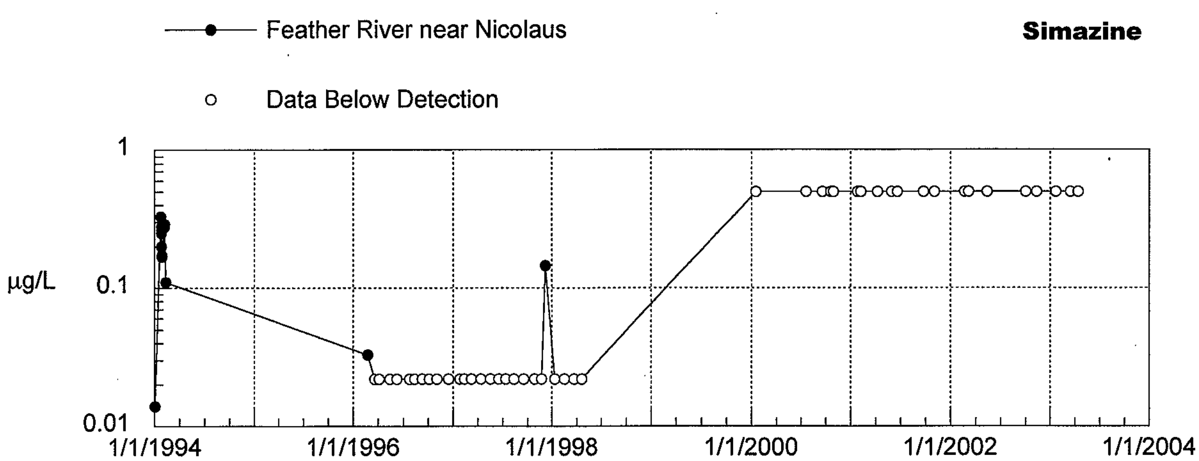

Arcade Creek at Norwood Ave.
Data Below Detection
Prometon
µg/L
1
0.1
0.01
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

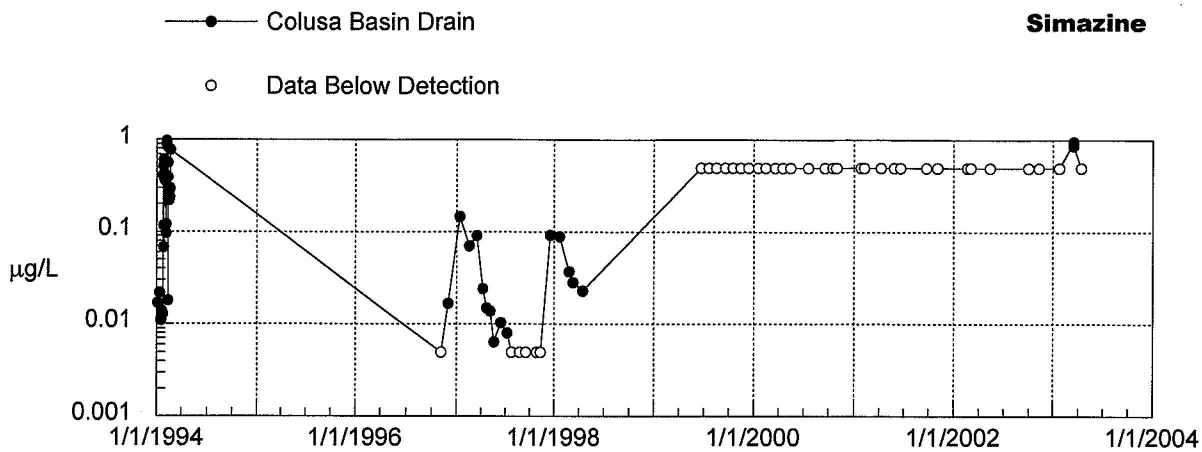

Colusa Basin Drain
Data Below Detection
Prometon
µg/L
1
0.1
0.01
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

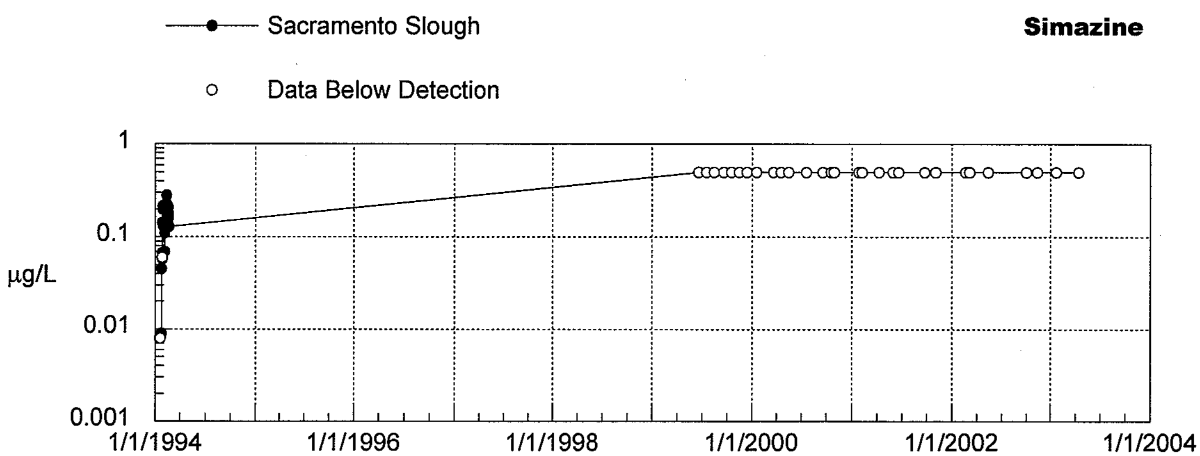

Arcade Creek at Norwood Ave.
Data Below Detection
Simazine
µg/L
1
0.1
0.01
0.001
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

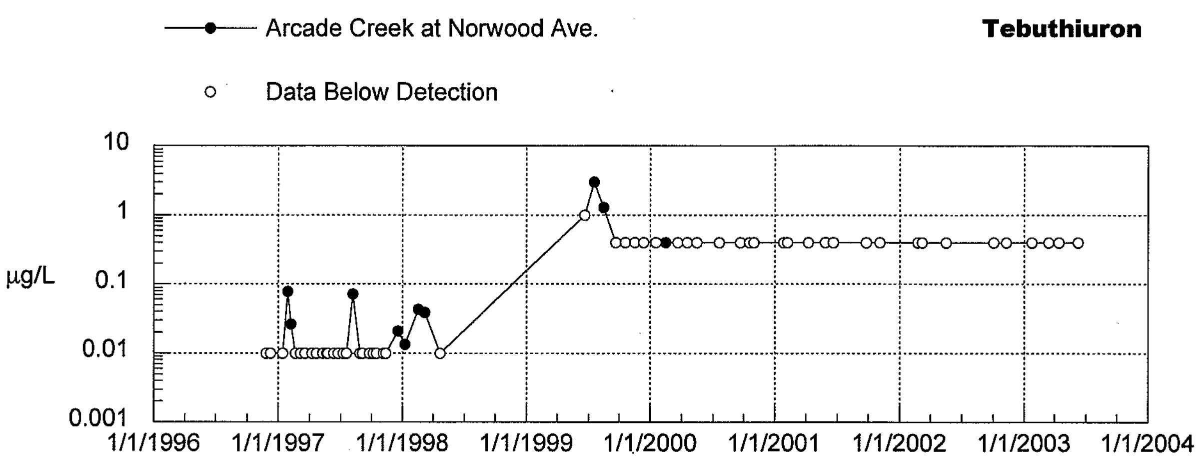

Sacramento River at Colusa
Data Below Detection
Simazine
µg/L
1
0.1
0.01
0.001
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

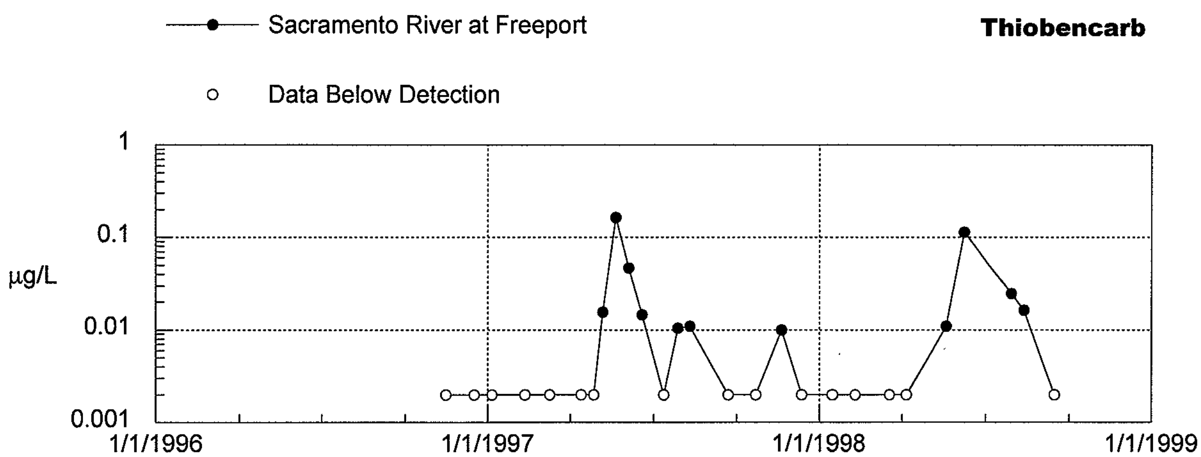

Sacramento River at Freeport
Data Below Detection
Simazine
µg/L
1
0.1
0.01
0.001
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Feather River near Nicolaus
Data Below Detection
Simazine
µg/L
1
0.1
0.01
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

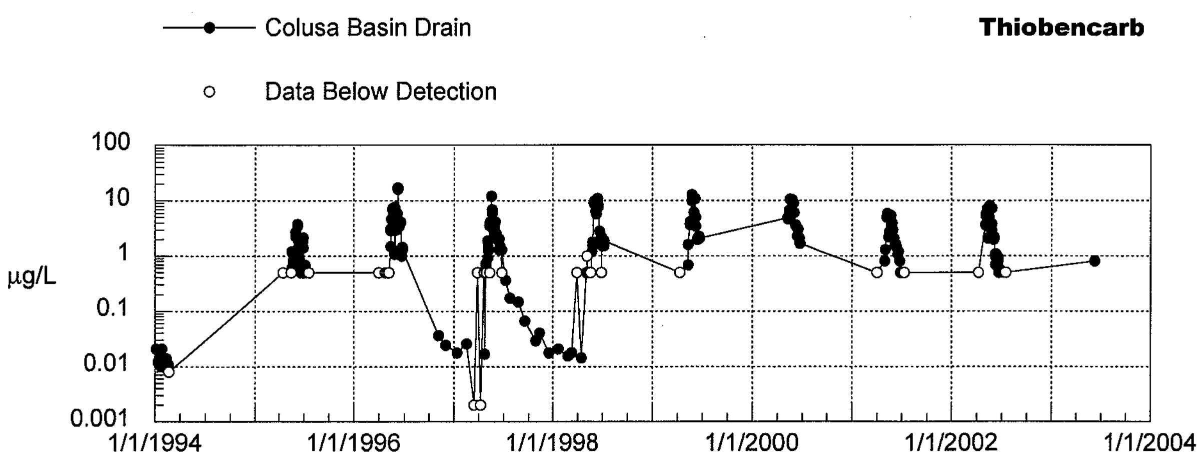

Colusa Basin Drain
Data Below Detection
Simazine
1
0.1
0.01
0.001
µg/L
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004


Sacramento Slough
Data Below Detection
Simazine
1
0.1
0.01
0.001
µg/L
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004


Arcade Creek at Norwood Ave.
Data Below Detection
Tebuthiuron
10
1
0.1
0.01
0.001
µg/L
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

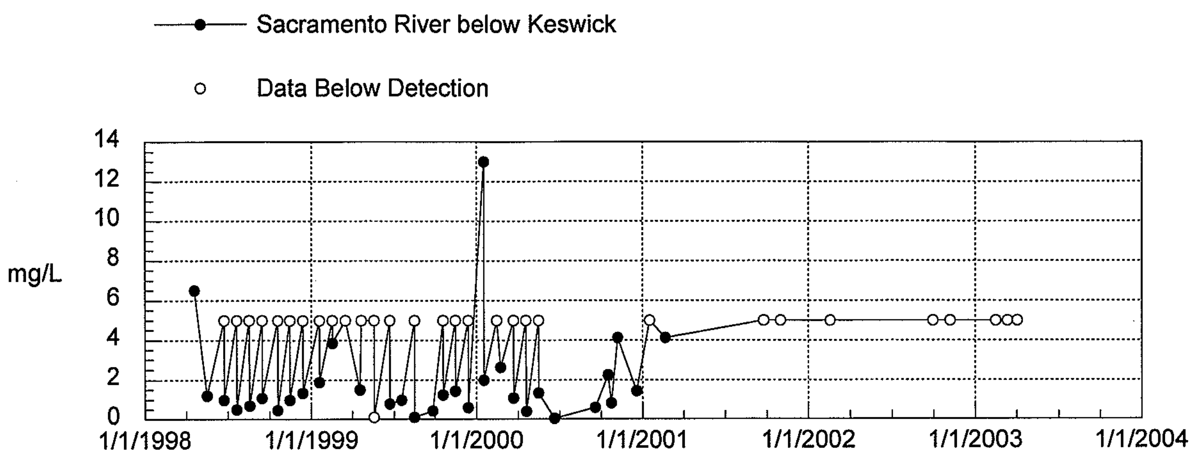


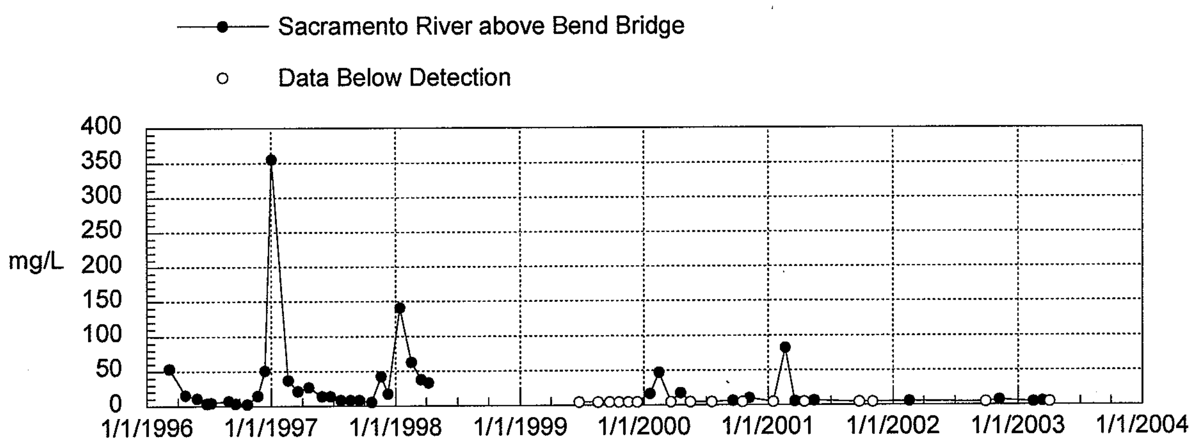
Sacramento River at Freeport
Data Below Detection
Thiobencarb
µg/L
1
0.1
0.01
0.001
1/1/1996
1/1/1997
1/1/1998
1/1/1999

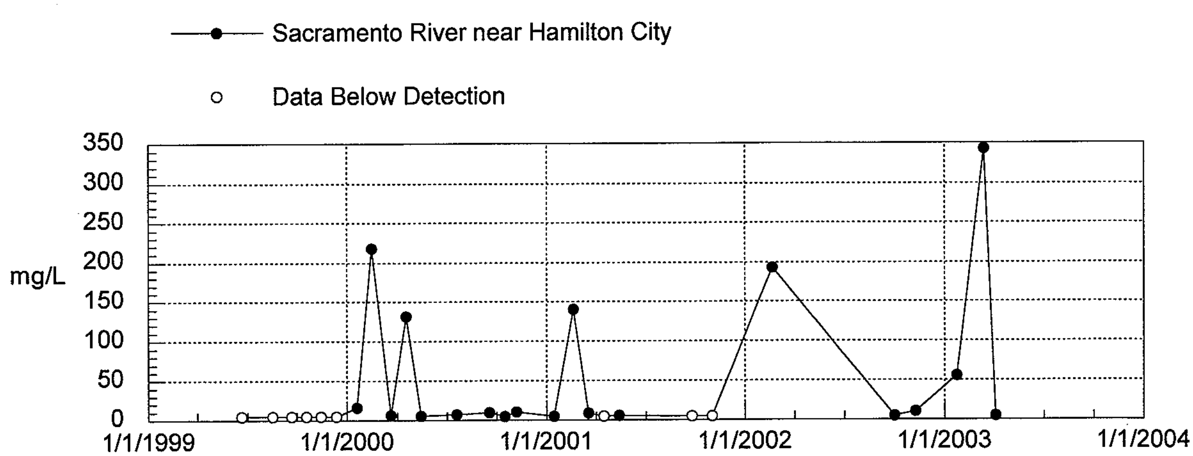


Colusa Basin Drain
Data Below Detection
Thiobencarb
µg/L
100
10
1
0.1
0.01
0.001
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

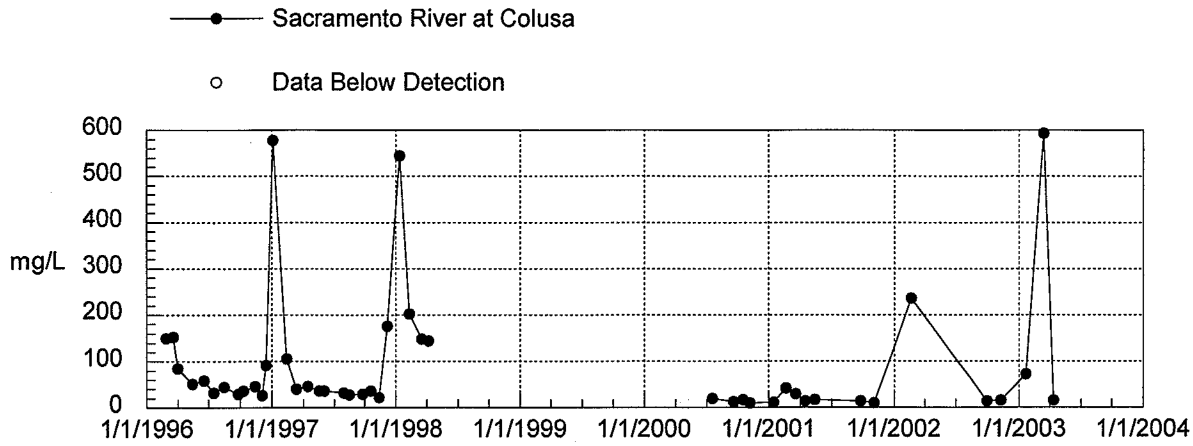
TOTAL SUSPENDED SOLIDS IN WATER

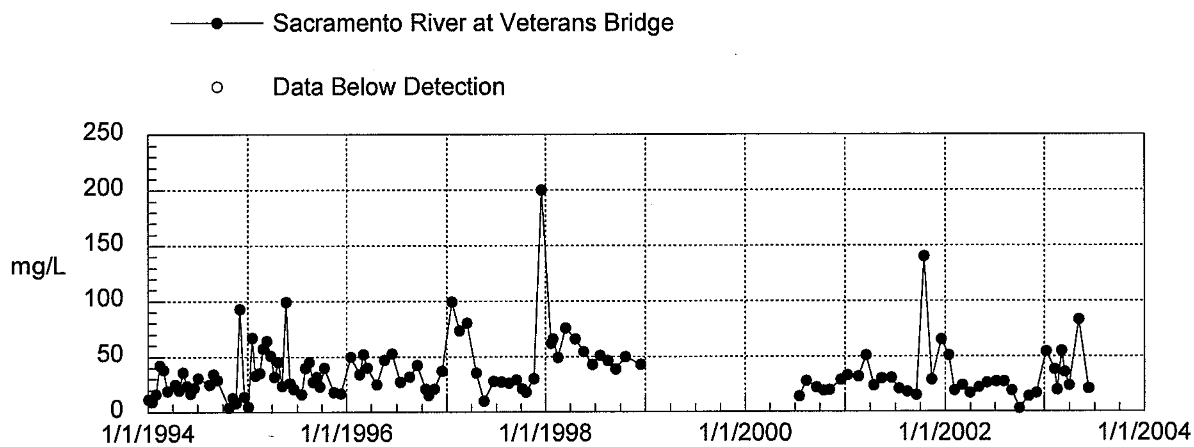


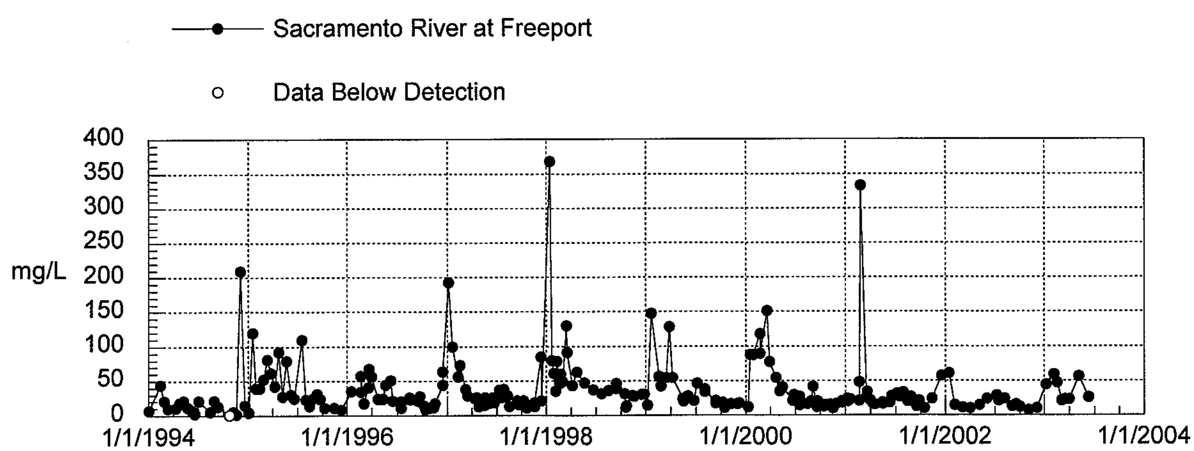




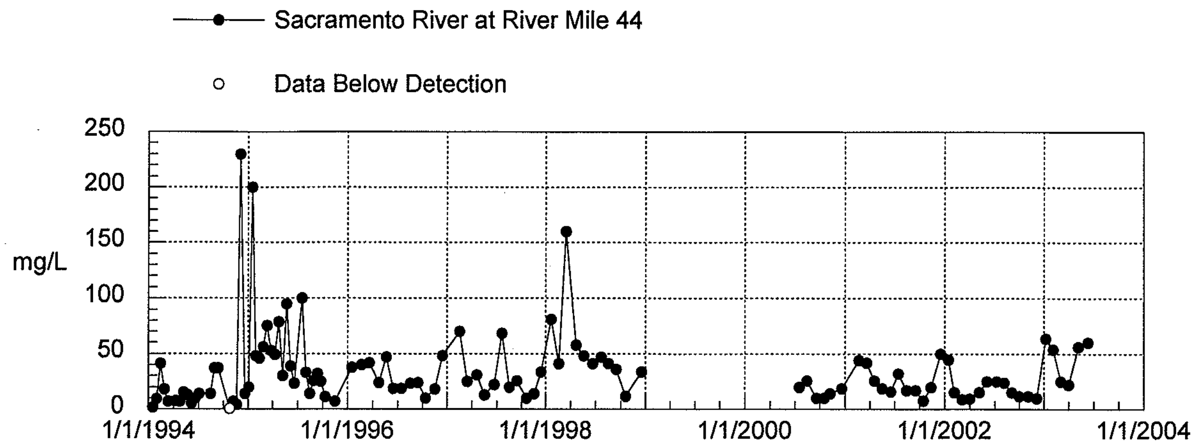
TOTAL SUSPENDED SOLIDS IN WATER

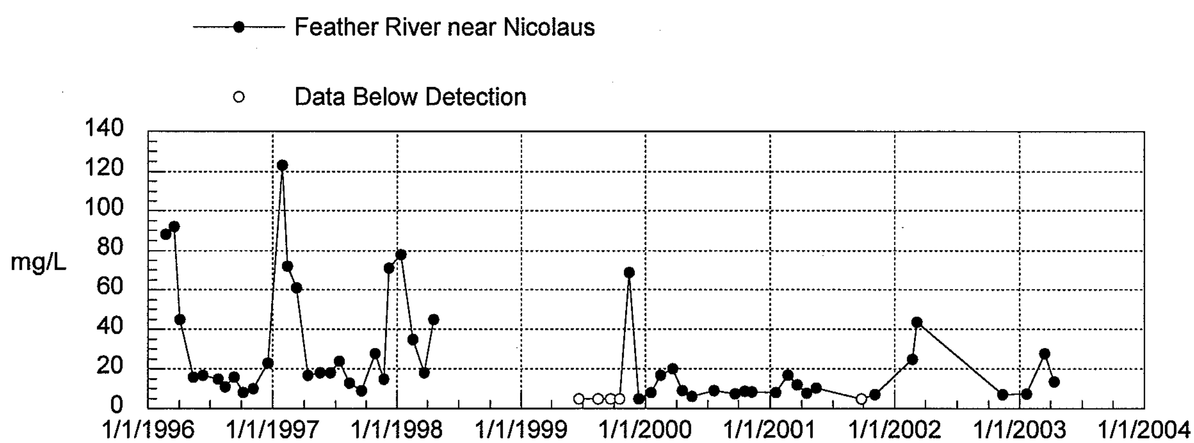


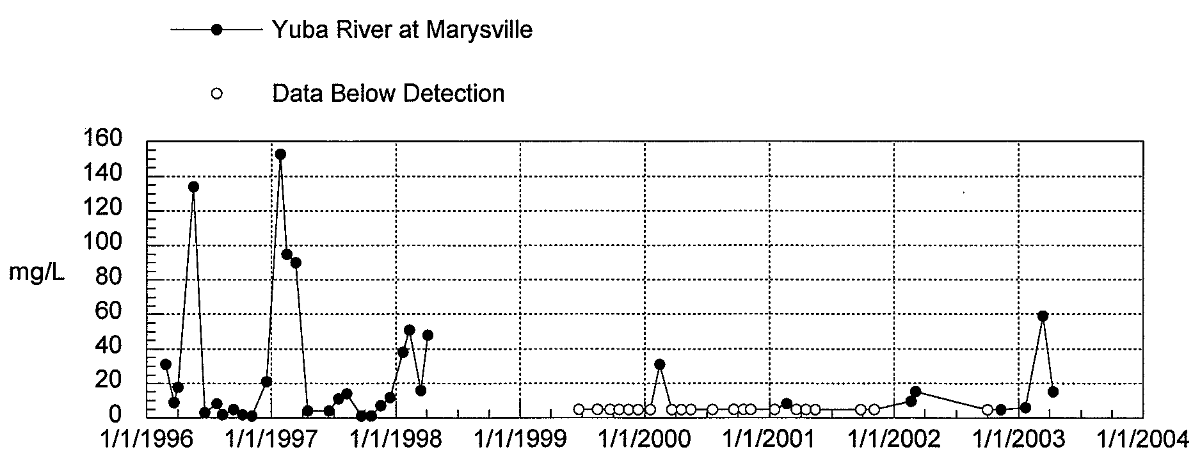




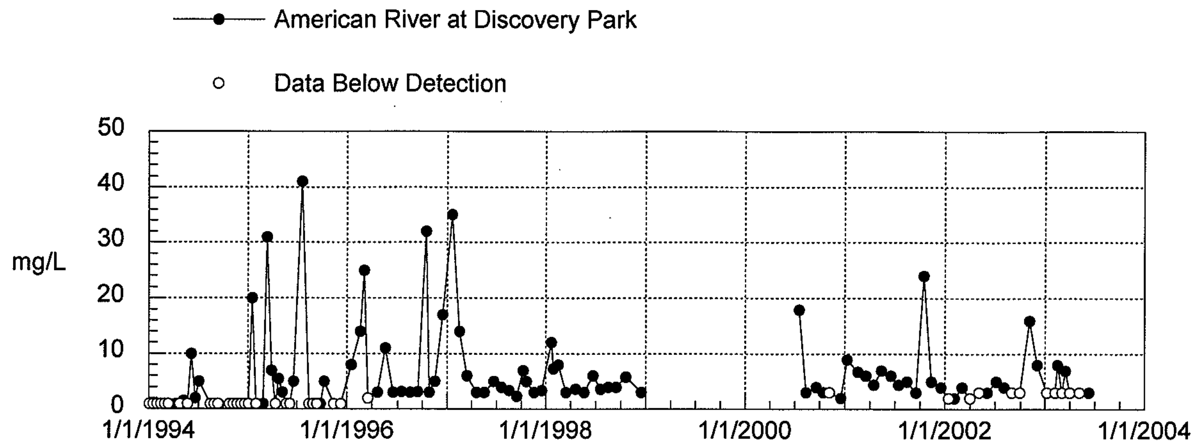
TOTAL SUSPENDED SOLIDS IN WATER

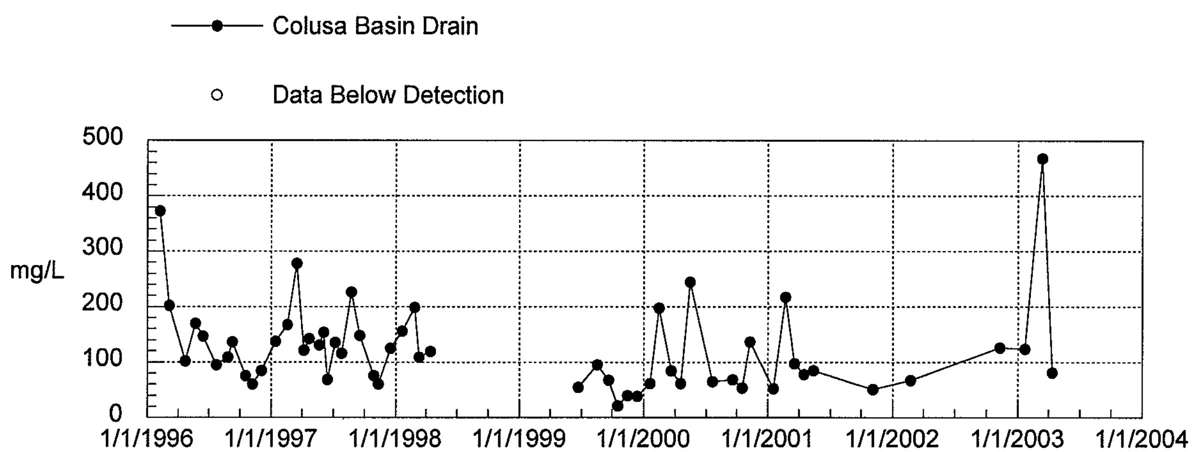


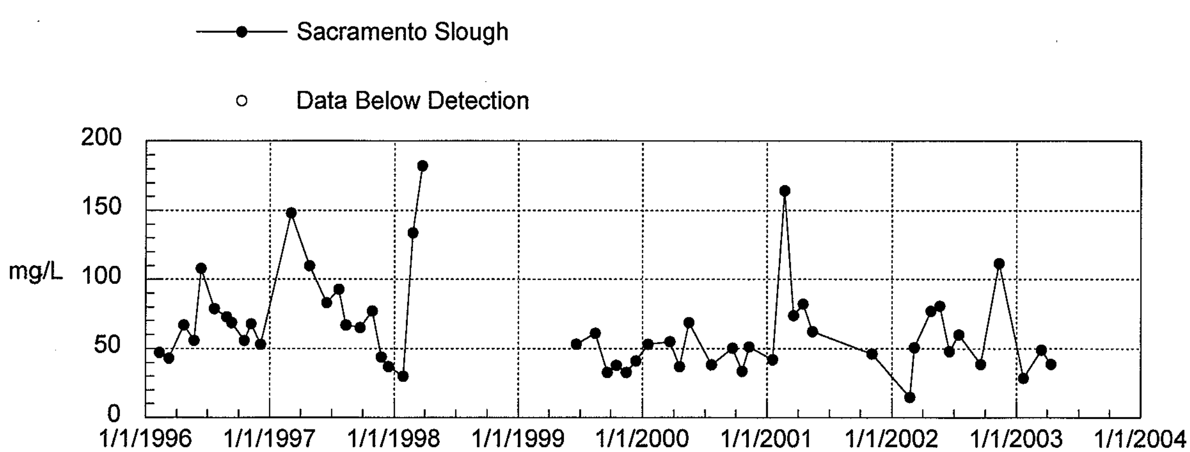




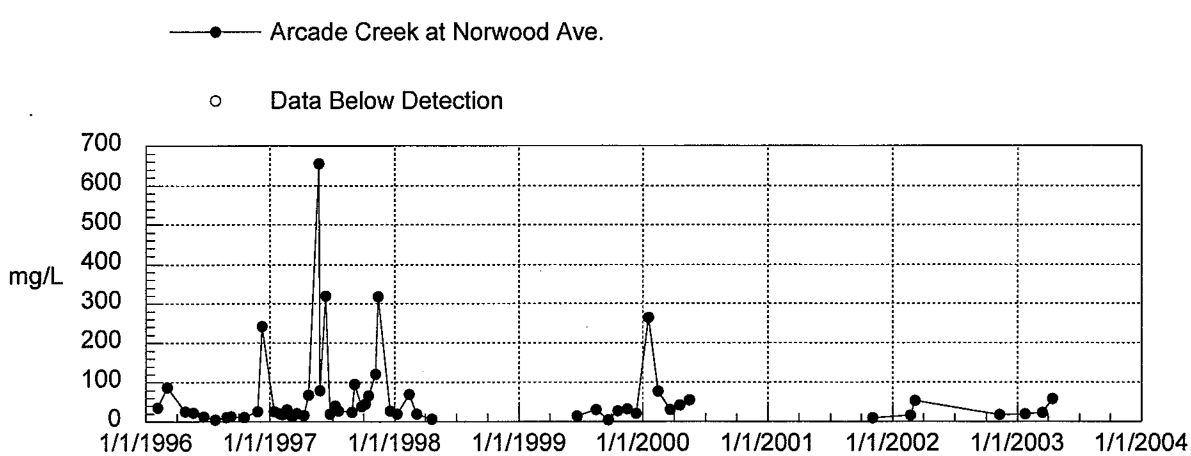
TOTAL SUSPENDED SOLIDS IN WATER



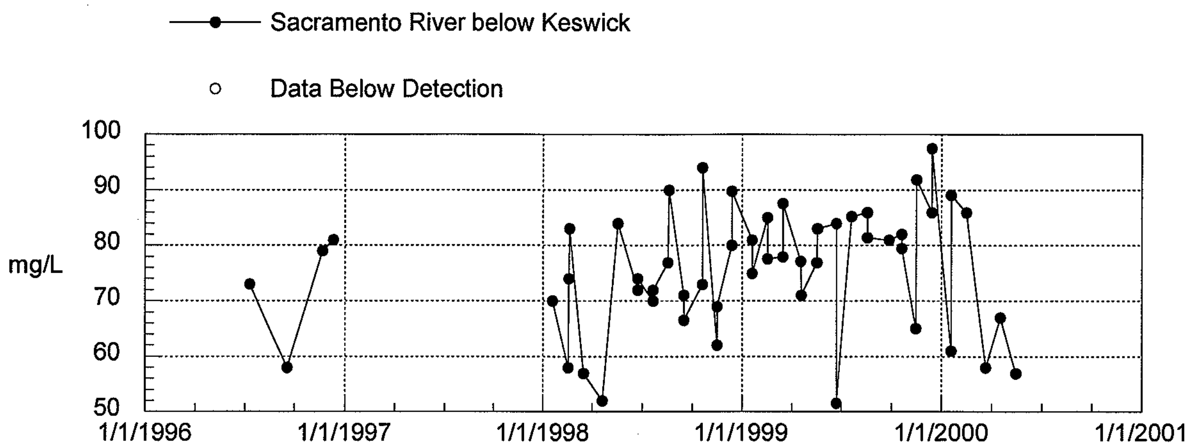


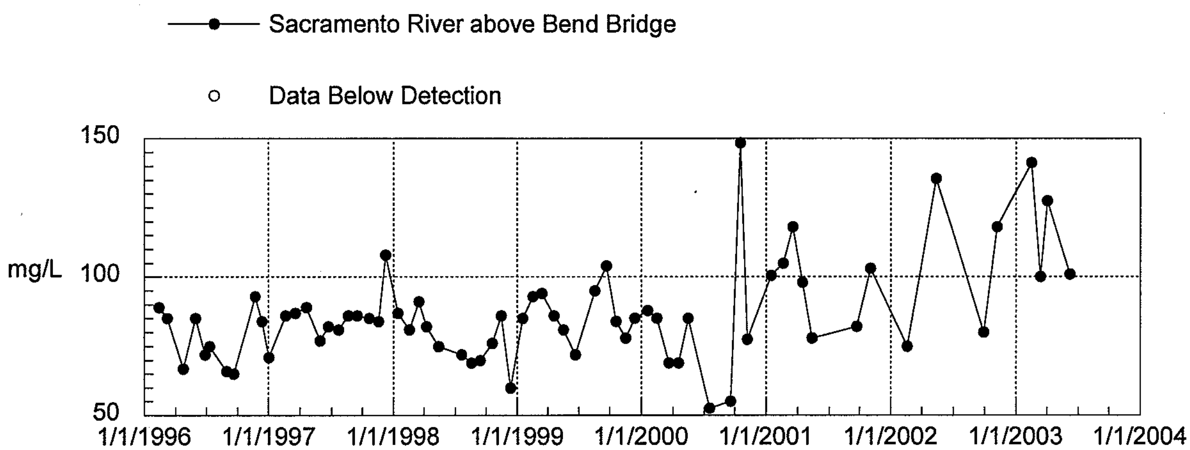


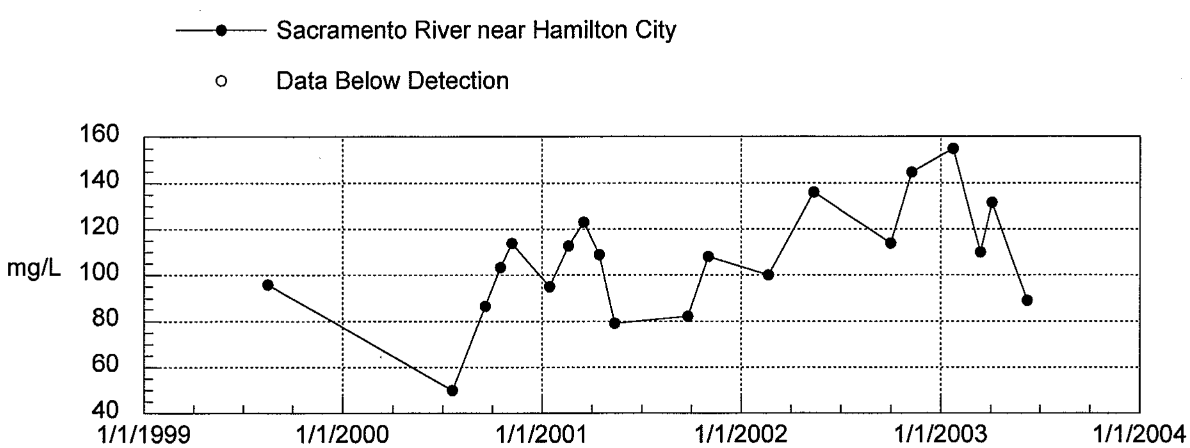
TOTAL SUSPENDED SOLIDS IN WATER

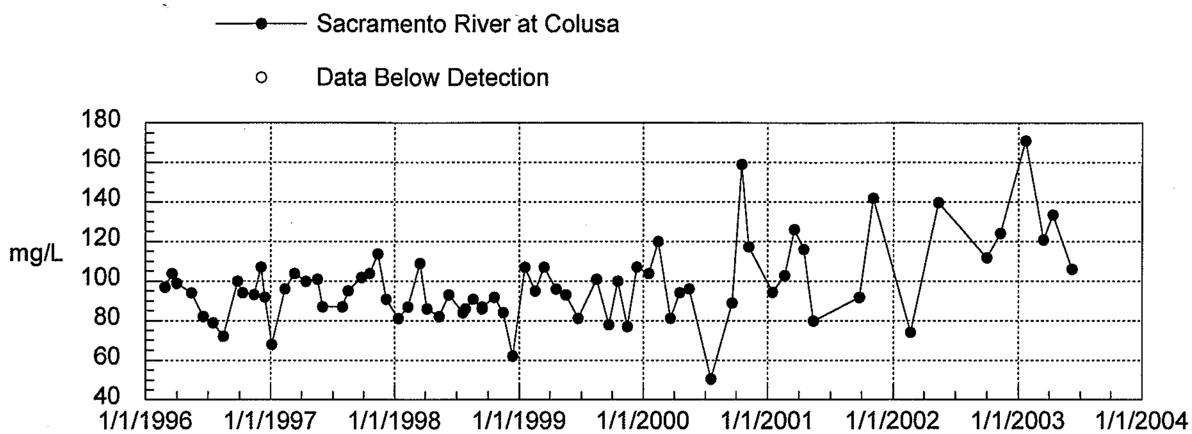


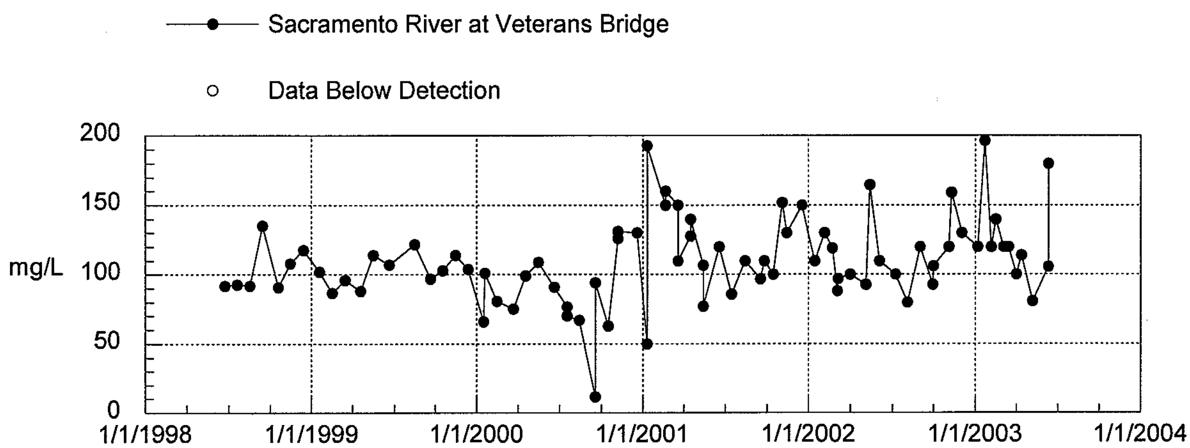
TOTAL DISSOLVED SOLIDS IN WATER

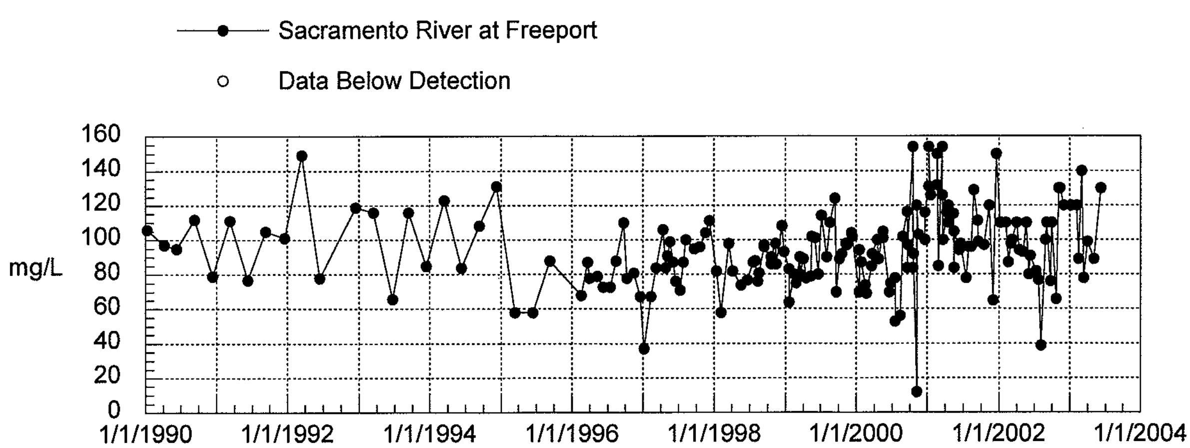




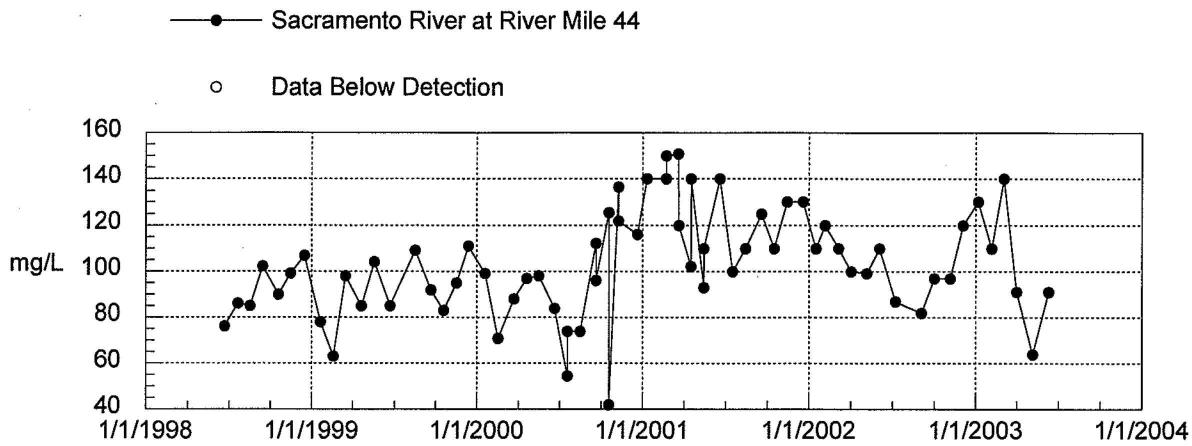


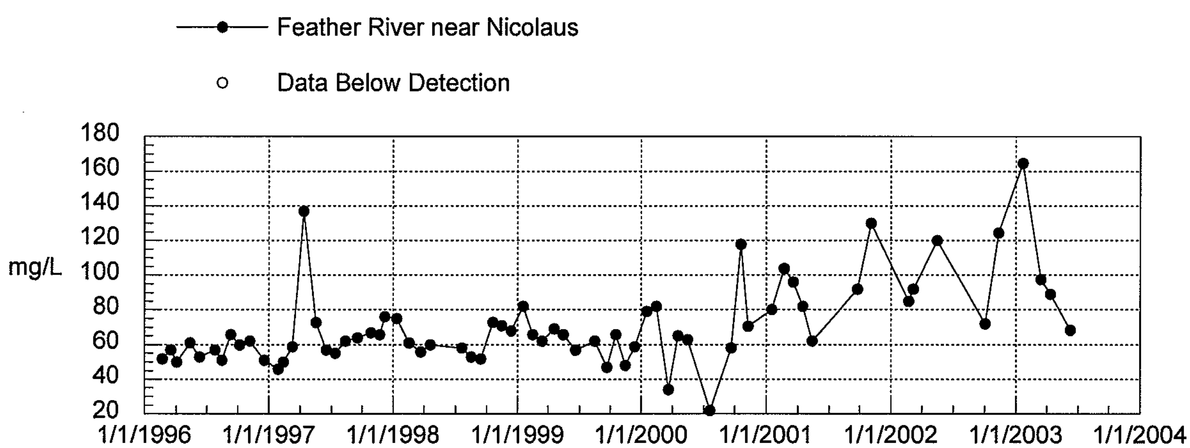

Sacramento River at Colusa
Data Below Detection
mg/L
180
160
140
120
100
80
60
40
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

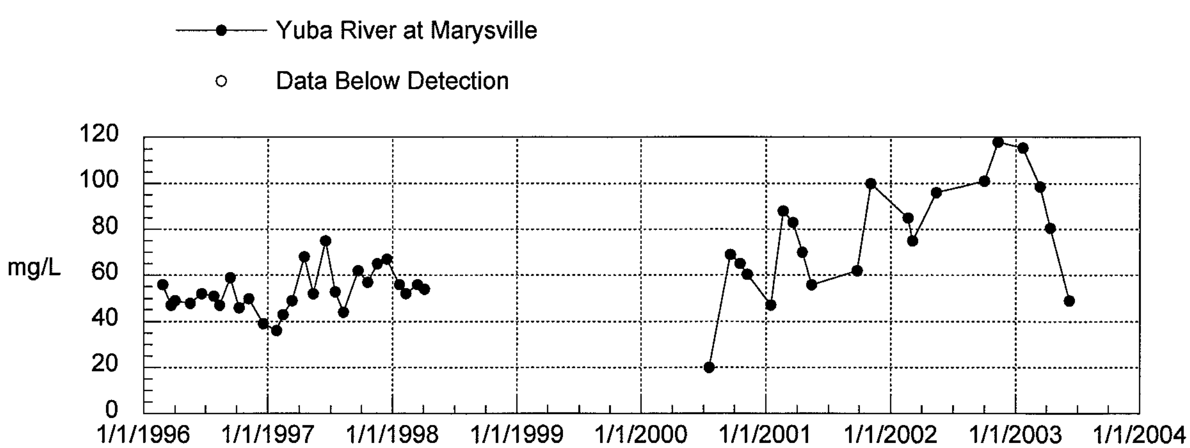

Sacramento River at Veterans Bridge
Data Below Detection
mg/L
200
150
100
50
0
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento River at Freeport
Data Below Detection
mg/L
160
140
120
100
80
60
40
20
0
1/1/1990
1/1/1992
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

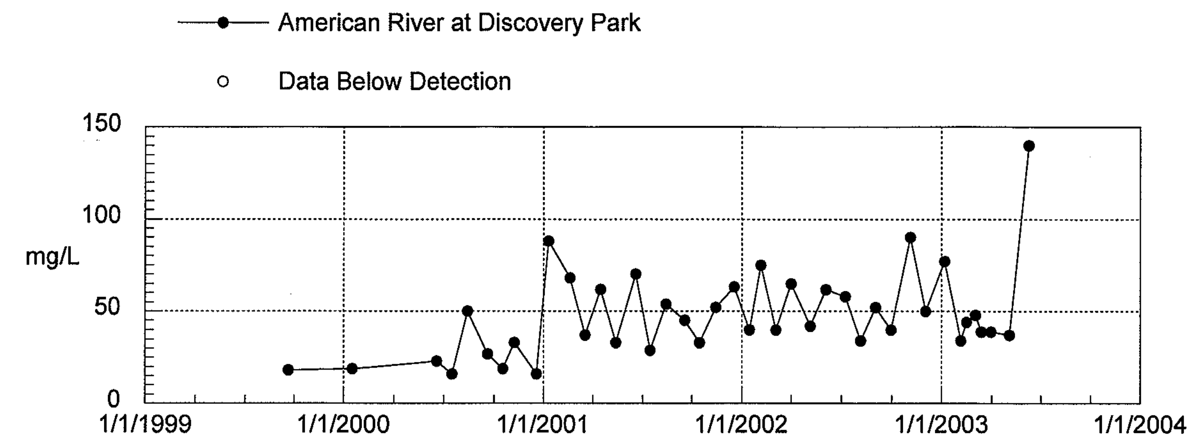
TOTAL DISSOLVED SOLIDS IN WATER

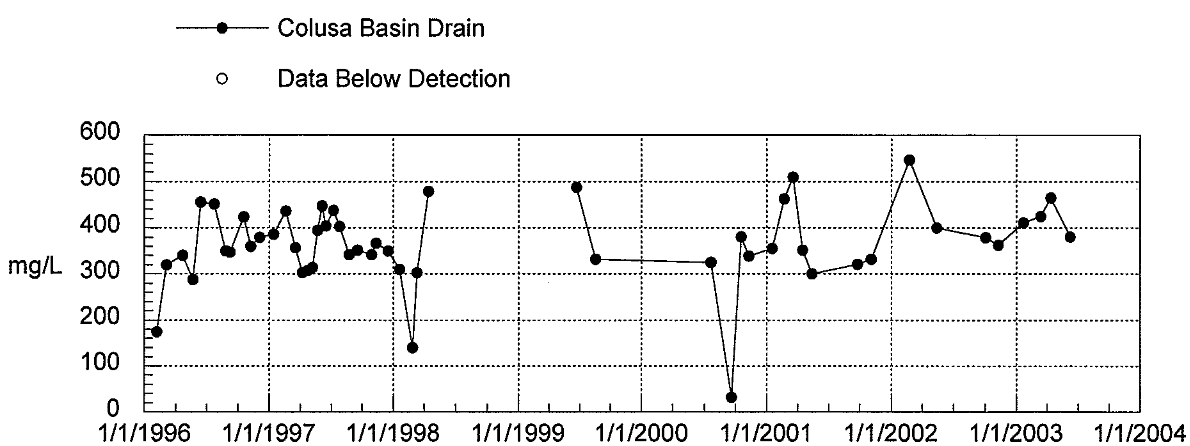


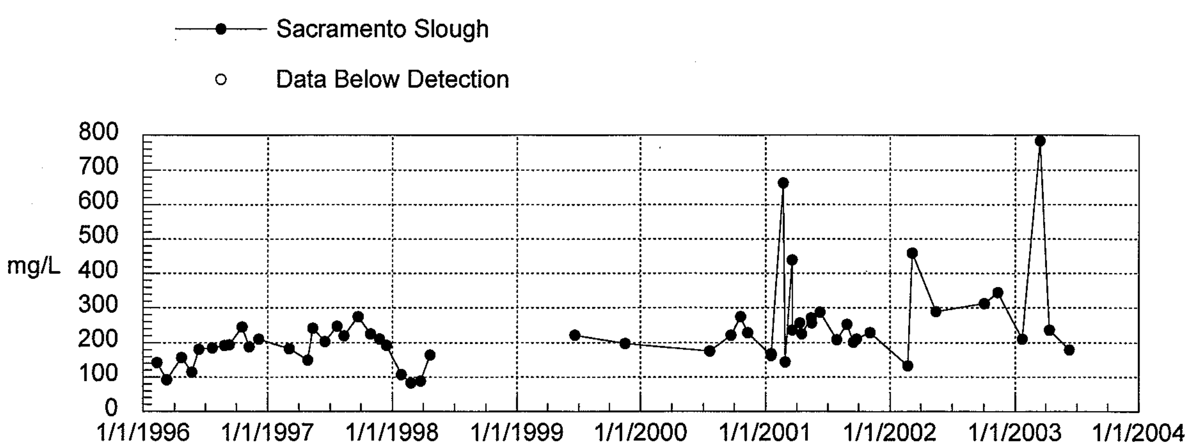


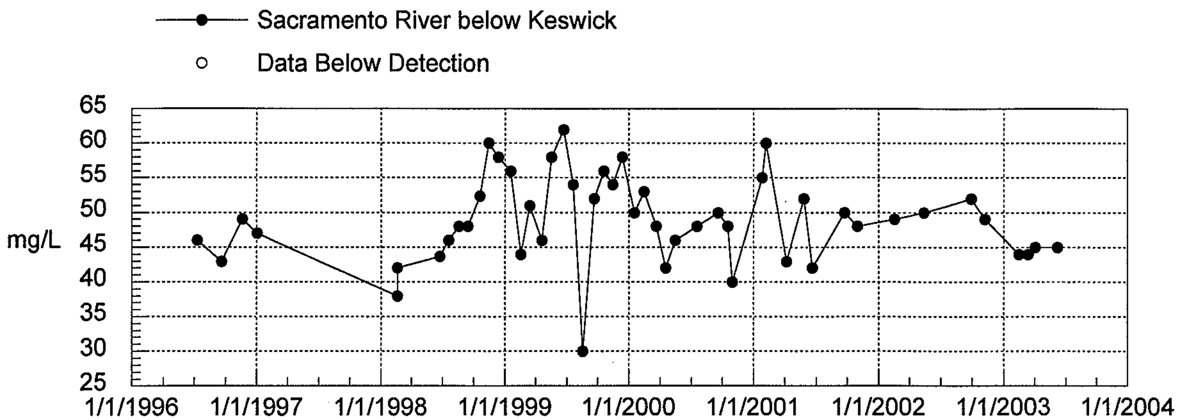


TOTAL DISSOLVED SOLIDS IN WATER

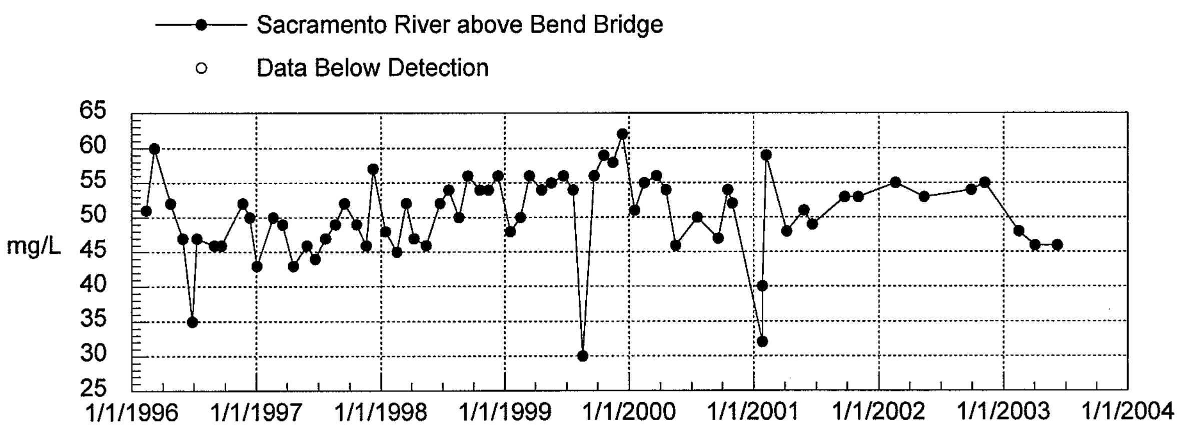




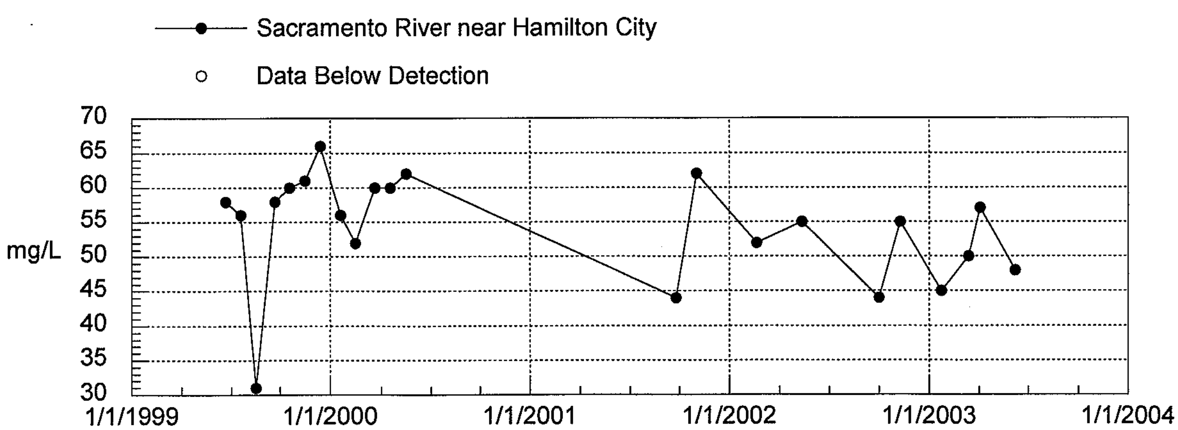




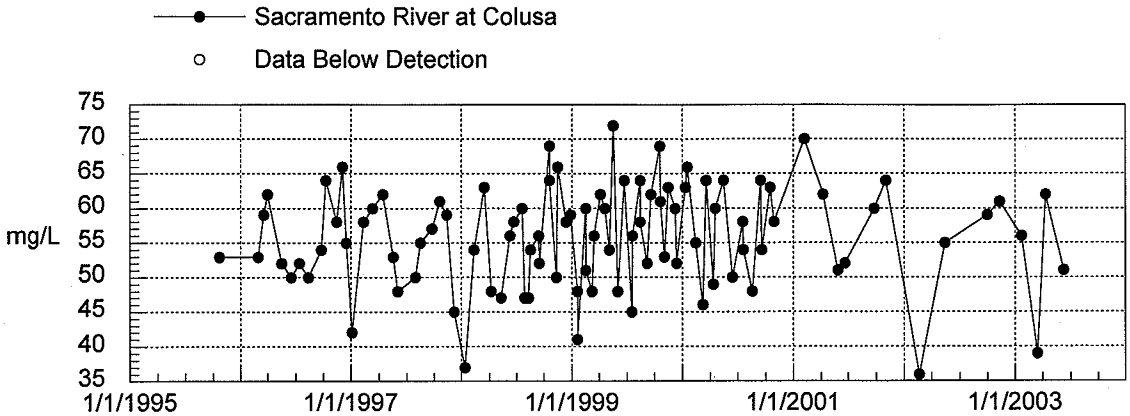
Sacramento River below Keswick
Data Below Detection
mg/L
65
60
55
50
45
40
35
30
25
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

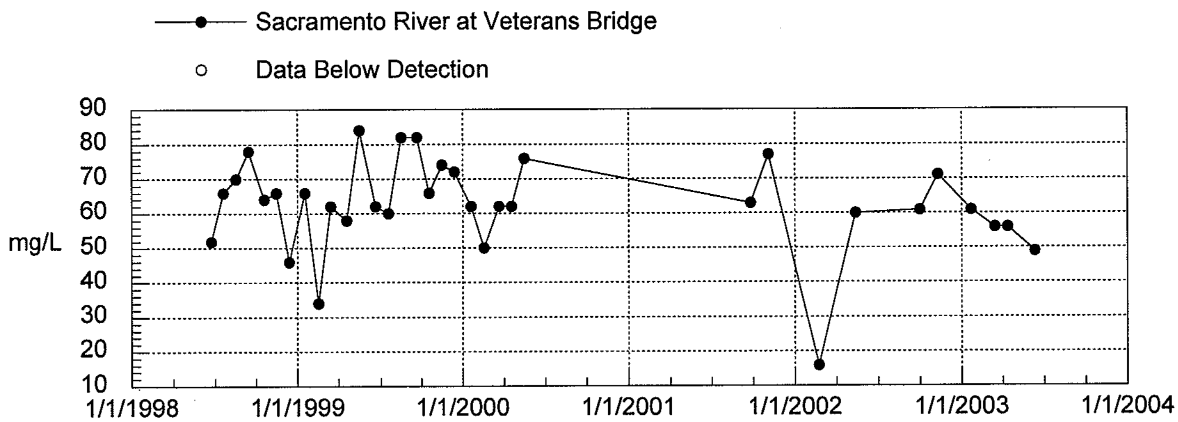


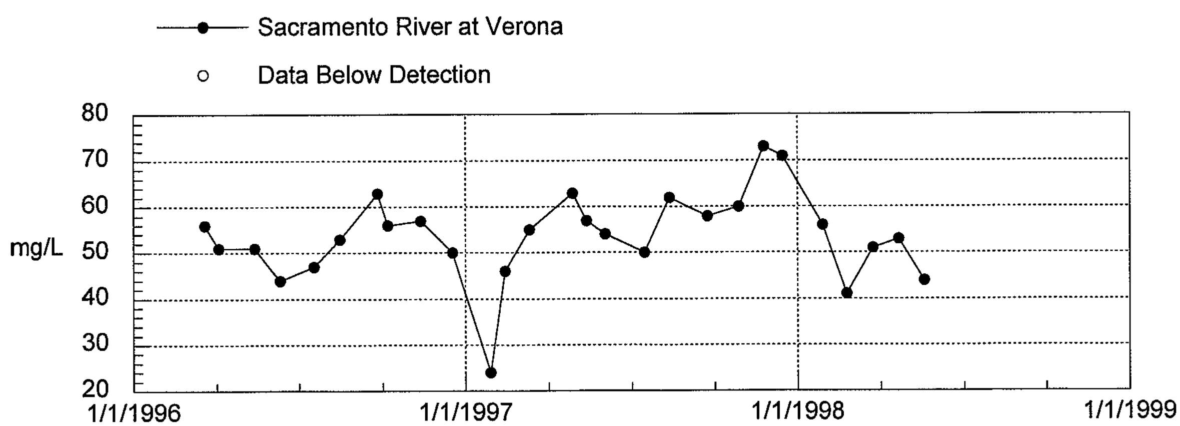
Sacramento River above Bend Bridge
Data Below Detection
mg/L
65
60
55
50
45
40
35
30
25
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

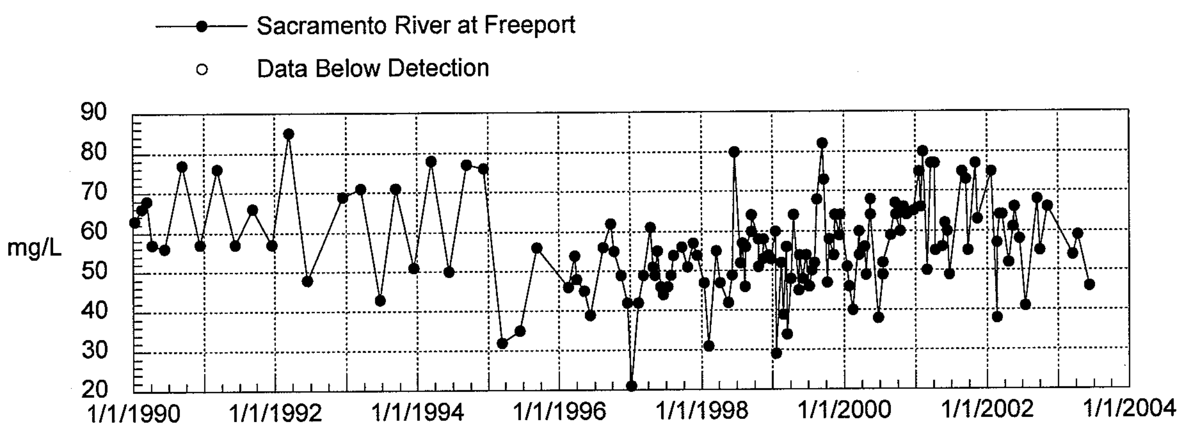


Sacramento River near Hamilton City
Data Below Detection
mg/L
70
65
60
55
50
45
40
35
30
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

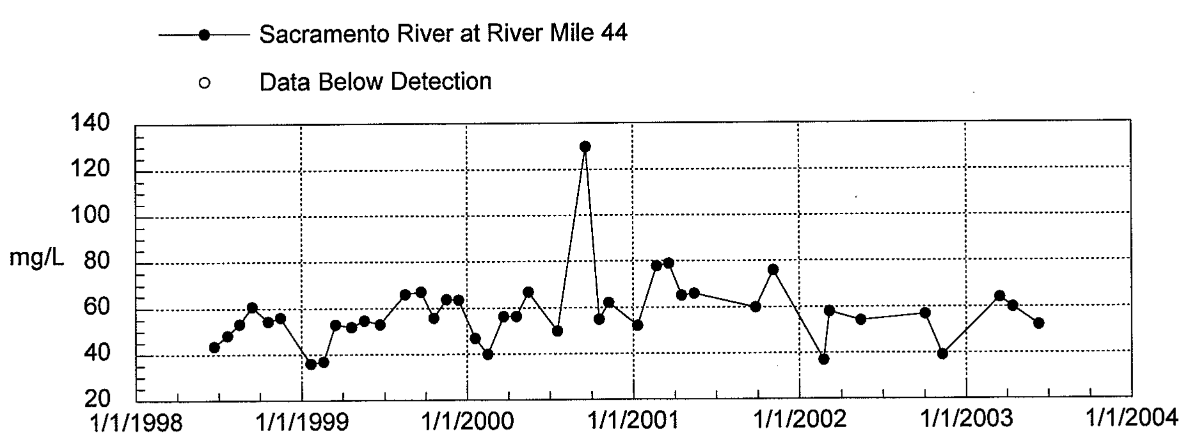

Sacramento River at Colusa
Data Below Detection
mg/L
75
70
65
60
55
50
45
40
35
1/1/1995
1/1/1997
1/1/1999
1/1/2001
1/1/2003


Sacramento River at Veterans Bridge
Data Below Detection
mg/L
90
80
70
60
50
40
30
20
10
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

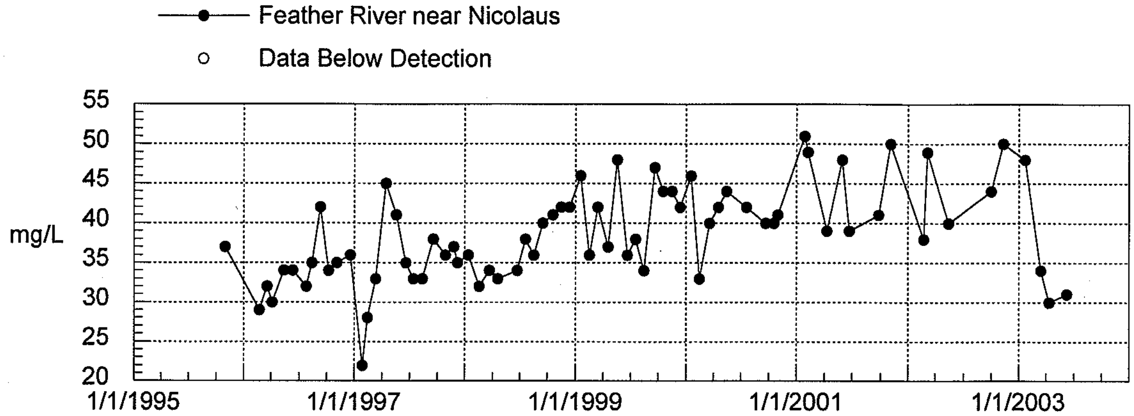

Sacramento River at Verona
Data Below Detection
mg/L
80
70
60
50
40
30
20
1/1/1996
1/1/1997
1/1/1998
1/1/1999

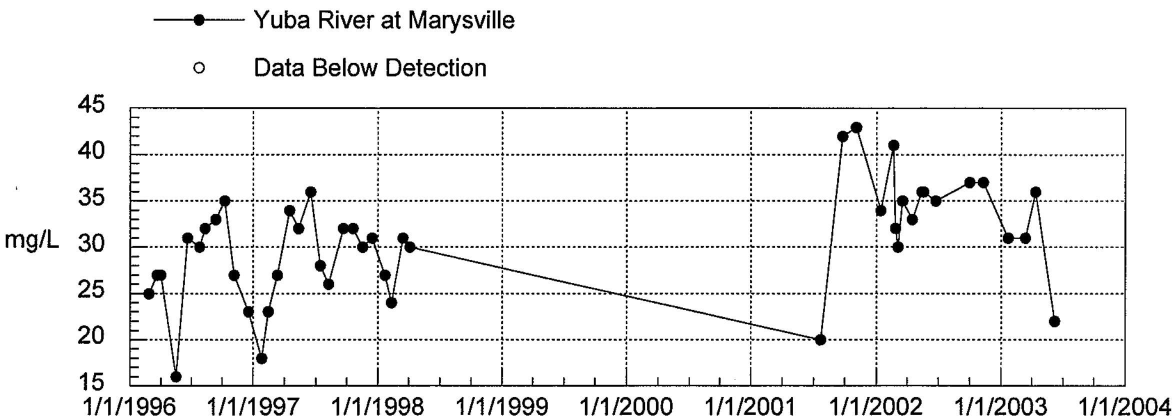


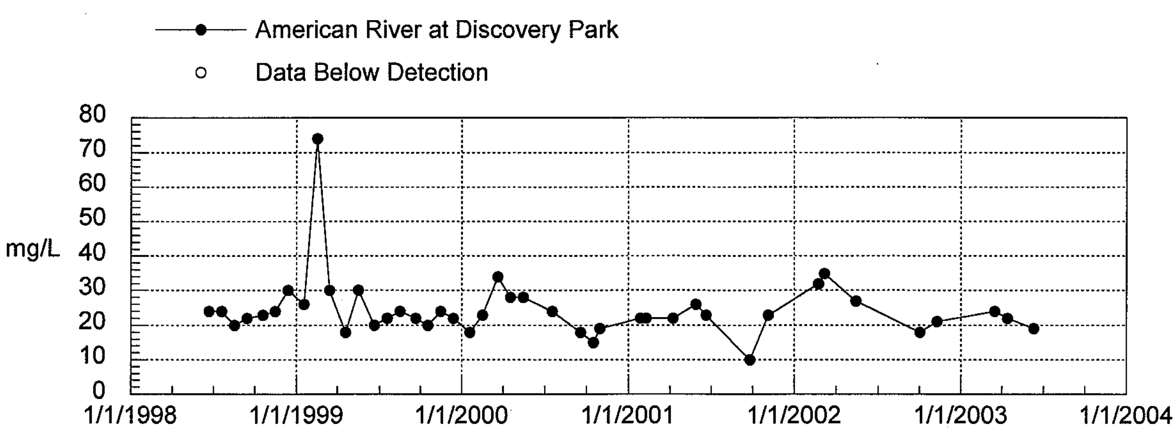
Sacramento River at Freeport
Data Below Detection
mg/L
90
80
70
60
50
40
30
20
1/1/1990
1/1/1992
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004



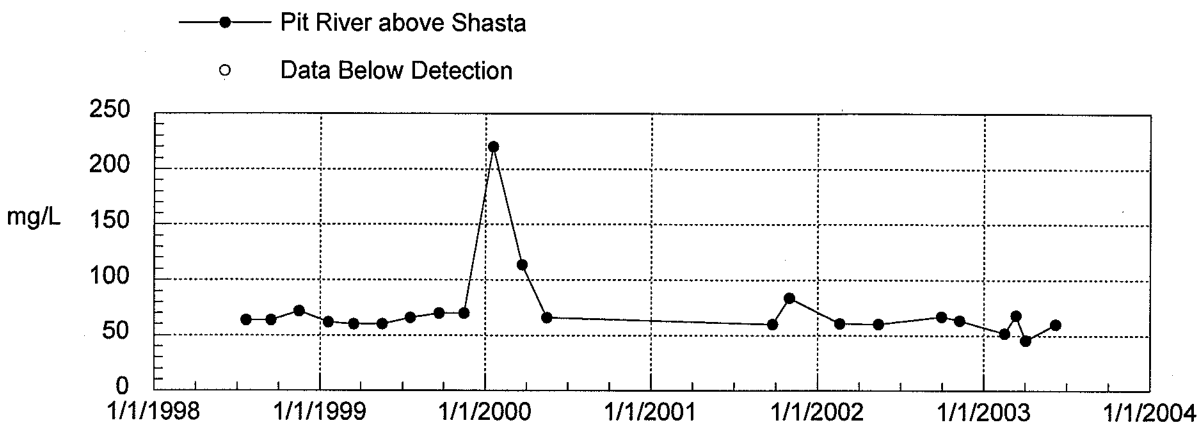
Sacramento River at River Mile 44
Data Below Detection
mg/L
140
120
100
80
60
40
20
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

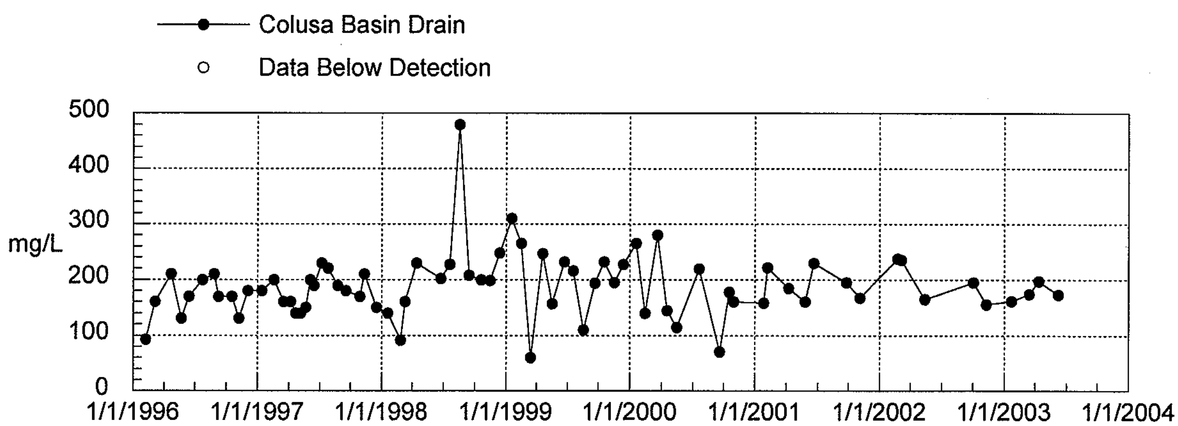

Feather River near Nicolaus
Data Below Detection
mg/L
55
50
45
40
35
30
25
20
1/1/1995
1/1/1997
1/1/1999
1/1/2001
1/1/2003

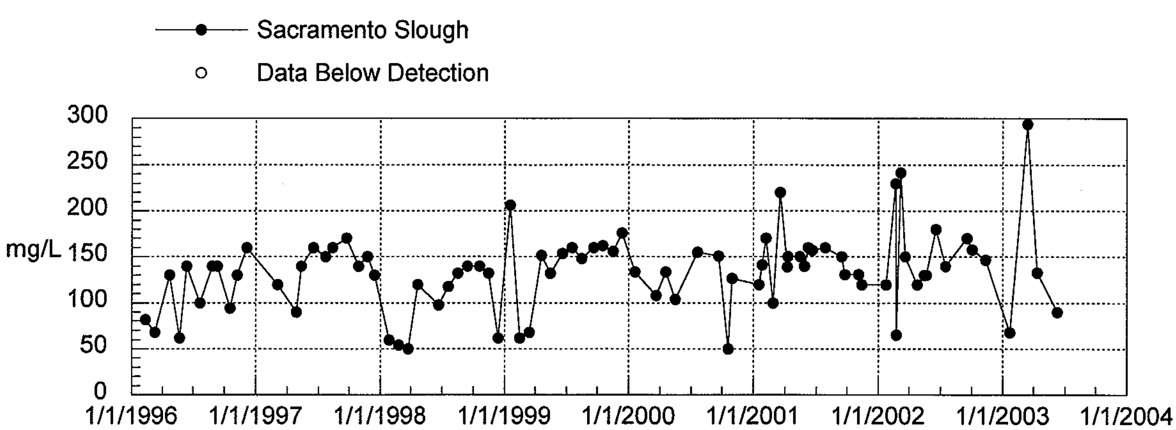

Yuba River at Marysville
Data Below Detection
mg/L
45
40
35
30
25
20
15
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

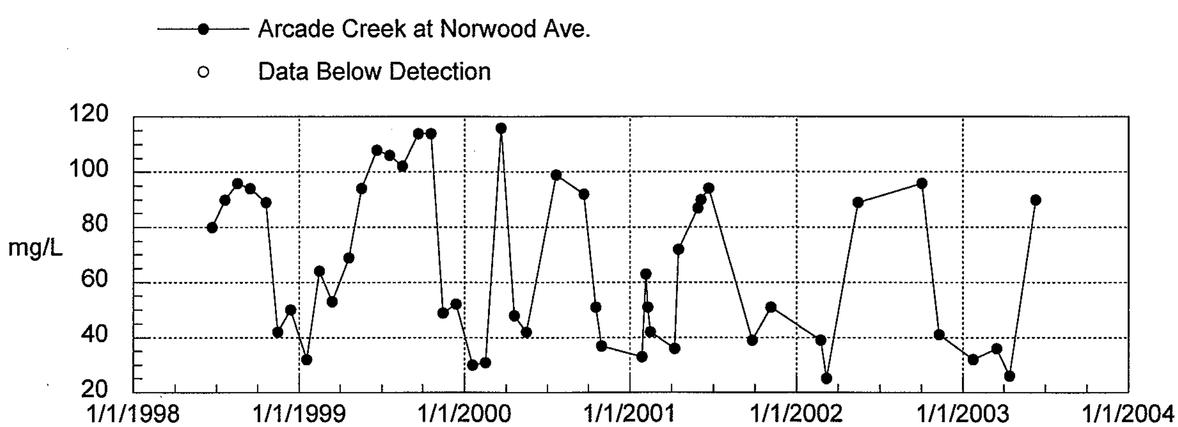

American River at Discovery Park
Data Below Detection
mg/L
80
70
60
50
40
30
20
10
0
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

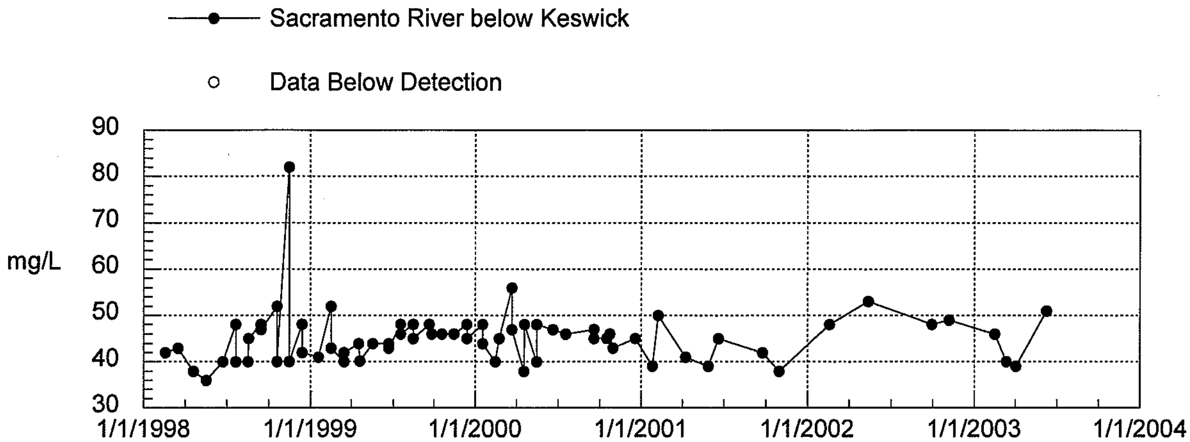
TOTAL ALKALINITY IN WATER

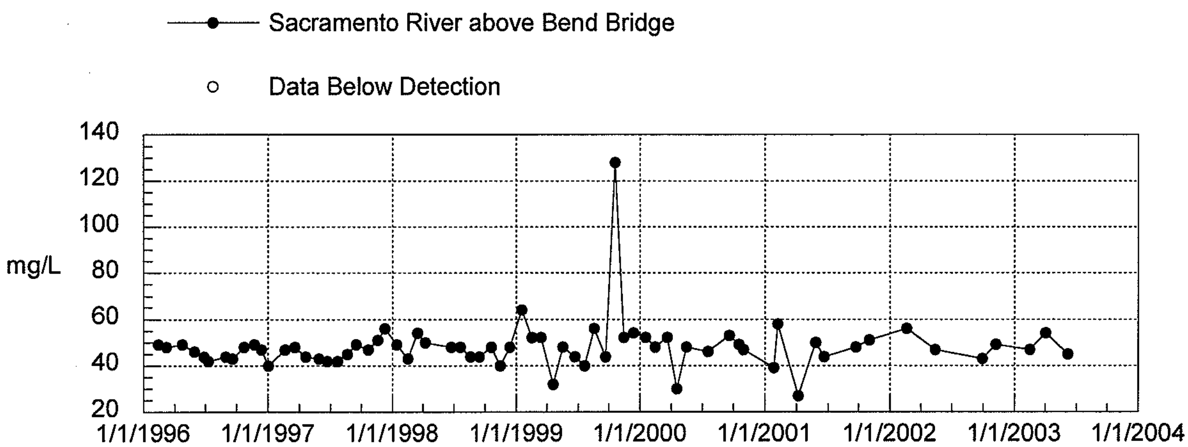


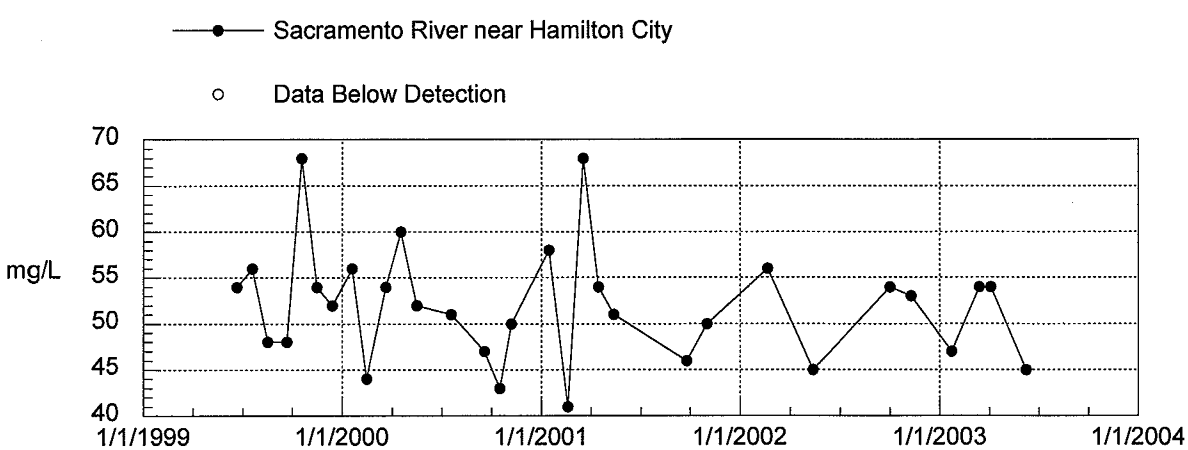


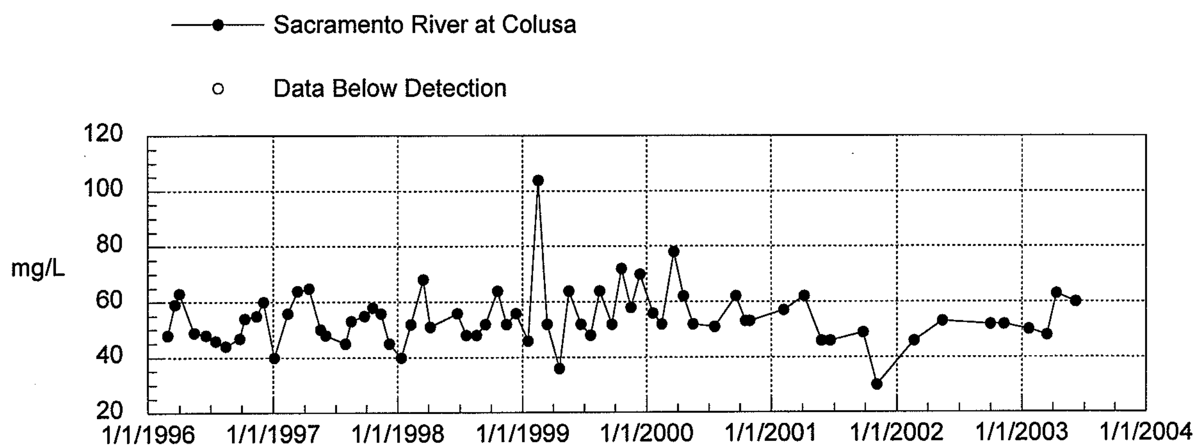


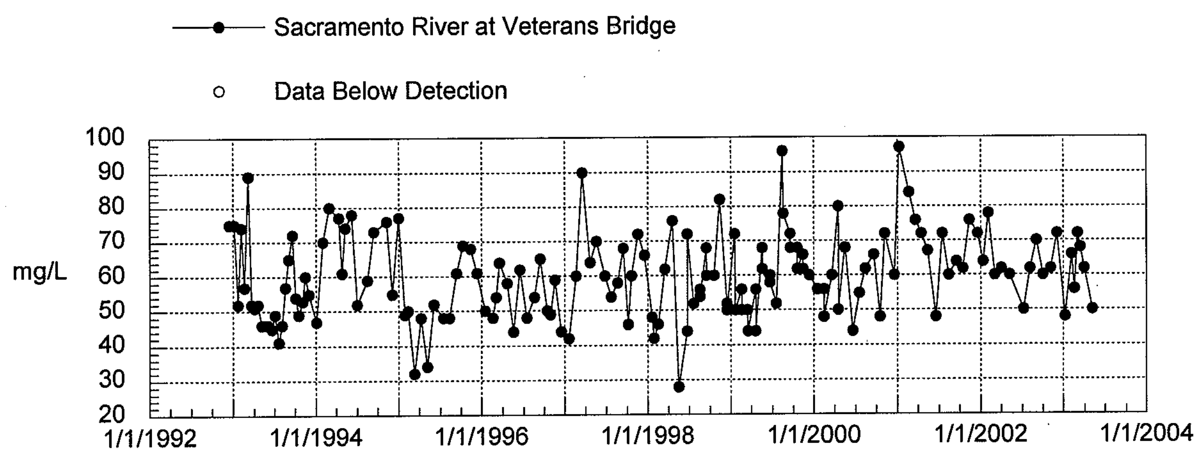

Arcade Creek at Norwood Ave.
Data Below Detection
120
100
80
60
40
20
mg/L
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

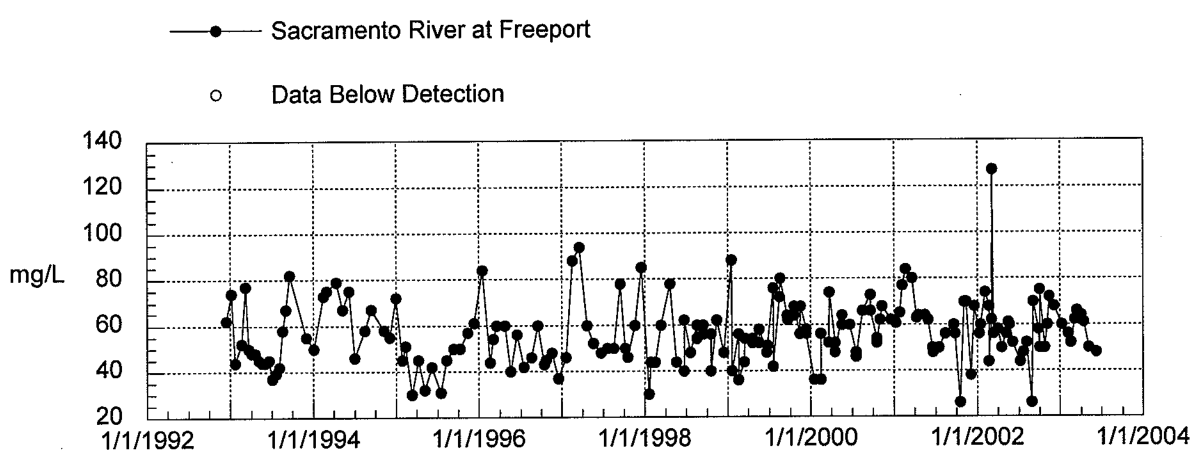

Sacramento River below Keswick
Data Below Detection
mg/L
90
80
70
60
50
40
30
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

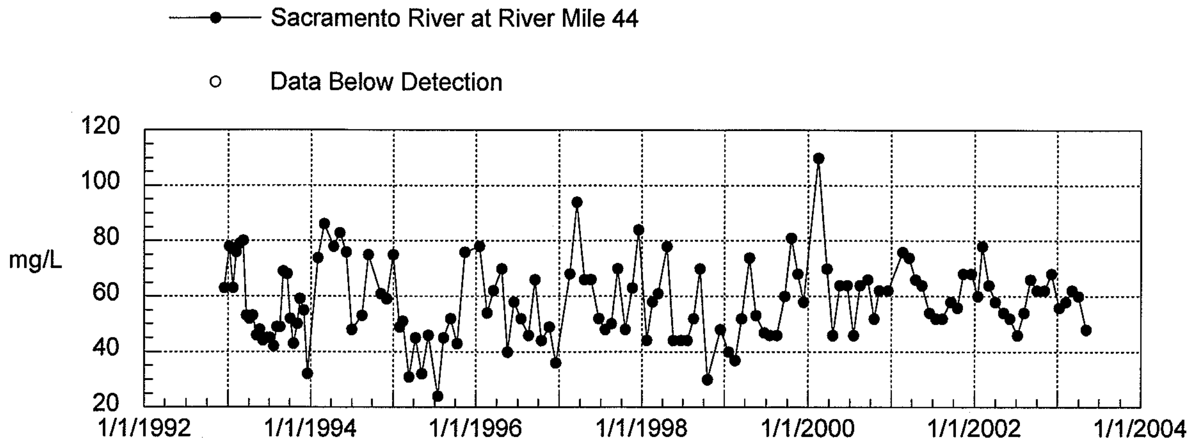

Sacramento River above Bend Bridge
Data Below Detection
mg/L
140
120
100
80
60
40
20
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

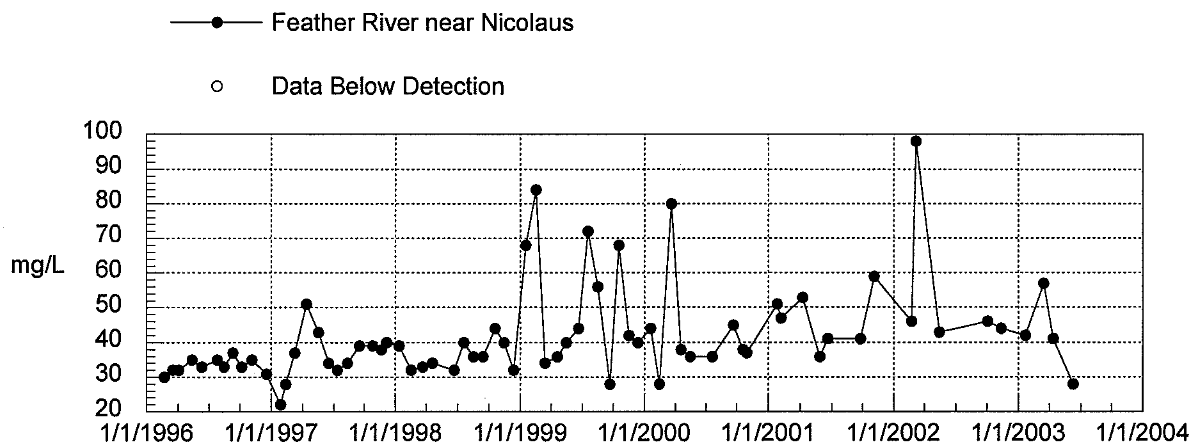

Sacramento River near Hamilton City
Data Below Detection
mg/L
70
65
60
55
50
45
40
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

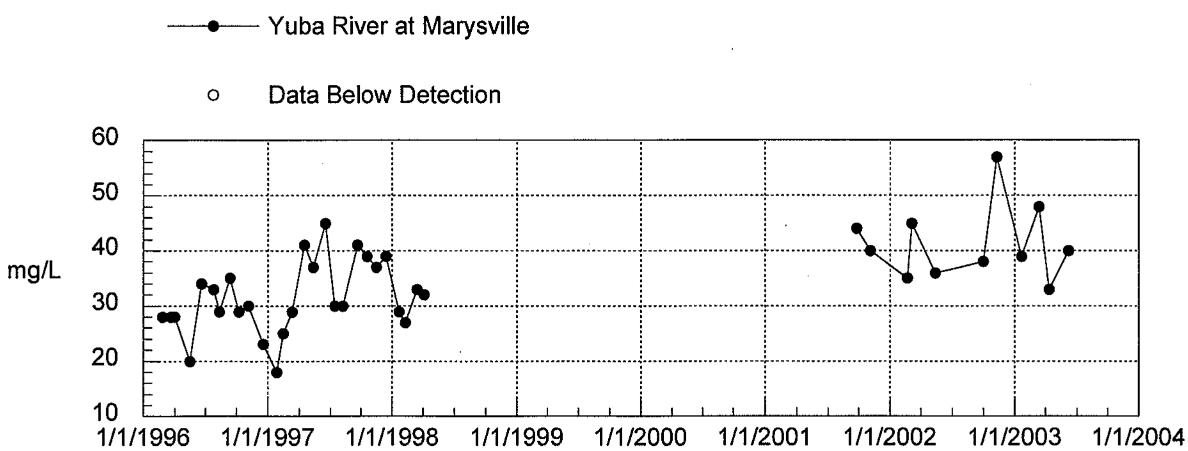

Sacramento River at Colusa
Data Below Detection
mg/L
120
100
80
60
40
20
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

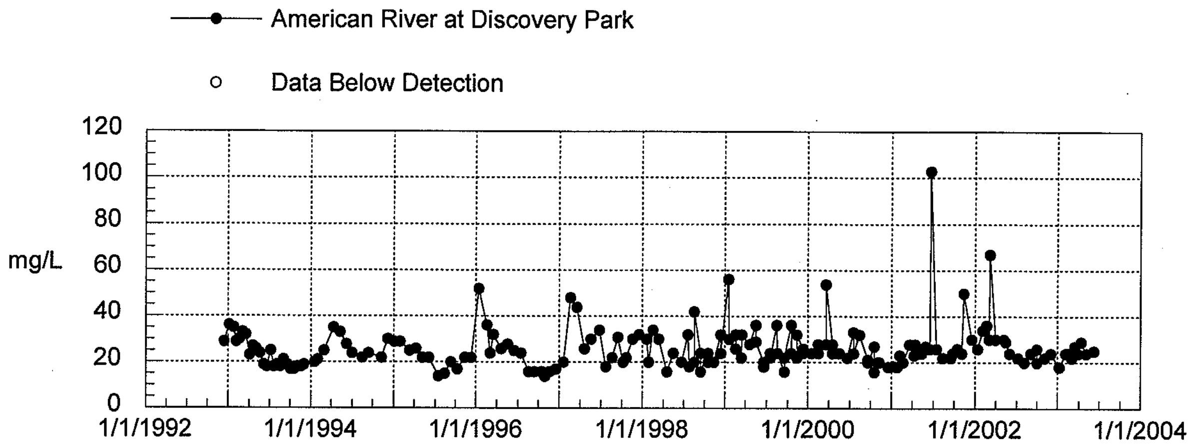

Sacramento River at Veterans Bridge
Data Below Detection
mg/L
100
90
80
70
60
50
40
30
20
1/1/1992
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

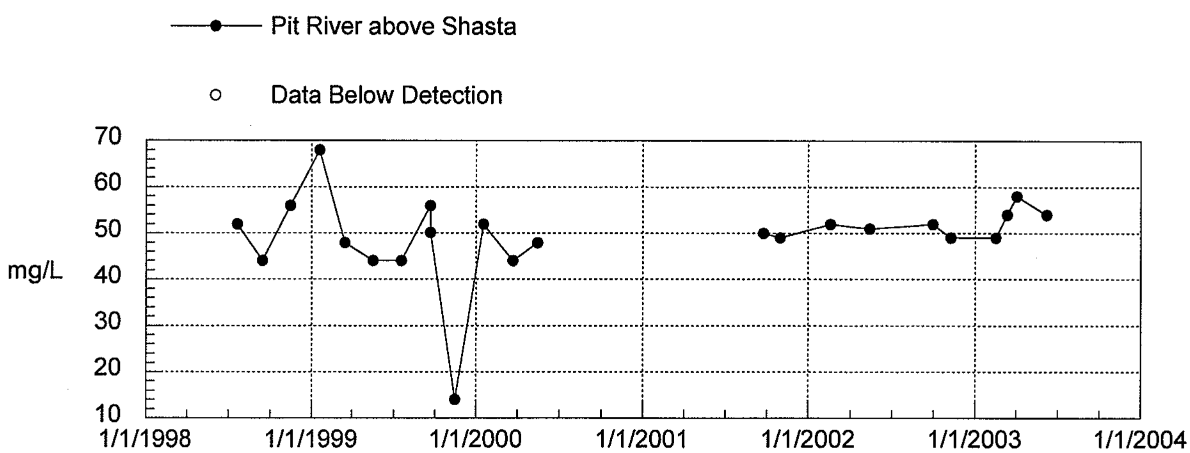

Sacramento River at Freeport
Data Below Detection
mg/L
140
120
100
80
60
40
20
1/1/1992
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

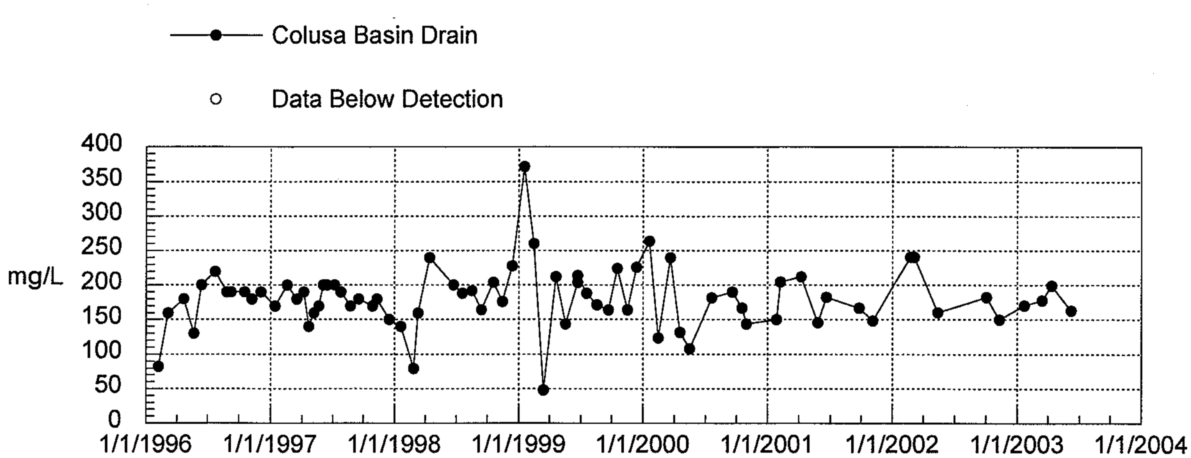

Sacramento River at River Mile 44
Data Below Detection
120
100
80
60
40
20
mg/L
1/1/1992
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

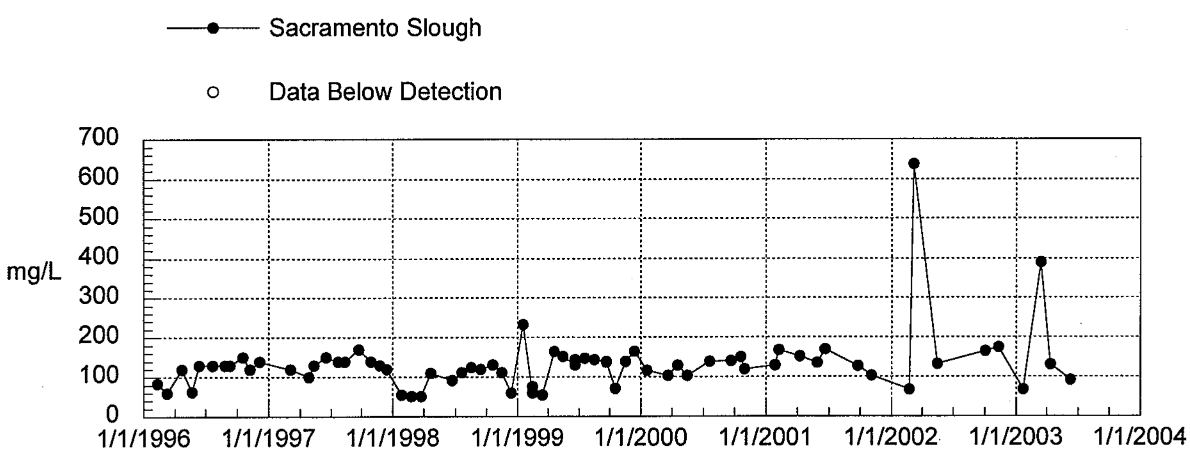

Feather River near Nicolaus
Data Below Detection
100
90
80
70
60
50
40
30
20
mg/L
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

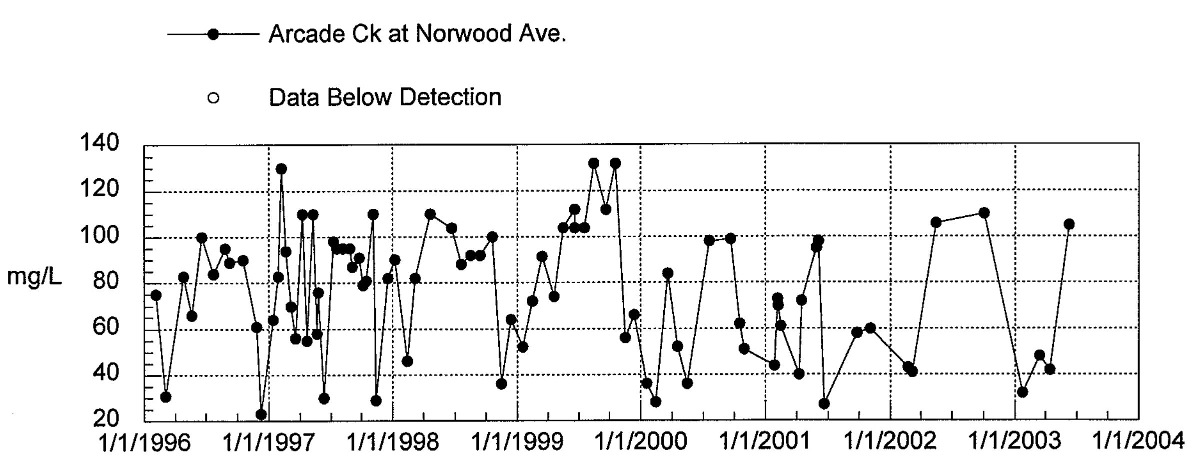

Yuba River at Marysville
Data Below Detection
60
50
40
30
20
10
mg/L
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


American River at Discovery Park
Data Below Detection
mg/L
0
20
40
60
80
100
120
1/1/1992
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

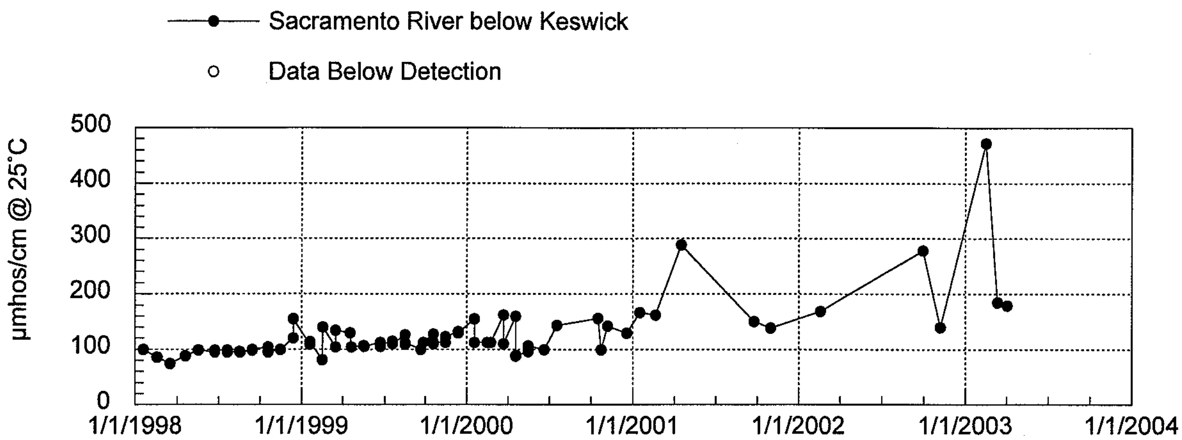

Pit River above Shasta
Data Below Detection
mg/L
10
20
30
40
50
60
70
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

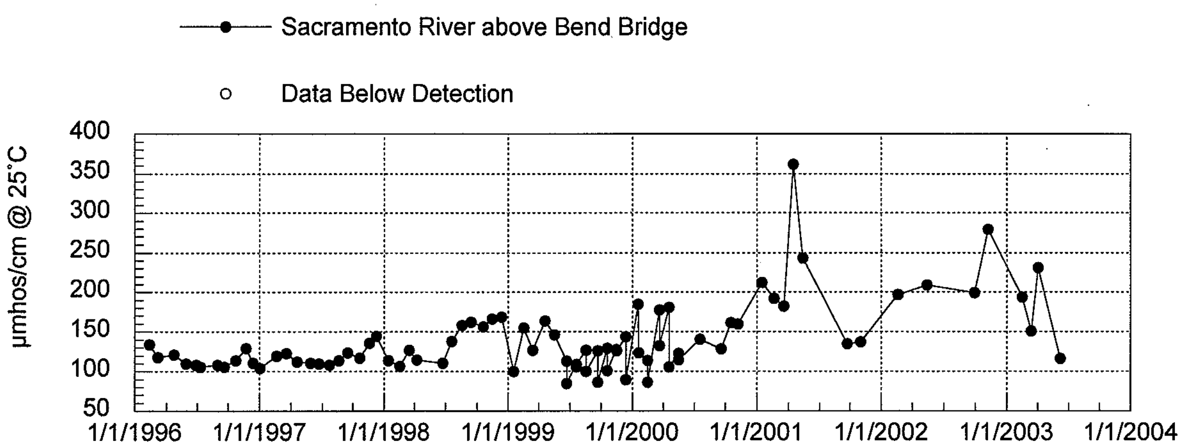

Colusa Basin Drain
Data Below Detection
mg/L
0
50
100
150
200
250
300
350
400
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

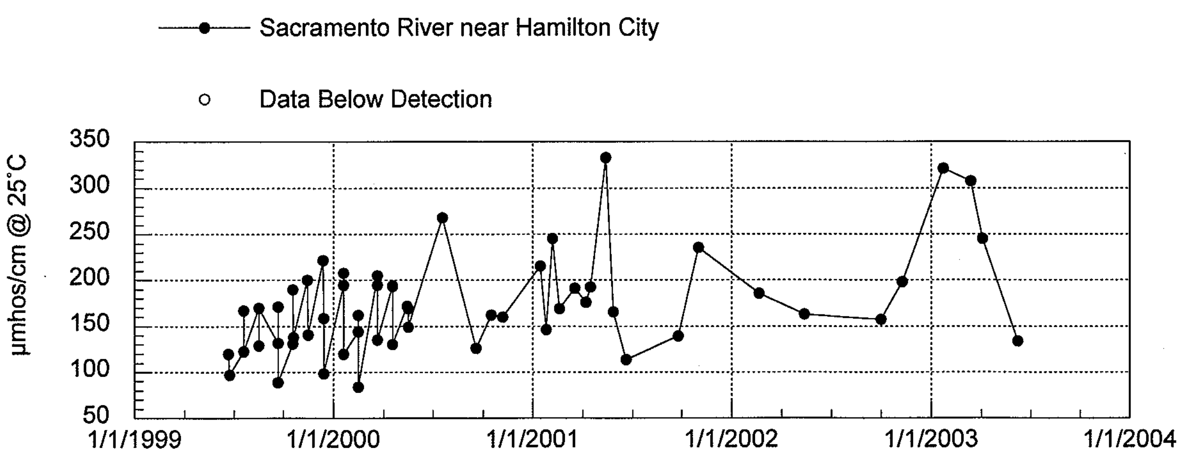

Sacramento Slough
Data Below Detection
mg/L
700
600
500
400
300
200
100
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

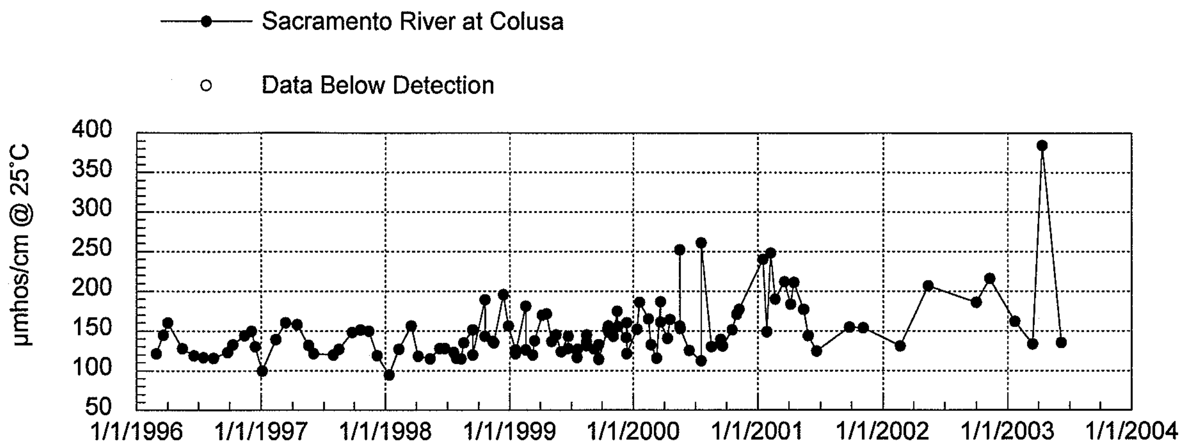

Arcade Ck at Norwood Ave.
Data Below Detection
mg/L
140
120
100
80
60
40
20
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

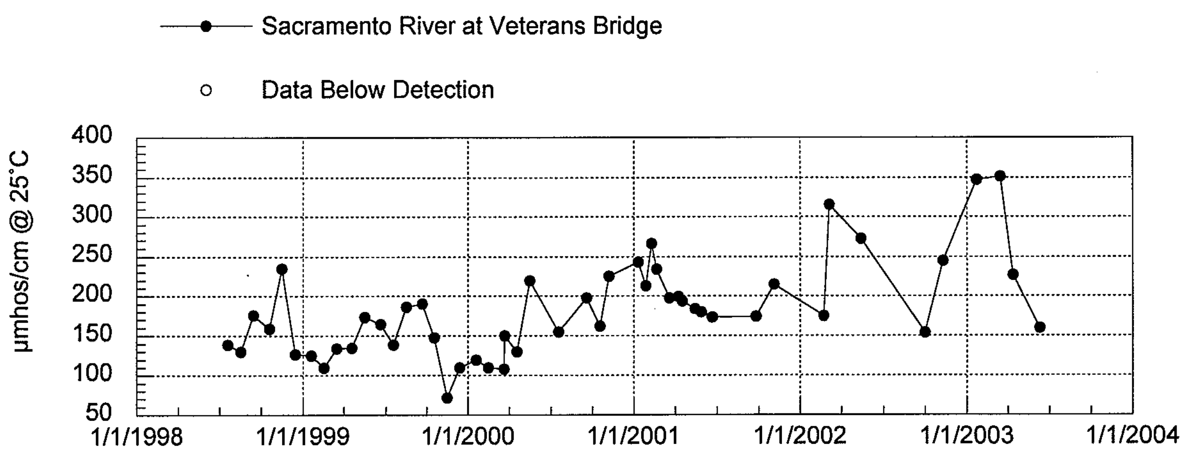
SPECIFIC CONDUCTANCE AT 25°C

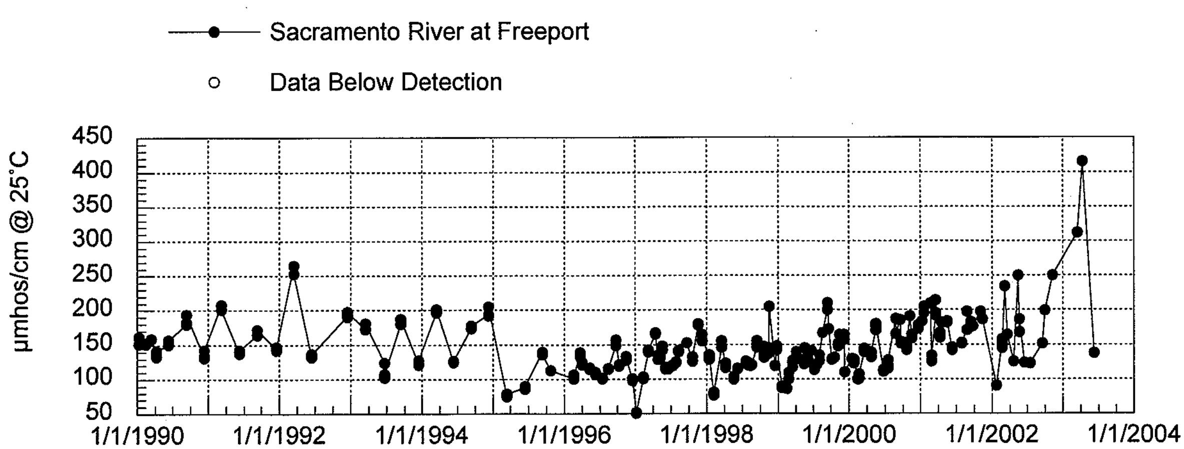


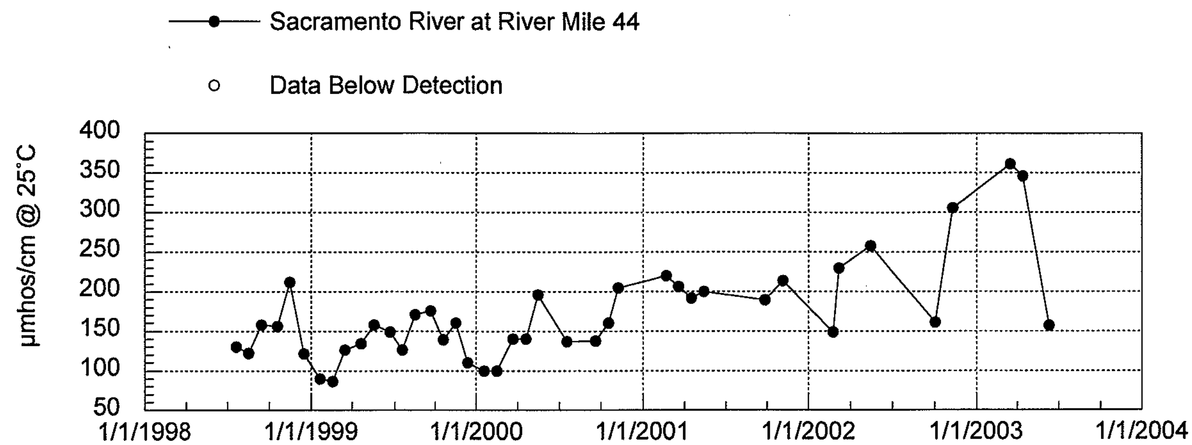




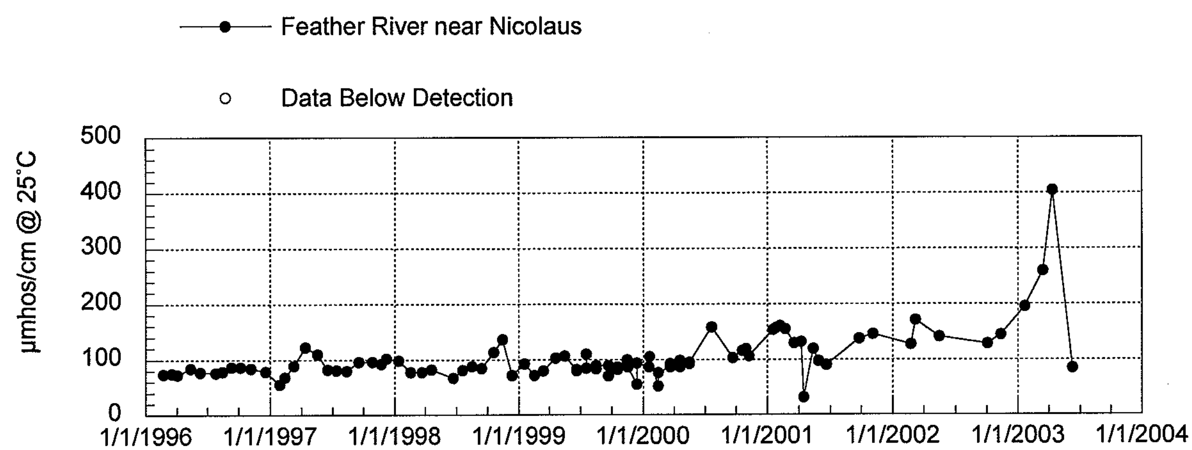

Sacramento River at Colusa
Data Below Detection
µmhos/cm @ 25°C
400
350
300
250
200
150
100
50
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento River at Veterans Bridge
Data Below Detection
µmhos/cm @ 25°C
400
350
300
250
200
150
100
50
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

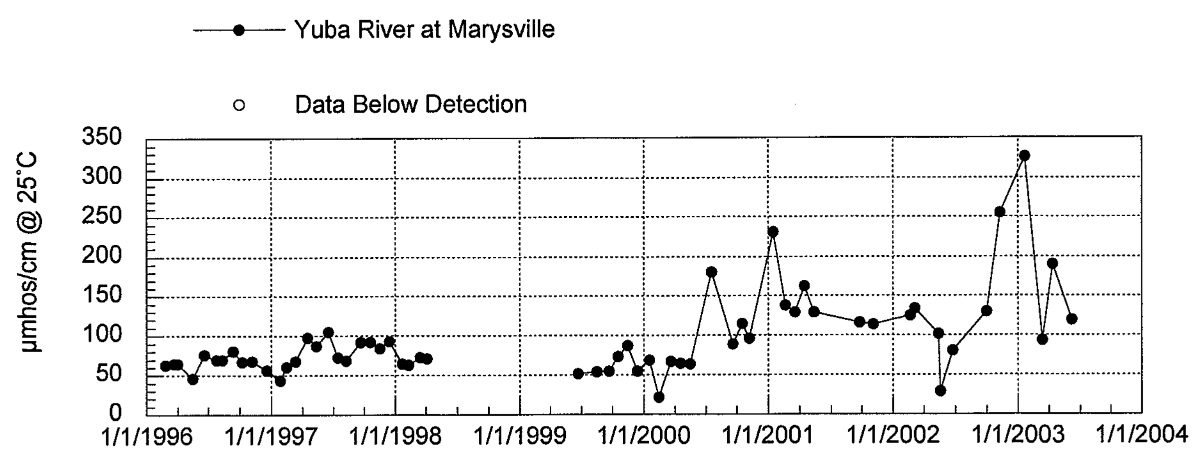

Sacramento River at Freeport
Data Below Detection
µmhos/cm @ 25°C
450
400
350
300
250
200
150
100
50
1/1/1990
1/1/1992
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004



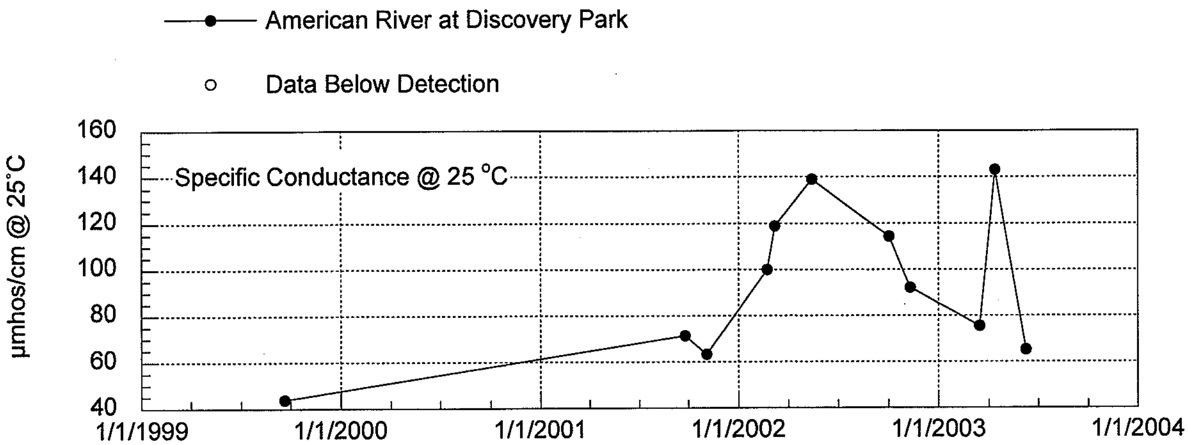
Sacramento River at River Mile 44
Data Below Detection
µmhos/cm @ 25°C
400
350
300
250
200
150
100
50
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

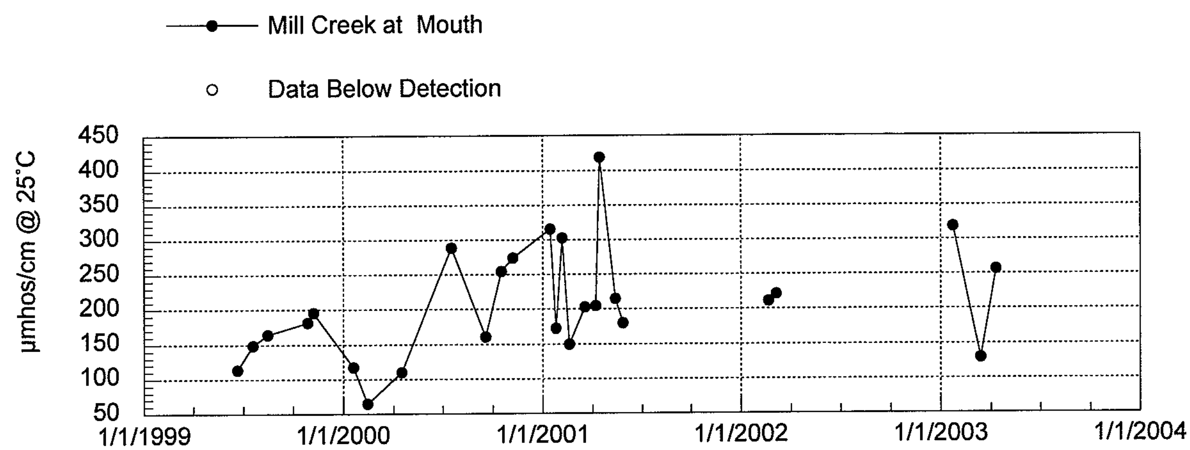


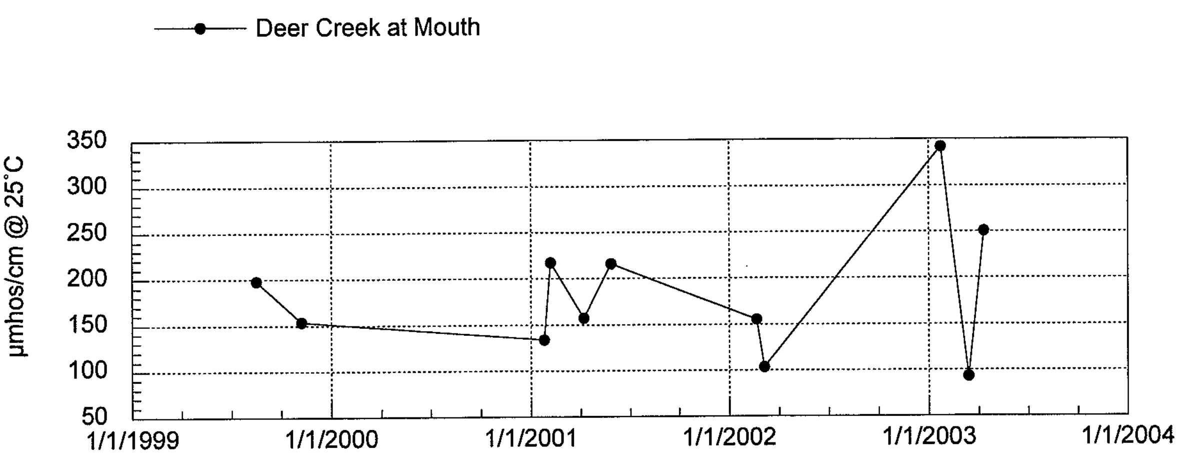
Feather River near Nicolaus
Data Below Detection
µmhos/cm @ 25°C
500
400
300
200
100
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

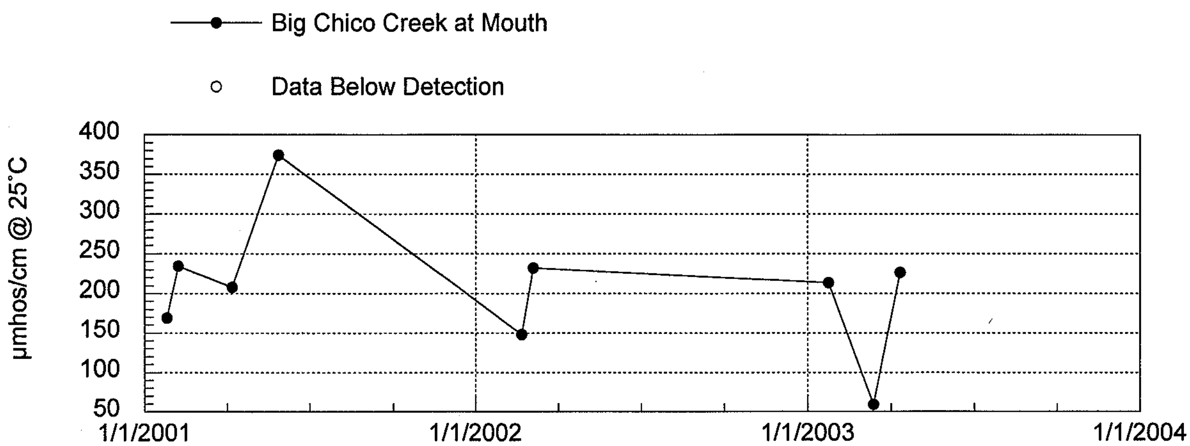


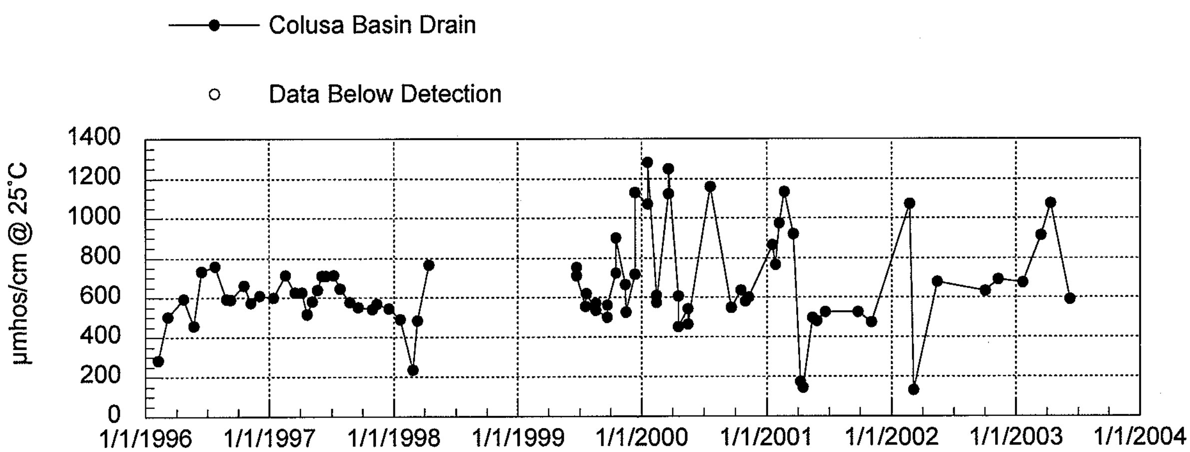
Yuba River at Marysville
Data Below Detection
µmhos/cm @ 25°C
350
300
250
200
150
100
50
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

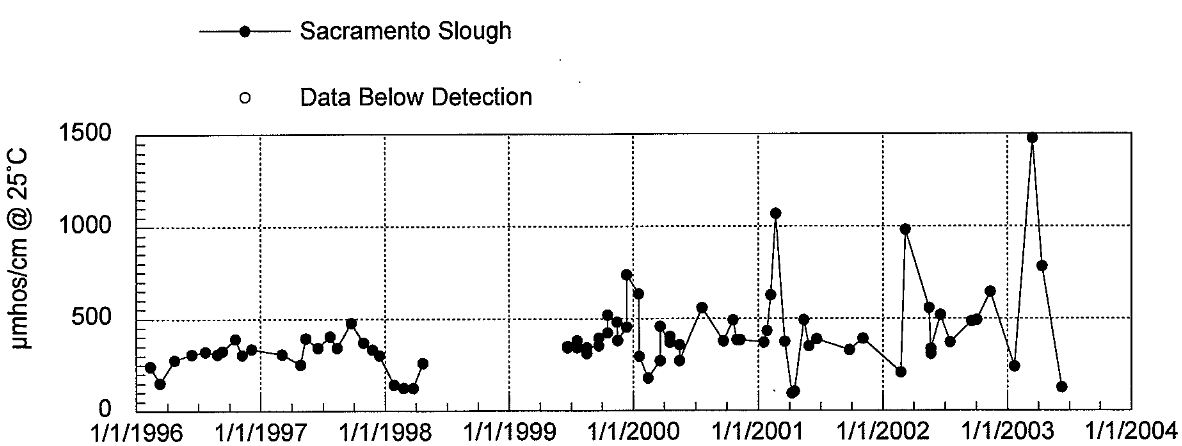

American River at Discovery Park
Data Below Detection
Specific Conductance @ 25 °C
μmhos/cm @ 25°C
160
140
120
100
80
60
40
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

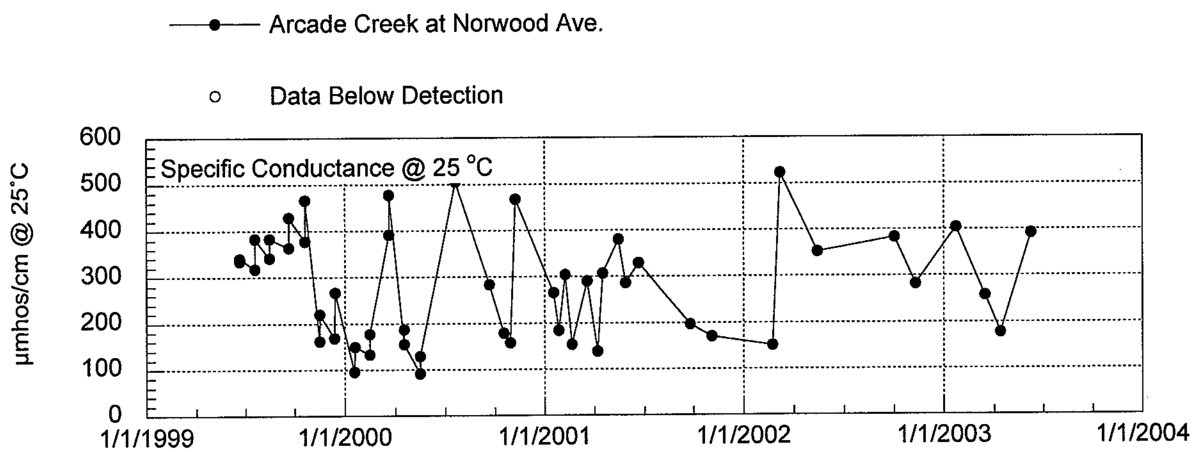

Mill Creek at Mouth
Data Below Detection
μmhos/cm @ 25°C
450
400
350
300
250
200
150
100
50
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Deer Creek at Mouth
μmhos/cm @ 25°C
350
300
250
200
150
100
50
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

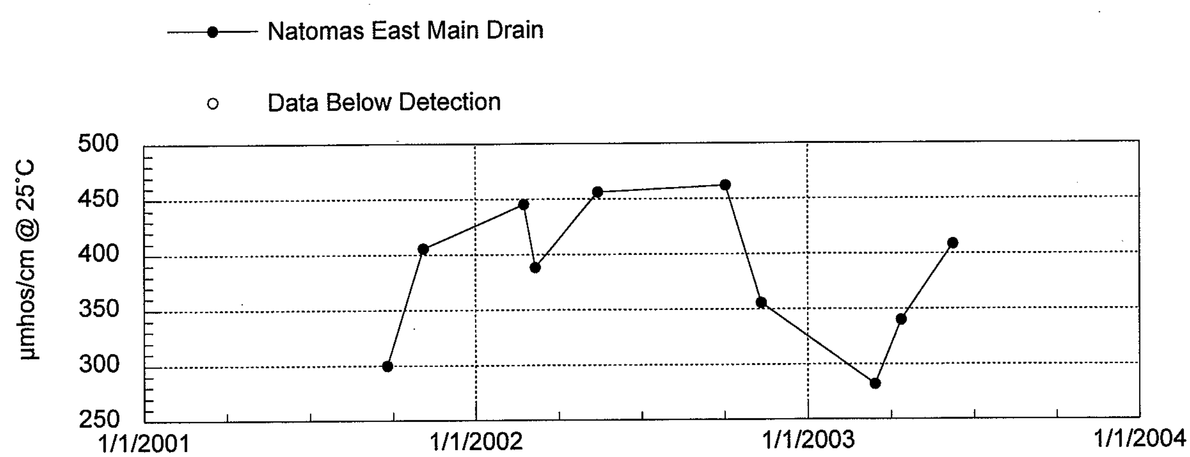

Big Chico Creek at Mouth
Data Below Detection
µmhos/cm @ 25°C
400
350
300
250
200
150
100
50
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Colusa Basin Drain
Data Below Detection
µmhos/cm @ 25°C
1400
1200
1000
800
600
400
200
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

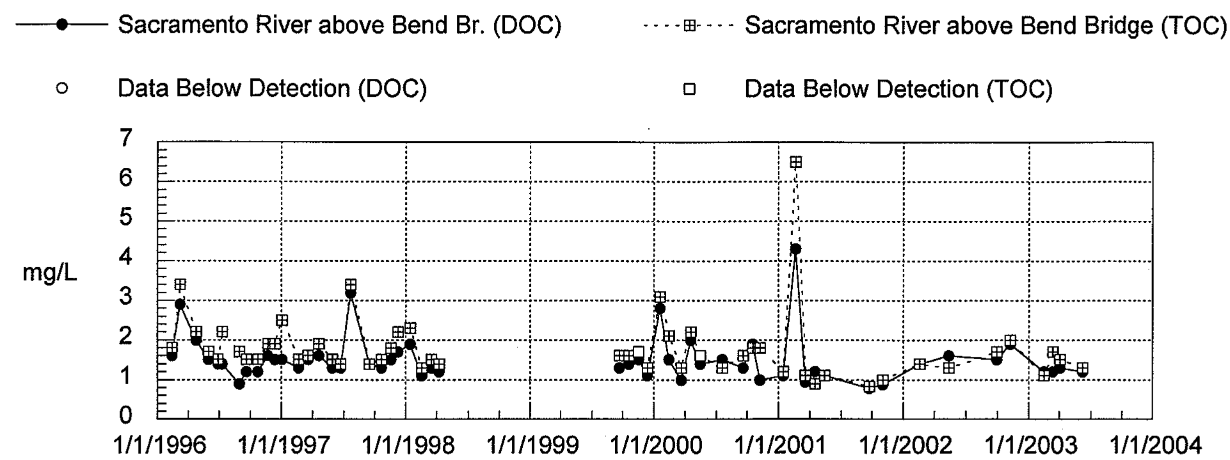

Sacramento Slough
Data Below Detection
µmhos/cm @ 25°C
1500
1000
500
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

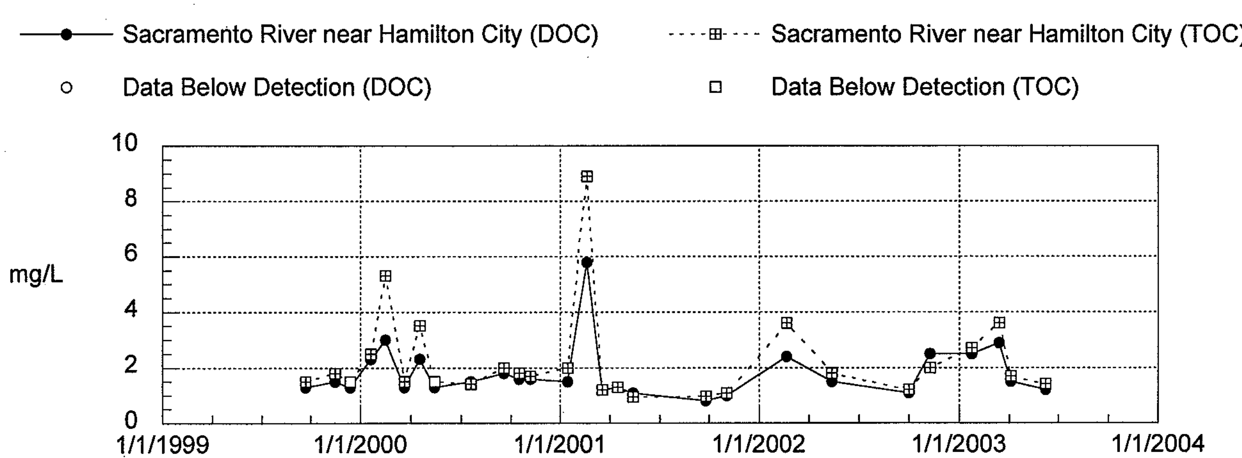


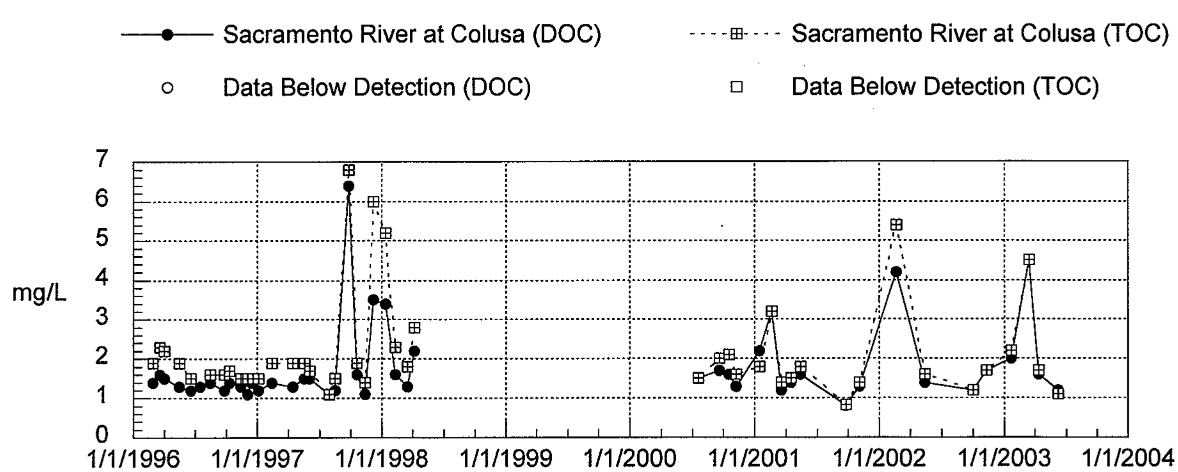
Arcade Creek at Norwood Ave.
Data Below Detection
Specific Conductance @ 25 °C
µmhos/cm @ 25°C
600
500
400
300
200
100
0
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

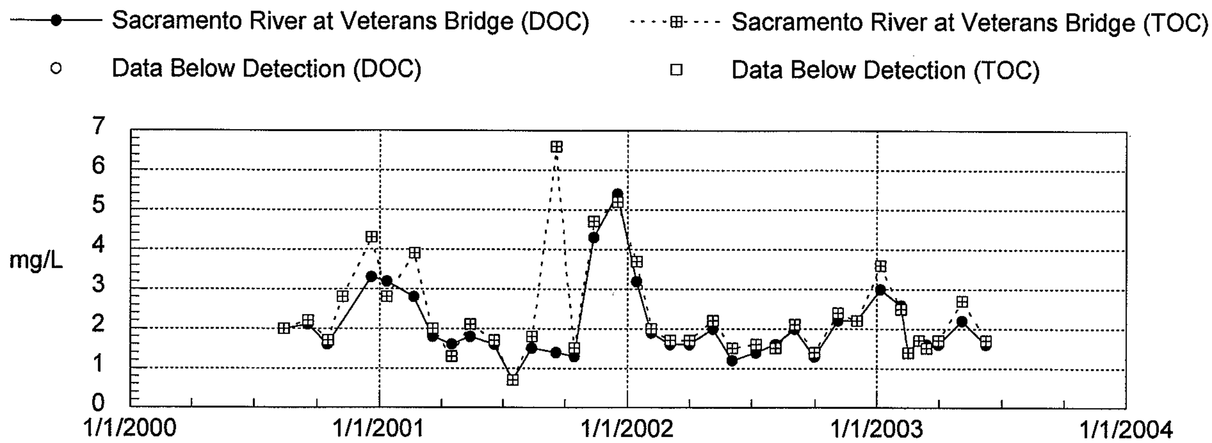


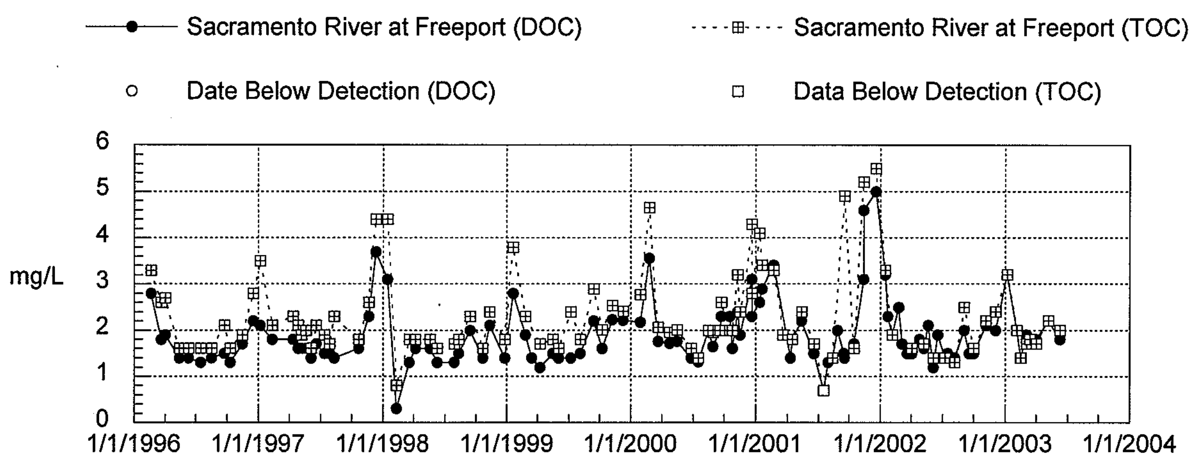
Natomas East Main Drain
Data Below Detection
µmhos/cm @ 25°C
500
450
400
350
300
250
1/1/2001
1/1/2002
1/1/2003
1/1/2004

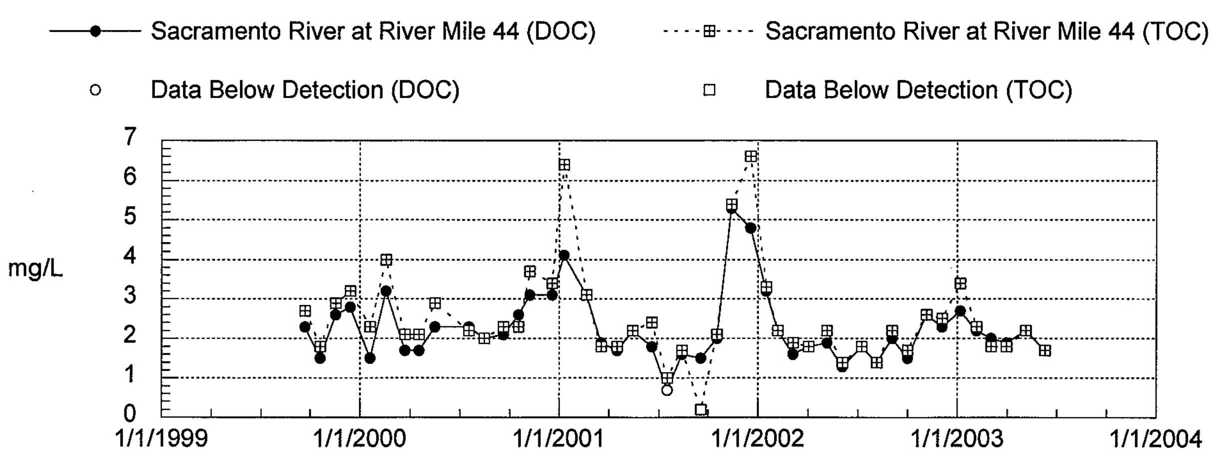

Sacramento River above Bend Br. (DOC)
Sacramento River above Bend Bridge (TOC)
Data Below Detection (DOC)
Data Below Detection (TOC)
mg/L
0
1
2
3
4
5
6
7
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

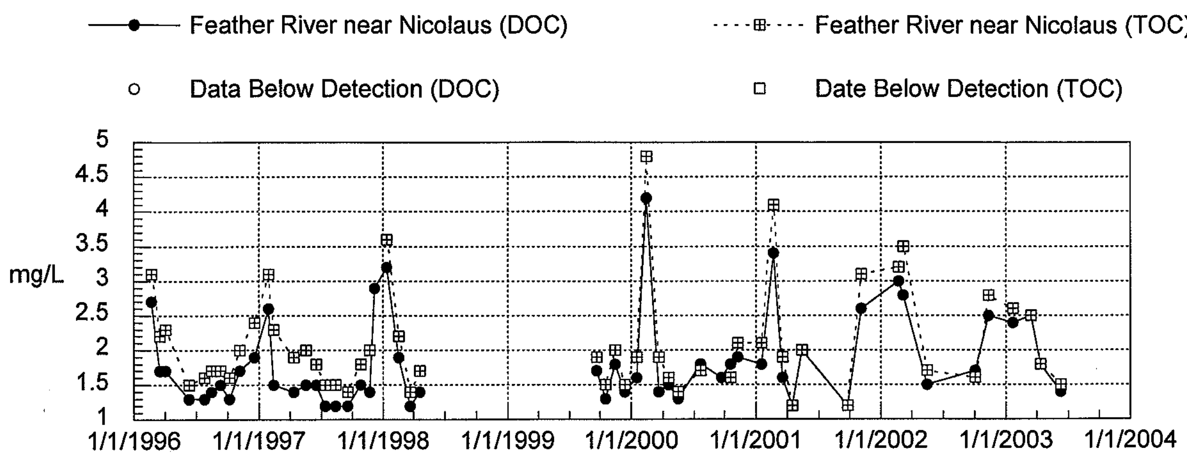

Sacramento River near Hamilton City (DOC)
Sacramento River near Hamilton City (TOC)
Data Below Detection (DOC)
Data Below Detection (TOC)
mg/L
0
2
4
6
8
10
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

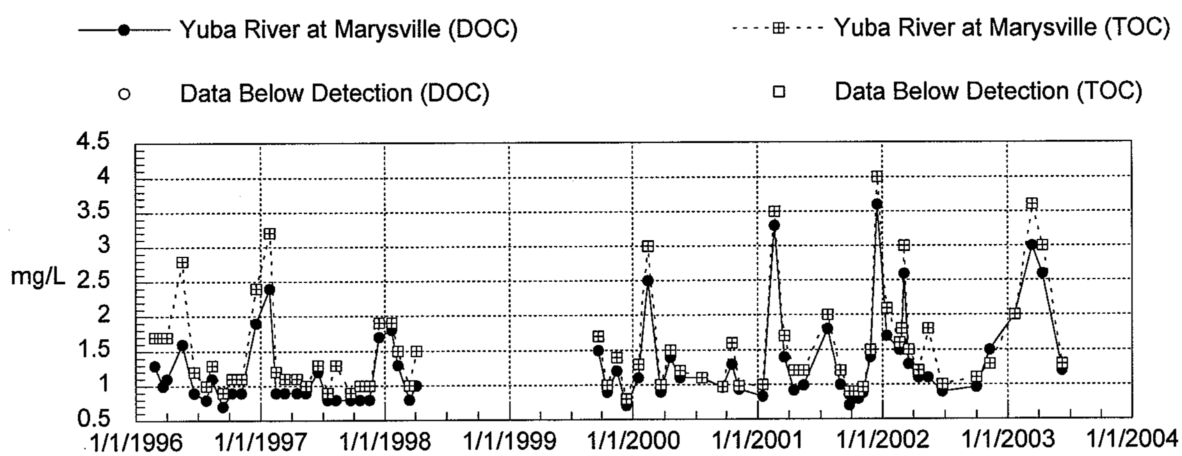

Sacramento River at Colusa (DOC)
Sacramento River at Colusa (TOC)
Data Below Detection (DOC)
Data Below Detection (TOC)
mg/L
0
1
2
3
4
5
6
7
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

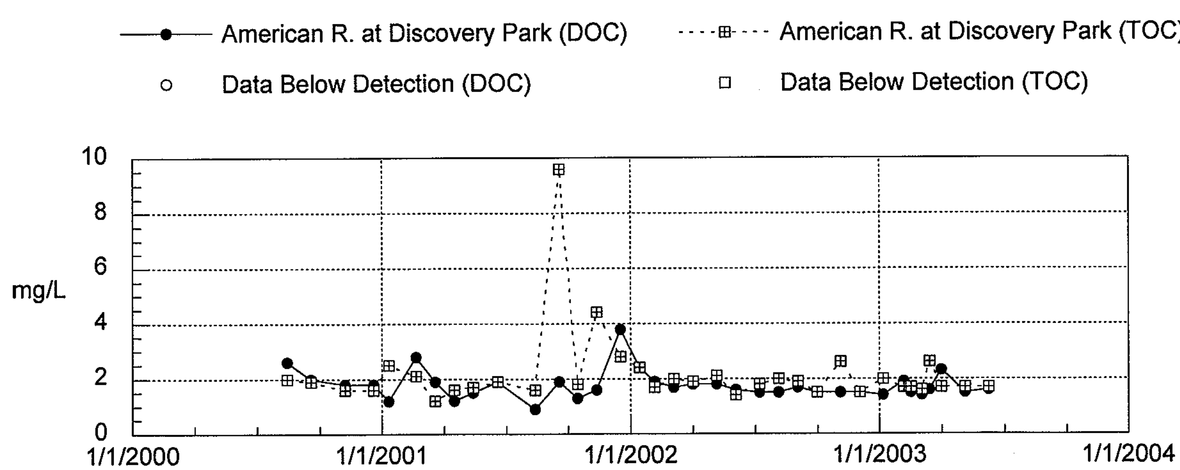

Sacramento River at Veterans Bridge (DOC)
Sacramento River at Veterans Bridge (TOC)
Data Below Detection (DOC)
Data Below Detection (TOC)
mg/L
0
1
2
3
4
5
6
7
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

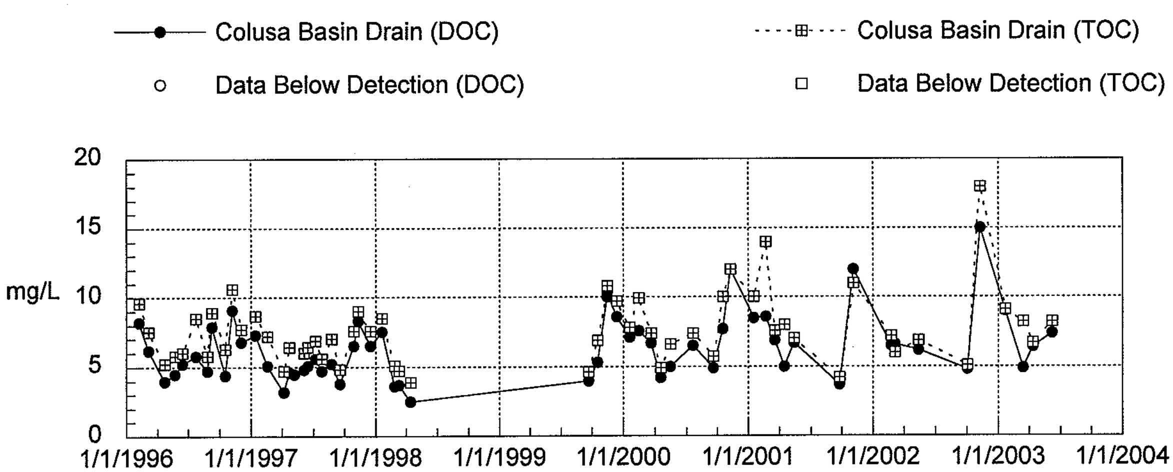

Sacramento River at Freeport (DOC)
Sacramento River at Freeport (TOC)
Date Below Detection (DOC)
Data Below Detection (TOC)
mg/L
0
1
2
3
4
5
6
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento River at River Mile 44 (DOC)
Sacramento River at River Mile 44 (TOC)
Data Below Detection (DOC)
Data Below Detection (TOC)
mg/L
0
1
2
3
4
5
6
7
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

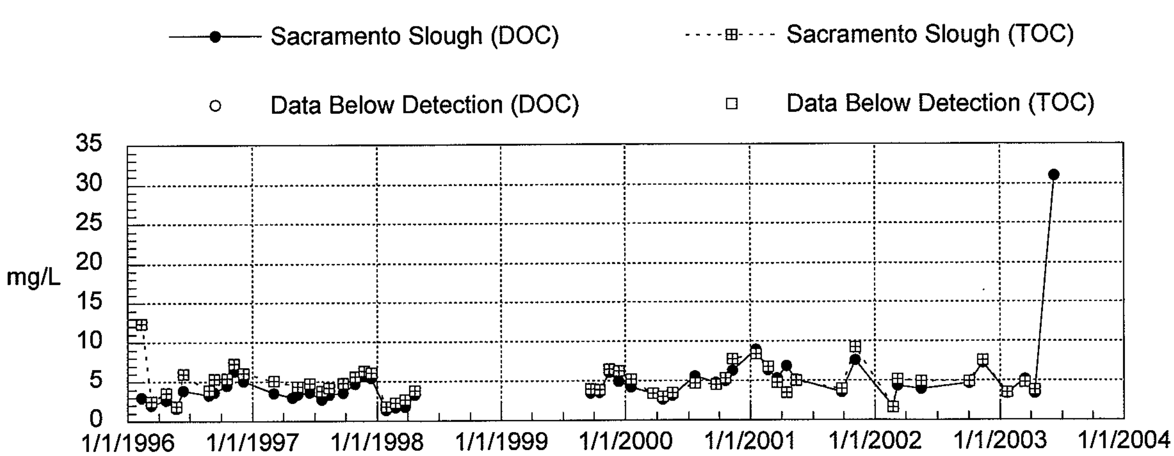

Feather River near Nicolaus (DOC)
Feather River near Nicolaus (TOC)
Data Below Detection (DOC)
Date Below Detection (TOC)
mg/L
5
4.5
4
3.5
3
2.5
2
1.5
1
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Yuba River at Marysville (DOC)
Yuba River at Marysville (TOC)
Data Below Detection (DOC)
Data Below Detection (TOC)
mg/L
4.5
4
3.5
3
2.5
2
1.5
1
0.5
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


American R. at Discovery Park (DOC)
American R. at Discovery Park (TOC)
Data Below Detection (DOC)
Data Below Detection (TOC)
mg/L
10
8
6
4
2
0
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

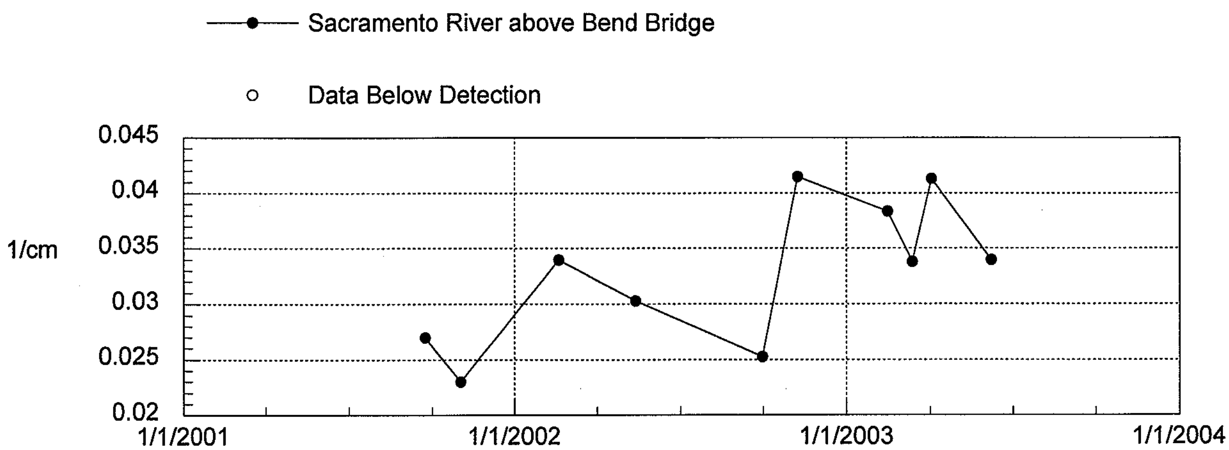


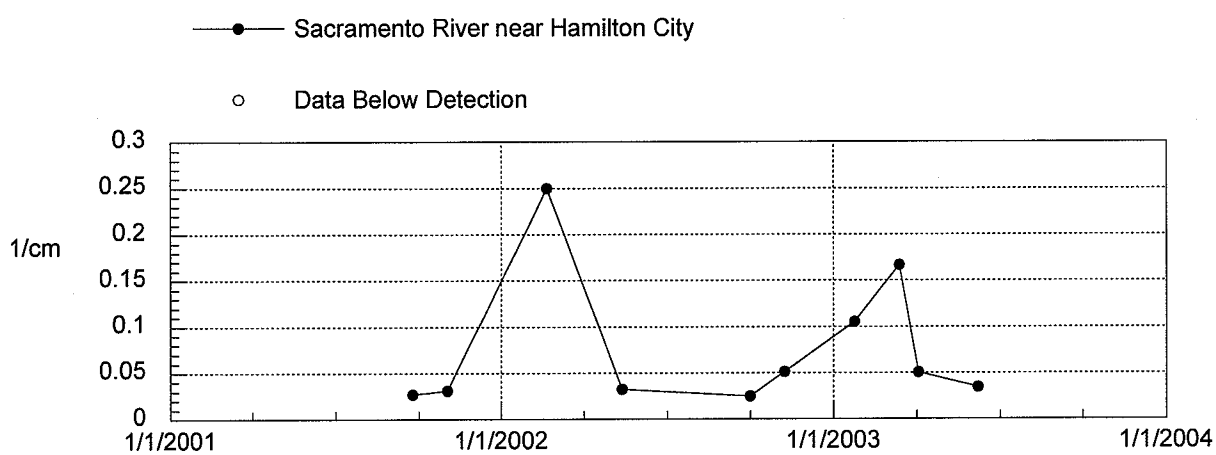
Colusa Basin Drain (DOC)
Colusa Basin Drain (TOC)
Data Below Detection (DOC)
Data Below Detection (TOC)
mg/L
20
15
10
5
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

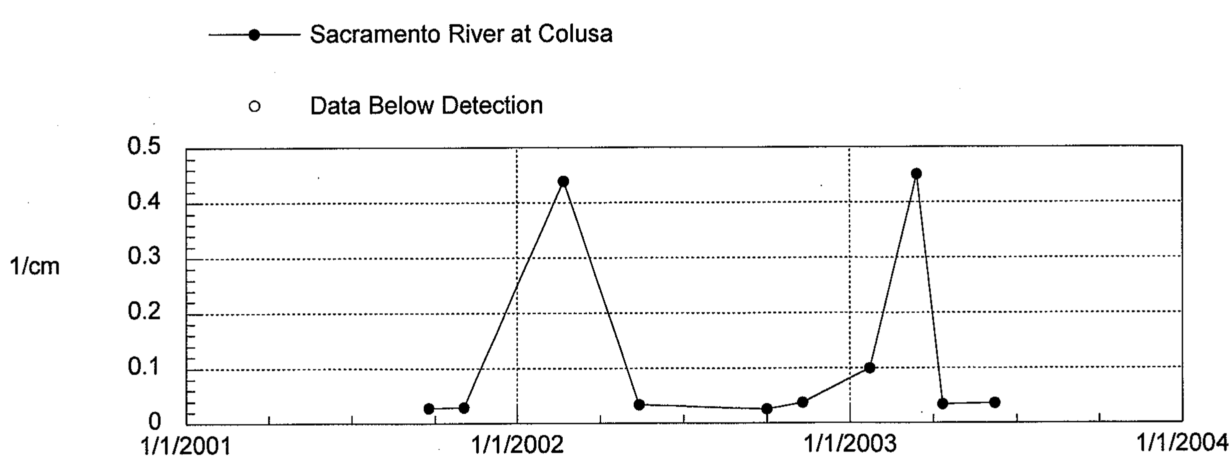


Sacramento Slough (DOC)
Sacramento Slough (TOC)
Data Below Detection (DOC)
Data Below Detection (TOC)
mg/L
35
30
25
20
15
10
5
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

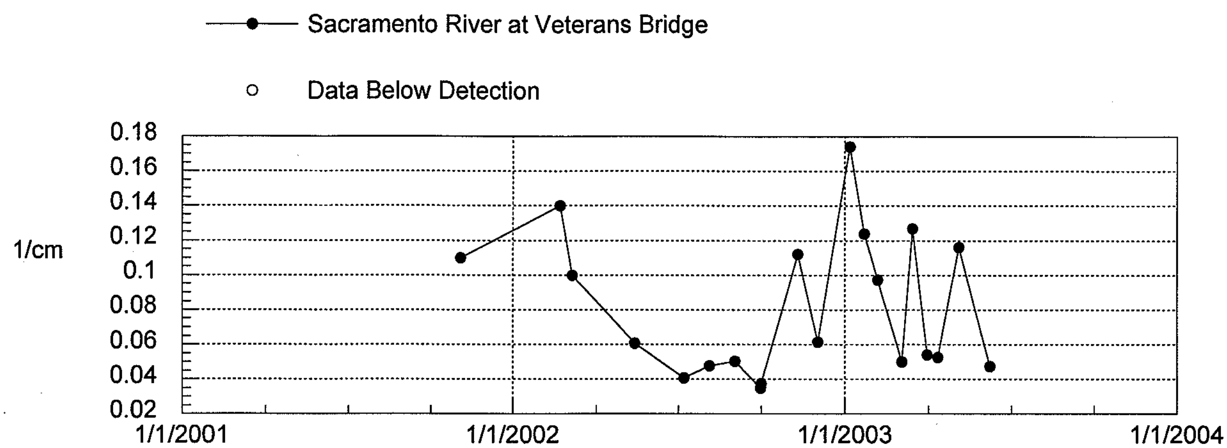
ULTRAVIOLET ABSORBANCE AT 254 nm

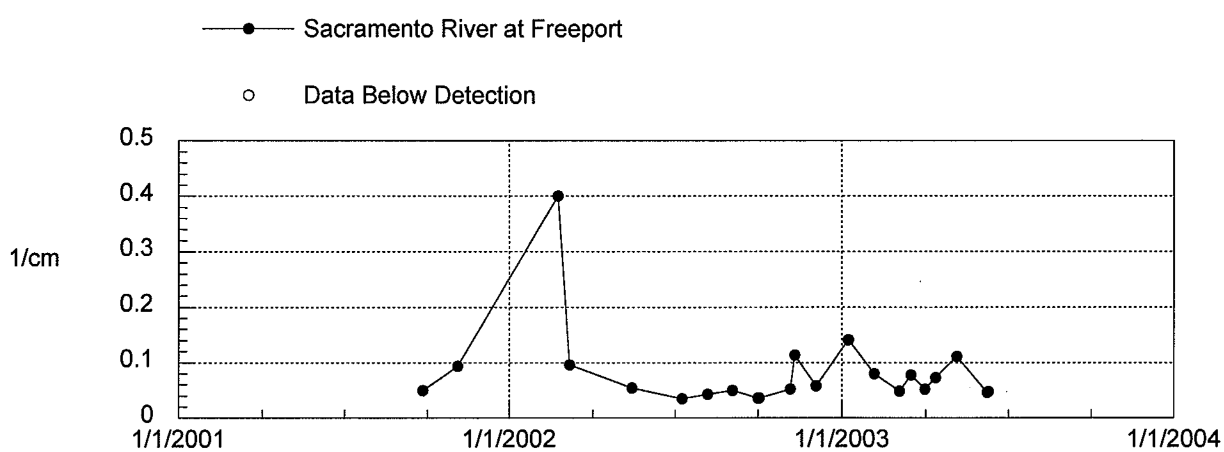


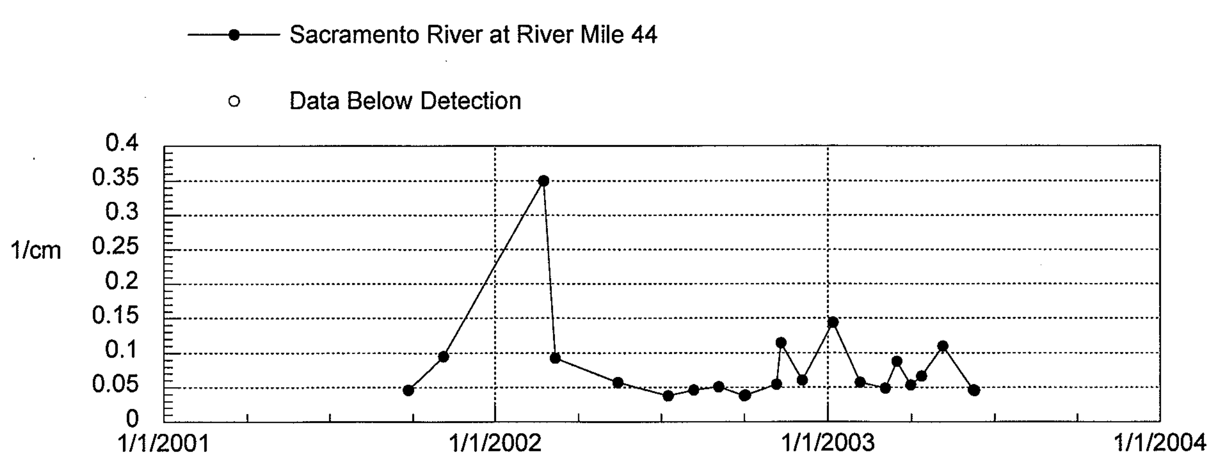




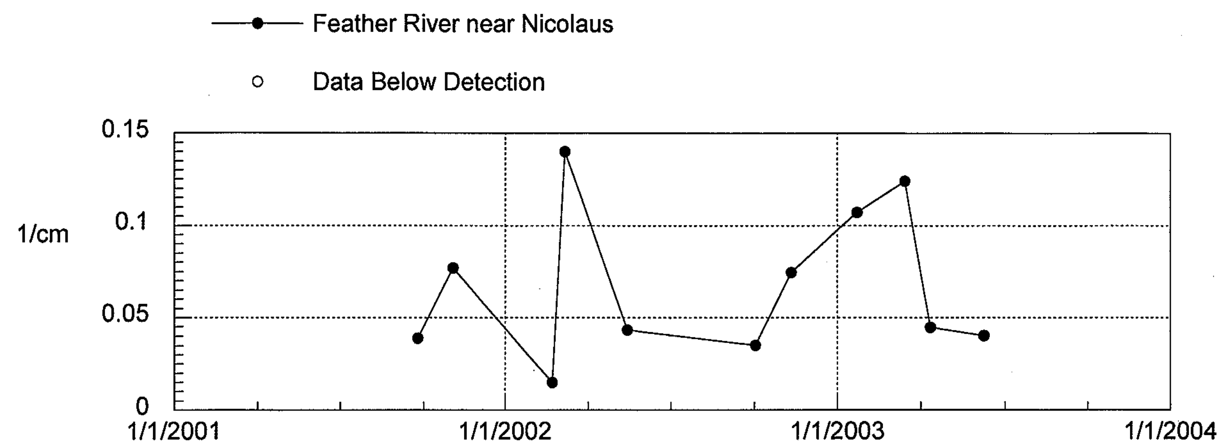
ULTRAVIOLET ABSORBANCE AT 254 nm

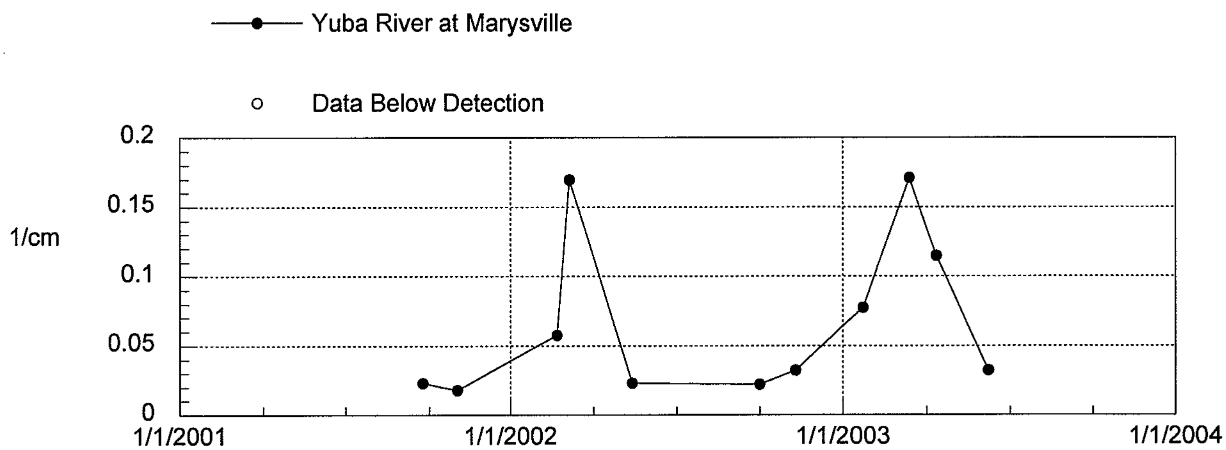


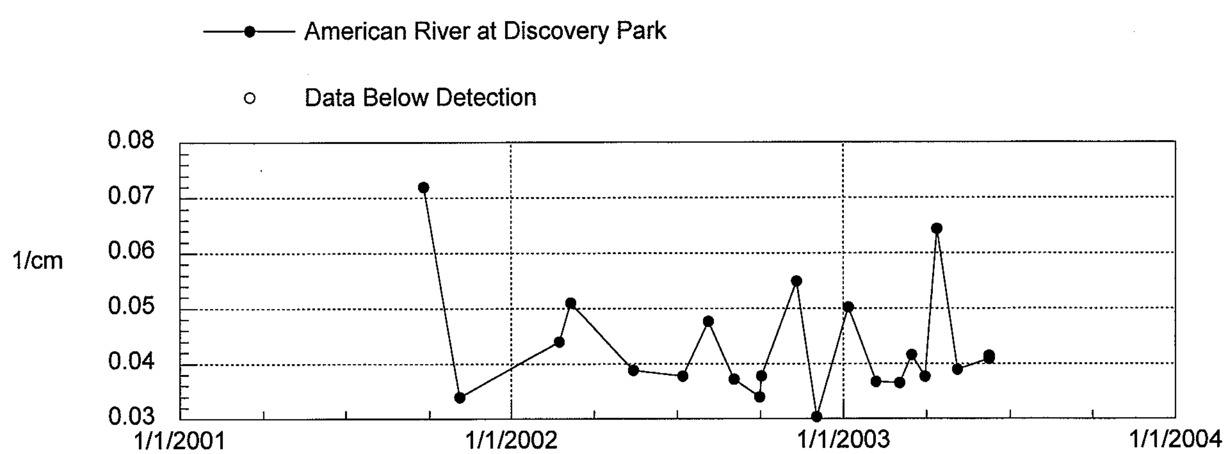




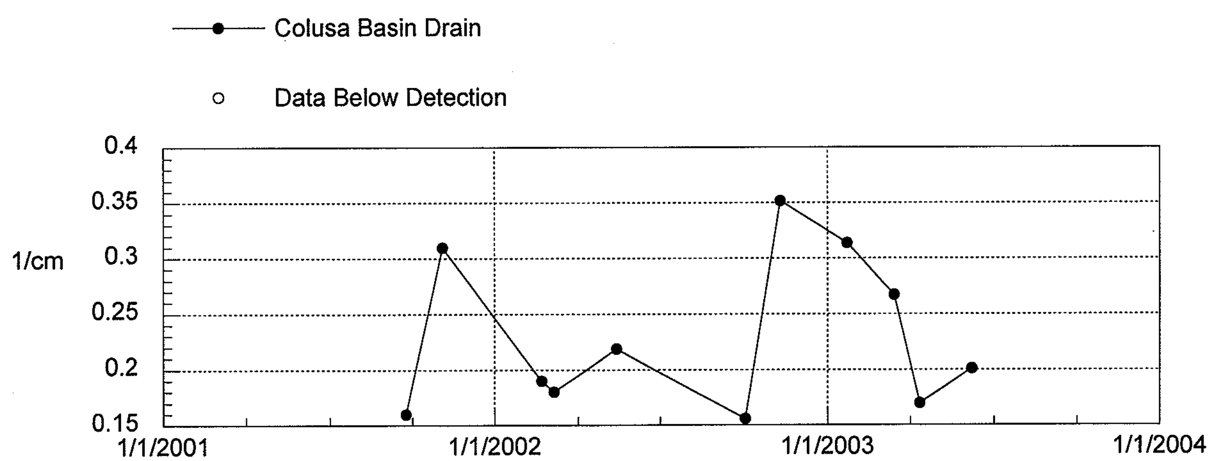
ULTRAVIOLET ABSORBANCE AT 254 nm

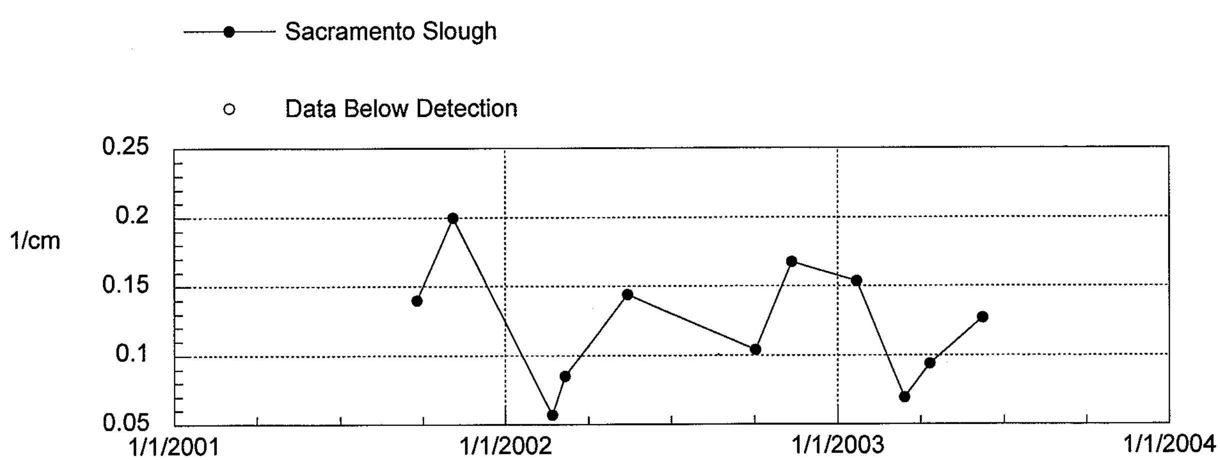


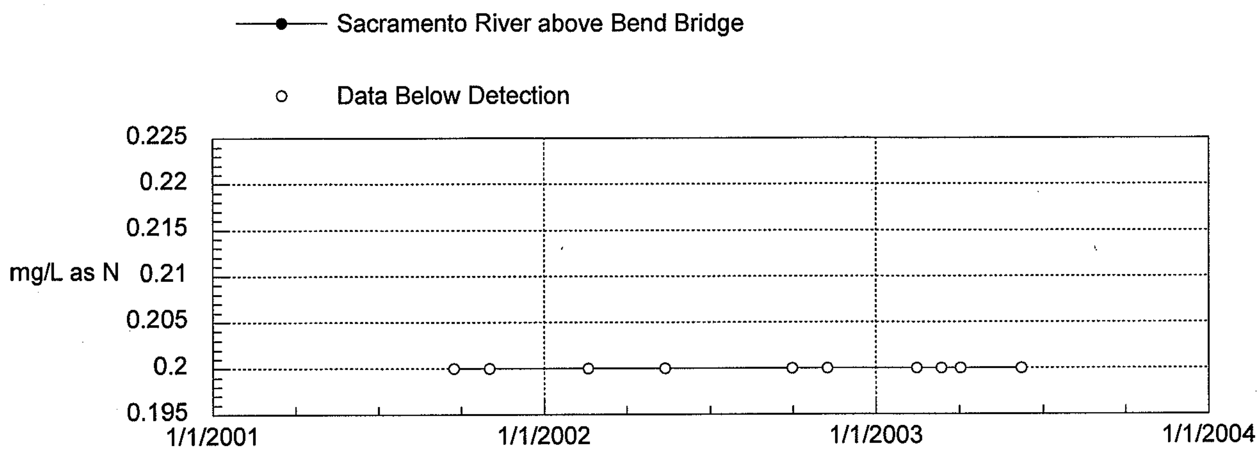


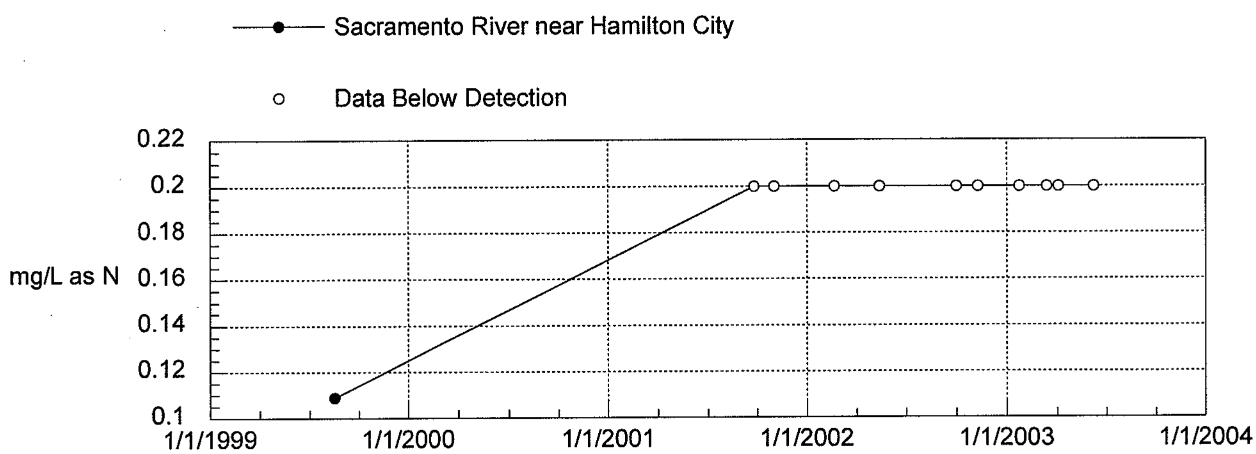


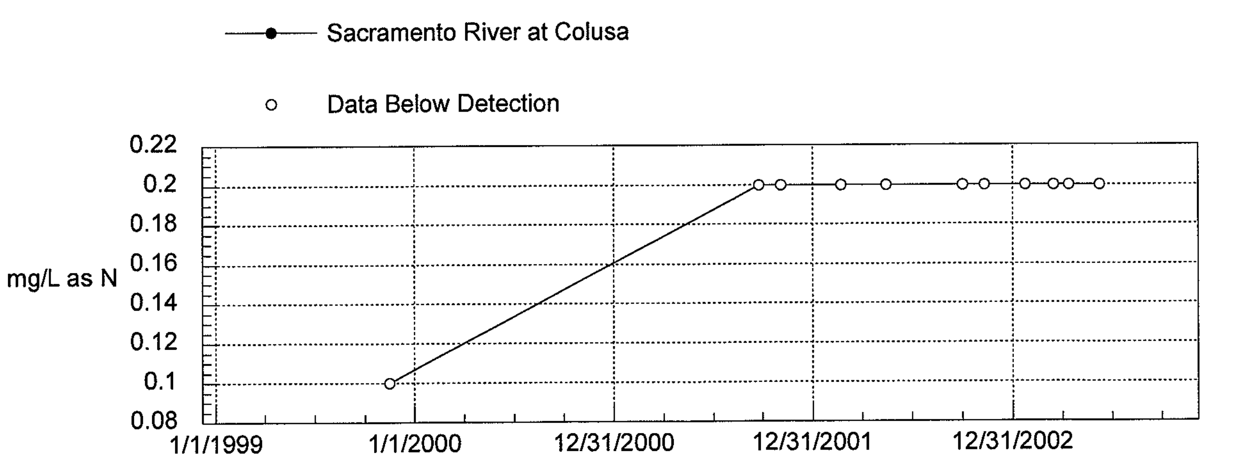
ULTRAVIOLET ABSORBANCE AT 254 nm

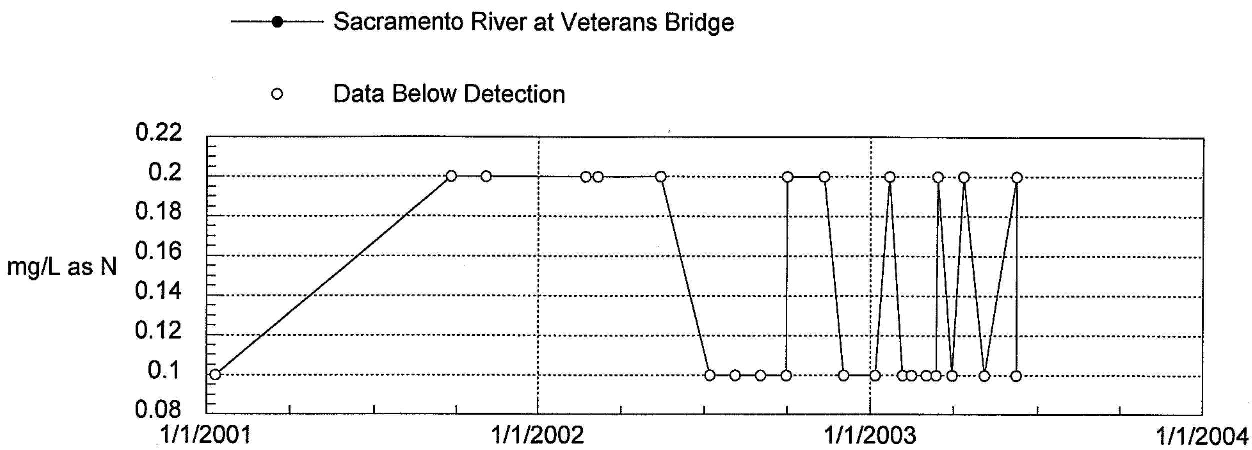


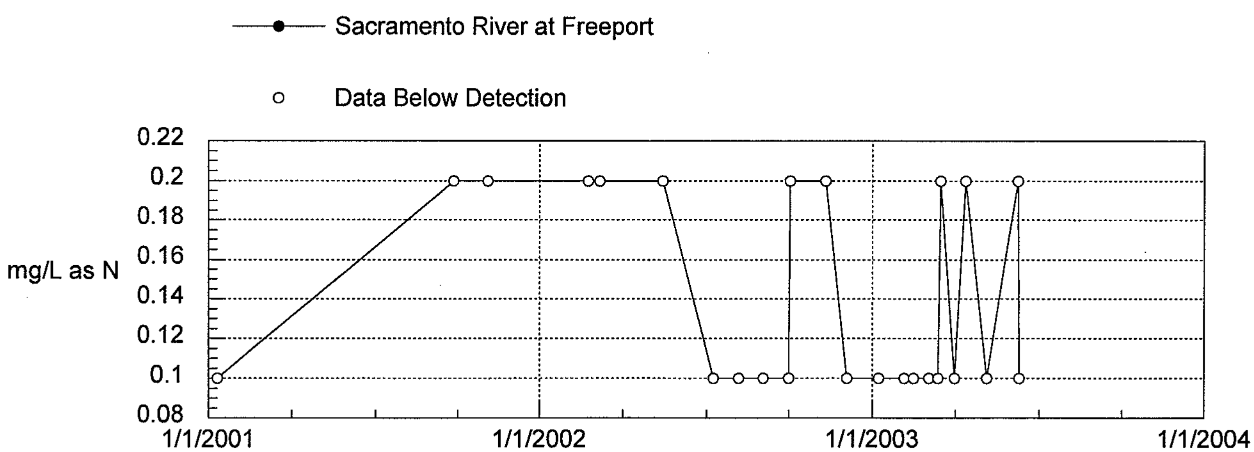


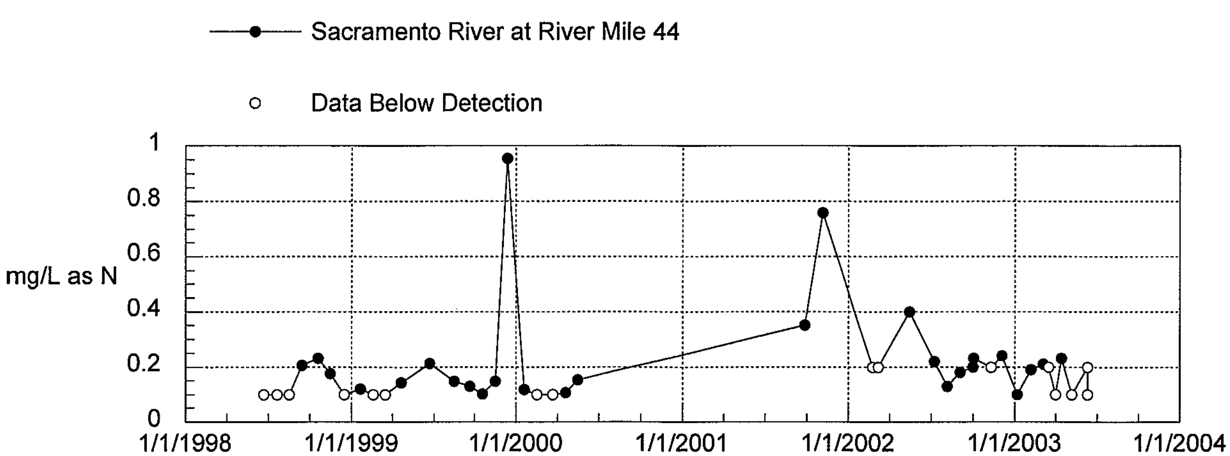

Sacramento River above Bend Bridge
Data Below Detection
mg/L as N
0.225
0.22
0.215
0.21
0.205
0.2
0.195
1/1/2001
1/1/2002
1/1/2003
1/1/2004

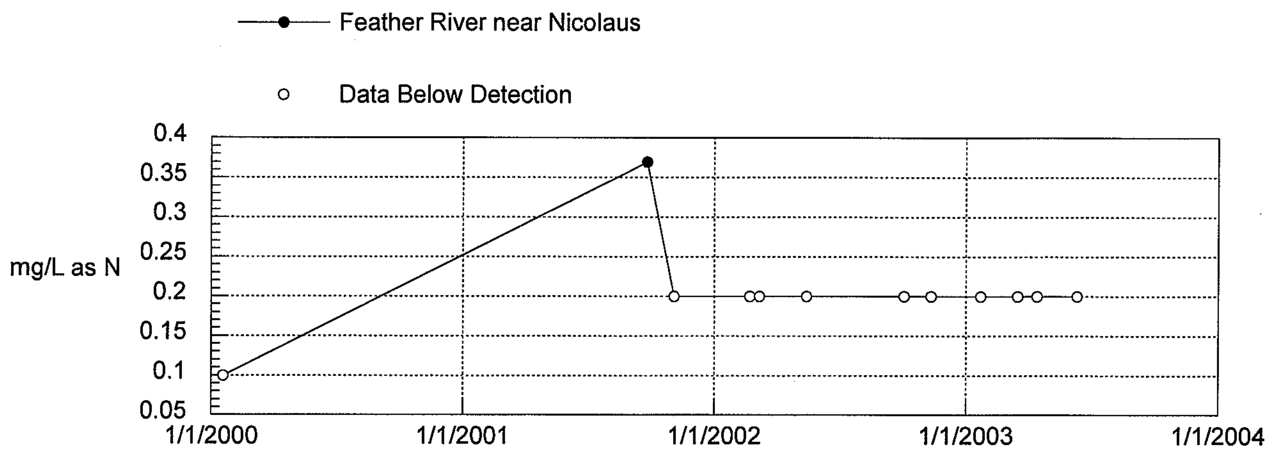

Sacramento River near Hamilton City
Data Below Detection
mg/L as N
0.22
0.2
0.18
0.16
0.14
0.12
0.1
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

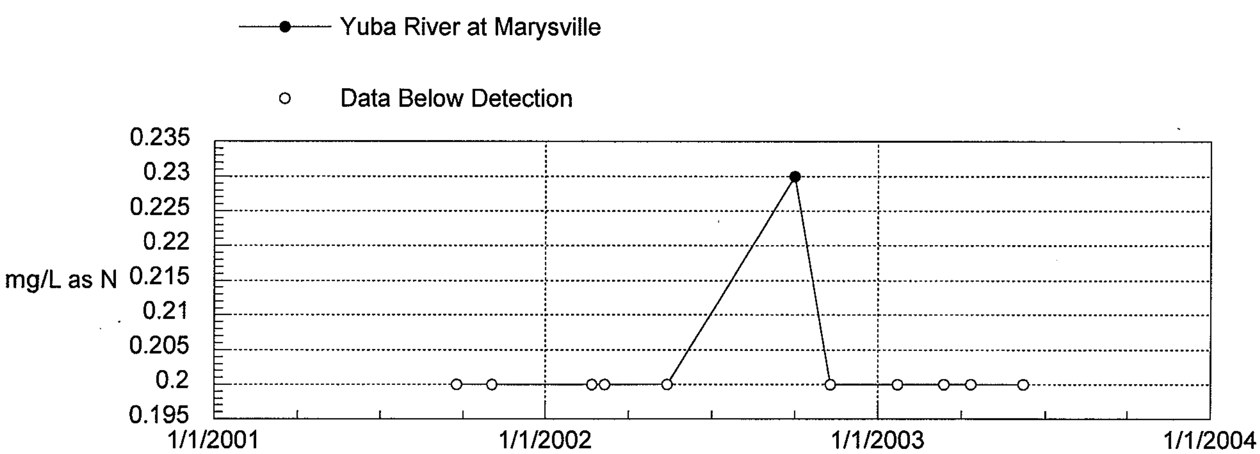

Sacramento River at Colusa
Data Below Detection
mg/L as N
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
1/1/1999
1/1/2000
12/31/2000
12/31/2001
12/31/2002

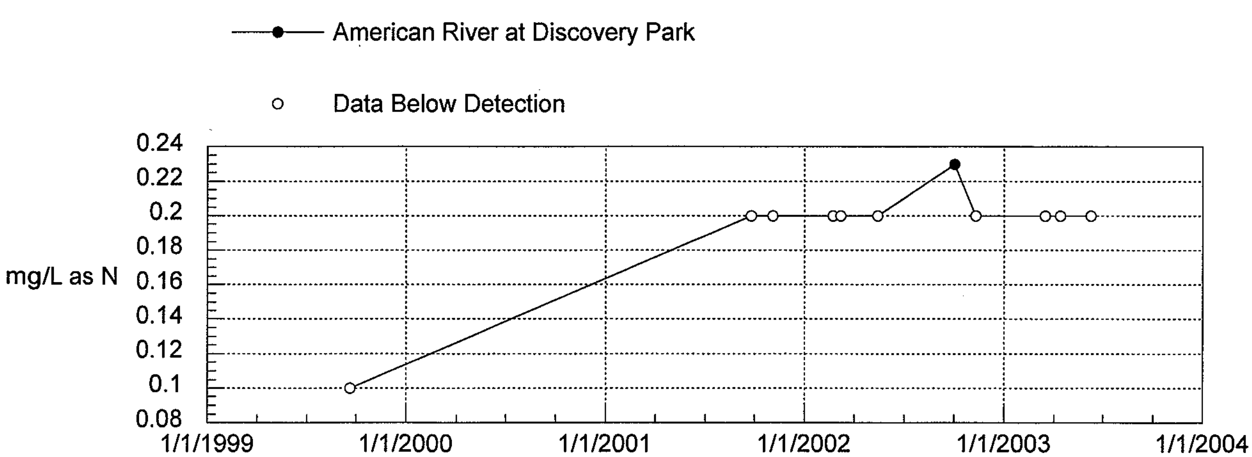

Sacramento River at Veterans Bridge
Data Below Detection
mg/L as N
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
1/1/2001
1/1/2002
1/1/2003
1/1/2004

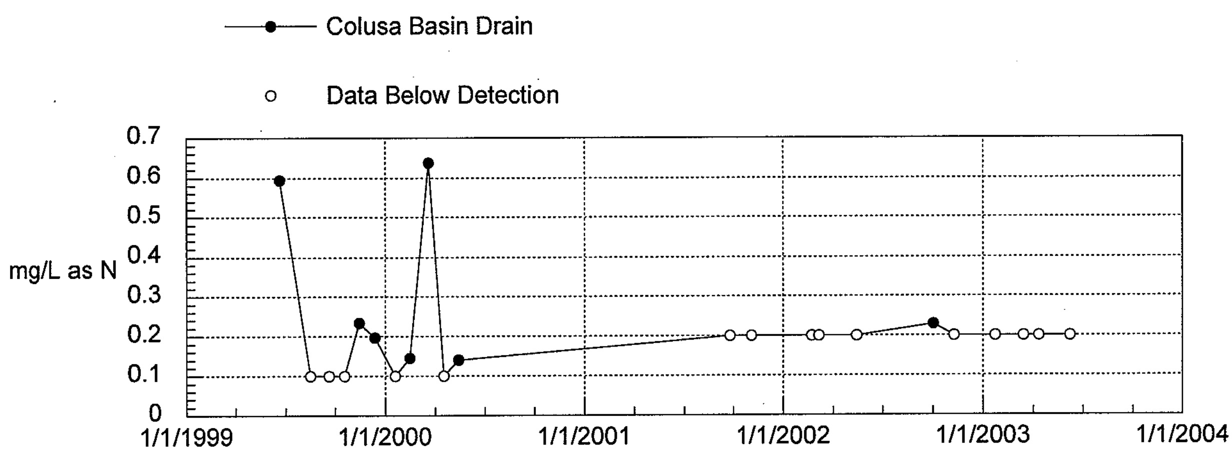

Sacramento River at Freeport
Data Below Detection
mg/L as N
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
1/1/2001
1/1/2002
1/1/2003
1/1/2004

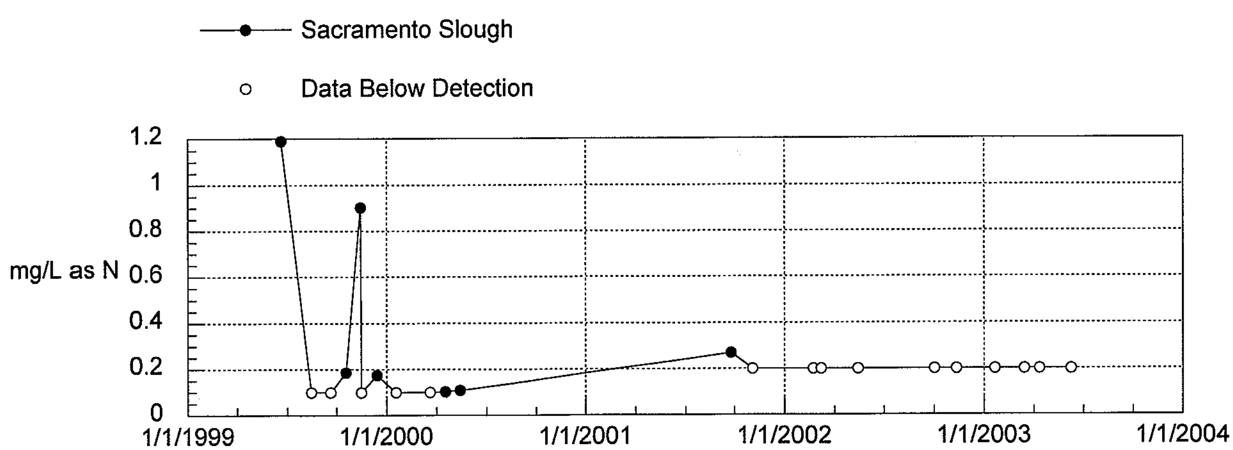

Sacramento River at River Mile 44
Data Below Detection
mg/L as N
1
0.8
0.6
0.4
0.2
0
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

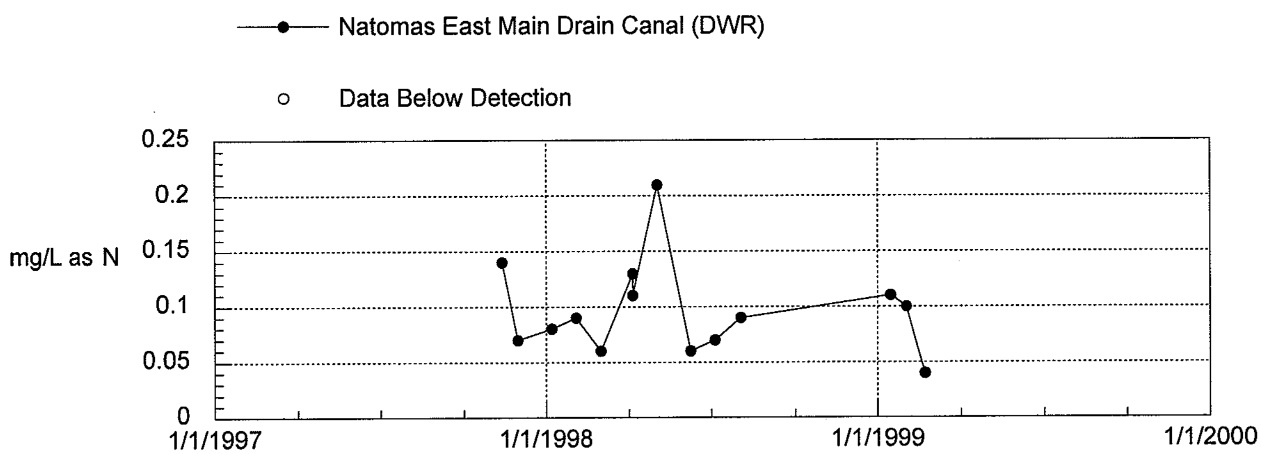

Feather River near Nicolaus
Data Below Detection
mg/L as N
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Yuba River at Marysville
Data Below Detection
mg/L as N
0.235
0.23
0.225
0.22
0.215
0.21
0.205
0.2
0.195
1/1/2001
1/1/2002
1/1/2003
1/1/2004

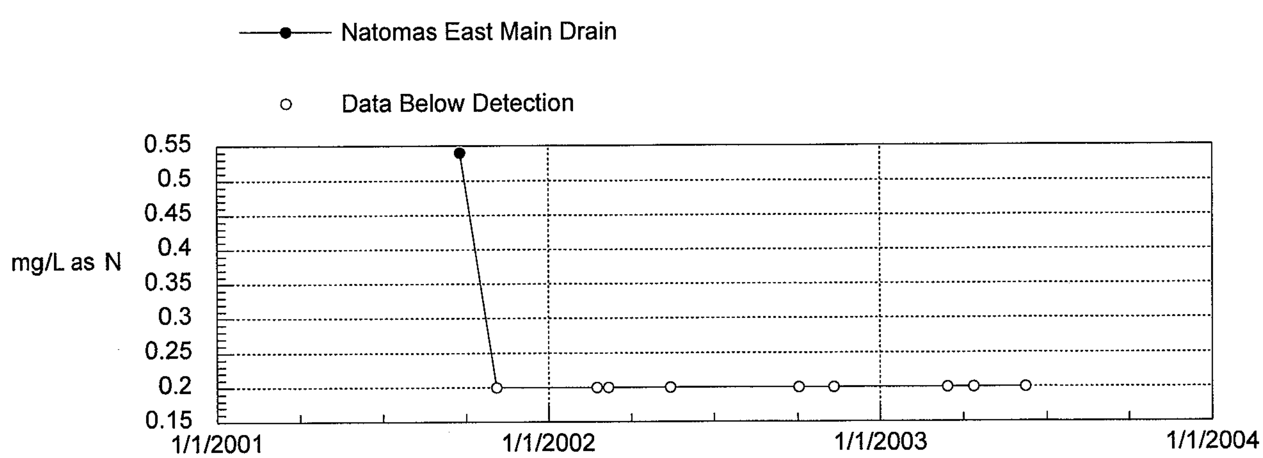

American River at Discovery Park
Data Below Detection
mg/L as N
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Colusa Basin Drain
Data Below Detection
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
mg/L as N
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento Slough
Data Below Detection
1.2
1
0.8
0.6
0.4
0.2
0
mg/L as N
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

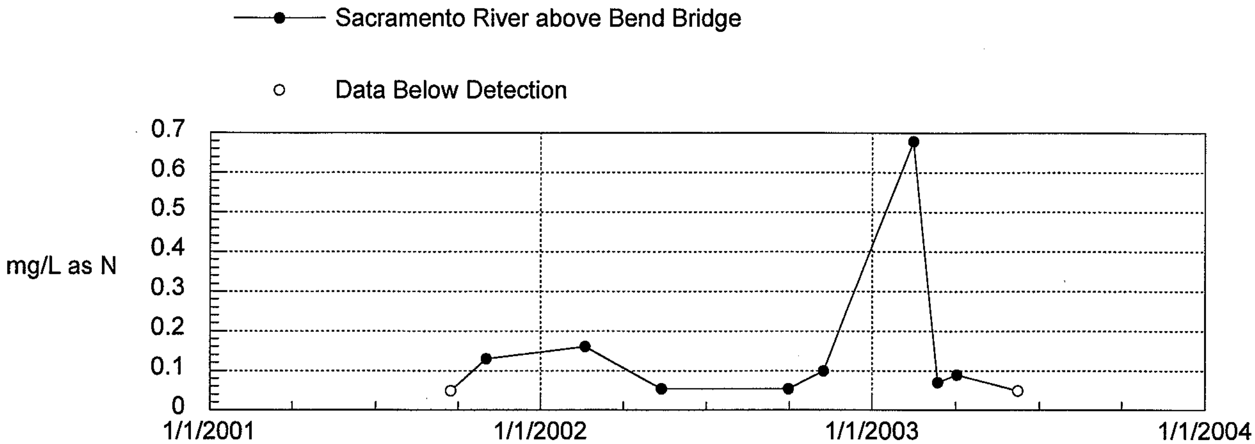


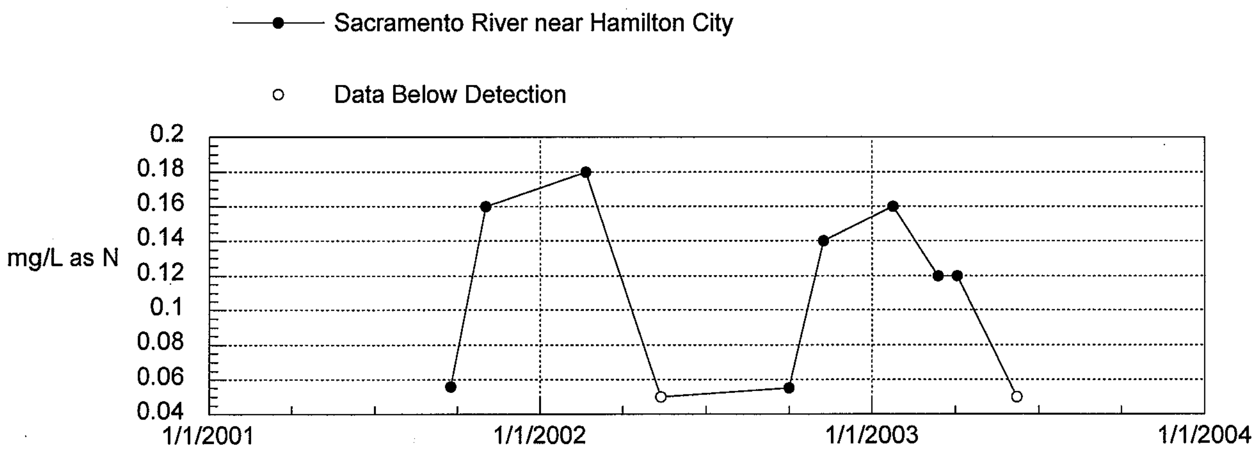
Natomas East Main Drain Canal (DWR)
Data Below Detection
mg/L as N
0.25
0.2
0.15
0.1
0.05
0
1/1/1997
1/1/1998
1/1/1999
1/1/2000

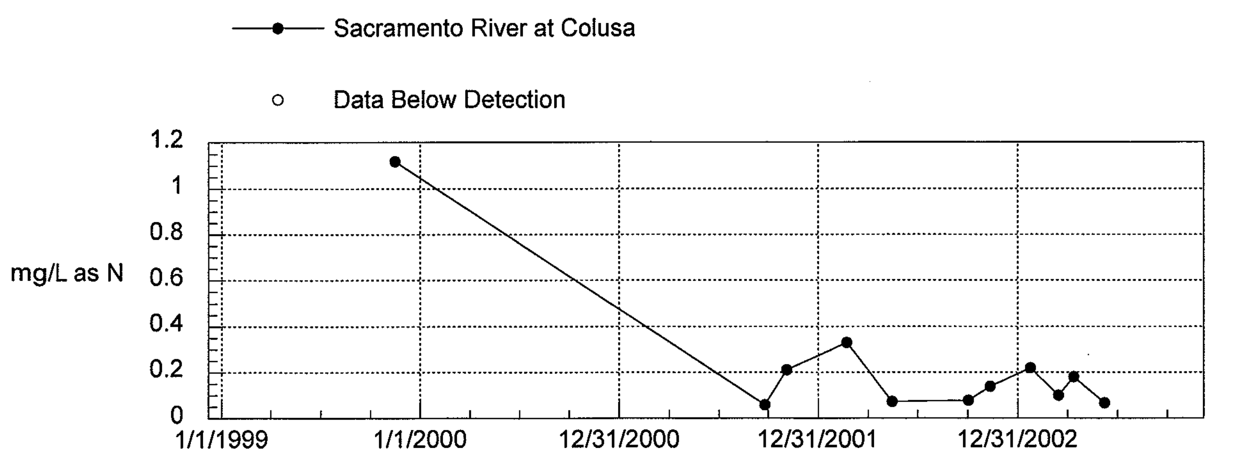


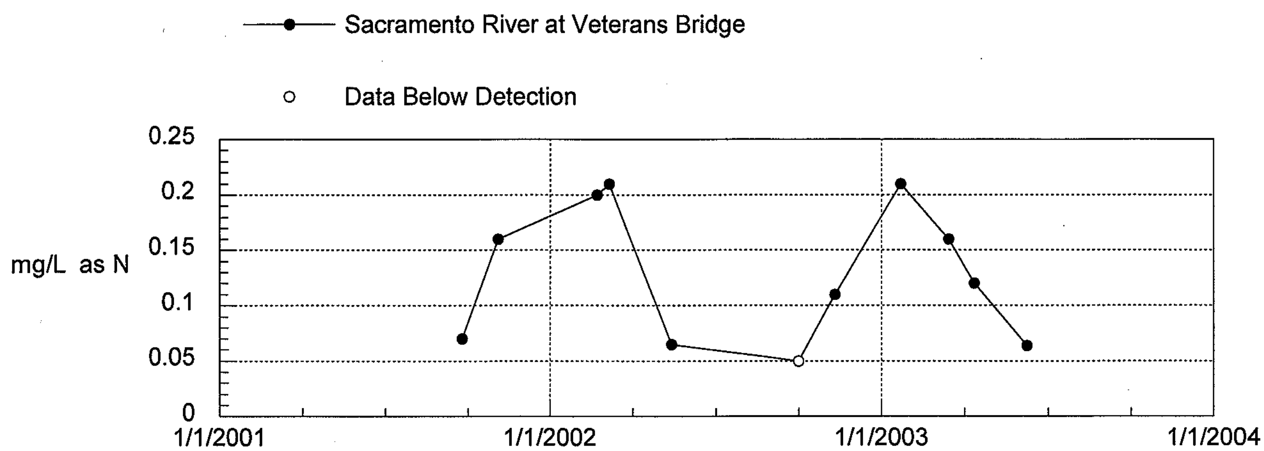
Natomas East Main Drain
Data Below Detection
mg/L as N
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
1/1/2001
1/1/2002
1/1/2003
1/1/2004

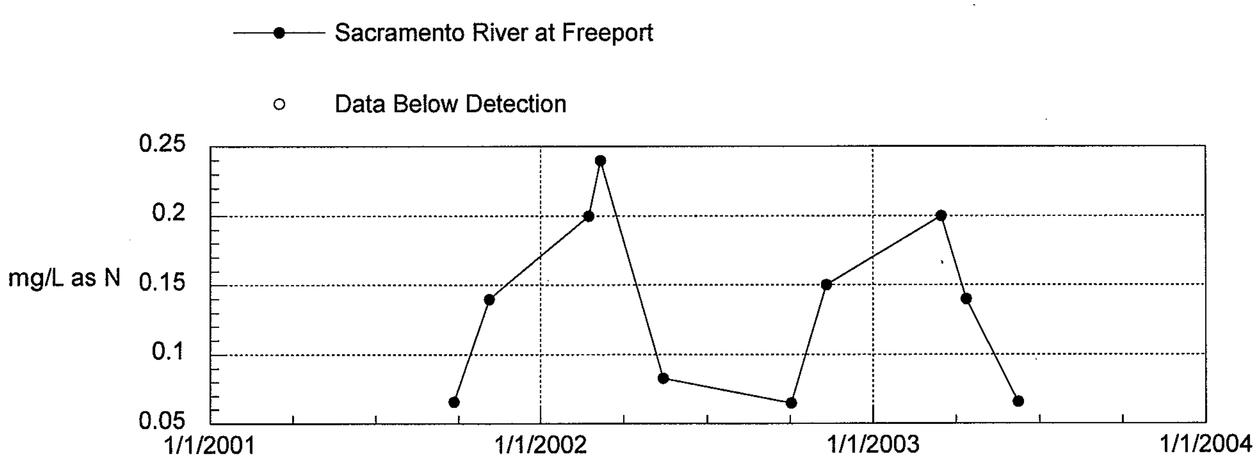
NITRATE NITROGEN IN WATER

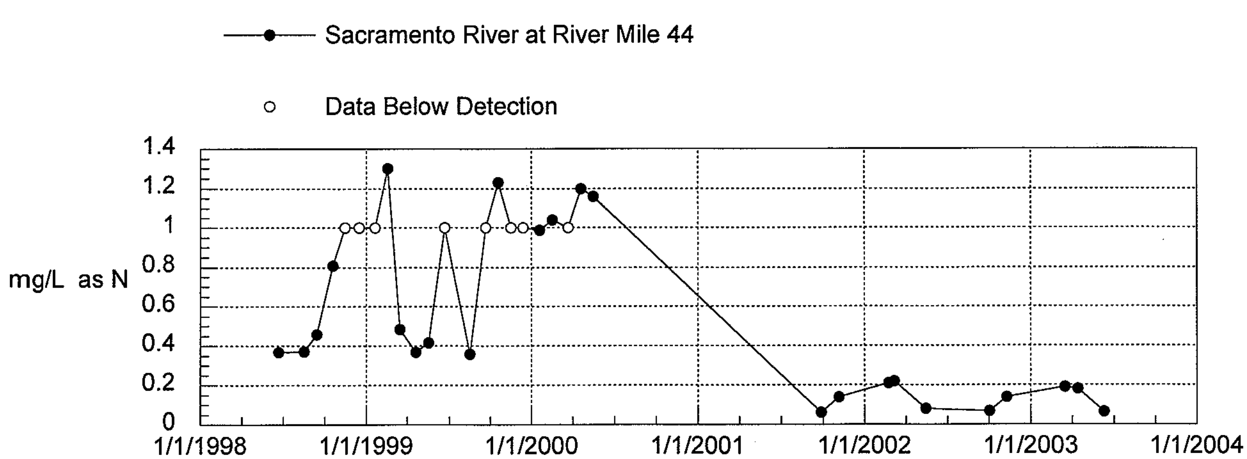


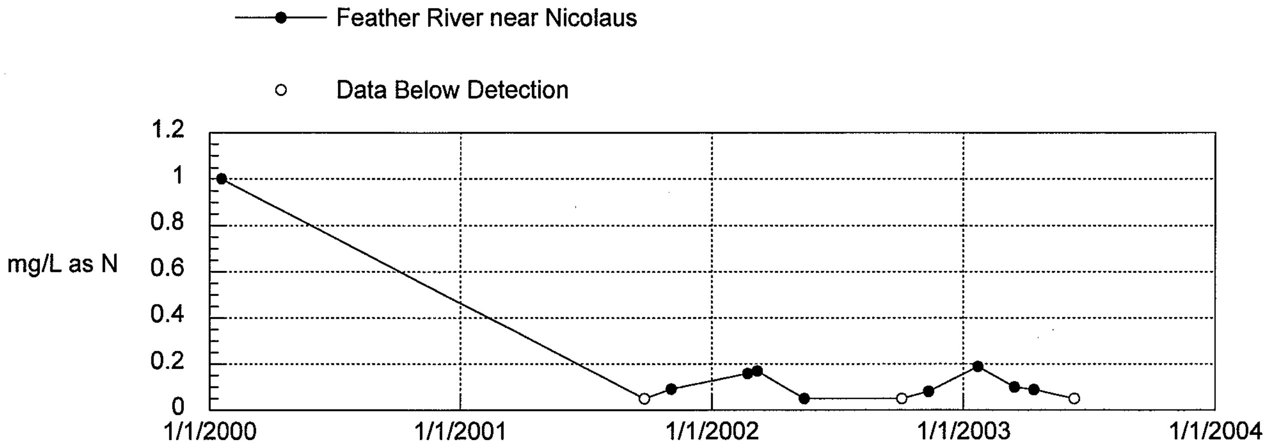




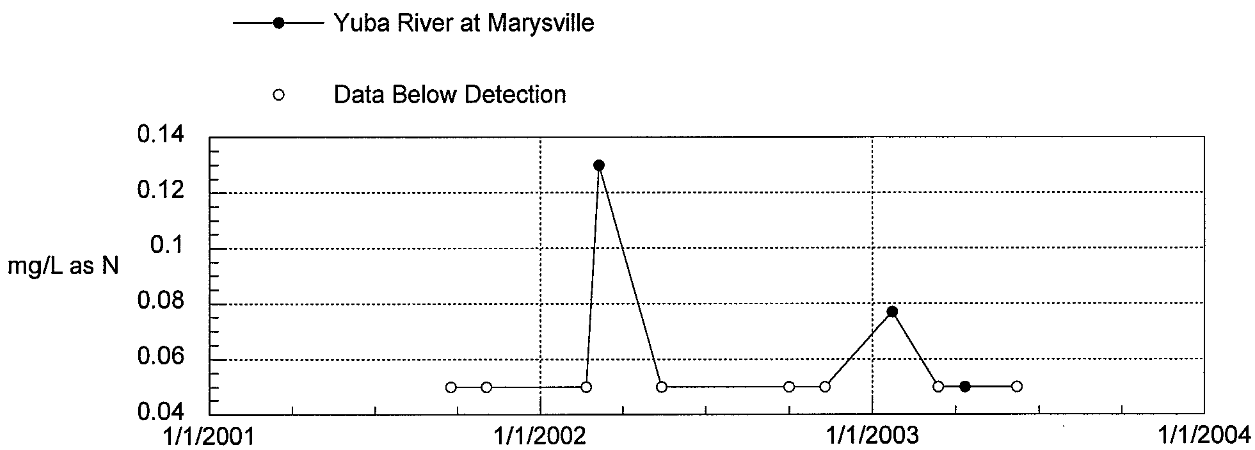

Sacramento River at Veterans Bridge
Data Below Detection
mg/L as N
0.25
0.2
0.15
0.1
0.05
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento River at Freeport
Data Below Detection
mg/L as N
0.25
0.2
0.15
0.1
0.05
1/1/2001
1/1/2002
1/1/2003
1/1/2004

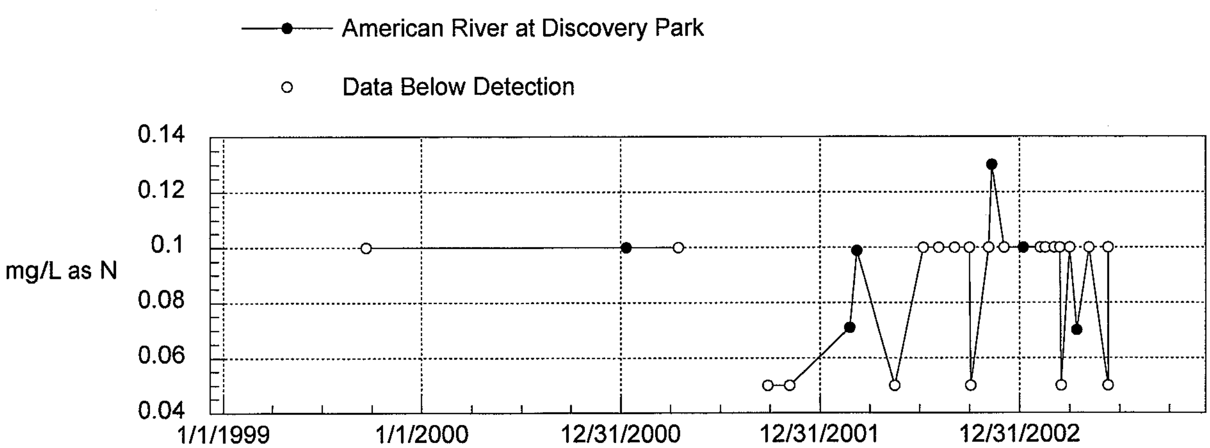

Sacramento River at River Mile 44
Data Below Detection
mg/L as N
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004



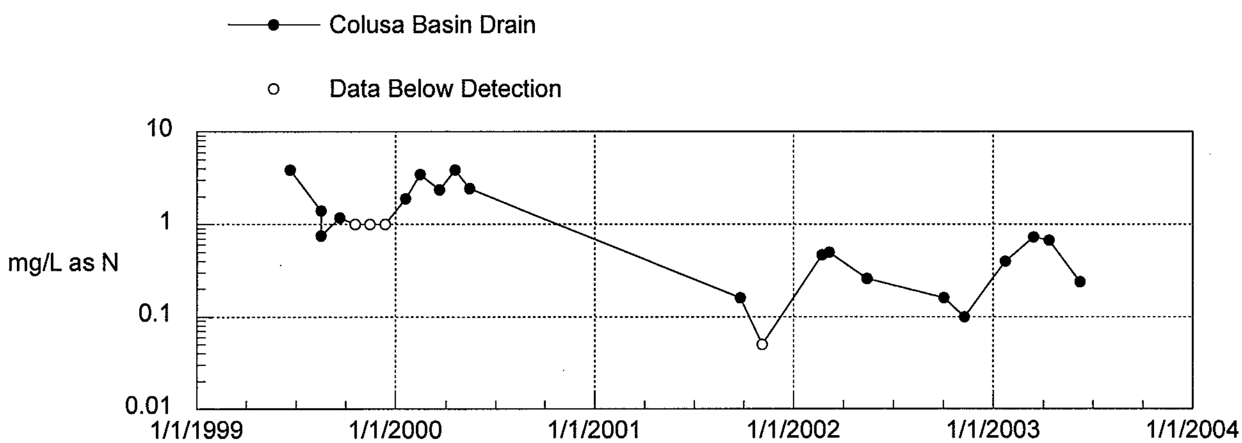
Feather River near Nicolaus
Data Below Detection
mg/L as N
1.2
1
0.8
0.6
0.4
0.2
0
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

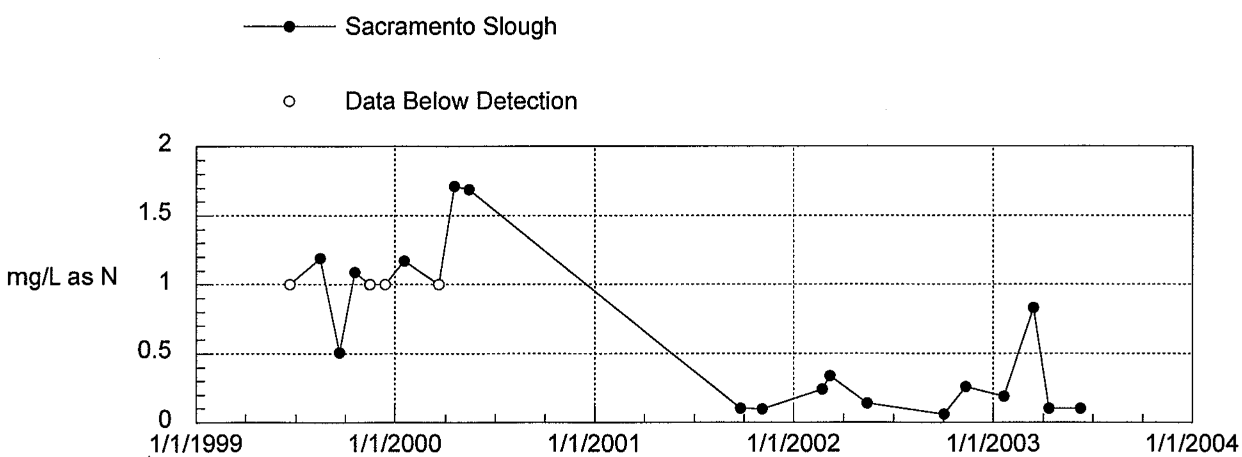


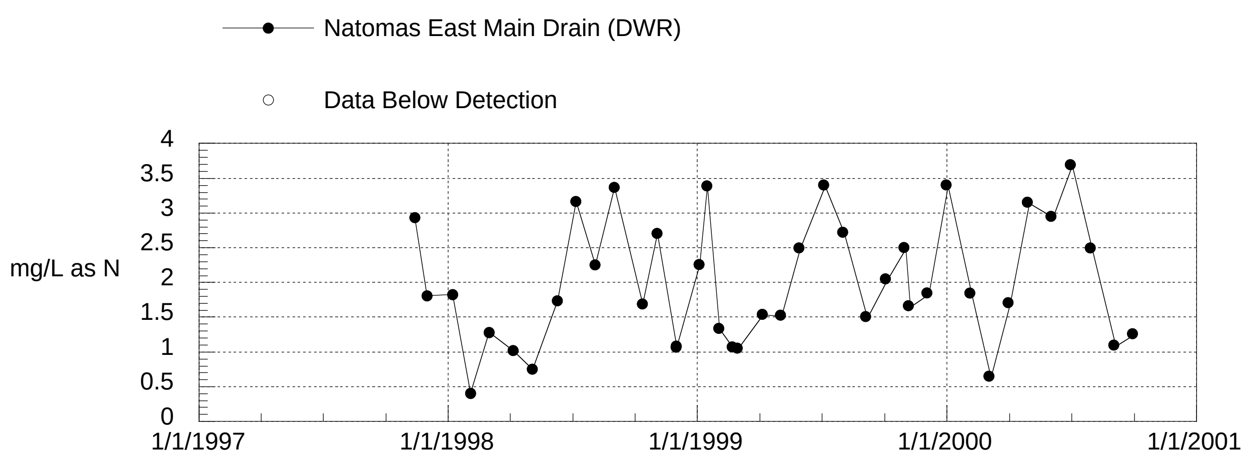
Yuba River at Marysville
Data Below Detection
mg/L as N
0.14
0.12
0.1
0.08
0.06
0.04
1/1/2001
1/1/2002
1/1/2003
1/1/2004

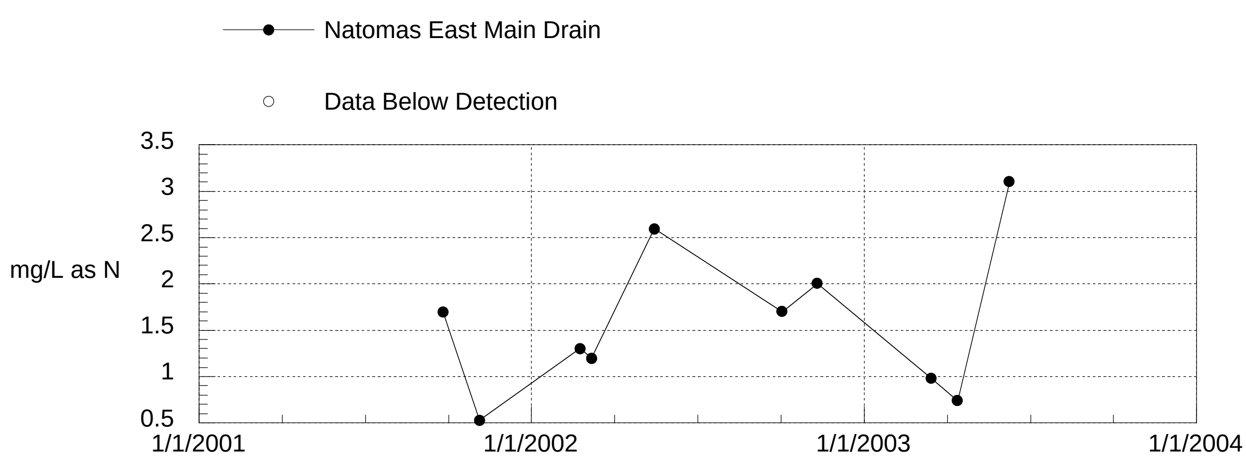


American River at Discovery Park
Data Below Detection
mg/L as N
0.14
0.12
0.1
0.08
0.06
0.04
1/1/1999
1/1/2000
12/31/2000
12/31/2001
12/31/2002

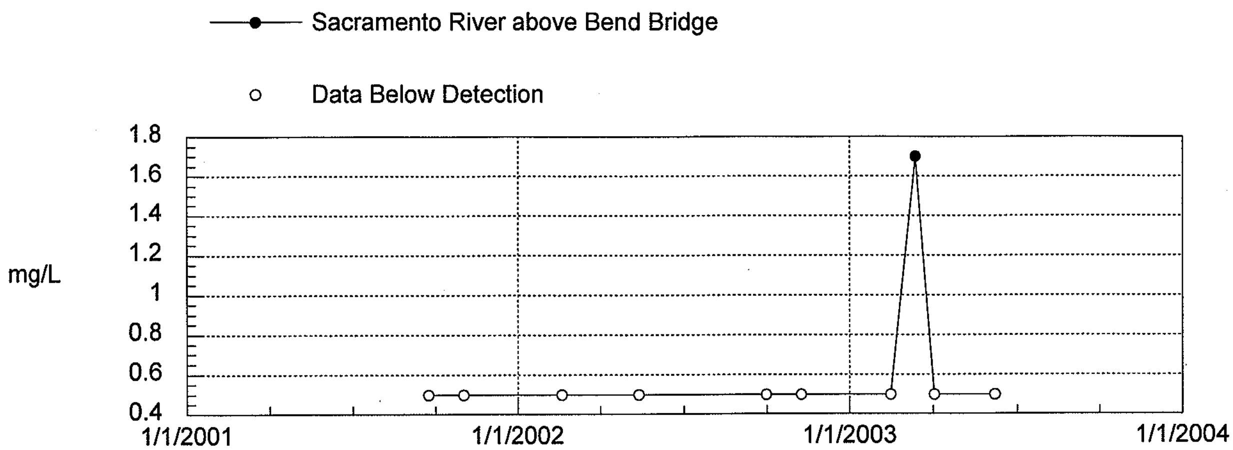

Colusa Basin Drain
Data Below Detection
10
1
0.1
0.01
mg/L as N
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

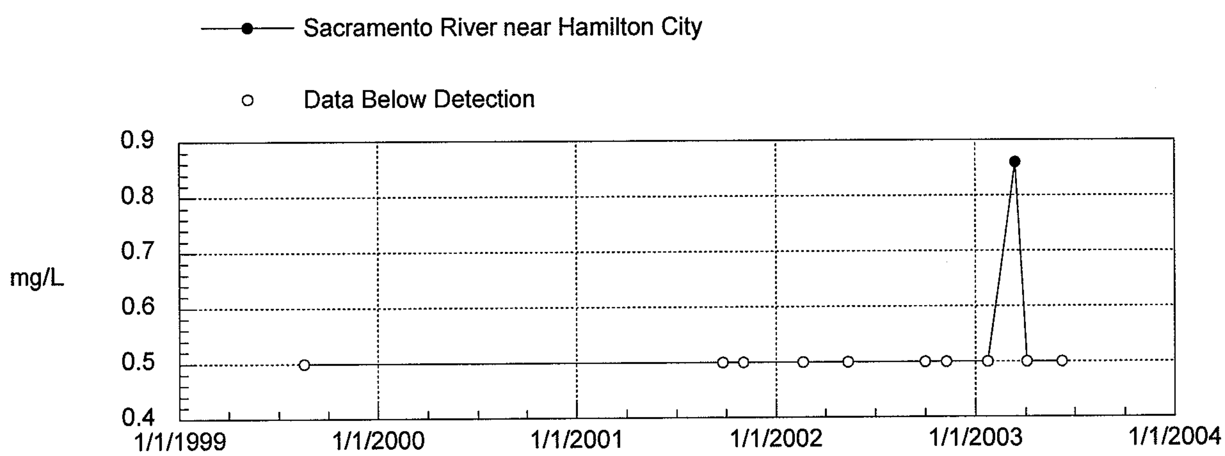

Sacramento Slough
Data Below Detection
2
1.5
1
0.5
0
mg/L as N
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

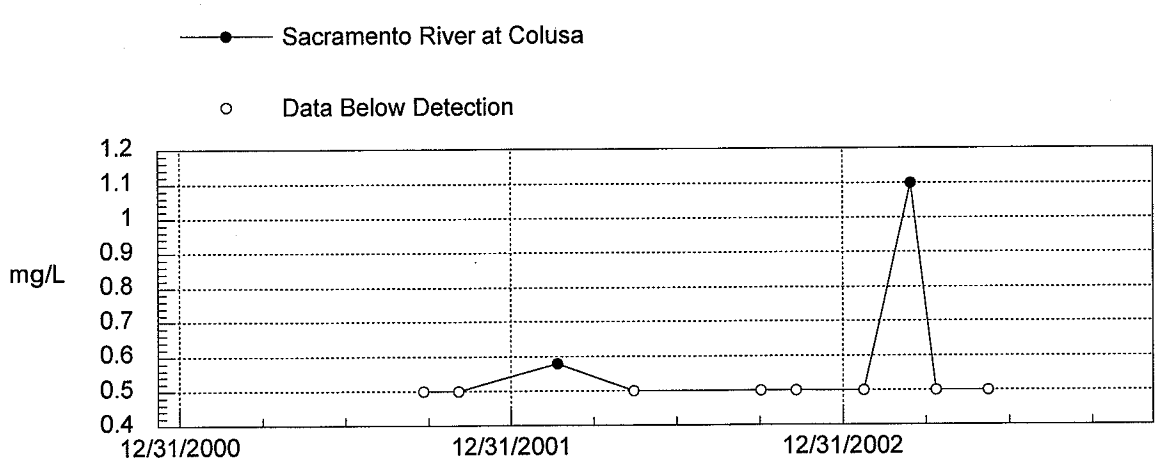

Natomas East Main Drain (DWR)
Data Below Detection
mg/L as N
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001

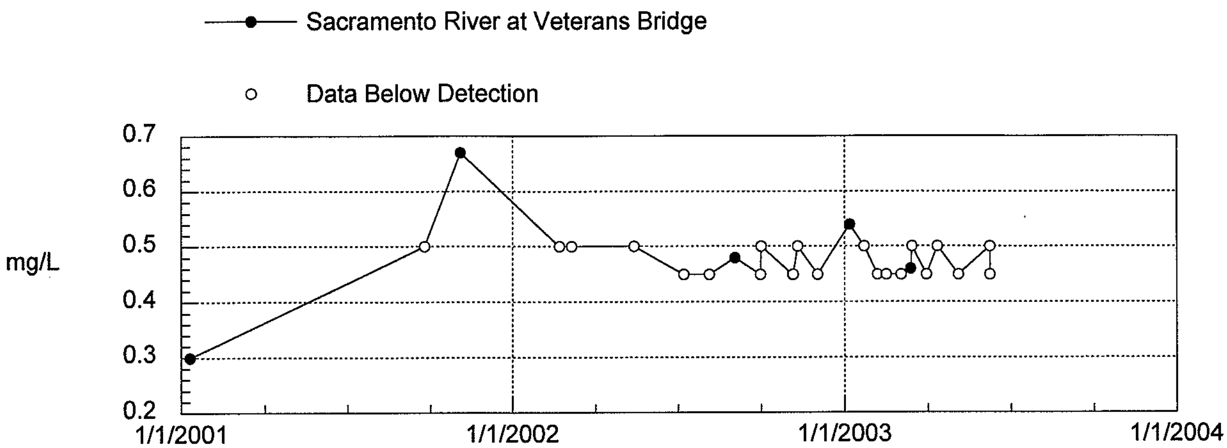

Natomas East Main Drain
Data Below Detection
mg/L as N
3.5
3
2.5
2
1.5
1
0.5
1/1/2001
1/1/2002
1/1/2003
1/1/2004

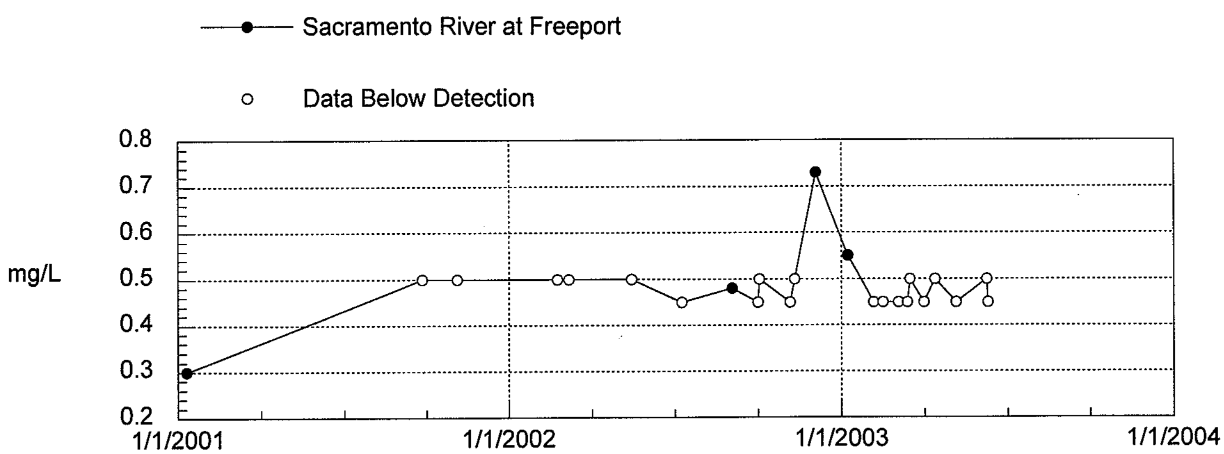
TOTAL KJELDAHL NITROGEN IN WATER

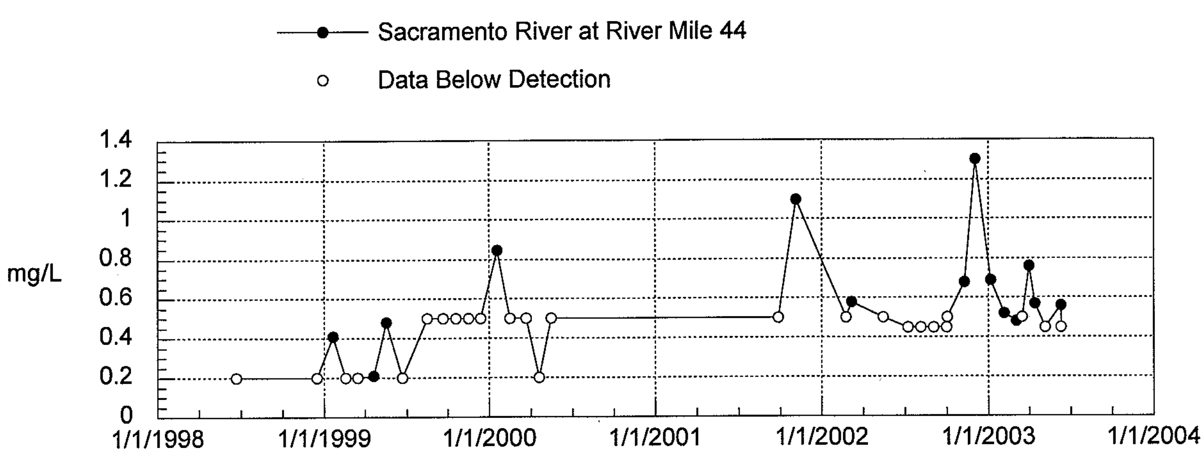




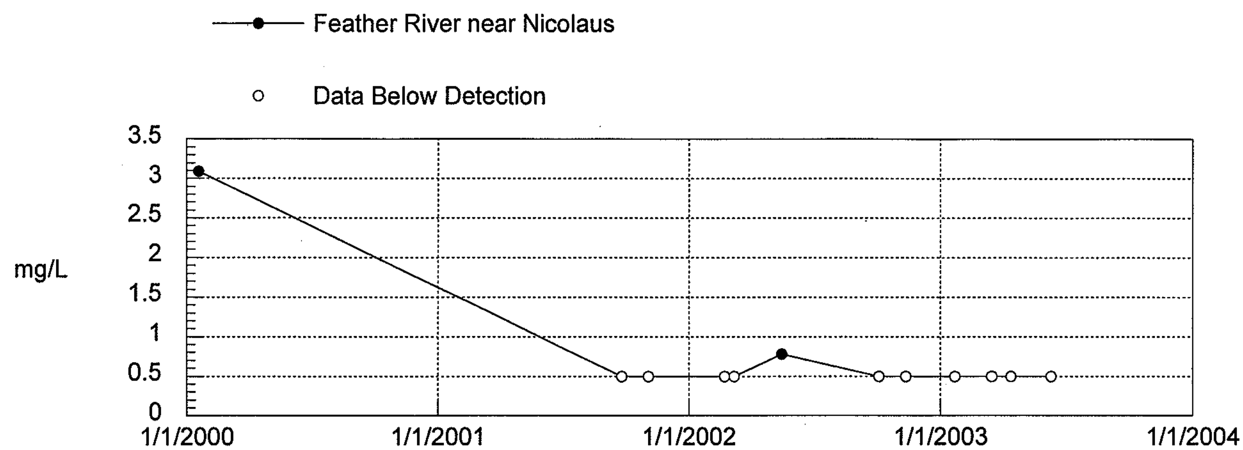


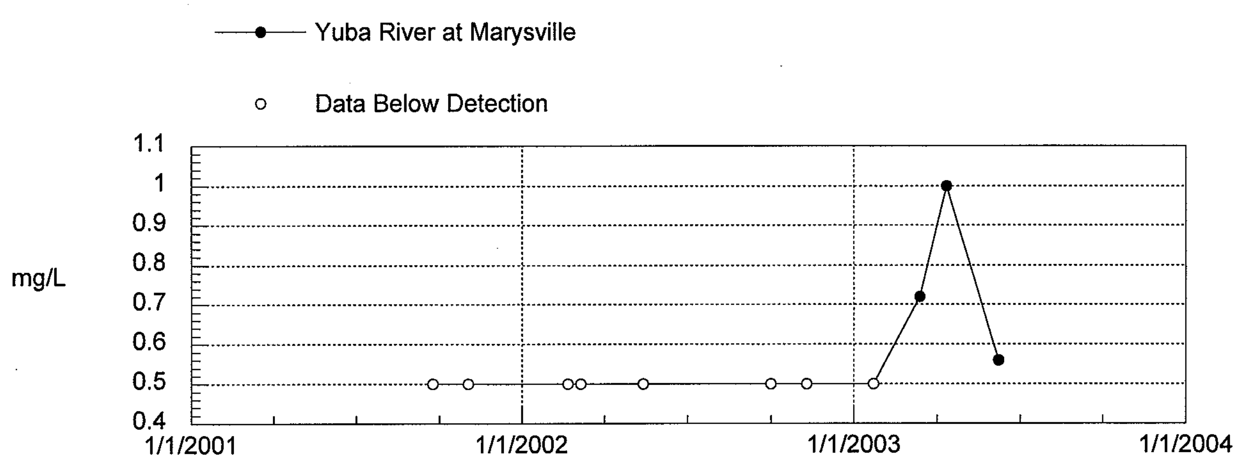

Sacramento River at Veterans Bridge
Data Below Detection
mg/L
0.7
0.6
0.5
0.4
0.3
0.2
1/1/2001
1/1/2002
1/1/2003
1/1/2004

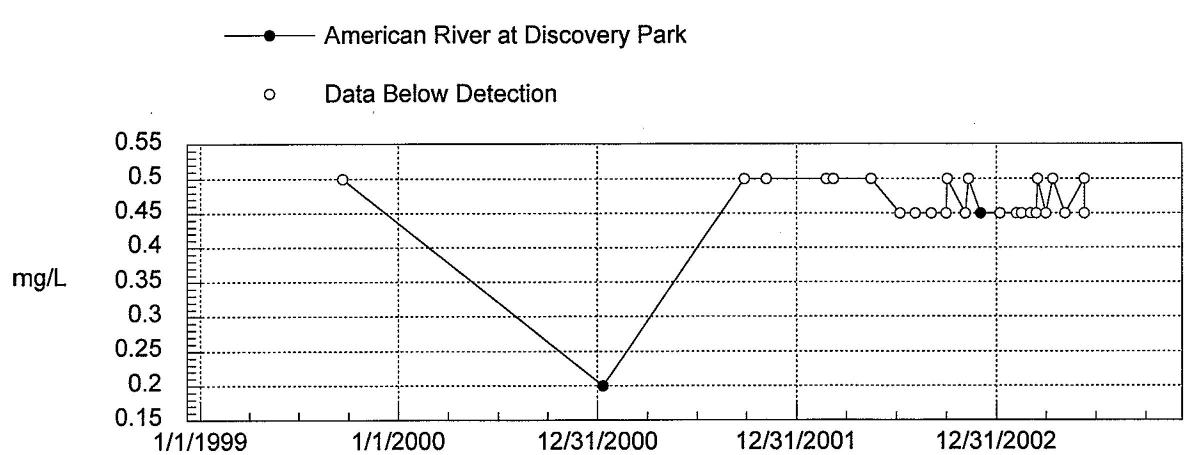

Sacramento River at Freeport
Data Below Detection
mg/L
0.8
0.7
0.6
0.5
0.4
0.3
0.2
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento River at River Mile 44
Data Below Detection
mg/L
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

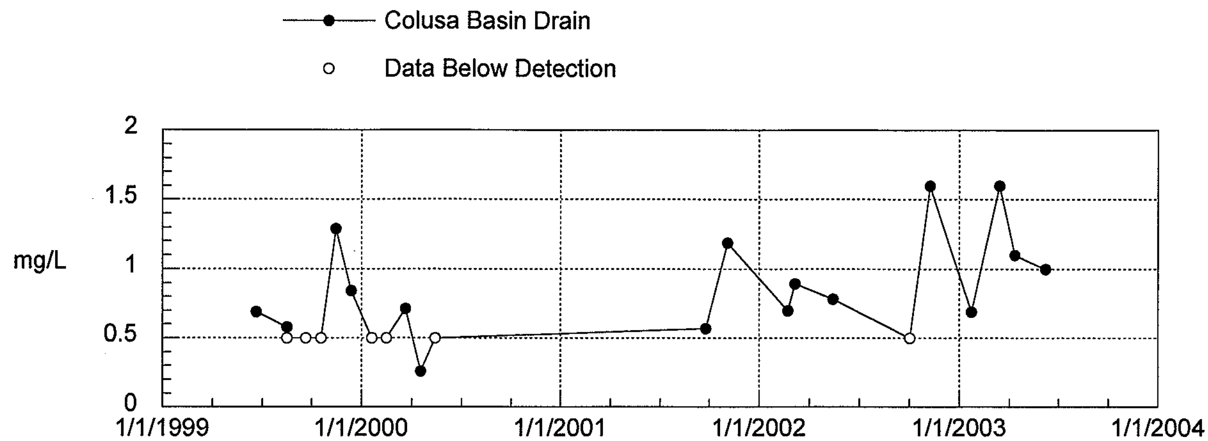
TOTAL KJELDAHL NITROGEN IN WATER

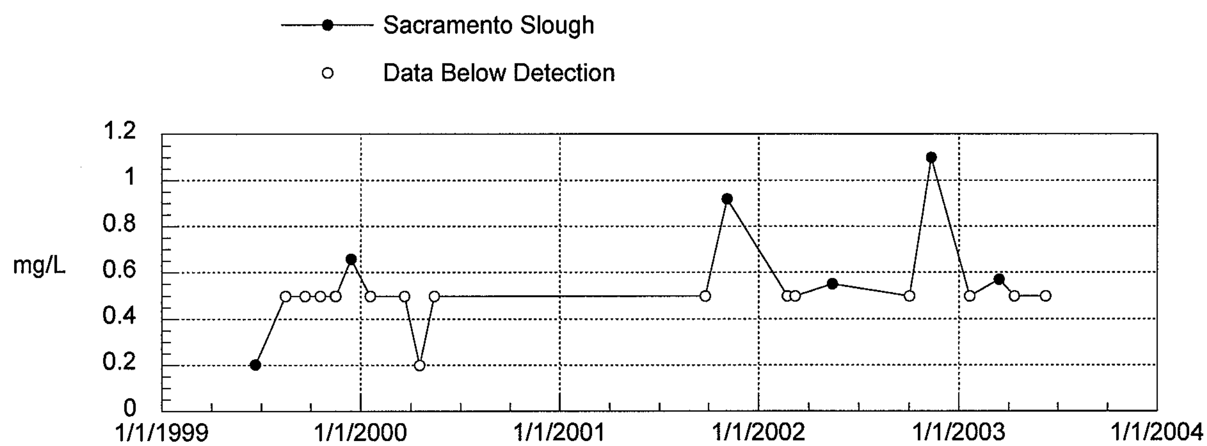


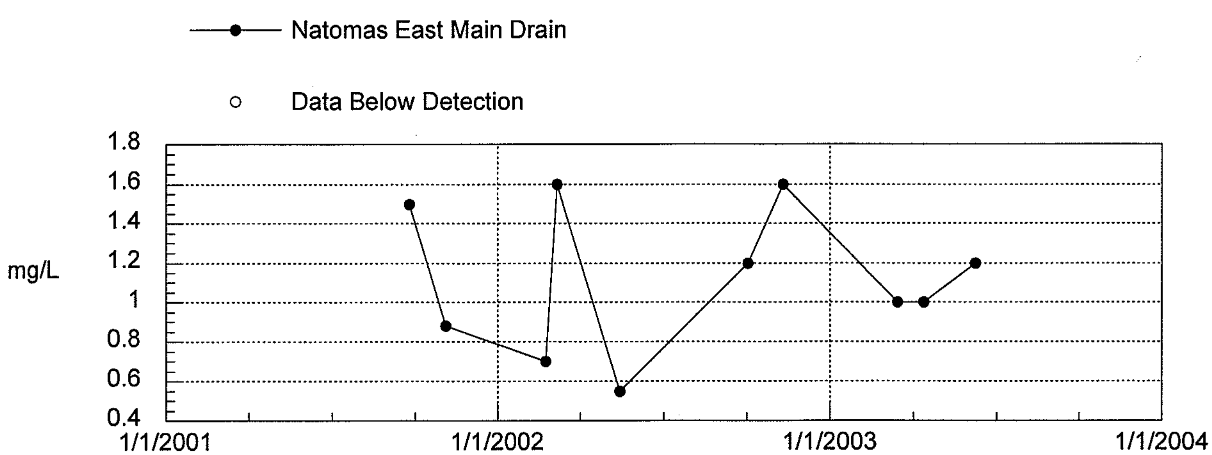




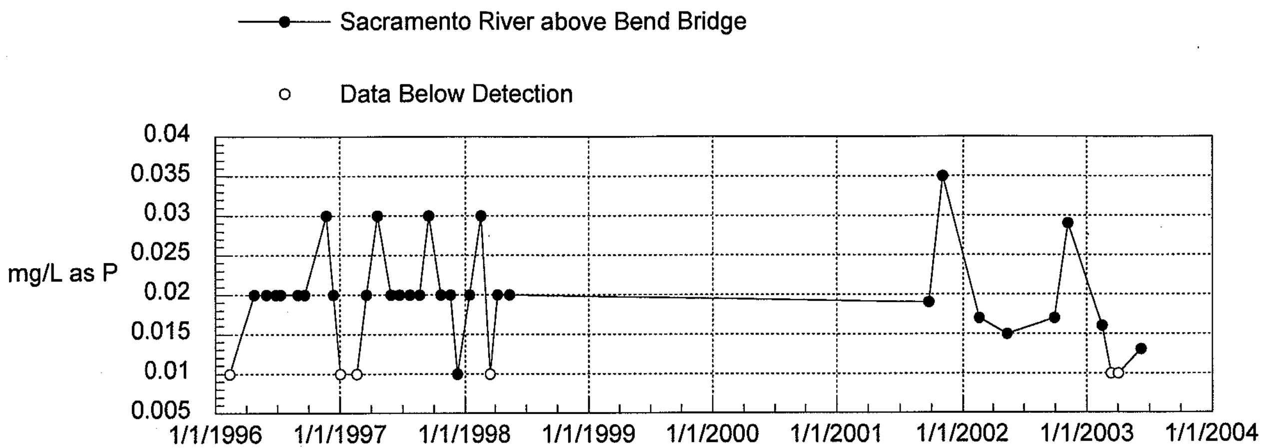
TOTAL KJELDAHL NITROGEN IN WATER

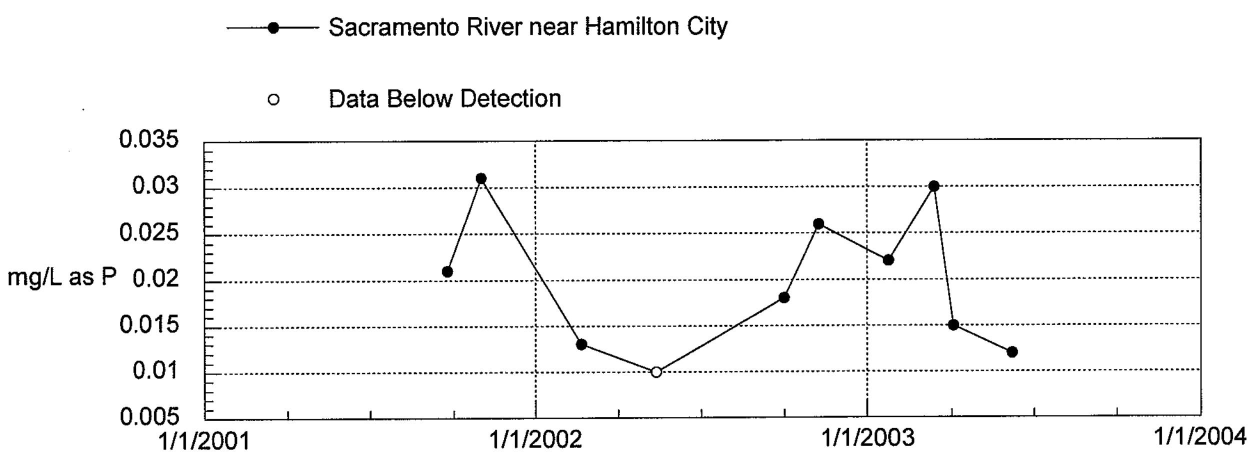


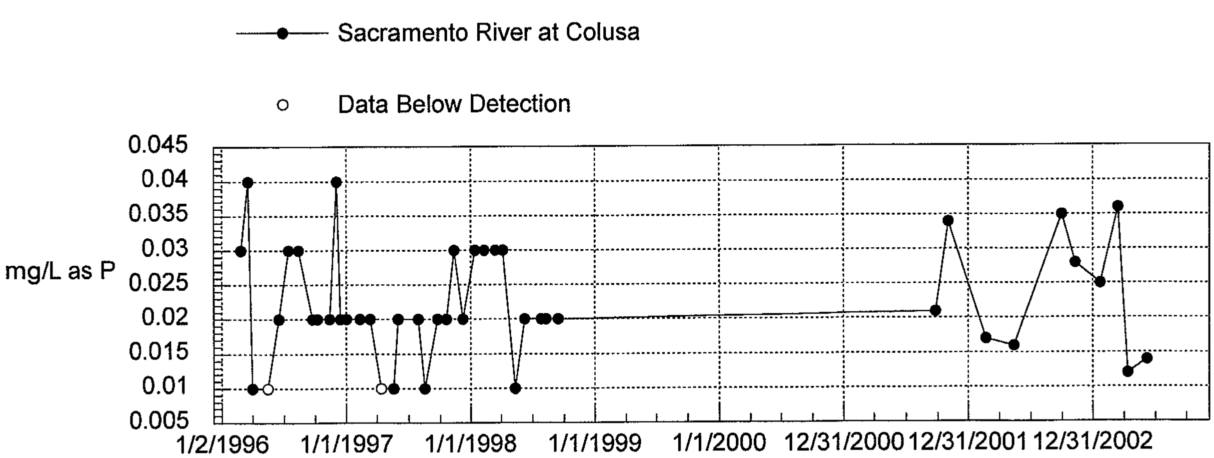


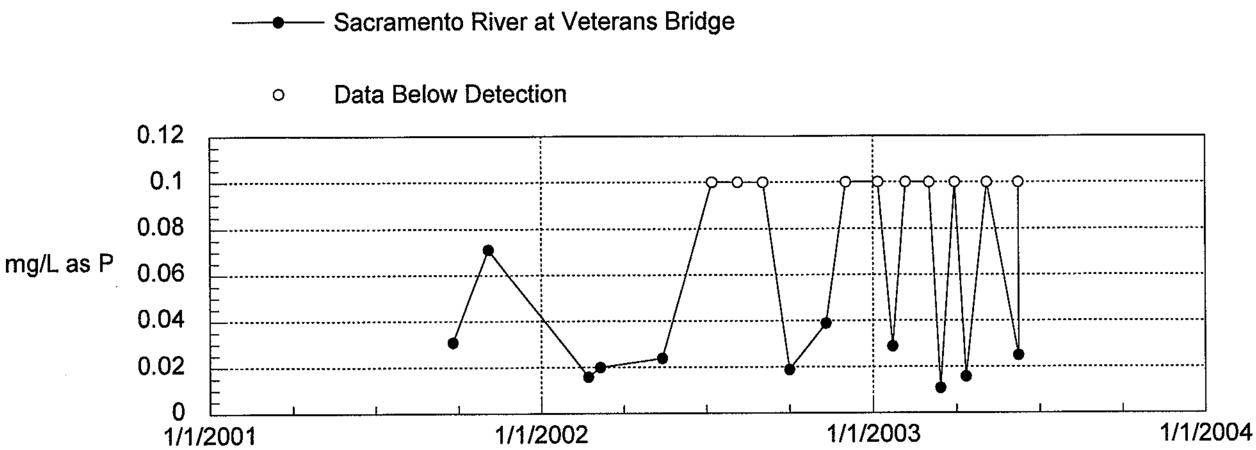


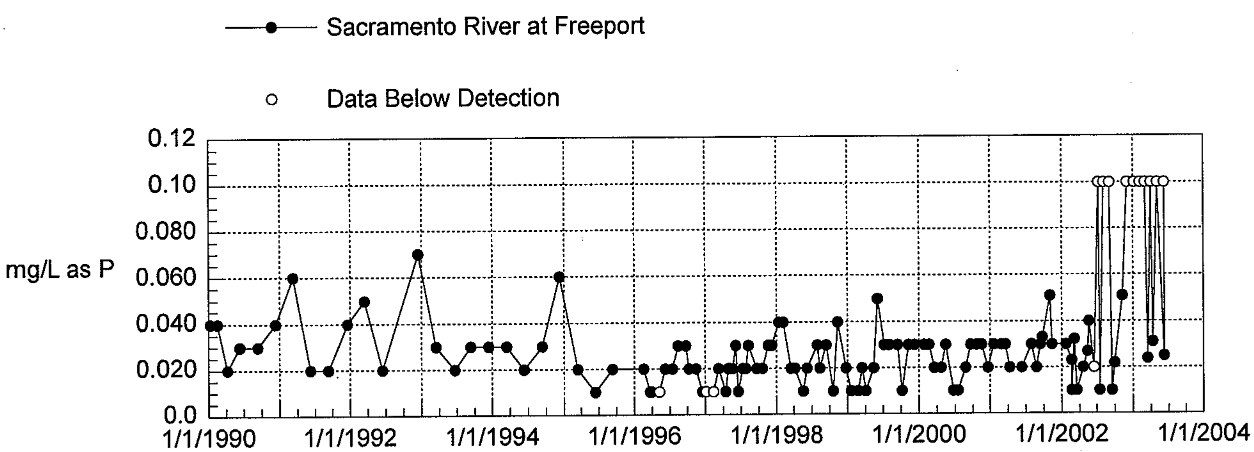
DISSOLVED ORTHOPHOSPHATE IN WATER

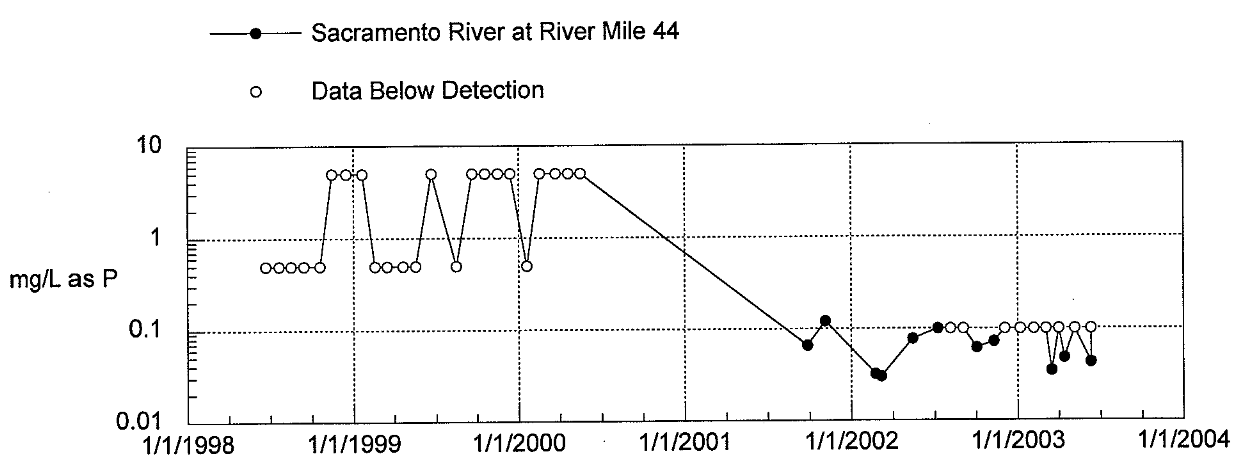




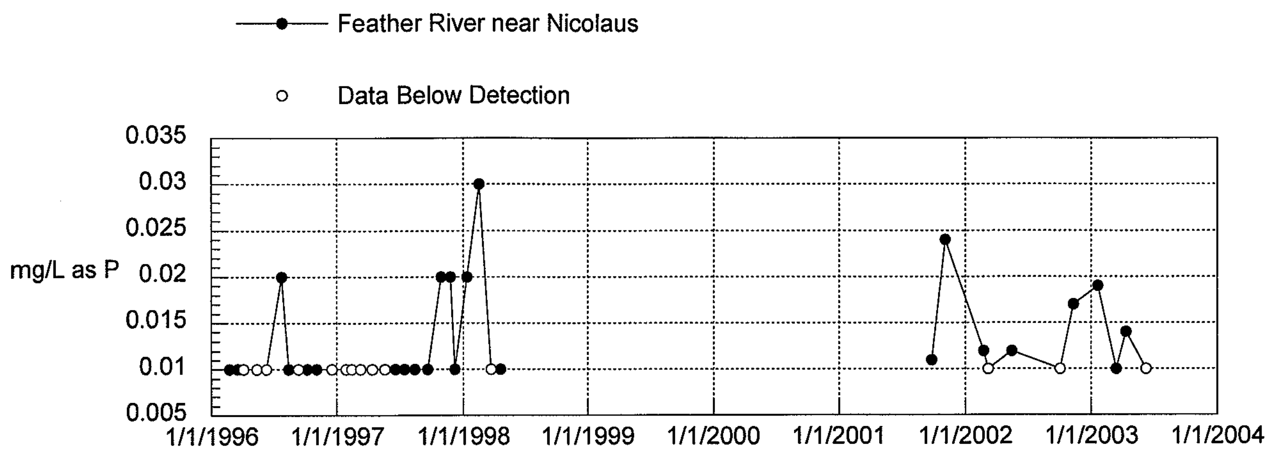


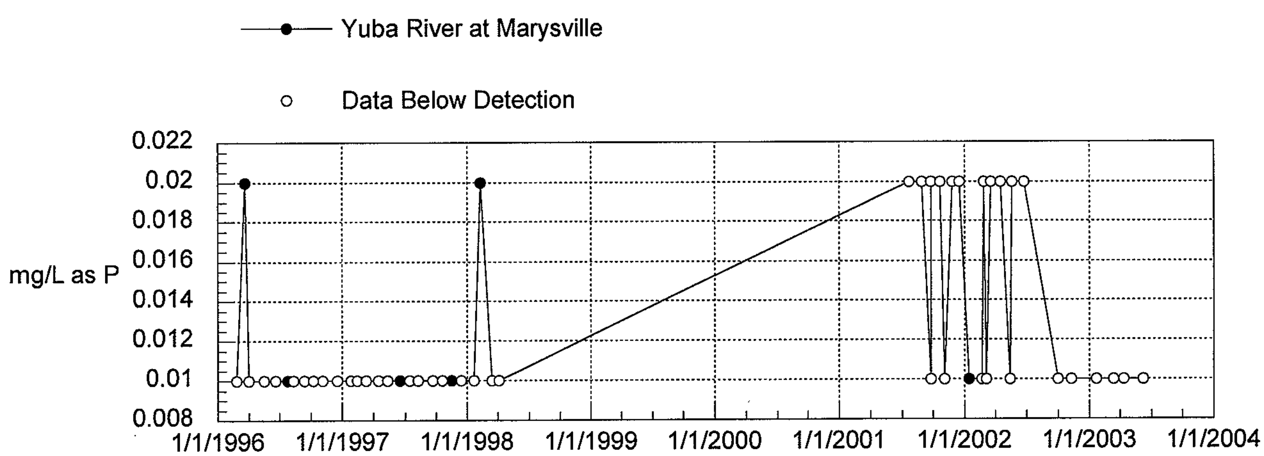

Sacramento River at Veterans Bridge
Data Below Detection
mg/L as P
0.12
0.1
0.08
0.06
0.04
0.02
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004

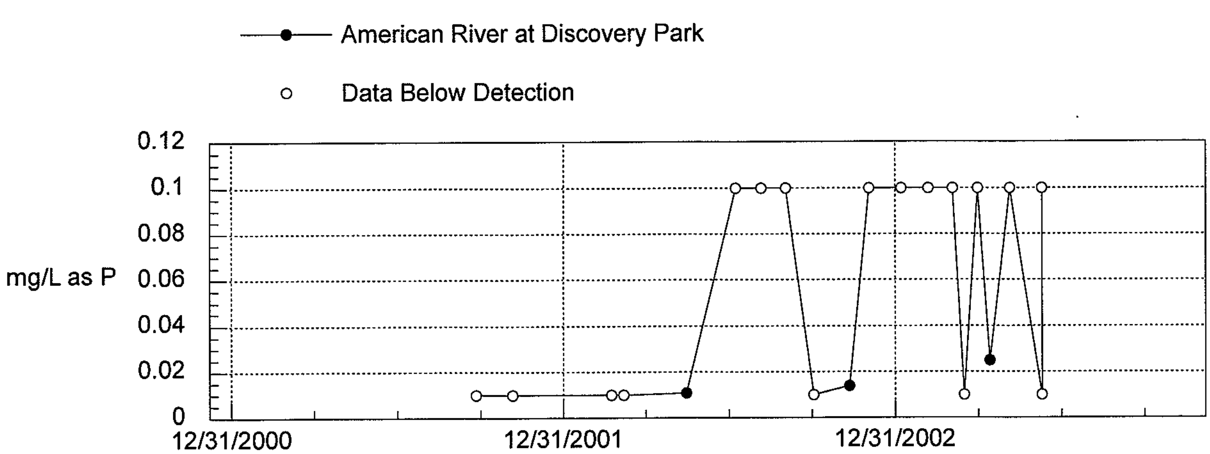

Sacramento River at Freeport
Data Below Detection
mg/L as P
0.12
0.10
0.080
0.060
0.040
0.020
0.0
1/1/1990
1/1/1992
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004


Sacramento River at River Mile 44
Data Below Detection
mg/L as P
10
1
0.1
0.01
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

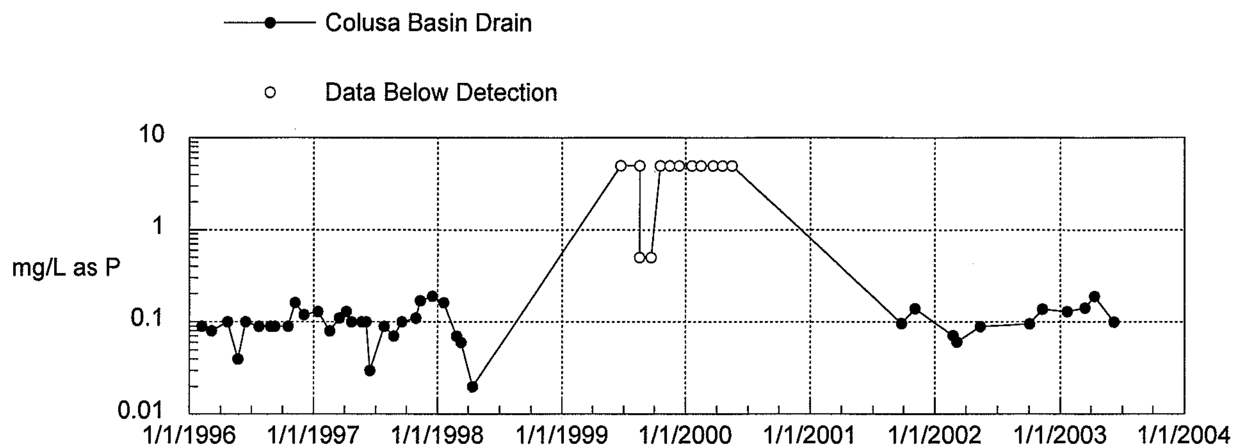
DISSOLVED ORTHOPHOSPHATE IN WATER

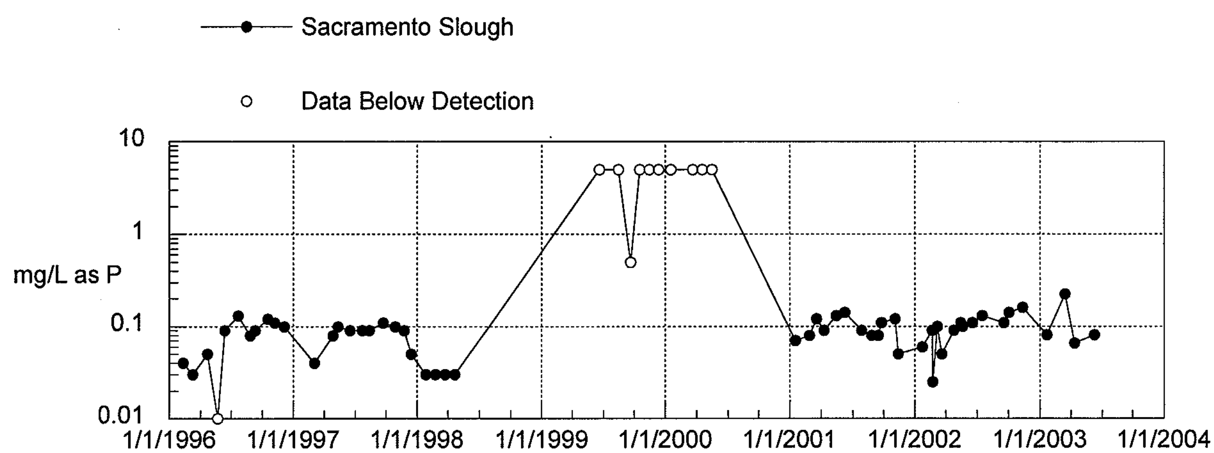


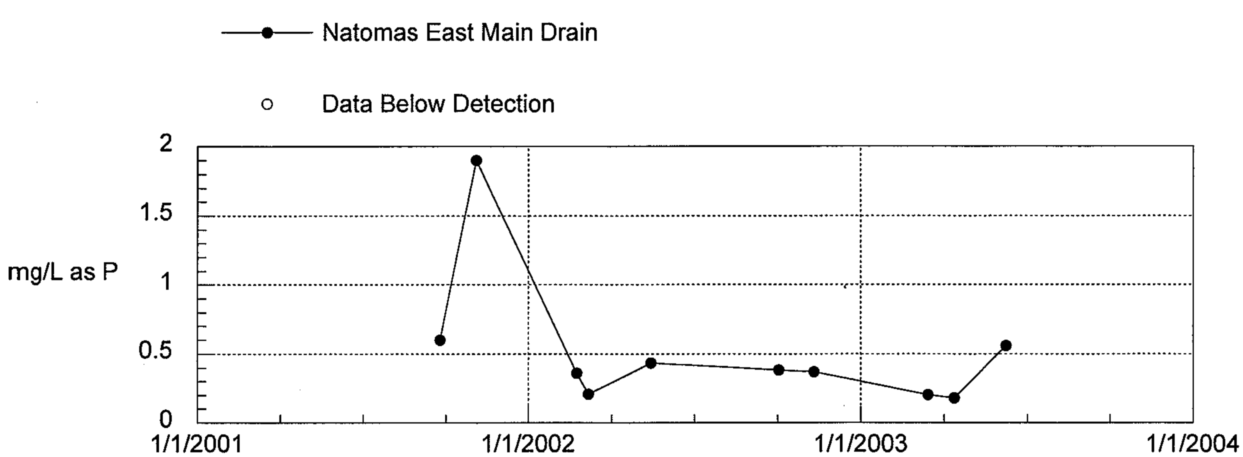




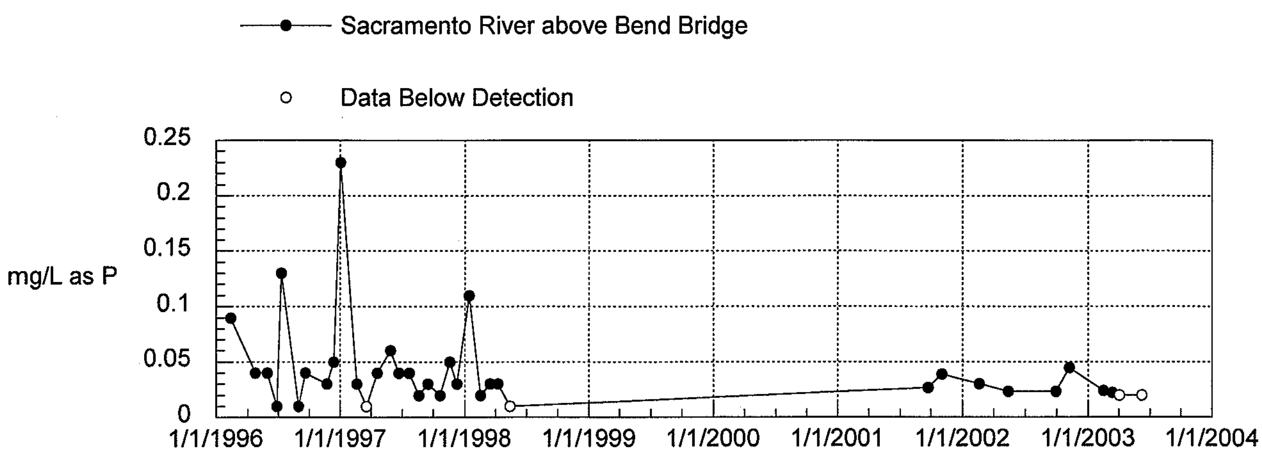
DISSOLVED ORTHOPHOSPHATE IN WATER

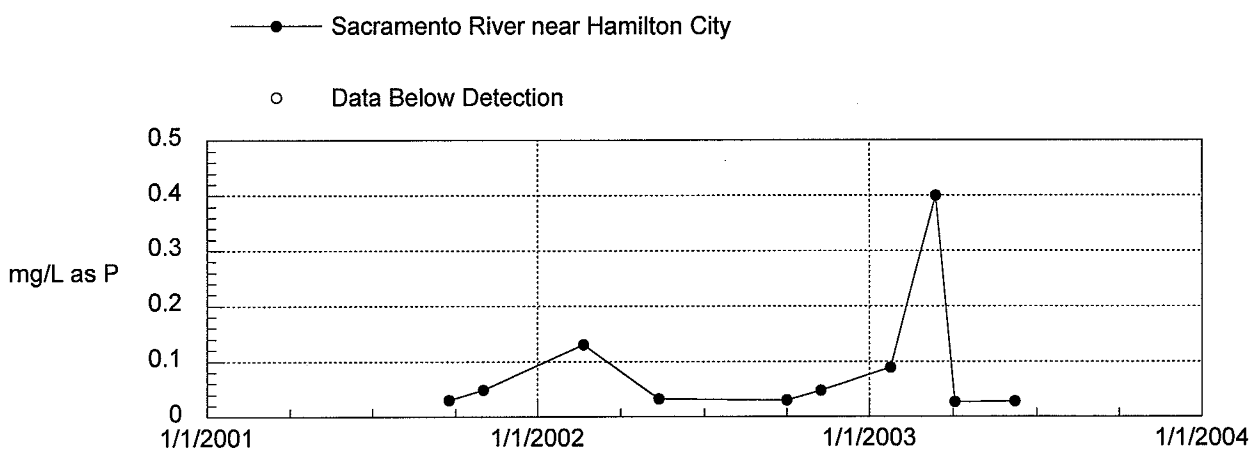


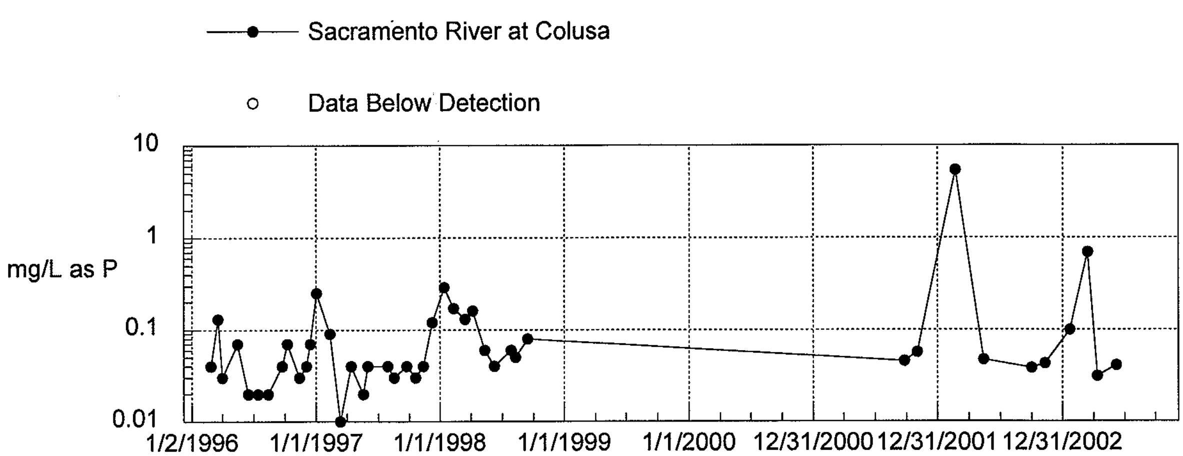


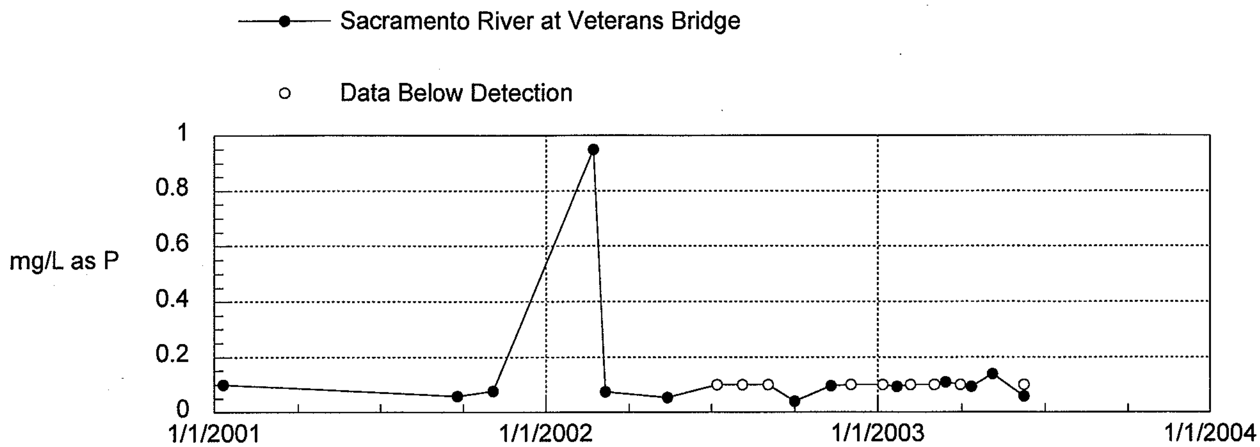


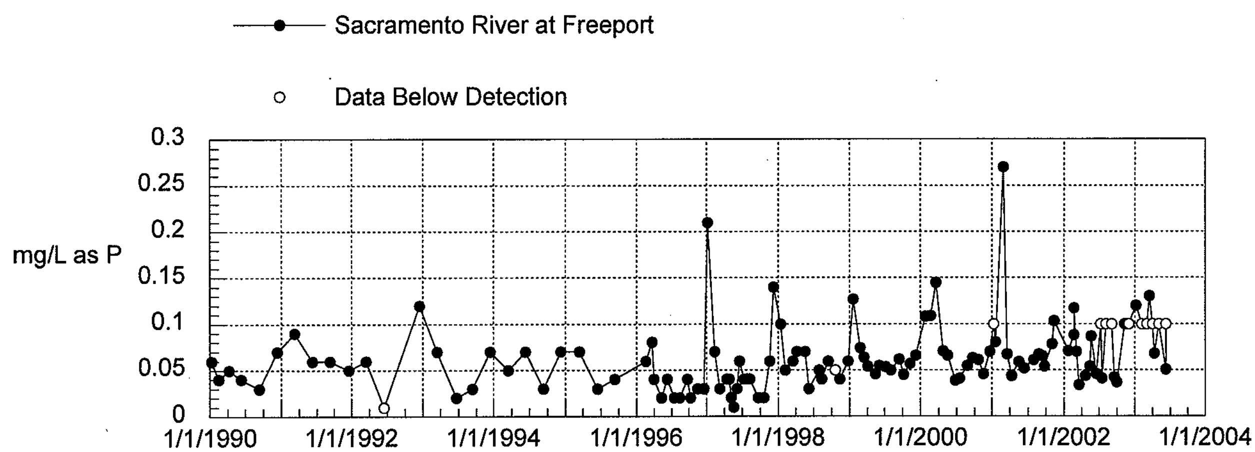
TOTAL PHOSPHOROUS IN WATER

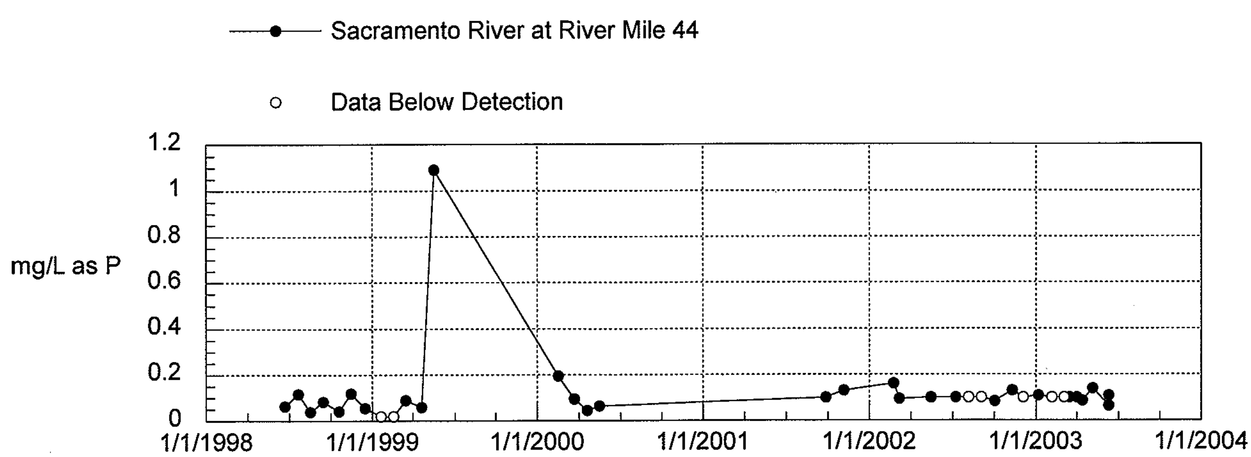




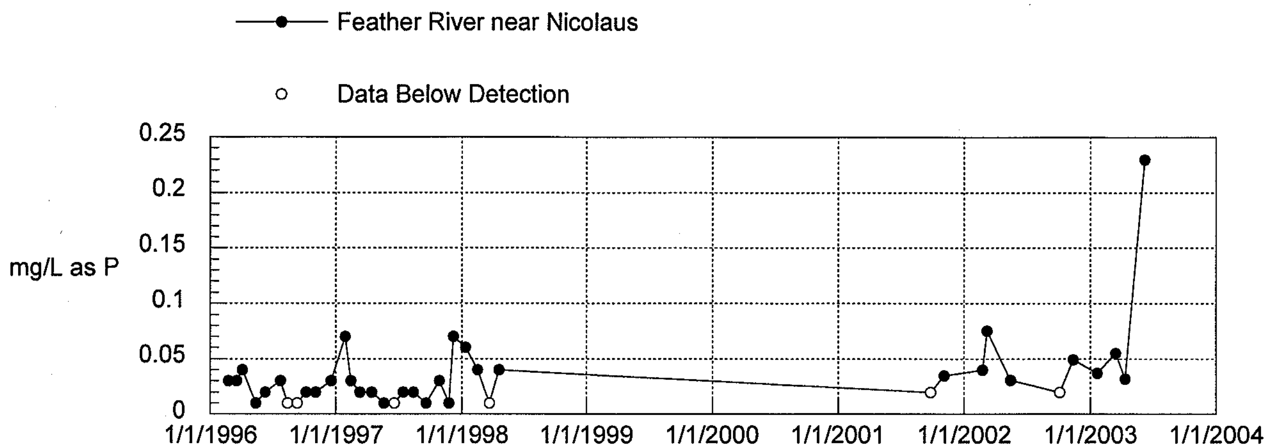


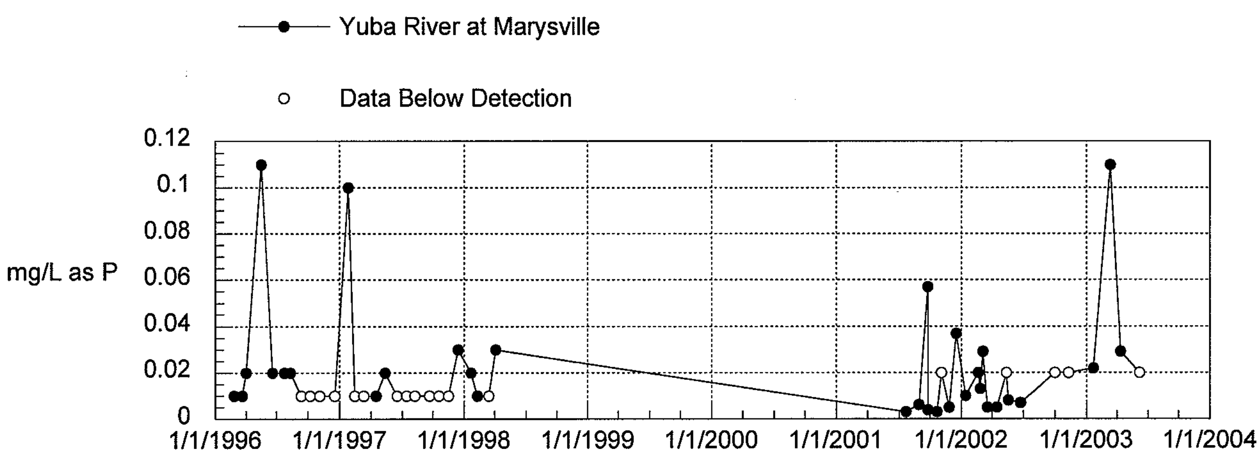

Sacramento River at Veterans Bridge
Data Below Detection
mg/L as P
1
0.8
0.6
0.4
0.2
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004

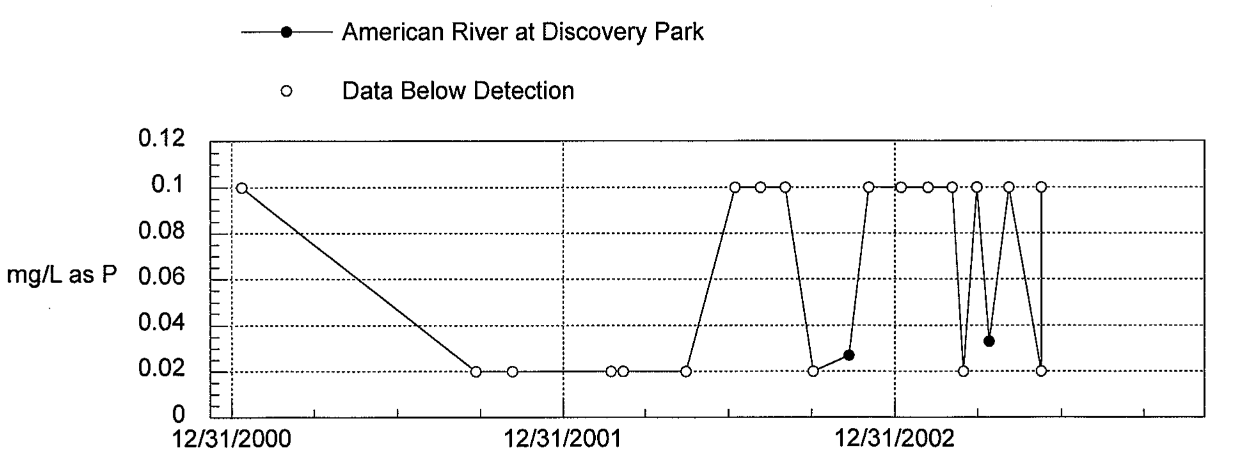

Sacramento River at Freeport
Data Below Detection
mg/L as P
0.3
0.25
0.2
0.15
0.1
0.05
0
1/1/1990
1/1/1992
1/1/1994
1/1/1996
1/1/1998
1/1/2000
1/1/2002
1/1/2004

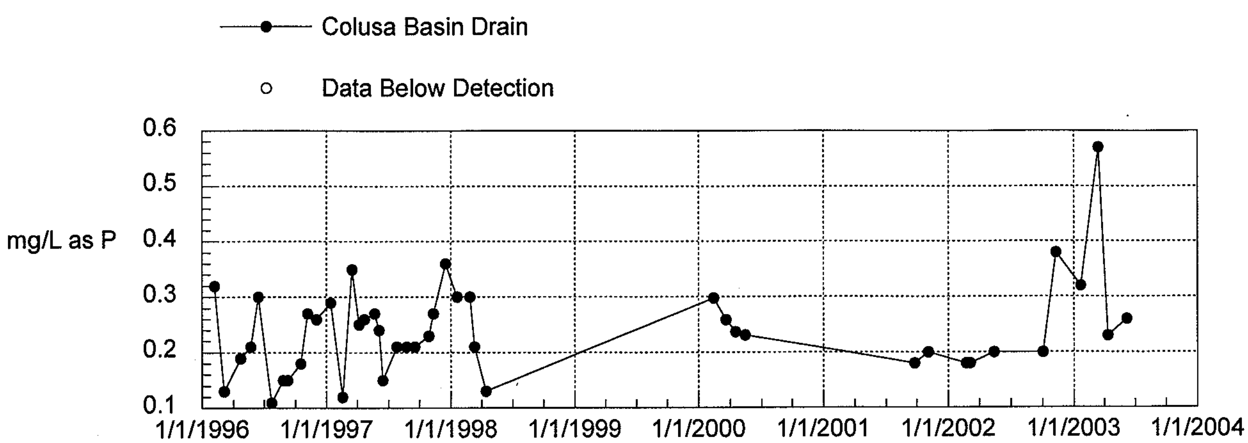

Sacramento River at River Mile 44
Data Below Detection
mg/L as P
1.2
1
0.8
0.6
0.4
0.2
0
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

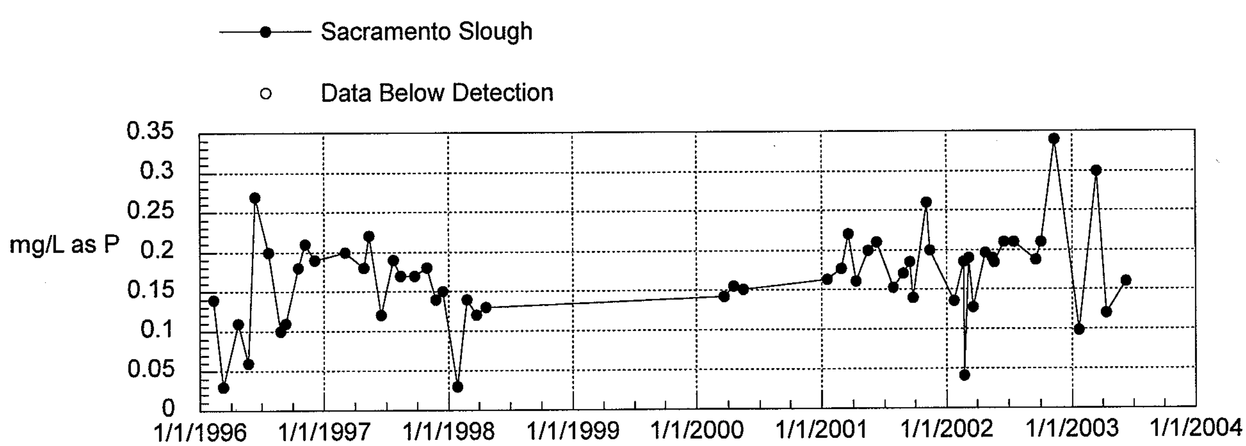
TOTAL PHOSPHOROUS IN WATER

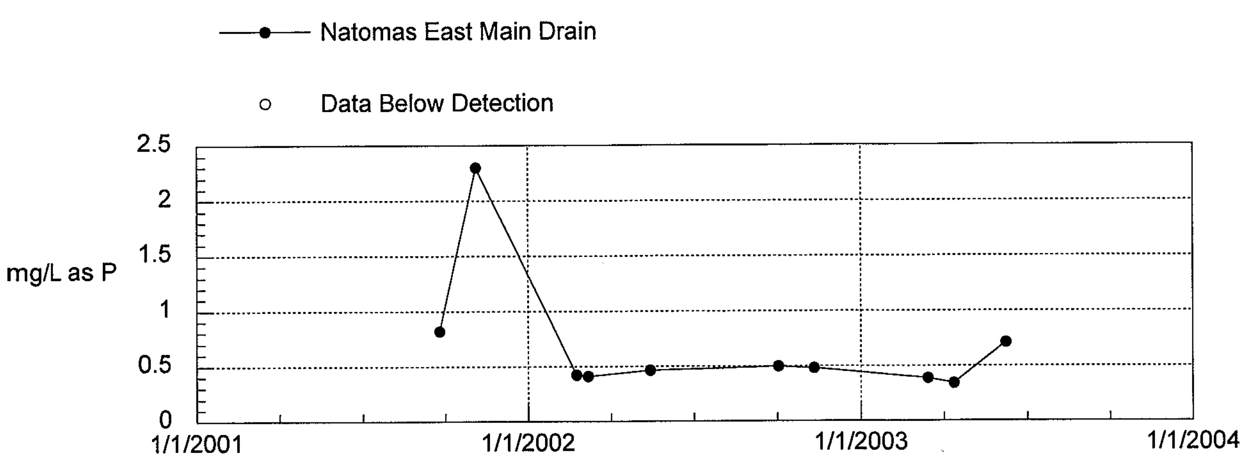


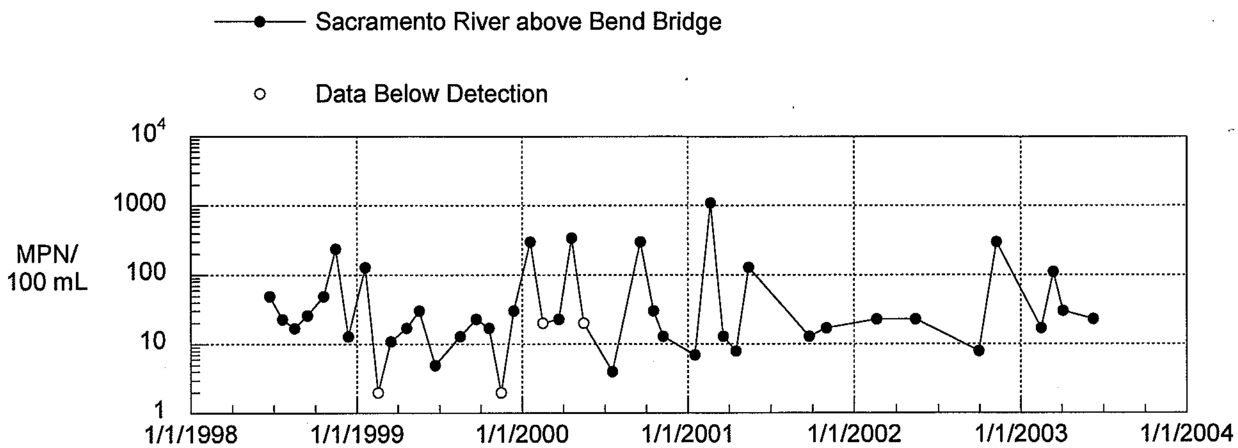


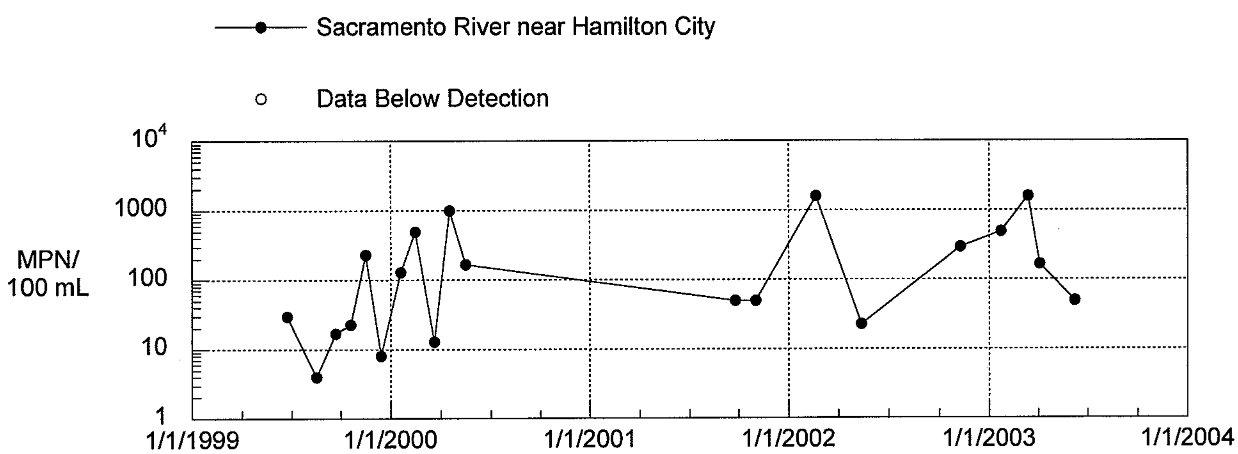


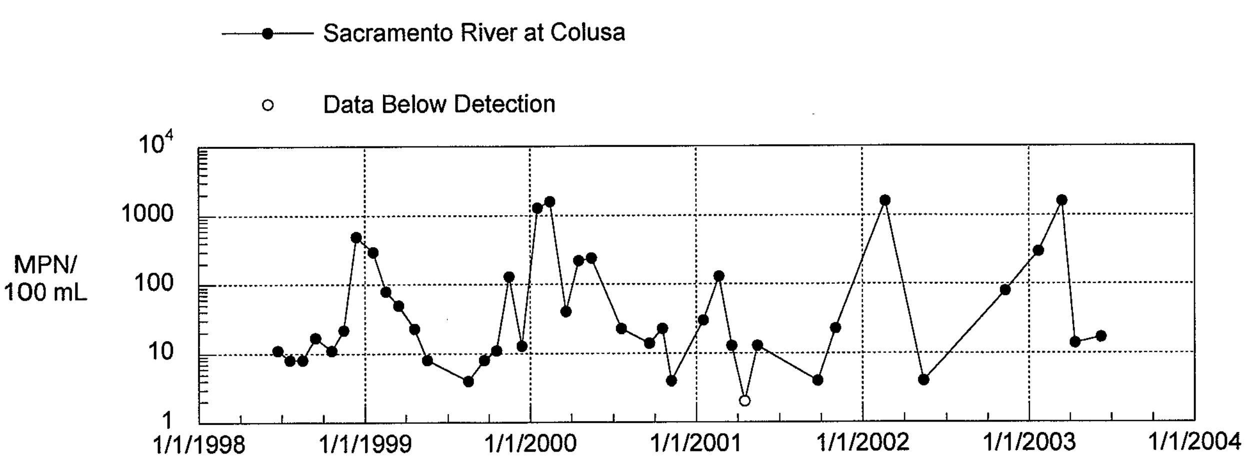

Colusa Basin Drain
Data Below Detection
mg/L as P
0.6
0.5
0.4
0.3
0.2
0.1
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento Slough
Data Below Detection
mg/L as P
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

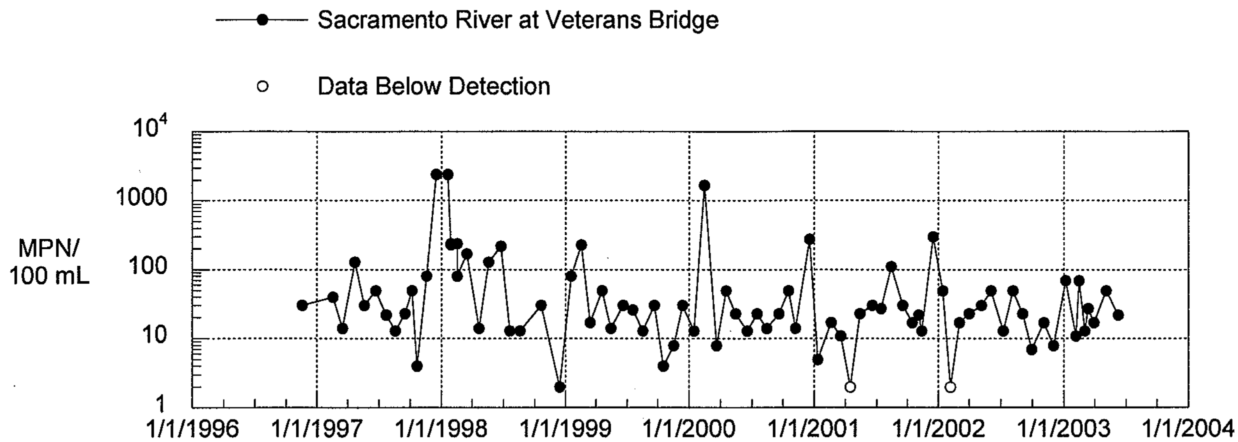

Natomas East Main Drain
Data Below Detection
mg/L as P
2.5
2
1.5
1
0.5
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004

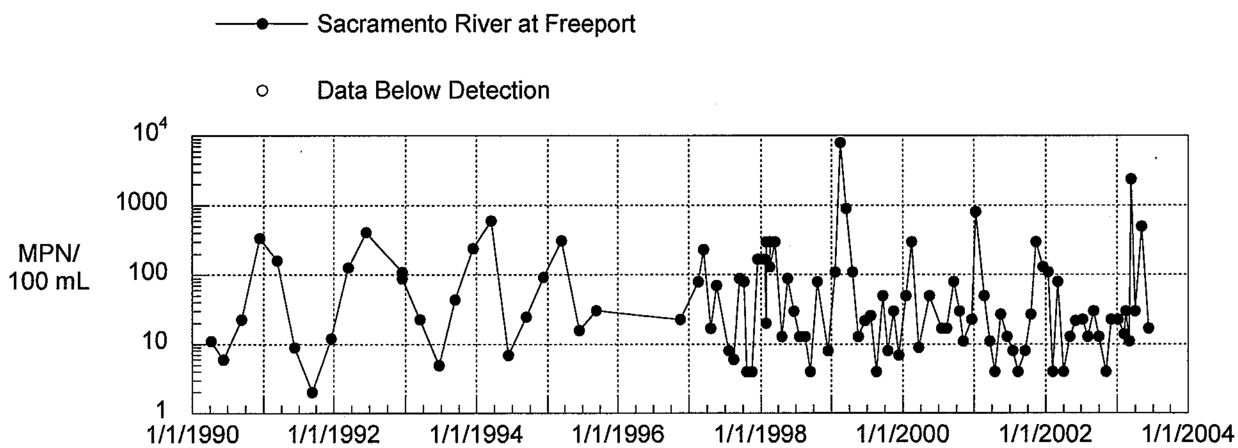

Sacramento River above Bend Bridge
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

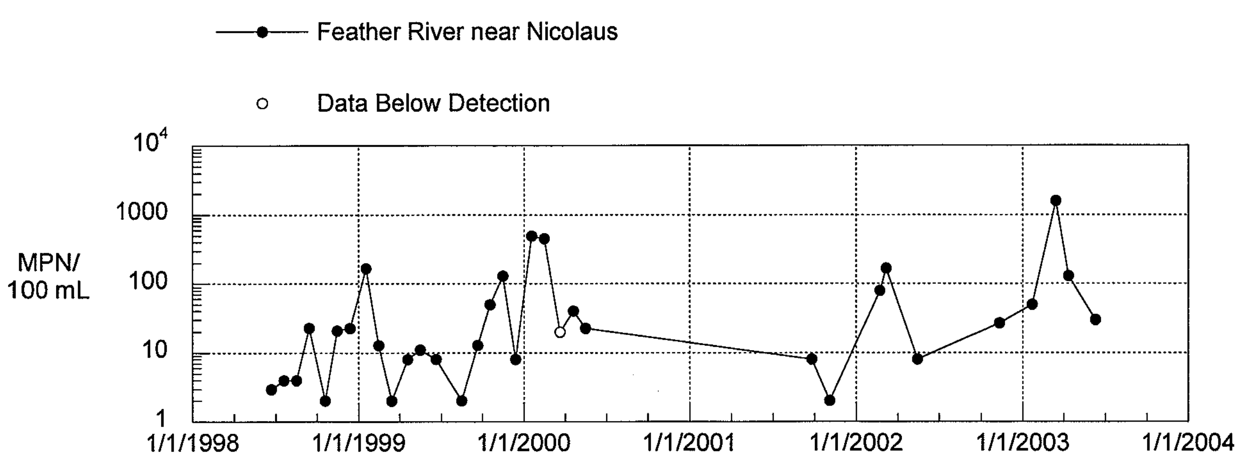

Sacramento River near Hamilton City
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

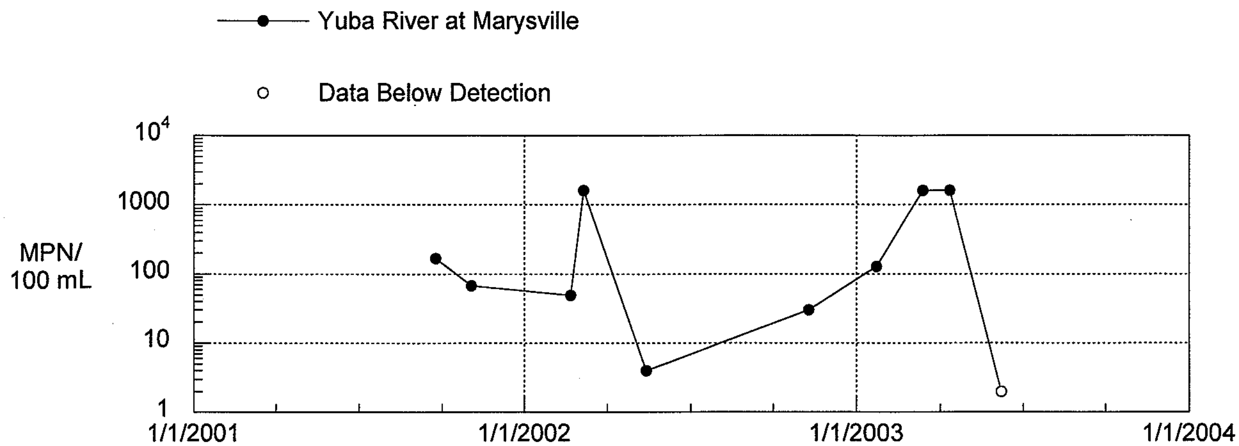

Sacramento River at Colusa
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

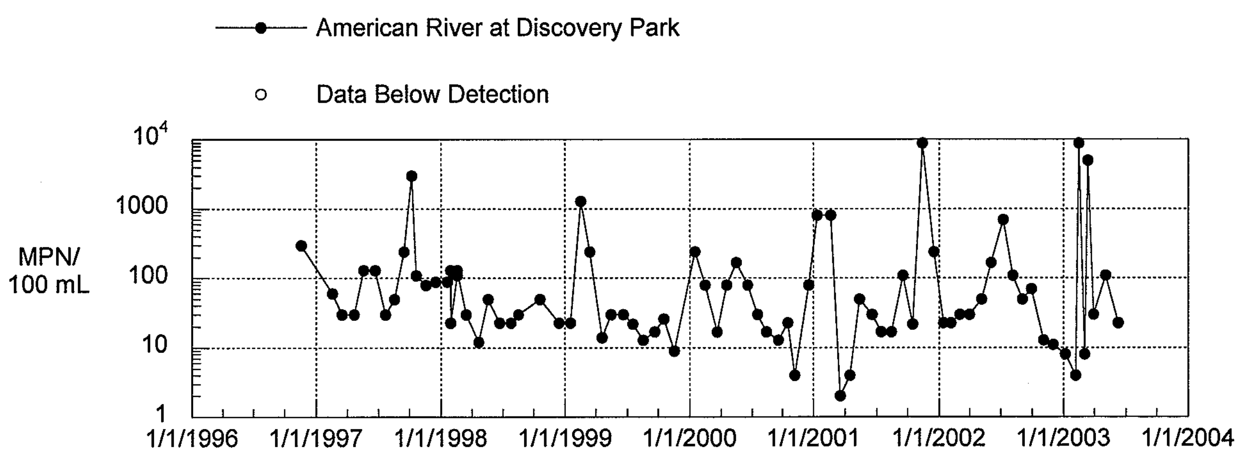
FECAL COLIFORM BACTERIA IN WATER

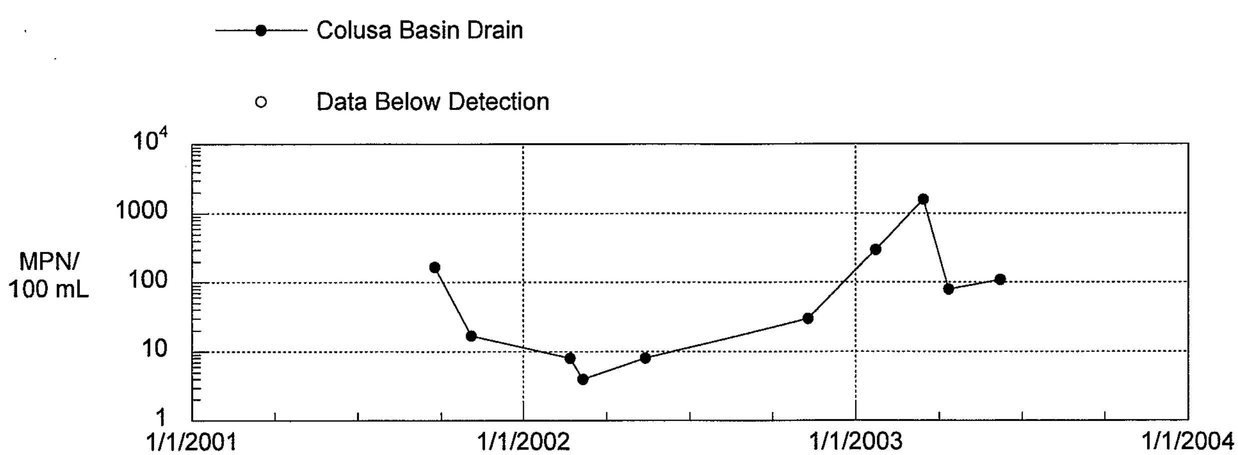


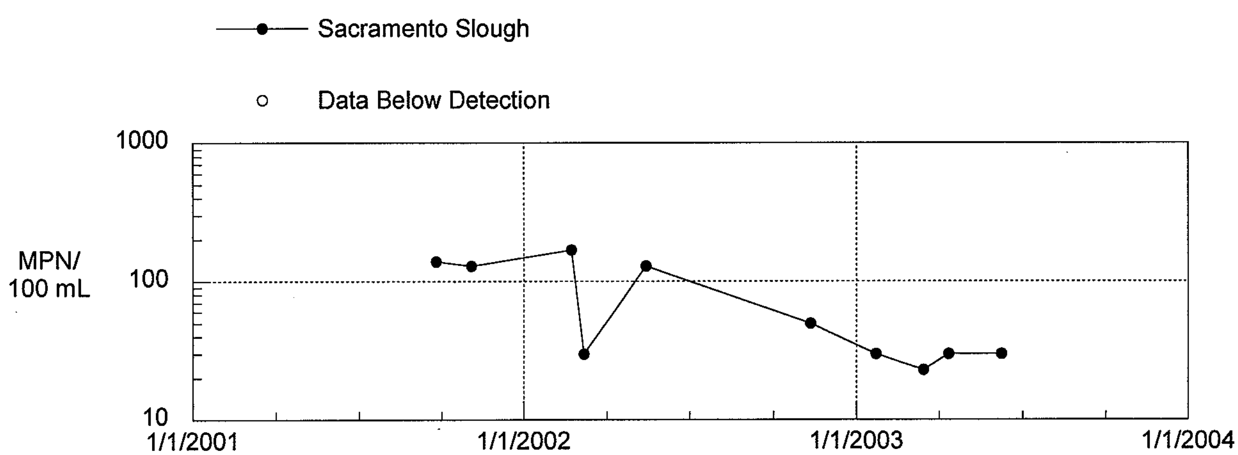


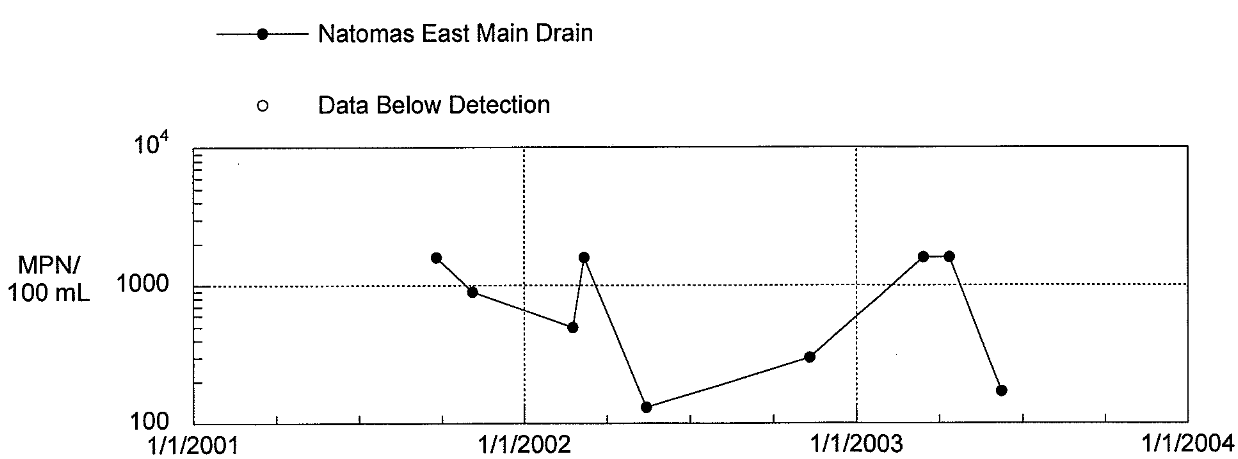


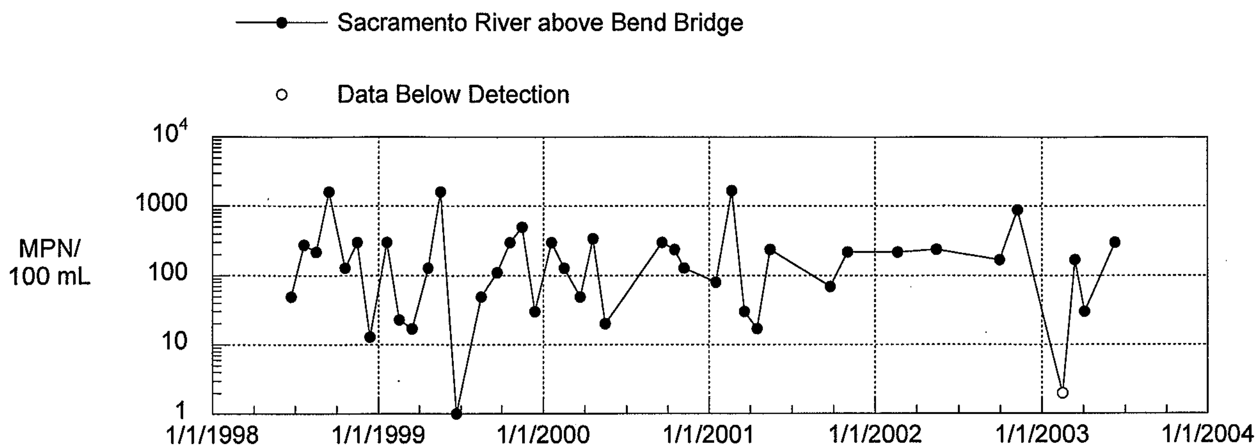

Yuba River at Marysville
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/2001
1/1/2002
1/1/2003
1/1/2004

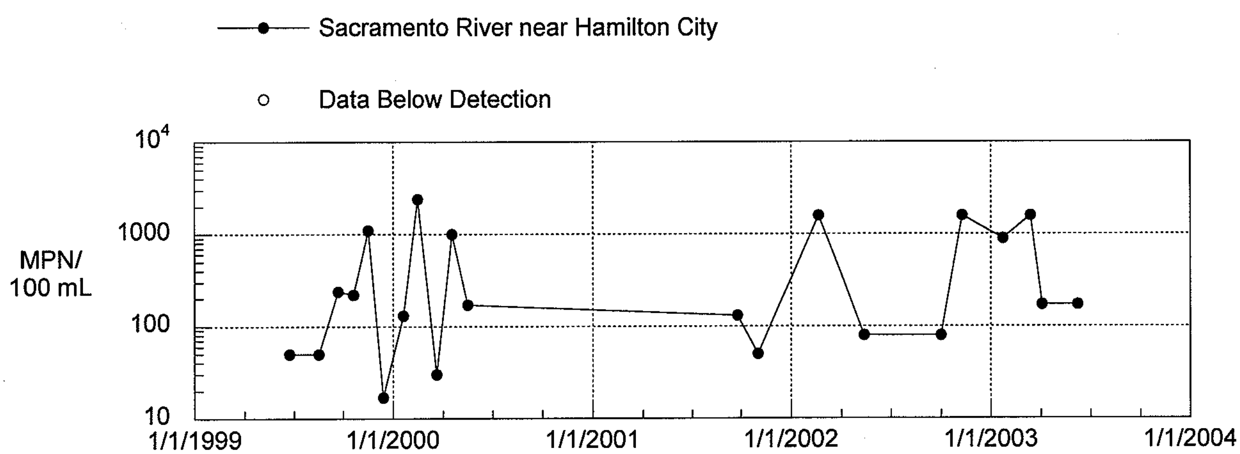

American River at Discovery Park
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

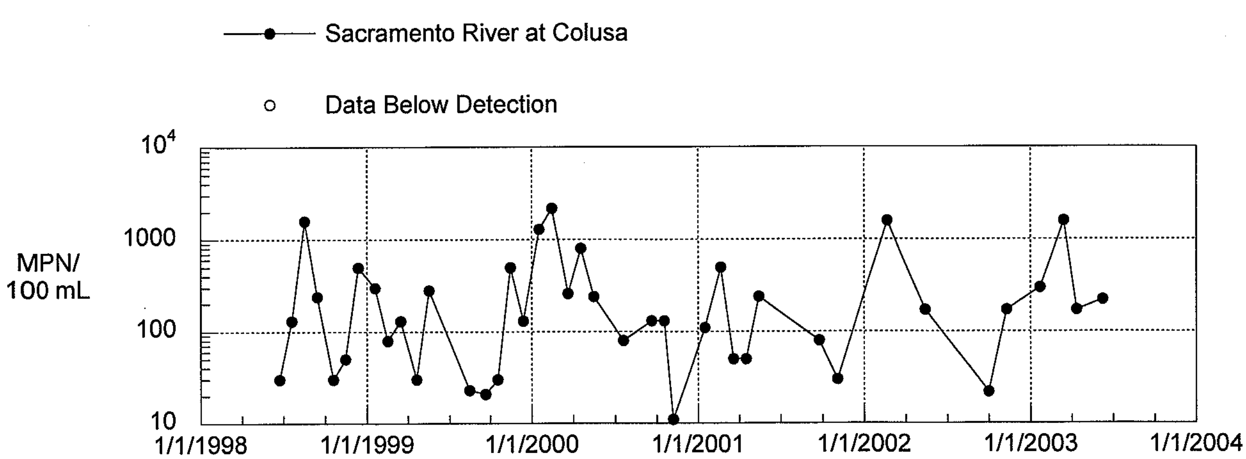

Colusa Basin Drain
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento Slough
Data Below Detection
1000
100
10
MPN/
100 mL
1/1/2001
1/1/2002
1/1/2003
1/1/2004

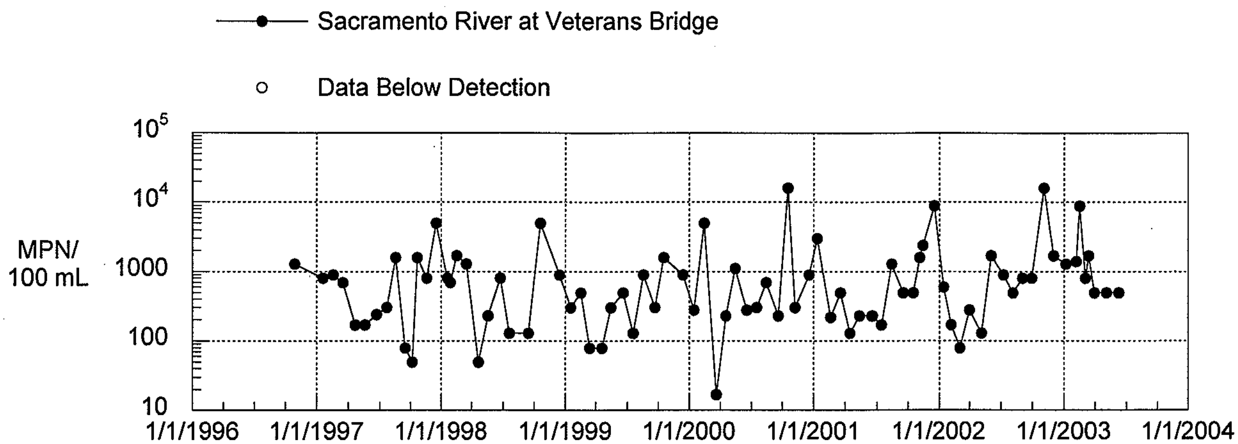

Natomas East Main Drain
Data Below Detection
10^4
1000
100
MPN/
100 mL
1/1/2001
1/1/2002
1/1/2003
1/1/2004

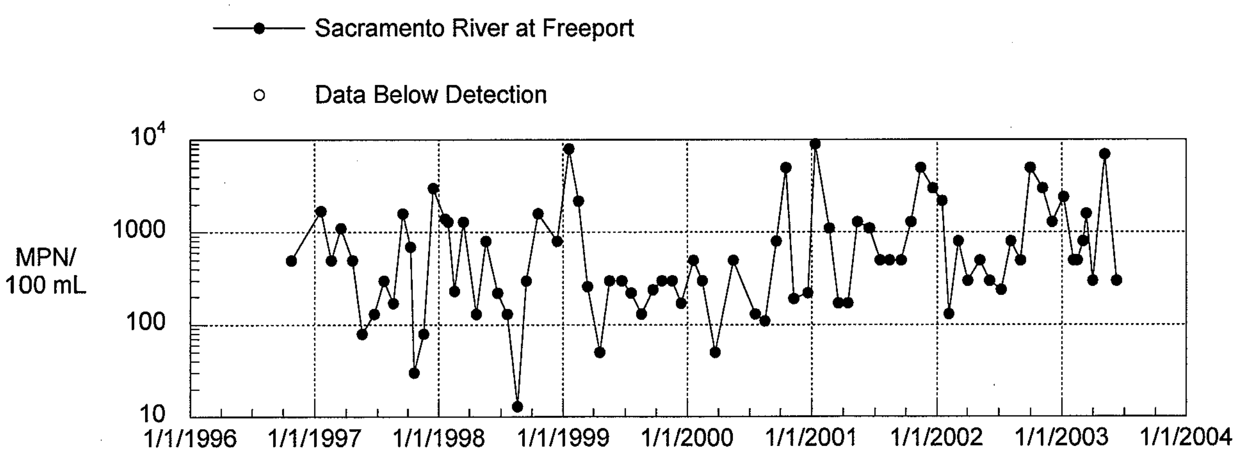

Sacramento River above Bend Bridge
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

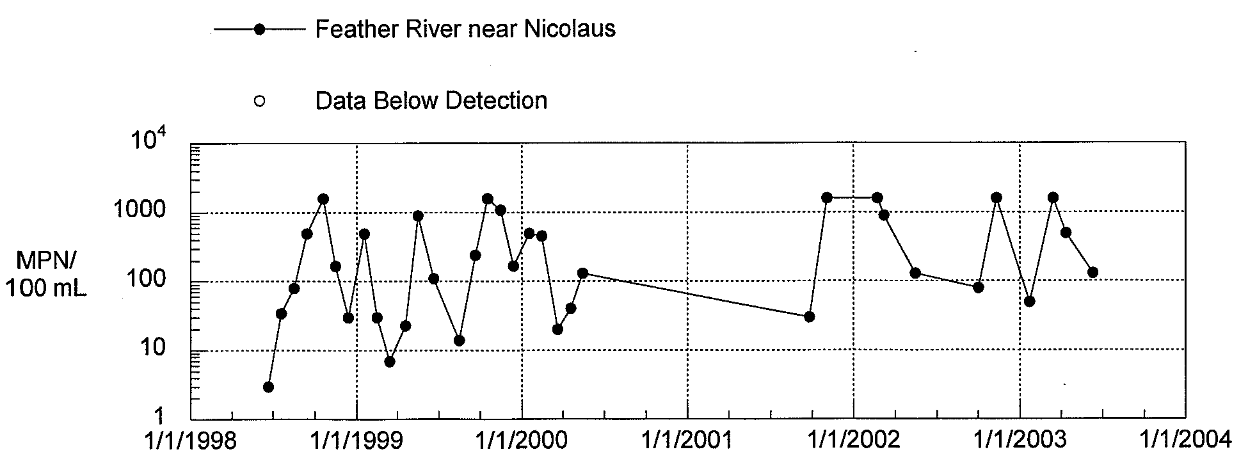

Sacramento River near Hamilton City
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento River at Colusa
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004

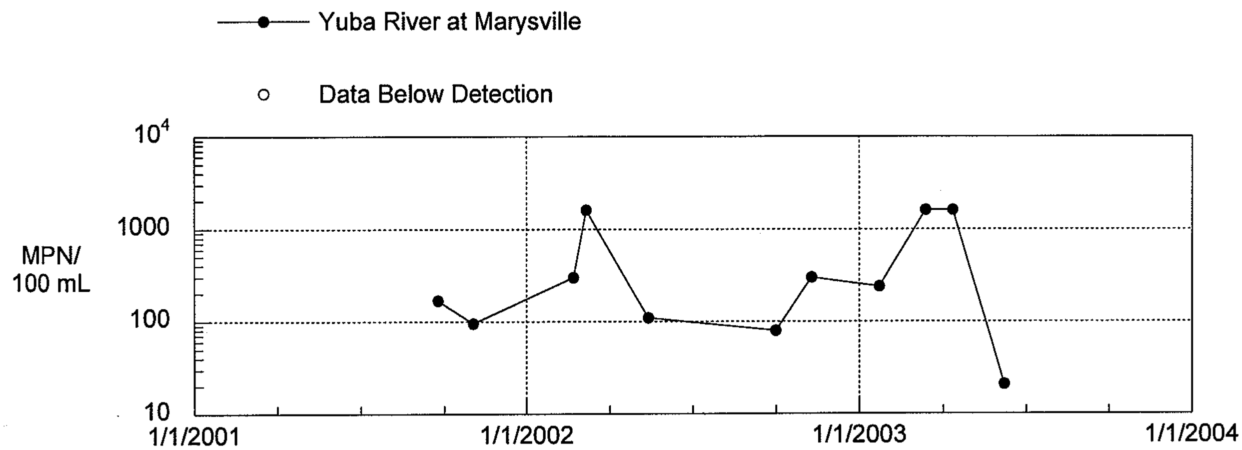
TOTAL COLIFORM BACTERIA IN WATER

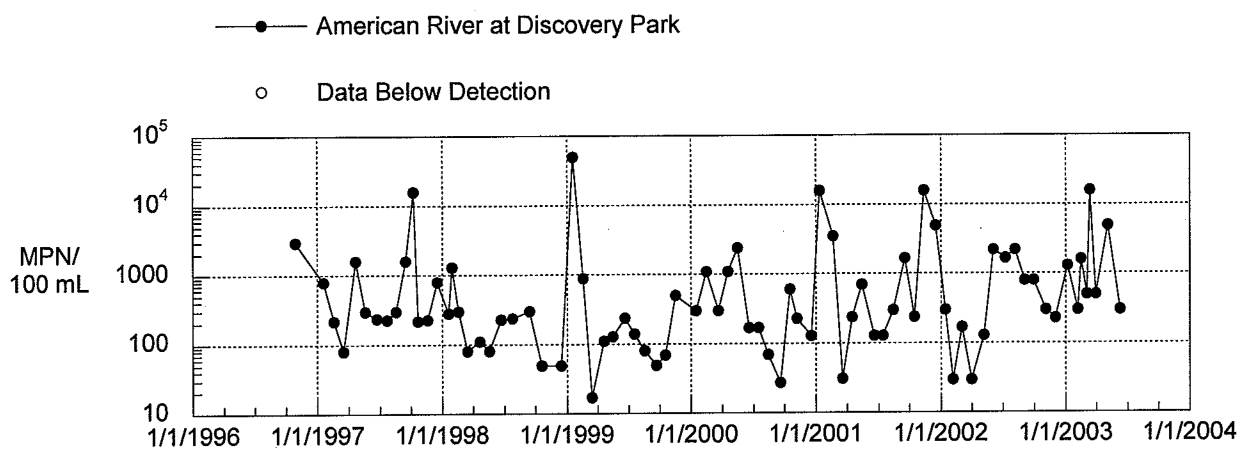


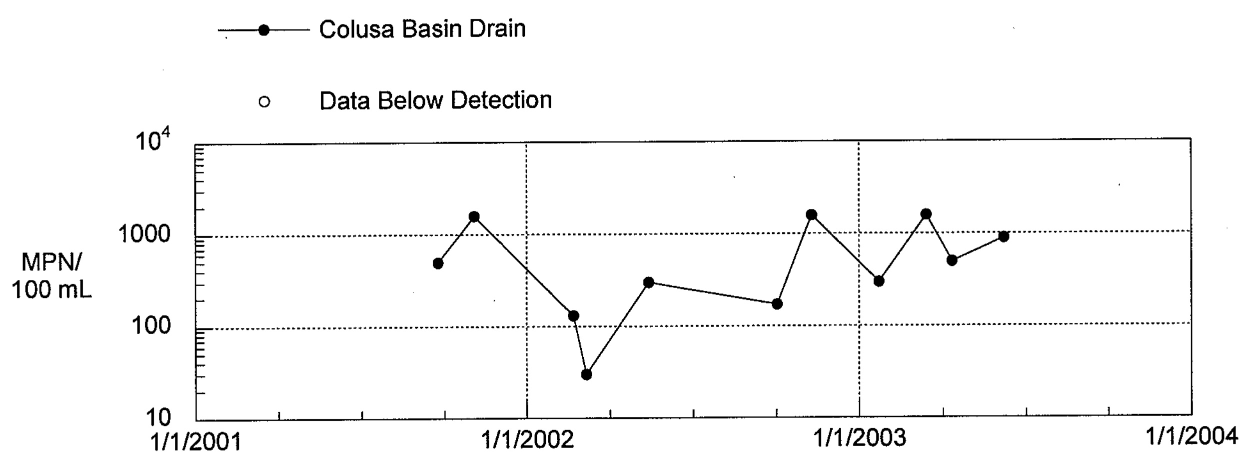


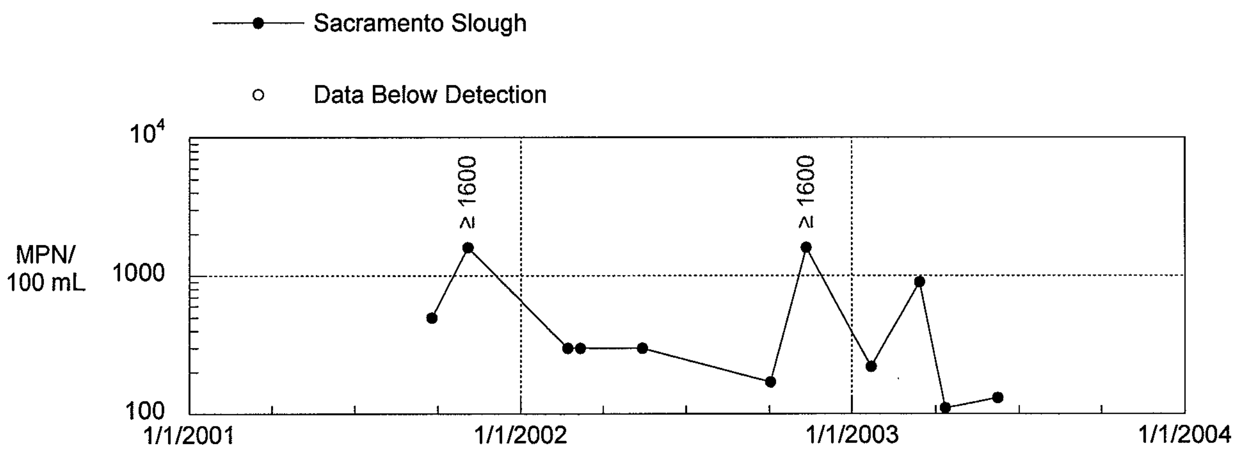


TOTAL COLIFORM BACTERIA IN WATER

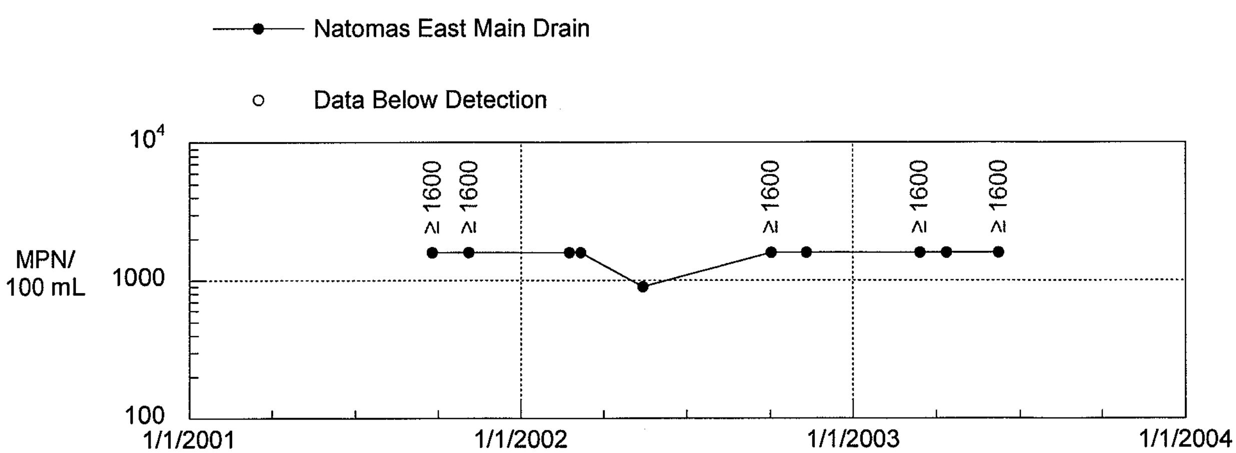




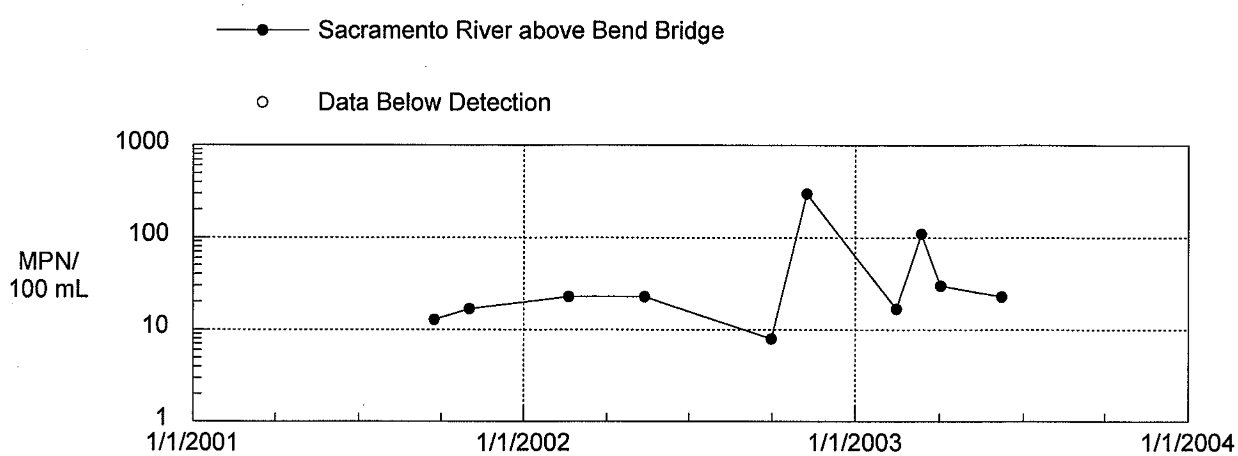


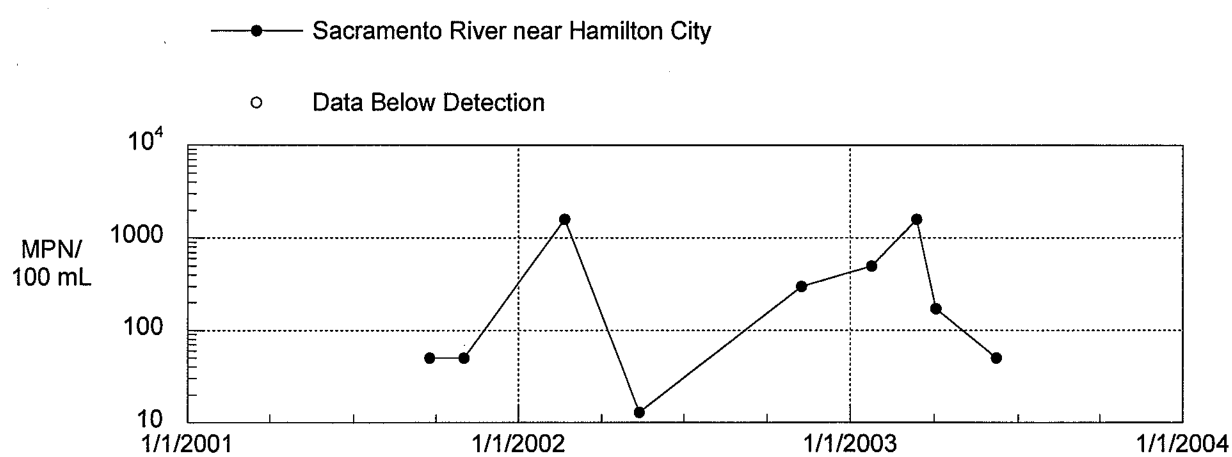


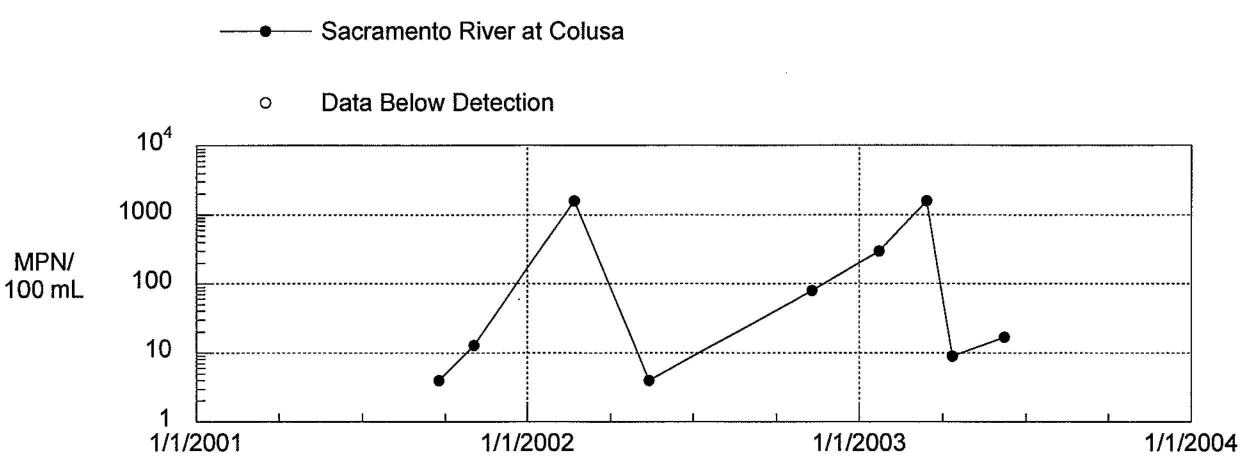
Sacramento Slough
Data Below Detection
MPN/
100 mL
10^4
1000
100
1/1/2001
1/1/2002
1/1/2003
1/1/2004
≥ 1600
≥ 1600

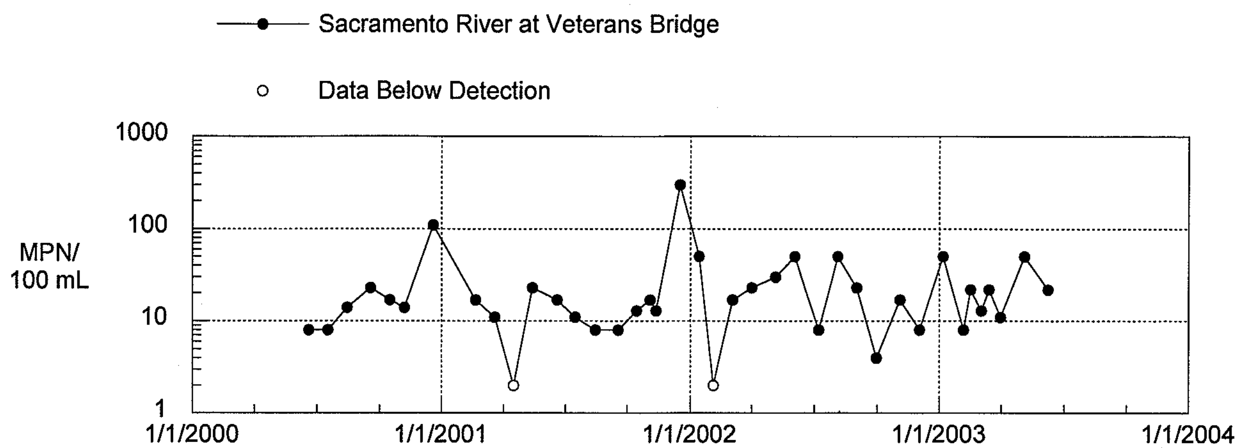


Natomas East Main Drain
Data Below Detection
MPN/
100 mL
10^4
1000
100
1/1/2001
1/1/2002
1/1/2003
1/1/2004
≥ 1600
≥ 1600
≥ 1600
≥ 1600
≥ 1600

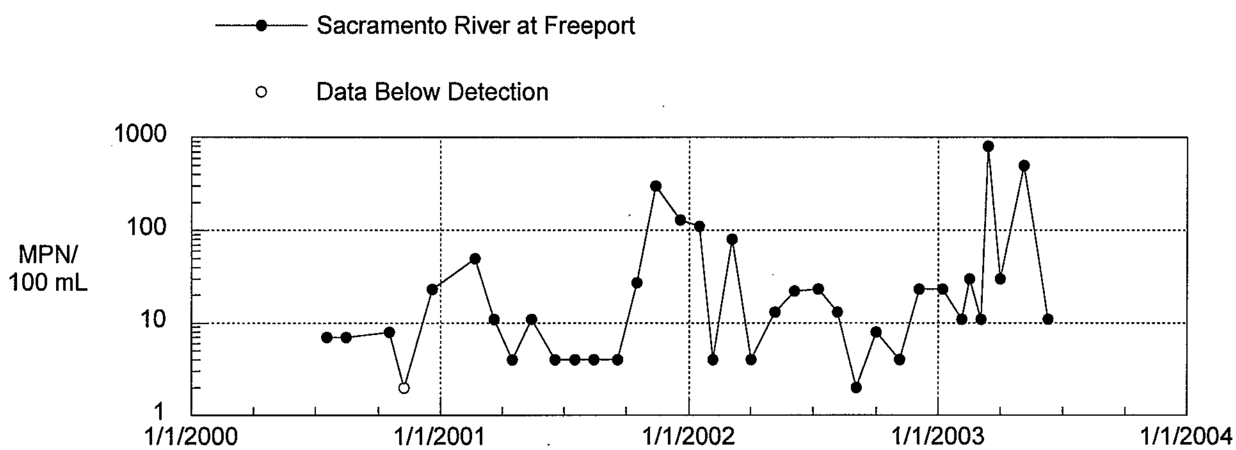

Sacramento River above Bend Bridge
Data Below Detection
1000
100
10
1
MPN/
100 mL
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento River near Hamilton City
Data Below Detection
10^4
1000
100
10
MPN/
100 mL
1/1/2001
1/1/2002
1/1/2003
1/1/2004

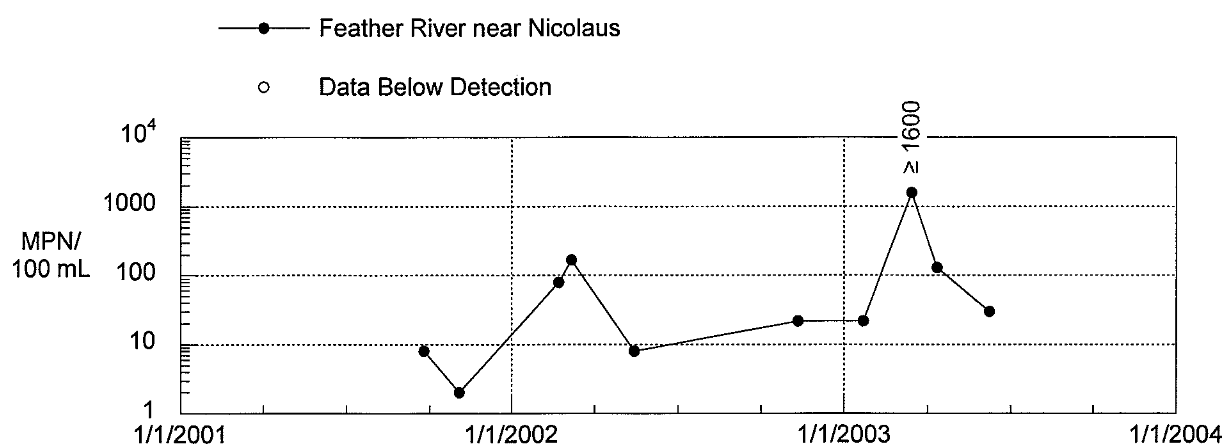

Sacramento River at Colusa
Data Below Detection
10^4
1000
100
10
1
MPN/
100 mL
1/1/2001
1/1/2002
1/1/2003
1/1/2004



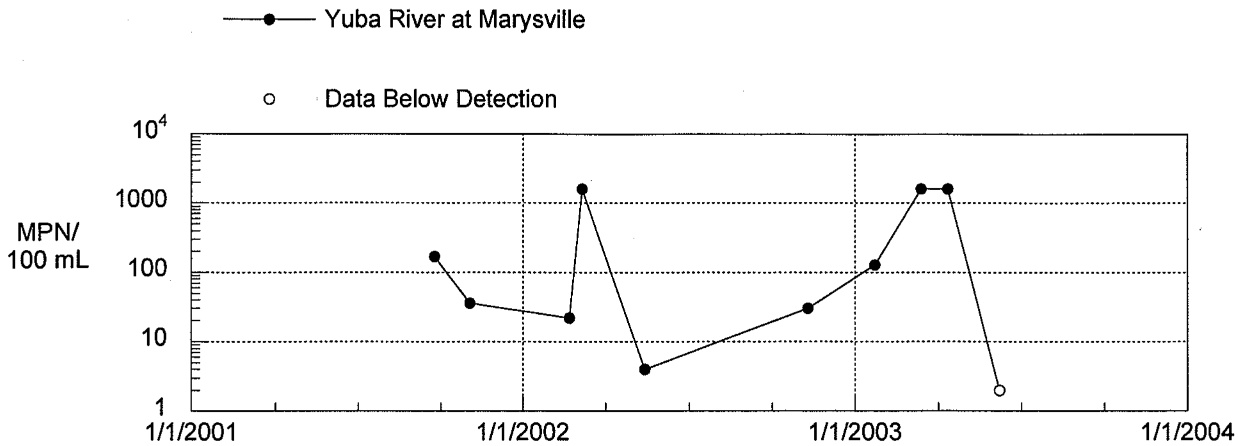
Sacramento River at Veterans Bridge
Data Below Detection
1000
100
10
1
MPN/
100 mL
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004



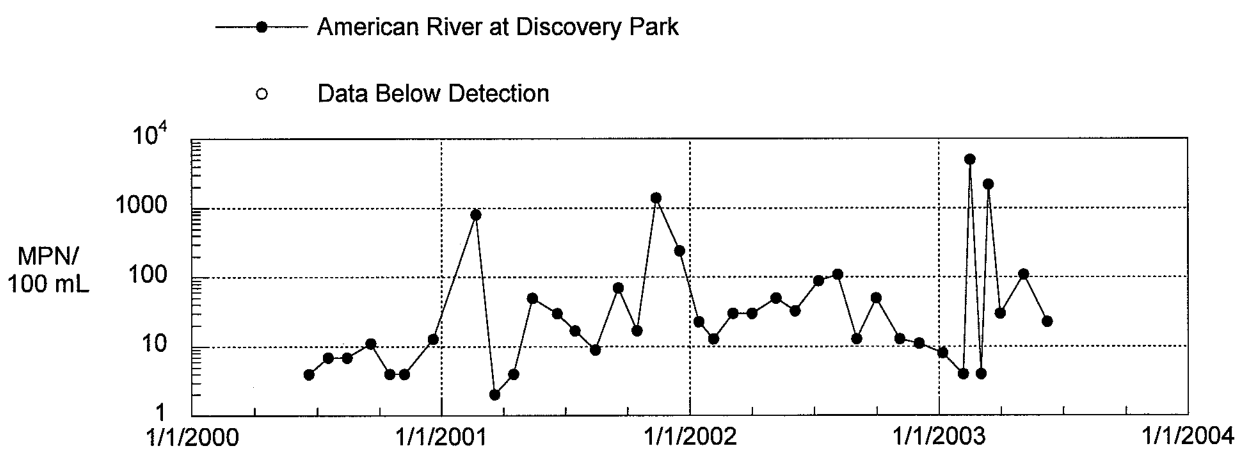
Sacramento River at Freeport
Data Below Detection
1000
100
10
1
MPN/
100 mL
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004



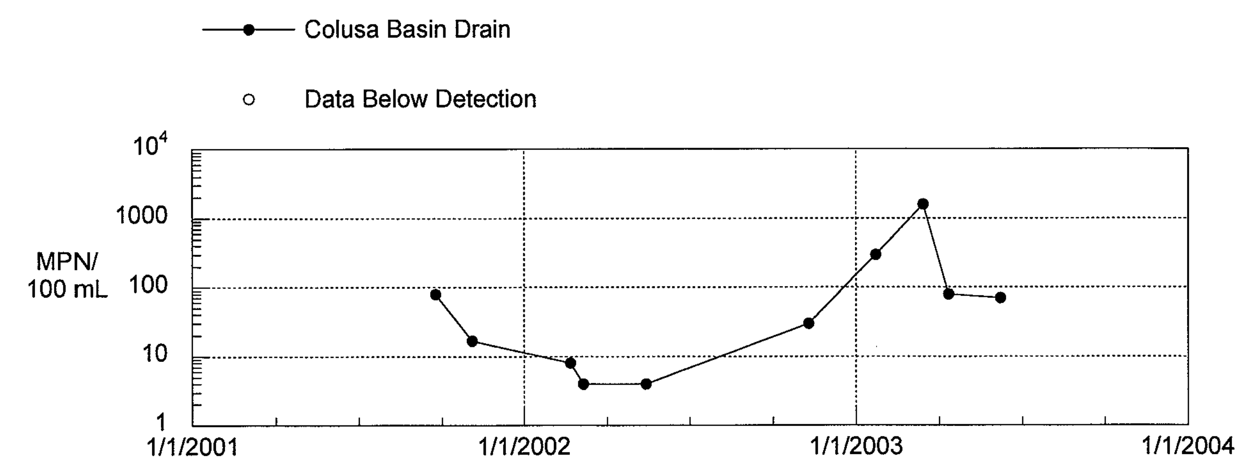
Feather River near Nicolaus
Data Below Detection
≥ 1600
10^4
1000
100
10
1
MPN/
100 mL
1/1/2001
1/1/2002
1/1/2003
1/1/2004



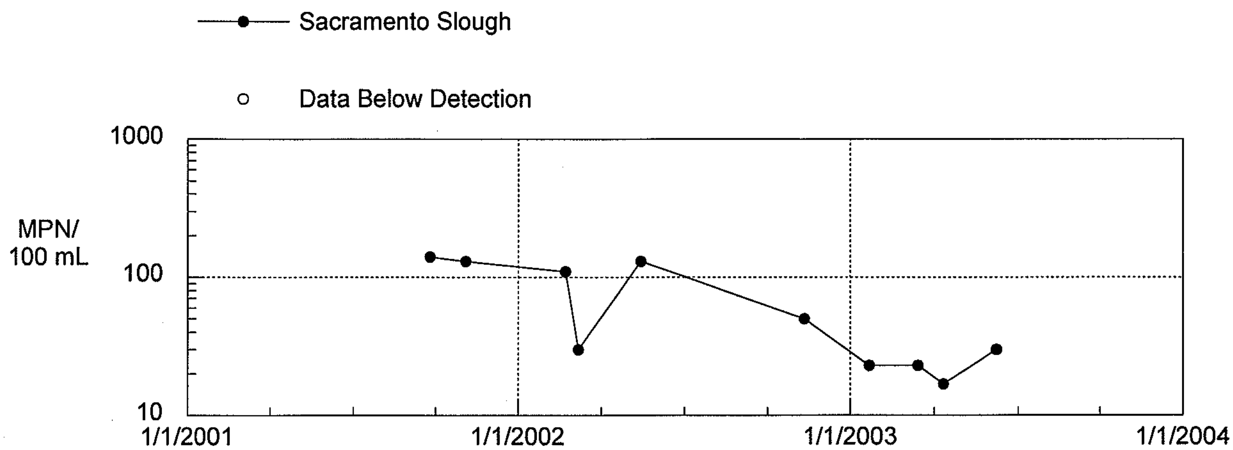
Yuba River at Marysville
Data Below Detection
MPN/ 100 mL
10^4
1000
100
10
1
1/1/2001
1/1/2002
1/1/2003
1/1/2004

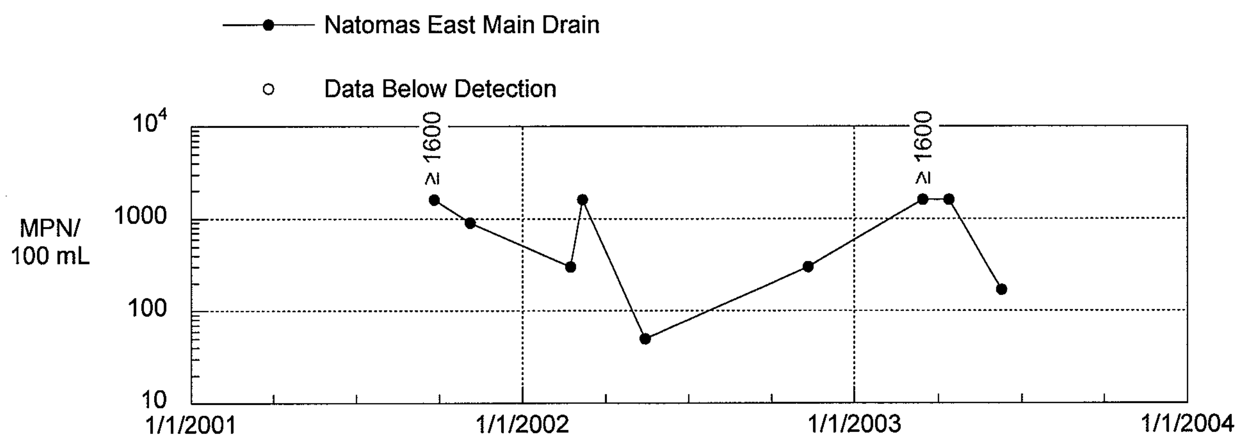


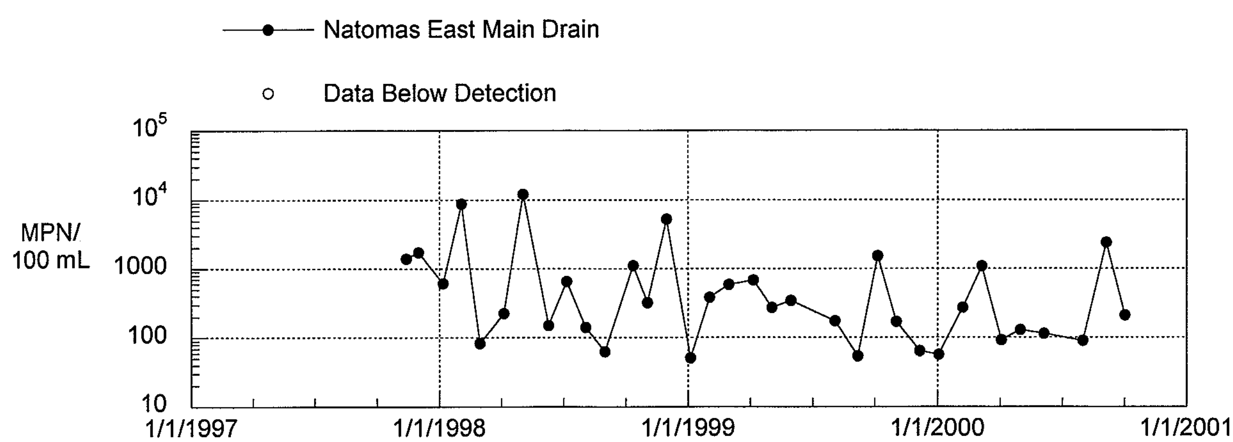
American River at Discovery Park
Data Below Detection
MPN/ 100 mL
10^4
1000
100
10
1
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004



Colusa Basin Drain
Data Below Detection
MPN/ 100 mL
10^4
1000
100
10
1
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Sacramento Slough
Data Below Detection
MPN/
100 mL
1000
100
10
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Natomas East Main Drain
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
≥ 1600
≥ 1600
1/1/2001
1/1/2002
1/1/2003
1/1/2004


Natomas East Main Drain
Data Below Detection
MPN/
100 mL
10^5
10^4
1000
100
10
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001

APPENDIX C:

FISH TISSUE DATA, SRWP AND CDWR, 1997-2002

YEAR	STATION LOCATION	Site ID	Site Category	Species	Tissue	Sample Type	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg, wet weight	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
1997	Colusa Basin Drain	COLDR	Ag Drain	White Catfish	fillet	Composite	5	288	78.8		0.304					
1997	Sacramento Slough	SACSL	Ag Drain	White Catfish	fillet	Composite	5	274	77.6		0.438					
1997	Cache Slough	CCHSL	Delta	White Catfish	fillet	Composite	5	279	78.7		0.552					
1997	Cache Slough	CCHSL	Delta	White Catfish	fillet	Composite	5	271	79.1		0.415					
1997	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Composite	5	258	79.9	0.92	0.285	9.4	12.9	2.83	32.7	0.96
1997	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Composite	5	256	80.3	1.55	0.390	33.4	46.7	8.78	67.8	2.43
1997	Sacramento R. above Bend Bridge	SRABB	Lower Sac. R. Mainstem	Rainbow Trout	fillet	Composite	5	313	75.3	2.54	0.032	7.3	ND	1.51	3.3	ND
1997	Sacramento R. below Keswick	SRBKR	Lower Sac. R. Mainstem	Rainbow Trout	fillet	Composite	5	366	72.4	3.99	0.032	23.8	27.0	2.88	26.4	0.62
1997	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem	White Catfish	fillet	Composite	5	249	79.0	0.84	0.553	10.7	14.7	3.25	42.9	1.11
1997	American R. at Discovery Park	ARDPK	Major Tributary	White Catfish	fillet	Composite	4	274	80.4	0.49	0.524	58.8	80.6	7.97	62.0	0.72
1997	Feather R. near Nicolaus	FRNIC	Major Tributary	White Catfish	fillet	Composite	5	264	81.1	0.49	0.391	10.5	ND	4.29	36.4	1.01
1997	McCloud R. above Shasta	MRASH	Tributary	Rainbow Trout	fillet	Composite	5	274	76.9		0.053					
1997	Pit R. above Shasta	PRASH	Tributary	Rainbow Trout	fillet	Individual	1	332	86.0		0.047					
1997	Sacramento R. above Shasta	SRASH	Tributary	Rainbow Trout	fillet	Composite	5	321	78.8		0.064					
1998	Colusa Basin Drain	COLDR	Ag Drain	Carp	fillet	Composite	5	386	76.8	1.78	0.106	6.6	1.9	1.89	684.0	20.07
1998	Natomas East Main Drain	NEMDR	Urban Creek/Runoff	Largemouth Bass	fillet	Composite	5	367	79.1	0.51	0.599	15.3	2.6	2.57	8.1	UJ
1998	Sacramento Slough	SACSL	Ag Drain	Largemouth Bass	fillet	Composite	5	381	78.1	1.23	0.506	5.5	1.0	ND	41.3	2.79
1998	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Composite	5	367	80.5	0.50	0.723	5.0	1.0	ND	32.7	2.53
1998	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Composite	5	345	77.0	0.86	0.748	6.2	1.0	ND	12.4	<2
1998	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Composite	5	334	76.6	0.90	0.895	116.9	1.0	1.01	25.0	2.01
1998	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Composite	5	286	80.5	1.67	0.518	46.5	3.8	3.78	75.9	2.28 J
1998	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Composite	5	250	80.0	1.94	0.258	57.1	10.0	16.40	129.5	<2
1998	Sacramento R. above Bend Bridge	SRABB	Lower Sac. R. Mainstem	Pike Minnow	fillet	Composite	5	254	79.8	1.06	0.119	8.7	1.0	ND	8.4	<2
1998	Sacramento R. below Keswick	SRBKR	Lower Sac. R. Mainstem	Rainbow Trout	fillet	Composite	5	399	74.0	4.40	0.036	26.1	1.6	1.55	36.5	<2
1998	Sacramento R. at Colusa	SRCOL	Lower Sac. R. Mainstem	Carp	fillet	Composite	5	398	80.3	1.00	0.186	5.6	1.0	ND	62.7	<2
1998	Sacramento R. at Colusa	SRCOL	Lower Sac. R. Mainstem	Pike Minnow	fillet	Composite	5	278	80.6	0.76	0.301	7.0	1.0	ND	17.3	<2
1998	Sacramento R. near Hamilton City	SRHAM	Lower Sac. R. Mainstem	Pike Minnow	fillet	Composite	5	286	79.1	1.30	0.216	10.0	1.0	1.14	20.9	<2
1998	Sacramento R. near Hamilton City	SRHAM	Lower Sac. R. Mainstem	Sacramento Sucker	fillet	Composite	5	322	79.1	1.24	0.030	1.4	1.1	ND	2.1	<2
1998	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem	Largemouth Bass	fillet	Composite	5	335	78.8	0.74	0.818	7.3	1.0	ND	22.5	<2
1998	American R. at Discovery Park	ARDPK	Major Tributary	Pike Minnow	fillet	Composite	5	283	75.0	4.02	0.418	35.7	11.0	21.78	58.2	3.67
1998	American R. at J Street	ARJST	Major Tributary	Largemouth Bass	fillet	Composite	4	375	78.5	0.67	0.659	5.3	2.0	2.01	4.8	<2
1998	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Composite	5	382	79.1	0.72	1.154	8.2	1.0	ND	14.1	<2
1999	Natomas East Main Drain	NEMDR	Urban Creek/Runoff	Largemouth Bass	fillet	Composite	5	332	79.2	0.7	0.680	35.1	26.0	4.08	16.1	<2
1999	Natomas East Main Drain	NEMDR	Urban Creek/Runoff	White Catfish	fillet	Composite	5	258	80.7		0.286					
1999	Sacramento Slough	SACSL	Ag Drain	White Catfish	fillet	Composite	5	263	79.1	0.4	0.639	1.2	ND	ND	17.9	<2
1999	Sacramento Slough	SACSL	Ag Drain	Largemouth Bass	fillet	Composite	5	381	80.6	1.0	0.442	11.0	ND	1.27	45.9	2.00
1999	Cache Slough	CCHSL	Delta	White Catfish	fillet	Composite	5		81.8	0.6		15.5	16.0	1.40	56.4	<2
1999	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Composite	5		79.6	0.4		6.5	ND	ND	17.0	<2
1999	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	385	76.6		0.877					
1999	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	340	78.3		0.747					
1999	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	340	78.6		0.872					
1999	Cache Slough	CCHSL	Delta	Carp	fillet	Composite	5	352	78.9		0.107					
1999	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	429	79.0		0.898					
1999	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	380	79.2		1.180					
1999	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	270	79.3		0.602					
1999	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	285	79.7		0.513					
1999	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	280	81.2		0.497					
1999	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	330	82.0		0.833					
1999	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	274	83.3		0.680					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Composite	5		80.4	1.2		18.1	21.0	1.99	31.5	<2
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Composite	5		79.8	2.0		24.8	24.0	2.67	58.8	<2
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Composite	5		79.8	1.0		26.0	26.0	2.58	44.3	<2
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Composite	5		72.2	3.9		36.6	29.0	5.50	88.6	<2
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Composite	5		77.7	1.1		11.0	ND	1.58	26.4	<2

YEAR	STATION LOCATION	Site ID	Site Category	Species	Tissue	Sample Type	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg, wet weight	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	250	58.9		0.197					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	283	69.3		0.448					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	379	76.7		1.010					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	385	76.7		1.340					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Bluegill	fillet	Composite	5	185	76.9		0.103					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	341	76.9		1.050					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	355	77.1		0.750					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	315	77.2		0.775					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	341	77.2		0.524					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	317	77.6		0.867					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	358	78.1		0.883					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	350	78.4		1.350					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	259	78.5		0.327					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	265	78.9		0.536					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	277	78.9		0.563					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	309	78.9		0.426					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	286	78.9		0.673					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	295	78.9		0.375					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	261	80.3		0.238					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	305	80.4		0.271					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	290	80.5		0.256					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	265	81.1		1.140					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	275	81.3		0.237					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	281	82.3		0.515					
1999	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	233	82.6		0.204					
1999	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	381	82.8		1.370					
1999	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem	Sacramento Sucker	fillet	Composite	5	318	79.6	1.37	0.098	19.0	15.0	2.44	18.2	<2
1999	American R. at Discovery Park	ARDPK	Major Tributary	Largemouth Bass	fillet	Composite	5	340	78.5	0.7	0.850	22.7	23.0	2.86	18.3	<2
1999	American R. at Discovery Park	ARDPK	Major Tributary	Sacramento Sucker	fillet	Composite	5	314	79.6	1.0	0.247	9.7	ND	1.10	7.6	<2
1999	American R. at J Street	ARJST	Major Tributary	Pike Minnow	fillet	Composite	5	248	78.4	1.0	0.426	16.2	18.0	2.48	16.3	<2
1999	American R. at J Street	ARJST	Major Tributary	Sacramento Sucker	fillet	Composite	5	266	77.5	1.1	0.099	2.5	ND	ND	2.9	<2
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Pike Minnow	fillet	Composite	5	287	80.5	0.7	1.200	19.0	20.0	ND	33.3	<2
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Composite	5		76.7	0.9		7.4	ND	ND	13.3	<2
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Striped Bass	fillet	Individual	1	626	76.3		1.280					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Striped Bass	fillet	Individual	1	645	76.5		0.320					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	339	76.7		2.080					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	361	77.7		1.520					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	321	77.8		0.667					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	495	77.8		2.350					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	305	77.9		0.649					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	White Catfish	fillet	Individual	1	497	77.9		0.745					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	314	77.9		0.633					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	310	78.0		0.555					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	310	78.0		0.667					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	322	78.1		0.787					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	456	78.1		1.510					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Striped Bass	fillet	Individual	1	817	78.5		3.500					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	350	78.9		1.030					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	Bluegill	fillet	Composite	5	184	79.7		0.121					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary	White Catfish	fillet	Individual	1	491	79.8		0.620					
1999	Clear Ck @ Hwy 273	CCHWY	Tributary	Riffle sculpin	fillet	Composite			79.3	1.13	0.241	2.7	ND	<RL	2.2	<2
1999	Clear Ck @ Reading Bar	CCRBR	Tributary	Riffle sculpin	fillet	Composite			80.0	0.83	0.160	<RL	ND	ND	<RL	<2
1999	Clear Ck @ Reading Bar	CCRBR	Tributary	Rainbow Trout	fillet	Composite			80.5	1.13	0.046	<RL	ND	ND	<RL	<2
1999	Clear Ck @ Reading Bar	CCRBR	Tributary	Riffle sculpin	liver	Composite			80.0	0.83	0.088					
1999	Clear Ck @ Reading Bar	CCRBR	Tributary	Rainbow Trout	liver	Composite			80.5	1.13	<.020					

YEAR	STATION LOCATION	Site ID	Site Category	Species	Tissue	Sample Type	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg, wet weight	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
1999	Clear Ck above Whiskeytown	CCWHI	Tributary	Rainbow Trout	fillet	Composite			78.1	1.96	0.050	0.9	ND	ND	<RL	<2
1999	Clear Ck above Whiskeytown	CCWHI	Tributary	Riffle sculpin	fillet	Composite			79.1	1.12	**0.107**	<RL	ND	ND	<RL	<2
1999	Clear Ck above Whiskeytown	CCWHI	Tributary	Rainbow Trout	liver	Composite			78.1	1.96	0.050					
1999	Clear Ck above Whiskeytown	CCWHI	Tributary	Riffle sculpin	fillet	Composite			79.1	1.12	**0.096**					
1999	Clear Ck above Whiskeytown	CCWHI	Tributary	Riffle sculpin	liver	Composite			79.1	1.12	0.213					
1999	Big Chico Ck @ Hwy 32	CHHWY	Tributary	Rainbow Trout	fillet	Composite			76.8	3.17	**0.041**	0.8	ND	ND	2.5	<2
1999	Big Chico Ck @ Hwy 32	CHHWY	Tributary	Rainbow Trout	fillet	Composite			76.8	3.17	**0.044**	0.8	ND	ND	2.5	<2
1999	Big Chico Ck @ Hwy 32	CHHWY	Tributary	Rainbow Trout	liver	Composite			76.8	3.17	0.037					
1999	Big Chico Ck @ Hwy 99	CHSYC	Tributary	Smallmouth bass	fillet	Composite			77.8	0.99	0.231	<RL	ND	<RL	<RL	<2
1999	Big Chico Ck @ Hwy 99	CHSYC	Tributary	Smallmouth bass	fillet	Composite			77.8	0.98		0.4	ND	ND	<RL	<2
1999	Big Chico Ck @ Hwy 99	CHSYC	Tributary	Riffle sculpin	fillet	Composite			79.6	0.61	0.146	<RL	ND	<RL	<RL	<2
1999	Big Chico Ck @ Hwy 99	CHSYC	Tributary	Smallmouth bass	liver	Composite			77.8	0.99	0.124					
1999	Big Chico Ck @ Hwy 99	CHSYC	Tributary	Riffle sculpin	liver	Composite			79.6	0.61	0.182					
1999	Deer Ck @ Hwy 99	DCHWY	Tributary	Riffle sculpin	fillet	Composite			77.2	2.84	0.082	0.4	ND	<RL	<RL	<2
1999	Deer Ck @ Hwy 99	DCHWY	Tributary	Smallmouth bass	fillet	Composite			79.2	0.93	0.075	<RL	ND	ND	<RL	<2
1999	Deer Ck @ Hwy 99	DCHWY	Tributary	Riffle sculpin	liver	Composite			77.2	2.84	0.043					
1999	Deer Ck @ Hwy 99	DCHWY	Tributary	Smallmouth bass	liver	Composite			79.2	0.93	0.044					
1999	Deer Ck below Childs Meadow	DCMDW	Tributary	Rainbow Trout	fillet	Composite			76.8	3.28	<.020	8.8	ND	<RL	4.9	<2
1999	Deer Ck below Childs Meadow	DCMDW	Tributary	Rainbow Trout	fillet	Composite			76.9	2.42		7.2	ND	<RL	4.0	<2
1999	Deer Ck below Childs Meadow	DCMDW	Tributary	Riffle sculpin	fillet	Composite			77.9	2.11	0.034	0.2	ND	ND	<RL	<2
1999	Deer Ck below Childs Meadow	DCMDW	Tributary	Rainbow Trout	liver	Composite			76.8	3.28	<.020					
1999	Deer Ck below Childs Meadow	DCMDW	Tributary	Riffle sculpin	liver	Composite			77.9	2.11	<.020					
1999	Mill Ck at Black Rock	MCBLK	Tributary	Riffle sculpin	fillet	Composite			79.1	0.73	0.327	<RL	ND	ND	<RL	<2
1999	Mill Ck at Black Rock	MCBLK	Tributary	Riffle sculpin	liver	Composite			79.1	0.73	0.353					
1999	Mill Ck at Hwy 99	MCHWY	Tributary	Riffle sculpin	fillet	Composite			79.7	1.01	0.279	0.2	ND	ND	<RL	<2
1999	Mill Ck at Hwy 99	MCHWY	Tributary	Riffle sculpin	liver	Composite			79.7	1.01	0.288					
1999	Putah Creek	PUTAH	Tributary	Sacramento Sucker	fillet	Composite	4	383	76.3	3.3	0.185	20.7	19.0	1.68	95.7	<2
1999	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Composite	5		77.9	0.6		3.9	ND	ND	13.2	<2
1999	Putah Creek	PUTAH	Tributary	White Catfish	fillet	Individual	1	470	73.3		0.146					
1999	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	425	76.0		0.592					
1999	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	354	76.7		0.396					
1999	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	410	77.0		0.540					
1999	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	345	77.1		0.231					
1999	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	402	78.6		0.630					
1999	Putah Creek	PUTAH	Tributary	Bluegill	fillet	Composite	5	112	78.9		0.097					
1999	Putah Creek	PUTAH	Tributary	Bluegill	fillet	Composite	5	135	79.5		0.123					
2000	Colusa Basin Drain	COLDR	Ag Drain	White Catfish	fillet	Composite	5	259.4	81.0	0.80	0.21	1.5	ND	ND	40.2	<RL
2000	Colusa Basin Drain	COLDR	Ag Drain	Carp	fillet	Composite	5	371.6	78.3	1.25	0.18	3.6	ND	ND	284.8	3.88
2000	Natomas East Main Drain	NEMDR	Urban Creek/Runoff	Largemouth Bass	fillet	Composite	5	350.4	76.8	0.74	0.65	23.4	32.0	1.82	17.2	<RL
2000	Natomas East Main Drain	NEMDR	Urban Creek/Runoff	White Catfish	fillet	Composite	4	275.75	78.8	2.00	0.21	37.0	45.0	2.66	37.9	<RL
2000	Natomas East Main Drain	NEMDR	Urban Creek/Runoff	Striped Bass	fillet	Individual	1	494	72.0		0.81					
2000	Sacramento Slough	SACSL	Ag Drain	White Catfish	fillet	Composite	5	261.6	80.7	1.89	0.44	26.6	28.0	1.77	64.5	2.55
2000	Sacramento Slough	SACSL	Ag Drain	Largemouth Bass	fillet	Composite	5	355	78.6	0.60	0.49	4.3	ND	ND	30.8	<RL
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Composite	10	288.2	79.7	1.06	0.4431	9.7	13.0	1.21	54.7	<RL
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Composite	6	361.8	78.7	0.76	0.50	5.5	ND	ND	31.2	<RL
2000	Cache Slough	CCHSL	Delta	Sacramento Sucker	fillet	Composite	5	393.6	78.5		0.11					
2000	Cache Slough	CCHSL	Delta	Crappie	fillet	Composite	5	231.2	77.0		0.32					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	400	78.6		1.14					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	276	82.6		0.21					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	319	78.6		0.82					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	254	81.3		0.14					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	258	80.5		0.43					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	259	80.7		0.53					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	275	78.3		0.52					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	290	82.3		0.49					

YEAR	STATION LOCATION	Site ID	Site Category	Species	Tissue	Sample Type	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg, wet weight	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	323	79.3		0.48					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	325	78.6		0.62					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	328	79.5		0.37					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	305	79.9		0.45					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	265	80.1		0.40					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	228	80.1		0.25					
2000	Cache Slough	CCHSL	Delta	White Catfish	fillet	Individual	1	385	83.8		1.00					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	560	76.2		1.27					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	348	77.3		0.31					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	340	77.5		0.53					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	382	77.8		0.48					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	348	78.3		0.49					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	365	76.2		0.59					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	388	77.5		0.60					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	270	79.5		0.39					
2000	Cache Slough	CCHSL	Delta	Largemouth Bass	fillet	Individual	1	290	80.1		0.31					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Composite	6	368.7	77.5	1.12	0.99	13.2	15.0	ND	16.8	<RL
2000	Sacramento R. at Mile 44	SRRMF	Delta	Sacramento Sucker	fillet	Composite	5	452.2	76.1	3.83	0.22	24.3	43.0	2.00	57.4	<RL
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Composite	7	287.86	79.6	1.46	0.38683	37.8	61.0	1.97	39.2	<RL
2000	Sacramento R. at Mile 44	SRRMF	Delta	Pike Minnow	fillet	Composite	5	252.2	81.7	0.96	0.11	5.0	ND	ND	9.7	<RL
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	327	75.9		0.92					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	345	75.9		0.89					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	350	74.1		0.86					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	359	75.1		0.86					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Composite										
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	343	74.4		0.70					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	392	74.8		1.08					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	386	74.2		1.26					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	376	73.5		1.06					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	359	76.0		1.11					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	356	74.0		0.74					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Striped Bass	fillet	Individual	1	450	74.8		0.34					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	286	75.9		0.45					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	281	78.1		0.44					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	227	77.7		0.18					
2000	Sacramento R. at Mile 44	SRRMF	Delta	Largemouth Bass	fillet	Individual	1	247	76.6		0.34					
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	317	80.6		0.56					
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	314	81.3		1.04					
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	259	77.3		0.18					
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	296	72.0		0.29					
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	294	79.2		0.25					
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	270	79.0		0.16					
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	265	77.1		0.24					
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	227	76.2		0.22					
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	207	75.9		0.24					
2000	Sacramento R. at Mile 44	SRRMF	Delta	White Catfish	fillet	Individual	1	345	79.4		0.72					
2000	Sacramento R. above Bend Bridge	SRABB	Lower Sac. R. Mainstem	Sacramento Sucker	fillet	Composite	5	457	75.3	7.04	0.10	10.6	10.0	ND	5.9	<RL
2000	Sacramento R. above Bend Bridge	SRABB	Lower Sac. R. Mainstem	Rainbow Trout	fillet	Composite	5	350	77.3	1.79	0.04	6.1	ND	ND	3.6	ND
2000	Sacramento R. below Keswick	SRBKR	Lower Sac. R. Mainstem	Rainbow Trout	fillet	Composite	4	422	73.9	5.32	0.04	11.3	11.0	ND	7.4	<RL
2000	Sacramento R. at Colusa	SRCOL	Lower Sac. R. Mainstem	Pike Minnow	fillet	Composite	5	275.2	78.7	1.36	0.15	10.8	14.0	ND	19.0	<RL
2000	Sacramento R. at Colusa	SRCOL	Lower Sac. R. Mainstem	Striped Bass	fillet	Individual	1	451	76.9	0.80	0.30	23.8	34.0	1.48	45.4	<RL
2000	Sacramento R. at Colusa	SRCOL	Lower Sac. R. Mainstem	Sacramento Sucker	fillet	Composite	5	290.4	79.7	0.86	0.06	3.8	ND	ND	7.5	ND
2000	Sacramento R. near Hamilton City	SRHAM	Lower Sac. R. Mainstem	Pike Minnow	fillet	Composite	5	298.2	79.0	1.05	0.29	9.1	12.0	ND	12.1	ND

YEAR	STATION LOCATION	Site ID	Site Category	Species	Tissue	Sample Type	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg, wet weight	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
2000	Sacramento R. near Hamilton City	SRHAM	Lower Sac. R. Mainstem	Sacramento Sucker	fillet	Composite	5	316.2	79.2	1.61	<.0314	0.6	ND	ND	ND	ND
2000	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem	Pike Minnow	fillet	Composite	4	266	80.3	0.63	0.25	25.5	22.0	1.07	34.2	<RL
2000	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem	White Catfish	fillet	Composite	5	263.6	78.4	3.04	0.21	40.5	49.0	2.40	77.0	<RL
2000	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem	Largemouth Bass	fillet	Composite	5	371.2	77.9	0.78	0.96	4.2	ND	ND	11.9	<RL
2000	American R. at Discovery Park	ARDPK	Major Tributary	Pike Minnow	fillet	Composite	5	277.8	78.1	1.94	0.42	27.4	27.0	6.38	35.0	<RL
2000	American R. at Discovery Park	ARDPK	Major Tributary	White Catfish	fillet	Composite	5	261.8	78.7	1.96	0.26	41.4	44.0	3.00	54.0	<RL
2000	American R. at Discovery Park	ARDPK	Major Tributary	Largemouth Bass	fillet	Composite	5	393.4	78.3	0.86	1.37	29.8	47.0	2.71	17.1	<RL
2000	American R. at Discovery Park	ARDPK	Major Tributary	Largemouth Bass	fillet	Individual	1	471	77.1		1.38					
2000	American R. at Discovery Park	ARDPK	Major Tributary	Redear Sunfish	fillet	Composite	5	192.8	77.0		0.30					
2000	American R. at J Street	ARJST	Major Tributary	Sacramento Sucker	fillet	Composite	5	249	79.6	1.32	0.08	7.6	10.0	ND	6.4	<RL
2000	American R. at J Street	ARJST	Major Tributary	Pike Minnow	fillet	Composite	5	264.6	77.6	2.85	0.54	32.3	33.0	7.71	36.6	<RL
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Pike Minnow	fillet	Composite	5	300.8	79.8	0.74	0.57	9.1	12.0	ND	16.9	<RL
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Composite	6	312.83	78.3	0.54	0.60658	5.7	ND	ND	6.5	ND
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Striped Bass	fillet	Individual	1	441	72.8		1.65					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	305	78.2		0.63					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	305	76.7		0.40					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	311	77.8		0.70					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	306	76.5		0.54					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	311	77.3		0.82					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	339	77.4		0.56					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Redear Sunfish	fillet	Composite	5	153.6	76.8		0.22					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Channel Catfish	fillet	Composite	5	478.6	72.2		0.73					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	White Catfish	fillet	Individual	1	272	80.5		0.39					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	White Catfish	fillet	Individual	1	269	79.4		0.85					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	White Catfish	fillet	Individual	1	545	69.2		0.55					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	305	75.6		0.47					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	334	75.8		0.79					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	362	76.9		1.00					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	236	77.7		0.21					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	233	78.6		0.27					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Striped Bass	fillet	Individual	1	556	75.2		1.22					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	White Catfish	fillet	Individual	1	492	69.6		0.55					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	White Catfish	fillet	Individual	1	670	73.2		1.25					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	334	74.9		0.55					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	321	75.8		0.42					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	302	78.2		0.67					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	355	75.9		0.86					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Individual	1	255	76.2		0.46					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	White Catfish	fillet	Individual	1	205	85.8		0.45					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary	White Catfish	fillet	Individual	1	278	79.9		1.21					
2000	Clear Creek at Mouth	CCMOU	Tributary	Rainbow Trout	fillet	Composite	5	358.8	77.8	1.34	0.05	8.4	11.0	ND	5.3	ND
2000	Clear Creek at Mouth	CCMOU	Tributary	Largemouth Bass	fillet	Composite	5	376.4	80.0	0.50	0.45	4.0	ND	ND	ND	ND
2000	Big Chico Ck near mouth	CHMOU	Tributary	Pike Minnow	fillet	Composite	5	288.2	79.9	0.74	0.48	5.1	ND	1.11	10.4	ND
2000	Big Chico Ck near mouth	CHMOU	Tributary	Largemouth Bass	fillet	Composite	5	358.8	76.0	1.19	0.33	2.5	ND	ND	11.0	<RL
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Composite	8	348	77.8	0.50	0.45	6.2	ND	ND	13.6	<RL
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	324	77.8		0.26					
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	376	78.2		0.45					
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	384	77.7		0.57					
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	409	77.3		0.82					
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	390	77.4		0.64					
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	306	77.8		0.28					
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	210	77.3		0.10					
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	385	74.3		0.50					

YEAR	STATION LOCATION	Site ID	Site Category	Species	Tissue	Sample Type	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg, wet weight	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	319	78.9		0.34					
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	342	78.5		0.34					
2000	Putah Creek	PUTAH	Tributary	Largemouth Bass	fillet	Individual	1	326	78.7		0.22					
2000	Putah Creek	PUTAH	Tributary	Bluegill	fillet	Composite	5	157a	79.8		0.16					
2000	Putah Creek	PUTAH	Tributary	Bluegill	fillet	Composite	5	147a	80.1		0.07					
2000	Putah Creek	PUTAH	Tributary	Bluegill	fillet	Composite	5	150a	78.2		0.16					
2000	Putah Creek	PUTAH	Tributary	Bluegill	fillet	Composite	5	148a	79.1		0.10					
2000	Upper Putah Creek	PUTAU	Tributary	Brown Trout	fillet	Composite	5	300.8	77.9	1.59	0.06	4.6	ND	ND	4.6	<RL
2000	Sacramento R. above Shasta	SRASH	Tributary	Rainbow Trout	fillet	Composite	5	318	81.1	0.47	0.06	3.5	ND	ND	ND	ND
2001	Sacramento R. at Mile 44	SRRMF	Delta	Splittail	fillet	Composite	4	387.5	78		0.37					
2001	Sacramento R. at Mile 44	SRRMF	Delta	Pike Minnow	fillet	Composite	5	270.8	79	2.12	0.18	13.4	12.0	ND	24.7	<RL
2001	Sacramento R. at Mile 44	SRRMF	Delta	Smallmouth Bass	fillet	Composite	5	338.2	78	0.67	0.57	6.6	ND	ND	7.0	2.82
2001	Colusa Basin Drain	COLDR	Ag Drain	Carp	fillet	Composite	5	398	79	0.87	0.17	5.8	ND	1.09	149.3	2.14
2001	Colusa Basin Drain	COLDR	Ag Drain	Channel Catfish	fillet	Composite				1.49		9.7	25.0	1.30	81.0	2.33
2001	Colusa Basin Drain	COLDR	Ag Drain	Crappie	fillet	Composite	5	240.8	79		0.08					
2001	American River at Sunrise	ARSNR	Major Tributary	Sacramento Sucker	fillet	Composite	5	462	76	6.20	0.20	63.1	92.0	3.62	68.1	<RL
2001	American R. at Discovery Park	ARDPK	Major Tributary	Redear Sunfish	fillet	Composite	5	169.4	78		0.08					
2001	American R. at Discovery Park	ARDPK	Major Tributary	Sacramento Sucker	fillet	Composite	5	489.4	78	3.28	0.35	62.7	102.0	17.89	43.3	<RL
2001	Sacramento R. below Keswick	SRBKR	Lower Sac. R. Mainstem	Rainbow Trout	fillet	Composite	5	321.2	76	3.03	<.007	9.8	ND	ND	3.3	<RL
2001	Feather River above Bear River	FRABR	Major Tributary	Redear Sunfish	fillet	Composite	5	159.2	77		0.10					
2001	Feather River above Bear River	FRABR	Major Tributary	Sacramento Sucker	fillet	Composite	5	496.6	77	3.50	0.27	25.3	31.0	ND	29.4	<RL
2001	Feather R. near Nicolaus	FRNIC	Major Tributary	Sacramento Sucker	fillet	Composite	5	469	79	2.22	0.28	12.3	12.0	ND	18.4	<RL
2001	Feather R. near Nicolaus	FRNIC	Major Tributary	Pike Minnow	fillet	Individual	1	500	71		0.64					
2002	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Composite	5	327	76.8		0.45					
2002	Feather R. near Nicolaus	FRNIC	Major Tributary	Largemouth Bass	fillet	Composite	5	337.8	76.9		0.41					
2002	Feather R. near Nicolaus	FRNIC	Major Tributary	Pike Minnow	fillet	Composite	5	334.8	79.0		0.88					
2002	Feather R. near Nicolaus	FRNIC	Major Tributary	Pike Minnow	fillet	Composite	5	357.2	78.0		1.38					
2002	American R. at Discovery Park	ARDPK	Major Tributary	Pike Minnow	fillet	Composite	5	327.8	77.9		0.45					
2002	American R. at Discovery Park	ARDPK	Major Tributary	Pike Minnow	fillet	Composite	5	305.4	77.1		0.40					
2002	American R. at Discovery Park	ARDPK	Major Tributary	Largemouth Bass	fillet	Composite	5	329.2	76.7		0.45					
2002	American R. at Discovery Park	ARDPK	Major Tributary	Largemouth Bass	fillet	Composite	5	377.4	76.3		0.89					
2002	American R. at Discovery Park	ARDPK	Major Tributary	Largemouth Bass	fillet	Individual	1	448	76.0		1.43					
2002	American R. at Discovery Park	ARDPK	Major Tributary	Sacramento Sucker	fillet	Composite	5	488.8	72.89	7.88	0.28	291.7	414.0	9.05	57.5	1.79
2002	American R. at Discovery Park	ARDPK	Major Tributary	Sacramento Sucker	fillet	Composite	5	439	74.1	5.12	0.13	44.2	55.0	5.62	30.3	1.38
2002	American R. at Discovery Park	ARDPK	Major Tributary	Striped Bass	fillet	Individual	1	559	77.0		0.28					
2002	Sacramento R. at Mile 44	SRRMF	Lower Sac. R. Mainstem	Largemouth Bass	fillet	Composite	5	392.4	76.5		0.89					
2002	Sacramento R. at Mile 44	SRRMF	Lower Sac. R. Mainstem	Largemouth Bass	fillet	Composite	5	392.6	74.9		0.93					
2002	Sacramento R. at Mile 44	SRRMF	Lower Sac. R. Mainstem	Sacramento Sucker	fillet	Composite	5	492.6	69.3	10.4	0.21	62.838	108	12.737	181.3	3.04
2002	Colusa Basin Drain	COLDR	Ag Drain	Carp	fillet	Composite	3	504.33	78.2		0.41					

"<" indicates concentration not detected above specific reporting limit (for mercury and dieldrin)
"J" indicates the analyte was positively identified and the associated value is an estimated concentration
"ND" indicates "Not Detected"
"UJ" indicates that the analyte was not detected above the reported quantitation limit
<RL indicates not detected above reporting limits for individual compounds or congeners (for PCBs, aroclors, chlordanes, DDTs)
All tissue concentration data are provided on a "Wet Weight" basis
Blanks indicate data not reported or analyzed

APPENDIX D:

REVIEW OF QUALITY CONTROL DATA

REVIEW OF QUALITY CONTROL DATA

The Quality Assurance procedures for the 2002-2003 SRWP monitoring program are documented in the Quality Assurance Project Plan (QAPP) (SRWP 2002). This appendix summarizes the types of quality assurance assessments used in the SRWP monitoring program and presents the results of those evaluations. Detailed procedures for preparation and analysis of quality control samples are provided in the analytical method documents referenced in the QAPP.

QUALITY ASSURANCE PROCEDURES AND OBJECTIVES

Qualitative Objectives

Comparability— Comparability of the data can be defined as the similarity of data generated by different monitoring programs. For the purpose of the SRWP Monitoring Program, this objective is addressed primarily by using standard sampling and analytical procedures where possible. Additionally, comparability of analytical data is addressed by analysis of standard reference materials (discussed subsequently in this document).

Representativeness—Representativeness can be defined as the degree to which the environmental data generated by the monitoring program accurately and precisely represent actual environmental conditions. For the SRWP, this objective is addressed by the overall design of the monitoring program. Specifically, assuring the representativeness of the data is addressed primarily by selecting appropriate locations, methods, times, and frequencies of sampling for each environmental parameter, and by maintaining the integrity of the sample after collection. Each of these elements of the quality assurance program are addressed elsewhere in this document.

Completeness

Data completeness is a measure of the amount of successfully collected and validated data relative to the amount of data planned to be collected for the project. Completeness is usually expressed as a percentage value. A project objective for percent completeness is typically based on the percentage of the data needed for the program or study to reach valid conclusions. Because the SRWP is intended to be a long term monitoring program, data that are not successfully collected for a specific sample event or site can typically be recollected at a later sampling event. For this reason, most of the data planned for collection can not be considered absolutely critical, and it is difficult to set an meaningful objective for data completeness. However, some reasonable objectives for data are desirable, if only to measure the effectiveness of the Monitoring Program. The following program goals for data completeness are based on the planned sampling frequency and a subjective determination of the relative importance of the monitoring element within the Monitoring Program:

Table 1. SRWP Goals For Data Completeness

Monitoring Element	Completeness Objective
Mercury	90%
Pesticides	90%
General Water Quality Constituents	90%
Pathogens	90%
Aquatic Toxicity	90%
Benthic Invertebrates	95%
Fish Tissue	85%

Field Procedures

For basic water quality analyses, quality control samples to be prepared in the field consisted of field blanks and field duplicates.

Field Blanks

The purpose of analyzing field blanks is to demonstrate that sampling procedures and equipment do not result in contamination of the environmental samples. Field blanks were generally prepared and analyzed for all analytes of interest at the rate of one per sample event, along with the associated environmental samples. Field blanks consisted of laboratory-prepared blank water processed through the sampling equipment using the same procedures used for environmental samples. If the concentration in the associated environmental samples was less than five times the value detected in the field blank, the results for the environmental samples may be affected by contamination and were qualified as an *upper limit* of the reported sample result.

Field Duplicates

The purpose of analyzing field duplicates is to demonstrate the precision of sampling and analytical processes. Field duplicates were prepared and analyzed at a rate of 1 per event for most analytes. Field duplicates consisted of two aliquots from the same composite sample, or of two grab samples collected in rapid succession. If the relative Percent Difference (RPD) of field duplicate results was greater than 25% and the absolute difference is greater than the RL, environmental results were qualified as *estimated*.

Laboratory Analyses

For basic water quality analyses, quality control samples prepared in the contract laboratory(s) will typically consist of equipment blanks, method blanks, standard reference materials, laboratory duplicates, matrix spikes, and matrix spike duplicates. Laboratory analyses for coliform bacteria will include negative and positive quality control samples, as specified in the method documents.

Equipment Blanks

The purpose of analyzing equipment blanks is to demonstrate that sampling equipment is free from contamination. Prior to using sampling equipment for the collection of environmental samples, the laboratory responsible for cleaning and preparation of the equipment will prepare bottle blanks and sampler blanks. These were prepared and analyzed by the lab at the rate of one each per batch of bottles or sampling equipment. The blanks were analyzed using the same analytical methods specified for environmental samples.

Method Blanks

The purpose of analyzing method blanks is to demonstrate that the analytical procedures do not result in sample contamination. Method blanks were prepared and analyzed by the contract laboratory at a rate of at least one for each analytical batch. Method blanks consisted of laboratory-prepared blank water processed along with the batch of environmental samples. If the result for a single method blank was greater than the MDL, the source(s) of contamination should be corrected, and the associated samples should be reanalyzed. If reanalysis was not possible, the associated sample results were qualified as an *upper limit* of the actual sample result.

Laboratory Control Samples

The purpose of analyzing laboratory control samples is to demonstrate the accuracy of the analytical method. Laboratory control samples were analyzed at the rate of one per sample batch for most analytes. Laboratory control samples consisted of laboratory fortified method blanks. If recovery of any analyte is outside the acceptable range for accuracy, the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and the laboratory control sample should be reanalyzed. If reanalysis was not possible, the associated sample results were qualified as *low or high biased*.

Laboratory Duplicates

The purpose of analyzing laboratory duplicates is to demonstrate the precision of the analytical method. Laboratory duplicates were analyzed at the rate of one pair per sample batch. Laboratory duplicates will consist of duplicate laboratory fortified method blanks. If the Relative Percent Difference (RPD) for any analyte is greater than the precision criterion *and* the absolute difference between duplicates is greater than the RL, the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and laboratory duplicates should be reanalyzed. If reanalysis was not possible, the associated sample results were qualified as *not reproducible* due to analytical variability.

Matrix Spikes and Matrix Spike Duplicates

The purpose of analyzing matrix spikes and matrix spike duplicates is to demonstrate the performance of the analytical method in a particular sample matrix. Matrix spikes and matrix spike duplicates were typically analyzed at the rate of one pair per sample batch for most analytes. Each matrix spike and matrix spike duplicate consisted of an aliquot of laboratory-fortified environmental sample.

If matrix spike recovery of any analyte is outside the acceptable range, the results for that analyte have failed the acceptance criteria for that specific matrix. If recovery of laboratory control samples is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. If the matrix problem can't be corrected, the results for that analyte were qualified as appropriate (*low or high biased*) due to matrix interference.

If matrix spike duplicate RPD for any analyte is greater than the precision criterion, the results for that analyte have failed the acceptance criteria for that specific matrix. If the RPD for laboratory duplicates is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. If the matrix problem can't be corrected, the results for that analyte were qualified as *not reproducible*, due to matrix interference.

Aquatic Toxicity Quality Control

For aquatic toxicity tests, the acceptability of test results was determined primarily by performance-based criteria for test organisms, culture and test conditions, and the results of control bioassays. Control bioassays included testing with reference toxicants, reference sediments, and negative and solvent controls. Test acceptability requirements are documented in the method documents for each bioassay method and in the QAPP.

In addition to the QA requirements for the toxicity testing methods, samples collected for aquatic toxicity testing were reserved for other QC analyses. An additional ten percent of analyses consisted of laboratory splits, spikes, and blanks. The results of duplicate analyses are considered acceptable if the results are not significantly different at the 95% confidence level *or* the RPD for the results is less than 30%. Acceptable results for tests with blanks are no significant toxicity. Although the laboratory has no formal limit of acceptability for analysis of spiked samples, the pattern and progress of toxic responses are evaluated subjectively for consistency with expected responses for the level of the spiked compound.

Benthic Invertebrates Processing and Analysis

Accuracy of identifications and precision of enumeration of benthic invertebrate collections was assessed by re-analysis of samples at the rate of one for every ten samples analyzed. This consisted of complete re-examination of the organisms in the archived original sample, including remnants from the sorting process. If any additional organisms are identified in the "remnant" fraction of the archived sample, the numbers of taxa and organisms was recorded. The total number of organisms and enumeration of individual taxa for the re-examined sample should be within 5% of the original total. Discrepancies in taxonomic identification or enumeration were resolved by consultation between taxonomic analysts.

Fish Tissue

Quality assurance and assessment procedures for analysis of contaminants in fish tissue were generally similar to those for water quality samples (documented above). However, for analysis of PCBs and chlorinated pesticides, surrogate compounds (internal standards) were added to each sample to assess analytical accuracy of classes of similar compounds. The acceptable range for recovery of surrogate compounds was set by the analyzing laboratory. If surrogate recoveries were outside the defined range, the sample batch was prepared again and reanalyzed. If reanalysis was not possible, the associated environmental data for all analytes by the specific method was qualified as low or high biased, consistent with the surrogate recovery bias. If surrogate recovery bias is inconsistent for different surrogate compounds, the associated environmental data was qualified as biased due to indeterminate surrogate recovery bias.

SUMMARY OF QUALITY CONTROL DATA

Aquatic Toxicity

For SRWP samples collected and analyzed in 2002-2003, aquatic toxicity tests met all performance criteria and all reported data were unqualified. The results for quality control analyses for aquatic toxicity testing are presented in monitoring data summaries produced by Pacific EcoRisk.

The overall completion rate was greater than the 90% objective for the program, and this monitoring element provided data that were adequate for the purposes of the SRWP.

Fish Tissue Monitoring

The results of quality control analyses performed for 2002 fish tissue monitoring are reported in “Quality Assurance/Quality Control Document for the Sacramento River Toxic Pollutant Control Program” prepared by the California Department of Fish and Game. All of the 2002-2003 results met data quality objectives. Overall, this monitoring element provided data that were of adequate quality for the purposes of the SRWP and met the completeness target of 85%.

Bioassessment

Bioassessment monitoring was limited to habitat assessment of prospective reference sites in 2002-2003. No quality control data resulted from the bioassessment reference site development effort.

Water Column Chemical and Microbiology Monitoring

Quality control data for SRWP monitoring data collected from July 2002 through June 2003 are summarized below. Quality control data were evaluated using methods documented in the Quality Assurance Project Plan (QAPP) for the SRWP (SRWP 2002). Sample results were reviewed for conformance with recommended allowable holding times for specific analyses and for compliance with SRWP Monitoring Program data quality objectives for laboratory and external QC results. Internal laboratory QC data reviewed include results for method blanks, laboratory control samples (standard reference materials), laboratory duplicates, matrix spikes, and matrix spike duplicates. Field and external laboratory QC data reviewed include results for field blanks and field duplicates. Program specifications for data quality are summarized in Tables 1-6.

Holding Times

Data quality objectives for holding times generally conform to EPA recommendations specified for the analytical methods used for individual parameters. Allowable holding times for the project range from 24 hours for microbiological analyses to 6 months for metals and hardness (after preservation). Of the total analyses performed, 99% were within acceptable holding times. Analyses performed outside of acceptable limits resulted in qualification of some analytical results for alkalinity, nitrate, nitrite, dissolved orthophosphate, and UVA_{254}. Most of the qualified data were for nitrate, dissolved orthophosphate, and UVA_{254} analyses, due to the short 48-hour holding times and the logistics of getting samples to the lab from distant sampling locations. All of these samples were filtered and preserved (as appropriate for the specific analysis) as soon as they were received by the laboratory. These results are presented in Table 2.

Laboratory Method and Filter Blanks

Laboratory method blanks and filter blanks were analyzed to evaluate the potential for contamination attributable to analytical reagents and sample processing. The project data quality objective for laboratory method and filter blanks was defined as below the method detection limit. If detectable levels of an analyte were determined to be present in method or filter blanks, sample results were accepted without qualification if the associated environmental sample results were greater than five times the concentration detected in the blank. If detectable levels of an analyte were determined to be present in method or filter blanks and associated environmental sample results were less than five (5) times the concentration detected in the blank, the reported analytical results were qualified as an upper limit of the actual sample result.

For SRWP 2002-2003 monitoring results, ammonia, methylmercury, orthophosphate, TKN, and UVA_{254} were detected in laboratory method blanks in a total of 12 of 856 analyses. The overall success rate for analyses of laboratory method and filter blanks was 99%. These results indicate that laboratory contamination of water quality samples is not a significant problem. Results for laboratory method blanks are summarized in Table 3.

Laboratory Control Sample Recoveries

Laboratory control samples were analyzed to evaluate analytical accuracy. If recoveries were outside the acceptable range for the analysis, associated samples results were qualified as "*low*- or *high-biased*" as indicated by the control sample recovery.

For SRWP 2002-2003 monitoring results, 39 of 593 laboratory control sample recoveries were outside project specifications, all for pesticide analyses. The overall success rate for analysis of laboratory control samples was 93%. These results indicate that analytical accuracy was adequate for analysis of water quality samples for the project. Results for laboratory control sample recoveries are summarized in Table 4 - Table 7.

Laboratory Duplicates

Analyses of duplicate samples were conducted to evaluate analytical precision. If laboratory duplicate results were outside the project data quality objective, associated samples results were qualified as "estimated" (not reproducible) due to analytical variability. An RPD greater than the project data quality objective was not considered cause for qualification of analytical results if measured differences between replicates were less than the reporting limit, or if matrix spike duplicate results were acceptable.

For SRWP 2002-2003 monitoring results, 6 of 297 laboratory duplicate results were outside program specifications. Five of the six results outside quality objectives were for methylmercury analyses very near the reporting limit, suggesting that the reporting limit for this parameter may need to be slightly higher for reliable quantitation. The overall success rate for analyses of laboratory duplicate samples was 98%. These results indicate that analytical precision was adequate to produce reliable data for the SRWP. Results for laboratory duplicate analyses are summarized in Table 8.

Matrix Spike Recoveries

Analyses of matrix spike samples (spiked environmental samples) were performed to evaluate the effect of water quality sample matrix on analytical accuracy. When a matrix spike recovery does not meet the project data quality objective, associated sample results are considered "*low*- or *high-biased*" due to matrix interference, as indicated by the recovery.

For SRWP 2002-2003 monitoring results, reported matrix spike recoveries exceeded program specifications for 81 of 831 total analyses. The overall success rates for analyses of matrix spike recoveries were 78%, 93%, and 88% for pesticide analyses (by EPA methods 619, 8321, and 8141, respectively) and 97% for all other analyses. Five of the pesticides analyzed by EPA 619 exceeded the project DQO frequently, with 22% of the total recoveries for this methods outside of program specifications (including surrogate compounds). Matrix spike recoveries and lab control sample recoveries that were outside DQOs were almost universally high, indicating an overall tendency for *high bias* for this analysis for some specific pesticides. Note that only one of these pesticides is commonly detected (simazine, in about 25% of all samples collected in the watershed). In combination with the results for laboratory control samples, these results indicate that with the exception of a few triazine pesticides, matrix interference did not represent a significant problem and that analytical accuracy was adequate to produce reliable data for water quality samples for the SRWP. Results for matrix spike recoveries are summarized in Table 9 – Table 12.

Matrix Spike Duplicates

Analyses of matrix spike duplicate samples were performed to evaluate the effect of water quality sample matrix on analytical precision. If matrix spike duplicate results were outside this range, associated samples results were qualified as "*estimated*" due to matrix variability.

For SRWP 2002-2003 monitoring results, matrix spike duplicate RPDs exceeded project objectives in a total of 64 of 505 analyses. The overall success rate for analyses of matrix spike duplicates was 87%. All but one of the results exceeding the project DQO (20%) were for pesticide analyses at one site (Arcade Creek). In combination with the results for laboratory duplicates, these results indicate that matrix interference did not represent a significant problem for most analyses and that analytical precision was adequate to produce reliable water quality data for the SRWP. However, problems due to matrix effects on precision were more frequently observed for pesticide analyses than is desirable. Results for matrix spike duplicate RPDs are summarized in Table 13.

Field Blanks

Field blanks were submitted and analyzed to evaluate the potential for sampling equipment and procedures to contaminate water quality samples. The project data quality objective for field and equipment blanks was defined as below the program reporting limit. If detectable levels of an analyte were determined to be present in field blanks, sample results were accepted without qualification if the environmental results were greater than five (5) times the concentrations detected in the blank. If detectable levels of an analyte were determined to be present in field or equipment blanks and sample results were less than five (5) times the concentrations detected in the blank, the reported results were qualified as an upper limit of the true sample concentration.

For SRWP 2002-2003 monitoring results, SRWP analytes were detected above reporting limits in 6 of 524 field blank analyses: 1 ammonia analysis, 1 UVA_{254} analysis, 4 total mercury analyses, and 1 methylmercury analyses. The overall success rate for analysis of field blanks was 99%. Results of analyses of field blanks indicate that sampling procedures and equipment were generally adequate to prevent detectable or significant levels of contamination of samples collected for the SRWP. Results for field blank analyses are summarized in Table 14.

Field Duplicates

The purpose of analyzing duplicate field samples is to measure the reproducibility (i.e. precision) of analyte concentrations in field samples from replicate composite or grab samples. The results provide a measure of the variability attributable to sampling and sample handling procedures after sample collection. The project data quality objective for duplicates field samples was defined as a relative percent difference (RPD) of less than or equal to 25%. Duplicate RPDs outside this range resulted in the qualification of sample result data as "estimated" (not reproducible) due to sample variability. An RPD greater than 25% was not considered cause for qualification of data if measured differences between replicates were less than the reporting limit.

For SRWP 2002-2003 monitoring results, field duplicate RPDs exceeded program specifications for 5 of 551 pairs of analyses. The overall success rate for analysis of field duplicates was 99%. These results indicate that sampling and sample handling-generated variability was not excessive, and that sampling procedures were performed in a manner to provide adequate data for the SRWP. Results for field duplicates are summarized in Table 15.

Summary

From June 2002 through July 2003, the SRWP monitoring program successfully completed 4632 of 4712 planned water chemistry and aquatic toxicity analyses for a completion rate of 98%. Of the 3857 completed analyses, data qualifications were required for 148 analytical results, leaving 4484 unqualified results for an overall analytical success rate of 96.8% for water chemistry, microbiology, and aquatic toxicity monitoring for 2002-2003. These results are summarized in Table 16.

The quality control results for 2002-2003 indicate that sampling and analytical methods for water column monitoring were generally adequate to produce reliable data for the SRWP.

Table 2. Summary of Compliance with Holding Times for SRWP Analyses, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
alkalinity, total	14 days	102	1	99
ammonia	28 days	80	0	100
coliform, fecal	24 hours	45	0	100
coliform, total	24 hours	53	0	100
E. coli	24 hours	45	0	100
hardness	6 months	88	0	100
mercury, dissolved	90 days	94	0	100
mercury, total	90 days	94	0	100
methylmercury, dissolved	6 months	94	0	100
methylmercury, total	6 months	94	0	100
nitrate	28 days(5)	73	0	100
nitrate + nitrite	28 days	7	0	100
nitrite	48 hours	80	3	96
nitrogen, total Kjeldahl	28 days	80	0	100
organic carbon, dissolved	28 days(6)	54	0	100
organic carbon, total	28 days(6)	54	0	100
orthophosphate, dissolved	48 hours	80	10	88
pesticides, EPA 507	40 days	14	0	100
pesticides, EPA 619	40 days	286	0	100
pesticides, EPA 8141A	40 days	2388	0	100
pesticides, EPA 8321A	40 days	919	0	100
phosphorus, total	28 days	80	0	100
total dissolved solids	7 days	54	0	100
total suspended solids	7 days	89	0	100
UVA_{254}	7 days(5)	75	0	100
total for all parameters		5122	49	99.7%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2002)

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

(5) The QAPP (SRWP 2002) specifies a holding time of 48 hours. However, the methods specify analysis within 28 days for nitrate samples preserved within 48 hours and 7 days for UVA samples filtered within 48 hours, and no data were qualified based on exceedance of the 48 hour holding time.

(6) The QAPP (SRWP 2002) specifies a holding time of 7 days. However, standard laboratory practice for this parameter is analysis within 28 days for properly preserved and stored samples, and no data were qualified based on exceedance of the 7 day holding time.

Table 3. Summary of Compliance with Laboratory Method Blank Results for SRWP Analyses, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
ammonia	<RL or <S/5	9	3	67
mercury, total	<RL or <S/5	24	0	100
methylmercury, total	<RL or <S/5	57	2	97
nitrate	<RL or <S/5	9	0	100
nitrate + nitrite	<RL or <S/5	1	0	100
nitrite	<RL or <S/5	13	0	100
nitrogen, total Kjeldahl	<RL or <S/5	10	2	80
organic carbon, dissolved	<RL or <S/5	63	0	100
organic carbon, total	<RL or <S/5	60	0	100
orthophosphate, dissolved	<RL or <S/5	16	2	88
pesticides, EPA 507	<RL or <S/5	2	0	100
pesticides, EPA 619	<RL or <S/5	66	0	100
pesticides, EPA 8141A	<RL or <S/5	326	0	100
pesticides, EPA 8321A	<RL or <S/5	149	0	100
phosphorus, total	<RL or <S/5	7	0	100
total dissolved solids	<RL or <S/5	15	0	100
total suspended solids	<RL or <S/5	14	0	100
UVA_{254}	<RL or <S/5	15	3	80
total for all analyses		856	12	99%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2002)

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 4. Summary of Laboratory Control Sample and SRM Recoveries for SRWP Non-Pesticide Analyses, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
ammonia	80% - 120%	8	0	100
mercury, total	80% - 120%	12	0	100
methylmercury, total	80% - 120%	38	0	100
nitrate	80% - 120%	8	0	100
nitrite	80% - 120%	8	0	100
nitrogen, total Kjeldahl (TKN)	80% - 120%	7	0	100
organic carbon, dissolved	80% - 120%	14	0	100
organic carbon, total	80% - 120%	16	0	100
orthophosphate, dissolved	80% - 120%	8	0	100
phosphorus, total	80% - 120%	8	0	100
total dissolved solids	80% - 120%	14	0	100
total suspended solids	80% - 120%	7	0	100
total for all analyses		148	0	100%

(1) Data quality Objectives (DQO) for EPA 619 LCS Recoveries were revised by the laboratory during the 2002-2003 monitoring period.

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 5. Summary of Laboratory Control Sample Recoveries for SRWP Triazine Pesticide Analyses by EPA Method 619, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
ametryn	45-165%, 54-138%	5	1	80
atraton	29-187%, 49-141%	5	1	80
atrazine	38-176%, 48-142%	5	1	80
cyanazine	38-193%, 45-154%	5	1	80
prometon	19-191%, 50-143%	6	1	83
prometryn	45-143%, 19-183%	6	0	100
propazine	24-184%, 37-154%	6	0	100
simazine	14-176%, 49-114%	5	3	40
simetryn	14-191%, 44-144%	6	1	83
terbuthylazine	19-183%, 53-144%	6	3	50
terbutryn	46-163%, 52-135%	5	1	80
tributylphosphate (surrogate)	39-171%, 43-139%	6	0	100
triphenylphosphate (surrogate)	36-148%, 36-169%	6	0	100
total for EPA method 8321A		72	13	82%

(1) Data quality Objectives (DQO) for EPA 619 LCS Recoveries were revised (tightened) by the laboratory during the 2002-2003 monitoring period.

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 6. Summary of Laboratory Control Sample Recoveries for SRWP Organophosphate Pesticide Analyses by EPA Method 8141, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
azinphosmethyl	27-151%	9	1	89
bolstar	40-117%	9	0	100
chlorpyrifos	37-120%	9	1	89
coumaphos	46-134%	9	0	100
def/merphos	34-140%, 44-128%	9	1	89
demeton (total)	21-80%	9	2	78
diazinon	36-113%	9	2	78
dichlorvos	41-126%	9	0	100
dimethoate	51-161%	9	1	89
disulfoton	39-109%	9	0	100
EPN	37-159%	9	0	100
EPTC	43-130%	9	0	100
ethion	54-115%	9	1	89
ethoprop	38-118%	9	1	89
ethyl parathion	44-133%	9	0	100
fensulfothion	36-161%	9	0	100
fenthion	52-113%	9	1	89
malathion	54-121%	9	1	89
methyl parathion	28-132%	9	1	89
mevinphos	31-150%	9	1	89
naled	27-237%	9	2	78
phorate	34-104%	9	1	89
prowl	32-128%	9	1	89
ronnel	47-112%	9	1	89
stirophos	25-180%	9	1	89
sulfotep	50-114%	9	0	100
tokuthion	36-126%	9	0	100
tributylphosphate (surrogate)	47-126%	9	0	100
trichloronate	49-116%	9	0	100
trifluralin	33-105%	9	2	78
triphenylphosphate (surrogate)	42-123%	9	1	89
total for EPA method 8141A		279	23	92%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2002)

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 7. Summary of Laboratory Control Sample Recoveries for SRWP Carbamate Pesticide Analyses by EPA Method 8321, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
aldicarb	44-132%, 22-146%	6	0	100
bromacil	54-145%, 58-111%	6	0	100
carbaryl	68-112%, 40-131%	6	1	83
carbofuran	44-128%, 54-155%	6	0	100
diuron	57-133%, 72-124%	6	0	100
fenuron	59-96%, 48-117%	6	1	83
fluometuron	57-135%, 66-158%	6	0	100
isoxaben (surrogate)	40-140%	4	0	100
linuron	53-135%, 64-131%	6	0	100
methiocarb	42-129%, 63-123%	6	1	83
methomyl	37-113%, 34-125%	6	0	100
monuron	55-129%, 55-134%	6	0	100
neburon	55-132%, 65-129%	6	0	100
tebuthiuron	51-134%, 67-109%	6	0	100
tributylphosphate (surrogate)	40-140%, 62-102%	6	0	100
triphenylphosphate (surrogate)	40-140%, 61-108%	6	0	100
totals for EPA method 619		94	3	97%

(1) Data quality Objectives (DQO) for EPA 8321 LCS Recoveries were revised (tightened) by the laboratory during the 2002-2003 monitoring period.

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 8. Summary of Laboratory Duplicate Results for SRWP Analyses, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
mercury, dissolved	≤20% RPD	8	0	100
mercury, total	≤20% RPD	4	1	75
methylmercury, dissolved	≤20% RPD	7	2	71
methylmercury, total	≤20% RPD	15	3	80
nitrate	≤20% RPD	14	0	100
nitrate + nitrite	≤20% RPD	1	0	100
nitrite	≤20% RPD	16	0	100
nitrogen, total Kjeldahl	≤20% RPD	6	0	100
organic carbon, dissolved	≤20% RPD	51	0	100
organic carbon, total	≤20% RPD	53	0	100
orthophosphate, dissolved	≤20% RPD	20	0	100
phosphorus, total	≤20% RPD	17	0	100
total dissolved solids	≤20% RPD	5	0	100
total suspended solids	≤20% RPD	5	0	100
UVA_{254}	≤20% RPD	75	0	100
total for all analyses		297	6	98%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2002)

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 9. Summary of Matrix Spike Recoveries for SRWP Analyses, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
ammonia	80% - 120%	13	0	100
mercury, dissolved	80% - 120%	6	1	83
mercury, total	80% - 120%	6	0	100
methylmercury, dissolved	80% - 120%	16	2	88
methylmercury, total	80% - 120%	14	1	93
nitrate	80% - 120%	23	0	100
nitrate + nitrite	80% - 120%	2	0	100
nitrite	80% - 120%	21	0	100
nitrogen, total Kjeldahl	80% - 120%	16	0	100
organic carbon, dissolved	80% - 120%	19	0	100
organic carbon, total	80% - 120%	17	2	88
orthophosphate, dissolved	80% - 120%	19	0	100
phosphorus, total	80% - 120%	17	0	100
total dissolved solids (TDS)	80% - 120%	8	0	100
total suspended solids (TSS)	80% - 120%	8	0	100
total for all analyses		205	6	97%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2002)

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 10. Summary of Matrix Spike Recoveries for SRWP Pesticide Analyses by EPA Method 619, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
ametryn	54-138%	4	0	100
atraton	49-141%	4	2	50
atrazine	48-142%	4	2	50
cyanazine	45-154%	4	1	75
deca (surrogate)	50-126%	5	0	100
prometon	19-191%, 50-143%	6	4	33
prometryn	19-183%, 45-143%	6	1	83
propazine	24-184%, 37-154%	6	4	33
simazine	49-114%	4	3	25
simetryn	14-191%, 44-144%	6	3	50
TCMX (surrogate)	30-116%	5	0	100
terbuthylazine	19-183%, 53-144%	6	3	50
terbutryn	52-135%	4	0	100
tributylphosphate (surrogate)	39-171%, 43-139%	28	3	89
triphenylphosphate (surrogate)	36-148%, 36-169%	28	0	100
total for all analyses		120	26	78%

(1) Data Quality Objectives (DQO) for EPA 619 MS Recoveries were revised (tightened) by the laboratory during the 2002-2003 monitoring period.

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 11. Summary of Matrix Spike Recoveries for SRWP Pesticide Analyses by EPA Method 8321 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
aldicarb	22-146%, 44-132%	6	0	100
bromacil	54-145%, 58-111%	6	2	67
carbaryl	40-131%, 68-112%	6	1	83
carbofuran	44-128%, 54-155%	6	0	100
diuron	57-133%, 72-124%	6	2	67
fenuron	48-117%, 59-96%	6	1	83
fluometuron	57-135%, 66-158%	6	0	100
isoxaben (surrogate)	40-140%	29	1	97
linuron	53-135%, 64-131%	6	0	100
methiocarb	42-129%, 63-123%	6	0	100
methomyl	34-125%, 37-113%	6	0	100
monuron	55-129%, 55-134%	6	0	100
neburon	55-132%, 65-129%	6	1	83
tebuthiuron	51-134%, 67-109%	6	1	83
tributylphosphate (surrogate)	40-140%, 62-102%	43	3	93
triphenylphosphate (surrogate)	40-140%, 61-108%	43	1	98
total for all analyses		193	13	93%

(1) Data Quality Objectives (DQO) for EPA 8321 MS Recoveries were revised (tightened) by the laboratory during the 2002-2003 monitoring period.

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 12. Summary of Matrix Spike Recoveries for SRWP Pesticide Analyses by EPA Method 8141, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
azinphosmethyl	27-151%	5	3	40
bolstar	40-117%	5	1	80
chlorpyrifos	37-120%	5	1	80
coumaphos	46-134%	6	1	83
def/merphos	44-128%	6	1	83
demeton (total)	21-80%	6	3	50
diazinon	36-113%	5	1	80
dichlorvos	41-126%	6	0	100
dimethoate	51-161%	5	3	40
disulfoton	39-109%	6	1	83
EPN	37-159%	6	0	100
EPTC	43-130%	6	0	100
ethion	54-115%	6	0	100
ethoprop	38-118%	5	2	60
ethyl parathion	44-133%	6	0	100
fensulfothion	36-161%	6	0	100
fenthion	52-113%	6	1	83
malathion	54-121%	6	2	67
methyl parathion	28-132%	5	2	60
mevinphos	31-150%	5	2	60
naled	27-237%	5	2	60
phorate	34-104%	5	1	80
prowl	32-128%	5	1	80
ronnel	47-112%	6	1	83
stirophos	25-180%	6	1	83
sulfotep	50-114%	6	0	100
tokuthion	36-126%	5	1	80
tributylphosphate (surrogate)	47-126%	76	4	95
trichloronate	49-116%	6	0	100
trifluralin	33-105%	5	1	80
triphenylphosphate (surrogate)	42-123%	76	0	100
total for all analyses		313	36	88%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2002)

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 13. Summary of Matrix Spike Duplicate Results for SRWP Analyses, 2002-2003 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
ammonia	≤20% RPD	13	0	100
mercury, dissolved	≤20% RPD	6	0	100
mercury, total	≤20% RPD	6	0	100
methylmercury, dissolved	≤20% RPD	16	1	94
methylmercury, total	≤20% RPD	14	0	100
nitrate	≤20% RPD	23	0	100
nitrate + nitrite	≤20% RPD	2	0	100
nitrite as NO2	≤20% RPD	21	0	100
nitrogen, total Kjeldahl	≤20% RPD	16	0	100
organic carbon, dissolved	≤20% RPD	19	0	100
organic carbon, total	≤20% RPD	17	0	100
orthophosphate, dissolved	≤20% RPD	19	0	100
pesticides, EPA 619	≤20% RPD	54	12	78
pesticides, EPA 8141A	≤20% RPD	166	36	78
pesticides, EPA 8321A	≤20% RPD	78	15	81
phosphorus, total	≤20% RPD	17	0	100
total dissolved solids	≤20% RPD	10	0	100
total suspended solids	≤20% RPD	8	0	100
total for all analyses		505	64	87%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2002)

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 14. Summary of Field Blank Results for SRWP Analyses, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
ammonia	<RL or <S/5	6	0	100
coliform, fecal	<RL or <S/5	5	0	100
coliform, total	<RL or <S/5	6	0	100
E. coli	<RL or <S/5	5	0	100
mercury, dissolved	<RL or <S/5	7	3	57
mercury, total	<RL or <S/5	7	1	86
methylmercury, dissolved	<RL or <S/5	7	1	86
methylmercury, total	<RL or <S/5	7	0	100
nitrate as NO3	<RL or <S/5	6	0	100
nitrite as NO2	<RL or <S/5	6	0	100
nitrogen, total Kjeldahl	<RL or <S/5	6	0	100
organic carbon, dissolved	<RL or <S/5	6	0	100
organic carbon, total	<RL or <S/5	6	0	100
orthophosphate, dissolved	<RL or <S/5	6	0	100
pesticides, EPA 507	<RL or <S/5	2	0	100
pesticides, EPA 619	<RL or <S/5	66	0	100
pesticides, EPA 8141A	<RL or <S/5	209	0	100
pesticides, EPA 8321A	<RL or <S/5	149	0	100
phosphorus, total	<RL or <S/5	6	0	100
UVA_{254}	<RL or <S/5	6	1	83
total for all analyses		524	6	99%

(1) Data Quality Objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2002)

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 15. Summary of Field Duplicate Results for SRWP Analyses, 2002-2003 Monitoring

Parameters	DQO (1)	Number Tested (2)	Number Outside DQO (3)	% Success (4)
alkalinity	≤25% RPD	6	0	100
ammonia	≤25% RPD	6	0	100
hardness	≤25% RPD	6	0	100
mercury, dissolved	≤25% RPD	5	1	80
mercury, total	≤25% RPD	5	3	40
methylmercury, dissolved	≤25% RPD	5	0	100
methylmercury, total	≤25% RPD	5	0	100
nitrate	≤25% RPD	6	0	100
nitrite	≤25% RPD	6	0	100
nitrogen, total Kjeldahl	≤25% RPD	6	0	100
organic carbon, dissolved	≤25% RPD	6	0	100
organic carbon, total	≤25% RPD	6	1	83
orthophosphate, dissolved	≤25% RPD	6	0	100
pesticides, EPA 507	≤25% RPD	2	0	100
pesticides, EPA 619	≤25% RPD	66	0	100
pesticides, EPA 8141A	≤25% RPD	209	0	100
pesticides, EPA 8321A	≤25% RPD	174	0	100
phosphorus, total	≤25% RPD	6	0	100
total dissolved solids	≤25% RPD	6	0	100
total suspended solids	≤25% RPD	8	0	100
UVA_{254}	≤25% RPD	6	0	100
total for all analyses		551	5	99%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2002)

(2) Total number of results for parameter

(3) Number of results not achieving DQO

(4) Success rate, i.e. percent of results achieving DQO

Table 16. Summary of Planned and Completed Environmental Analyses for SRWP Monitoring, 2002-2003 Monitoring

Parameter	Total Environmental Analyses Planned	Environmental Analyses Completed	Total Percent Completeness
Mercury, total, filtered and unfiltered	172	164	95
Methylmercury, total, filtered and unfiltered	172	164	95
Total Suspended Solids (TSS)	86	81	94
Alkalinity	96	91	95
Hardness	84	77	92
Organic Carbon, total and dissolved	84	84	100
Total Dissolved Solids (TDS)	48	48	100
UVA254	66	63	95
Field Measurements	512	512	100
Nitrogen and Phosphorus Compounds	432	408	94
Molinate and Thibencarb (EPA 507)	10	10	100
Triazine Pesticides (EPA 619)	154	154	100
Organophosphate Pesticides (EPA 8141A)	2052	1969	96
Carbamate Pesticides (EPA 8321A)	600	596	99
E. coli	48	40	83
Coliform Bacteria, fecal	48	40	83
Coliform Bacteria, total	48	47	98
Aquatic Toxicity, (*Ceriodaphnia*)	84	84	100
Total for all analyses	4712	4632	98.3%
Minus total qualified data		(148)	
Total unqualified data		4484	96.8%
% Success averaged by parameter			95.6%

APPENDIX E:

COMMENTS AND RESPONSES

RESPONSES TO SPECIFIC COMMENTS ON THE PUBLIC DRAFT ANNUAL MONITORING REPORT, 2002-2003.

Comments were received from three peer reviewers of the Annual Monitoring Report: Joe Domagalski (USGS), Paul Olson (County of Sacramento), and Rainer Hoenicke (SFEI). Additional comments were received from Debra Denton (USEPA, Region 9), Mike Zanoli (CDWR), and Robert Brodberg (OEHHA). Specific comments on the Public Draft Annual Monitoring Report (2002-2003) are provided below (in order of receipt) and are followed by the responses addressing each comment. Peer reviewers were also asked to consider additional questions regarding alternatives for organization of future reports and for redesign of the SRWP monitoring program. The peer reviewers responses to these additional questions are intended to inform and be considered by the SRWP Board of Trustees and Subcommittees, as well as the broader stakeholder community, and are therefore not addressed in this document. The peer reviewers' responses to these additional programmatic questions are included with the full text of the Annual Monitoring Report comments submitted by peer reviewers. The full text of the peer reviewers' comments are provided following the responses to specific comments below.

Comments from Mike Zanoli, California Department of Water Resources (Received May 26, 2004)

MZ-1. Suggest mentioning Arcade Ck OP problems in E.S. p vi.

Response: This was addressed as recommended in the final report.

MZ-2. Suggest discussing the presence of the drinking water focus group as guiding dw monitoring somewhere in the overview section.

Response: This was addressed as recommended in the final report.

MZ-3. How did you come up with the land use data for Arcade Ck and footnote #3 for NEMDC in Table 1? Is a reference available for these?

Response: The land use information in Table 1 are derived from the USGS National Land Use Database (NLDC 2001), last updated in 2000. More information about this data source is available from http://www.mrlc.gov/index.asp.

MZ-4. In Table 3, DWR is not listed for N&P compounds and pathogens. Is someone else doing this work or is it our data?

Response: SRWP and DWR both monitor nutrients in Natomas East Main Drain.

MZ-5. Consider listing DWR/MWQI under the "Data Review Process" on p14.

Response: This was addressed as recommended in the final report.

MZ-6. Good use of MCLs, BP objectives, etc., to evaluate DW water quality data.

No response necessary.

MZ-7. What is the difference between Natomas East Main Drain and Natomas East Main Drainage Canal data? These are both listed in a couple of places.

Response: These are different names used for what are very nearly the same sites on the same waterbody. Discussion and presentation of data for Natomas East Main Drain were consolidated for the final report.

MZ-8. Please add DWR to the MWQI accro on p iii, before, after, or in parentheses. I didn't see anywhere in the report where our complete ID was shown together.

Response: This was addressed as recommended in the final report.

MZ-9. On p 95, 3rd para, line 7, it looks like there is a comma instead of a period.

Response: This was corrected in the final report.

MZ-10. On p 95, please explain the statement that TDS data had 95% compliance but no conc's >500 mg/L. (e.g., how was there 5% noncompliance?)

Response: The 95% estimate frequency of compliance is based on the statistical distribution of data. This was clarified in the final report text.

MZ-11. On p 95, table 28, where did the B.P. objective of 125 us/cm for EC come from?

Response: The Basin Plan objected cited should be 150 µS/cm. This was corrected in the final report.

MZ-12. Since both NEMDC and ag drains have the highest conc's of all sample sites, suggest adding to discussion on p 96, para 1.

Response: This was addressed as recommended in the final report.

MZ-13. It probably warrants mention somewhere in the report that NEMDC has the highest DW parameter conc's of most sites monitored, and is also specifically mentioned in the CALFED water quality plan for DW as a site of concern.

Response: This was addressed as recommended in the final report.

MZ-14. Although very high, coliform results for NEMDC are common in urban drains, as with the Sac city and county storm water sites.

Response: Additional text stating this was included in the final report.

MZ-15. On p 102, consider mentioning the importance of assessing Delta TOC sources and loads as a primary CALFED water quality goal and its importance in the upcoming drinking water policy work.

Response: This was addressed as recommended in the final report.

MZ-16. General ? Why are Arcade Ck MeHg conc's so high? No one knows. Steve Clark didn't know last year when I asked him either.

Response: This hasn't been specifically investigated. However, tthe Arcade Creek drainage does include historical gold mining dredge material, is relatively shallow and slow moving in some reaches, and high levels of some nutrients and organic carbon. This combination of conditions result in a fairly "productive" aquatic environment and may act similarly to natural wetlands (at least for the purpose of methylation of mercury).

Comments from Robert Brodberg, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (Received May 21, 2004)

RB-1. Please correct the following in the final report: OEHHA is not part of DHS (at least not yet, we will see what happens with the CPR). OEHHA is a separate office in the California Environmental Protection Agency just like the State Water Board and the Regional Boards.

Response: This was addressed as recommended.

Comments from Rainer Hoenicke, San Francisco Estuary Institute (June 7, 2004)

RH-1. The report, as currently written, represents a valuable reference document. As such, it could benefit from an Appendix that summarizes field sampling and laboratory analysis procedures (in addition to the Review of Quality Assurance Data). For example, it would be valuable for those who are unfamiliar with the fish tissue sampling element to know if composites were comprised of individuals of similar age and size. Also, a table summarizing the field and lab methods used for analysis, including references, might be useful.

Response: Selected tables summarizing sampling and analytical methods from the 2002-2003 Quality Assurance Project Plan (QAPP) were added as Appendix F. The complete QAPPs for each year are made available on the SRWP's website (http://www.sacriver.org).

RH-2. The uninitiated reader may not be familiar with trophic level classification systems and may benefit from a brief explanation of how trophic level 3 and 4 are defined.

Response: This information was included in the draft report as a footnote, but was also added to text in the Executive Summary, as recommended.

Comments from Paul Olson, County of Sacramento Department of Water Resources (June 9, 2004)

PO-1. On page 32, there is comment that the Sacramento Regional Wastewater Treatment Plant is a source of methyl Hg. Is this supported by the treatment plant's data or where did this conclusion come from?

Response: The conclusion that the Sacramento Regional Wastewater Treatment Plant may be responsible for some of the increase in methylmercury below Freeport was inferred from the observed increase below the treatment plant at River Mile 44. Treatment plant data were not used directly in reaching this conclusion.

PO-2. On page 35, there is discussion that there is strong seasonal patterns for total Hg concentrations. A figure as those shown for methyl Hg would be an aid to the reader. Also, statistical analysis showing these relations would be useful.

Response: Seasonal patterns are illustrated in Figure 17 and referenced in the text, Because the relationship between seasonal variation in flows and total mercury is well-documented and accepted (and has been discussed in more detail in previous annual reports), explicit statistical characterization of these relationships was not considered essential to the goals of this report. However, it may be valuable to conduct these analyses again for future summary reports or evaluating trends in loads or concentrations.

PO-3. n page 123, year 7 monitoring is not mentioned in the text.

Response: This was corrected in the final report.

Comments from Joe Domagalski, U.S. Geological Survey (June 14, 2004)

JD-1. Throughout the report, I was sometimes confused with the term "event-based" sampling. This can mean something different to hydrologists or other scientists, and I would suggest that each time you used that term, to add another descriptor. The best example is actually on page 80, last paragraph. The author of that section clearly described the types of events where samples were collected. Although it may seem redundant, people will be reading different parts of the report, not necessarily the entire report, and will need to know the exact definition of this term.

Response: This was addressed as recommended in the final report.

JD-2. I realize that this is a draft report, and that the maps were probably copies, but it would be helpful to have sharper images prepared for the final.

Response: Maps with poor resolution were replaced for the final report.

JD-3. Table 8 and 9. I recommend adding maximum and minimum values to the concentrations of Hg in fish tissue in addition to showing the mean.

Response: This was addressed as recommended in the final report.

JD-4. I recommend adding some additional explanation about the increase in mercury sources between Red Bluff and Colusa. There are data available on the amount of total mercury in bed sediment in Thomes and Cottonwood Creek (Domagalski and others, 2000, http://ca.water.usgs.gov/sac_nawqa/waterindex.html). In the less than 63-micron fraction of sediment, total Hg in Thomes Creek is 0.09 ppm, and the amount in Cottonwood Creek is 0.05 ppm. These levels are similar to the Sacramento River sediments above the confluence with the Feather River. Unfortunately, we do not have bed sediment concentration data for Mill Creek. It could be argued that the Thomes and Cottonwood might increase the concentration and load of total mercury in the water column of the Sacramento River, and that the source of the load is natural soil with concentrations of mercury at natural background levels. There is no evidence of an elevated natural or anthropogenic source of total mercury in those two respective watersheds. It might suggest that erosion control in those two watersheds might be warranted to decrease the load of total mercury. On the other hand, since this source of mercury is probably "old" and not very reactive with respect to methylation, source control be unwarranted since it would not decrease mercury levels in fish. It also suggests that further study of this mercury, from the bed sediments of Thomes and Cottonwood, could be addressed according to the methods of Bloom (2003), and summarized in Domagalski and others (2004) where source sediment is incubated with receiving sediment to determine the methylation potential. In contrast, Mill Creek mercury is from a geothermal source, and there is evidence of elevated methylmercury in Mill Creek water samples indicating a higher potential of methylation, and bioaccumulation, of that mercury. This should also be investigated through a commissioned study of source and receiving sediment methylation potential. It also needs to be pointed out that the Mill Creek discharge was relatively low in the study completed by Domagalski, and does not necessarily demonstrate the loading that could occur during a more significant hydrological event. During the New Year's storm of 1997, discharge on Mill Creek increased to a max of about 14,000 cubic feet per second. Although a rare event, there is ample evidence from the long-term discharge record on Mill Creek that high-flow episodic events occur. These large events not only increase the load of total mercury to the Sacramento River, but also probably contribute mercury in a form that might be bio-available. Add these references to the list: Bloom, N., 2003, Solid Phase Mercury Speciation and Incubation Studies in or Related to Mine-site Run-off in the Cache Creek Watershed (CA), http://loer.tamug.tamu.edu/calfed/FinalReports.htm and Domagalski, J.L., Alpers, C.N., Slotton, D., Suchanek, T.H., and Ayers, S.M., 2004, Summary and Synthesis of Mercury Studies in the Cache Creek Watershed, California, 2000-2001, http://loer.tamug.tamu.edu/calfed/FinalReports.htm.

Response: Additional discussion of the results were added as recommended to the final report. Your recommendations for additional analyses and studies will be considered as part of the evaluation of program goals and monitoring program re-design.

JD-5. On table 11, consider indicating that loads are only appropriate for the day of measurement. You want to avoid people taking the daily loads measured and multiplying by 365 to obtain an annual load, which would not be appropriate.

Response: This was addressed as recommended in the final report.

JD-6. The discussion on mercury concentration temporal distribution and patterns is interesting, but could be strengthened by adding an analysis of sediment concentration over that period. There is a long-term sediment record for the Sacramento River at Freeport and other sites. The benefit to that analysis would be to see if the sediment trend matches that for mercury, which would point to natural fluctuations. Dina Saleh, at USGS, recently completed a trend analysis for carbon, nutrients, and sediment for various sites of the Sacramento River Basin. Dina's report actually shows that trends in sediment concentrations have not changed in the last 20 years for the large Sacramento River sites, so a potential decrease in source strength might actually be occurring. Since very few remediation projects have occurred in the time frame of your analysis, the decrease might be due to a continued decrease in the amount of high mercury sediment transported out of the Feather and Yuba drainages. Please note that Dina Saleh used a different approach for her trend analysis. Her approach was to use the season Kendall test and LOWESS (Locally Weighted Scatterplot Smoothing) smoothing technique, which removes the effect of streamflow variation on the concentration trend. See Dina's report for a full explanation, and add this reference to the report: Saleh, D.K., Domagalski, J.L., Kratzer, C.R., and Knifong, D.L., 2003, Organic carbon trends, loads, and yields to the Sacramento-San Joaquin Delta, California, Water years 1980-2000. U.S. Geological Survey Water-Resources Investigations Report 03-4070, 77 pages plus data CD).

Response: Additional trend analyses of sediment concentrations would provide valuable information about potential mercury trends, but could not be considered for this document. These analyses will be considered as part of the evaluation of program goals and monitoring program re-design.

JD-7. On page 37, you refer to the DTMC evaluation of land use and other factors. Is a reference available for that work?

Response: The reference is to the SRWP's and DTMC's Strategic Plan for mercury management. The reference is included in the final report.

JD-8. Page 38, add Mill Creek as a potential source of bio-available mercury under high flow conditions associated with rainfall.

Response: This was addressed as recommended in the final report.

JD-9. Please indicate the number of samples for each of the sites shown in boxplots throughout the report.

Response: Unfortunately, the software used to create the original plots does not support this option and recreating the plots or adding the data by hand would have been too time-consuming. This format change will be included in future reports.

JD-10. On the figures that show trends, such as figures 10 through 15, you will need to indicate the level of significance for each of those trend lines.

Response: All trend lines illustrated were significant at $p<0.05$. This information was specified with the figures in the final report.

JD-11. Table 12 has at least one serious omission, which is the sampling and reports completed by the U.S. Geological Survey and others as part of the Organophosphorus Insecticide Focus Group. Please add that monitoring program to the table and also add the following citations to your reference list: Dileanis, P.D., Bennett, K.P., and Domagalski, J.L., 2002, Occurrence and transport of diazinon in the Sacramento River, California and selected tributaries during three winter storms, January-February 2000. U.S. Geological Survey Water-Resources Investigations Report 02-4101, 71 p. ; also, Dileanis, P.D., Brown, D.L., Knifong, D.L., and Saleh, D., 2003, Occurrence and transport of diazinon in the Sacramento River and selected tributaries, California, during two winter storms, January-February 2001. U.S. Geological Survey Water-Resources Investigations Report 03-4111, 75 pages. Note that data are also available from the USGS database for three winter storms in January through March 2002.

Response: This was addressed as recommended in the final report.

JD-12. Table 12: For USGS sampling, add Arcade Creek for continuation of NAWQA monitoring, and Sacramento Slough up until September 2004. The NAWQA Program is eliminating funding for the Sacramento Slough site because of budgetary reasons.

Response: This was addressed as recommended in the final report.

JD-13. Page 83, section on "Attainment of Beneficial uses and Potential Impairment' of Aquatic Toxicity, I suggest adding the reference for the diazinon ecological risk study of Giddings et al, 2000: Giddings, J.M., Hall Jr., L.W., and Solomon, K.R., 2000, Ecological risks of diazinon from agricultural use in the Sacramento-San Joaquin River basins, California, Risk Analysis, vol. 20, pp. 545-572). Even though the work is not strictly speaking that of aquatic toxicity, the approach of probabilistic ecological risk assessment is considered by some stakeholders as an alternative approach to understanding aquatic toxicity.

Response: The reference was added as recommended in the final report.

JD-14. The use of the acronym PBO is first shown on page 84, but not described until page 85.

Response: This was addressed as recommended in the final report.

JD-15. Page 100: Change electrical conductivity to specific conductance.

Response: This was addressed as recommended in the final report.

JD-16. Add reference to Dina Saleh's report on organic carbon loads and trends in the Central Valley (Saleh and others, full reference given above in note 6).

Response: This was addressed as recommended in the final report.

JD-17. In References, Domagalski, 1998, Journal of Geochemical Exploration should be replaced by the Applied Geochemistry article. Full citation: Domagalski J., 2001, Mercury and methylmercury in water and sediment of the Sacramento River Basin, California, Applied Geochemistry, vol. 16, p. 1677-1691.

Response: This was addressed as recommended in the final report.

Comments from Debra Denton, U.S. Environmental Protection Agency, Region 9 (June 18, 2004)

Note: The following comments were paraphrased from personal communications and review of the Annual Report with Debra Denton on June 18, 2004. No written comments were provided.

DD-1. Funding through USEPA has been critical to the SRWP. Please provide amounts of total funds provided to the SRTPCP.

Response: This was addressed as recommended in the final report.

DD-2. Page 3, footnote. Please cite the CWA with this footnote.

A reference to the Clean Water Act was added in the final report.

DD-3. On Page 62. Can the thiobencarb results be compared to NOEC values in addition to LOECs?

Response: No NOEC value for thiobencarb was provided in USEPA OPP Ecotoxicity Database.

DD-4. Please elaborate on the need for flow and information regarding the relationship of samples to event hydrographs for accurate load estimates.

Response: This was addressed as recommended in the final report.

DD-5. Page 87. Add the following text: "These sublethal toxic effects need to be further evaluated by additional testing to quantify the potential frequency and magnitude of toxicity at these sites."

Response: This was addressed as recommended in the final report.

DD-6. Can anything be done to improve the presentation of information in Table 26?

Response: The complete set of information and relationships in this table are difficult to present coherently. The table was modified (and I think, improved) for the final report.

DD-7. In Figure 28, How are "lesser tribs" defined?

Response: "Lesser tribs" are all tributaries that are not "major tributaries" e.g., the American, Feather, and Yuba Rivers.

DD-8. Please add explanation of abbreviations and column heading to appendix of summary statistics.

Response: This was addressed as recommended in the final report.

The additional questions to Peer Reviewers and the full text of their responses and comments follow:

QUESTIONS FOR PEER REVIEWERS
Of the
Sacramento River Watershed Program
Annual Monitoring Report: 2002-2003
May 2004

Report Organization

The SRWP is planning to redesign next year's annual report. We are considering possibly starting a two-part reporting process with one technical report, like the current annual report, and another much shorter summary report targeting a non-technical audience. Therefore, the following questions relate to redesigning the report.

1. Could this annual report be better organized? If so, how do you suggest it would be reorganized? Do you suggest more information be put into appendices?
2. We plan on preparing some type of summary report or executive summary that be a stand-alone document. This summary report would target a college-educated but non-technical audience. What information should this summary report contain?
    - Tables and maps of SRWP monitoring sites;
    - Graphs and tables of monitoring data;
    - A simplified explanation of "What do these monitoring results mean"? Is the river and are its tributaries polluted? What do the data mean with respect to beneficial uses?
    - What do you think about the summary report including 1-2 pages discussing the results from each of the areas of monitoring—general and physical parameters, aquatic toxicity, pesticides, bioassessment, mercury in water and fish tissue, drinking water quality?
3. Does the information presented in the summary report need to be summarized further than is done in the annual report? Can you suggest examples of data summaries from reports you know of?
4. What should be the focus of the summary report?
    - The past year's monitoring done by the SRWP?
    - The past year's comprehensive data review of SRWP and other monitoring data?
    - The comprehensive long-term data set of SRWP and others monitoring data from the mid-1990s to the present?

Monitoring Program Design

1. When money resources are limited what parameters and or sites would you recommend as deleting or reducing the frequency of sampling? Why?

2. What water quality parameters would you recommend as being added such that it would be helpful for future considerations or enhance decision making? For example, adding DOC, specific ions that would be helpful for using in the Biotic Ligand Model for assessing metals within the watershed?

3. What emerging pollutants based on your experience in the watershed should we consider adding to our list?

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Jerry Toyan June 7, 2004
Sacramento Regional County Sanitation District
10545 Armswtrong Avenue, Suite 101
Mather, CA 95655

Dear Jerry:

Thank you for the opportunity to review the Public Draft of the Sacramento River Watershed Program Annual Monitoring Report. It is a well-written and organized document that clearly articulates the objectives of the monitoring program and how results relate to the objectives. I have grouped comments into three categories:

1. General observations and suggestions for improvement or clarification of the Public Draft
2. Report organization and suggestions in response to Debora Denton's questions
3. Monitoring Program design and suggestions for modifications in sampling frequency, mix of parameters, or locations

1. General Comments

The report, as currently written, represents a valuable reference document. As such, it could benefit from an Appendix that summarizes field sampling and laboratory analysis procedures (in addition to the Review of Quality Assurance Data). For example, it would be valuable for those who are unfamiliar with the fish tissue sampling element to know if composites were comprised of individuals of similar age and size. Also, a table summarizing the field and lab methods used for analysis, including references, might be useful.

The uninitiated reader may not be familiar with trophic level classification systems and may benefit from a brief explanation of how trophic level 3 and 4 are defined.

2. Report Organization

My main recommendation for the redesign of next year's annual reporting approach would be to assemble a focus group comprised of your traditional stakeholders, as well as potential new ones. This group could help you prioritize audiences that you may want to reach beyond your traditional group of regulators, NPDES permit holders, and scientists represented in various data user groups. The SRWP has matured to a point where the results could be used to educate a broader public audience and individual land managers through the emerging Coalition Groups that have organized in response to the agricultural waste discharge requirement waiver conditions.

While the current reporting effort has been adequate for the segment of information users that knows what to look for, future information dissemination tools might include a much broader variety, such as fact sheets, watershed maps with extensive legends and graphs depicting summarized data, and raw data with associated metadata available in electronic format for specific data users. Based on the types of audiences that could benefit from ambient monitoring information, the specific vehicles for information delivery and educational tools required will become apparent.

Depending on past and anticipated trends in water quality conditions and beneficial use recovery, concise summaries for a decision-making audience may not need to be issued on an annual basis, but possibly every two to five years. For example, information relevant to managers about persistent, bioaccumulative pollutants, such as methylmercury, chlorinated hydrocarbons, and brominated compounds, may not require reporting as frequently as information about pesticide concentrations and how management actions may have resulted in beneficial use recovery. For next year, I would recommend taking a comprehensive look at the long-term data set in the context of other data. Wherever possible, the use of maps should be a priority in communication tools that are directed to both the general public and a managerial and policy-making audience. For example, sub-watershed maps could depict watershed characteristics and condition, such as vegetation cover and habitat types, land uses, natural resources of special concern, impaired creek and river reaches, pesticide use statistics, potential reference streams with little or no evidence of beneficial use impairment, as well as geographic depiction of monitoring results.

Highlights of results from both the ambient monitoring program and other data-gathering efforts could be summarized to identify to what degree management questions can be answered. Summary reports could be organized based on the United Nations "Pressure-State-Response Model", or variations thereof (environmental condition, stressors, exposure to stressors, and management response) to link watershed characteristics and resources with impairment data that could point to management options. While it may be useful to discuss the meaning of results for each of the areas of monitoring, it will be important to link findings about possible impairment (as expressed in benthic invertebrate communities deviating from reference conditions, or continued population declines in special-status species) to presumed stressors impacting the chemical, physical, and biological integrity of water. Examples of data summaries you may want to consider are:
http://www.frap.cdf.ca.gov/assessment2003/Assessment_Summary/Exec_sum_300.pdf
http://www.chesapeakebay.net/wquality.htm and several topic reports, among them:
http://www.chesapeakebay.net/info/pressreleases/ec2003/20years.pdf
http://www.tbep.org/baystate.html
http://www.sfei.org/rmp/pulse/pulse2004.html

3. Monitoring Program Design

Response to Question 1: I would use the following criteria for monitoring frequency: Scale the temporal frequency to: (1) the known or presumed persistence of a contaminant; (2) the extent to which management steps are being implemented to prevent or reduce releases of pollutants into surface waters (i.e., adjust sampling frequency based on expected speed of recovery); (3) the degree to which natural variability drives the distribution, transformation, or transport of a pollutant (e.g. high-flow vs. dry-season base flow; extreme events).

Tissue levels of chlorinated hydrocarbons and brominated compounds are unlikely to change from year to year. Reduce sampling to every three to five years. If few or no management measures are implemented to control a pollutant at the source (e.g., total Hg), annual pre-determined monitoring may not be necessary. Event-based sampling may be appropriate for pollutants mobilized during high-flow events, and depending on circumstances, funds saved in one year may be used in years when floods do occur.

Spatial coverage could be re-evaluated by re-visiting the underlying management questions. Work with Regional Water Board, State Board, EPA staff, and your stakeholder groups to revisit information needs. This could be done in conjunction with the Interagency Coordination Committee (IACC) and upcoming re-tooling of the Surface Water Ambient Monitoring Program (SWAMP). Determine if the probabilistic sampling design Jim Harrington's team is using for EMAP could be used to augment the deterministic component used by SRWP. As a general rule: The sampling frequencies and spatial coverage will to a large extent be driven by the types of management questions and information needs the decision-makers will have. If emphasis is shifting away from "characterization" toward evaluating processes and testing conceptual models about limiting factors to beneficial use recovery, as well as testing specific hypotheses, then your sampling frequency will be dependent upon the specific "drivers" that influence change.

Question 2: To some extent, answers to this question also depend on how the management questions are revised or refined. If answers to metal transformation and bioavailability are needed for the development of site-specific objectives, for instance, then this will drive expansion of the parameter list. If the potential for sediment toxicity of pyrethroid pesticides needs to be evaluated, then you may want to include sediment grain-size and TOC measurements. My recommendation is to start the process of articulating the information needs first, and then determine in a workgroup setting which additional parameters are required to answer specific management questions. It would also be helpful to inventory other study and monitoring efforts that could provide answers to questions your stakeholders have and incorporate results into your analysis, such as PRISM projects, SWAMP-funded efforts, etc.

Question 3: Add emerging pollutants in sub-watersheds where you suspect their occurrence (urban and urbanizing watersheds; high percentage of certain crops updated regularly by the Department of Water Resources). These could include PBDEs and beak-down products, new generations of pesticides, bioaccumulative personal care products, etc. Use new bioassays currently tested and used in the North Coast Region quantifying estrogenic effects on fish in watersheds where these types of pollutants are suspected to occur.

The SRWP has generated an extremely valuable database, and the re-evaluation of reporting approaches and monitoring design is very timely. The expanded legislative mandates given to the State Board and the Regional Water Boards (e.g., allocation and management of incentive programs through Propositions 13, 40, and 50; agricultural discharge waiver requirements; direct involvement in timber harvest planning and compliance issues) add new challenges and responsibilities to evaluating environmental performance, and the Watershed Program is in a good position to assist in meeting these challenges.

The San Francisco Bay Regional Monitoring Program is currently undergoing its second round of adjustments. It might be informative for a representative from the Watershed

Program to follow the upcoming process of revisiting management and monitoring questions and potential shifts in program emphasis. Please call me at 510-746-7381 or Jay Davis at 746-7368 if you have any questions.

Sincerely,

Rainer Hoenicke, Ph.D.
Environmental Scientist

Cc: Debra Denton, Jay Davis, Sarah Lowe, Mike Connor, Tom Grovhaug, Val Connor, Sam Ziegler

COUNTY OF SACRAMENTO
MUNICIPAL SERVICES AGENCY –CHERYL CRESON, ADMINISTRATOR
JOHN O'FARRELL, DEPUTY ADMINSTRATOR

Department of Water Resources

Including service to the Cities of Citrus Heights, Elk Grove and Rancho Cordova

Keith DeVore, Director

June 9, 2004

Mr. Jerry Troyan
Sacramento Regional County Sanitation District
10545 Armstrong Avenue, Suite 101
Mather, CA 95655

Subject: Peer Review of Sacramento River Watershed Program 2002-2003 Annual Monitoring Report

Dear Mr. Troyan:

Thank you for providing us with the opportunity to make these comments. The report is a very impressive document showcasing the important work by the SRWP.

<u>Comments to Report</u>
On page 32, there is comment that the Sacramento Regional Wastewater Treatment Plant is a source of methyl Hg. Is this supported by the treatment plant's data or where did this conclusion come from?

On page 35, there is discussion that there is strong seasonal patterns for total Hg concentrations. A figure as those shown for methyl Hg would be an aid to the reader. Also, statistical analysis showing these relations would be useful.

On page 123, year 7 monitoring is not mentioned in the text.

This is an excellent report with useful conclusions.

I. Questions for Peer Reviews

<u>Report Organization</u>
The report is well organized and is an important reference for those of us in the region. Items that may be considered in future editions are:

Use tables and graphs to show numbers and statistics. It is difficult to follow and compare data presented within the text.

Limit bulleted items to one or two sentences. Increase the use of bulleted items.

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Facilities Operations and Administration 3 ramento, CA 95827 • Phone: (916) 875-4913

Include tables and figures with or immediately following the text that describes them.

Summary Report

We feel that a stand alone summary report or executive summary would be a great way to reach a broader audience. The report should include monitoring maps and simplified graphs to assist in providing a concise evaluation of the data. The existing format of evaluating constituents or groups of constituents separately (i.e. mercury, pesticides, etc.) is clear and should be used in the summary report.

The summary report should focus on beneficial uses. Despite this being a sometimes murky area it is how the data affects the general public. It would also be more straightforward to use numbers only in tables rather than presenting percentages and concentrations within the text. The shorter the text for each section the more accessible the summary will be. The summary report should not focus on results, but be limited to conclusions. Only data tables and graphs relating to conclusions presented in the summary should be included. Water quality results are difficult to comprehend and often meaningless to the public. Only conclusions and recommendations relating to beneficial uses and trends should be included.

The summary report should be based on a comprehensive long-term data set of relevant data. Only analyzing the current data may be confusing to a broader audience.

Monitoring Program Design

When money for monitoring is limited, limit the bioassessment. Bioassessment is often more habitat influenced. In addition, bioassessment data is not impacted as greatly by long intervals of limited data as compared to the other testing carried out by the SRWP.

SWRP should actively engage in monitoring for pyrethroids and pyrethrins, as well as piperonly butoxide (PBO). While PBO decreases the toxicity of OP pesticides, it increases the toxicity and persistence of pyrethroids and pyrethrins. It is important to determine how these pesticides are spreading in the environment as their use increases. This is important to understand the full impact to downstream users from agriculture's decreasing use of diazinon.

Corinne de Leon
Associate Civil Engineer
County of Sacramento
Department of Water Resources

Paul Olson
Associate Civil Engineer
County of Sacramento
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June 8, 2004

Jerry Troyan
Sacramento Regional County Sanitation District
10545 Armstrong Avenue
Suite 101
Mather, CA 95655

Jerry,

Thank you for the opportunity to review the 2002-2003 Annual Monitoring Report for the Sacramento River Watershed Program. I would like to start out by congratulating the authors on a well-written document. The organization is suitable, and the writing style is consistent throughout. I will divide my review into two parts. The first part will be my comments on specific sections, and the second part will address the questions posed by Debra Denton.

1.) Throughout the report, I was sometimes confused with the term "event-based" sampling. This can mean something different to hydrologists or other scientists, and I would suggest that each time you used that term, to add another descriptor. The best example is actually on page 80, last paragraph. The author of that section clearly described the types of events where samples were collected. Although it may seem redundant, people will be reading different parts of the report, not necessarily the entire report, and will need to know the exact definition of this term.

2.) I realize that this is a draft report, and that the maps were probably copies, but it would be helpful to have sharper images prepared for the final.

3.) Table 8 and 9. I recommend adding maximum and minimum values to the concentrations of Hg in fish tissue in addition to showing the mean.

4.) I recommend adding some additional explanation about the increase in mercury sources between Red Bluff and Colusa. There are data available on the amount of total mercury in bed sediment in Thomes and Cottonwood Creek (Domagalski and others, 2000, http://ca.water.usgs.gov/sac_nawqa/waterindex.html). In the less than 63-micron fraction of sediment, total Hg in Thomes Creek is 0.09 ppm, and the amount in Cottonwood Creek is 0.05 ppm. These levels are similar to the Sacramento River sediments above the confluence with the Feather River. Unfortunately, we do not have bed sediment concentration data for Mill Creek. It could be argued that the Thomes and Cottonwood might increase the concentration and load of total mercury in the water column of the Sacramento River, and that the source of the load is natural soil with concentrations of mercury at natural background levels. There is no evidence of an elevated natural or anthropogenic source of total mercury in those two respective watersheds. It might suggest that erosion control in those two watersheds might be warranted to decrease the load of total mercury. On the other hand, since this source of mercury is probably "old" and not very reactive with respect to methylation, source control be unwarranted since it would not decrease mercury levels in fish. It also suggests that further study of this mercury, from the bed sediments of Thomes and Cottonwood, could be addressed according to the methods of Bloom (2003), and summarized in Domagalski and others (2004) where source sediment is incubated with receiving sediment to determine the methylation potential. In contrast, Mill Creek mercury is from a geothermal source, and there is evidence of elevated methylmercury in Mill Creek water samples indicating a higher potential of methylation, and bioaccumulation, of that mercury. This should also be investigated through a commissioned study of source and receiving sediment methylation potential. It also needs to be pointed out that the Mill Creek discharge was relatively low in the study completed by Domagalski, and does not necessarily demonstrate the loading that could occur during a more significant hydrological event. During the New Year's storm of 1997, discharge on Mill Creek increased to a max of about 14,000 cubic feet per second. Although a rare event, there is ample evidence from the long-term discharge record on Mill Creek that high-flow episodic events occur. These large events not only increase the load of total mercury to the Sacramento River, but also probably contribute mercury in a form that might be bio-available. Add these references to the list: Bloom, N., 2003, Solid Phase Mercury Speciation and Incubation Studies in or Related to Mine-site Run-off in the Cache Creek Watershed (CA), http://loer.tamug.tamu.edu/calfed/FinalReports.htm and Domagalski, J.L., Alpers, C.N., Slotton, D., Suchanek, T.H., and Ayers, S.M., 2004, Summary and Synthesis of Mercury Studies in the Cache Creek Watershed, California, 2000-2001, http://loer.tamug.tamu.edu/calfed/FinalReports.htm.

5.) On table 11, consider indicating that loads are only appropriate for the day of measurement. You want to avoid people taking the daily loads measured and multiplying by 365 to obtain an annual load, which would not be appropriate.

6.) The discussion on mercury concentration temporal distribution and patterns is interesting, but could be strengthened by adding an analysis of sediment concentration over that period. There is a long-term sediment record for the Sacramento River at Freeport and other sites. The benefit to that analysis would be to see if the sediment trend matches that for mercury, which would point to natural fluctuations. Dina Saleh, at USGS, recently completed a trend analysis for carbon, nutrients, and sediment for various sites of the Sacramento River Basin. Dina's report actually shows that trends in sediment concentrations have not changed in the last 20 years for the large Sacramento River sites, so a potential decrease in source strength might actually be occurring. Since very few remediation projects have occurred in the time frame of your analysis, the decrease might be due to a continued decrease in the amount of high mercury sediment transported out of the Feather and Yuba drainages. Please note that Dina Saleh used a different approach for her trend analysis. Her approach was to use the season Kendall test and LOWESS (Locally Weighted Scatterplot Smoothing) smoothing technique, which removes the effect of streamflow variation on the concentration trend. See Dina's report for a full explanation, and add this reference to the report: Saleh, D.K., Domagalski, J.L., Kratzer, C.R., and Knifong, D.L., 2003, Organic carbon trends, loads, and yields to the Sacramento-San Joaquin Delta, California, Water years 1980-2000. U.S. Geological Survey Water-Resources Investigations Report 03-4070, 77 pages plus data CD).

7.) On page 37, you refer to the DTMC evaluation of land use and other factors. Is a reference available for that work?

8.) Page 38, add Mill Creek as a potential source of bio-available mercury under high flow conditions associated with rainfall.

9.) Please indicate the number of samples for each of the sites shown in boxplots throughout the report.

10.) On the figures that show trends, such as figures 10 through 15, you will need to indicate the level of significance for each of those trend lines.

11.) Table 12 has at least one serious omission, which is the sampling and reports completed by the U.S. Geological Survey and others as part of the Organophosphorus Insecticide Focus Group. Please add that monitoring program to the table and also add the following citations to your reference list: Dileanis, P.D., Bennett, K.P., and Domagalski, J.L., 2002, Occurrence and transport of diazinon in the Sacramento River, California and selected tributaries during three winter storms, January-February 2000. U.S. Geological Survey Water-Resources Investigations Report 02-4101, 71 p. ; also, Dileanis, P.D., Brown, D.L., Knifong, D.L., and Saleh, D., 2003, Occurrence and transport of diazinon in the Sacramento River and selected tributaries, California, during two winter storms, January-February 2001. U.S. Geological Survey Water-Resources Investigations Report 03-4111, 75 pages. Note that data are also available from the USGS database for three winter storms in January through March 2002.

12.) Table 12: For USGS sampling, add Arcade Creek for continuation of NAWQA monitoring, and Sacramento Slough up until September 2004. The NAWQA Program is eliminating funding for the Sacramento Slough site because of budgetary reasons.

13.) Page 83, section on "Attainment of Beneficial uses and Potential Impairment' of Aquatic Toxicity, I suggest adding the reference for the diazinon ecological risk study of Giddings et al, 2000: Giddings, J.M., Hall Jr., L.W., and Solomon, K.R., 2000, Ecological risks of diazinon from agricultural use in the Sacramento-San Joaquin River basins, California, Risk Analysis, vol. 20, pp. 545-572). Even though the work is not strictly speaking that of aquatic toxicity, the approach of probabilistic ecological risk assessment is considered by some stakeholders as an alternative approach to understanding aquatic toxicity.

14.) The use of the acronym PBO is first shown on page 84, but not described until page 85.

15.) Page 100: Change electrical conductivity to specific conductance.

16.) Add reference to Dina Saleh's report on organic carbon loads and trends in the Central Valley (Saleh and others, full reference given above in note 6).

17.) In References, Domagalski, 1998, Journal of Geochemical Exploration should be replaced by the Applied Geochemistry article. Full citation: Domagalski J., 2001, Mercury and methylmercury in water and sediment of the Sacramento River Basin, California, Applied Geochemistry, vol. 16, p. 1677-1691.

Responses to Debra Denton's Questions

Report Organization

1.) The general organization of the report is suitable, but may benefit from some layout changes, such as having some of the figures closer to the point in the text where they are first referenced. The report has the same general format from topic to topic, which allows the reader to make comparisons on the various constituents of concern.
2.) A summary report should be a glossy document with maps, graphs, and tables that easily indicate what water quality problems exist in the basin, what is being done to attain or restore beneficial uses in problem areas, and results of regulatory or stakeholder actions that have improved water quality. It would be useful to have a very short one to two page fact sheet that could be mailed out or placed on a web site to interested parties, and a longer summary, maybe up to 25 to 30 pages that explains water quality conditions in more detail, but in general, non-scientific terms.
3.) The USGS NAWQA summary reports contain examples of both one to two page summaries, and glossy 30 page non-technical descriptions of water quality conditions in individual basins.
4.) I would like to see the summary focus primarily on status and trends, and clearly show results of stakeholder or regulatory activity in attaining beneficial uses. Perhaps a detailed case study of one or more such activities would be useful.

Monitoring Program Design

1.) Under a scenario of budget cutbacks, I would recommend focusing on constituents currently being considered for, or with active, TMDL programs. That would mean cutting back on general chemical characteristics except for organic carbon, nutrients, and pathogens, while maintaining monitoring for mercury and pesticides. Monitoring on smaller tributaries could be cut back, while maintaining the sampling frequency on large river sites (Sacramento, Feather, American, and Yuba rivers). This would also mean cutting back on bioassessments since protocols have not yet been developed for the large river sites.
2.) I am not familiar with the Biotic Ligand Model, so I cannot comment on that. Metals other than mercury are generally not a problem in the watershed, except for some highly localized areas. One exception might be arsenic, if water quality standards for that metal are lowered.
3.) Pharmaceutical compounds are receiving increased attention, and adding a limited sampling might be useful. Selected samples could be added at a limited number of sites under both low flow and storm water runoff conditions.

I hope that you find these comments useful. It was a pleasure to review this document.

Sincerely,

Joseph Domagalski

APPENDIX F:

METHODS FOR 2002-2003 MONITORING

(from 2002-2003 Quality Assurance Project Plan)

Table A-1. Parameters Measured for the SRWP Monitoring Program

Chemical and Physical Water Quality Characteristics	
Mercury	*General Constituents*
Mercury, filtered and unfiltered	Alkalinity
Methylmercury, filtered and unfiltered	Hardness
	Total Suspended Solids
Nitrogen and Phosphorus Compounds	Total Dissolved Solids
Ammonia Nitrogen	Dissolved Organic Carbon
Nitrate and Nitrite Nitrogen	Total Organic Carbon
Total Kjeldahl Nitrogen	UVA_{254}
Dissolved Orthophosphate and Total Phosphorus	
	Field Parameters
Pesticides	Temperature
Organophosphate Pesticides	pH
Carbamate Pesticides	Dissolved Oxygen
Triazine Pesticides	Conductivity
Microbiological Water Quality Characteristics	
Escherischia coli	Total coliform bacteria
Enterococcus spp.	Fecal coliform bacteria
Aquatic Toxicity	
Ceriodaphnia reproduction	*Ceriodaphnia* mortality
Fish Tissue	**Bioassessment**
Mercury	*Physical Habitat*
Chlorinated pesticides	Selection of potential reference sites
PCBs	Measures of habitat quality
	Benthic Invertebrates
	Community abundance and diversity metrics

Table A-3. Summary of Sampling Sites, Frequency, and Parameters.

Monitoring Locations [c]	Chemical Characteristics												Pathogens			Aquatic Toxicity		Fish Tissue		Bioassess-ment[b]	
	Hg and MeHg (filtered and unfiltered)	TSS	Hardness	Alkalinity	TOC	DOC	UVA 254	TDS	Nitrogen and Phosphorus compounds	OP pesticides	carbamate pesticides	triazines	E. coli	Enterococcus	Total, Fecal Coliforms	Ceriodaphnia	WC Tox Followup (a)	Mercury	PCBs & OC pest.	Benthic Invertebrates	Habitat Assessment
Pit R. above Shasta			atox	atox												6	(a)			RB	
Sac. R. below Keswick	5	5	atox	atox				RED								6	(a)				
Cottonwood Ck at mouth			atox	atox												6	(a)				
Cottonwood Creek (3 tributary sites)	12	12																			
Battle Creek (3 tributary sites)	12	12																			
Sac. R. at Bend Br	5	5	atox	atox	6	6	6	6	6				6	6	6	6	(a)				
Mill Creek @ Los Molinos										3											
Deer Creek										3											
Thomes Creek (3 tributary sites)	12	12																			
Dry Creek (trib to Little Chico Ck)	4	4																			
Little Chico Creek	4	4																			
Big Chico Creek										3											
Sac. R. near Hamilton City	5	5	atox	atox	6	6	6	6	6	6			6	6	6	6	(a)				
Sac. R. @ Colusa	5	5	atox	atox	6	6	6	6	6	6			6	6	6	6	(a)				
Sac. Slough	4	4	atox	atox	6	6	6	6	6	6	6		6	6	6	6	(a)				
Colusa Basin Dr	4	4	atox	atox	6	6	6	6	6	6	6		6	6	6	6	(a)		(c)		
Yuba R. at Marysville	5	5	atox	atox	6	6	6	6	6	6	6		6	6	6	6	(a)				
Feather R. near Nicolaus	5	5	atox	atox	6	6	6	6	6	6		4	6	6	6	6	(a)	4			
Sac. R. at Veterans Br.	CMP	CMP	CMP	6	CMP	CMP	6	6	6	6		4	CMP	6	CMP						
Arcade Creek	4	4		atox						6	6	6				6	(a)				
Natomas East Main Drain			DWR	DWR	DWR	DWR	DWR	DWR	6				6	6	6						
American R. at Discovery Pk	CMP	CMP	CMP	atox	CMP	CMP	6	CMP	6	CMP			CMP	6	CMP	6	(a)	6	2		
Sac. R. at Freeport	CMP, GS	CMP	CMP	GS	CMP	CMP	6	CMP	6	GS	GS	GS	CMP	6	CMP	6	(a)				
Sac. R. at RM44	CMP	CMP	CMP	6	CMP	CMP	6	CMP	6	CMP			CMP	6	CMP			4	2		
Cache Creek at Rumsey																6	(a)				
Number of Sites	14	14	0	2	7	7	11	8	12	11	4	3	8	12	8	14	(c)	3	2	0	0
Number of Regular Analyses	86	86	0	12	42	42	66	48	72	57	24	14	48	72	48	84	(a)	14	4	0	0
Additional QC Analyses	12	9	0	0	12	12	12	6	12	12	12	12	6	6	6	12	(c)	0	0	0	0

Table Notes: Values indicate number of environmental samples collected annually. Additional samples are collected for Quality Assurance. All water quality monitoring will be "event-based". "atox" indicates parameter is measured as part of aquatic toxicity monitoring. Text entries indicate data or samples collected by primary coordinating programs: CMP = Sacramento River Coordinated Monitoring Program; GS = USGS CF = CALFED; RB = Central Valley Regional Board.

(a) A fixed budget of $60,000 is allocated for Toxicity follow-up consisting of chemistry, TIE testing, and additional sampling that has no fixed frequency.

(b) Bioassessment monitoring will consist primarily of identifying and validating potential reference sites in the Sierra Foothills and Central Valley, with an estimated budget of $21,600.

(c) Additional fish tissue samples may be collected and analyzed for this site if funds are made available from the SWRCB TSMP.

2. Sampling Methods Requirements

Samples will be collected from three environmental media: water, tissue, and biota. Three different sample collection methods will be used for the monitoring elements in water: (1) basic water quality sampling, (2) pathogen sampling, and (3) toxicity sampling. Sampling of tissue will include methods specific for fish, and sampling for biota will include methods for benthic macroinvertebrates. For each of these methods described or referenced, it is the combined responsibility of all members of the sampling crew to determine if the performance requirements of the specific sampling method have been met, and to collect an additional sample if required. Descriptions of specific sampling methods and requirements are provided below.

2.1 Basic Water Quality Characteristics

Basic water quality monitoring will include sampling for mercury and methylmercury, pesticides, total suspended solids, hardness, total dissolved solids, alkalinity, nitrogen and phosphorus compounds, total organic carbon, dissolved organic carbon, and ultraviolet absorbance. Field-measured parameters (temperature, dissolved oxygen, specific conductivity, and pH) will also be measured at each site and event where basic water quality characteristic samples are collected. Field parameters will be measured using a YSI Model 57 Oxygen Meter for dissolved oxygen, VWR Scientific Traceable Digital Thermometer (Cat. #61220416) for temperature, Orion Model 230A pH meter, and an Orion Model 130 conductivity meter, or comparable instrument(s).

All water quality samples will be collected using clean techniques that minimize sample contamination. Sampling methods will generally conform to EPA "clean" sampling methodology described in *Method 1669: Sampling Ambient Water for Trace Metals* (USEPA 1995a). Specific methods are also documented in Appendix C[1]. Samples will generally be mid-depth grab samples and will be collected by boat or from shore using a peristaltic pump and acid-cleaned polyethylene or Teflon™ tubing. Grab samples will be collected into acid-cleaned glass carboys and aliquoted into glass, polyethylene, or Teflon™ sample containers appropriate for the analyses to be performed, *or* will be collected directly into the sample containers, if appropriate. Samples to be analyzed for dissolved (filtered) analytes will be filtered to 0.45 μm in the field using Gelman in-line filtration capsules.

After collection, samples will be stored at 4˚C until arrival at the contract laboratory. Samples to be analyzed for mercury will be preserved using ultrapure hydrochloric or bromochloric acid at the contract laboratory, immediately on arrival. Samples to be analyzed for other constituents will be preserved in the field, as appropriate (Table B-2).

This sample collection method requires that the sample collection tubing, and the sample bottle and lid come into contact only with surfaces known to be clean, or with the water sample. Additionally, mercury samples must have no air bubbles or head space present in the bottle immediately following sample collection. If air is present in the sample

---

[1] Water sampling for chemical parameters by Pacific EcoRisk will also generally adhere to their QA manual, which is included in Appendix D. Sections generally relevant to collecting samples for water chemistry include *Documentation*, *Collection and Handling of Samples*, Collection and Preparation of Receiving Water, *Instrument Calibration and Standardization*, and *Acquisition, Reduction, Validation and Reporting of Data*. General sample collection methods included in the PER QA Manual are superseded by any more specific collection methods for chemical analyses included or referenced in this Quality Assurance Project Plan.

container for mercury analyses, additional sample will be aliquoted into the same sample bottle. If the performance requirements for specific samples are not met, the sample will be re-collected. If contamination of the sample container is suspected, a fresh sample container will be used.

2.2 Pathogens

Pathogen monitoring will include sampling for pathogen indicator organism (fecal and total coliform bacteria, *E. coli*, and *Enterococcus* bacteria). *Note*: Samplers must wear gloves when collecting any pathogen samples.

<u>Bacteria</u>

Samples analyzed for bacteria will be collected as near-surface grab samples. Sampling for bacteria will be performed according to the sampling procedures detailed for Standard Methods 9221B and 9221E (APHA *et al.* 1998). In brief, the sampling procedures are summarized as follows:

- Sample containers should be cleaned and sterilized using procedures described in Standard Methods 9030 and 9040.
- For waters suspected to contain a chlorine residual, sample bottles should contain a small amount of sodium thiosulfate ($Na_2S_2O_3$) sufficient to neutralize bactericidal activity. For water containing high concentrations of copper or zinc, sample bottles should contain sufficient EDTA solution to reduce metal toxicity. *Note*: These conditions are rare in surface waters.
- Sample bottles may be glass or plastic (e.g. polypropylene) with a capacity of at least 120 mL. After sterilization, sample bottles should be kept closed until they are to be filled.
- When removing caps from sample bottles, be careful to avoid contaminating inner surface of caps or bottles.
- Using aseptic techniques, fill sample bottles leaving sufficient air space to facilitate mixing by shaking. Do not rinse bottles.
- Recap bottles tightly.

If at any time the sampling crew suspects that the sample or sampling container has been contaminated, the sample should be re-collected into a new sample container.

After collection, store samples at 4˚C until evaluation. Bacteriological tests must be set up within 24 hours of collection. The 20th edition of Standard Methods (APHA et al. 1998) recommends analysis of samples as soon as possible, but specifies that non-drinking water samples analyzed for non-compliance purposes may be held for up to 24 hours (below 10˚C) until time of analysis. For this reason, data from SRWP samples should not be used for assessment of regulatory compliance.

2.3 Aquatic Toxicity

Collection of water samples for analysis of ambient water column toxicity will be performed in accordance with guidance for sampling and sample handling documented in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (USEPA 1994a). In brief, the sampling requirements for toxicity testing are as follows:

- Water collected for toxicity tests will consist of grab samples.

- Samples will be collected directly into 4-L amber glass bottles, using the same equipment and procedures as for basic water quality samples (previously described in section 2.1).
- Sufficient volume will be collected to conduct the characterization and identification phases (Phase I and II) of chronic toxicity identification evaluation (TIE) procedures.
- Samples will be filtered in the laboratory as required for specific toxicity tests.
- After collection, samples will be chilled and maintained at 4˚C until testing.
- Toxicity tests will be initiated within 48 hours of sampling.

In some cases where significant toxicity is observed during aquatic toxicity testing, samples may be analyzed for any of the chemical parameters included in this QAPP. The specific analyses to be performed will depend on the pattern of toxicity observed, including any decision to filter samples for chemical analysis. Every effort will be made to be consistent with the sample requirements documented herein for the specific analyte. Because requirements for sample and preservation holding times, filtration, and original sample containers may not be strictly met, the results of the analyses will be used primarily for determining or confirming causes of toxicity, and will be qualified for any other use. Laboratories selected to perform these analyses must meet the same QA performance criteria used to select other laboratories for this monitoring program.

2.4 Fish Tissue

Tissue monitoring will include sampling of fish for analysis of mercury and trace organic concentrations in tissue. Fish tissue samples will be collected by the California Department of Fish and Game Moss Landing Marine Lab , using protocols detailed in *Contaminant Levels in Fish Tissue from San Francisco Ba*y (SFRWQCB 1995). Details of the protocols are documented in Appendix G and summarized below.

Collection of fish for analysis of mercury, PCBs, and chlorinated pesticides in tissue may be accomplished by a variety of methods, including hook and line, seines, gill nets, and electroshocking. Species collected will be non-migratory species that are most representative of a given location. Efforts will be made to collect fish of a similar (medium) size for each composite. Fish will be wrapped in trace metal- and organic-free Teflon™ sheets and frozen for transportation to the laboratory. The tissue samples are prepared in the laboratory using non-contaminating techniques in a clean room environment. Equal-weight tissue samples will be removed from five fish of a similar size and combined into a single 200 g composite sample.

Largemouth bass and white catfish are the primary target species. Other species may be targeted at sites where largemouth and white catfish are less abundant. Primary target species (white catfish and largemouth) that are larger than the specified size ranges should be kept if they are caught, as long as they are of legal size. Total length (longest length from tip of tail fin to tip of nose/mouth) and fork length should be measured in the field. Size ranges to be targeted for each species are as follows:

- White catfish, 229–330 mm;
- Largemouth bass, 305–438 mm
- Sacramento sucker, 340–500 mm
- Sacramento pikeminnow, 195–400 mm
- Common carp, 400–600 mm
- Rainbow trout, 250–400
- Channel catfish, 300–500
- Striped bass, >457 mm (legal limit)

Species not listed are considered bycatch and should not be collected unless requested by the SRWP Fish focus group.

Collection, handling and storage of tissue samples will be performed in a manner consistent with Regional Monitoring Program (RMP) protocols (SFEI 1999, SFRWQCB 1995) to assure the collection of representative, uncontaminated tissue chemistry samples. Briefly, the key aspects of quality control associated with chemistry sample collection are as follows:

- Field personnel will be thoroughly trained in the proper use of sample collection gear and will be able to distinguish acceptable versus unacceptable samples in accordance with pre-established criteria.
- Field personnel will be thoroughly trained to recognize and avoid potential sources of sample contamination (e.g., engine exhaust, winch wires, deck surfaces, ice used for cooling).
- Samplers and utensils which come in direct contact with the sample will be made of non-contaminating materials (e.g., glass, high-quality stainless steel and/or Teflon™) and will be thoroughly cleaned between sampling stations.
- Sample containers will be pre-cleaned and of the recommended type.

In general, sampling protocols are consistent with national guidance developed by USEPA (2000). The Program employs a composite sampling strategy, as recommended in the USEPA guidance document. The target number of fish to be collected for each composite is five for all current target species (but may be higher for alternate smaller species). In any single composite the total length of the smallest fish should be no less than 75% of the total length of the largest fish. If, after expending a reasonable amount of effort, the field crew is unable to catch the required number of fish of an appropriate size range at a location, the sampling contractor will contact the SFEI Program Manager to discuss whether sampling should continue at that location.

If the performance requirements documented in the sampling protocols are not met, the sample will be re-collected. Sample collection will be conducted between September 1 and October 15. Samples will be distributed to the analytical laboratories within 45 days (i.e., by November 30) after the completion of sampling.

2.5 Bioassessment

Bioassessment monitoring includes sampling of benthic invertebrates for bioassessment evaluations. The procedure for collecting samples of benthic invertebrates from wadable streams is based on the method detailed in *California Stream Bioassessment Procedures (Habitat Assessment and Biological Sampling)* (CDFG 1996a). Specific procedures are documented in Appendix F. The method can be briefly summarized as follows:

1. Reaches for benthic invertebrate sampling are selected after an initial reconnaissance of the section or stream. The overall goal is to select homogenous wadable reaches that best typify a riffle or run condition. Avoid walking in the stream when conducting a reconnaissance survey. Each riffle used for biological assessment must be approached from downstream and no portion of the riffle disturbed until all sampling is complete. Habitat assessment should be conducted after macroinvertebrates have been collected.
2. Fill out a field log sheet for each riffle section. Enter watershed name, station name, sample identification number, date, time and names of crew members.
3. To select a transect, place the measuring tape along the bank of the entire riffle section. Each meter (3 ft) mark represents a possible transect location. Select the transects from all possible meter marks along the measuring tape using the provided table of random numbers. If only one transect is to be sampled, then

select one meter mark in the top one-third of the riffle. Record the meter mark in the field log for each transect.

4. Once transects have been selected, benthic macroinvertebrates are collected from several locations along the transect and combine them into one sample. If possible, choose three locations; the two side margins and the center of the stream. If the riffle is not ideal, then make adjustments to accommodate prevailing conditions. When making adjustments, such as increasing or reducing the number of locations for collecting organisms or sampling substrate that is not gravel/cobble, try to sample similar conditions at each reach. Record the number of locations per transect in the field log.
5. Starting from the transect furthest downstream, collect macroinvertebrates with a sampling device appropriate for stream conditions. Appropriate devices for wadable reaches include the D-shaped kick-net, Needham-type kick-screen, Surber bottom samplers, and the Hess bottom sampler. Appropriate devices for non-wadable reaches include Eckman and Ponar dredges, and drift nets. Combine the three collections. Measure and record stream temperature.
6. For wadable reaches, place the combined contents from the transect in a standard size 30 or 35 (0.6 or 0.5 mm, respectively) testing sieve. Large organic material is removed by hand while carefully inspecting for clinging organisms. All remaining material is placed with forceps in a 95% ethanol filled jar. If there is considerable debris in the net, inspect the sample in a white enameled pan and rinse material from the pan through the sieve before placing it in the jar.
7. Using a pencil, record the following information for each sample on a piece of water-proof paper and place in the jar:
   - sample identification number followed by -01, -02 (to identify each transect)
   - collection date and time
   - sampler type
   - sample area
   - habitat type
   - collectors name
   - comments

If the sample collection requirements above are not met, the sample will be re-collected, if it is possible to do so without compromising sample quality.

The procedures for collecting biological samples of benthic invertebrates from non-wadable streams generally follow *Methods For Collecting Benthic Invertebrate Samples As Part Of The National Water Quality Assessment Program* (USGS 1993a). Specific procedures and any modifications are documented in Appendix F.

Table B-2. Sampling Requirements

Parameter	Sample Container	Sample Volume[1]	Immediate Processing and Storage	Holding Time[2]
Mercury				
Total Mercury[3]	Teflon™, or glass w/ PTFE-lined cap	250 mL	Store at 4˚C; Field-filtered[3]; Preserve with HCl within 48 hours	28 days
Methylmercury[3]		250 mL		6 months
Pesticides				
Organophosphates	Amber Glass	2 Liters	Store at 4˚C; Extract within 7 days	40 days
Carbamates	Amber Glass	1 Liter	Store at 4˚C; Extract within 7 days	40 days
Triazines	Amber Glass	1 Liter	Store at 4˚C; Extract within 7 days	40 days
General Constituents				
Total Suspended Solids	Polyethylene	500 mL	Store at 4˚C	7 days
Hardness	Polyethylene	125 mL	Store at 4˚C; Preserve to ≤pH 2 with HNO_3	6 months
Total Dissolved Solids	Polyethylene	500 mL	Filtered; Store at 4˚C	7 days
Alkalinity	Polyethylene	500 mL	Store at 4˚C	14 days
Total Organic Carbon	Amber Glass, PTFE-lined cap	125 mL	Preserve w/ H_2SO_4; Store at 4˚C;	7 days
Dissolved Organic Carbon	Amber Glass, PTFE-lined cap	125 mL	Field-filtered[4]; Preserve w/ H_2SO_4; Store at 4˚C;	7 days
UVA_{254}	Amber Glass, PTFE-lined cap	125 mL	Store at 4˚C;	48 hours
Nitrogen and Phosphorus Compounds				
Ammonia, TKN, and Total Phosphorus	Polyethylene	1 Liter	Preserve to ≤pH 2 with H_2SO_4; Store at 4˚C;	28 days
Dissolved Orthophosphate	Polyethylene	250 mL	Field-filtered; Store at 4˚C;	48 hours
Nitrate, Nitrite	Polyethylene	500 mL	Store at 4˚C	48 hours
Pathogens				
Total & fecal coliforms, *E. coli*, *Enterococcus*	Polyethylene	250 mL	Store at 4˚C	24 hours[5]
Biota				
Benthic Invertebrates	Polyethylene	NA	95% EtOH	NA[6]
Tissue				
Fish Tissue	Teflon	200 g	Freeze until processing	6 months
Toxicity				
Aquatic bioassays and chemistry[8]	Amber Glass	16 L	Store at 4˚C	36 hours[7]
Trace metals[8]	Polyethylene	500 mL	Filter as necessary; Preserve to ≤pH 2 with HNO_3	40 days

1. Additional volumes may be required for QC analyses; NA = Not Applicable
2. Holding time after initial preservation or extraction.
3. Applies only to filtered samples. Both filtered and unfiltered mercury and methylmercury are collected.
4. Field-filtration and preservation is preferred, but DOC samples may be filtered and preserved in the laboratory within 48 hours, if field filtration is not practical.
5. Samples for bacteria analyses should be set up as soon as possible.
6. There is no maximum holding time for preserved benthic invertebrate identifications.
7. Results for tests initiated after 36 hours will be qualified, as appropriate.
8. For interpretation of toxicity results, samples may be split from aquatic toxicity samples in the laboratory and analyzed for specific chemical parameters. All other sampling requirements (sample containers, filtration, preservation, holding times) for these samples are as specified in this document for the specific analytical method. Results of these analyses are qualified for any other use (e.g. characterization of ambient conditions) because of potential holding time exceedances and variance from sampling requirements.

3. Sample Handling and Custody

All samples will be packed in wet ice or frozen ice packs during shipment, so that they will be kept at approximately 4˚C. Samples will be shipped in insulated containers. All caps and lids will be checked for tightness prior to shipping.

All samples will be handled, prepared, transported and stored in a manner so as to minimize bulk loss, analyte loss, contamination or biological degradation. Sample containers will be clearly labeled with an indelible marker. Where appropriate, samples may be frozen to prevent biological degradation. Water samples will be kept in Teflon™, glass, or polyethylene bottles and kept cool at a temperature of 4˚C until analyzed. Maximum holding times for specific analyses are listed in Table B-2.

All samples remaining after successful completion of analyses will be disposed of properly. It is the responsibility of the personnel of each analytical laboratory to ensure that all applicable regulations are followed in the disposal of samples or related chemicals.

Chain-of-custody procedures require that possession of samples be traceable from the time the samples are collected until completion and submittal of analytical results. A complete chain-of-custody form is to accompany the transfer of samples to the analyzing laboratory.

A sample is considered under custody if:

- it is in actual possession;
- it is in view after in physical possession;
- it is placed in a secure area (accessible by or under the scrutiny of authorized personnel only after in possession)

With the exception of aquatic toxicity samples, samples will be kept for a minimum of 28 days after collection. The QA officer for each laboratory will evaluate the data before the end of the 28 day period. After this period, samples may be disposed of properly when all analyses have been completed, and data quality objectives have been met. Aquatic toxicity samples may be disposed of after initial testing is complete, if no further analyses are warranted.

Sample Holding Times

Data quality objectives for sample holding times conform to recommendations documented in the analytical methods for individual parameters. All samples will be analyzed by the contract laboratory before the maximum allowable holding time for any sample is exceeded. Holding times for specific parameters are presented in Table B-2.

Field Log

Field crews shall be required to keep a field log for each sampling event. The following items should be recorded in the field log for each sampling event:

- time of sample collection;
- sample ID numbers, including etched bottle ID numbers for Teflon™ mercury sample containers and unique IDs for any replicate or blank samples;

- the results of any field measurements (temperature, D.O., pH, conductivity, turbidity) and the time that measurements were made;
- qualitative descriptions of relevant water conditions (e.g. color, flow level, clarity) or weather (e.g. wind, rain) at the time of sample collection;
- a description of any unusual occurrences associated with the sampling event, particularly those that may affect sample or data quality.

Appropriate pages from the sampling log will be photo-copied and transmitted to the Quality Assurance Manager at the conclusion of each sampling run.

The field crews shall have custody of samples during field sampling. Chain of custody forms will accompany all samples during shipment to contract laboratories. All water quality samples will be transported to the analytical laboratory by the field crew or by overnight courier.

Laboratory Custody Log

Laboratories shall maintain custody logs sufficient to track each sample submitted and to analyze or preserve each sample within specified holding times.

4. Analytical Methods Requirements

4.1 Basic Water Chemistry Analyses

Water quality samples may be analyzed for filtered and unfiltered fractions of mercury and methylmercury, trace elements, pesticides, and conventional water quality constituents. Analytical methods are summarized in Tables B-3 through B-5.

<u>Mercury and Trace Metals</u>

Prior to analysis of any environmental samples for mercury, methylmercury, or other trace metals, the laboratory must have demonstrated the ability to meet the minimum performance requirements for each analytical method. Initial demonstration of laboratory capability includes the following:

- the ability to produce a detection limit equal to or less than the method detection limit (MDL) listed in Table B-3;
- the ability to generate acceptable precision and recovery, as defined by s and X in Table B-3;
- the ability to generate average recoveries within 15% of the stated concentration in a Standard Reference Material (SRM).

Procedures for demonstrating analytical performance requirements, extraction procedures, and waste disposal and pollution prevention requirements are detailed in the Standard Operating Protocols or EPA Method documents for each analytical method. EPA's recommended minimum performance requirements are summarized for each trace element in Table B-3.

Pesticides

Prior to analysis of any environmental samples for pesticides, the laboratory must have demonstrated the ability to meet the minimum performance requirements for each analytical method. Initial demonstration of laboratory capability includes the following:

- the ability to produce a reporting limit equal to or less than the reporting limit (RL) listed in Table B-4;
- the ability to generate acceptable precision and recovery, as defined by the specified method;

Procedures for demonstrating analytical performance requirements, extraction procedures, and waste disposal and pollution prevention requirements are detailed in the EPA Method documents for each analytical method. EPA's recommended minimum performance requirements are summarized in the method documents.

Conventional Constituents

Analyzing laboratories must demonstrate the ability to produce reporting limits approximately equal to or below the estimated reporting limits listed in Table B-5. Precision and replicate measurements in ambient waters should be less than 20% Relative Percent Difference for all constituents. Average recovery of appropriate reference materials should be between 80 and 120% for all constituents.

Table B-3. Trace Metals: Laboratory Performance Requirements for Analysis of Water Quality Samples for Trace Metals

Analyte	Method (1)	MDL(2), µg/L	RL(3), µg/L	Accuracy(4), *X*	Precision(5), *s*	MS Rec(6)	MS/MSD RPD(7)
Arsenic	EPA 1632, 1639	.002 2.0	.005 2.0	59-134% 56-131	< 42% 31	55-146% 56-131	20% 20
Cadmium	EPA 1639	.0024	.01	64-125	23	64-145	20
Chromium	EPA 1639	0.1	0.2	74-131	26	74-131	20
Copper	EPA 1639	.024	0.1	67-154	43	63-159	20
Lead	EPA 1639	.0081	.02	56-144	44	52-144	20
Mercury	EPA 1631	.00005	.0002	70-130	21	70-130	24
Methyl-mercury	EPA 1630	.00002	.00006	69-131	31	65-135	35
Nickel	EPA 1639	.029	0.1	65-145	27	65-145	20
Selenium	EPA 1639	.83	2.0	56-131	31	56-131	20
Silver	EPA 1639	.029	0.1	55-142	19	55-142	20
Zinc	EPA 1639	.14	0.5	67-142	43	46-146	20

(1) SOP or EPA Method number
(2) Method Detection Limit: minimum concentration that can be reported with 99% confidence that the analyte is greater than zero.
(3) Target Project Reporting Limit: MDL multiplied by 3.18 and rounded to the nearest multiple of 1, 2, 5, 10, 20, 50, etc.,
(4) X = Average recovery for demonstration of initial performance
(5) s = standard deviation of recovery for demonstration of initial performance
(6) Percent recovery of matrix spike
(7) Relative percent difference of matrix spike duplicates

Table B-4 Pesticides: Analytical Methods and Estimated Reporting Limits

Analyte	RL[1]	Analyte	RL[1]
Organophosphate and urea pesticides by EPA Method 8141a			
Azinphosmethyl	1.0	Fenthion	0.10
Bolstar	0.10	Malathion	0.10
Chlorpyrifos	0.05	Merphos	0.10
Coumaphos	0.20	Mevinphos	0.70
Def	0.10	Naled	0.50
Demeton-S	0.20	Parathion, ethyl	0.10
Diazinon	0.05	Parathion, methyl	0.10
Dichlorovos	0.20	Phorate	0.10
Dimethoate	0.10	Prowl	0.10
Disulfoton	0.10	Ronnel	0.10
EPN	0.10	Stirophos	0.10
EPTC	0.10	Tokuthion	0.10
Ethion	0.10	Trichloronate	0.10
Ethoprop	0.10	Trifluralin	0.10
Fensulfotion	0.50		
Carbamate pesticides by EPA Method 8321			
Aldicarb	0.8	Linuron	0.8
Aminocarb	0.8	Methiocarb	0.8
Barban	7.0	Methomyl	7.0
Benomyl (Carbendazim)	0.8	Mexacarbate	0.8
Bromacil	0.8	Monuron	0.8
Carbaryl	0.14	Neburon	0.8
Carbofuran	0.14	Oxamyl	7.0
Chloropropham	7.0	Propachlor	7.0
Chloroxuron	0.8	Propoxur	0.8
Diuron	0.8	Siduron	0.8
Fenuron	0.8	Tebuthiuron	0.8
Fluometuron	0.8		
Triazine pesticides by EPA Method 619			
Ametryn	0.5	Propazine	0.5
Atraton	0.5	Simetryn	0.5
Atrazine	0.5	Simazine	0.5
Cyanazine	0.5	Terbuthylazine	0.5
Prometon	0.5	Terbutryn	0.5
Prometryn	0.5		

(1) Reporting Limit for project, based on detection limits achievable by analyzing laboratory. Because detection limits are affected by differences in sample matrices, the RLs listed are estimates.

Table B-5 General Constituents:.
Analytical Methods and Project Reporting Limits

Constituent	Fractions	Method # (1)	RL, mg/L (2)
Alkalinity	Total	SM 403	*10*
Chloride	Dissolved	EPA 300	1.0
Iron	Dissolved	EPA 6010A	0.01
Manganese	Dissolved	EPA 6010A	0.01
Calcium	Dissolved	EPA 6010A	0.2
Magnesium	Dissolved	EPA 6010A	0.1
Silica	Dissolved	EPA 200.7	0.1
Sodium	Dissolved	EPA 6010A	1.0
Sulfate	Dissolved	EPA 300	1.0
Potassium	Dissolved	EPA 6010A	0.1
Suspended Solids, Total	Total	EPA 160.2	5.0
Hardness	Total, as CaCO3	EPA 130.2	5.0
Turbidity	Total	EPA 180.1	1.0 NTU
Dissolved Solids, Total	Total	EPA 160.1	5.0
Nitrate	Dissolved	EPA 300	.05
Nitrite	Dissolved	EPA 300	.02
Ammonia N	Dissolved	EPA 350.3	0.2
Total Kjeldahl N	Total	EPA 351.3	0.5
Orthophosphate	Dissolved	EPA 300	0.01
Phosphorus	Total	EPA 365.3	0.02
Organic Carbon	Total, Dissolved	SM 5310 C	0.2
UVA_{254}	Filtered	5910B	NA(3)

(1) Standard Methods (SM), EPA Method number, or reference.
(2) Reporting Limit for project, based on detection limits achievable by analyzing laboratory
(3) Detection limit for UVA_{254} not be rigorously determined because it is a “non-specific” method (APHA *et al*. 1995)

4.2 Pathogen Analyses

Water quality samples will be analyzed for for fecal and total coliform bacteria, *E. coli*, and *Enterococcus.* Analysis for coliform bacteria must be performed in accordance with the methods referenced in Table B-6. The laboratory must demonstrate the ability to meet the performance requirements described in this method.

Table B-6 Pathogens:
Analytical Methods, and Estimated Project Reporting Limits

Constituent	Method (1)	RL (2)
Total Coliform	SM 9221B	2 MPN 100 mL
Fecal Coliform	SM 9221E	2 MPN 100 mL
E. coli	SM 9221B/E mod. MUG	2 MPN 100 mL
Enterococcus	SM 9230C	1 colony/100 mL

(1) Standard Methods (SM) number or method reference.
(2) Reporting Limit for project.

4.3 Aquatic Toxicity Analyses

Water quality samples will be analyzed for toxicity to *Ceriodaphnia dubia*. Determination of chronic toxicity shall be performed generally as described in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (USEPA 1994a). The only modification to these procedures is that test containers are grouped by treatment instead of being randomly arranged. This modification is not expected to have any impact on the toxicity test results.

If initial testing indicates the presence of significant and consistent toxicity, Toxicity Identification Evaluation (TIE) procedures may be initiated. Because factors responsible for chronic toxicity may not be stable for extended periods, TIE procedures may be initiated prior to completion of initial chronic toxicity testing if early responses of test organisms suggest that toxic conditions are probable, and if there is a history of toxicity at the site. The decision to initiate TIE procedures will be a consensus decision made by the Toxicity Testing Focus Group (comprised of members of the Toxics and Monitoring Sub-Committees of the Sacramento River Watershed Program). When deciding whether to initiate TIE procedures for a specific site and sample event, the Focus Group will consider a number of different factors including the history of toxicity at the site, the level of toxicity, and the species and endpoints exhibiting toxic effects. The rationale for initiating TIE procedures for a specific sample will be clearly documented in subsequent data reports. TIE methods will generally adhere to EPA procedures documented in conducting TIEs (USEPA 1991, 1992, 1993a-b). For samples exhibiting toxic effects consistent with carbofuran, diazinon, or chlorpyrifos, TIE procedures will follow those documented in Bailey *et al*. (1996). Laboratory Standard Operating Procedures for conducting TIEs are documented in Appendix D. Any project-specific modifications to these methods will be documented in future amendments to this QAPP.

4.4 Fish Tissue

Fish tissue samples will be analyzed for total mercury, PCBs, and chlorinated pesticides. Laboratories will use the protocols referenced in Table B-7 for analysis of mercury, chlorinated pesticides, and PCBs in fish tissue. These protocols are documented in Appendix G. Prior to analysis of any tissue samples, the laboratory must demonstrate the following:

- the ability to produce a detection limit equal to or less than the method detection limit (MDL) listed in Table B-7;
- the ability to generate acceptable precision and recovery, as defined in Table B-11;
- the ability to generate acceptable recoveries of a Standard Reference Material (SRM) within the limits cited in Table B-11.

Table B-7 Fish Tissue: Analytical Methods, Method Detection Limits, and Estimated Project Reporting Limits

Constituent and Method (1)	MDL (2) ng/g w.w.	RL (3) ng/g w.w.	Constituent and Method (1)	MDL (2) ng/g w.w.	RL (3) ng/g w.w.
Mercury by CVAA (SFBRWQCB 1995; Appendix G)	10	20	PCBs by ECD/GC (Appendix G)	0.2	0.5
Chlorinated pesticides by ECD/GC (Appendix G))					
Aldrin	0.26	1.0	Endosulfan sulfate	1.6	5.0
Chlordane, cis	0.68	2.0	Endrin	0.71	2.0
Chlordane, trans	0.40	2.0	Ethion	1.9	6.0
Chlordene, alpha	0.26	1.0	HCH, alpha	0.36	1.0
Chlordene, gamma	0.25	1.0	HCH, beta	0.56	2.0
Chlorpyrifos	0.81	2.0	HCH, gamma	0.27	1.0
Dacthal	0.58	2.0	HCH, delta	0.33	2.0
DDD, o,p'	0.71	2.0	Heptachlor	0.51	2.0
DDD, p,p'	0.84	2.0	Heptachlor epoxide	0.37	1.0
DDE, o,p'	0.53	2.0	Hexachlorobenzene	0.10	0.3
DDE, p,p'	0.56	2.0	Methoxychlor	1.3	5.0
DDMU, p,p'	1.1	3.0	Mirex	0.93	3.0
DDT, o,p'	1.0	3.0	Nonachlor, cis	0.96	2.4
DDT, p,p'	2.0	5.0	Nonachlor, trans	0.35	1.0
Diazinon	6.4	20	Oxadiazon	0.88	3.0
Dichlorobenzo-phenone, p,p'	5.0	20	Oxychlordane	0.29	1.0
Dicofol (Kelthane)	5.0	10	Parathion, ethyl	0.64	2.0
Dieldrin	0.40	2.0	Parathion, methyl	1.2	4.0
Endosulfan I	0.74	2.0	Tetradifon (Tedion)	0.54	2.0
Endosulfan II	0.70	2.0	Toxaphene	20	50

(1) CVAA = Cold Vapor Atomic Absorption
ECD/GC = Electron Capture Detection/Gas Chromatography
(2) Method Detection Limit: minimum concentration that can be reported with 99% confidence that the analyte is greater than zero; units are ng/g wet weight
(3) Target Project Reporting Limit: MDL multiplied by 3.18 and rounded to the nearest multiple of 1, 2, 5, 10, 20, 50, etc.; units are ng/g wet weight.

4.5 Biota

Analysis of benthic invertebrates for community abundance and diversity parameters will adhere to the protocols described in *California Stream Bioassessment Procedures (Macroinvertebrate Laboratory and Data Analyses)* (CDFG 1996) in Appendix G. This document describes sorting and identification procedures used to identify and quantify benthic invertebrate samples, and various community metrics calculated for each sample.