WATER QUALITY IN THE CALLEGUAS CREEK AND SANTA CLARA RIVER WATERSHEDS

UNDER THE
SURFACE WATER AMBIENT MONITORING PROGRAM
FISCAL YEAR 2000-2001

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EXECUTIVE SUMMARY

California's Surface Water Ambient Monitoring Program (SWAMP) is a comprehensive monitoring program designed to assess the quality of the beneficial uses of the State's water resources. SWAMP activities include surveying each hydrologic unit in the State at least once every five years; using consistent sampling methods, analytical procedures, data quality objectives, and centralized reporting requirements; analyzing spatial and temporal trends in water quality statewide; and evaluating waterbodies based on water quality standards and available data. Two types of monitoring are conducted under SWAMP: ambient monitoring, in which waters are surveyed without bias to known impairment, and site-specific monitoring, in which problem sites or clean sites (reference sites) are characterized.

The Los Angeles Regional Water Quality Control Board (LARWQCB) has developed an ambient monitoring program that obtains site-specific information while still encompassing regional ambient monitoring goals. Ultimately, this data will allow the LARWQCB to answer the following questions:

- What is the percentage of streams in a watershed or the region that support their beneficial uses (e.g., water contact recreation, cold freshwater habitat, etc.?)
- Is the percent of streams in a watershed or the region that support their beneficial uses increasing or decreasing over time?

Under the first year of SWAMP funding, the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds were sampled. The CAL watershed is approximately 343 miles^2 and includes urban development, residential areas, open space, golf courses and agriculture. Mugu Lagoon, at the mouth of the watershed, is one of the larger estuarine and wetland habitats remaining in southern California. This watershed has been studied extensively and known impairments include boron, chloride, nitrogen, sulfate, total dissolved solids (TDS), algae, fecal coliform, metals, organic pesticides, and toxicity in water, and organic pesticides and metals in tissues and sediments.

A directed approach to sampling was taken. Sampling for chronic toxicity and potential causes was a high priority, as was determining the extent of nutrient and chloride impairment and associated problems. A sub-objective of the monitoring design was to obtain and fill in data where it was missing or non-existent. A total of 13 sites were each sampled once in the CAL watershed in 2001. Twelve sites were sampled for field measurements (dissolved oxygen [DO], pH, depth, temperature, velocity, conductivity, and turbidity), conventional water chemistry (nutrients [ammonia, chloride, nitrate, nitrite, phosphate, and sulfate], TDS, boron, chlorophyll a [chl a]), metals chemistry, organophosphate chemistry, toxicity (including enzyme-linked immunosorbent assays [ELISA] for chlorpyrifos and diazinon), and bioassessment. Additionally, one station at the base of the watershed was sampled for the above mentioned parameters as well as trace organics and bioaccumulation of contaminants in clam (*Corbicula fluminea*) tissue.

The STC watershed is approximately 1200 miles^2 and is the largest river system in southern California that remains in a relatively natural state. The river system includes

extensive high quality riparian habitat, supports endangered fish, such as steelhead and unarmored stickleback, and serves as a wildlife corridor. Limited data are available but known impairments include chloride, nitrogen, TDS, coliform, organics, and pH in water.

Sites were randomly selected to provide a broad baseline of the overall health of the watershed because there is a lack of consistent, complete data. However, to evaluate the condition of specific tributaries, directed sampling was conducted at the base of each tributary above its confluence with the main stem of the river. A total of 38 sites were sampled, comprised of 30 randomly selected sites and 8 directed sites. Sampling began in 2001 and continued through 2003. Some sites were sampled multiple times. The 30 random sites were sampled for field measurements (DO, pH, depth, temperature, velocity, conductivity, and turbidity), conventional water chemistry (nutrients [ammonia, chloride, nitrate, nitrite, phosphate, and sulfate], TDS, boron, chlorophyll a), toxicity, and bioassessment. The directed sites were sampled for the previous parameters as well as trace organics, bioaccumulation, water column and sediment metals, sediment grain size, and ELISAs for chlorpyrifos and diazinon. One of the directed sites, Bouquet Canyon Creek, was sampled bi-weekly from August 2002 through August 2003 for chlorpyrifos and diazinon using ELISA.

Calleguas Creek Watershed

Data collected in the CAL watershed indicate a number of conventional water quality concerns. Ten of 13 sites had DO concentrations <90% saturation. pH was low at three sites. Inorganic N concentrations exceeded Basin Plan objectives at 7 sites: total NH_3-N at one and NO_3-N at 6 sites located in the western portion of the CAL watershed. PO_4-P concentrations exceeded USEPA recommended limits at 11 sites and Ecoregion III reference conditions for total P at all sites. Chloride concentrations exceeded either Basin Plan objectives or the USEPA 4-d average criterion for toxicity to aquatic life at 6 sites distributed throughout the watershed. Boron exceeded Basin Plan objectives at two sites, sulfate at 4 sites, and TDS at 6 sites. The majority of these sites were located in the eastern half of the watershed.

Water column aluminum concentrations at 11 of 13 sites exceeded either the Basin Plan objective or the USEPA 4-d average criterion for toxicity to aquatic life. Metals in *Corbicula fluminea* tissue from 403CAL004 were relatively low within the context of this study; only arsenic exceeded USFWS guidelines. CAL watershed sediments were not analyzed for metals and *C. fluminea* were deployed at only one station. Thus it is not possible to assess long term accumulation of metals in sediments or aquatic organisms.

At 12 of 13 sites in the CAL watershed, organic compounds were present at levels exceeding criteria established to protect human and aquatic life. Chlorpyrifos exceeded the California Department of Fish and Game (DFG) 1-h and 4-d average criteria for toxicity to aquatic life at 9 sites; diazinon exceeded both criteria at 9 sites and the 4-d average at one site. Chlordane, DDT, PCBs and HCH beta exceeded established criteria at 403CAL004, and toxaphene accumulated in *Corbicula fluminea* tissues at this site to a level exceeding the OEHHA screening value. Azinphos methyl and parathion methyl were also present at levels exceeding established criteria. Many other organic

compounds were detected in the CAL watershed but were either present at levels below established criteria or we were unable to find criteria with which to compare measurements.

Toxicity was widespread throughout the CAL watershed. Eight of 13 sites had either chronic or acute toxicity. Although the TIE was inconclusive, water column chemistry suggests that aluminum, chlorpyrifos, and diazinon, which were elevated above established criteria at many sites, may have been responsible. Concurrence between multiple toxicity tests at a site was rare, indicating that different factors may be causing toxicity at different sites.

Of the 11 sites sampled for bioassessment, IBI scores were Very Poor and Poor, indicating degraded ecological condition. Potential causes of poor benthic community structure are toxicity, organics pollution, and metals pollution. DO concentrations at < 90 % saturation may also contribute to poor IBI scores. Additional studies of metals and organic compounds in sediments and bioaccumulation in tissue may provide further insight on the causes of poor benthic community structure.

Santa Clara River Watershed

Similar indicators of potential conventional water quality concerns were seen in the STC watershed as in the CAL watershed. DO saturation was <90% at 15 of 38 sites, which were distributed throughout the watershed. pH was high at four sites. Inorganic N concentrations exceeded Basin Plan objectives at 7 sites: total and un-ionized NH_3-N at 3 sites, total NH_3-N at one site, un-ionized NH_3-N at one site, and NO_3-N at two sites. Four of the 5 sites where NH_3-N exceeded Basin Plan thresholds were clustered along the mainstem of the river; NO_3-N concentrations exceeded1 mg l^{-1} in the same area. PO_4-P concentrations exceeded USEPA recommended limits at 13 sites. TDS concentrations exceeded Basin Plan objectives at 12 sites, many of which were in the Santa Paula and Piru sub-watersheds. Sulfate exceeded Basin Plan objectives at 10 of the 12 sites where TDS was elevated. Chloride was elevated at 7 sites in the eastern half of the watershed and boron was elevated at three sites on Piru Creek.

Metals in sediment, tissue and water were only measured at the integrator sites. However the presence of metals in these matrices at the integrator sites at levels exceeding established criteria suggests that metals pollution may occur throughout the STC watershed. Water column aluminum concentrations exceeded USEPA criteria for toxicity to aquatic life at 4 sites but aluminum was not present at elevated levels in sediments or tissues. Tissue samples showed bioaccumulation of arsenic at levels exceeding OHEEA screening values and USFWS guidelines at 7 sites, and copper was also elevated at one of these sites (403STCBQT). Sediment metals were elevated above SQGs at three sites: cadmium at 403STCPRU, copper and lead at –CTC, and a suite of metals at –SFO. Compared to other samples and SQGs, sediment metals were very high at 403STCSFO, which is downstream of a reservoir that was treated with metals to control biofouling. Sediment, tissue and water samples each indicated different metals that may be of concern.

Organic compounds were also only measured at integrator sites. Similar to metals, the presence of organic compounds in water samples from integrator sites at levels exceeding established criteria suggests that organics pollution also occurs throughout the watershed. DDT and PCBs exceeded established criteria at all the integrator sites. Chlordane was elevated at three sites. Chlorpyrifos and diazinon were elevated at 403STCBQT along with azinphos methyl, and they were elevated at –CTC along with mirex. Chlorpyrifos was elevated at –EST, and diazinon and PAHs were elevated at –NRB. Sediments were analyzed for organics at only two sites: none were found at 403STCBQT, but DDE (p,p') and DDT (p,p') were elevated relative to SQGs at –EST. No organics in tissues were elevated above OEHHA screening values.

Toxicity occurred at 13 sites in the STC watershed and was primarily limited to two areas: the mainstem of the river and the northern portion of the Piru Creek sub-watershed. The cause of toxicity at many of these sites is unknown because metals and organics were not sampled. Toxicity was detected in samples from only two integrator sites: 403STCBQT and –EST. A number of factors could have contributed to toxicity at –BQT but the TIE indicated that diazinon was the probable cause of toxicity. At –EST, toxicity may have been caused by DDT, PCBs, chlorpyrifos, or arsenic.

The bioassessment data indicate that ecological condition was at least fair at about half of the sites, with the condition at the other half being poor or very poor. IBI scores were Good at 6 sites, Fair at 13 sites, Poor at 11 sites and Very Poor at 7 sites. One site was not sampled. At 41% of sites where IBI scores were low, chronic or acute toxicity was detected, however, toxicity was also detected at 37% of sites with Fair and Good IBI scores. Toxicity is not a likely cause of poor benthic community condition at the integrator sites, many of which had Very Poor or Poor IBI scores, because samples from only two of these 8 sites indicated toxicity. Other influences on benthic community structure throughout much of the watershed are unknown because metals and organics were not sampled. It is also unlikely that decreased DO availability contributed to poor benthic community structure because 6 of the randomly selected sites with DO < 90 % saturation had fair or good IBI scores. Pollution by metals and organics may have contributed to the poor quality of the benthic communities at the integrator sites. However, the ability to draw conclusions about the effects of metals or organics on benthic community structure is limited because these constituents were not measured at many of the sites with Fair or Good IBI scores.

Goals for monitoring in both watersheds were met. In the CAL watershed, the extent of toxicity was documented and possible causes identified. The extent of inorganic constituent impairments, such as nutrients and chloride, was determined. Problems associated with nutrients could be investigated in future studies with additional measurements of benthic primary production. In the STC watershed, the probabilistic sampling design allowed inferences to be made about much of the watershed that was previously uninvestigated. A broad picture of inorganic constituents, toxicity, and bioassessment is now available for the watershed. Future concurrent sampling of metals

and organics throughout the watershed would help to identify causes of toxicity and poor benthic community structure.

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%R	Percent Recovery
AB	Assembly Bill
ABL	Aquatic Bioassessment Laboratory
AMS	Applied Marine Sciences, Inc.
ASBS	Area of Special Biological Significance
BQT	Bouquet Canyon Creek
BWC	Beardsley Wash Canyon
CAL	Calleguas Creek
CDF	Cumulative Frequency Distribution Function
CFCP	Coastal Fish Contaminants Project
Chl a	Chlorophyll a
CI	Confidence Interval
CRM	Certified Reference Material
CTC	Castaic Creek
CTR	California Toxics Rule
CWA	Clean Water Act
DFG	Department of Fish and Game
DFG-WPCL	California Department of Fish and Game-Fish & Wildlife Water Pollution Control Laboratory
DHS	Department of Health Services
DO	Dissolved Oxygen
ELISA	Enzyme-linked immunosorbent assay
EMAP	Environmental Monitoring and Assessment Program
EST	Santa Clara River Estuary Site
FDQ	Field Blind Duplicate
FIA	Flow Injection Analysis
IBI	Index of Biotic Integrity
LCM	Laboratory Control Material
LCS	Laboratory Control Spike
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MPSL-DFG	California Department of Fish and Game-Marine Pollution Studies Laboratory
MS	Matrix Spike
MSD	Matrix Spike Duplicate
N	Nitrogen
NPDES	National Pollutant Discharge Elimination System
NRB	Newhall Ranch Blue Cut
NTR	National Toxics Rule
OCP	Organochlorine Pesticide
OEHHA	Office of Environmental Health Hazard Assessment US EPA
OPP	Organophosphate Pesticide
P	Phosphorus
PAH	Polynuclear Aromatic Hydrocarbon

PCB	Polychlorinated Biphenyl
PEC	Probable Effects Concentrations
POTW	Publicly Owned Treatment Works
PRU	Piru Creek
QA/QC	Quality Assurance/ Quality Control
QAMP	Quality Assurance Management Plan
RL	Reporting Limit
RPD	Relative Percent Difference
RWQCB	Regional Water Quality Control Board
LARWQCB	Los Angeles Regional Water Quality Control Board
SFL	Sierra Foothills Laboratory, Inc.
SFO	San Francisquito Creek
SMWP	State Mussel Watch Program
SOP	Standard Operating Procedure
SQG	Sediment Quality Guidelines
SSP	Sespe Creek
STC	Santa Clara River
STP	Santa Paula Creek
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
TEC	Threshold Effects Concentrations
TIE	Toxicity Identification Evaluation
TMDL	Total Maximum Daily Load
TSMP	Toxic Substances Monitoring Program
TTP	Toxicity Testing Program
UCD-GC	University of California, Davis-Granite Canyon Marine Laboratory
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WMI	Watershed Management Initiative
WPCL	Water Pollution Control Laboratory

<u>Units</u>

l	liter
ml	milliliter
µl	microliter
g	gram
mg	milligram
µg	microgram
ng	nanogram
kg	kilogram
ppt	part per thousand
ppm	part per million
ppb	part per billion

Equivalents

1 ppt	1 mg g^{-1}
1 ppm	1 mg kg^{-1}, 1 μg g^{-1}, 1 mg l^{-1}
1 ppb	1 μg kg^{-1}, 1 ng g^{-1}, 1 μg l^{-1}

1 INTRODUCTION

1.1 Overview of the Surface Water Ambient Monitoring Program (SWAMP) in California

The quality of surface waters in the state of California is provided for by the Porter-Cologne Water Quality Control Act and the federal Clean Water Act (CWA). These acts require implementation of efforts intended to protect and restore the integrity of surface waters. However, current monitoring and assessment capability at the State Water Resources Control Board (SWRCB) is limited and tends to be focused on specific program needs. This has led to a fragmentation of monitoring efforts resulting in gaps in needed information and a lack of integrated analyses. A solution to this problem was presented in California Assembly Bill (AB) 982 (Water Code Section 13192; Statutes of 1999), which required the SWRCB to prepare a proposal for a comprehensive surface water quality monitoring program. This ambient monitoring would be independent of individual water quality programs and would provide a measure of (1) the overall quality of water resources and (2) the overall effectiveness of Regional Water Quality Control Boards' (RWQCB) prevention, regulatory, and remedial actions. When fully implemented, AB 982 will help to alleviate the fragmented water quality issues within the State.

The SWRCB Report to the Legislature from November 2000 entitled "Proposal for a Comprehensive Ambient Surface Water Quality Monitoring Program" (November 2000 Legislative Report) proposed to restructure existing water quality monitoring programs into a new program, the Surface Water Ambient Monitoring Program (SWAMP). The proposal focused on a number of programmatic objectives designed to assess the quality of the beneficial uses of the State's water resources. Some of these objectives are satisfied with the information produced by existing monitoring efforts within the SWRCB and other agencies. Each of the SWRCB and RWQCB's existing monitoring programs, e.g., the State Mussel Watch Program (SMWP), the Toxic Substances Monitoring Program (TSMP), the Toxicity Testing Program (TTP), Coastal Fish Contaminants Project (CFCP), and fish/shellfish contamination studies, have been incorporated to the extent and manner possible into SWAMP to ensure a coordinated approach without duplication. SWAMP also coordinates with other programs implemented in the State to assure that the ambient monitoring efforts are not duplicated.

When fully implemented, SWAMP will cover four activities:

- Comprehensive environmental monitoring focused on providing information necessary to effectively manage the State's water resources. Each hydrologic unit will be surveyed at least once every five years and all waters will be included without bias to known impairment;
- Consistency in sampling methods, analytical procedures, data quality objectives, and centralized reporting requirements;
- Analysis of spatial and temporal trends in water quality statewide; and
- Development of a Water Quality Control Policy and consistent implementation of the CWA section 303 (d) procedures for listing and delisting of waterbodies based

on water quality standards and available data. SWAMP data can also be used in the bi-annual water quality reports to the United States Environmental Protection Agency (US EPA) required by section 305 (b) of the CWA.

These activities contribute to the goals or expected end-products of SWAMP:

- Creation of an ambient monitoring program that addresses all hydrologic units of the State at least one time every five years using consistent and objective monitoring, sampling and analytical methods; consistent data quality assurance protocols; and centralized data management;
- Documentation of ambient water quality conditions in potentially clean and polluted areas;
- Identification of specific water quality problems preventing the SWRCB, RWQCBs, and the public from realizing beneficial uses of water in targeted watersheds; and
- Data to evaluate the overall effectiveness of water quality regulatory programs in protecting beneficial uses of waters of the State.

However, funding is not currently available to implement SWAMP fully. As a result, SWAMP primarily focuses on the site-specific needs of each RWQCB. The RWQCBs were charged with establishing monitoring priorities for the water bodies within their jurisdictions. Efforts primarily focused on site-specific monitoring to better characterize problem sites or clean locations (reference sites) to meet each RWQCB's needs for 303(d) listing, Total Maximum Daily Load (TMDL) development, and other core regulatory programs. During this first phase, RWQCBs were able to use SWAMP resources to address high priority water quality issues in their region, while following SWAMP protocols to ensure statewide data comparability. When additional funding is available in the future, activities designed to achieve the overall goal of developing a statewide picture of the status and trends of the quality of California's surface water resources will be initiated.

1.2 Goals of SWAMP in the Los Angeles Region

In the Los Angeles region, both the Site-Specific Monitoring goals and the Regional Monitoring goals have been integrated into one ambient monitoring program that encompasses regional goals while still obtaining site-specific information. The Site-Specific Monitoring portion develops site-specific information on representative sites or water bodies that are (1) known or suspected to have water quality problems and (2) known or suspected to be clean. Uses of this information include, but are not limited to, development of 305(b) reports, 303 (d) listing or delisting, TMDL development, and National Pollutant Discharge Elimination System (NPDES) permit renewals. Ultimately, the following questions will be answered:

- What is the percentage of streams in a watershed or the region that support their beneficial uses (e.g., water contact recreation, cold freshwater habitat, etc.?)
- Is the percent of streams in a watershed or the region that support their beneficial uses increasing or decreasing over time?

1.3 Overview of the Los Angeles Region SWAMP Program

Sampling and analysis will be used to assess ambient conditions of watersheds in Los Angeles and Ventura counties and will further delineate the nature, extent, and sources of toxic pollutants which have been detected or are suspected to be problematic for this region and its individual watersheds. In general, in lieu of extant temporally and spatially diverse information on a watershed, the condition of the entire watershed is assessed by sampling randomly selected sites while the tributaries are assessed by sampling directed sites. Where extensive information is already available or where the watershed is small and therefore does not lend itself to a random sampling design, the watershed is assessed by sampling directed sites.

Where applicable, a triad approach (water chemistry, benthic community analysis, and toxicity testing) will be used. The benthic community analysis, or bioassessment, is useful in assessing water quality because of 1) the sensitivity of benthic macroinvertebrates to low-level disturbances and 2) the integration of water quality conditions over time. Thus, the composition of aquatic communities reflects a cumulative response to multiple stressors over time and is a direct measure of ecological condition. The analysis performed will follow the California Stream Bioassessment Protocol developed by the California Department of Fish and Game (DFG), which focuses on the benthic macroinvertebrate assemblage and a physical habitat assessment. The information gathered will be used in trend analysis, identifying impaired beneficial uses, and development of an index of biological integrity (IBI). In addition, bioaccumulation tests will be conducted in order to address possible human health concerns and ecological concerns such as benthic community impacts, which may result if bioavailable contaminants at a site are taken up by organisms. These bioaccumulation tests will help to demonstrate the bioavailability of contaminants at these stations and may identify impaired beneficial uses.

1.4 Selection and Description of Sampled Waterbodies

Watershed Selection

LARWQCB proposes to visit each hydrologic unit one year ahead of the Watershed Management Initiative (WMI) schedule for targeted watersheds, which rotate on a five-year cycle. This allows for data to be gathered, analyzed, and interpreted for use the following year during NPDES permit renewals, development of 305(b) reports, 303(d) listings of Water Quality-Limited segments, and TMDL development. The Santa Clara River (STC) and Calleguas Creek (CAL) watersheds (Figure 1) were on the WMI schedule for 2001-2002, thus they were sampled under the first year of SWAMP funding, fiscal year 2000-2001.

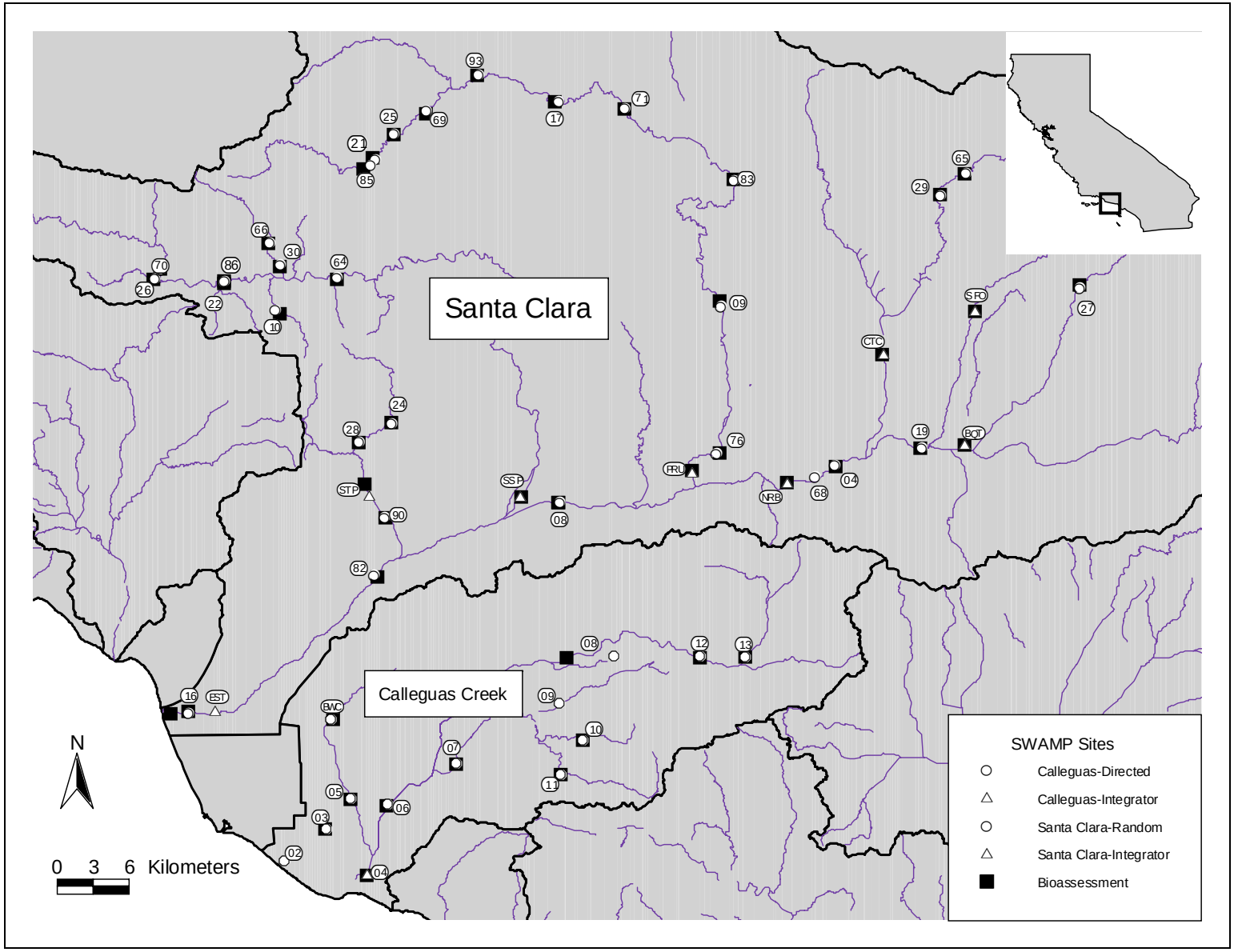

Figure 1. Map of the Calleguas Creek and Santa Clara River watersheds with locations of sampling sites.

Watershed Descriptions

Calleguas Creek Watershed

The CAL watershed is approximately 343 miles^2 and lies mostly within Ventura County with a small portion extending into western Los Angeles County. This watershed, which is elongated along an east-west axis, is about 30 miles long and 14 miles wide. The northern boundary of the watershed is formed by the Santa Susana Mountains, South Mountain, and Oak Ridge; the southern boundary is formed by the Simi Hills and Santa Monica Mountains.

Land uses vary throughout the watershed. Urban development is generally restricted to the city limits of Simi Valley, Moorpark, Thousand Oaks, and Camarillo. Although some residential development has occurred along the slopes of the watershed, most upland areas are still open space. However, it is becoming increasingly popular to locate golf courses in these open areas. Agricultural activities, primarily cultivation of orchards and row crops, are spread out along valleys and on the Oxnard Plain.

Mugu Lagoon, located at the mouth of the watershed, is one of the larger estuarine and wetland habitats remaining in southern California. The Point Mugu Naval Air Base is located in the immediate area and the surrounding Oxnard Plain supports a large variety of agricultural crops. These fields drain into ditches which either enter the lagoon through tile drains, or through CAL and its tributaries. Also proximal to the lagoon are freshwater wetlands created on a seasonal basis to support duck hunting clubs. The lagoon borders on an Area of Special Biological Significance (ASBS) and supports a great diversity of wildlife including several endangered birds and one endangered plant species. The designated beneficial uses in the watershed are wildlife habitat, marine habitat, estuarine habitat, wetlands habitat, warmwater habitat, migratory habitat, spawning habitat, preservation of rare and endangered species, preservation of biological habitats, contact and non-contact water recreation, navigation, commercial and recreational fishing, shellfish harvesting, municipal supply, industrial service supply, industrial process supply, agricultural supply, groundwater recharge, and freshwater replenishment. Supplies of ground water are critical to agricultural operations and industry (sand and gravel mining) in this watershed. Moreover, much of the population in the watershed relies upon ground water for drinking.

The CAL watershed has been studied much more comprehensively than the STC watershed. A large database containing Publicly Owned Treatment Works' (POTWs) monitoring data exists, a number of toxicity studies have been performed in this watershed (Anderson et al. 2002), and sampling for TMDLs is ongoing. CAL and the surrounding areas also have other identified impairments such as nutrients and chloride (LARWQCB 2002). Aquatic life in both Mugu Lagoon and the inland streams of this watershed has been impacted by pollutants from nonpoint sources (LARWQCB 2001):

- DDT, PCBs, other pesticides, and some metals have been detected in both sediment and biota collected from surface waterbodies of this watershed.
- Ambient toxicity has been revealed in several studies from periodic toxicity testing in the watershed. Ammonia from POTWs and pesticides such as diazinon

and chlorpyrifos are implicated.

- Fish collected from CAL and Revolon Slough exhibit skin lesions and have been found to have other histopathologic abnormalities.
- High levels of minerals and nitrates are common in surface water bodies and groundwater.
- Sediment toxicity is elevated in some parts of the lagoon. Reproduction is impaired in a resident endangered species, the light-footed clapper rail, due to elevated levels of DDT and PCBs.
- There are multiple major and minor discharges to CAL and its tributaries. Most of the discharges are nonhazardous.

Overall, this is a very impaired watershed. Portions of CAL and its tributaries are on the 2002 303(d) list for boron, chloride, nitrogen (nitrite + nitrate and ammonium), sulfate, total dissolved solids (TDS), algae, fecal coliform, metals, organic pesticides, and toxicity in water. For tissues and sediments, listings occur for organic pesticides and metals. Current efforts are underway at the LARWQCB to address these constituents through TMDL development. It appears that the sources of many of these pollutants are agricultural activities (mostly through continued disturbance and erosion of historically contaminated soils), which cover approximately 25% of the watershed along the inland valleys and coastal plain. The nearby naval facility has also been a contributor. Other nonpoint sources include residential and urban activities, which are present over approximately 25% of the watershed. The remaining 50% of the watershed is still open space although there is a severe lack of benthic and riparian habitat.

Since extensive monitoring has already occurred in the CAL watershed, particularly in the lower watershed, a directed approach to sampling was taken. Toxicity is a known impairment of the CAL watershed with severe consequences for aquatic life. It is therefore a high priority for additional monitoring and was the main focus in relation to SWAMP. Monitoring to determine the extent of nutrient and chloride impairment and associated problems was also an objective in this ambient monitoring plan. A sub-objective of the monitoring design was to obtain and fill in data where it was missing or non-existent.

Santa Clara River Watershed

The STC watershed, which lies in both Ventura and Los Angeles Counties, is approximately 1200 miles^2 and is the largest river system in southern California that remains in a relatively natural state. The river is a high-quality natural resource for much of its ~100 mile length. The river originates in the northern slope of the San Gabriel Mountains in Los Angeles County, traverses Ventura County, and flows into the Pacific Ocean halfway between the cities of San Buenaventura and Oxnard.

Extensive patches of high quality riparian habitat are present along the length of the river and its tributaries. The endangered fish, the unarmored stickleback, is resident in the river. Sespe Creek, one of the largest tributaries to the STC, is designated a wild trout stream and supports significant spawning and rearing habitat. Sespe Creek is also designated a wild and scenic river. Piru and Santa Paula Creeks, which are both

tributaries to the STC, also support good habitats for steelhead. In addition, the river serves as an important wildlife corridor. A lagoon exists at the mouth of the river and supports a large variety of wildlife. The designated beneficial uses in the watershed are wildlife habitat, marine habitat, estuarine habitat, wetlands habitat, warm and cold freshwater habitats, migratory habitat, spawning habitat, preservation of rare and endangered species, contact and non-contact water recreation, navigation, commercial and recreational fishing, municipal supply, industrial service supply, industrial process supply, agricultural supply, groundwater recharge, and freshwater replenishment.

There are several water quality problems and issues in the STC watershed (LARWQCB 2001):

- Increased loads of nitrogen and salts in supplies of ground water threaten beneficial uses such as irrigation and drinking water.
- Increased development in floodplain areas necessitates flood control measures such as channelization, which result in increased runoff volumes and velocities, erosion, and loss of habitat.
- Increased abundance of the exotic giant reed (*Arundo donax*) in many highly disturbed areas.
- Development pressure, particularly in the upper portion of the watershed threatens habitat and the water quality of the river.
- Many of the smaller communities in the watershed are unsewered. Impacts on drinking water wells from septic tanks are a major concern in portions of the upper watershed. The effects of septic system use in the Oxnard Forebay area, a prime groundwater recharge area, are also of concern.
- There are multiple major and minor discharges to the STC and its tributaries. Most of the discharges are nonhazardous.

Limited data (beyond mineral and nitrogen concentrations) are available for much of the STC. Portions of the STC are on the 2002 303(d) list for chloride, nitrogen (nitrite + nitrate and ammonium), TDS, coliforms, organics, and pH in water. These impairments may be attributable in part to agricultural practices, notably fertilizer-related salts and nitrogen as well as movement of historic pesticides. Two major spills of crude oil into the river occurred in the early 1990s; recovery has been helped somewhat by winter flooding events. Natural oil seeps discharge significant amounts of oil into Santa Paula Creek.

The primary objective of monitoring in the STC watershed was to provide a broad baseline of the overall health of the watershed. Existing data are inconsistent and incomplete for constituents and sampling locations. The monitoring done under SWAMP was designed to fill in many of the data gaps and provide data where none currently exist. Biological assessment work was a major component of the program.

1.5 Scope of Report

This is the first SWAMP report prepared for LARWQCB. This report provides a summary of data collected under the 2000-2001 LARWQCB Task Order. Data were collected from fall 2001 through June 2003. Data were analyzed for spatial patterns and compared with established water quality criteria; there is insufficient data to support temporal trend analysis. Additionally, most sites were only sampled once; the data presented are each a "snapshot in time" and reflect the quality of the water at the time of sampling only. Additional sampling would be required to determine the temporal extent or persistence of any potential problems brought to light in this report. This report does not provide an analysis of beneficial use support or determination of impairment of water bodies; however, data provided herein can be used in support of such determinations.

2 METHODS

2.1 Watershed Monitoring Strategy and Sampling Design

Calleguas Creek Watershed

The sampling program for the CAL watershed was based on a directed approach that focused on gathering more information on the chronic toxicity problem and the potential causes. Chlorpyrifos and diazinon were suspected causes of the toxicity. One goal was to either verify suspected causes or identify new causes of the toxicity utilizing toxicity identification evaluations (TIEs). Once the cause is identified, the sources of the toxicant can be defined and plans developed to control the toxic events.

A total of 13 sites were each sampled once in the CAL watershed in 2001. Twelve sites (Figure 1, Table 1) were sampled for field measurements (dissolved oxygen [DO], pH, depth, temperature, velocity, conductivity, and turbidity), conventional water chemistry (nutrients [ammonia, chloride, nitrate, nitrite, phosphate, and sulfate], TDS, boron, chlorophyll a [chl a]), metals chemistry, organophosphate chemistry, toxicity (including enzyme-linked immunosorbent assays [ELISA] for chlorpyrifos and diazinon), and bioassessment. Additionally, one station at the base of the watershed was sampled for the above mentioned parameters as well as trace organics and bioaccumulation of contaminants in clam (*Corbicula fluminea*) tissue.

Santa Clara River Watershed

The overall sampling goals for the STC watershed were to fill in gaps in existing data and provide data where none currently exist. A total of 38 sites were sampled, comprised of 30 randomly selected sites and 8 directed sites. The sampling program used a probabilistic approach based on the USEPA Environmental Monitoring and Assessment Program (EMAP) design protocol in order to gather more information on ambient conditions in the watershed without bias to known impairments or relatively undisturbed conditions. As described by ABL (2003), USEPA in Corvallis, OR, designed a probabilistic survey of the STC watershed. Project parameters included all streams with flowing water within the STC watershed as defined by the USGS 4th field hydrologic unit 18070102. The RF3 files restricted all streams to perennial and non-perennial 3rd strahler order and higher to ensure that all streams with flowing water were potentially sampleable. A 300 percent oversampling feature was built into the design of 30 sites to be sampled per year for a total of two years or 60 base sites plus 180 oversampled sites. 180 oversampled sites were established because there is evidence that a significant proportion of 3rd order streams were likely to be dry.

A master list of 240 sites was used as a base for evaluation. The first 30 sites were evaluated in order. The second 30 sites were set aside for analysis and sampling in the next season, therefore, were not evaluated. All sites remaining were then evaluated in order until a final number of 30 sites total were ready for sampling in fall of 2001. All sites represented equal stream lengths and thus had equal weight.

Table 1. Sites with descriptive names, dates sampled, and categories of parameters measured. S=sediment, T=tissue, W=water.

				Field Measurements	Conventional water chemistry	Metals			Sediment physical characteristics	Trace organics			Toxicity		Bioassessment
Site	**Descriptive Name**	**Date(s)**		**W**	**W**	**S**	**T**	**W**	**S**	**S**	**T**	**W**	**S**	**W**	
CALLEGUAS CREEK WATERSHED															
403CAL002	Rio de Santa Clara	29/Oct/2001		X	X			X				X		X	
403CAL003	Mugu Drain	29/Oct/2001		X	X			X				X		X	X
403CAL004	Calleguas Creek Main Stem (downstream of confluence with Revolon Slough)	12/Nov/2001		X	X		X	X			X	X		X	X
403CAL005	Revolon Slough	31/Oct/2001		X	X			X				X		X	X
403CAL006	Calleguas Creek Main Stem (between Revolon Slough and Conejo Creek)	29/Oct/2001		X	X			X				X		X	X
403CAL007	Conejo Creek	29/Oct/2001		X	X			X				X		X	X
403CAL008	Arroyo Las Posas	30/Oct/2001		X	X			X				X		X	X
403CAL009	Arroyo Santa Rosa	31/Oct/2001		X	X			X				X		X	
403CAL010	North Fork Arroyo Conejo	31/Oct/2001		X	X			X				X		X	X
403CAL011	South Branch Arroyo Conejo	31/Oct/2001		X	X			X				X		X	X
403CAL012	Arroyo Simi	30/Oct/2001		X	X			X				X		X	X
403CAL013	Tapo Canyon Tributary	30/Oct/2001		X	X			X				X		X	X
403CALBWC	Beardsley Wash at Central Avenue	31/Oct/2001		X	X			X				X		X	X
SANTA CLARA RIVER WATERSHED															
403STC004	Santa Clara River near Chiquito Cyn Rd	30/Oct/2001	25/Feb/2003	X	X									X	X
403STC008	Santa Clara River - A street in Fillmore	13/Nov/2001	24/Feb/2003	X	X									X	X
403STC009	Piru Creek - Piru Canyon Rd	15/Nov/2001	14/Jul/2003	X	X									X	X
403STC010	Lion Canyon		18/Feb/2003	X	X									X	X
403STC016	Santa Clara River near estuary	14/Nov/2001	24/Feb/2003	X	X									X	X
403STC017	Piru Creek near Gold Hill Rd	05/Dec/2001	23/Jun/2003	X	X									X	X
403STC019	Santa Clara River	31/Oct/2001	25/Feb/2003	X	X									X	X
403STC021	Piru Creek - Forest Service Rd 7N13	06/Dec/2001	23/Jun/2003	X	X									X	X
403STC022	Sespe Creek - Rose Valley Rd	14/Nov/2001	19/Feb/2003	X	X									X	X
403STC024	Tributary to Santa Paula Creek near Big Cone Campsite	14/Nov/2001	19/Feb/2003	X	X									X	X
403STC025	Piru Creek		23/Jun/2003	X	X									X	X
403STC026	Tule Creek		19/Feb/2003	X	X									X	X
403STC027	Bouquet Canyon - Forest Service Rd 5N44	13/Nov/2001	24/Feb/2003	X	X									X	X
403STC028	Santa Paula Canyon		19/Feb/2003	X	X									X	X
403STC029	Elizabeth Canyon		20/Feb/2003	X	X									X	X

Site	Descriptive Name	Date(s)		Field Measurements	Conventional water chemistry	Metals			Sediment physical characteristics	Trace organics			Toxicity		Bioassessment
				W	W	S	T	W	S	S	T	W	S	W	
403STC030	Piedra Blanca Creek		18/Feb/2003	X	X									X	X
403STC064	Bear Canyon		19/Feb/2003	X	X									X	X
403STC065	Elizabeth Canyon		20/Feb/2003	X	X									X	X
403STC066	Piedra Blanca Creek		18/Feb/2003	X	X									X	X
403STC068	Santa Clara River		25/Feb/2003	X	X									X	
403STC069	Piru Creek		23/Jun/2003	X	X									X	X
403STC070	Sespe Creek		19/Feb/2003	X	X									X	X
403STC071	Piru Creek		17/Feb/2003	X	X									X	X
403STC076	Piru Creek		25/Feb/2003	X	X									X	X
403STC082	Santa Clara River		24/Feb/2003	X	X									X	X
403STC083	Piru Creek		20/Feb/2003	X	X									X	X
403STC085	Piru Creek		23/Jun/2003	X	X									X	X
403STC086	Rock Creek		19/Feb/2003	X	X									X	X
403STC090	Santa Paula Canyon		24/Feb/2003	X	X									X	X
403STC093	Piru Creek		17/Feb/2003	X	X									X	X
403STCBQT	Bouquet Canyon Creek	31/Oct/2001	13/Jan/2003	X	X	X	X	X		X	X	X	X	X	X
403STCCTC	Castaic Creek	13/Nov/2001		X	X	X	X	X		X	X	X		X	X
403STCPRU	Piru Creek	01/Nov/2001		X	X	X	X	X		X	X	X		X	X
403STCSFO	San Francisquito Creek	31/Oct/2001		X	X	X		X		X		X		X	X
403STCSSP	Sespe Creek	15/Nov/2001		X	X	X	X	X		X	X	X		X	X
403STCSTP	Santa Paula Creek	01/Nov/2001		X	X	X	X	X		X	X	X		X	X
403STCNRB	Newhall Ranch Blue Cut	30/Oct/2001	13/Nov/2001	X	X	X		X		X		X		X	X
403STCEST	Santa Clara River Estuary	14/Nov/2001		X	X	X	X	X		X	X	X		X	X

Field Measurements-DO, pH, depth, temperature, velocity conductivity, turbidity
Conventional water chemistry- ammonia-N, boron, chloride, chlorophyll a, nitrate-N, nitrite-N, ortho-phosphate-P, sulfate, TDS
Sediment physical characteristics-Grain size
Trace organics-Pesticides, PCBs, PAHs
Trace metals-Ag, Al, As, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Se, Zn

Sampling began in 2001 at 10 sites randomly chosen from the larger pool of 30 sites (Figure 1, Table 1), and at "integrator" sites:

- Newhall Ranch Blue Cut [NRB], a hydrologically important station in the middle of the watershed that represents the surface water and ground water interaction in the area;
- One station at the base of each of the six main subwatersheds (Santa Paula Creek [STP], Sespe Creek [SSP], Piru Creek [PRU], Castaic Creek [CTC], San Francisquito Creek [SFO], and Bouquet Canyon Creek [BQT]); and
- A station at the very bottom of the watershed (prior to meeting the estuary).

In 2003, the 10 randomly chosen sites were sampled again along with the remaining 20 randomly selected sites. Sampling at all sites consisted of field measurements (DO, pH, depth, temperature, velocity, conductivity, and turbidity), conventional water chemistry (nutrients [ammonia, chloride, nitrate, nitrite, phosphate, and sulfate], TDS, boron, chlorophyll a), toxicity, and bioassessment. In 2001, the subwatershed stations were also sampled for trace organics, bioaccumulation, metals chemistry in the water column and sediment, sediment grain size, and ELISAs for chlorpyrifos and diazinon (Table 1). Bouquet Canyon Creek was sampled bi-weekly from August 2002 through August 2003 for chlorpyrifos and diazinon using ELISA and was re-sampled for the full suite of water chemistry and sediment trace organic chemistry in 2003. The estuary station was sampled once in 2001 for sediment trace organic chemistry in addition to the all parameters listed above (Table 1).

Data from the 2003 sampling event, when the 30 randomly selected sites were sampled, were used to estimate conditions in sampleable streams throughout the STC watershed. These estimates are presented as cumulative frequency distribution functions (CDFs) with 95% confidence intervals (CIs).

2.2 Sample Collection

All field measurements, sample collection, transportation and chain of custody procedures were performed according to protocols specified in the SWAMP Quality Assurance Management Plan (QAMP) and its appendices (Puckett 2002, http://www.swrcb.ca.gov/swamp/qapp.html).

2.3 Sample Analysis

Analytical Chemistry

Appendix A Table 1 lists all chemical constituents in sediment and water with their respective analytical laboratories and methods used. Appendix A Table 2 lists all chemical constituents in sediment and water with the number of samples taken, number of results below the method detection limit (MDL), the MDL, the reporting limit (RL), and the units for each. Tissue data is not currently in the SWAMP database; thus it is not included in Appendix A. In the near future, when tissue data is added to the database,

this information will be available. All analytes in sediment are reported on a dry weight basis, in tissue they are reported on a wet weight basis.

Trace organics are presented in the following categories: organic pesticides (organochlorine pesticides [OCP] and organophosphate pesticides [OPP]), polynuclear aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). All trace organic data in sediment and tissue are surrogate corrected. Total DDT (∑ ortho and para DDD, DDE, and DDT, and DDMU) and chlordane (∑ oxychlordane and alpha and gamma isomers of chlordane, chlordene and nonachlor) were summed using both 0 and ½ the MDL for values of individual isomers below their respective MDLs and both summations are presented for comparison.

The QAMP (2002) requires that at least 5% of the samples measured with ELISA are also measured by instrumental analysis using USEPA analytical chemistry methods. Thus, when both ELISA and instrument-based measures for chlorpyrifos and diazinon are available, instrument-based measures are presented because they have lower detection limits (0.02 vs. 0.05 μg l^{-1} for chlorpyrifos and 0.005 vs. 0.03 μg l^{-1} for diazinon). Regressions of instrument-based vs. ELISA data produced r^2 of 0.2888 for chlorpyrifos and 0.9864 for diazinon.

Fifty individual PCB congeners were analyzed in this study. To calculate total PCBs for comparison with criteria, we summed the values of each of the 50 congeners using both 0 and ½ the MDL for values of individual congeners below their respective MDLs and both summations are presented for comparison. In either case, because only 50 of 209 possible congeners were analyzed, our total PCB values underestimate the true totals.

Bioaccumulation

Bioaccumulation of contaminants in the tissue of the freshwater clam *Corbicula fluminea* was also measured as a time-integrative tool for assessing water quality. Concentrations of contaminants in tissue may reflect conditions in the immediate environment or may integrate conditions in the watershed above the area. *C. fluminea* collection, deployment and retrieval are described in the QAMP. *C. fluminea* were deployed on October 1, 2001 and retrieved on November 1, 2001. *C. fluminea* were not retrieved from two sites, 403STCBQT and –SFO; they were presumably lost or stolen. *C. fluminea* were redeployed at 430STCBQT on January 13, 2003, and retrieved on February 10, 2003. *C. fluminea* tissues were analyzed for metals and trace organics.

Toxicity

Toxicity in the CAL watershed was measured in the fall of 2001, using the freshwater species *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow) for all sites except 403CAL004, which was tested using the saltwater species *Holmesimysis costata* (mysid shrimp) and *Strongylocentrotus purpuratus* (sea urchin). Samples from the STC watershed were tested for toxicity using *C. dubia* and *P. promelas* over 4 sampling events occurring in the fall of 2001, and January, February and June-July 2003. Each of the 38 sites was sampled at least once, and sampling was repeated at 12 sites, for a total of 50 samples tested for toxicity. In January 2003, sediment from 403STCBQT

was also tested for toxicity using *Hyalella azteca* (amphipod). Protocols for each of these tests and associated supporting materials are available in Appendix F of the QAMP.

Results of the toxicity tests are reported as acute (mortality), chronic (reduced growth or reproduction), or no effect. Field samples were compared to controls and toxicity was considered to occur if both of the following criteria were met: sample mean significantly different from control (significance level: $p<0.05$) and sample mean <80% of control. If the sample mean was <80% of control but the p-value was >0.05 due to high variability, or if the p-value was <0.05 but the sample mean was not <80% of the control mean, toxicity was not considered to occur.

TIEs were conducted following determination of toxicity to *Ceriodaphnia dubia* and to *Holmesimysis costa* in samples from 403STCBQT and 403CAL004, respectively. TIE procedures are available in Appendix F of the QAMP and in Appendix B of this report.

In November 2001, water samples from all CAL sites and selected sites in the STC watershed were analyzed for diazinon and chlorpyrifos using ELISA. Beginning in August 2002, and continuing for one year, samples were collected bi-weekly from 403STCBQT and analyzed for diazinon and chlorpyrifos using ELISA. An additional sample from 403STCCBQT was collected in January 2003 and analyzed for diazinon using ELISA. ELISA protocols are available in Appendix F of the QAMP. ELISA MDLs are 0.05 $\mu g\ l^{-1}$ for chlorpyrifos and 0.03 $\mu g\ l^{-1}$ for diazinon.

Bioassessment

The analysis of macroinvertebrate benthic communities, or bioassessment, was used to evaluate ecological condition at 48 sites in the CAL and STC watersheds by California DFG Aquatic Bioassessment Laboratory (ABL). Twelve sites in the STC watershed (the 10 randomly chosen sites and –BQT and –NRB) were sampled twice for a total of 60 samples. 403CAL002 and –009 and 403STC068 were not sampled. Sampling procedures and analytical methods are available in the QAMP and its Appendix G. An index of biotic integrity (IBI) was recently developed for the southern California coastal region (Ode et al. unpublished data) and was used to characterize the biotic condition of the sites. Additional information is available in Appendix C.

2.4 Comparison to established thresholds

Chemical concentrations in water were compared to objectives established in the 1994 Basin Plan (CRWQCB LAR 1994) and to USEPA and California DFG 4-day and 1-hour averages and instantaneous maxima for toxicity to aquatic life criteria as summarized in Marshack (2003). If neither of these types of thresholds has been established, data were compared to other criteria included in Marshack (2003) such as California primary and secondary maximum contaminant levels (MCLs), Department of Health Services (DHS) action levels, and California Toxics Rule (CTR)/National Toxics Rule (NTR) criteria. Data were also compared to USEPA criteria recommendations (USEPA 1986, 2000).

Chemical concentrations in sediment were compared to consensus-based sediment quality guidelines (SQG) presented in MacDonald et al. (2000). Adverse effects on sediment-dwelling organisms are not expected to occur below a threshold effects concentration (TEC), and adverse effects are expected to occur frequently above a probable effects concentration (PEC) (MacDonald et al. 2000). At concentrations between a TEC and PEC, it is difficult to predict whether or not the sediments will be toxic to organisms.

Tissue contaminants were compared to available Office of Environmental Health Hazard Assessment (OEHHA) screening values for human health protection (Brodberg and Pollack 1999) and US Fish and Wildlife Service (USFWS) guidelines for wildlife protection (M. Lyons, pers. comm.). The USFWS values provided are not established regulations and are only intended to identify samples that may be of concern. Human health criteria were used for two reasons. First, contaminant levels measured in whole body *Corbicula fluminea* samples could serve as a surrogate for other organisms from the streams that may be consumed whole. Second, few current, reliable wildlife-based criteria are available.

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3 QUALITY ASSURANCE & QUALITY CONTROL

In any project of great magnitude, such as SWAMP, assuring the quality of the data is a critical step in accepting and using the data provided from the study. Since the results of SWAMP will be used to support rulemaking, enforcement, regulatory, and policy decisions, thorough objectives for achieving quality data are outlined in the QAMP. In short, data quality is assured through analysis of:

- Field blind duplicates
- Laboratory replicates
- Laboratory method blanks
- Matrix spikes and matrix spike duplicates
- Certified reference materials/laboratory control spikes.

Data in this report have been verified according to the SWAMP Standard Operating Procedures (SOPs) for chemistry, field and toxicity data verification. Data have not been validated.

3.1 Field Blind Duplicates

Field blind duplicates (FDQs) were analyzed to assess field homogeneity and field sampling procedures. FDQs for water were sampled at 4 stations (403CAL005, 403STC070, -082, and -EST) by collecting a separate grab sample immediately following the collection of the field sample. Sediment and tissue FDQs were obtained from homogenized samples from 403STCEST and –STP respectively. Duplicate values were compared to field sample values from each site and relative percent difference (RPD) was calculated as follows:

RPD=|(Value1-Value2)|/(AVERAGE(Value1+Value2))*100

where:
Value1=field sample value
Value2=duplicate sample value.

If either Value 1 or Value 2 was < 3 times the MDL, the RPD was not calculated as the values were too low to calculate a meaningful difference between them. RPDs <25% were considered acceptable as specified in the QAMP. RPDs >25% are shown in Table 2; all other RPDs were acceptable.

3.2 Laboratory Replicates

Laboratory replicates were analyzed to assess laboratory precision. A replicate of at least one field sample per batch was processed and analyzed for laboratory precision. The replicates were compared and RPD was calculated as described in Section 3.1 where Value1=replicate 1 value and Value2=replicate 2 value. If either Value 1 or Value 2 was < 3 times the MDL, the RPD was not calculated as the values are too low to calculate a

meaningful difference between them.

RPDs <25% were considered acceptable as specified in the QAMP. RPDs >25% are shown in Table 3; all other RPDs were acceptable.

Table 2. Sediment, tissue and water field blind duplicates that exceeded the allowable 25% relative percent difference (RPD).

Analyte	Units	Site	Field Sample	Field Duplicate	RPD	Laboratory
Sediment						
Aluminum	mg kg^{-1}	403STCEST	21200.00	27600.00	26	MPSL-DFG
Cadmium	mg kg^{-1}	403STCEST	0.22	0.16	32	MPSL-DFG
Chromium	mg kg^{-1}	403STCEST	8.83	4.76	60	MPSL-DFG
DDE (p,p')	ng g^{-1}	403STCEST	7.17	4.72	41	DFG-WPCL
Manganese	mg kg^{-1}	403STCEST	177.00	132.00	29	MPSL-DFG
Nickel	mg kg^{-1}	403STCEST	6.02	4.00	40	MPSL-DFG
Tissue						
Aluminum	mg kg^{-1}	403STCSTP	21.15	15.73	29	MPSL-DFG
Fluorenes, C2 -	ng g^{-1}	403STCSTP	25.30	35.40	33	DFG-WPCL
Phenanthrene/ Anthracene, C1 -	ng g^{-1}	403STCSTP	117.00	190.00	48	DFG-WPCL
Selenium	mg kg^{-1}	403STCSTP	0.34	0.69	68	MPSL-DFG
Water						
Total Aluminum	mg l^{-1}	403STCEST	0.438	0.607	32	MPSL-DFG
Boron	mg l^{-1}	403CAL005	1.8000	0.8500	72	SFL
Chlorophyll a	µg l^{-1}	403CAL005	19	5.3	113	SFL
Chlorophyll a	µg l^{-1}	403STC070	0.1900	0.8600	128	MPSL-DFG
Chlorophyll a	µg l^{-1}	403STC082	0.7700	1.0600	32	MPSL-DFG
Thiobencarb	µg l^{-1}	403STCEST	0.5300	1.2000	77	DFG-WPCL

Table 3. Sediment and water laboratory replicates that exceeded the allowable 25% relative percent difference (RPD).

Analyte	Units	Site	Laboratory Replicate 1	Laboratory Replicate 2	RPD	Laboratory	Batch ID
Sediment							
Aluminum	mg kg^{-1}	403STCNRB	40000	23234	53	MPSL-DFG	R4-031002-ICP
Chromium	mg kg^{-1}	403STCNRB	22.9	15.5	39	MPSL-DFG	R4-031002-ICP
Water							
Total Nickel	µg l^{-1}	403STCCTC	2.12	1.6	28	MPSL-DFG	R4-121901-ICP

3.3 Laboratory Method Blanks

Laboratory method blanks were used to assess laboratory contamination during all stages of sample preparation and analysis. The blanks were processed through the entire analytical procedure in a manner identical to the samples. Per the QAMP for both organic and inorganic analyses, at least one laboratory method blank should be analyzed per 20 samples or one per batch, whichever is more frequent; however there were several batches where blanks were not performed at the required frequency (Table 4). Acceptable results are those that are less than the specified MDL for each analyte in water, sediment or tissue. Laboratory blanks for which analytes were detected are presented in Table 5; all other blanks were acceptable. Two sediment blanks had values that were slightly above the MDL but less than or equal to the RL. Twenty tissue blanks had detectable levels of PCBs; each PCB concentration exceeded the MDL but was less than the RL. Nineteen water blanks had detectable levels of analytes. The value of each water blank, with the exception of PCBs, was above the MDL but less than the RL.

Table 4. Batches for which no laboratory blanks were run.

Analyte	Batch ID	Matrix	Sample Dates
Chlorophyll a	CHL03-0023c	Water	14/Jul/2003
Chlorpyrifos, Diazinon	BQTEL8GC	Water	07/Nov/2002
Chlorpyrifos, Diazinon	BQTEL9GC	Water	18/Nov/2002
Chlorpyrifos, Diazinon	BQTEL10GC	Water	03/Dec/2002
Nitrite-N	L-110501-NO2	Water	29/Oct/2001-30/Oct/2001
OCPs	L39801BS179_KRPEST	Sediment	14/Nov/2001
PAHs	L-110301-PAH	Water	30/Oct/2001- 01/Nov/2001
PCBs	L39801_BS179_KR_CONG	Sediment	14/Nov/2001
Total Dissolved Solids	063003-TDS	Water	23/Jun/2003
Total Dissolved Solids	L-111501-TDS	Water	13/Nov/2001
Total Dissolved Solids	L-110701-TDS	Water	31/Oct/2001-01/Nov/2001

3.4 Matrix Spikes and Matrix Spike Duplicates

A laboratory fortified sample matrix (matrix spike, or MS) and a laboratory fortified sample matrix duplicate (MSD) were used both to evaluate the effect of the sample matrix on the recovery of the compound(s) of interest and to assess analytical precision and accuracy.

Aliquots of randomly selected field samples were spiked with known amounts of target analytes. The percent recovery (%R) of the spike was calculated as follows:

$$\%R=(\text{MS Result} - \text{Sample Result})/(\text{Expected Value} - \text{Sample Result}) * 100$$

Table 5. Laboratory method blanks in which analytes were detected.

Analyte	Units	Result	MDL	RL	Laboratory	Method Name	Batch ID
Sediment							
PCB 110	ng g^{-1}	0.261	0.25	0.25	DFG-WPCL	EPA 8082	L39801_BS179_KR_CONG
PCB 110	ng g^{-1}	0.26	0.25	0.500	DFG-WPCL	EPA 8081A	L42402_BS 236_KR_CONGENER
Tissue							
PCB 052	ng g^{-1}	0.313	0.25	1	DFG-WPCL	EPA 8082	L34902_BS 227_KR_CONGENERS
PCB 070	ng g^{-1}	0.291	0.25	1	DFG-WPCL	EPA 8082	L34902_BS 227_KR_CONGENERS
PCB 095	ng g^{-1}	0.336	0.25	1	DFG-WPCL	EPA 8082	L34902_BS 227_KR_CONGENERS
PCB 101	ng g^{-1}	0.358	0.25	1	DFG-WPCL	EPA 8082	L34902_BS 227_KR_CONGENERS
PCB 110	ng g^{-1}	0.491	0.25	1	DFG-WPCL	EPA 8082	L34902_BS 227_KR_CONGENERS
PCB 118	ng g^{-1}	0.408	0.25	1	DFG-WPCL	EPA 8082	L34902_BS 227_KR_CONGENERS
PCB 157	ng g^{-1}	0.340	0.25	1	DFG-WPCL	EPA 8082	L34902_BS 227_KR_CONGENERS
PCB 028	ng g^{-1}	1.14	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 031	ng g^{-1}	0.92	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 044	ng g^{-1}	1.40	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 052	ng g^{-1}	0.80	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 066	ng g^{-1}	1.27	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 070	ng g^{-1}	2.25	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 087	ng g^{-1}	0.91	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 095	ng g^{-1}	1.63	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 101	ng g^{-1}	1.46	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 105	ng g^{-1}	1.94	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 110	ng g^{-1}	4.41	0.629	5.00	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 118	ng g^{-1}	3.17	0.629	4.00	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
PCB 138	ng g^{-1}	1.08	0.629	3.15	DFG-WPCL	EPA 8082	L39703_BS272_KR_CONGENERS
Water							
Ammonia-N	mg l^{-1}	0.077	0.05	0.1	DFG-WPCL	EPA 350.3	011503-NH3
Ammonia-N	mg l^{-1}	0.061	0.05	0.1	DFG-WPCL	EPA 350.3	062703-NH3
Boron	mg l^{-1}	0.050	0.01	0.1	SFL	SM 4500BB	R4-112601-B
Boron	mg l^{-1}	0.050	0.01	0.1	SFL	SM 4500BB	R4-112601-B

Analyte	Units	Result	MDL	RL	Laboratory	Method Name	Batch ID
Boron	mg l^{-1}	0.050	0.01	0.1	SFL	SM 4500BB	R4-112601-B
Boron	mg l^{-1}	0.050	0.01	0.1	SFL	SM 4500BB	R4-121401-B
Chlorophyll a	µg l^{-1}	2.700	0.5	5	SFL	SM 10200H-2b	R4-112001-Chl
Chlorophyll a	µg l^{-1}	2.700	0.5	5	SFL	SM 10200H-2b	R4-112001-Chl
Chlorophyll a	µg l^{-1}	2.700	0.5	5	SFL	SM 10200H-2b	R4-112001-Chl
Chlorophyll a	µg l^{-1}	1.250	0.5	2	SFL	SM 10200H-2b	R4-121401-Chl
PCB 027	µg l^{-1}	0.007	0.001	0.002	DFG-WPCL	EPA 8082	L-112101-PCB
PCB 052	µg l^{-1}	0.006	0.001	0.002	DFG-WPCL	EPA 8082	L-112101-PCB
PCB 137	µg l^{-1}	0.004	0.001	0.002	DFG-WPCL	EPA 8082	L-110401-PCB
PCB 137	µg l^{-1}	0.005	0.001	0.002	DFG-WPCL	EPA 8082	L-112101-PCB
Pheophytin a	µg l^{-1}	2.700	0.5	5	SFL	SM 10200H-2a	R4-112001-Ph
Pheophytin a	µg l^{-1}	1.250	0.5	2	SFL	SM 10200H-2a	R4-121401-Ph
Trichloronate	µg l^{-1}	0.040	0.03	0.05	DFG-WPCL	EPA 8141A	L-110801-OPP
Trichloronate	µg l^{-1}	0.040	0.03	0.05	DFG-WPCL	EPA 8141A	L-110801-OPP
Trichloronate	µg l^{-1}	0.040	0.03	0.05	DFG-WPCL	EPA 8141A	L-111901-OPP

This process was repeated for a subset of field samples to create MSDs to assess both laboratory precision and accuracy. As required by the QAMP, for both organic and inorganic analyses at least one MS/MSD pair should be performed per 20 samples or one per batch, whichever is more frequent, however there were several batches where MS/MSDs were not performed at the required frequency (Table 6).

The MS/MSD %Rs and RPDs were evaluated and calculated as described in Section 3.1 where Value1=matrix spike value and Value2=matrix spike duplicate value. The %Rs acceptance criteria for the analyte groups are presented in Table 7. Unacceptable MS/MSD %Rs and RPDs are presented in Table 8. Parent sample results were not provided for tissue batches L-032803-PAH (Fall 2001), L-031804-PAH (February 2003), L34902_BS 225_KR_CONGENERS (Fall 2001), L34902_BS 227_KR_PESTICIDES (Fall 2001); therefore, the MS/MSD %Rs and RPDs could not be evaluated. All other MS/MSD %Rs and RPDs were acceptable.

Table 6. Batches for which no matrix spikes were run.

Analyte	Batch ID	Matrix	Sample Dates
Ammonia as N	022403-NH3	Water	19/Feb/2003-20/Feb/2003
Chloride	022103-CL	Water	19/Feb/2003-20/Feb/2003
Hardness as CaCO3	012103-HARD	Water	13/Jan/2003
Nitrate-N	022403-NO3-2	Water	17/Feb/2003-19/Feb/2003
Nitrate-N	L-112001-aNO3	Water	14/Nov/2001-15/Nov/2001
Nitrate-N	L-121001-aNO3	Water	06/Dec/2001
OCPs	L-011803-OCH	Water	13/Jan/2003
OCPs	L39801BS179_KRPEST	Sediment	14/Nov/2001
OPPs	L-011803-OP	Water	13/Jan/2003
PAHs	L-011803-PAH	Water	13/Jan/2003
PCBs	L-011803-PCB	Water	13/Jan/2003
OCPs	L-110301-OCH	Water	No MS run on samples collected 29-30/Oct/2001 and extracted 01/Nov/2001; no MSD run on samples collected 31/Oct/2001-01/Nov/2001 and extracted 03-04/Nov/2001
PAHs	L-110301-PAH	Water	
PCBs	L-110401-PCB	Water	
OPPs	L-110801-OPP	Water	
PCBs	L39801_BS179_KR_CONG	Sediment	14/Nov/2001
Sulfate	022103-SO4	Water	19/Feb/2003-20/Feb/2003

Table 7. Acceptable quality control sample recovery criteria for different categories of compounds in water, sediment and tissue.

Matrix	Analyte Group	% Recovery Acceptance Criteria
Water	Conventional Constituents	80-120
	Trace Metals (Including Mercury)	75-125
	Synthetic Organics (PCBs, PAHs, OCPs, OPPs)	50-150
	Chlorpyrifos and Diazinon (ELISA method)	80-120
Sediment and Tissue	Trace Metals (Including Mercury)	75-125
	Synthetic Organics (PCBs, PAHs, OCPs, OPPs)	50-150

Table 8. Matrix spikes (MS), matrix spike duplicates (MSD), or relative percent differences (RPD) that did not meet specified criteria. Boldface indicates the portion that did not meet quality control criteria.

Analyte	Analyte Grouping	Laboratory	Batch ID	Acceptable % Recovery	MS % Recovery	MSD % Recovery	RPD
Sediment							
Arsenic	Metals	MPSL-DFG	2003Dig15	75-125	96	**50**	**63**
Benzo(b)fluoranthene	PAHs	DFG-WPCL	L-031503-PAH	50-150	128.74	65.63	**65**
Benzo(e)pyrene	PAHs	DFG-WPCL	L-031503-PAH	50-150	93.20	66.30	**34**
Benzo(k)fluoranthene	PAHs	DFG-WPCL	L-031503-PAH	50-150	96.58	73.13	**28**
Chlorpyrifos	OPPs	DFG-WPCL	L39801BS179_KRPEST	50-150	**49.48**	**21.29**	**80**
Chromium	Metals	MPSL-DFG	2003Dig15	75-125	84	**46**	**58**
Chrysene	PAHs	DFG-WPCL	L-031503-PAH	50-150	99.15	59.56	**50**
Copper	Metals	MPSL-DFG	2003Dig15	75-125	97	**51**	**62**
DDT (o,p')	OCPs	DFG-WPCL	L42402_BS 236_KR_PEST	50-150	**45.51**	66.03	**37**
Endosulfan sulfate	OCPs	DFG-WPCL	L39801BS179_KRPEST	50-150	**35.36**	**33.33**	5.9
Fluoranthene	PAHs	DFG-WPCL	L-031503-PAH	50-150	97.47	64.59	**41**
delta HCH	OCPs	DFG-WPCL	L39801BS179_KRPEST	50-150	**0**	**0**	0
delta HCH	OCPs	DFG-WPCL	L42402_BS 236_KR_PEST	50-150	**18.9**	**28.7**	**41**
Heptachlor	OCPs	DFG-WPCL	L39801BS179_KRPEST	50-150	**17**	**0**	**200**
Manganese	Metals	MPSL-DFG	2002Dig7	75-125	**63**	78	21
Manganese	Metals	MPSL-DFG	2003Dig15	75-125	105	**19**	**139**
Naphthalenes, C1 -	PAHs	DFG-WPCL	L-031503-PAH	50-150	**219.7**	**224.4**	2.1
Nickel	Metals	MPSL-DFG	2003Dig15	75-125	88	**54**	**48**
PCB 008	PCBs	DFG-WPCL	L42402_BS 236_KR_CONGENER	50-150	54.29	79.15	**37**
PCB 029	PCBs	DFG-WPCL	L39801_BS179_KR_CONG	50-150	61.24	**38.05**	**47**
PCB 029	PCBs	DFG-WPCL	L42402_BS 236_KR_CONGENER	50-150	**35.63**	79.57	**76**
PCB 056	PCBs	DFG-WPCL	L39801_BS179_KR_CONG	50-150	57.75	**43.13**	**29**
Pyrene	PAHs	DFG-WPCL	L-031503-PAH	50-150	80.61	60.37	**29**
Zinc	Metals	MPSL-DFG	2003Dig15	75-125	90	**48**	**61**
Tissue							
Aluminum	Metals	MPSL-DFG	2004Dig36	75-125	**148.00**	91.00	**48**
Arsenic	Metals	MPSL-DFG	2004Dig36	75-125	**126.00**	101.00	22
Chromium	Metals	MPSL-DFG	2004Dig36	75-125	**135.00**	110.00	20
Copper	Metals	MPSL-DFG	2004Dig36	75-125	**134.00**	111.00	19
Manganese	Metals	MPSL-DFG	2004Dig36	75-125	**140.00**	118.00	18
Nickel	Metals	MPSL-DFG	2004Dig36	75-125	**139.00**	110.00	23

Analyte	Analyte Grouping	Laboratory	Batch ID	Acceptable % Recovery	MS % Recovery	MSD % Recovery	RPD
PCB 170	PCBs	DFG-WPCL	L39703_BS272_KR_CONGENERS	50-150	**0**	**0**	0
Selenium	Metals	MPSL-DFG	2004Dig36	75-125	110.00	84.00	**27**
Water							
Acenaphthylene	PAHs	DFG-WPCL	L-112001-PAH	50-150	70.2	100	**35**
Benzo(g,h,i)perylene	PAHs	DFG-WPCL	L-112001-PAH	50-150	67.4	87.2	**26**
Ciodrin(Crotoxyphos)	OPPs	DFG-WPCL	L-011803-OP	50-150	88.2	65.5	**30**
Chloride	Conventionals	DFG-WPCL	022003-CL	80-120	112.1	**75.8**	**39**
Chlorpyrifos	OPPs	UCD-GC	7ELGC	80-120	**127**	-	-
Coumaphos	OPPs	DFG-WPCL	L-111901-OPP	50-150	71.8	94.2	**27**
Dibenz(a,h)anthracene	PAHs	DFG-WPCL	L-112001-PAH	50-150	77.2	101	**27**
Dimethylnaphthalene, 2,6-	PAHs	DFG-WPCL	L-112001-PAH	50-150	65.8	88.5	**29**
Dioxathion	OPPs	DFG-WPCL	L-111901-OPP	50-150	95.6	69.6	**31**
Endrin	OCPs	DFG-WPCL	L-011803-OCH	50-150	113	86.5	**27**
Fensulfothion	OPPs	DFG-WPCL	L-011803-OP	50-150	106	81	**27**
Fluorene	PAHs	DFG-WPCL	L-112001-PAH	50-150	66.6	94.6	**35**
HCH, delta	OCPs	DFG-WPCL	L-011803-OCH	50-150	61	80	**27**
HCH, gamma	OCPs	DFG-WPCL	L-011803-OCH	50-150	84	60.5	**33**
Methylnaphthalene, 2-	PAHs	DFG-WPCL	L-112001-PAH	50-150	65.8	96.6	**38**
Naled(Dibrom)	OPPs	DFG-WPCL	L-111901-OPP	50-150	98.7	76.0	**26**
Naphthalene	PAHs	DFG-WPCL	L-112001-PAH	50-150	62.5	104	**50**
Phosmet	OPPs	DFG-WPCL	L-011803-OP	50-150	80	108	**30**
Thionzin(Thionazin)	OPPs	DFG-WPCL	L-011803-OP	50-150	61.2	80.1	**27**
Trichlorfon	OPPs	DFG-WPCL	L-011803-OP	50-150	103	77.5	**28**

3.5 Certified Reference Materials and Laboratory Control Spikes

Certified reference materials (CRM), laboratory control spikes (LCS), and laboratory control materials (LCM) were analyzed to assess the accuracy of a given analysis method (i.e., the closeness of a measurement to the "true" value). As required by the QAMP, one CRM, LCS, or LCM should be analyzed per 20 samples or one per batch, whichever is more frequent, however there were several batches where CRMs, LCSs, or LCMs were not performed at the required frequency (Table 9). The %Rs acceptance criteria for the analyte groups are presented in Table 7. Unacceptable CRM, LCS, and LCM recoveries are presented in Table 10; all other recoveries were acceptable.

Table 9. Batches for which certified reference materials, laboratory control spikes, or laboratory control materials were not run.

Analyte	Batch ID	Matrix
Chlorpyrifos, Diazinon	BQTEL8GC	Water
Chlorpyrifos, Diazinon	BQTEL9GC	Water
Chlorpyrifos, Diazinon	BQTEL10GC	Water
Grain Size	AMS111301-1	Sediment
Grain Size	AMS122901-1	Sediment
Nitrate-N	L-111501-aNO3	Water
Nitrate-N	L-112001-aNO3	Water
OCPs	L-011803-OCH	Water
OCPs	L-112101-OCH	Water
OCPs	L39801BS179_KRPEST	Sediment
OPPs	L-011803-OP	Water
PAHs	L-011803-PAH	Water
PCBs	L-011803-PCB	Water
PCBs	L39801_BS179_KR_CONG	Sediment
Total Dissolved Solids	022603-TDS	Water
Total Dissolved Solids	063003-TDS	Water

Table 10. Sediment, tissue and water certified reference material (CRM), laboratory controlled spike (LCS), and laboratory control material (LCM) results that did not meet quality assurance criteria.

Analyte	Analyte Group	Sample Type	% Recovery Acceptance Criteria	Actual % Recovery	Laboratory	Batch ID
Sediment						
Benzo(a)pyrene	PAHs	LCS	50-150	24.4	DFG-WPCL	L-031503-PAH
Benzo(b)fluoranthene	PAHs	LCS	50-150	166	DFG-WPCL	L-031503-PAH
Chlorpyrifos	OPPs	LCS	50-150	26.37	DFG-WPCL	L39801BS179_KRPEST
Endosulfan sulfate	OCPs	LCS	50-150	32.70	DFG-WPCL	L39801BS179_KRPEST
delta HCH	OCPs	CRM	50-150	0	DFG-WPCL	L39801BS179_KRPEST
delta HCH	OCPs	LCS	50-150	0	DFG-WPCL	L39801BS179_KRPEST
delta HCH	OCPs	LCS	50-150	38.3	DFG-WPCL	L42402_BS 236_KR_PEST
Heptachlor	OCPs	LCS	50-150	0	DFG-WPCL	L39801BS179_KRPEST
Indeno(1,2,3-c,d) pyrene	PAHs	CRM	50-150	151	DFG-WPCL	L-010902-PAH
Indeno(1,2,3-c,d) pyrene	PAHs	LCS	50-150	155	DFG-WPCL	L-031503-PAH
Manganese	Metals	CRM	75-125	65	MPSL-DFG	2002Dig7
Naphthalenes, C1	PAHs	LCS	50-150	209	DFG-WPCL	L-010902-PAH
Naphthalenes, C1 -	PAHs	LCS	50-150	194	DFG-WPCL	L-031503-PAH
PCB 029	PCBs	LCS	50-150	33.20	DFG-WPCL	L39801_BS179_KR_CONG
PCB 056	PCBs	LCS	50-150	36.40	DFG-WPCL	L39801_BS179_KR_CONG
PCB 060	PCBs	LCS	50-150	47.60	DFG-WPCL	L39801_BS179_KR_CONG
Perylene	PAHs	CRM	50-150	44.5	DFG-WPCL	L-031503-PAH
Silver	Metals	CRM	75-125	128	MPSL-DFG	2002Dig7
Tissue						
Benzo(a)pyrene	PAHs	LCS	50-150	23.00	DFG-WPCL	L-031804-PAH
DDD(o,p')	OCPs	CRM	50-150	157.14	DFG-WPCL	L39703_BS272_KR_PESTICIDES
Endosulfan II	OCPs	LCS	50-150	45.10	DFG-WPCL	L39703_BS272_KR_PESTICIDES

Analyte	Analyte Group	Sample Type	% Recovery Acceptance Criteria	Actual % Recovery	Laboratory	Batch ID
1,-Methylnaphthalene	PAHs	CRM	50-150	49.19	DFG-WPCL	L-031804-PAH
Naphthalenes, C1 -	PAHs	LCS	50-150	205.00	DFG-WPCL	L-031804-PAH
Phenanthrene	PAHs	LCS	50-150	248.00	DFG-WPCL	L-031804-PAH
PCB 018	PCBs	CRM	50-150	39.9	DFG-WPCL	L39703_BS272_KR_CONGENERS
PCB 031	PCBs	CRM	50-150	22.2	DFG-WPCL	L39703_BS272_KR_CONGENERS
PCB 170	PCBs	LCS	50-150	<2.0	DFG-WPCL	L39703_BS272_KR_CONGENERS
PCB 170	PCBs	CRM	50-150	34.8	DFG-WPCL	L39703_BS272_KR_CONGENERS
Silver	Metals	CRM	75-125	69.0	MPSL-DFG	ICP051602
Water						
Total Aluminum	Metals	CRM	75-125	72.94	MPSL-DFG	R4-121901-ICP
Total Aluminum	Metals	CRM	75-125	69.72	MPSL-DFG	R4-121901-ICP
Benzo(b)fluoranthene	PAHs	LCS	50-150	41.1	DFG-WPCL	L-011803-PAH
Benzo(k)fluoranthene	PAHs	LCS	50-150	40.7	DFG-WPCL	L-011803-PAH
Chlorpyrifos	OPPs	LCM	80-120	0	UCD-GC	BQTEL2GC
Chlorpyrifos	OPPs	LCM	80-120	0	UCD-GC	BQTEL3GC
Chlorpyrifos	OPPs	LCM	80-120	62.80	UCD-GC	BQTEL5GC
Chlorpyrifos	OPPs	LCM	80-120	73.20	UCD-GC	BQTEL6GC
Chlorpyrifos	OPPs	LCM	80-120	64.00	UCD-GC	BQTEL11GC
Chlorpyrifos	OPPs	LCM	80-120	0	UCD-GC	BQTEL15GC
Chlorpyrifos	OPPs	LCM	80-120	0	UCD-GC	BQTEL18GC
Chlorpyrifos	OPPs	LCM	80-120	0	UCD-GC	BQTEL19GC
Chlorpyrifos	OPPs	LCM	80-120	0	UCD-GC	BQTEL20GC
Chlorpyrifos	OPPs	LCM	80-120	0	UCD-GC	BQTEL21GC
Chlorpyrifos	OPPs	LCM	80-120	127.2	UCD-GC	9ELGC
Diazinon	OPPs	LCM	80-120	122.40	UCD-GC	BQTEL2GC

Analyte	Analyte Group	Sample Type	% Recovery Acceptance Criteria	Actual % Recovery	Laboratory	Batch ID
Diazinon	OPPs	LCM	80-120	128.40	UCD-GC	BQTEL3GC
Diazinon	OPPs	LCM	80-120	0	UCD-GC	BQTEL4GC
Diazinon	OPPs	LCM	80-120	154.80	UCD-GC	BQTEL11GC
Diazinon	OPPs	LCM	80-120	134.00	UCD-GC	BQTEL15GC
Diazinon	OPPs	LCM	80-120	136.00	UCD-GC	BQTEL16GC
PCB 114	PCBs	LCS	50-150	10	DFG-WPCL	L-112101-PCB
Total Silver	Metals	CRM	75-125	14.62	MPSL-DFG	R4-121901-ICP
Total Silver	Metals	CRM	75-125	13.85	MPSL-DFG	R4-121901-ICP

3.6 Toxicity Tests

There were minor deviations in water quality parameters or test conditions (temperature, light) in some replicates, and incoming sample temperature or holding times were exceeded in some cases. However, the data should be considered acceptable for the intended purpose.

3.7 Holding Times

Holding time criteria for organic compounds in tissues are 12 months from sample date to extraction date and 40 days from extraction date to analysis date (USEPA 1997). Holding time criteria for the following tissue batches were exceeded (Table 11):

- PAH Fall 2001 and Feb 2003 (L-040803-PAH and L-031804-PAH)
- OCP February 2003 (L39703_BS272_KR_PESTICIDES)
- PCB February 2003 (L39703_BS272_KR_CONGENERS).

There is insufficient data in the form of published studies to confirm the integrity of samples frozen more than 12 months, particularly with regard to PAHs. McFarland et al., (1995) found that the concentration of many compounds decreased after 12 months. The elapsed time between sample date and extraction date for PCBs and OCPs in samples from February 2003 was just over 12 months and is likely not problematic, however 58 days elapsed between extraction and analysis. A similar situation was found for PAH data from February 2003. For PAHs in samples from fall 2001, more than 17 months elapsed between sample date and extraction date and 99 days elapsed between extraction and analysis. All of these data are included in this report but should be used with caution as they are considered to be estimated.

Table 11. Batches of organic compounds in tissues where holding times were exceeded.

Batch ID	Sample Date	Extraction Date	Analysis Date	Months Between Sample/Extract Dates	Days Between Extract/Analysis Dates
PAH Fall 01	1-Nov-01	8-Apr-03	16-Jul-03	17.25	99
PAH Feb 03	10-Feb-03	18-Mar-04	21-May-04	13.25	61
OCP Feb 03	10-Feb-03	1-Mar-04	27-Apr-04	12.75	58
PCB Feb 03	10-Feb-03	1-Mar-04	27-Apr-04	12.75	58

3.8 Contamination

On February 12, 2004, the California DFG Water Pollution Control Laboratory (DFG-WPCL) notified SWAMP participants of a low level of contamination that occurred in samples analyzed for NO_3 by flow injection analysis method (FIA). The contamination (0.036 ± 0.027 mg l^{-1} [36 ppb]) was significant only for NO_3 results reported <0.150 mg l^{-1} (150 ppb). A list of samples that were analyzed via FIA and therefore positively

biased by 0.036 m mg l^{-1} is presented in Table 12. These samples were not given different symbols in Figures 13 and 14 as the concentrations are very low and are well below Basin Plan criteria for NO_3.

Table 12. Samples with low level (0.036 ± 0.027 mg l^{-1} [36 ppb]) nitrate-N contamination.

Site	Sample Date	Batch ID	Method Nmae	Nitrate as N	Units
403STC009	14/Jul/2003	071503-NO3	QC 10107041B	0.141	mg l^{-1}
403STC024	19/Feb/2003	022403-NO3	QC 10107041B	0.076	mg l^{-1}
403STC027	24/Feb/2003	022603-NO3-2	QC 10107041B	0.0355	mg l^{-1}
403STC028	19/Feb/2003	022403-NO3	QC 10107041B	0.054	mg l^{-1}
403STC065	20/Feb/2003	022403-NO3	QC 10107041B	0.115	mg l^{-1}
403STC076	25/Feb/2003	022603-NO3-2	QC 10107041B	0.0346	mg l^{-1}
403STC090	24/Feb/2003	022603-NO3-2	QC 10107041B	0.138	mg l^{-1}

3.9 QA/QC Summary

All of the data met the quality assurance/quality control (QA/QC) criteria and are considered usable without further evaluation with the following exceptions. Delta HCH results in sediments from batch L42402_BS236_KR_PEST were rejected by the laboratory and should be considered unusable. This batch contained one LARWQCB sample from 403STCBQT.

If data do not meet one portion of the QA/QC criteria, such as laboratory replicate RPD, they can be cross-checked against other criteria, such as MS/MSD and CRM recovery. If two of the following criteria are met, then the data are acceptable: laboratory replicate RPD, MS/MSD recovery and RPDs, CRM/LCS recovery. Therefore, if the laboratory replicate RPD is >25% but the MS/MSD and the CRM for that analyte are acceptable, or if a MS/MSD is unacceptable but the laboratory replicate RPD and CRM for that analyte are acceptable, then the data are acceptable and can be used. For many of the analytes listed in Tables 3, 8 and 10, this was the case. For example, none of the analytes listed in Table 3 appear in Tables 8 or 10 for the same batches; thus the data is acceptable. Only the following analytes did not meet MS/MSD and CRM/LCS criteria:

- In sediment
  - Benzo(b)fluoranthene and naphthalenes, C1-(QA Batch L-031503-PAH)
  - chlorpyrifos and endosufan sulfate (QA Batch L39801BS179_KRPEST)
  - Delta HCH and heptachlor (QA Batch L39801BS179_KRPEST)
  - Manganese (QA Batch 2002Dig7)
  - PCB 029 and PCB 056 (QA Batch L39801_BS179_KR_CONG);
- In tissue
  - PCB 170 (L39703_BS272_KR_CONGENERS)

Results for these analytes are presented in this report but should be interpreted cautiously as measured values should be considered estimated.

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4 RESULTS AND DISCUSSION

4.1 Field Measurements in Water

Dissolved oxygen, pH, specific conductivity, temperature, turbidity, velocity

DO ranged from 64 to 166 % saturation in the CAL watershed and from 21 to 145 % saturation in the STC watershed (Figure 2A). Basin Plan objectives for DO are presented in mg l^{-1} (CRWQCB LAR 1994) preventing direct comparison of the data collected to the established objectives, however streams with <90 % saturation may be considered unhealthy (http://www.lakeaccess.org/russ/oxygen.htm). Many CAL and a fair number of STC watershed stations were below this potential threshold (Figure 3). Data from the 30 stations sampled in 2003 indicate that 83% of STC stream km had DO >90 % saturation (Figure 2B). The % of streams above or below thresholds cannot be evaluated in the CAL watershed because a directed sampling approach was used.

pH ranged from 5.98 to 7.9 in the CAL watershed and from 6.55 to 10.4 in the STC watershed (Figure 4A). The acceptable range for pH is 6.5-8.5 (CRWQCB LAR 1994); several CAL stations were <6.5 whereas several STC stations were >8.5 (Figure 5). Data from the 30 stations sampled in 2003 indicate that 97% of STC streams had acceptable pH values (Figure 4B); only one value (8.55) exceeded the acceptable range.

Specific conductivity ranged from 0.948 to 5.807 mS cm^{-1} in the CAL watershed and from 0.357 to 8.21 mS cm^{-1} in the STC watershed (Figure 6A). All of the values fell between 0 and 4 mS cm^{-1} except for measurements taken at 403CAL002 and 403STC019, which were higher. Distribution of data from the 30 STC stations sampled in 2003 is shown in Figure 6B. There are no numeric Basin Plan objectives for specific conductivity, however 93% of streams were <2 mS cm^{-1}.

Temperature data from the CAL and STC watersheds for discrete sampling periods are presented in Table 13. The lowest average temperature occurred in winter 2003 and the highest average temperature was in summer 2003. There are no numeric Basin Plan objectives for temperature.

Table 13. Seasonal temperature data from the Calleguas Creek and Santa Clara River watersheds from discrete sampling periods.

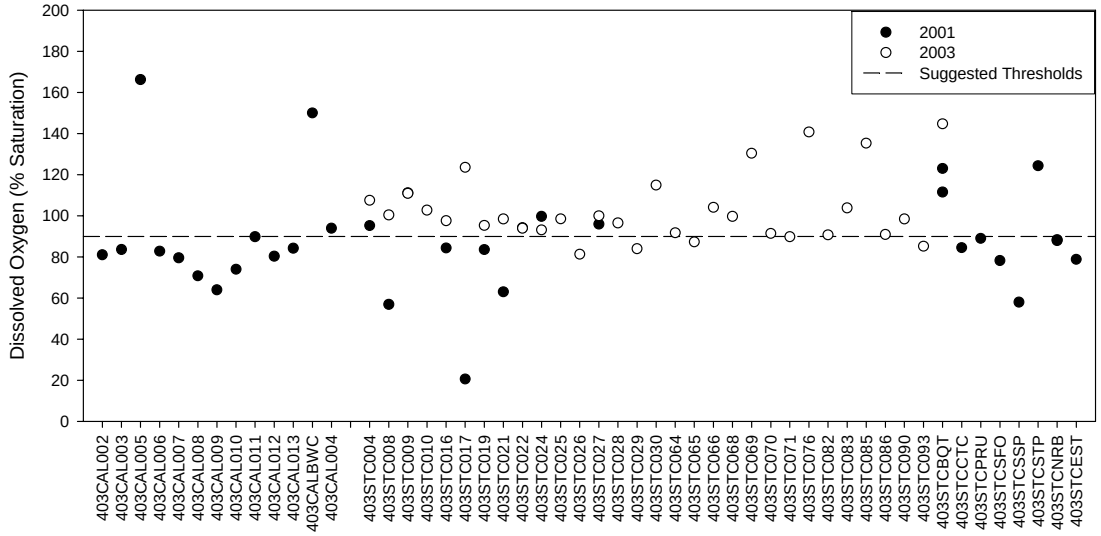
Watershed and Sampling Period	Temperature °C			
	Range	Mean	SE	n
Calleguas Creek				
Oct-Nov 2001	15.3 - 24.2	19.5	0.7	13
Santa Clara River				
Oct-Dec 2001	4.6 - 24.2	15.6	1.1	20
Jan-Feb 2003	8.5 - 15.8	11.9	0.5	25
Jun-Jul 2003	23.2 - 27.3	25.5	0.6	6

Turbidity ranged from 1.9 to 50 NTU in the CAL watershed and from 0.02 to 1065 NTU in the STC watershed (Figure 7A). Data from the 30 stations sampled in 2003 indicate

that 90% of STC streams were <100 NTU (Figure 7B). The relatively high values of 442, 786 and 1065 were obtained on 2/25/03 from 3 stations along the STC between the outlets of Bouquet Canyon Creek and Piru Creek (Figure 8) and are likely due to a precipitation event. There are no numeric Basin Plan objectives for turbidity.

Stream velocities ranged from 0.172 to 3.78 ft s^{-1} in the CAL watershed and from 0 to 9.42 ft s^{-1} in the STC watershed (Figure 9). With the exception of the 9.42 ft s^{-1} measurement taken at 403STCNRB, all velocity measurements were <6.0 ft s^{-1}. Measurements were not taken at many stations due to probe failure; a reliable CDF cannot be constructed. There are no numeric Basin Plan objectives for velocity.

A)



B)

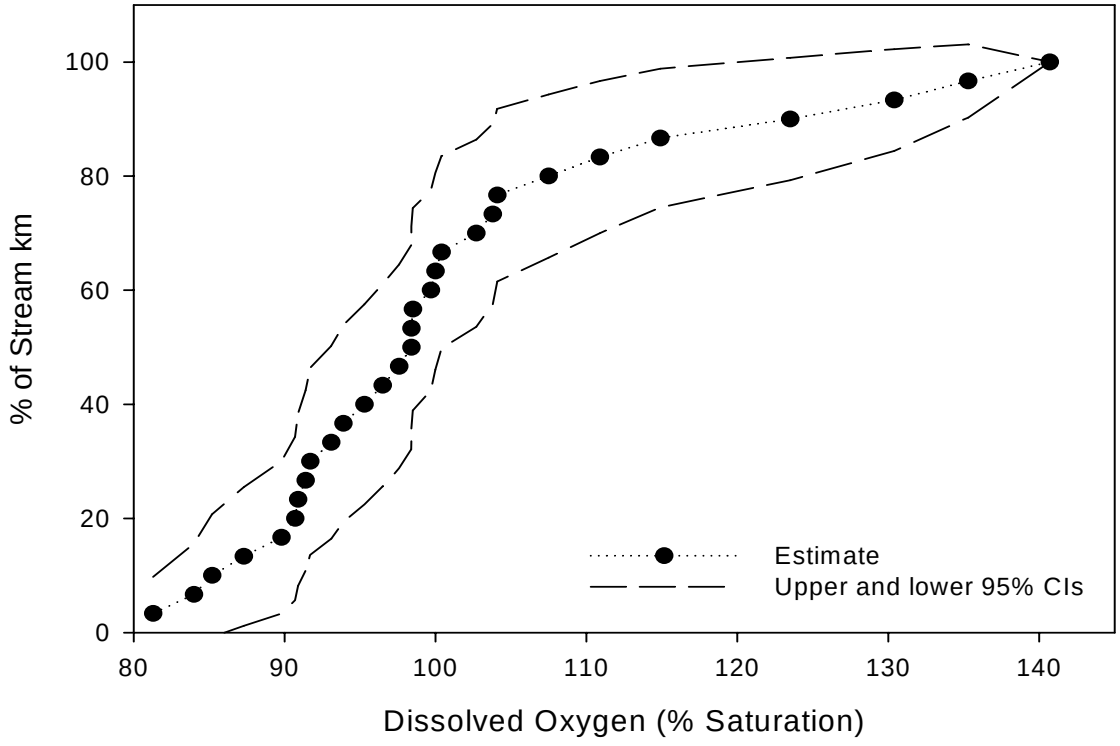


Figure 2. A) Dissolved oxygen values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. The reference line at 90 % saturation indicates a suggested threshold. B) Cumulative frequency distribution with 95% confidence intervals of dissolved oxygen in the Santa Clara River watershed.

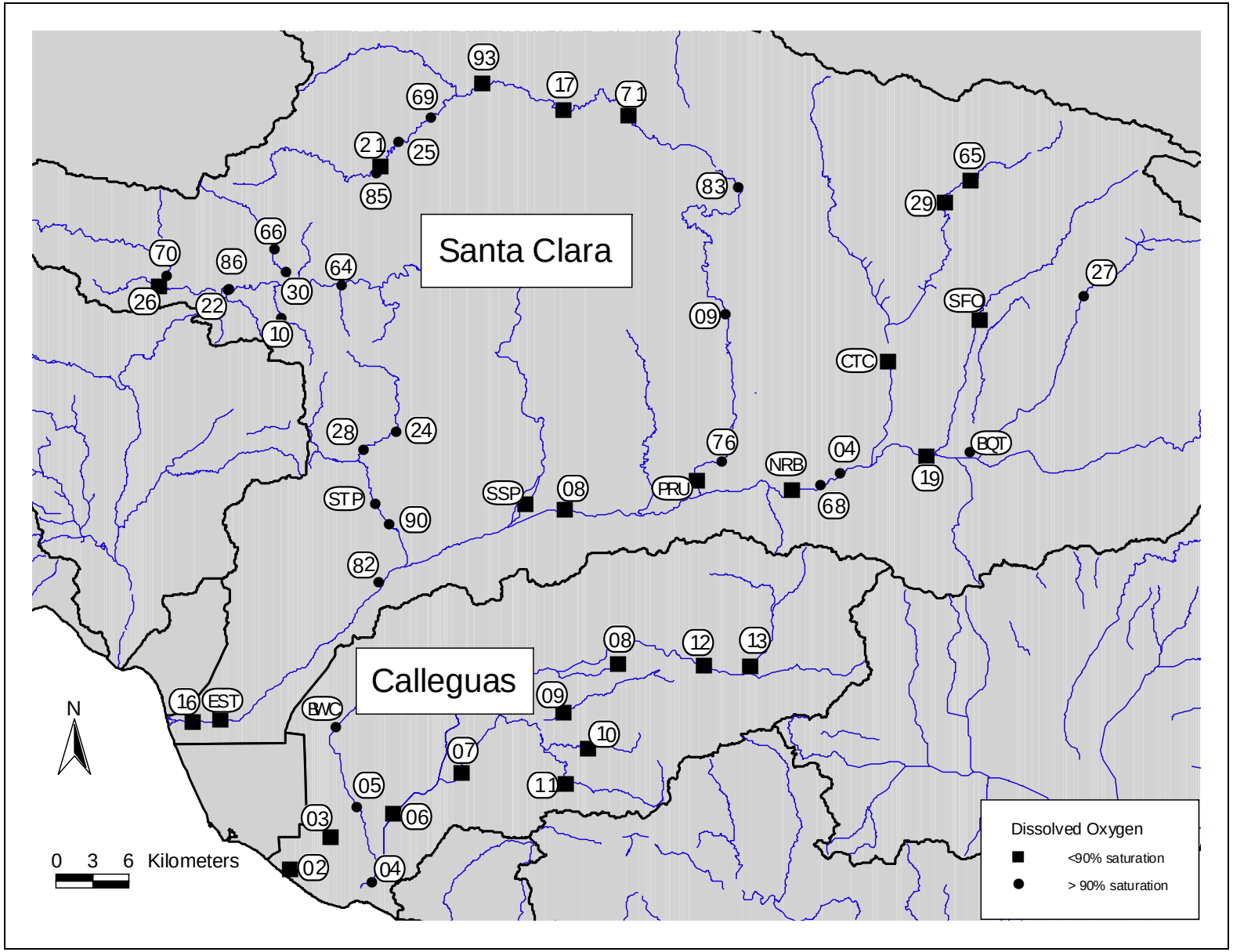
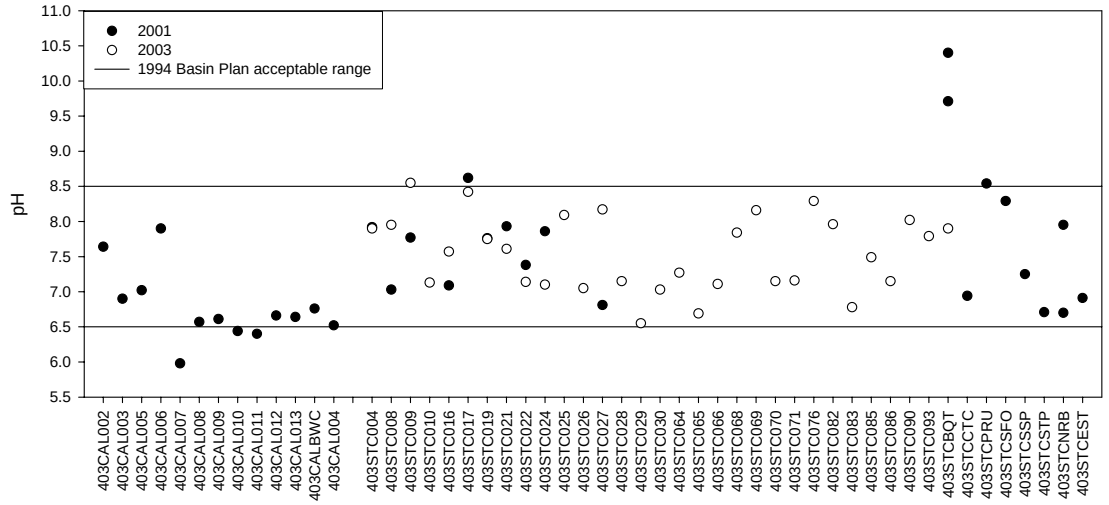


Figure 3. Dissolved oxygen at stations in the Calleguas Creek and Santa Clara River watersheds.

A)



B)

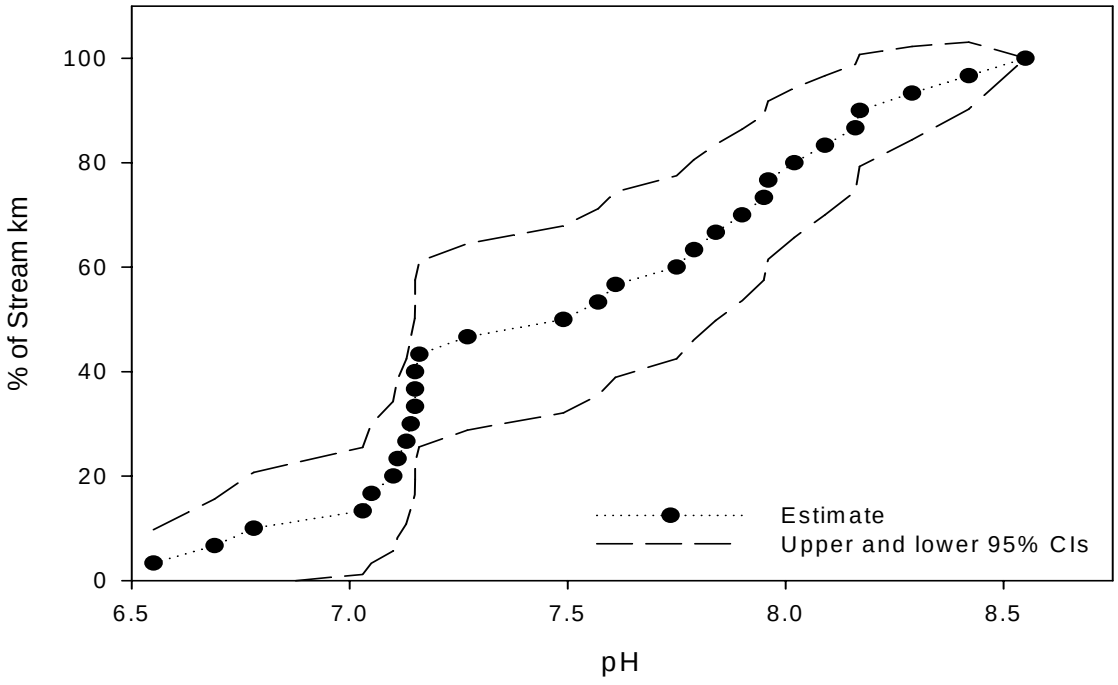


Figure 4. A) pH values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. Reference lines at 6.5 and 8.5 bracket the acceptable pH values in the 1994 Basin Plan. B) Cumulative frequency distribution with 95% confidence intervals of pH in the Santa Clara River watershed.

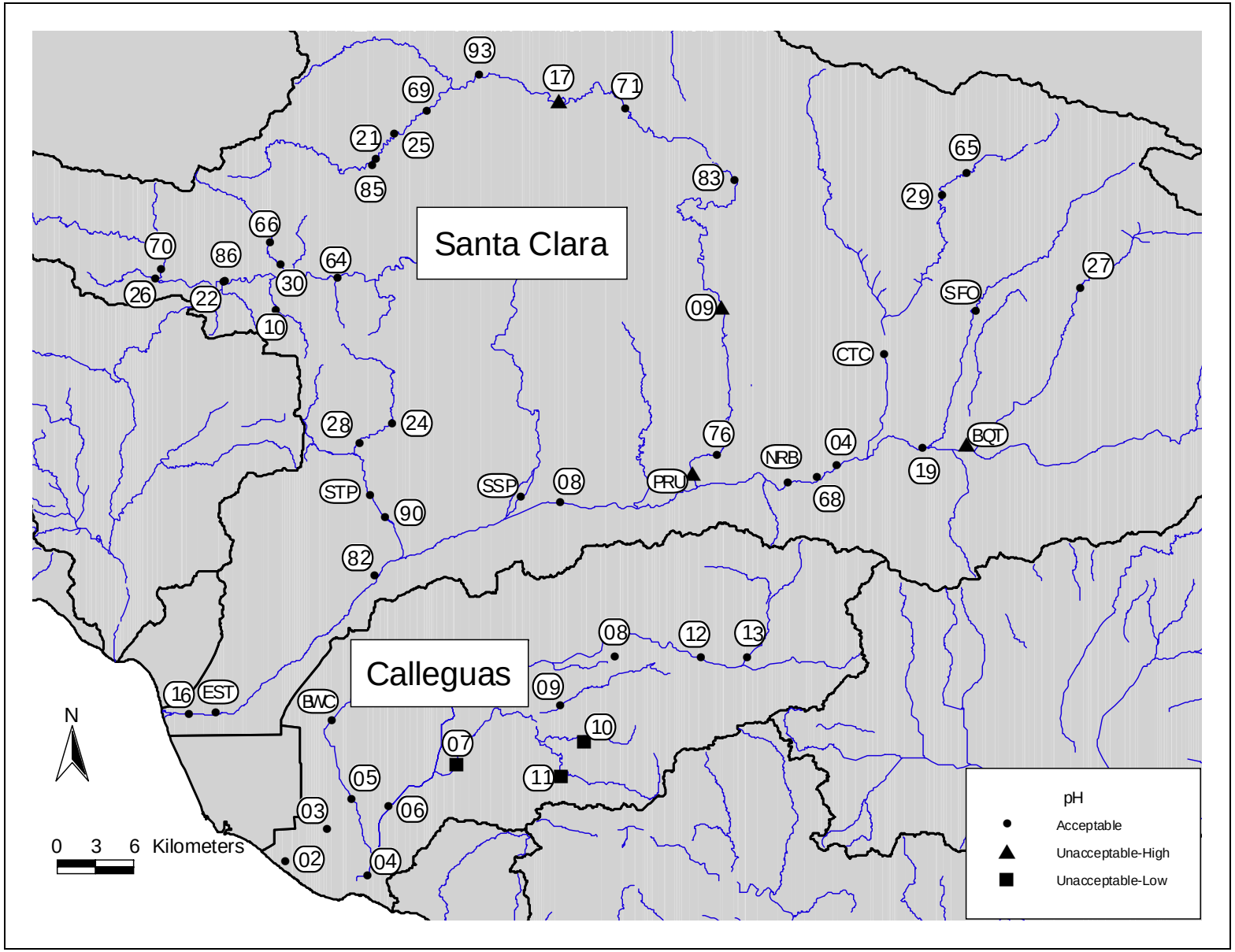
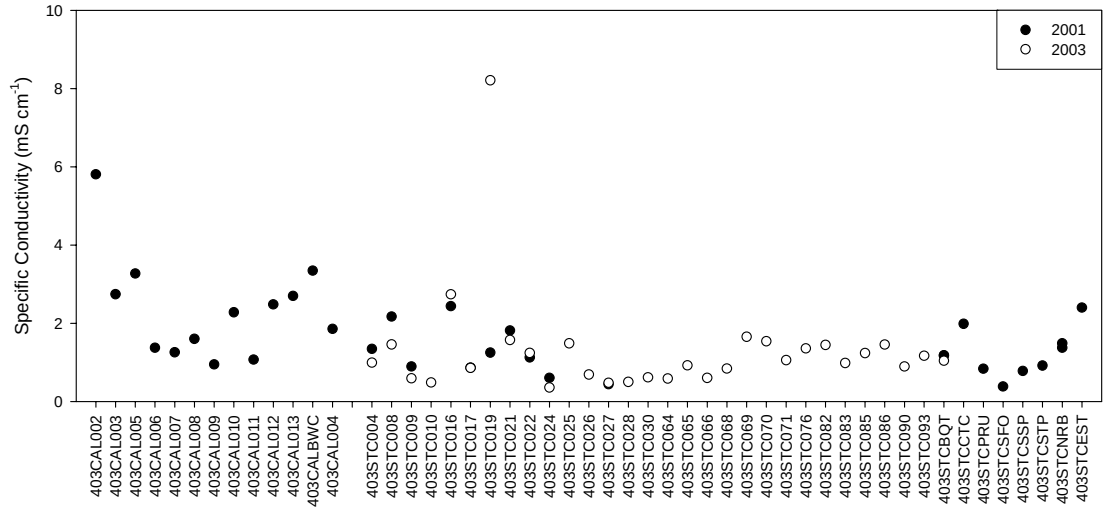


Figure 5. pH at stations in the Calleguas Creek and Santa Clara River watersheds.

A)



B)

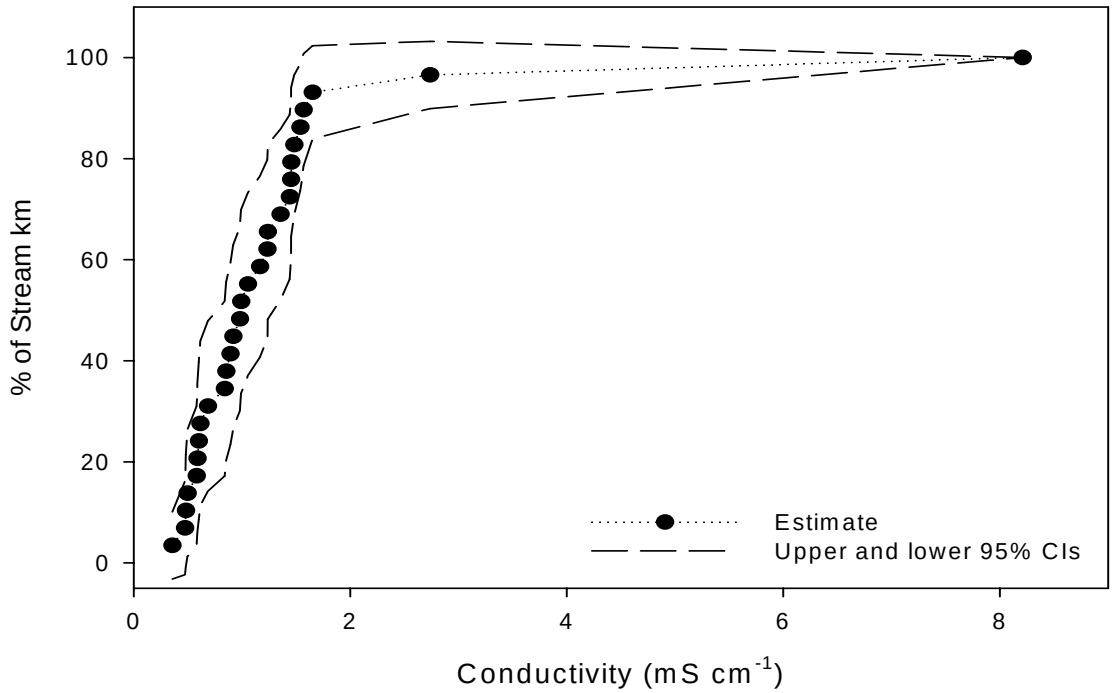
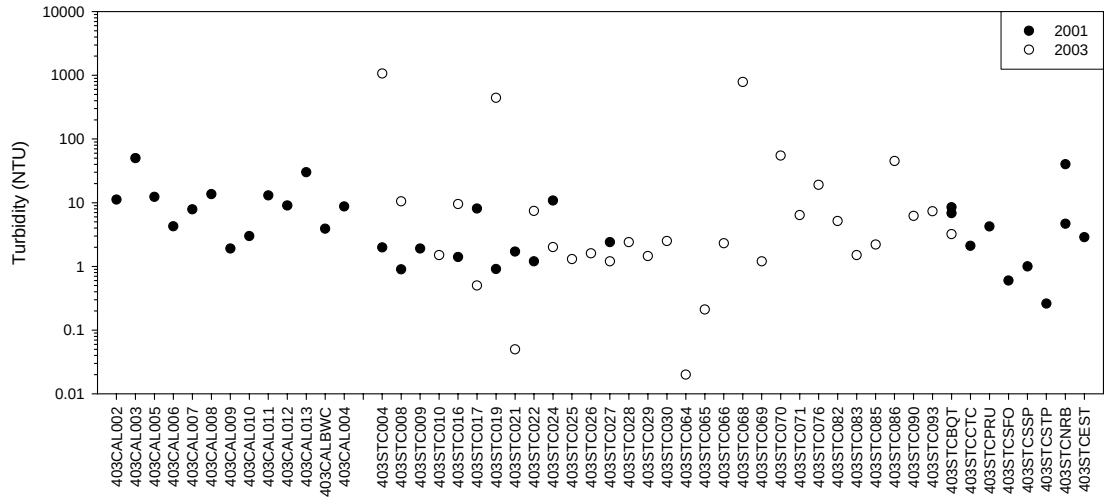


Figure 6. A) Specific conductivity values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. B) Cumulative frequency distribution with 95% confidence intervals of conductivity in the Santa Clara River watershed.

A)



B)

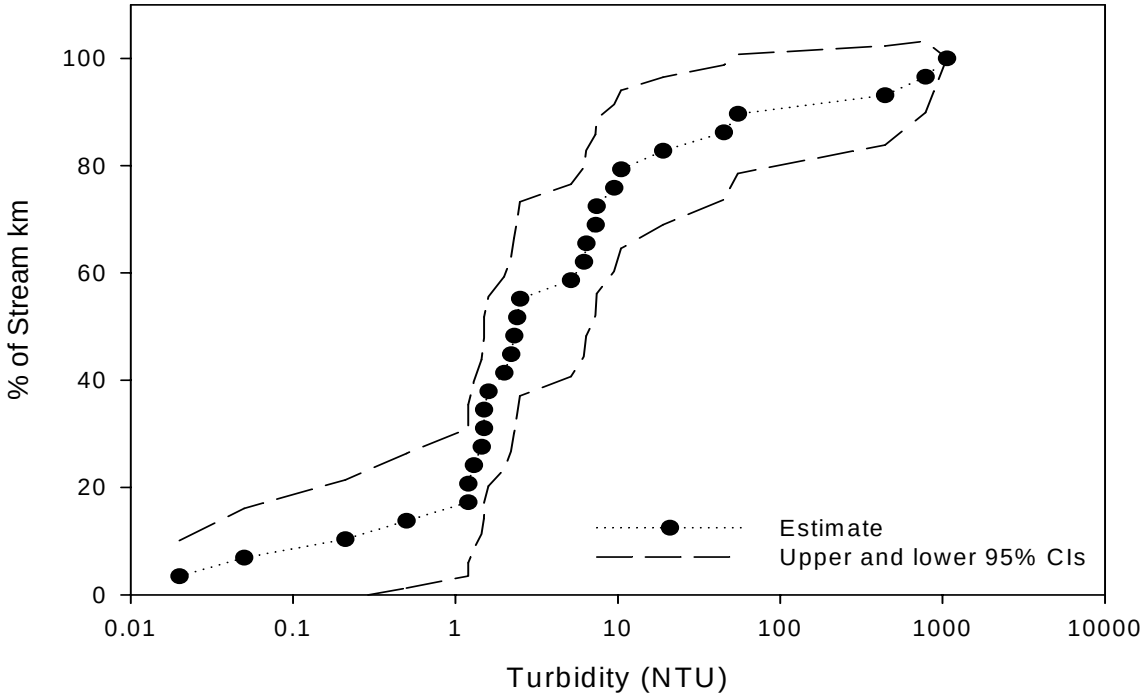


Figure 7. A) Turbidity values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. B) Cumulative frequency distribution with 95% confidence intervals of turbidity in the Santa Clara River watershed.

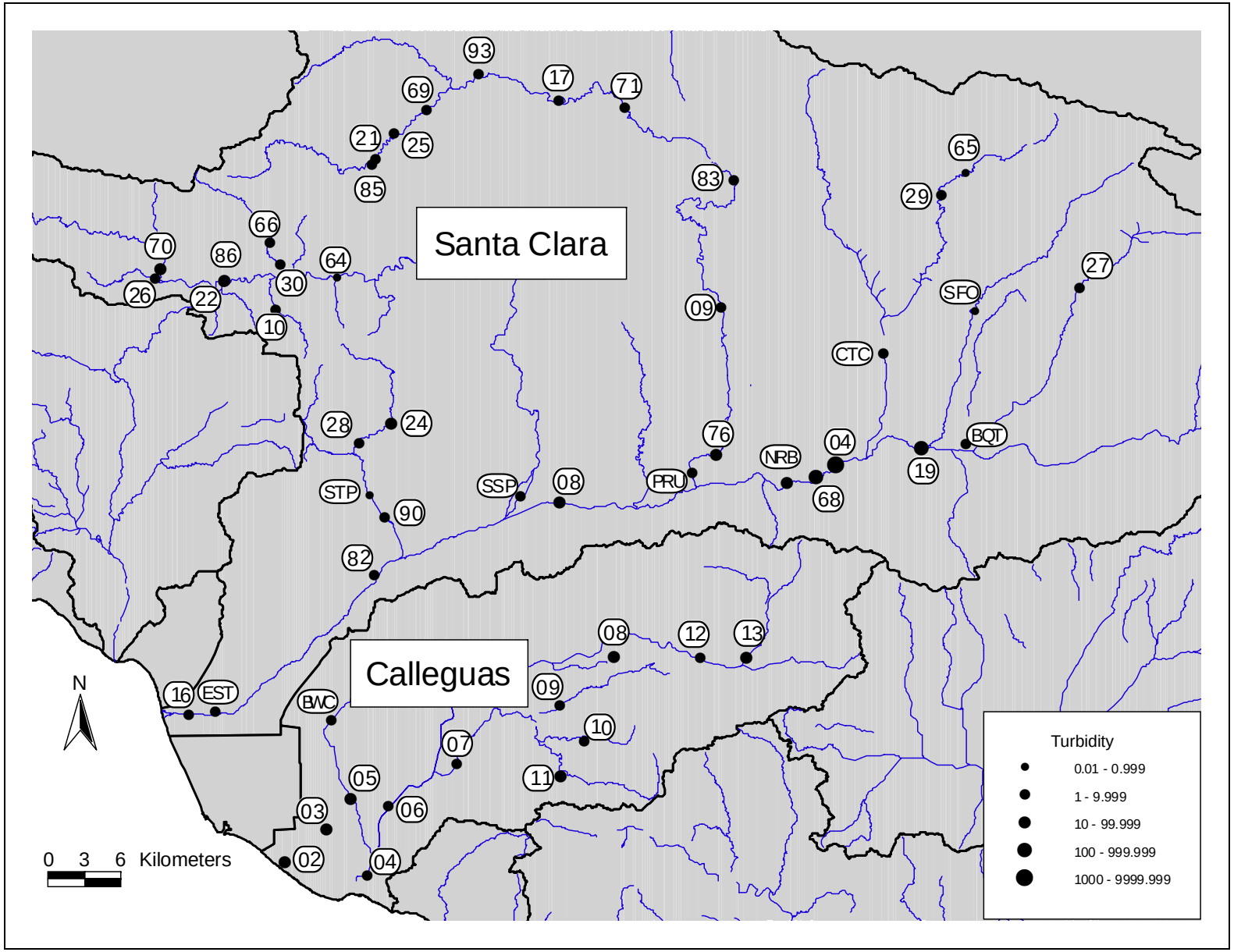


Figure 8. Turbidity at stations in the Calleguas Creek and Santa Clara River watersheds.

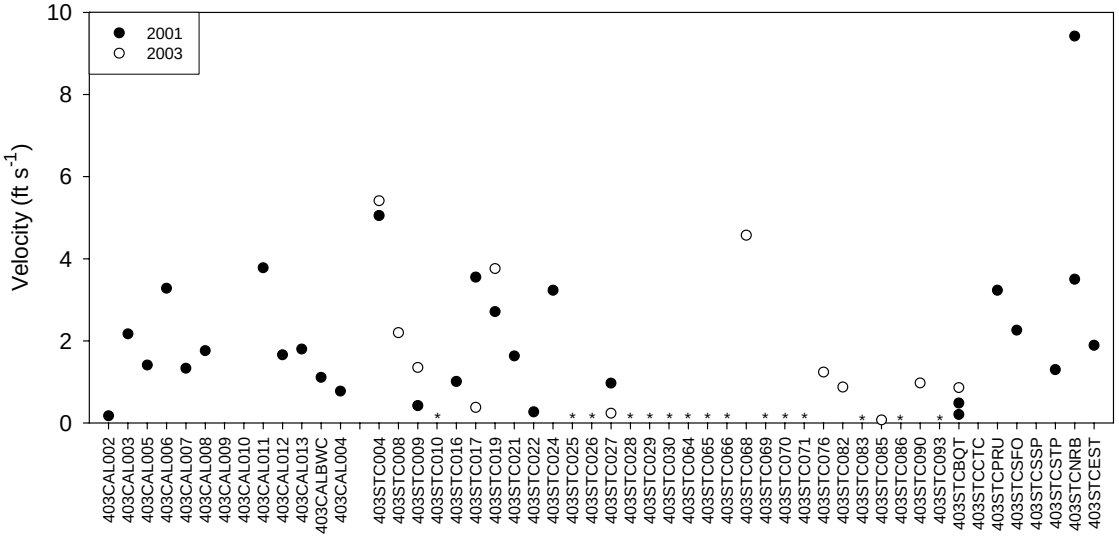


Figure 9. Stream velocity in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

4.2 Conventional Constituents in Water

Ammonia, nitrate+ nitrite, orthophosphate, boron, chloride, sulfate, TDS, chlorophyll a

Total ammonia-N concentrations ranged from 0.15 to 3.94 mg l^{-1} in the CAL watershed and from <0.05 to 6.640 mg l^{-1} in the STC watershed (Figure 10A). Total ammonia-N values at all sites except one met the 1-hour average objectives[1] for COLD waters (0.48 to 28.77 mg l^{-1}) (Figure 11), which are more conservative than the WARM water objectives (0.75 to 28.77 mg l^{-1}) (CRWQCB LAR 1994). Four additional sites had total ammonia-N values that did not meet the lower 4-day average objectives for COLD waters (0.077 to 2.47 mg l^{-1}), which are also more conservative than those for WARM waters (0.11 to 2.47 mg l^{-1}) (CRWQCB LAR 1994). Generally, the objectives were exceeded because total NH_3-N was relatively high; however a low total NH_3-N value at 403STCBQT exceeded the objective when temperature and pH were high. 60% of STC streams had total ammonia -N values <MDL (Figure 12).

Un-ionized NH_3-N ranged from $7.22x10^{-5}$ to $6.44x10^{-3}$ mg l^{-1}in the CAL watershed and from $1.40x10^{-4}$ to $1.817x10^{-1}$ mg l^{-1} in the STC watershed (Figure 10B). Un-ionized ammonia-N values at all sites met the 1-hour average objectives for COLD waters, which are the same as WARM water objectives (0.0075 to 0.21 mg l^{-1}) (CRWQCB LAR 1994). Values from 5 sites did not meet the 4-day average objectives for COLD waters ($6.58x10^{-4}$ to $3.45x10^{-2}$ mg l^{-1}) (Figure 12), which are more conservative than those for WARM waters ($6.58x10^{-4}$ to $4.85x10^{-2}$ mg l^{-1}) (CRWQCB LAR 1994). A reliable CDF cannot be constructed because many total ammonia-N values were <MDL, preventing calculation of un-ionized ammonia-N.

Nitrite-N concentrations ranged from 0.020 to 0.320 mg l^{-1} in the CAL watershed and from <0.005 to 0.420 mg l^{-1} in the STC watershed (Figure 13A). All values were below the Basin Plan MCL of 1.0 mg l^{-1} (CRWQCB LAR 1994). 57% of STC streams had nitrite-N values <MDL (Figure 14A).

Basin Plan limits are 10 mg l^{-1} for nitrate-N and for nitrite-N + nitrate-N (CRWQCB LAR 1994). Additionally, in the STC and CAL watersheds, there are reach-specific objectives of either 5 or 10 mg l^{-1} nitrite-N + nitrate-N. Because nitrite-N values were so low, nitrite-N + nitrate-N values are almost identical to those of nitrate-N. Nitrate-N concentrations ranged from <0.09 to 64.2 mg l^{-1} in the CAL watershed and from <0.005 to 31.5 mg l^{-1} in the STC watershed (Figure 13B). Data from the 30 stations sampled in 2003 indicate that 23% of STC streams had nitrate-N > 0.38 mg l^{-1}, which is the suggested total N value for reference conditions in the Xeric West portion of the US (US EPA 2000), and 20% were > 1.0 mg l^{-1} (Figure 14B). Nitrate-N values above the 10 mg l^{-1} MCL specified in the 1994 Basin Plan occurred at stations in the lower portions of each watershed (403CAL002-006, –BWC, and 403STC016) (Figure 15).

Orthophosphate-P values ranged from 0.05 to 1.34 mg l^{-1} in the CAL watershed and from 0.009 to 0.18 mg l^{-1} in the STC watershed (Figure 16A). No orthophosphate-P objective

[1] Objectives for total and un-ionized ammonia vary with pH and temperature (CRWQCB LAR 1994).

is specified in the Basin Plan, but USEPA recommended limits for orthophosphate-P and total P in streams are 0.05 and 0.10 mg l^{-1}, respectively (US EPA 1986). Data from the 30 stations sampled in 2003 indicate that orthophosphate-P was > 0.05 mg l^{-1} in 27% of streams and > 0.10 mg l^{-1} in 13% (Figure 16B). The suggested total P value for reference conditions in the Xeric West portion of the US is 0.0218 mg l^{-1} (US EPA 2000); orthophosphate-P in 57% of STC streams exceeded this value. The highest values, which exceeded 1.0 mg l^{-1}, occurred in the CAL watershed at sites 004 and 006-008 (Figure 17).

Boron concentrations ranged from 0.28 to 2.8 mg l^{-1} in the CAL watershed and from 0.06 to 5.70 mg l^{-1} in the STC watershed (Figure 18A). Basin Plan boron objectives in the CAL and STC watersheds vary from 0.5 to 1.5 mg l^{-1} with stream reach, and there are no objectives for the lowest reaches in each watershed (CRWQCB LAR 1994). Samples from 5 sites had boron concentrations that exceeded their respective stream reach objectives, and most of the samples collected at sites for which objectives do not exist had relatively high boron concentrations (Figure 19). Data from the 30 stations sampled in 2003 indicate that 17% of STC streams had boron concentrations ≥ 1.0 mg l^{-1} (Figure 18B), which is the California DHS action level for drinking water (Marshack 2003).

Chloride concentrations ranged from 91.2 to 730 mg l^{-1} in the CAL watershed and from 1.74 to 187 mg l^{-1} in the STC watershed (Figure 20A). Basin Plan chloride objectives in these watersheds also vary, from 45 to 150 mg l^{-1}, with stream reach, and there are no objectives for the lowest reaches in each watershed (CRWQCB LAR 1994). Samples from 11 sites had chloride concentrations that exceeded their respective stream reach objectives, and three of the four highest concentrations were from sites for which objectives do not exist (Figures 20A and 21). However, most values were below the USEPA 4-day average criteria for toxicity to aquatic life of 230 mg l^{-1} (Marshack 2003); exceedences of this criterion occurred in the CAL watershed. Data from the 30 stations sampled in 2003 indicate that chloride concentrations in 100% of STC streams were <230 mg l^{-1} (Figure 20B).

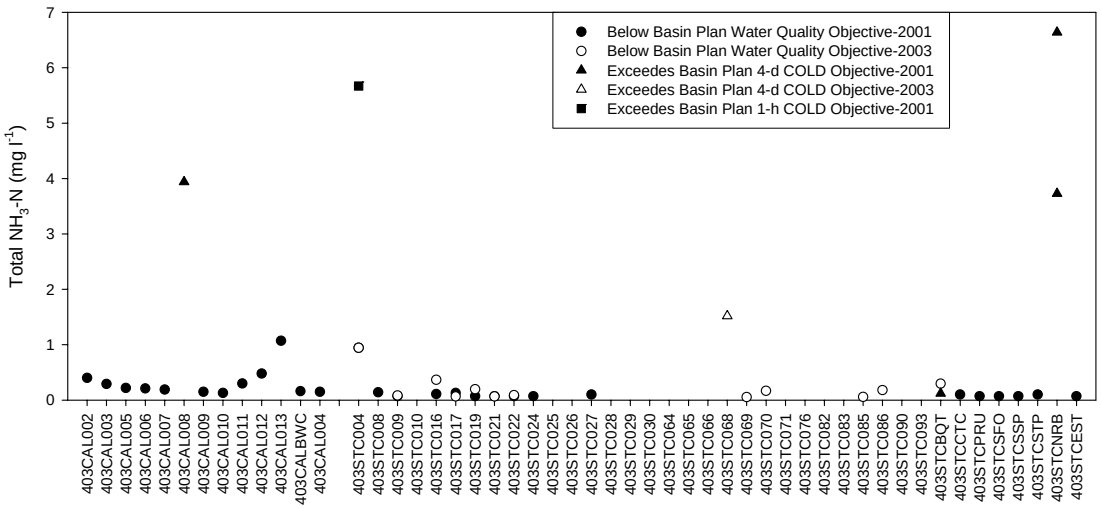
Sulfate concentrations ranged from 118 to 1650 mg l^{-1} in the CAL watershed and from 21.6 to 1170 mg l^{-1} in the STC watershed (Figure 22A). Basin Plan sulfate objectives in these watersheds vary from 100 to 650 mg l^{-1} depending on stream reach, and there are no objectives for the lowest reaches in each watershed (CRWQCB LAR 1994). Samples from 14 sites had sulfate concentrations that exceeded their respective stream reach objectives (Figure 23). Most of the samples collected at sites for which objectives do not exist had relatively high sulfate concentrations. Suggested drinking water criteria are 250 and 500 mg l^{-1} (Marshack 2003). Data from the 30 stations sampled in 2003 indicate that 47% and 30% of STC streams exceed these criteria, respectively (Figure 22B).

TDS values ranged from 690 to 4470 mg l^{-1} in the CAL watershed and from 234 to 1900 mg l^{-1} in the STC watershed (Figure 24A). Basin Plan TDS objectives vary from 500 to 1300 mg l^{-1} depending on stream reach, and similar to boron, chloride and sulfate, there are no objectives for the lowest reaches in each watershed (CRWQCB LAR 1994). Samples from 18 sites had TDS concentrations that exceeded their respective stream reach objectives, and samples collected at sites for which objectives do not exist had

relatively high TDS concentrations (Figure 25). Data from the 30 stations sampled in 2003 indicate that TDS concentrations in 70% of STC streams exceeded state and federal drinking water criteria of 500 mg l^{-1} (Marshack 2003) (Figure 24B).

Chlorophyll a values ranged from 2.7 to to 55.0 µg l^{-1} in the CAL watershed and from 0.06 to 16.9 µg l^{-1} in the STC watershed (Figure 26A). The highest values overall were from sites throughout the CAL watershed and several sites in the STC watershed (Figure 27). There are no established objectives for chl a suspended in the water column for flowing waters in the 1994 Basin Plan or elsewhere. However the suggested chl a value for reference conditions in the Xeric West portion of the US is 1.78 µg l^{-1} as determined by the fluorometric method (US EPA 2000); data from the 30 stations sampled in 2003 indicate that 20% of STC streams exceeded this value (Figure 26B).

A)



B)

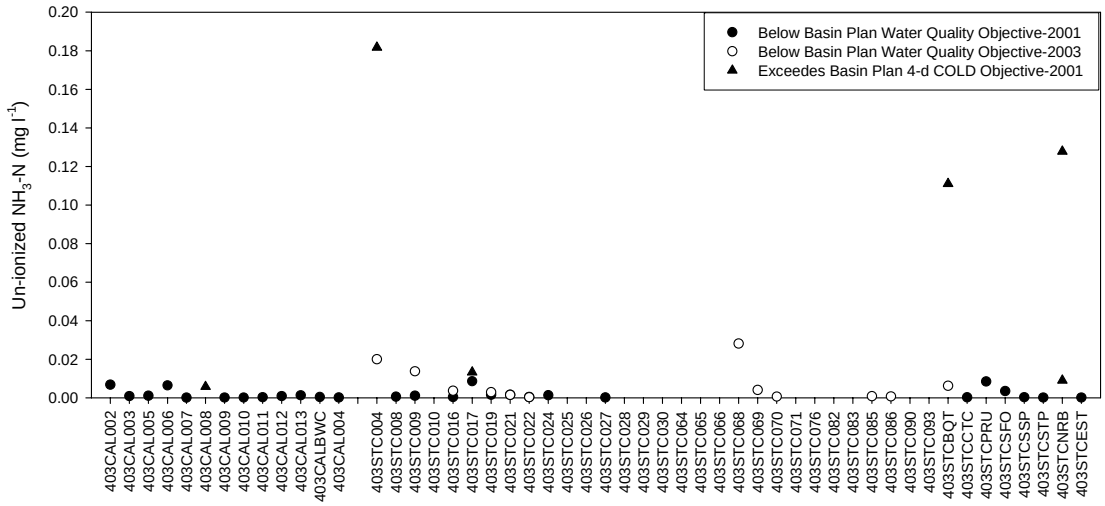


Figure 10. Total ammonia-N (A) and un-ionized ammonia-N (B) values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. When no value is graphed, total NH_3-N was <0.05 mg l^{-1}, which prevents calculation of un-ionized NH_3-N.

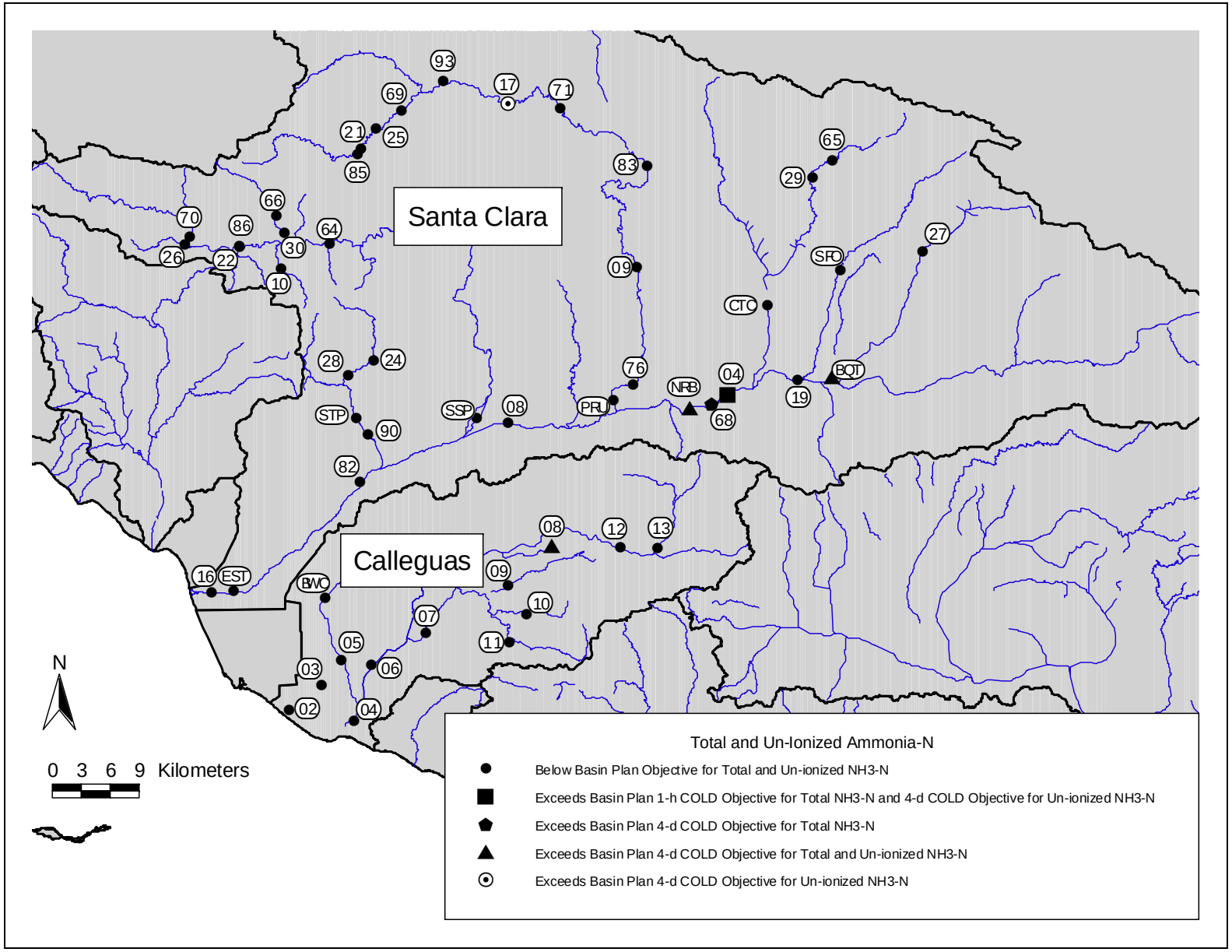


Figure 11. Total and un-ionized ammonia-N at stations in the Calleguas Creek and Santa Clara River watersheds.

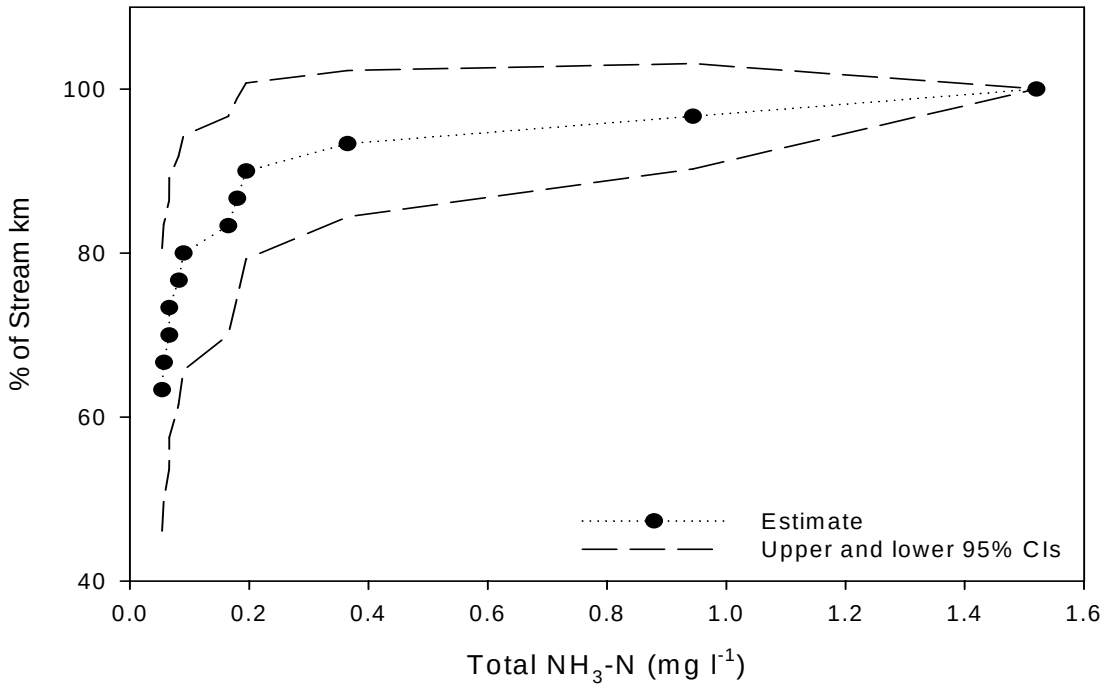
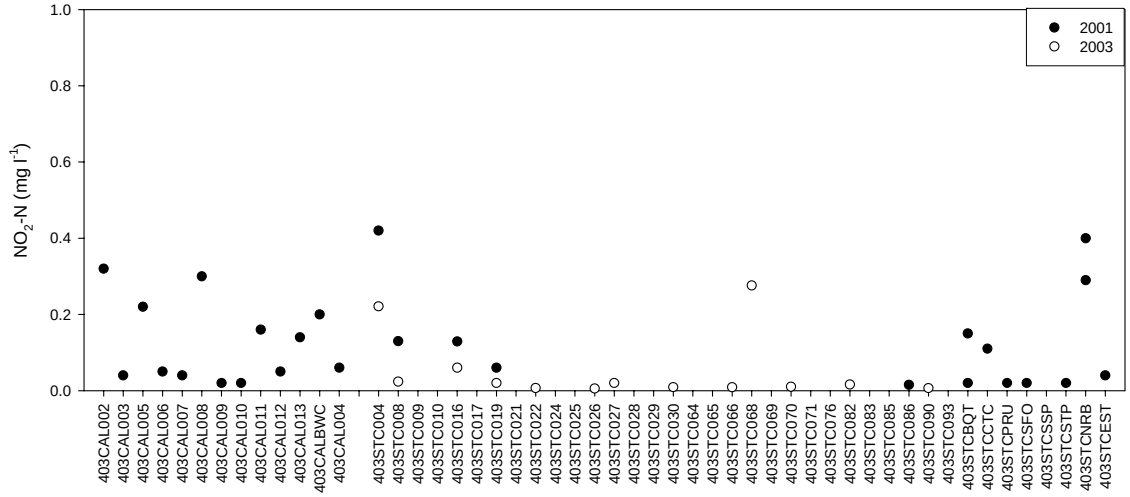


Figure 12. Cumulative frequency distribution with 95% confidence intervals of total ammonia-N in the Santa Clara River watershed.

A)



B)

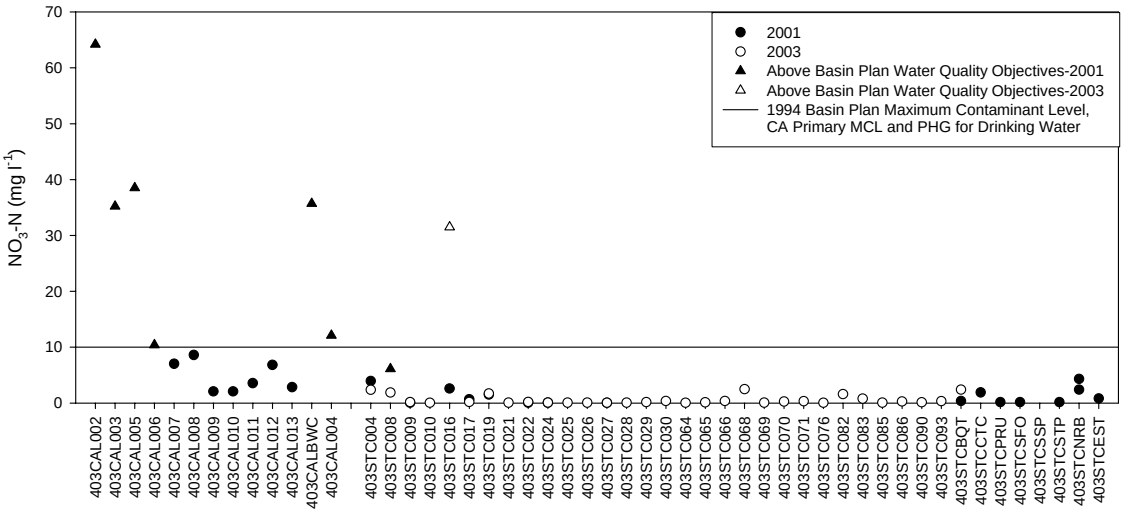
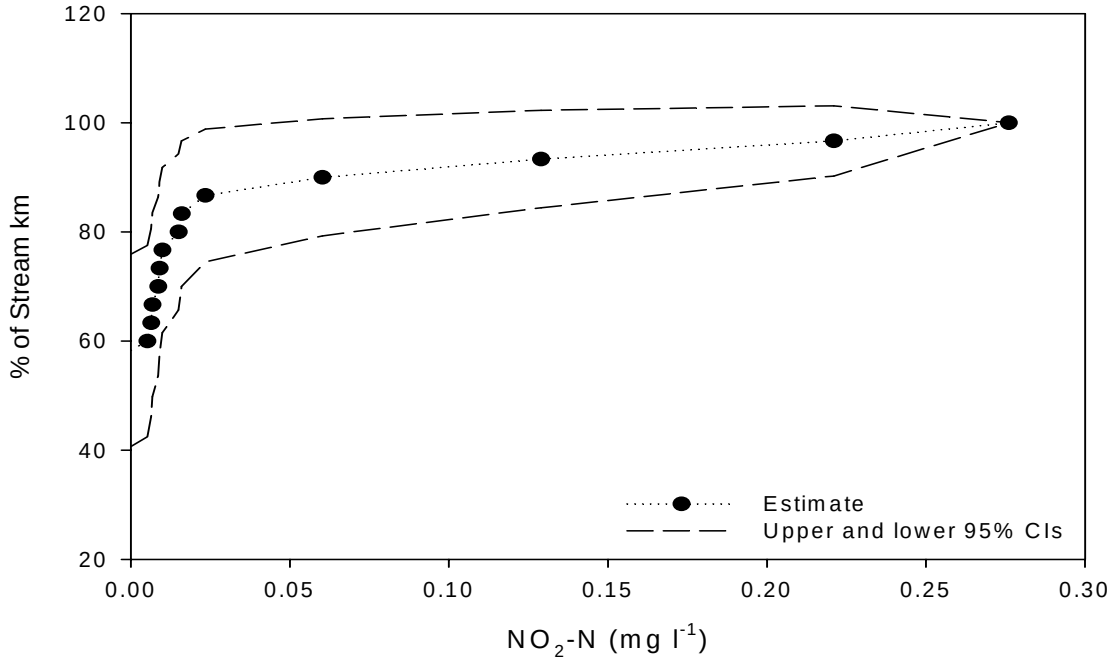


Figure 13. A) Nitrite -N values and B) nitrate-N values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. When no value is graphed, it was <MDL.

A)



B)

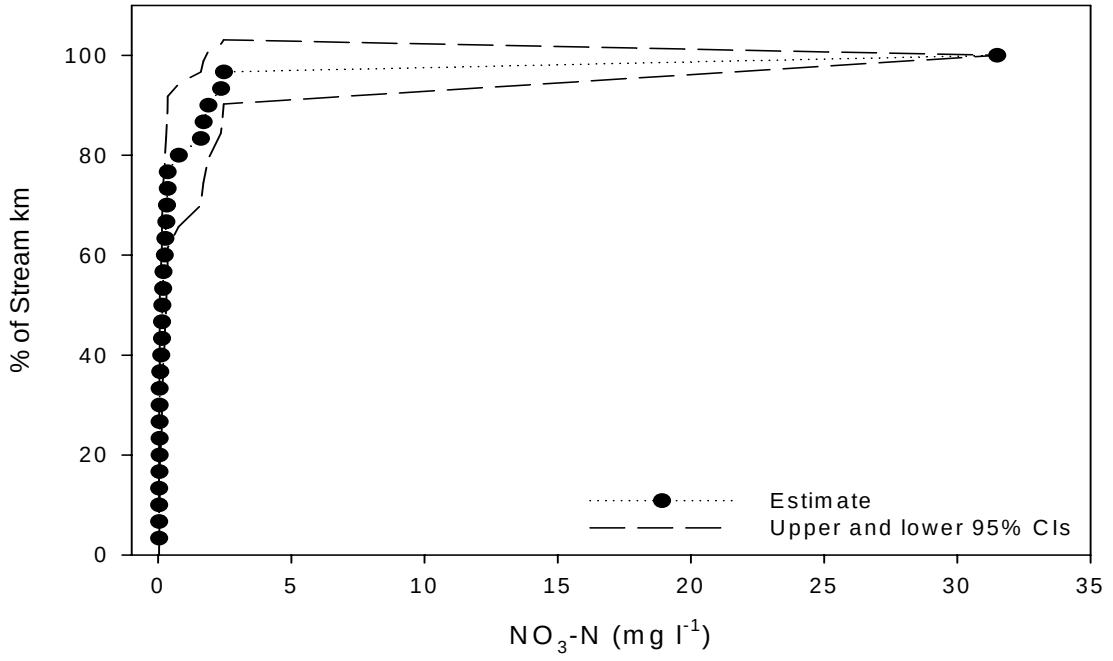


Figure 14. Cumulative frequency distribution with 95% confidence intervals of nitrite-N (A) and nitrate-N (B) in the Santa Clara River watershed.

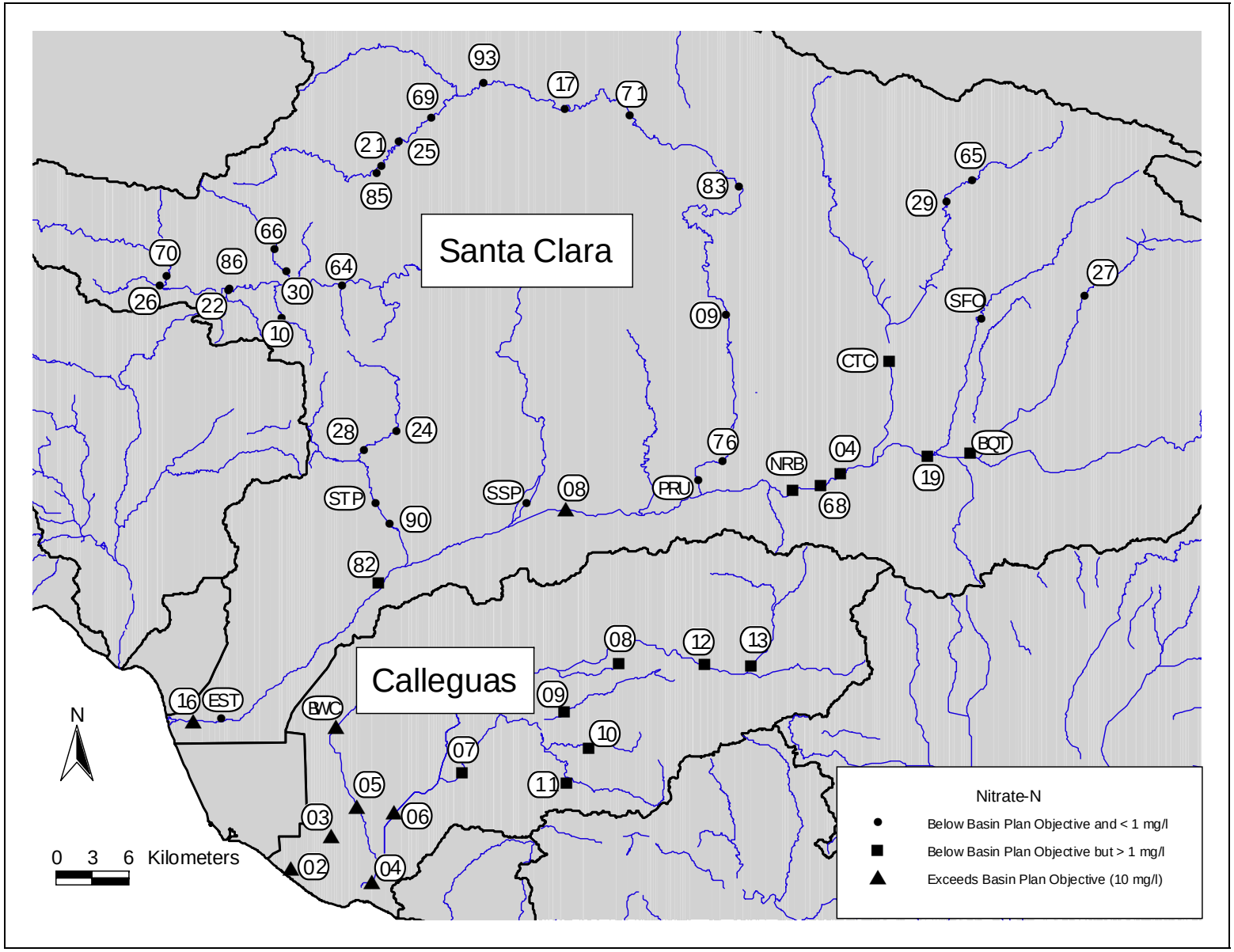
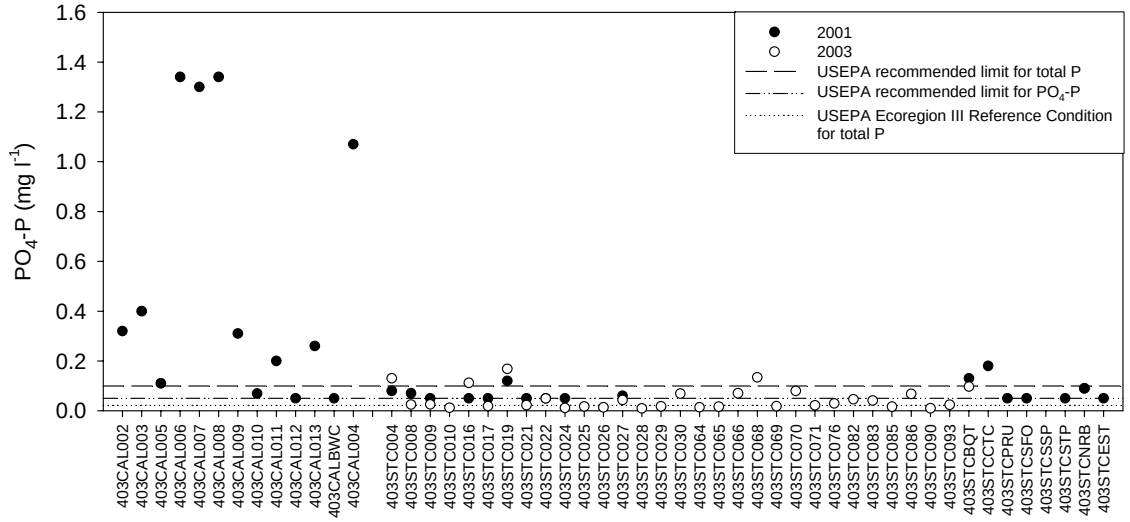


Figure 15. Nitrate-N at stations in the Calleguas Creek and Santa Clara River watersheds.

A)



B)

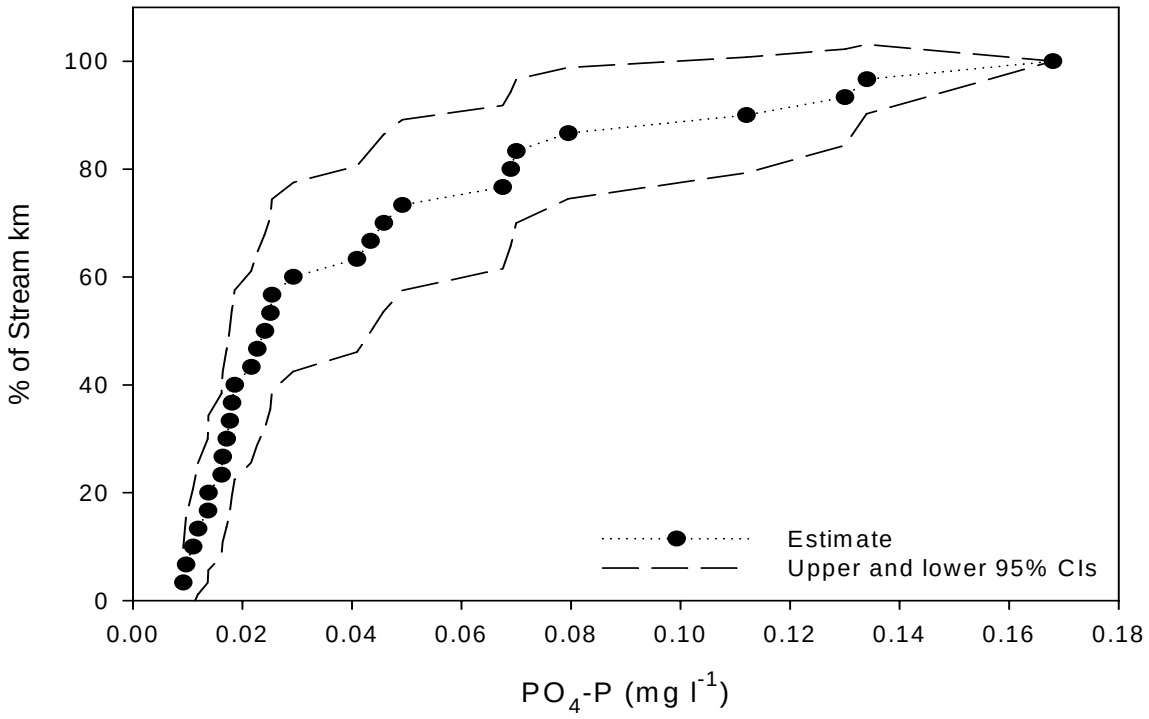


Figure 16. A) Orthophosphate-P values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. When no value is graphed, it was <MDL. B) Cumulative frequency distribution with 95% confidence intervals of orthophosphate-P in the Santa Clara River watershed.

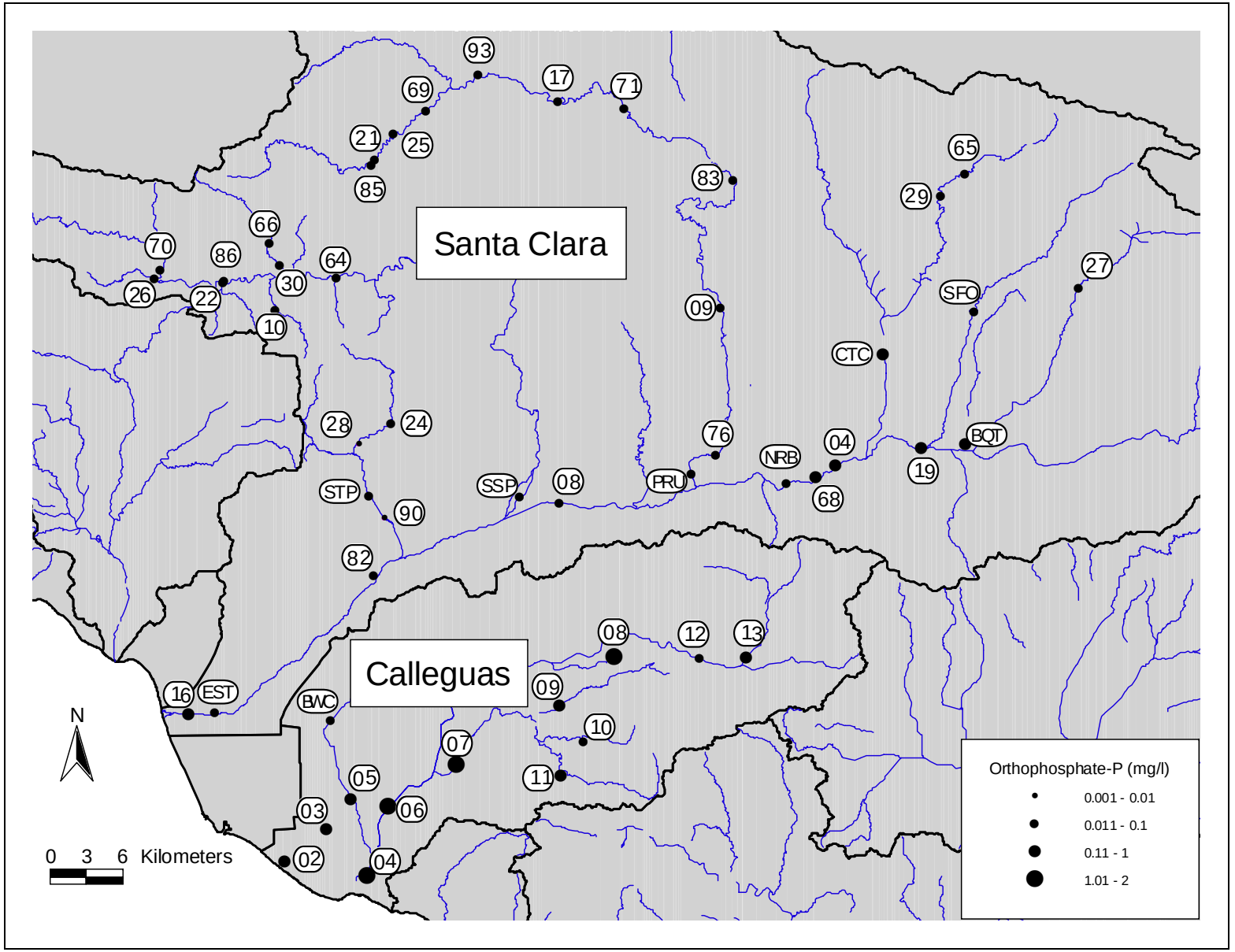
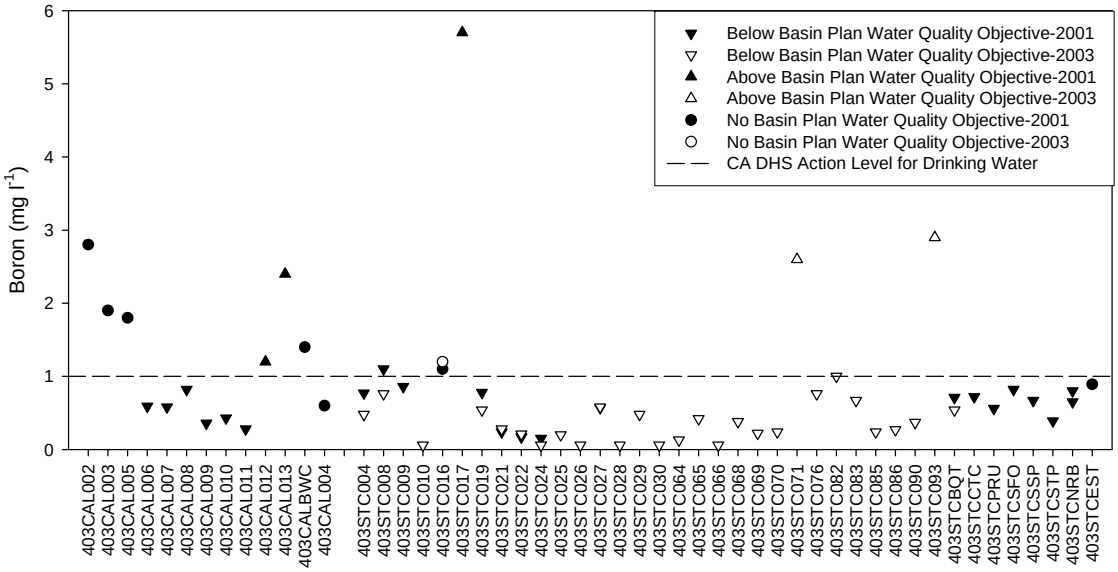


Figure 17. Orthophosphate-P at stations in the Calleguas Creek and Santa Clara River watersheds.

A)



B)

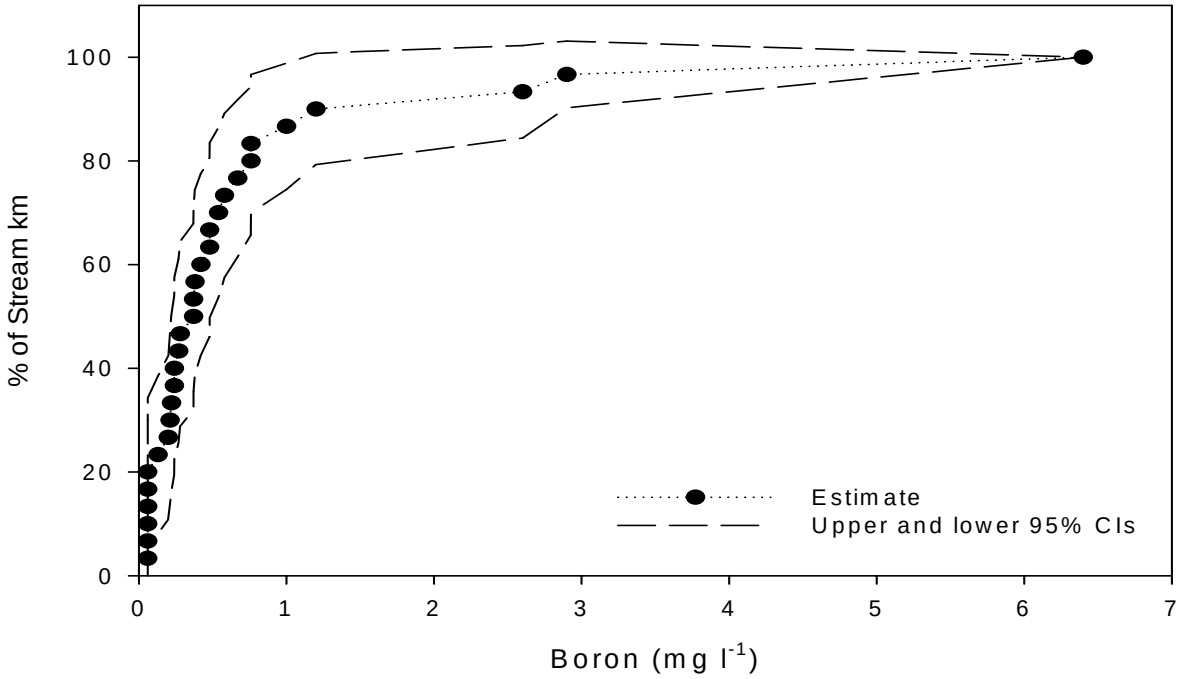


Figure 18. A) Boron values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. B) Cumulative frequency distribution with 95% confidence intervals of boron in the Santa Clara River watershed.

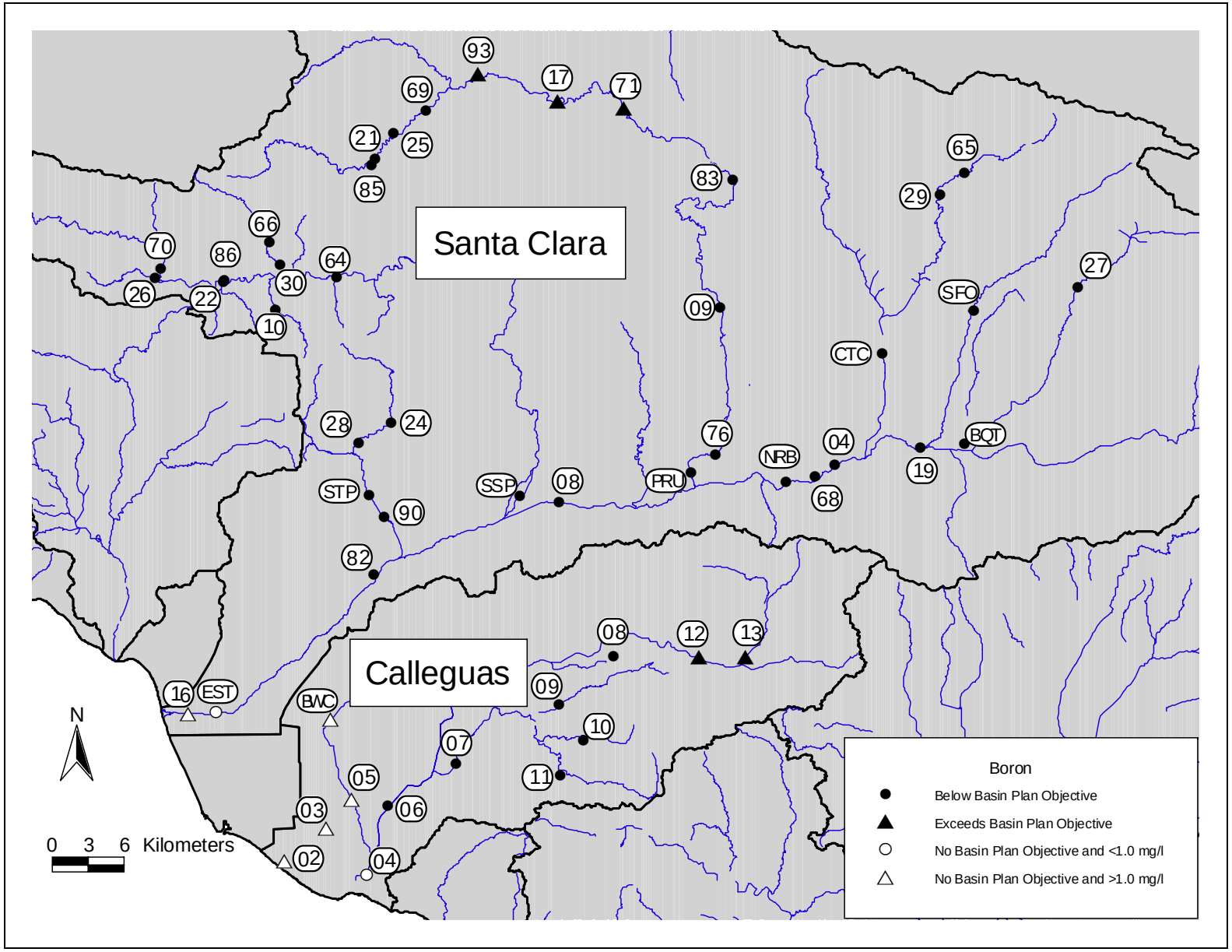
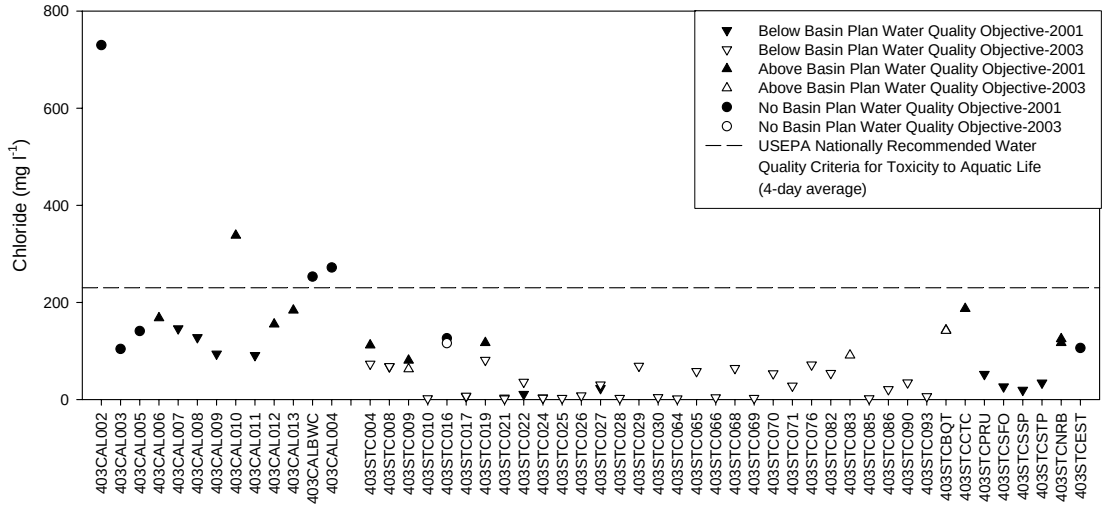


Figure 19. Boron at stations in the Calleguas Creek and Santa Clara River watersheds.

A)



B)

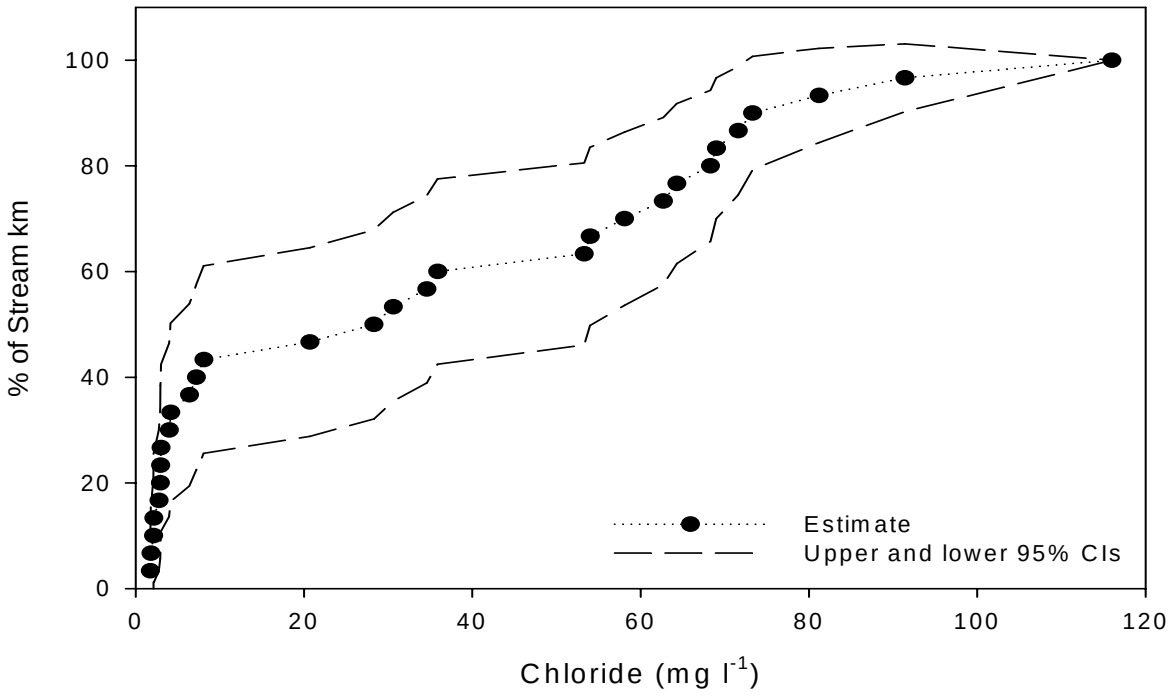


Figure 20. A) Chloride values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. B) Cumulative frequency distribution with 95% confidence intervals of chloride in the Santa Clara River watershed.

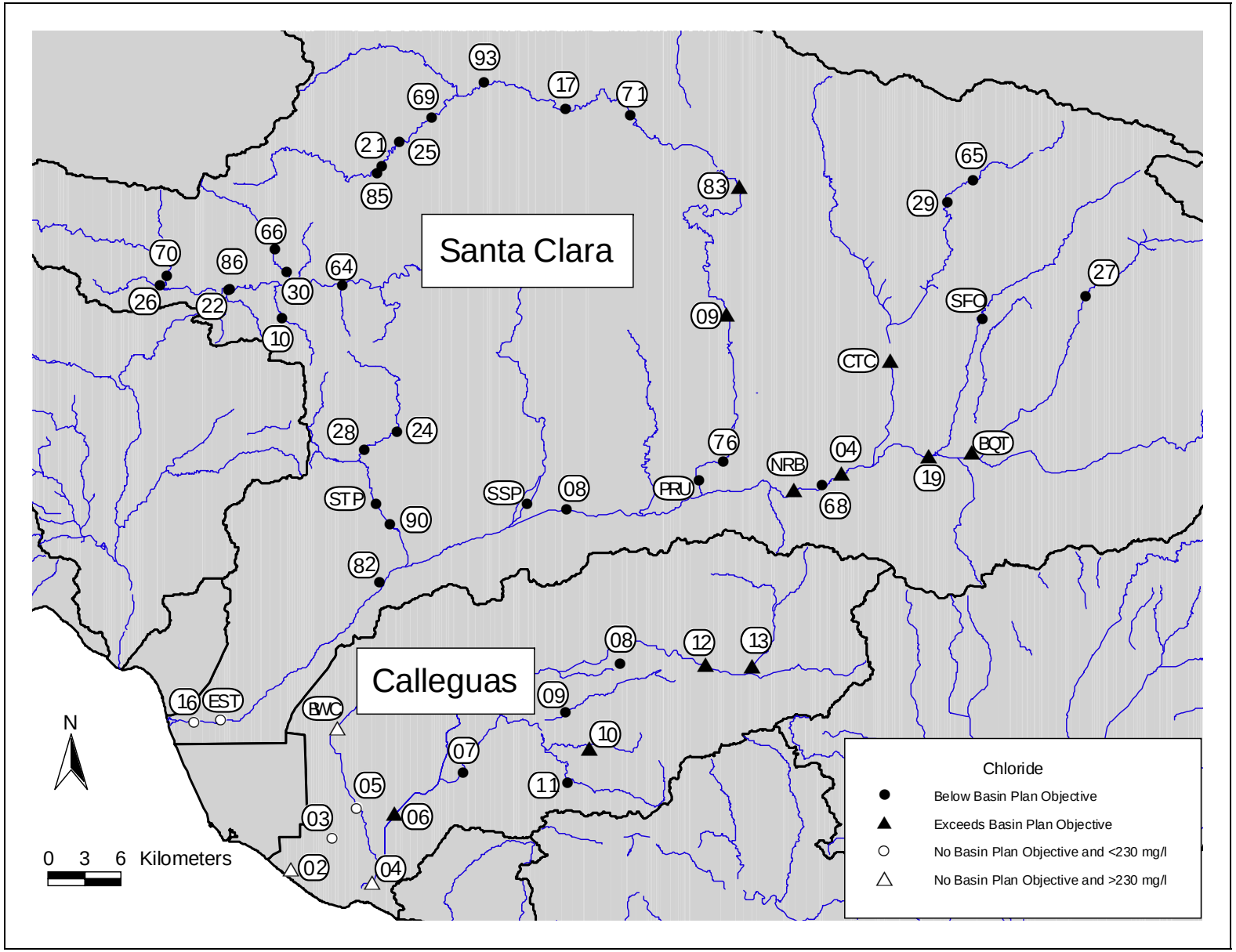
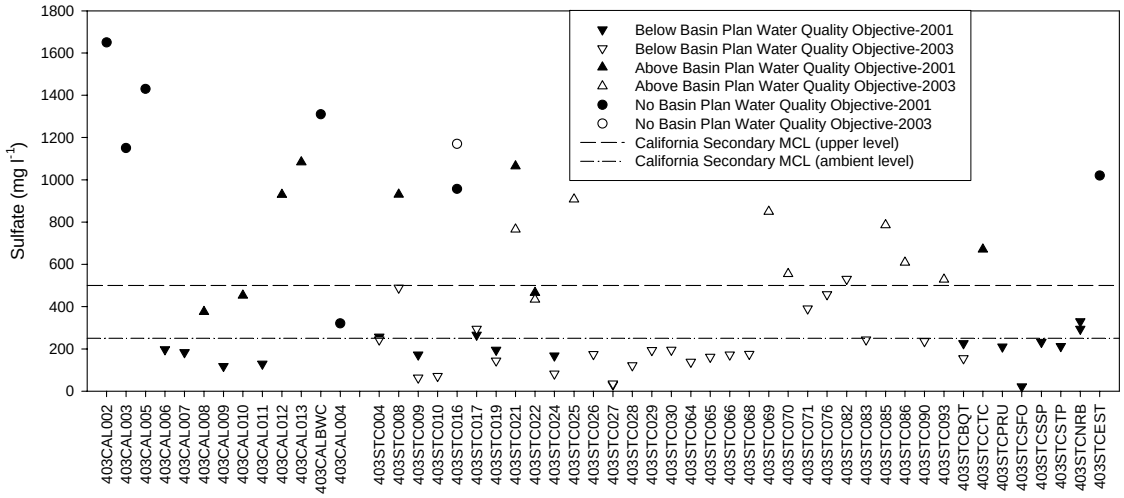


Figure 21. Chloride at stations in the Calleguas Creek and Santa Clara River watersheds.

A)



B)

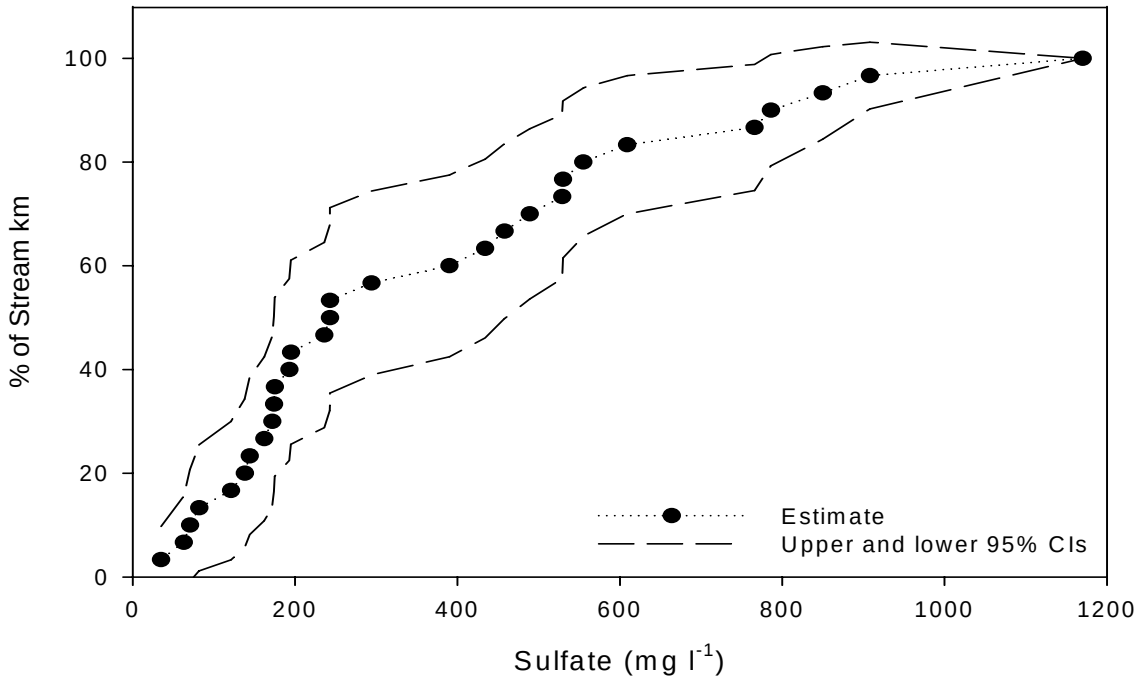


Figure 22. A) Sulfate values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. B) Cumulative frequency distribution with 95% confidence intervals of sulfate in the Santa Clara River watershed.

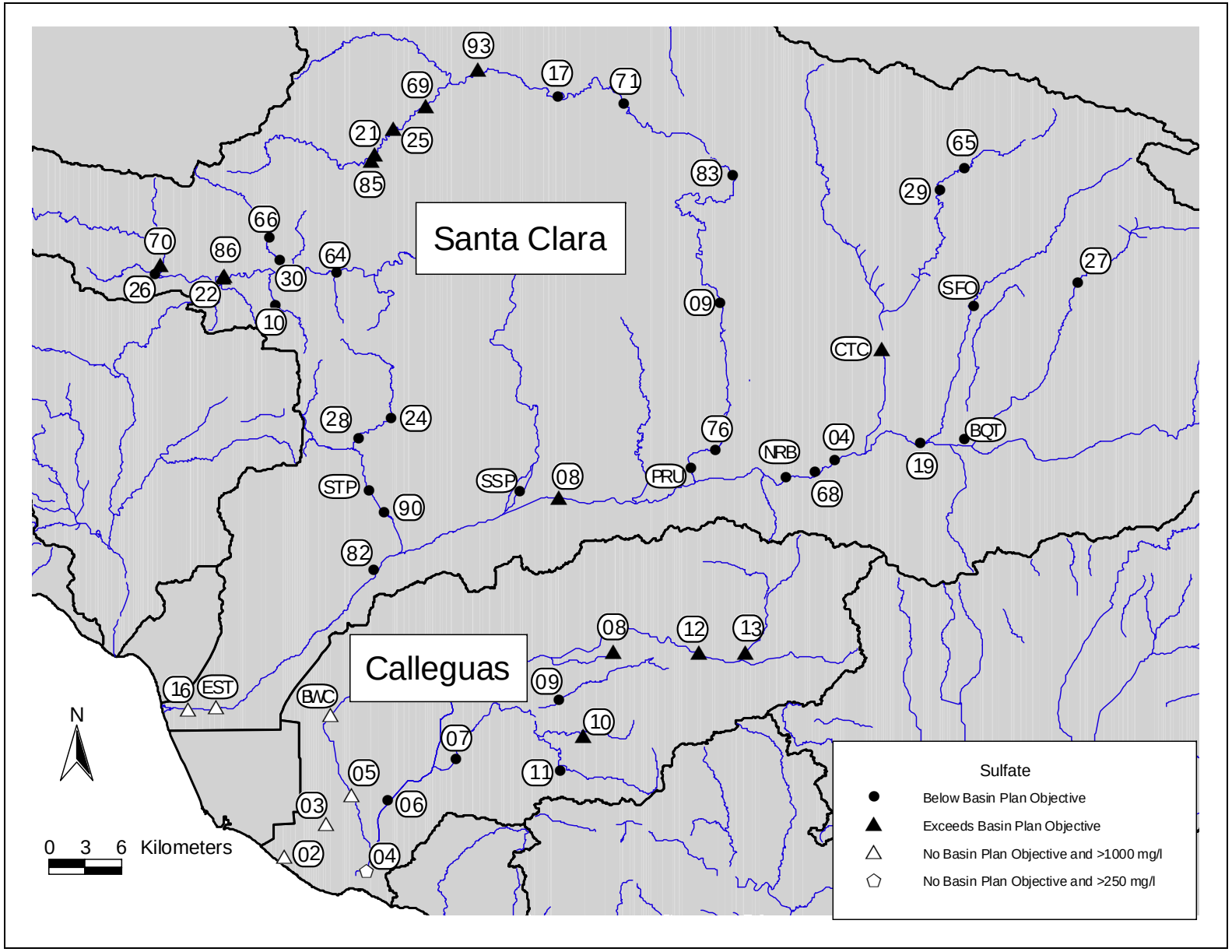
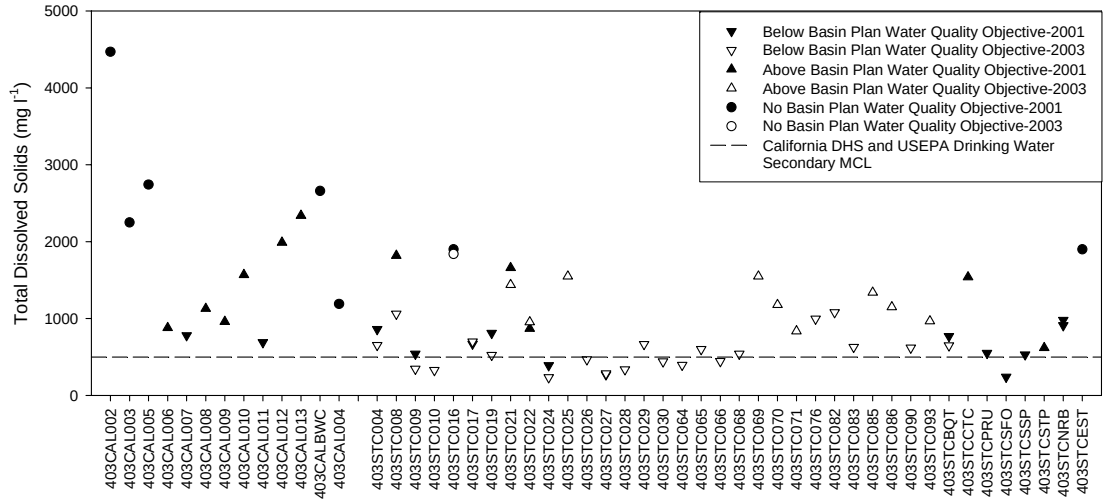


Figure 23. Sulfate at stations in the Calleguas Creek and Santa Clara River watersheds.

A)



B)

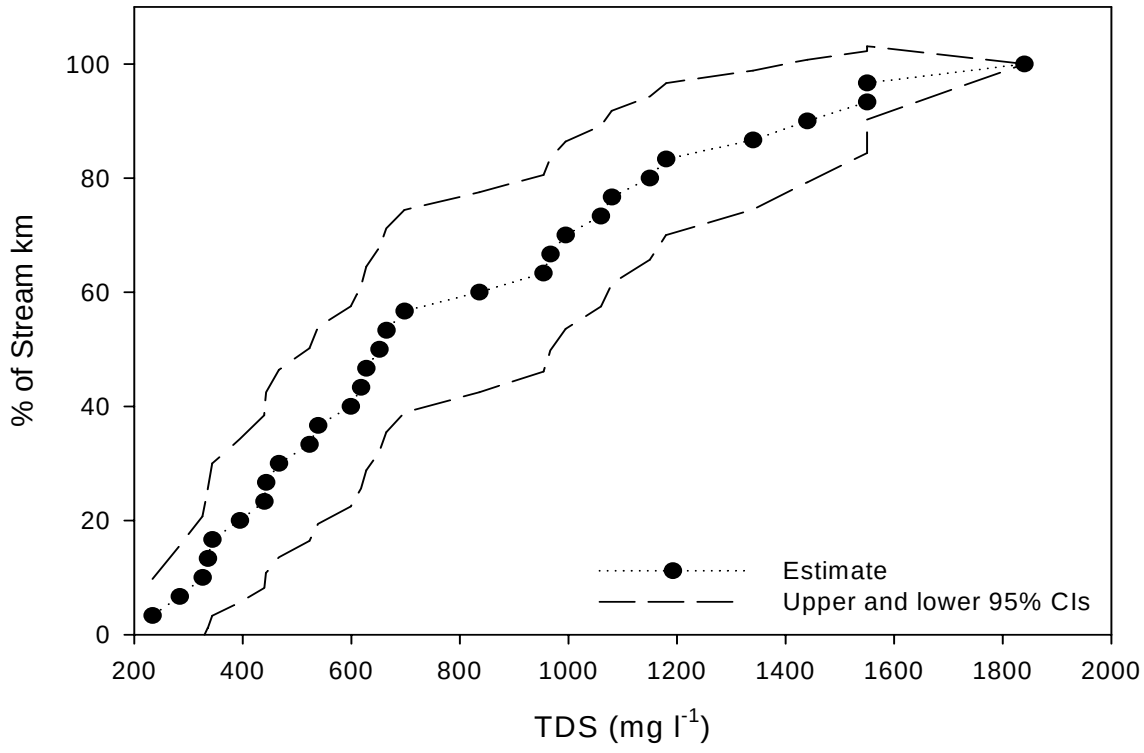


Figure 24. A) Total dissolved solids in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. B) Cumulative frequency distribution with 95% confidence intervals of total dissolved solids (TDS) in the Santa Clara River watershed.

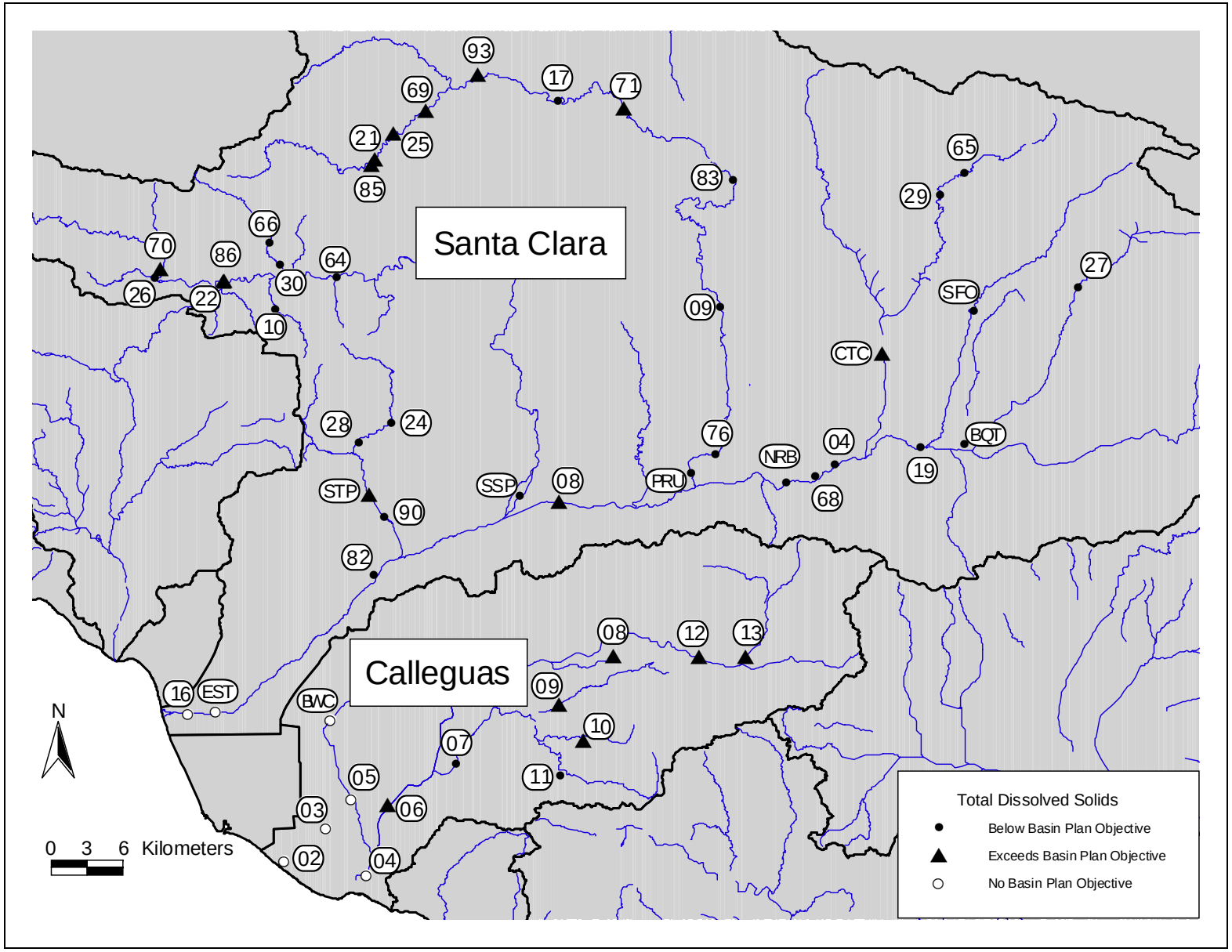
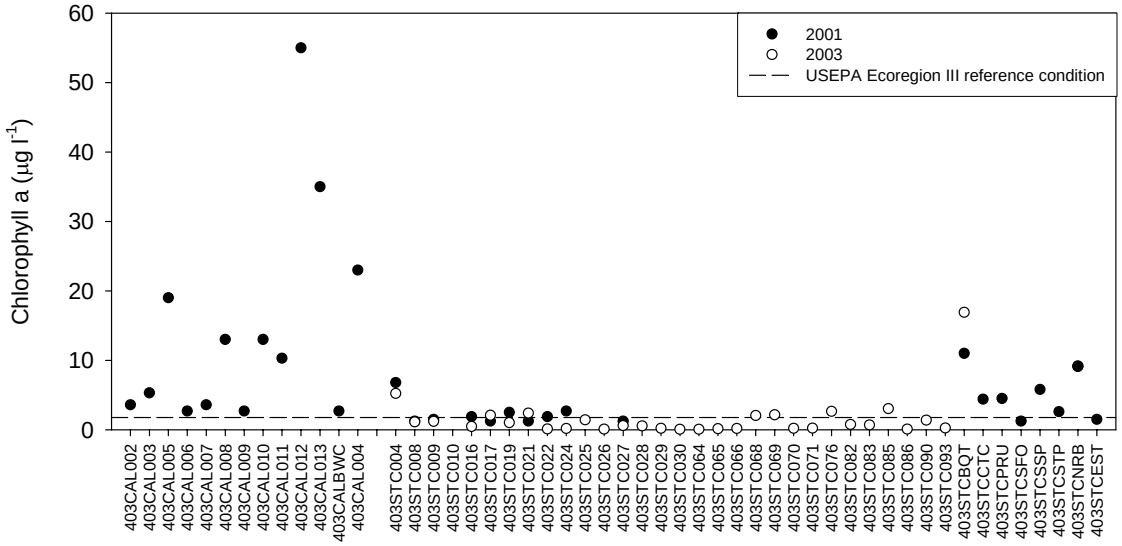


Figure 25. Total dissolved solids at stations in the Calleguas Creek and Santa Clara River watersheds.

A)



B)

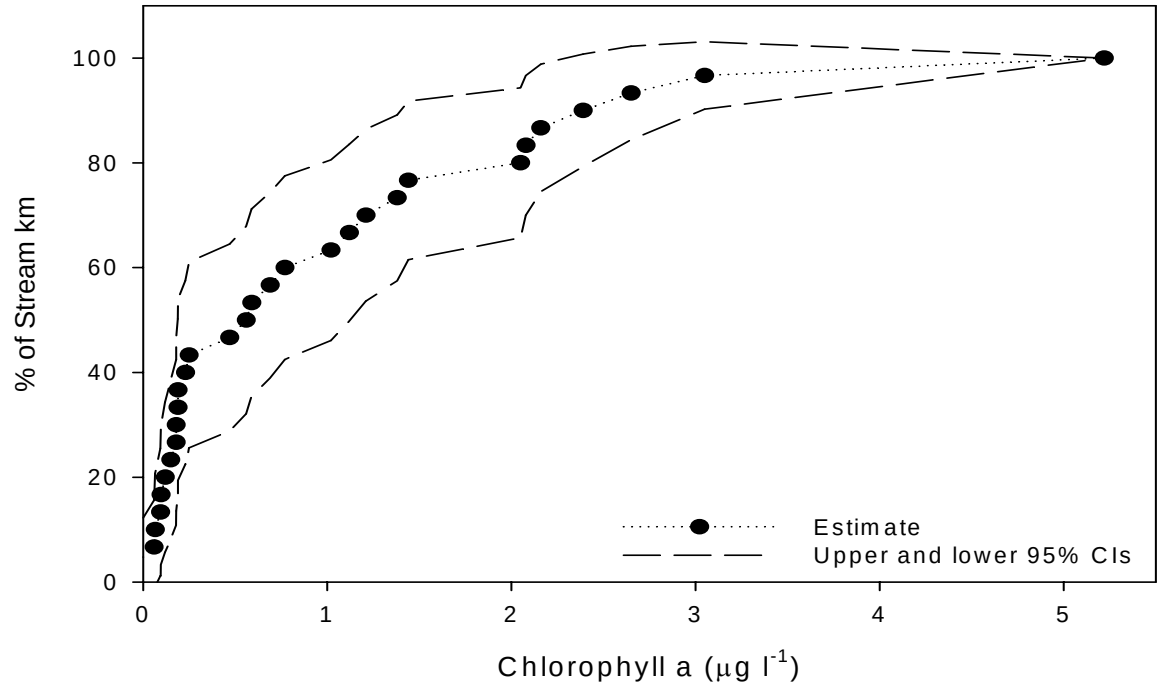


Figure 26. A) Chlorophyll a values in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds. B) Cumulative frequency distribution with 95% confidence intervals of chlorophyll a in the Santa Clara River watershed.

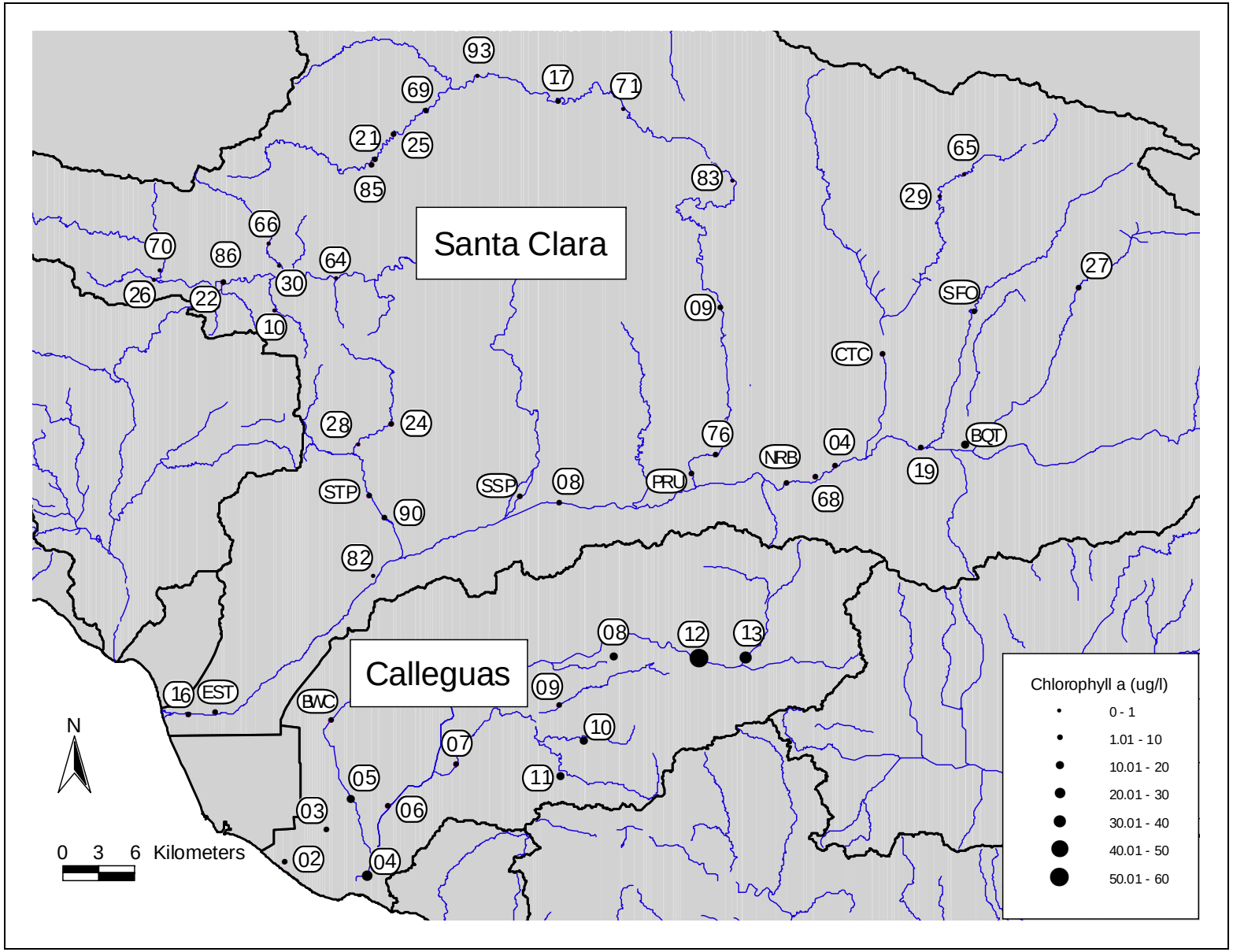


Figure 27. Chlorophyll a at stations in the Calleguas Creek and Santa Clara River watersheds.

4.3 Metals in Water

Total aluminum, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, zinc

The minimum and maximum values for total aluminum, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver and zinc are shown in Table 14 along with established Basin Plan objectives (CRWQCB LAR 1994) and USEPA 1-hour and 4-day averages for toxicity to aquatic life criteria (Marshack 2003).

Total aluminum values from all sites except 403CAL003 were below the Basin Plan objective of 1.0 mg l^{-1} (Figure 28). One value from 403STCNRB exceeded the USEPA 1-hour average and samples from many sites exceeded the USEPA 4-day average for toxicity to aquatic life. Levels of total arsenic, cadmium, chromium, mercury and nickel were all less than their respective Basin Plan objectives (Table 14).

Levels of total cadmium, copper, lead, nickel, silver and zinc were all below the USEPA 1-hour and 4-day averages for toxicity to aquatic life criteria, which vary with hardness, as suggested in Marshack (2003). Total arsenic and mercury were also below their respective USEPA criteria but many total aluminum values exceeded the 1-hour and 4-day criteria (Figure 28).

Table 14. Minimum and maximum concentrations of metals in water samples. Established Basin Plan objectives and USEPA 1-hour and 4-day averages for toxicity to aquatic life criteria are included for comparison. n=number of samples. Values in bold type exceed established criteria.

	Result				Basin	USEPA	USEPA
Analyte	**Minimum**	**Maximum**	**n**	**Units**	**Plan**	**1-hour**	**4-day**
Aluminum	0.002	**1.951**	22	mg l^{-1}	1.0	0.750	0.087
Arsenic	0.0005	0.0173	22	mg l^{-1}	0.05	0.340	0.150
Cadmium	0.00004	0.00067	22	mg l^{-1}	0.005	vary with hardness	
Chromium	0.00128	0.00766	22	mg l^{-1}	0.05	vary with hardness	
Copper	1.43	29.8	22	μg l^{-1}	-	vary with hardness	
Lead	0.03	3.15	22	μg l^{-1}	-	vary with hardness	
Manganese	3.19	366.0	22	μg l^{-1}	-	-	-
Mercury	0.049	11.600	22	ng l^{-1}	2000	1400	770
Nickel	0.314	14.400	22	μg l^{-1}	100	vary with hardness	
Silver	0.01	0.05	22	μg l^{-1}	-	vary with hardness	
Zinc	0.27	107.00	22	μg l^{-1}	-	vary with hardness	

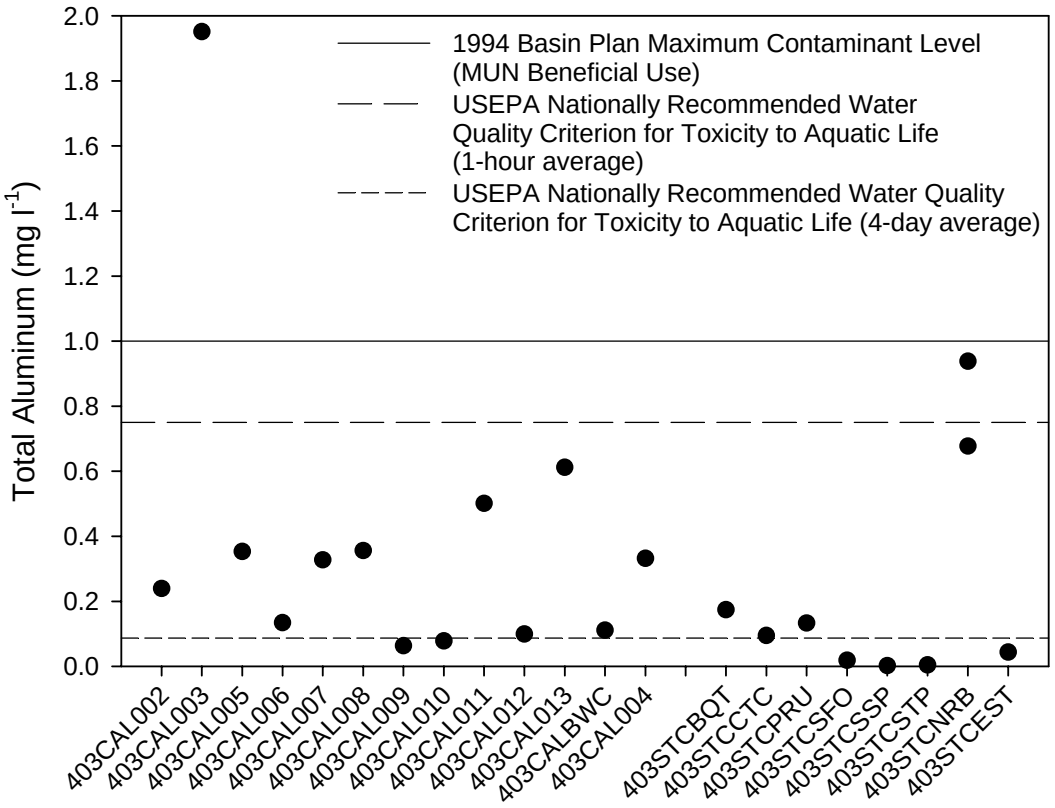


Figure 28. Total aluminum values in water in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

4.4 Sediment Grain Size

Grain size distribution varied widely among sites from 2% sand at 403STCSFO to 97% sand at 403STCEST (Figure 29). Overall, gravel was the smallest component; values ranged from 0 to 3.4%. Silt content was relatively high at 403STCCTC, -PRU, and –SFO with values ranging from 46 to 54%. Silt content at the remaining sites ranged from 1 to 27%. Clay content was also very high at 403STCSFO (44%) and ranged from 1 to 21% at the other sites.

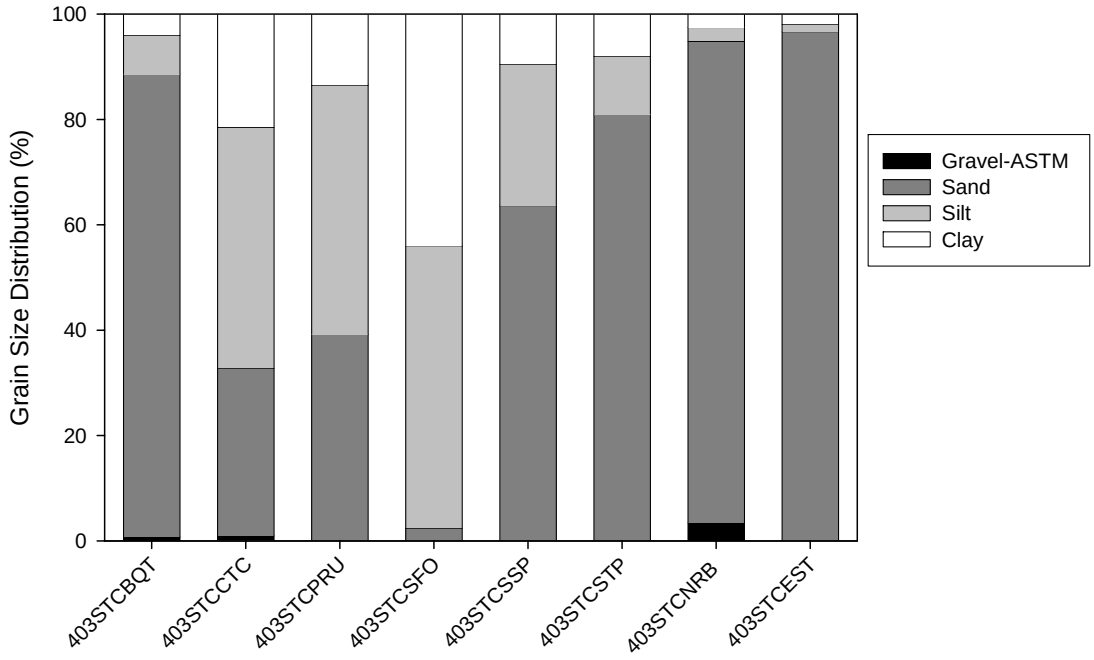


Figure 29. Distribution of gravel, sand, silt and clay in sediments from the Santa Clara River (STC) watershed.

4.5 Metals in Sediment (STC watershed only)

Aluminum, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, zinc and grain size

Aluminum ranged from 6820 to 72,000 mg kg^{-1} (Figure 30). The highest value was from 403STCSFO. The Basin Plan does not establish objectives for sediments, and aluminum is not included in MacDonald et al. (2000).

Arsenic ranged from 2.51 to 46.60 mg kg^{-1} (Figure 31). The highest value was again from 403STCSFO and was an order of magnitude greater than the next highest concentration. The 46.60 mg kg^{-1} value was greater than MacDonald et al.'s (2000) TEC

and PEC (Table 15); all other values were less than the TEC. 403STCSFO also had high water column arsenic values relative to other sites.

Table 15. Consensus-based threshold effects concentrations (TEC) and probable effects concentrations (PEC) for metals in sediments. Concentrations are in mg kg^{-1} dry weight. From MacDonald et al. (2000).

Metals	Consensus-based TEC	Consensus-based PEC
Arsenic	9.79	33.0
Cadmium	0.99	4.98
Chromium	43.4	111
Copper	31.6	149
Lead	35.8	128
Mercury	0.18*	1.06
Nickel	22.7	48.6
Zinc	121	459

*only 35% of samples predicted to be not toxic were not toxic; number may be low

Cadmium ranged from 0.06 to 2.01 mg kg^{-1} (Figure 32). All of the values were <0.5 mg kg^{-1} with the exception of 403STCPRU (2.01 mg kg^{-1}), which exceeded MacDonald et al.'s (2000) TEC but not the PEC (Table 15).

Chromium ranged from 5.82 to 63.80 mg kg^{-1}, and again the highest value was at 403STCSFO (Figure 33). This value exceeded MacDonald et al.'s (2000) TEC but not the PEC (Table 15); all other values were below the TEC.

Copper values ranged from 9.44 to 544.00 mg kg^{-1} (Figure 34) with the highest value being from 403STCSFO. This value exceeded MacDonald et al.'s (2000) TEC and PEC (Table 15). The next highest value, 51.90 mg kg^{-1} from –CTC, exceeded the TEC; all other values were below the TEC.

Lead ranged from 4.68 to 49.70 mg kg^{-1} and the highest two values were from 403STCSFO and –CTC (49.70 and 43.00 mg kg^{-1} respectively) (Figure 35). These values exceeded MacDonald et al.'s (2000) TEC but were below the PEC (Table 15); all other values were below the TEC.

Manganese ranged from 77.8 to 676 mg kg^{-1} and the highest value was from 403STCSFO (Figure 36). Manganese is not included in MacDonald et al. (2000).

Mercury ranged from 0.104 to 0.519 mg kg^{-1} and the highest value was again from 403STCSFO (Figure 37) and exceeded MacDonald et al.'s (2000) TEC but was below the PEC (Table 15). The next highest value was 0.171 mg kg^{-1} and was below the TEC.

Nickel ranged from 5.620 to 46.400 mg kg^{-1} and the highest value was from 403STCSFO (Figure 38). This value exceeded MacDonald et al.'s (2000) TEC but was below the PEC (Table 15); all other values were below the TEC.

Silver ranged from 0.13 to 0.38 mg kg^{-1} (Figure 39). The highest value was from 403STCCTC followed by –PRU and then –SFO. Silver is not included in MacDonald et al. (2000).

Zinc values ranged from 17.00 to 149.00 mg kg^{-1} and the highest value was from 403STCSFO (Figure 40). This value exceeded MacDonald et al.'s (2000) TEC but was below the PEC (Table 15); all other values were below the TEC.

For some metals, concentration was related to grain size distribution (Table 16). As % sand increased, the metal concentration decreased in many cases. Sediment sand content explained 80% of the variability in zinc and chromium concentrations but explained little of the variability in cadmium or nickel concentrations.

In summary, sediment metals were often highest at 403STCSFO (Figure 41), which is downstream of a reservoir that was treated with heavy metals to control primary production and reduce fouling on equipment. Sediments at this site were also mostly composed of silt and clay with only 2.42% sand (Figure 29). Metal concentrations from this site frequently exceeded the TECs identified in MacDonald et al. (2000) and occasionally exceeded the PECs. Cadmium at 403STCPRU and copper and lead at 403STCCTC also exceeded MacDonald et al.'s (2000) SQGs. These sites also had large silt and clay fractions (Figure 29). While often only 403STCSFO exceeded SQGs, a pattern emerges among Figures 30-40. For aluminum, arsenic, chromium, copper, lead, mercury, nickel and zinc, the top three values in order were from 403STCSFO, –CTC and –PRU. For cadmium the top three values in order were from 403STCPRU, –CTC and –SFO. For silver, the top three values in order were from 403STCCTC, –PRU and –SFO.

Table 16. Results of regression analyses of individual metals concentrations versus percent sand.

Metal	% Variability Explained by % Sand (r^2)
Aluminum	0.5424
Arsenic	0.5924
Cadmium	0.2125
Chromium	0.7994
Copper	0.5564
Lead	0.6560
Manganese	0.4167
Mercury	0.6627
Nickel	0.0050
Silver	0.4890
Zinc	0.8013

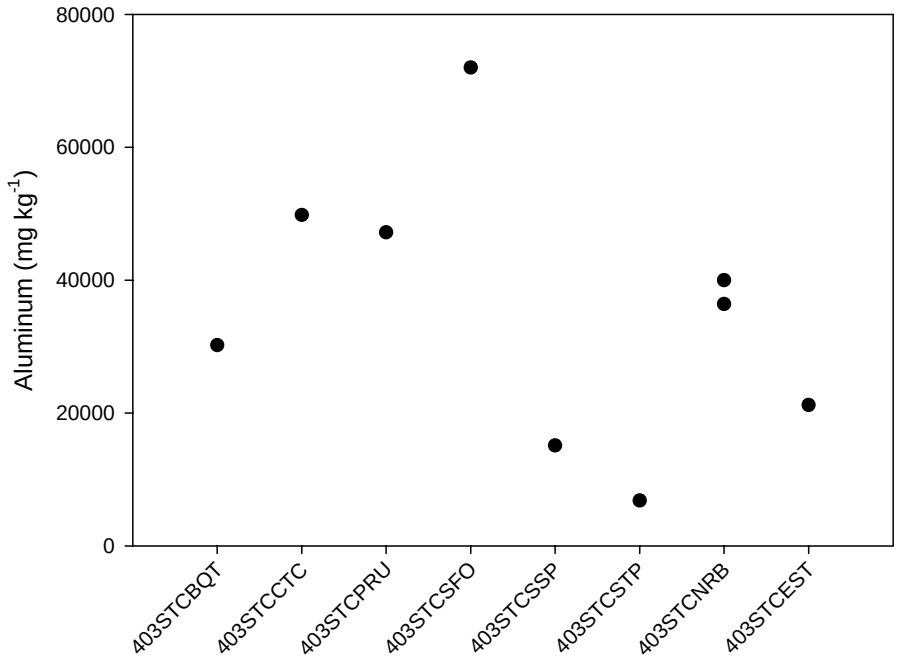


Figure 30. Aluminum concentrations in sediments from the Santa Clara River (STC) watershed.

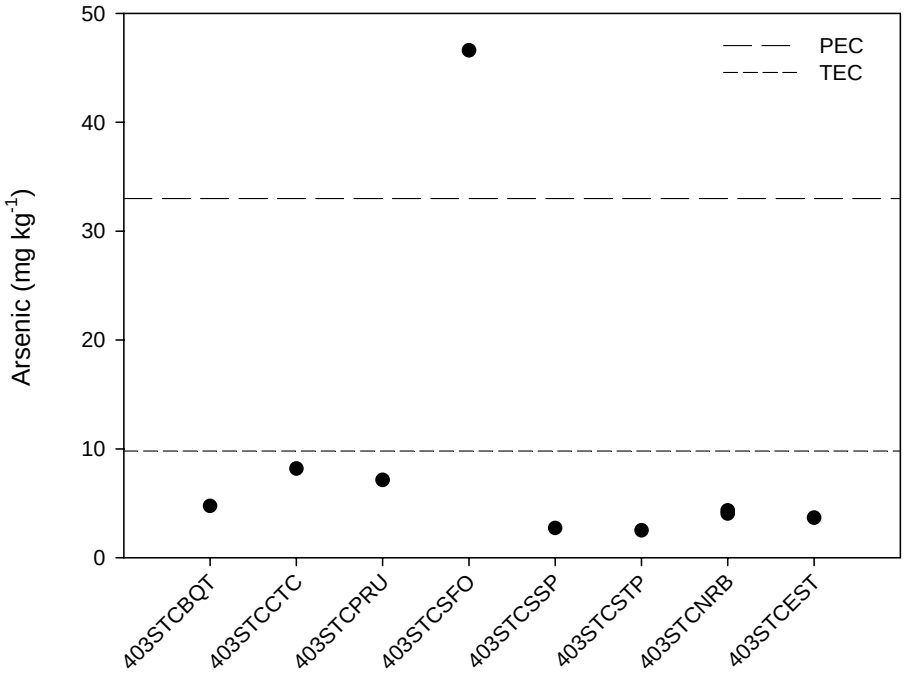


Figure 31. Arsenic concentrations in sediments from the Santa Clara River (STC) watershed. Probable effects concentration (PEC) and threshold effects concentration (TEC) values from MacDonald et al. (2000).

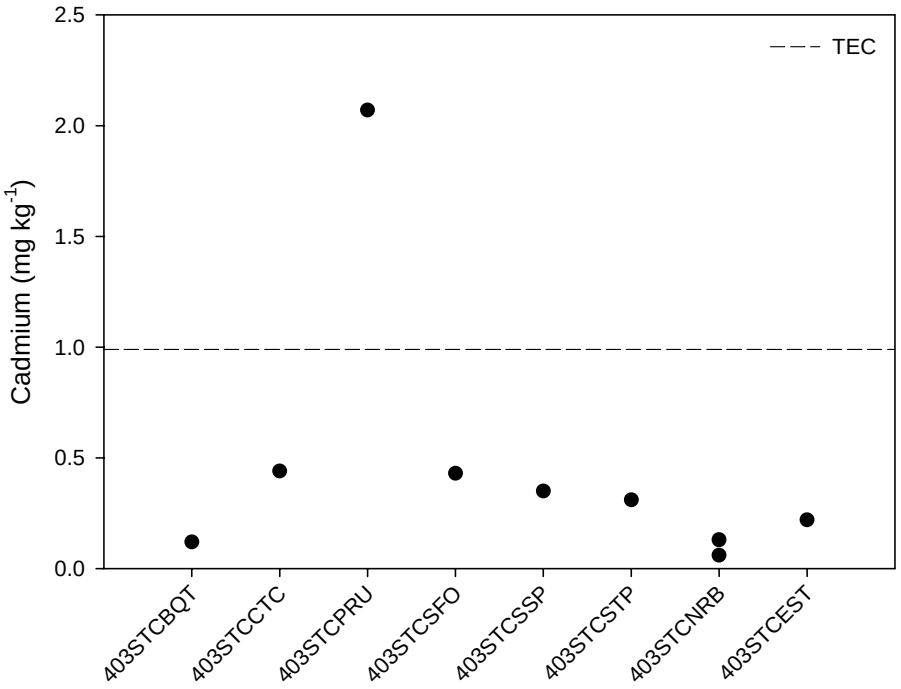


Figure 32. Cadmium concentrations in sediments from the Santa Clara River (STC) watershed. Threshold effects concentration (TEC) value from MacDonald et al. (2000).

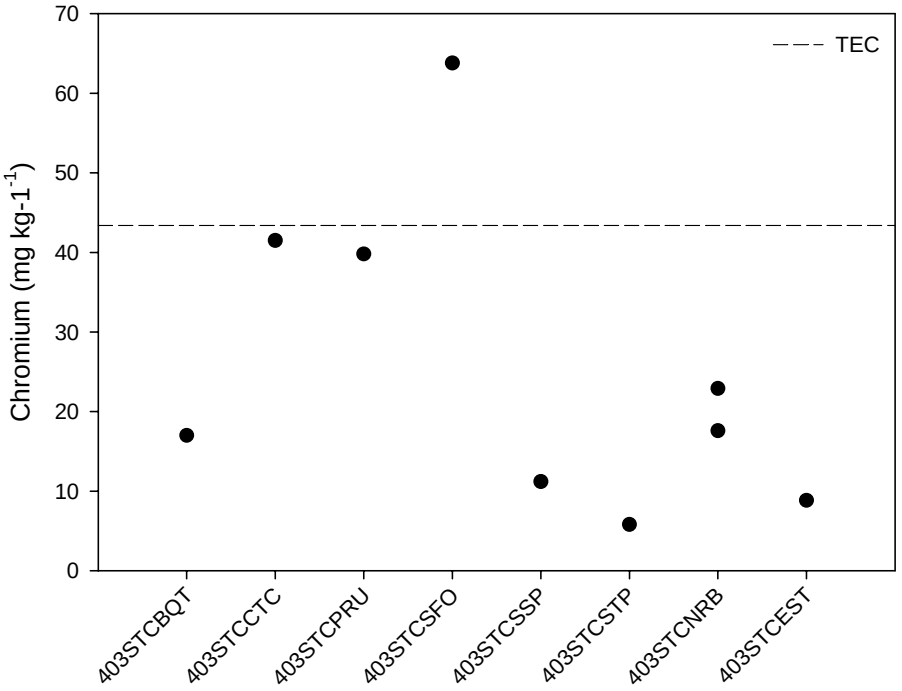


Figure 33. Chromium concentrations in sediments from the Santa Clara River (STC) watershed. Threshold effects concentration (TEC) value from MacDonald et al. (2000).

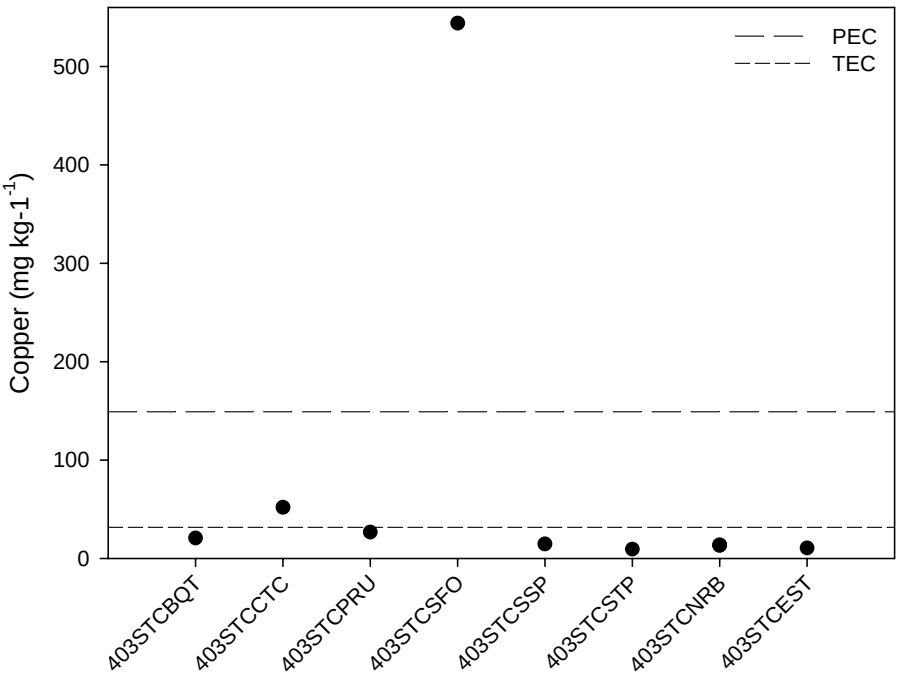


Figure 34. Copper concentrations in sediments from the Santa Clara River (STC) watershed. Probable effects concentration (PEC) and threshold effects concentration (TEC) values from MacDonald et al. (2000).

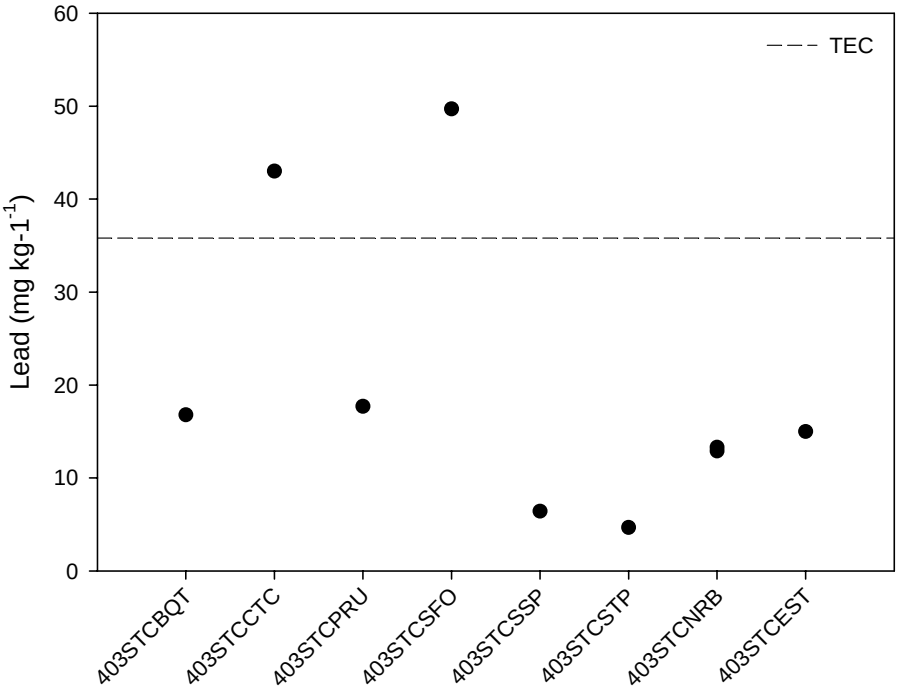


Figure 35. Lead concentrations in sediments from the Santa Clara River (STC) watershed. Threshold effects concentration (TEC) value from MacDonald et al. (2000).

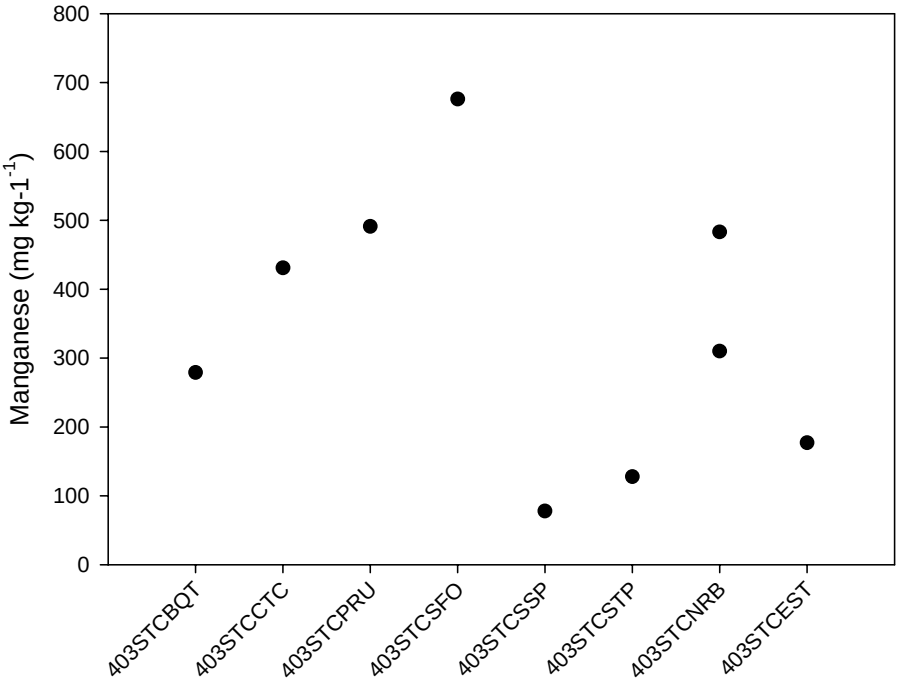


Figure 36. Manganese concentrations in sediments from the Santa Clara River (STC) watershed.

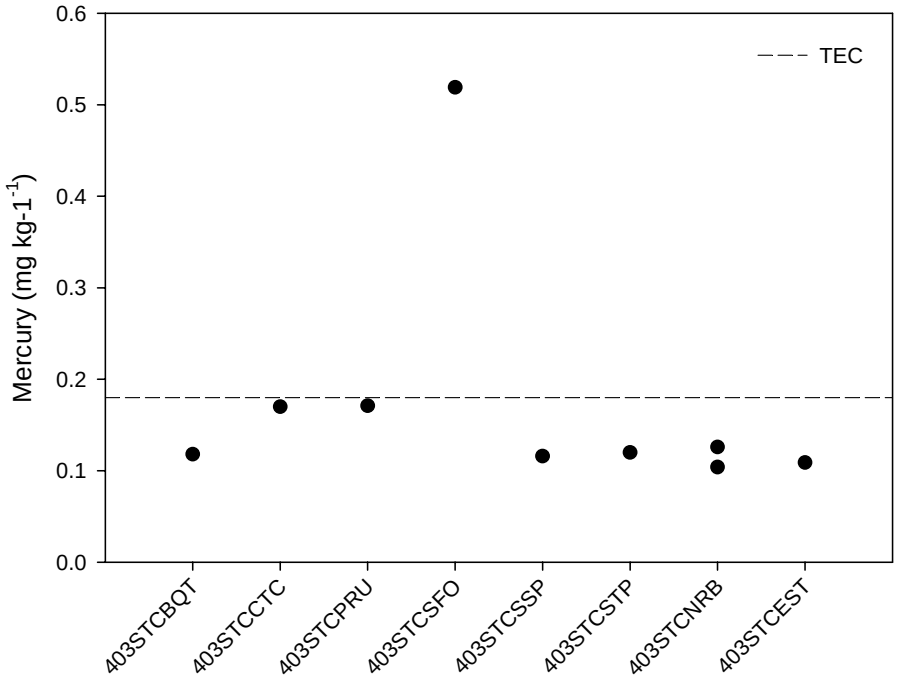


Figure 37. Mercury concentrations in sediments from the Santa Clara River (STC) watershed. Threshold effects concentration (TEC) value from MacDonald et al. (2000).

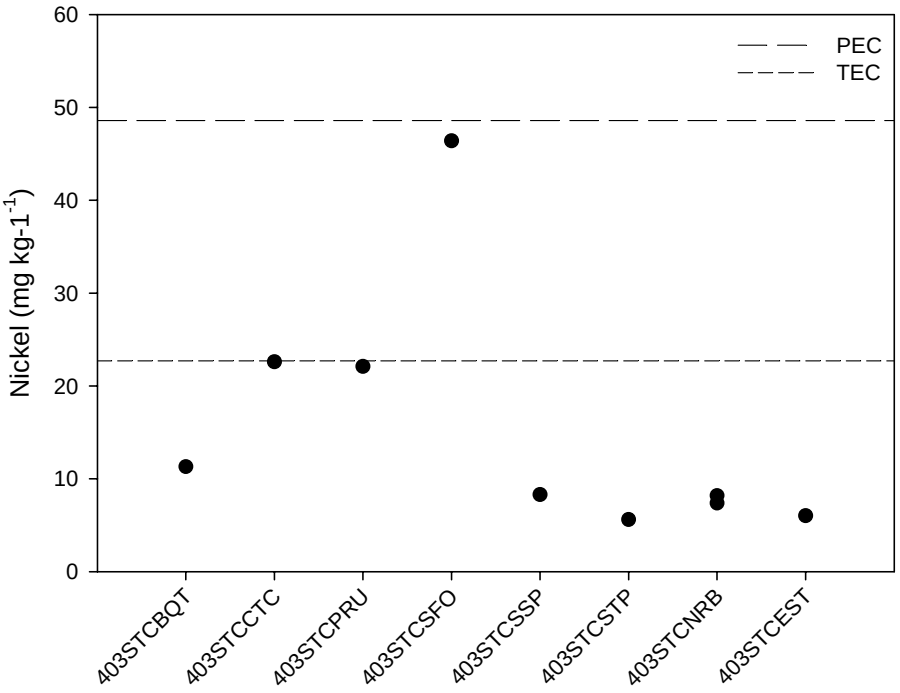


Figure 38. Nickel concentrations in sediments from the Santa Clara River (STC) watershed. Probable effects concentration (PEC) and threshold effects concentration (TEC) values from MacDonald et al. (2000).

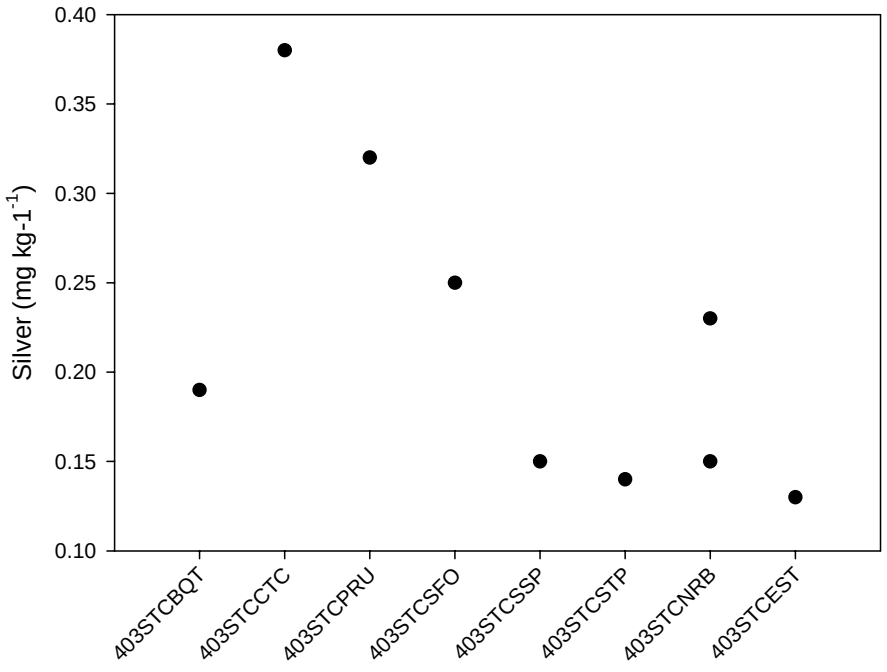


Figure 39. Silver concentrations in sediments from the Santa Clara River (STC) watershed.

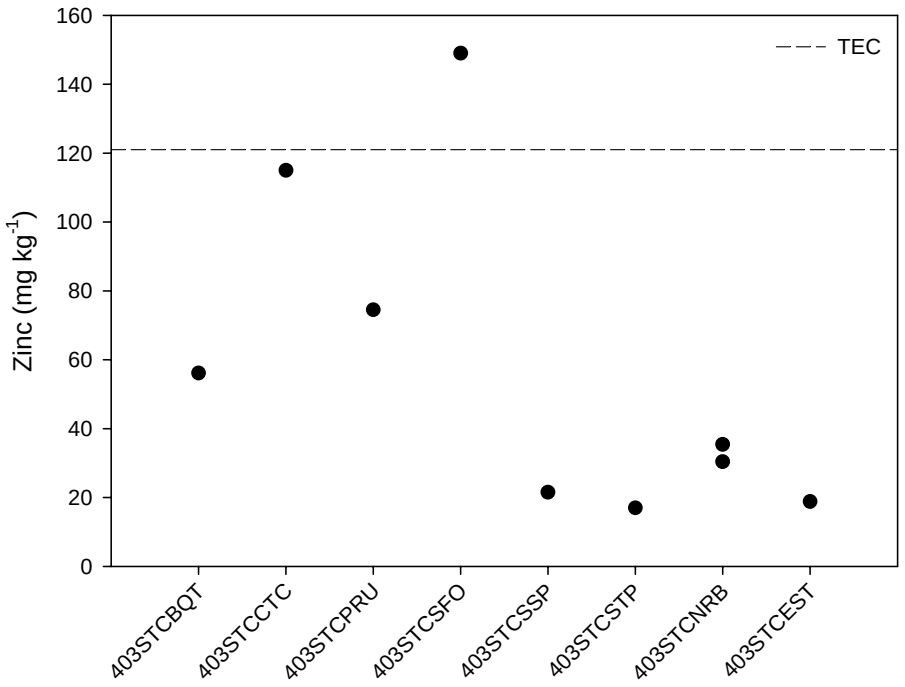


Figure 40. Zinc concentrations in sediments from the Santa Clara River (STC) watershed. Threshold effects concentration (TEC) value from MacDonald et al. (2000).

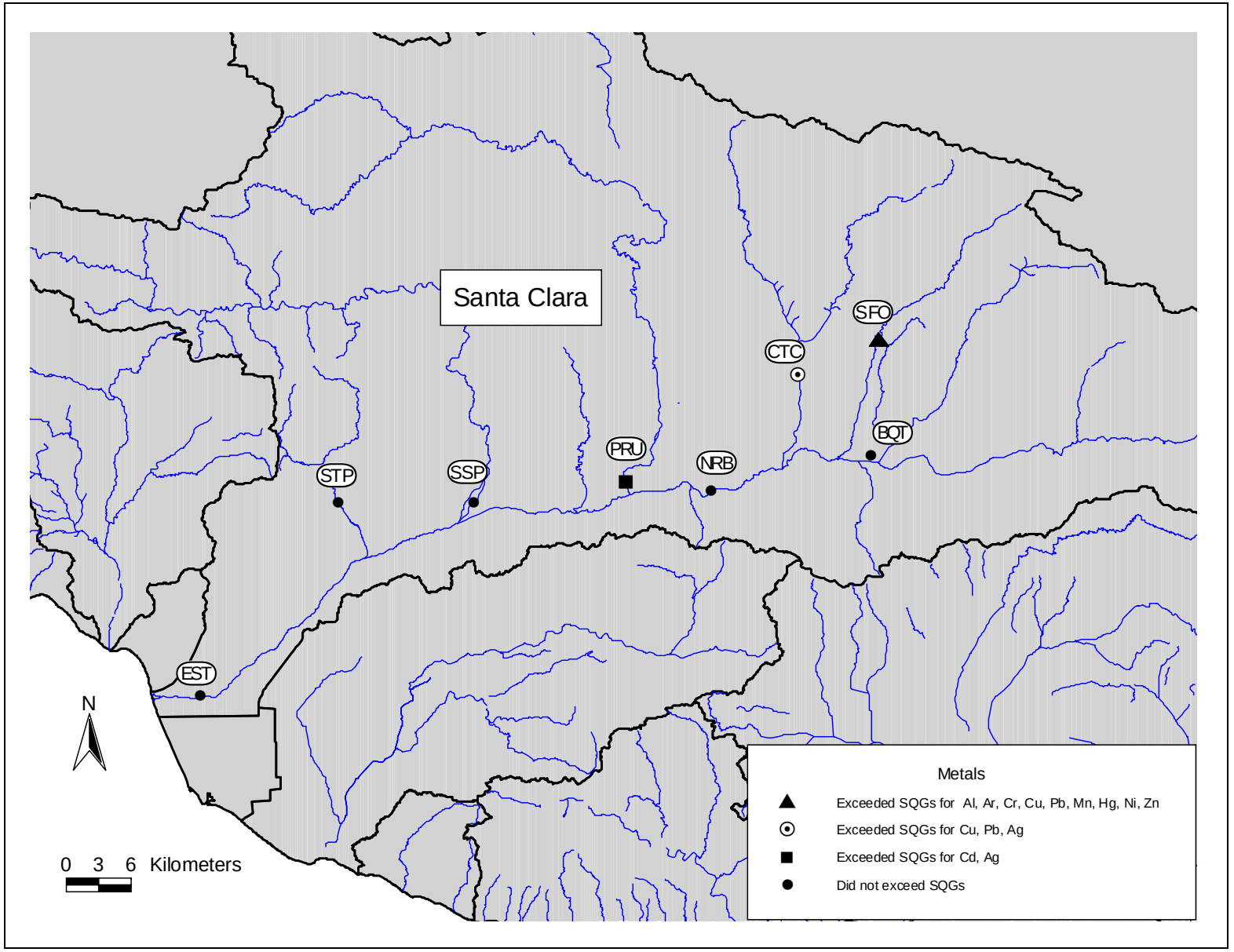


Figure 41. Sediment metals that exceeded sediment quality guidelines (SQGs) at sites in the Santa Clara River watershed.

4.5 Metals in Tissue

Aluminum, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver, zinc

The minimum and maximum values for aluminum, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver and zinc in *Corbicula fluminea* tissue are shown in Table 17 along with available OEHHA screening values (Brodberg and Pollock 1999) and USFWS guidelines (M. Lyons, pers. comm.). The values of these metals in *C. fluminea* at each site are presented in Figures 42-53.

Arsenic in tissue from all sites exceeded the USFWS guideline. Arsenic in tissue at 403STCBQT and –PRU (Figure 43) exceeded the OEHHA screening value and copper in tissue from –BQT (Figure 46) exceeded the USFWS guideline. All samples were below the cadmium, mercury and selenium thresholds. There are no established thresholds for aluminum, chromium, lead, manganese, nickel, silver or zinc in tissue.

Metals concentrations in tissue were often highest at 403STCBQT and/or 403STCPRU. The exception to this was selenium, which was highest at 403STCSSP but still below the OEHHA screening value (Table 17).

Table 17. Minimum and maximum concentrations of metals in *Corbicula fluminea* tissues. Established Office of Environmental Health Hazard Assessment screening values (OEHHA SV) (Brodberg and Pollock 1999) and US Fish and Wildlife Service (USFWS) (M. Lyons, pers. comm.) guidelines are included for comparison. All values are in mg kg^{-1} wet weight. n=number of samples. Values in bold type exceed established criteria.

	Result			OEHHA	USFWS
Analyte	**Minimum**	**Maximum**	**n**	**SV**	**Guidelines**
Aluminum	6.8284	122.7754	7	-	-
Arsenic	**0.7799**	**1.5022**	7	1.0	0.25
Cadmium	0.0986	0.2335	7	3.0	-
Chromium	0.3576	1.0556	7	-	-
Copper	7.9082	**17.6320**	7	-	15
Lead	0.0153	0.0655	7	-	-
Manganese	1.1196	8.5186	7	-	-
Mercury	0.0167	0.0219	6	0.3	0.3
Nickel	0.1413	0.4322	7	-	-
Selenium	0.2421	0.6853	7	2.0	-
Silver	0.0067	0.0249	7	-	-
Zinc	6.6097	14.0940	7	-	-

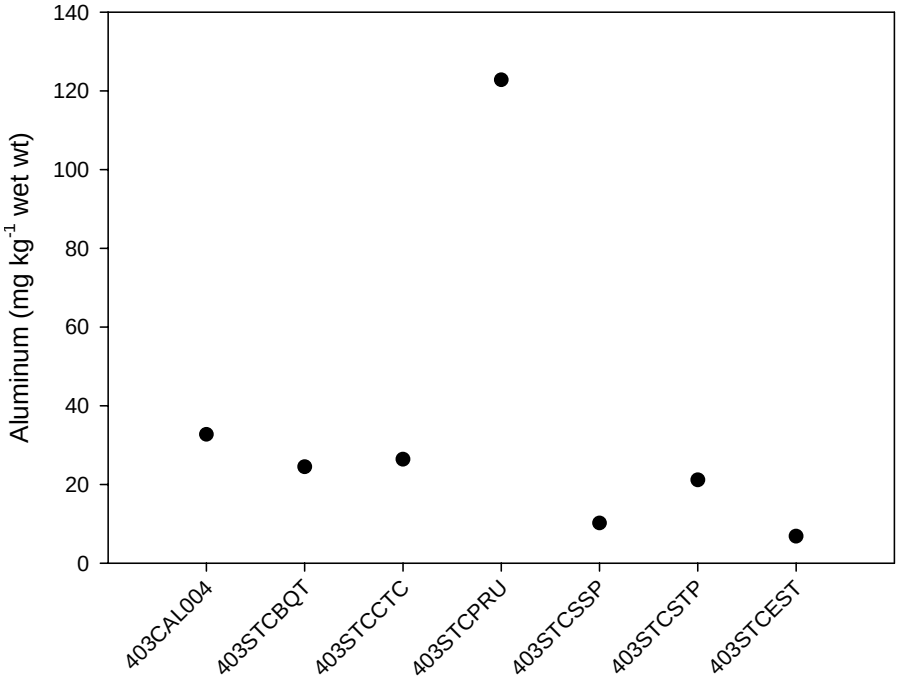


Figure 42. Aluminum concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

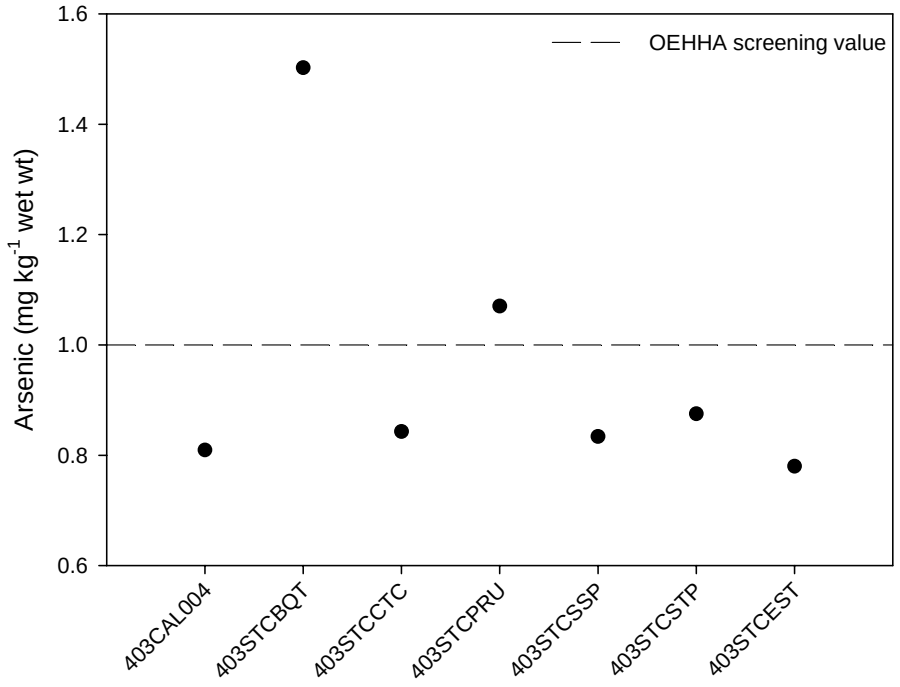


Figure 43. Arsenic concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

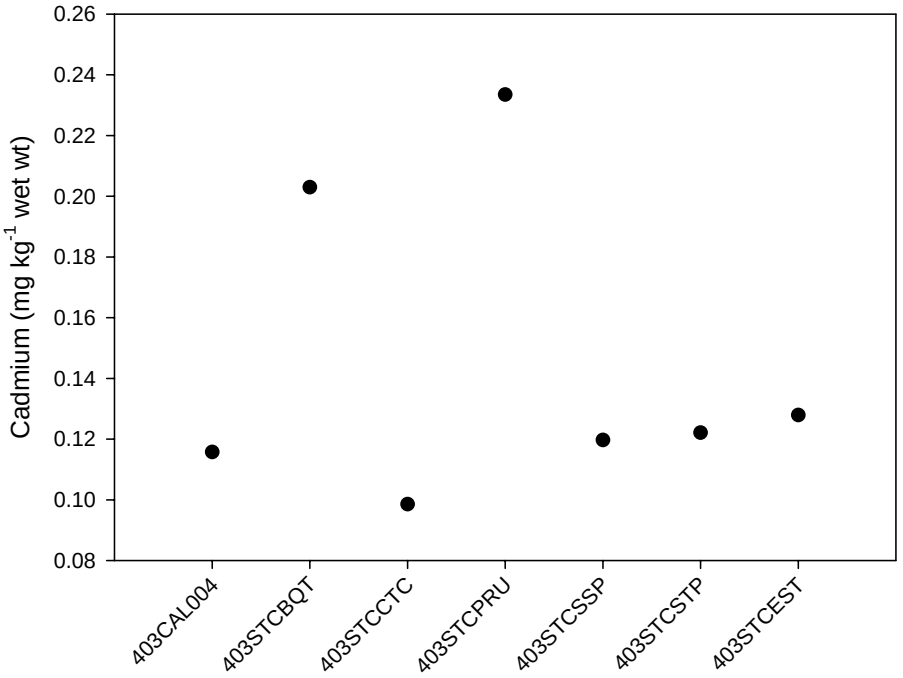


Figure 44. Cadmium concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

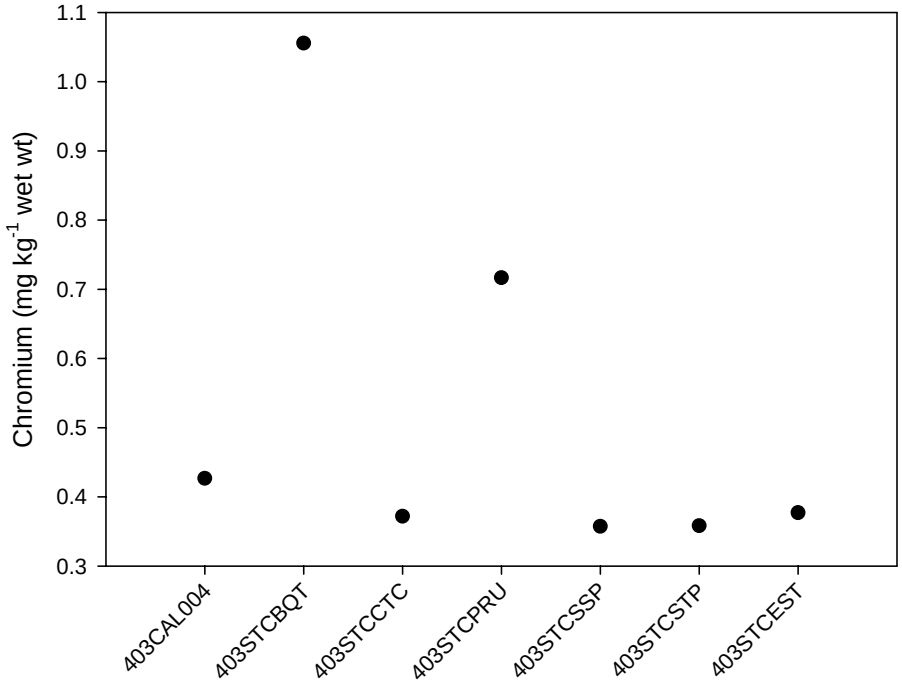


Figure 45. Chromium concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

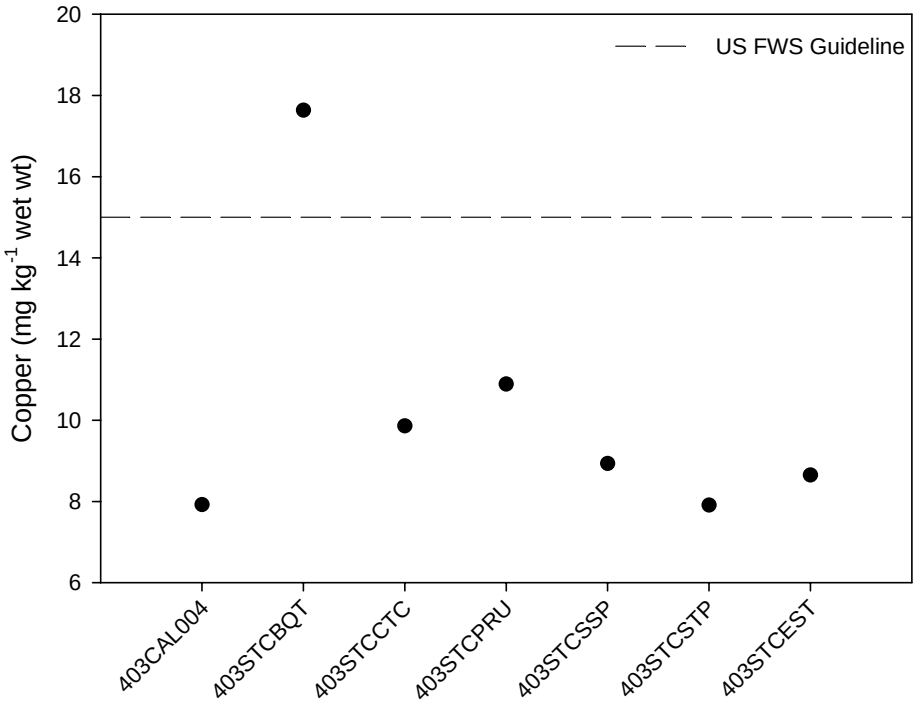


Figure 46. Copper concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

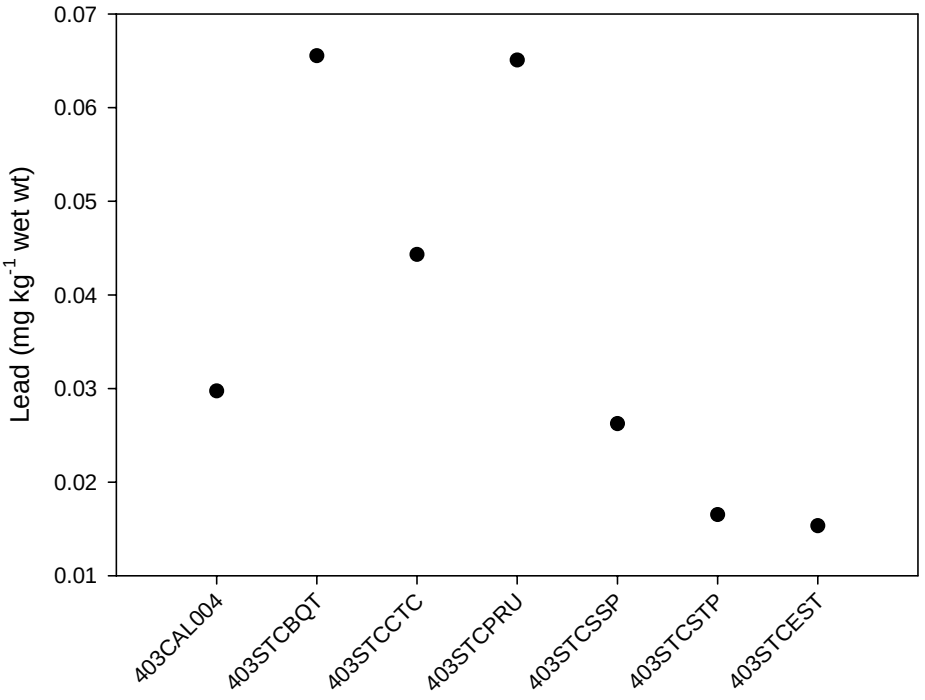


Figure 47. Lead concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

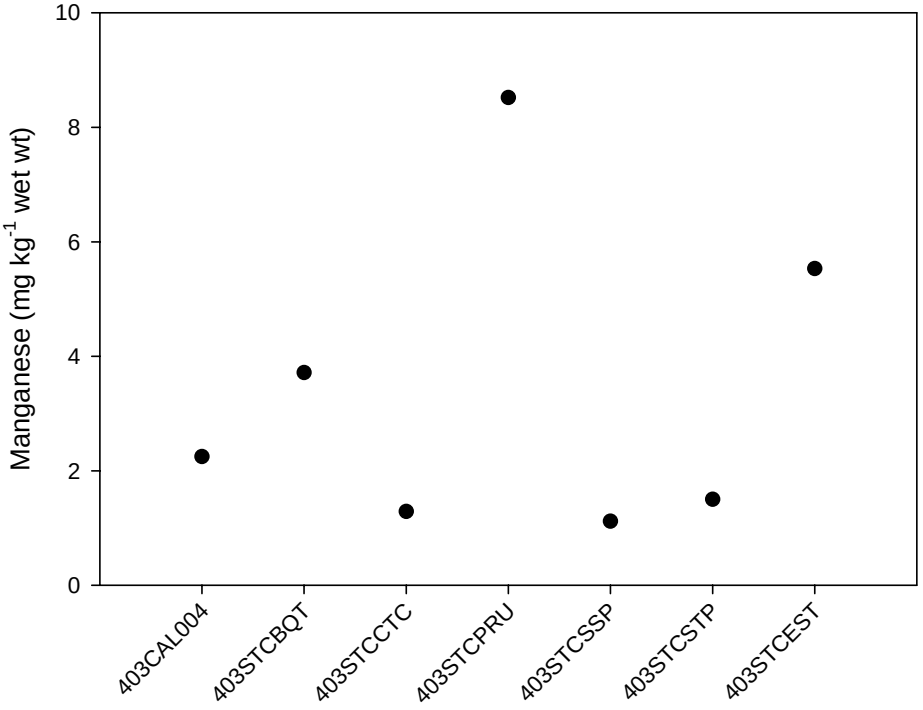


Figure 48. Manganese concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

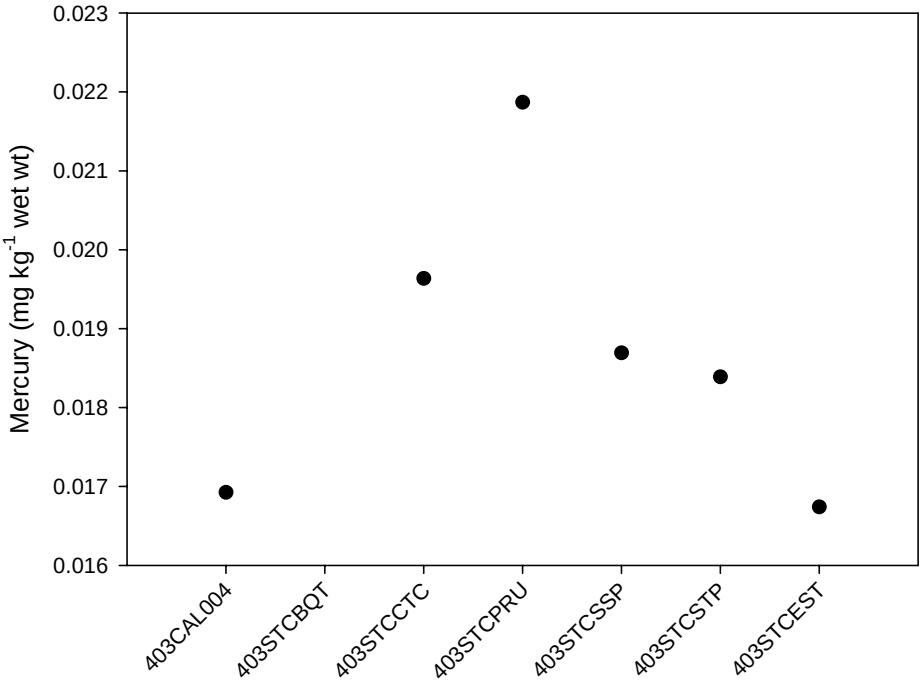


Figure 49. Mercury concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

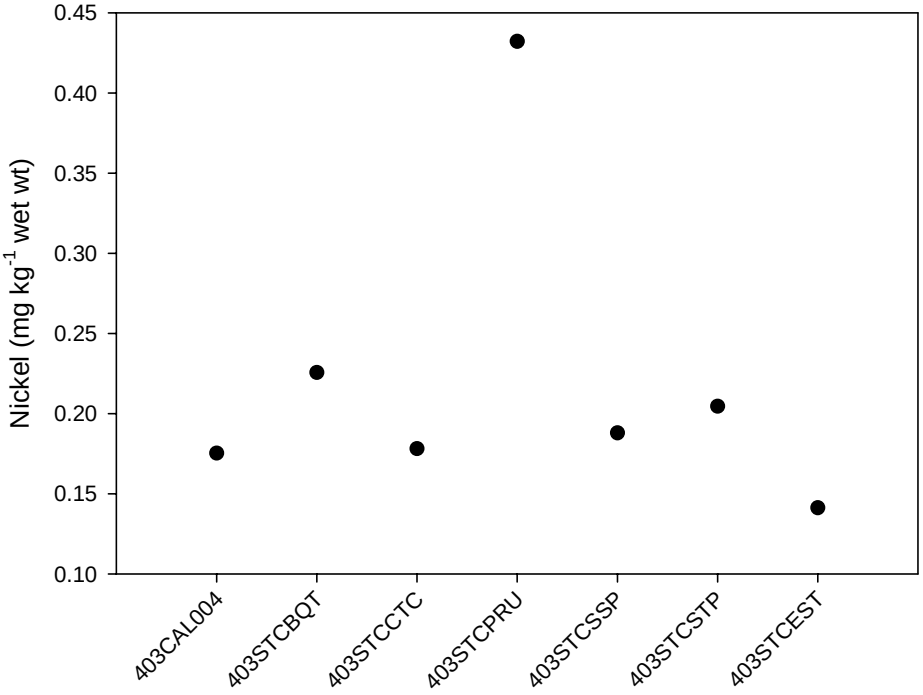


Figure 50. Nickel concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

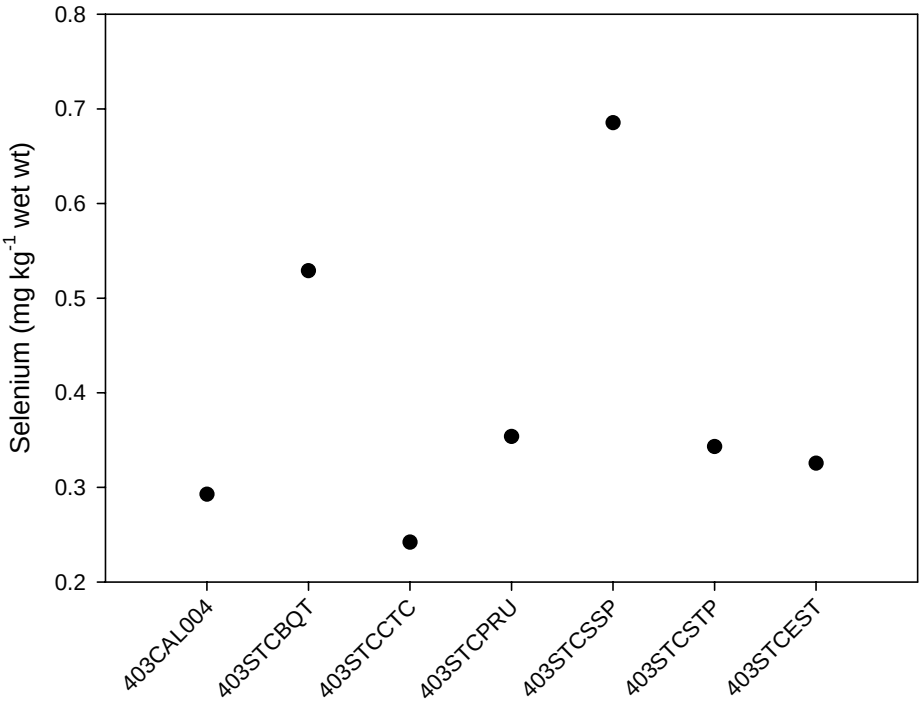


Figure 51. Selenium concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

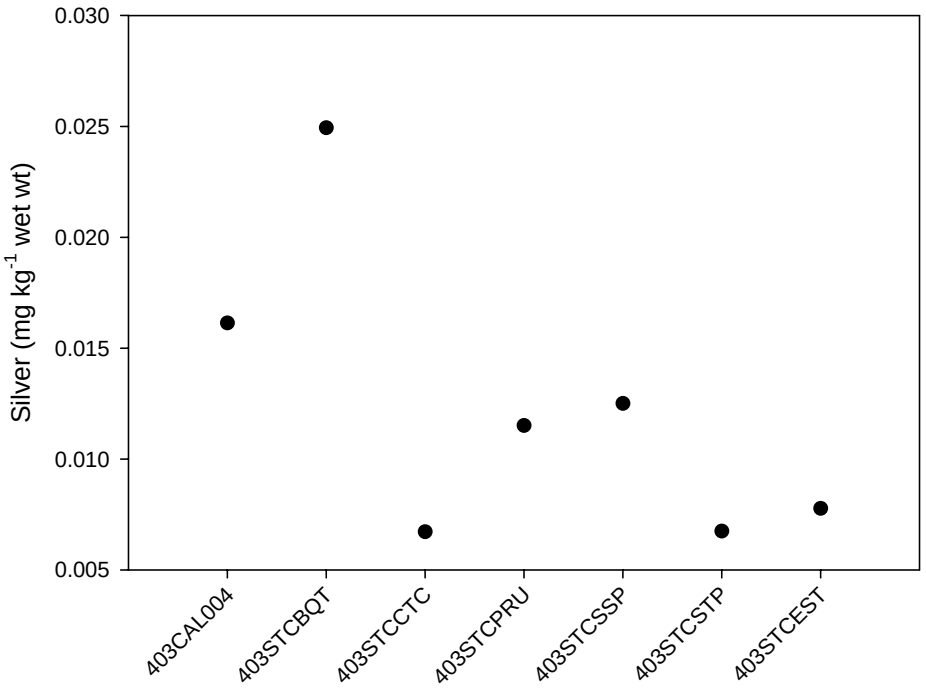


Figure 52. Silver concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

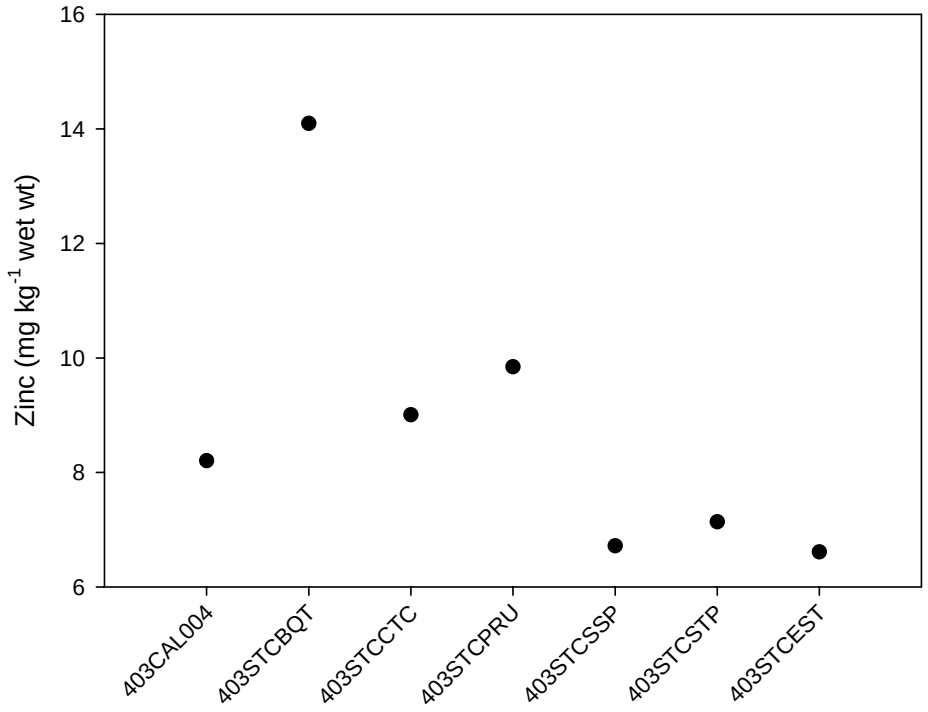


Figure 53. Zinc concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

4.6 Trace Organics in Water

Organic Pesticides, PAHs, PCBs

Organochlorine pesticides (OCPs) that were detected are presented in Table 18. All other OCPs were below the detection limits in all samples. We were not able to find established criteria for dacthal, HCH delta, oxadiazon or tedion. Because the individual isomers chlordene alpha and gamma, nonachlor cis and trans and oxychlordane are included in the summation of total chlordane, none of them alone was compared to established criteria.

Total chlordane, summed using either ½ MDLs for values below MDLs or only detected values, was below both the Basin Plan objective and the CTR instantaneous maximum for toxicity to aquatic life (Table 19)[2]. Using ½ the MDL for individual isomers below the MDL, total chlordane exceeded the CTR 4-day average for toxicity to aquatic life in 5 samples; if only the detected values were used, the criterion was exceeded by only two samples.

The CTR criteria for DDD, DDE and DDT (Table 19) are each less than the MDL for these chemicals, therefore, any samples in which these chemicals were detected exceeded established criteria. Total DDT, summed using either ½ MDLs for values below MDLs or only detected values, was below the US EPA instantaneous maximum for toxicity to aquatic life (Table 19). When only the detected values were used in summation, total DDT in 6 samples exceeded the US EPA 4-day average and the CTR criteria for sources of drinking water (Table 19). However, when ½ the MDL was used in the summation for isomers that were below the MDL, all samples exceeded the aforementioned criteria, which suggests that the MDLs are too high to allow meaningful comparisons to established criteria.

Concentrations of dieldrin, endosulfan II, endosulfan sulfate, endrin aldehyde, endrin ketone, HCH gamma, hexachlorobenzene, and methoxychlor were each less than their respective criteria (Table 19). HCH beta was detected in one sample and it exceeded the CTR criterion for sources of drinking water. Mirex was detected in one sample and it exceeded the US EPA instantaneous maximum for toxicity to aquatic life.

Chlorpyrifos and diazinon in water samples taken in 2001 are shown in Figures 54 and 55. All samples in which chlorpyrifos was detected (12 of 22) equaled or exceeded the California DFG 1-hour average for toxicity to aquatic life (Table 20) and thus also exceeded the 4-day average as well. As the MDL is 0.02 $\mu g\ l^{-1}$, it is unknown if any of the samples below the MDL exceeded the 4-day average criterion of 0.014 $\mu g\ l^{-1}$. Diazinon concentrations exceeded the California DFG 1-hour average for toxicity to aquatic life in 12 samples and exceeded the 4-day average in 15 samples. MDLs for diazinon are adequate for comparison to established thresholds.

Chlorpyrifos and diazinon in water samples taken from 403STCBQT between August 2002 and August 2003 are shown in Figures 56 and 57. The ELISA technique was used

[2] Unless otherwise noted, all water quality objectives in section 4.6 are from Marshack (2003).

Table 18. Organochlorine pesticides in water in the Calleguas (CAL) and Santa Clara River (STC) watersheds. – indicates the sample was below the MDL. Values below the RL were reported as the mean of the MDL and the RL. All values are in µg l^{-1}. Values in bold type exceed the established criteria listed in Table 19.

Analyte / Site / Date	403CAL004 11/12/2001	403STCBQT 10/31/2001	403STCBQT 1/13/2003	403STCCTC 11/13/2001	403STCEST 11/14/2001	403STCNRB 11/13/2001	403STCNRB 10/30/2001	403STCPRU 11/1/2001	403STCSFO 10/31/2001	403STCSSP 11/15/2001	403STCSTP 11/1/2001	MDL	RL
Chlordene, alpha	-	-	-	-	-	0.002	0.002	-	-	-	0.002	0.001	0.002
Chlordene, gamma	-	-	-	-	-	-	0.003	-	-	-	-	0.001	0.002
Total chlordane* (using only detected values)	**0.013**	0.003	0	0	0	0.002	**0.005**	0	0	0	0.002	-	-
Total chlordane* (using ½ MDL)	**0.015**	**0.006**	0.0035	0.0035	0.0035	**0.005**	**0.0075**	0.0035	0.0035	0.0035	**0.005**	-	-
Dacthal	0.047	-	-	-	0.016	0.500	0.003	-	-	-	-	0.001	0.002
DDD(o,p')	-	**0.002**	-	**0.015**	-	-	-	-	-	-	-	0.001	0.002
DDE(p,p')	**0.004**	**0.009**	-	**0.002**	**0.004**	-	-	-	-	-	-	0.001	0.002
DDT(p,p')	**0.003**	-	-	**0.006**	**0.003**	**0.007**	-	**0.003**	-	-	-	0.002	0.005
Total DDT† (using only detected values)	**0.007**	**0.011**	0	**0.023**	**0.007**	**0.007**	0	**0.003**	0	0	0	-	-
Total DDT† (using ½ MDL)	**0.0095**	**0.0140**	**0.0040**	**0.0250**	**0.0095**	**0.0100**	**0.0040**	**0.0060**	**0.0040**	**0.0040**	**0.0040**	-	-
Dieldrin	0.005	-	-	-	-	-	-	-	-	-	-	0.001	0.002
Endosulfan II	0.003	-	-	-	-	-	-	-	-	-	-	0.001	0.002
Endosulfan sulfate	0.005	0.002	-	0.005	0.003	0.003	0.004	-	-	-	-	0.001	0.002

Analyte / Site / Date	403CAL004 11/12/2001	403STCBQT 10/31/2001	403STCBQT 1/13/2003	403STCCTC 11/13/2001	403STCEST 11/14/2001	403STCNRB 11/13/2001	403STCNRB 10/30/2001	403STCPRU 11/1/2001	403STCSFO 10/31/2001	403STCSSP 11/15/2001	403STCSTP 11/1/2001	MDL	RL
Endrin Aldehyde	-	-	-	-	-	-	-	-	0.003	0.003	-	0.002	0.005
Endrin Ketone	0.003	-	-	0.006	-	0.003	-	-	-	-	-	0.002	0.005
HCH, beta	**0.029**	-	-	-	-	-	-	-	-	-	-	0.001	0.002
HCH, delta	-	-	-	-	-	-	-	0.003	-	-	-	0.001	0.002
HCH, gamma	0.007	-	-	-	-	0.005	-	-	-	-	-	0.001	0.002
Hexachlorobenzene	0.005	0.007	-	-	-	0.006	-	-	-	-	0.002	0.0005	0.001
Methoxychlor	-	0.005	-	0.002	-	0.003	-	-	-	-	-	0.001	0.002
Mirex	-	-	-	**0.006**	-	-	-	-	-	-	-	0.001	0.002
Nonachlor, cis	0.002	-	-	-	-	-	-	-	-	-	-	0.001	0.002
Nonachlor, trans	0.002	0.003	-	-	-	-	-	-	-	-	-	0.001	0.002
Oxadiazon	0.020	-	-	0.020	0.011	0.019	-	-	-	-	-	0.001	0.002
Oxychlordane	0.009	-	-	-	-	-	-	-	-	-	-	0.001	0.002
Tedion	0.010	0.008	-	0.003	0.004	0.003	-	-	-	-	-	0.001	0.002

*$\sum$ oxychlordane and alpha and gamma isomers of chlordane, chlordene and cis and trans isomers of nonachlor
†$\sum$ ortho and para DDD, DDE, and DDT, and DDMU

Table 19. Established criteria or objectives for organochlorine pesticides in water. All values are in µg l^{-1}.

Analyte	Criterion	Relevant Portion of Criterion	Source
Total chlordane	0.1	Municipal Beneficial Use	R4 Basin Plan
	0.0043	Aquatic life toxicity-4-d average	CTR
	2.4	Aquatic life toxicity-instantaneous maximum	CTR
DDD(o,p')	0.00083 (1)	Sources of drinking water-humans	CTR
DDE(p,p')	0.00059 (1)	Sources of drinking water-humans	CTR
DDT(p,p')	0.00059 (1)	Sources of drinking water-humans	CTR
Total DDT	0.001	Aquatic life toxicity-4-d average	USEPA
	1.1	Aquatic life toxicity-instantaneous maximum	USEPA
	0.00014	Sources of drinking water-humans	CTR
Dieldrin	0.056	Aquatic life toxicity-4-d average (total)	CTR
	0.24	Aquatic life toxicity-1-h average (total)	CTR
Endosulfan II	110 (2)	Sources of drinking water-humans	CTR
	0.056 (2)	Aquatic life toxicity-4-d average (total)	USEPA
	0.22 (2)	Aquatic life toxicity-instantaneous maximum	USEPA
Endosulfan sulfate	0.056 (3)	Aquatic life toxicity-24-h average	USEPA
Endrin Aldehyde	2 (4)	Municipal Beneficial Use	R4 Basin Plan
Endrin Ketone	0.76 (5)	Sources of drinking water-humans	CTR
	0.036 (4)	Aquatic life toxicity-4-d average (total)	CTR
	0.086 (4)	Aquatic life toxicity-1-h average (total)	CTR
HCH, beta	0.014	Sources of drinking water-humans	CTR
HCH, gamma (Lindane)	0.2	Municipal Beneficial Use	R4 Basin Plan
	0.95	Aquatic life toxicity-1-h average (total)	USEPA
	0.08	Aquatic life toxicity-4-d average	USEPA
Hexachlorobenzene	1	Municipal Beneficial Use	R4 Basin Plan
Methoxychlor	40	Municipal Beneficial Use	R4 Basin Plan
	0.03	Aquatic life toxicity-instantaneous maximum	USEPA
Mirex	0.001	Aquatic life toxicity-instantaneous maximum	USEPA

(1) Criteria are for DDD, DDE, and DDT
(2) Criterion most appropriately applied to the sum of Endosulfan I and II
(3) Based on Endosulfan
(4) Criterion is for Endrin
(5) Criterion applies separately to Endrin and Endrin Aldehyde

to measure these values, thus the chlorpyrifos values shown (MDL 0.05 μg l^{-1}) automatically exceed the California DFG 1-hour and 4-day average criteria for toxicity to aquatic life of 0.02 and 0.014 μg l^{-1} respectively (Table 20). Diazinon concentrations ranged from 0.054 to 6.696 μg l^{-1} and all samples exceeded the California DFG 4-day average criterion for toxicity to aquatic life (0.05 μg l^{-1}, Table 20) and all samples but one (March 18, 2003; 0.054 μg l^{-1}) exceeded the 1-hour average criterion (0.08 μg l^{-1}, Table 20). Several samples also exceeded the California DHS action level for drinking water of 6 μg l^{-1}.

Additional organophosphate pesticides (OPPs) that were detected are presented in Tables 21 (CAL watershed) and 22 (STC watershed). Many values were between their MDL and RL, in which case the value reported is the mean of the MDL and RL. Thus, many values are identical. All other OPPs were below the detection limits in all samples. We were not able to find established criteria for ciodrin, coumaphos, dichlofenthion, dicrotophos, dioxathion, fenthion, methidathion, mevinphos, naled, phorate, phosphamidon, terbufos, tetrachlorovinphos, thiobencarb, tokuthion, or trichloronate. Concentrations of azinphos methyl exceeded the USEPA instantaneous maximum for toxicity to aquatic life (Table 20), and 3 CAL sites exceeded the parathion methyl California DFG instantaneous maximum for toxicity to aquatic life (Table 20). Concentrations of carbophenothion, demeton-s, dimethoate, and malathion were each less than their respective criteria

PAHs were below the detection limit from all sampled sites except 403STCNRB and 403STCBQT (Table 23). Benz(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, and chrysene exceeded the CTR objective for sources of drinking water. Benzo(a)pyrene met the Basin Plan objective and the California Primary MCL (Marshack 2003). Homologues of fluorene, naphthalene, and anthracene were each well below objectives. We were not able to find objectives or criteria for the other PAHs.

Results for individual PCB congeners are presented in Table 24. The total number of PCB congeners detected ranged from 2 to 12 out of a possible 50 that were analyzed, with the exception of 403STCBQT. Forty-two PCB congeners were detected in the October 31, 2001 sample but none was detected in the January 13, 2003 sample. The former sample was collected from stagnant water whereas the latter was taken from flowing water. If PCBs were fluxing from the sediments, they could have accumulated in the stagnant water resulting in the high number of detected congeners in October 2001.

The Basin Plan objectives for total PCBs are 0.014 and 0.030 μg l^{-1} for the protection of aquatic life in fresh and estuarine waters, respectively. These are the same criteria specified in the US EPA National Ambient Water Quality Criteria (Marshack 2003). Using only the detected values to calculate total PCBs, 7 of 11 samples exceeded their respective criteria. Using ½ the MDL for samples below the MDL, all samples exceeded their respective criteria, including 403STCBQT from January 13, 2003 in which all congeners were below the detection limit. This suggests that detection limits are too high to allow a meaningful comparison with established criteria if ½ MDL values are used in total PCB summations.

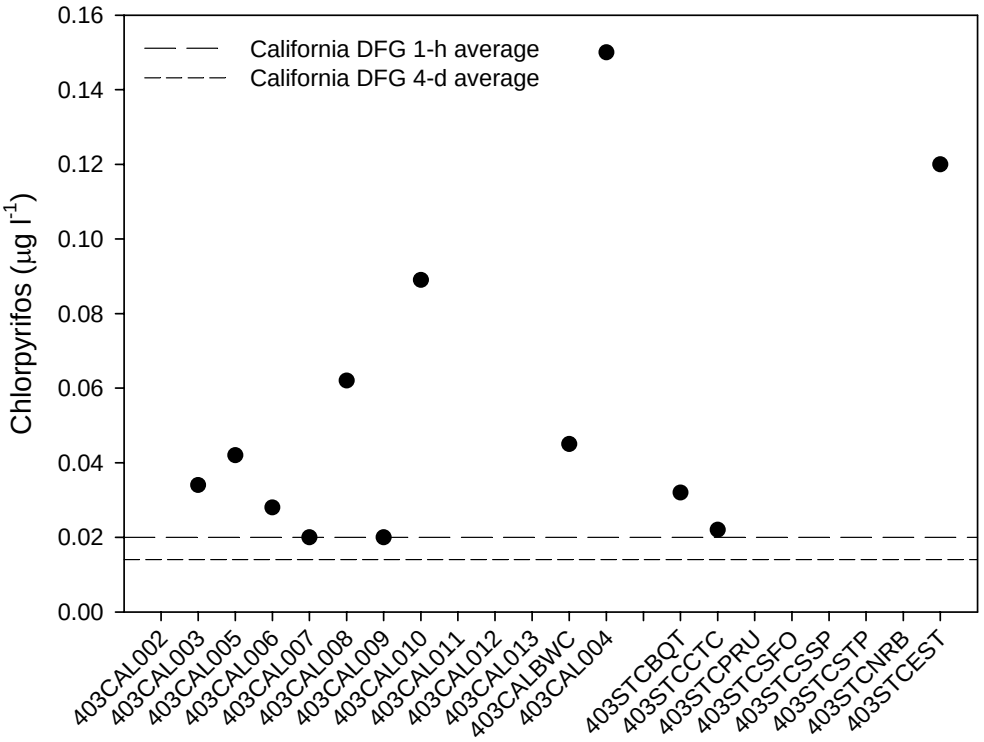


Figure 54. Chlorpyrifos in water in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

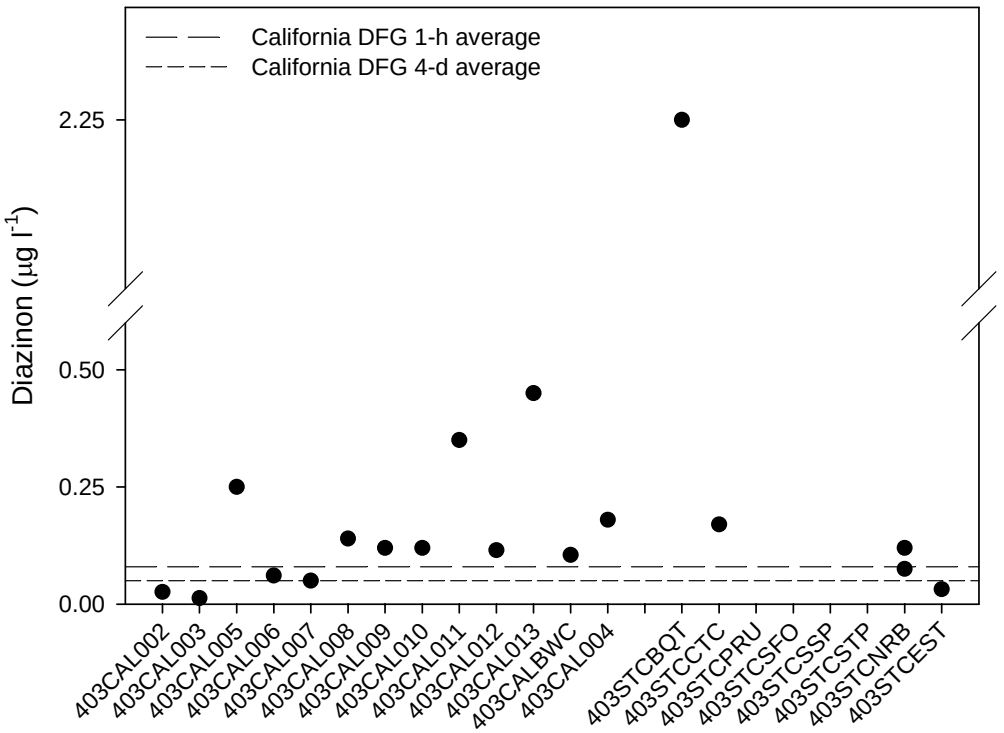


Figure 55. Diazinon in water in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds.

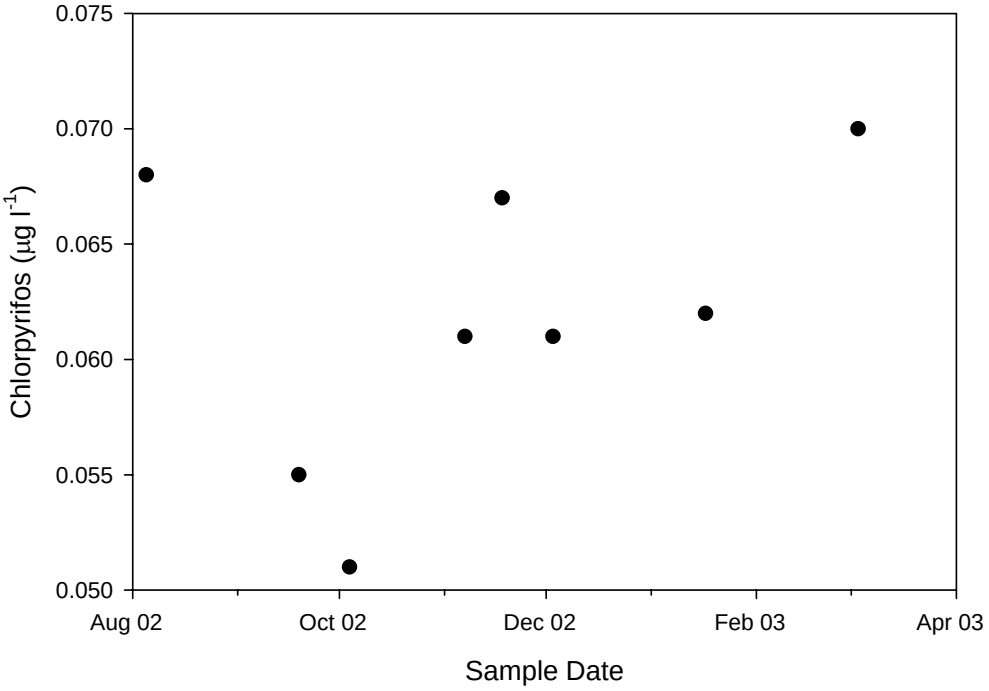


Figure 56. Chlorpyrifos in water at 403STCBQT from August 2002 through April 2003.

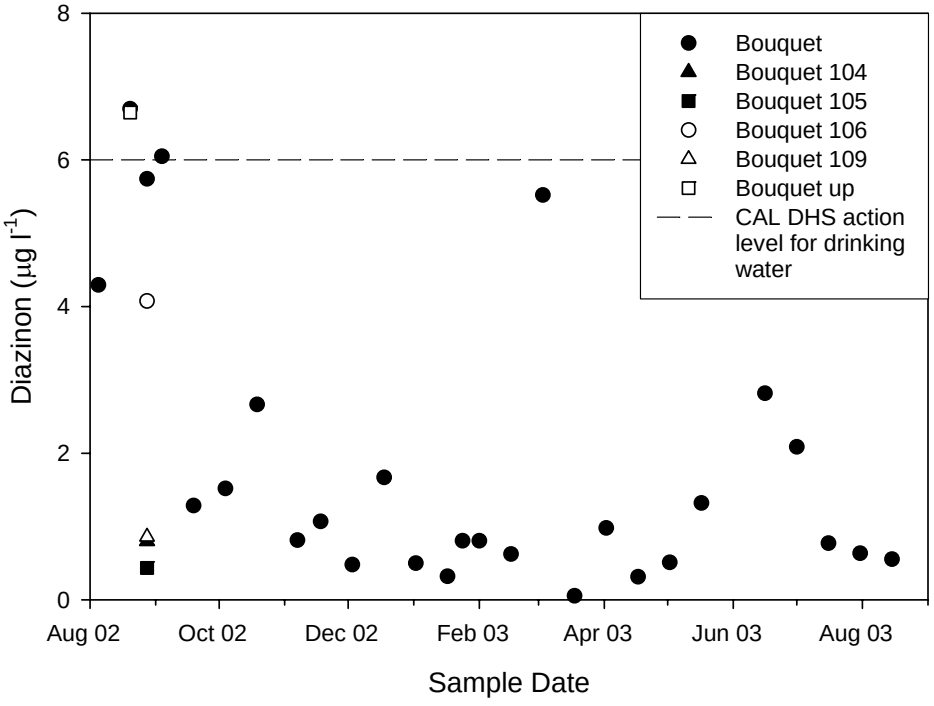


Figure 57. Diazinon in water at 403STCBQT from August 2002 through August 2003.

Table 20. Established criteria for organophosphate pesticides in water. All values are in µg l^{-1}.

Analyte	Criterion	Relevant Portion of Criterion	Source
Azinphos methyl	0.01	Aquatic life toxicity-instantaneous maximum	USEPA
Carbophenothion	7	Action level for drinking water	California DHS
Chlorpyrifos	0.02	Aquatic life toxicity-1-h average	California DFG
	0.014	Aquatic life toxicity-4-d average	California DFG
Demeton-s	0.1	Aquatic life toxicity-instantaneous maximum	USEPA
Diazinon	6	Action level for drinking water	California DHS
	0.08	Aquatic life toxicity-1-h average	California DFG
	0.05	Aquatic life toxicity-4-d average	California DFG
Dimethoate	1	Action level for drinking water	California DHS
Malathion	0.1	Aquatic life toxicity-1-h average	California DFG
Parathion methyl	2	Action level for drinking water	California DHS
	0.08	Aquatic life toxicity-instantaneous maximum	California DFG

Table 21. Organophosphate pesticides in water in the Calleguas Creek watershed. Values below the RL were calculated as 1/2 the distance between the MDL and the RL. – indicates the sample was below the MDL. All values are in µg l^{-1}. Values in bold type exceed the established criteria listed in Table 20.

Analyte / Site / Date	403CAL002 10/29/2001	403CAL003 10/29/2001	403CAL004 11/12/2001	403CAL005 10/31/2001	403CAL006 10/29/2001	403CAL007 10/29/2001	403CAL008 10/30/2001	403CAL009 10/31/2001	403CAL010 10/31/2001	403CAL011 10/31/2001	403CAL012 10/30/2001	403CAL013 10/30/2001	403CALBWC 10/31/2001	MDL	RL
Azinphos methyl	-	-	-	**0.04**	-	-	-	-	**0.04**	**0.05**	-	-	-	0.03	0.05
Carbophenothion	0.04	0.04	0.15	-	0.15	0.22	-	-	-	-	-	-	-	0.03	0.05
Ciodrin(Crotoxyphos)	0.05	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.05
Coumaphos	-	-	0.04	-	-	-	-	-	-	-	-	-	-	0.04	0.05
Demeton-s	-	-	-	-	-	-	-	-	-	-	0.04	-	-	0.04	0.05
Dichlofenthion	-	-	0.04	-	0.04	0.04	-	-	-	-	-	-	-	0.03	0.05
Dicrotophos	0.040	-	0.040	0.040	0.040	0.040	0.040	-	-	0.040	0.040	0.040	-	0.03	0.05
Dimethoate	-	-	-	-	-	-	0.04	-	-	0.04	0.04	0.04	0.04	0.03	0.05
Dioxathion	0.040	-	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.03	0.05
Fenthion	-	-	0.04	-	-	-	-	-	-	0.04	-	0.04	-	0.03	0.05
Malathion	-	0.08	0.04	-	-	-	0.04	-	-	-	-	0.04	-	0.03	0.05
Methidathion	-	0.04	-	-	-	-	-	-	-	-	-	-	-	0.03	0.05
Mevinphos (Phosdrin)	-	-	-	0.04	-	-	0.04	0.04	-	0.04	0.04	0.04	-	0.03	0.05
Naled(Dibrom)	-	-	-	-	-	-	0.04	-	-	0.04	0.04	0.04	-	0.03	0.05
Parathion, Ethyl	-	0.06	0.04	0.04	-	-	0.04	-	-	-	-	-	-	0.03	0.05
Parathion, Methyl	0.03	0.04	0.03	0.03	0.02	-	**0.15**	0.04	-	0.03	**0.11**	**0.16**	-	0.01	0.05
Phorate	-	-	0.040	-	-	-	0.040	-	-	0.040	-	-	-	0.03	0.05
Phosphamidon	0.040	-	-	-	0.040	-	-	-	-	-	-	-	0.040	0.03	0.05
Terbufos	-	-	-	-	-	-	-	-	-	-	0.040	-	-	0.03	0.05
Tetrachlorvinphos	-	-	-	-	-	-	-	-	-	0.050	-	-	-	0.03	0.05
Thiobencarb	-	0.100	0.940	-	-	-	-	-	-	1.010	-	-	0.550	0.1	0.2
Tokuthion	0.040	-	-	-	-	-	-	-	-	-	-	-	-	0.03	0.05
Trichloronate	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.03	0.05

Table 22. Organophosphate pesticides in water in the Santa Clara River watershed. Values below the RL were calculated as 1/2 the distance between the MDL and the RL. – indicates the sample was below the MDL. All values are in µg l^{-1}. Values in bold type exceed the established criteria listed in Table 20.

Analyte / Site / Date	403STCBQT 10/31/2001	403STCCTC 11/13/2001	403STCEST 11/14/2001	403STCNRB 10/30/2001	403STCNRB 11/13/2001	403STCPRU 11/1/2001	403STCSFO 10/31/2001	403STCSSP 11/15/2001	403STCSTP 11/1/2001	MDL	RL
Azinphos methyl	**0.04**	-	-	-	-	-	-	-	-	0.03	0.05
Carbophenothion	-	0.04	-	0.28	-	-	-	-	-	0.03	0.05
Dichlofenthion	-	-	-	0.04	0.05	-	-	-	-	0.03	0.05
Dicrotophos	-	-	-	-	-	-	-	-	-	0.03	0.05
Dimethoate	0.04	-	-	-	0.21	-	-	-	-	0.03	0.05
Dioxathion	0.040	0.040	0.040	0.040	0.040	-	-	-	0.040	0.03	0.05
Malathion	-	0.06	-	-	0.04	-	-	-	-	0.03	0.05
Mevinphos (Phosdrin)	-	-	-	-	-	-	-	-	0.04	0.03	0.05
Parathion, Ethyl	-	0.04	-	-	-	-	-	-	-	0.03	0.05
Parathion, Methyl	0.03	-	-	-	-	-	-	-	-	0.01	0.05
Tetrachlorvinphos	-	0.040	-	-	-	-	-	-	-	0.03	0.05
Thiobencarb	-	-	1.200	-	-	-	-	-	-	0.1	0.2
Trichloronate	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.03	0.05

Table 23. Polynuclear aromatic hydrocarbons in water at 403STCNRB, October 31, 2001. All other PAH results were below the MDL. Concentrations are in µg l^{-1}; – indicates the sample was below the MDL. Values in bold type exceed established criteria.

Site	403STCNRB	403STCBQT	MDL	RL	Criteria	Relevant Portion of Objective/Criteria	Source
Date	30/Oct/2001	13/Jan/2003					
Analyte							
Benz(a)anthracene	**0.035**		0.02	0.05	0.0044	Sources of drinking water	CTR
Benzo(a)pyrene	**0.035**		0.02	0.05	0.0044	Sources of drinking water	CTR
					0.2	Municipal Beneficial Use	R4 Basin Plan
					0.2		CA Primary MCL
Benzo(k)fluoranthene	**0.035**		0.02	0.05	0.0044	Sources of drinking water	CTR
Chrysene	**0.035**		0.02	0.05	0.0044	Sources of drinking water	CTR
Dibenzothiophenes, C1 -		0.0514	0.013	0.013			
Dibenzothiophenes, C2 -		0.0456	0.013	0.013			
Fluorenes, C1 -		0.0456	0.013	0.013	1300	Sources of drinking water (Fluorene)	CTR
Fluorenes, C3 -		0.0441	0.013	0.013	1300	Sources of drinking water (Fluorene)	CTR
Methylphenanthrene, 1-		0.0303	0.013	0.013			
Naphthalenes, C1 -		0.0384	0.013	0.013	170	Action level for drinking water (Naphthalene)	CA DHS
Naphthalenes, C2 -		0.0744	0.013	0.013	170	Action level for drinking water (Naphthalene)	CA DHS
Naphthalenes, C3 -		0.147	0.013	0.013	170	Action level for drinking water (Naphthalene)	CA DHS
Naphthalenes, C4 -		0.0306	0.013	0.013	170	Action level for drinking water (Naphthalene)	CA DHS
Phenanthrene		0.0828	0.013	0.013			
Phenanthrene	0.035		0.02	0.05			
Phenanthrene/Anthracene, C1 -		0.179	0.013	0.013	9600	Sources of drinking water (Anthracene)	CTR
Phenanthrene/Anthracene, C2 -		0.118	0.013	0.013	9600	Sources of drinking water (Anthracene)	CTR
Phenanthrene/Anthracene, C3 -		0.0455	0.013	0.013	9600	Sources of drinking water (Anthracene)	CTR
Trimethylnaphthalene, 2,3,5-	0.035		0.02	0.05			

Table 24. Individual polychlorinated biphenyl congeners in water. Concentrations are in µg l^{-1}, MDL is 0.001 and RL is 0.002 for all analytes. – indicates the sample was below the MDL. Values in bold type exceed established criteria.

Site	403CAL004	403STCBQT	403STCBQT	403STCCTC	403STCEST	403STCNRB	403STCNRB	403STCPRU	403STCSFO	403STCSSP	403STCSTP
Date	12/Nov/2001	31/Oct/2001	13/Jan/2003	13/Nov/2001	14/Nov/2001	10/Oct/2001	11/ Nov /2001	01/Nov/2001	31/Oct/2001	15/Nov/2001	01/Nov/2001
Analyte											
PCB 005	-	-	-	-	-	-	-	-	-	-	-
PCB 008	-	0.0188	-	-	-	0.002	-	0.00525	-	-	0.004
PCB 015	-	0.0153	-	-	-	0.002	-	0.0045	0.002	0.002	0.00305
PCB 018	-	0.012	-	-	-	0.01115	-	0.006	0.002575	0.004	0.0042
PCB 027	0.004	0.0259	-	-	-	0.0077	-	0.002625	-	-	-
PCB 028	-	-	-	-	-	-	-	-	-	-	-
PCB 029	0.018	0.003125	-	-	0.003	0.00375	-	0.0033	-	-	0.00325
PCB 031	0.004	0.028625	-	-	-	0.00275	-	0.00435	0.003	-	-
PCB 033	0.007	0.00563	-	-	0.002	-	-	0.006	-	-	0.004375
PCB 044	0.032	0.002	-	0.00525	-	-	-	-	-	-	-
PCB 049	-	0.00325	-	-	-	0.002	-	-	-	-	-
PCB 052	-	0.0103	-	0.01175	0.004	0.00733	-	-	-	-	-
PCB 056	-	0.00225	-	0.016	-	-	-	-	-	-	-
PCB 060	-	0.00225	-	0.0195	-	-	-	-	-	-	-
PCB 066	-	0.002	-	-	-	-	-	-	-	-	-
PCB 070	-	-	-	-	-	-	-	-	-	-	-
PCB 074	-	-	-	-	-	-	-	-	-	-	-
PCB 087	-	-	-	-	-	-	-	-	-	-	-
PCB 095	-	0.00225	-	-	-	-	-	-	-	-	-
PCB 097	-	0.0055	-	-	-	0.006	0.006	-	-	-	0.00225
PCB 099	-	0.00275	-	-	-	0.00238	-	-	0.002	-	-
PCB 101	0.021	0.006675	-	-	-	0.0027	-	-	-	-	-
PCB 105	-	0.0035	-	-	-	-	-	-	-	-	-
PCB 110	-	0.006	-	0.002	-	-	-	-	-	-	-
PCB 114	-	0.00425	-	0.00425	-	-	-	-	-	-	0.002
PCB 118	-	0.00275	-	-	-	-	-	-	-	-	-
PCB 128	-	0.00825	-	-	-	-	-	-	-	-	-

Site	403CAL004	403STCBQT	403STCBQT	403STCCTC	403STCEST	403STCNRB	403STCNRB	403STCPRU	403STCSFO	403STCSSP	403STCSTP
Date	**12/Nov/2001**	**31/Oct/2001**	**13/Jan/2003**	**13/Nov/2001**	**14/Nov/2001**	**10/Oct/2001**	**11/ Nov /2001**	**01/Nov/2001**	**31/Oct/2001**	**15/Nov/2001**	**01/Nov/2001**
Analyte											
PCB 137	-	0.01145	-	-	-	-	-	0.00588	0.00485	-	0.00625
PCB 138	-	0.00425	-	-	-	-	-	-	-	-	-
PCB 141	-	0.005	-	-	-	-	-	-	-	-	-
PCB 149	-	0.0025	-	-	-	-	-	-	-	-	-
PCB 151	-	0.00605	-	-	-	0.002	-	-	-	-	-
PCB 153	-	0.00555	-	-	-	-	-	-	-	-	-
PCB 156	0.007	0.02075	-	0.0285	-	0.00405	0.002	-	0.002425	-	-
PCB 157	-	0.00375	-	-	-	-	-	-	-	-	-
PCB 158	-	0.00413	-	-	-	-	-	-	-	-	-
PCB 170	-	0.00725	-	0.0075	-	-	-	-	-	-	-
PCB 174	-	-	-	-	-	-	-	-	-	-	-
PCB 177	-	-	-	-	-	-	-	-	-	-	-
PCB 180	-	-	-	-	-	-	-	-	-	-	-
PCB 183	-	0.008	-	-	-	0.002	-	0.00225	-	-	0.00275
PCB 187	0.002	0.00975	-	-	-	0.00253	-	-	-	-	0.002
PCB 189	-	0.00725	-	-	-	0.00533	-	-	-	-	-
PCB 194	-	0.0124	-	-	-	-	-	-	-	-	-
PCB 195	-	0.010875	-	-	-	-	-	-	-	-	-
PCB 200	-	0.00425	-	-	-	-	-	-	-	-	-
PCB 201	-	0.01325	-	-	-	-	-	-	-	-	-
PCB 203	-	0.0049	-	-	-	-	-	-	-	-	-
PCB 206	-	0.00495	-	-	-	0.002	-	-	-	-	-
PCB 209	-	0.00225	-	-	-	-	-	-	-	-	-
Total PCBs (using only detected values)	**0.095**	**0.32191**	0	**0.09475**	0.009	**0.06767**	0.008	**0.040155**	**0.01685**	0.006	**0.034125**
Total PCBs (using ½ MDL)	**0.116**	**0.32591**	**0.025**	**0.11575**	**0.0325**	**0.08667**	**0.032**	**0.060655**	**0.03885**	**0.03**	**0.054125**

4.7 Trace Organics in Sediment

Organic Pesticides, PAHs, and PCBs

Four organic pesticides were detected in sediment from 403STCEST on November 14, 2001 (Table 25). All other organic pesticides were below the MDL at 403STCEST, and all organic pesticides in the sample from 403STBQT on January 13, 2003 were below MDLs. Concentrations of DDE p,p' and DDT p,p' exceeded the TECs for the sum of DDE (3.16 μg kg^{-1}) and DDT (4.16 μg kg^{-1}) isomers specified in MacDonald et al. (2000), but were lower than the PECs. Chlorpyrifos and dacthal were not included in MacDonald et al. (2000).

Table 25. Sediment sample organic pesticide results for 403STCEST from November 14, 2001. All other organic pesticides were below the MDL. Values in bold type exceed established criteria.

Analyte	Category	Result	MDL	RL	Units
Chlorpyrifos	OPP	4.56	1.2	1.44	μg kg^{-1}
Dacthal	OCP	1.44	0.91	0.725	μg kg^{-1}
DDE(p,p')	OCP	**7.17**	0.83	2.88	μg kg^{-1}
DDT(p,p')	OCP	**4.48**	3.56	7.2	μg kg^{-1}

PAHs were detected in sediments from 403STBQT and 403STCEST (Table 26). More PAHs were below the detection limit in the 403STBQT sample, which has a lower MDL, than in the 403STCEST sample. All values were below the TECs presented in MacDonald et al. (2000).

Eleven individual PCB congeners were detected at 403STCEST and two were detected at 403STBQT (Table 27). No aroclors were detected in either sample. Total PCBs from –EST and –BQT using only the detected values in summation were 2.250 and 0.277 μg kg^{-1} respectively. Using ½ the MDL for values of individual congeners below the MDL, total PCBs were 4.914 μg kg^{-1} for –EST and 2.997 μg kg^{-1} for –BQT. Each of these values is below MacDonald et al.'s (2000) TEC of 59.8 μg kg^{-1}.

4.8 Trace Organics in Tissue

Organic Pesticides, PCBs

Organic pesticides, PAHs and PCBs that were detected in tissue of *Corbicula fluminea* deployed in the CAL and STC watersheds are presented in Tables 28-30, respectively. Detected values of chlorpyrifos, dieldrin, HCH gamma and heptachlor epoxide were below OEHHA screening values (Table 31). The detected value of toxaphene exceeded the OEHHA screening value. Total chlordane, total DDT, and total PCBs, summed using either only the detection limit or ½ the MDL for values below the MDL, were below OEHHA screening values. We were not able to find acceptable, established criteria for dacthal, oxadiazon, or PAHs.

Table 26. Sediment sample polynuclear aromatic hydrocarbon results. – indicates the sample was below the MDL. Concentrations are in µg kg^{-1}.

Site	403STCBQT	403STCEST
Date	13/Jan/2003	14/Nov/2001
MDL/RL	1.19	1.36
Analyte		
Acenaphthene	-	-
Acenaphthylene	-	-
Anthracene	-	7.84
Benz(a)anthracene	2.59	2.33
Benzo(a)pyrene	4.61	3.85
Benzo(b)fluoranthene	7.17	6.14
Benzo(e)pyrene	3.23	3.54
Benzo(g,h,i)perylene	5.13	5.29
Benzo(k)fluoranthene	1.99	1.65
Biphenyl	-	-
Chrysene	4.83	5.42
Chrysenes, C1 -	3.51	5.26
Chrysenes, C2 -	3.73	6.86
Chrysenes, C3 -	4.35	7.57
Dibenz(a,h)anthracene	-	-
Dibenzothiophene	-	-
Dibenzothiophenes, C1 -	4.33	12.60
Dibenzothiophenes, C2 -	7.38	21.90
Dibenzothiophenes, C3 -	7.07	27.10
Dimethylnaphthalene, 2,6-	-	1.87
Fluoranthene	8.84	5.34
Fluoranthene/Pyrenes, C1 -	8.79	4.85
Fluorene	-	-
Fluorenes, C1 -	-	1.52
Fluorenes, C2 -	-	2.42
Fluorenes, C3 -	7.33	3.43
Indeno(1,2,3-c,d)pyrene	6.34	4.66
Methylnaphthalene, 1-	-	2.25
Methylnaphthalene, 2-	-	2.77
Methylphenanthrene, 1-	2.85	1.99
Naphthalene	-	3.66
Naphthalenes, C1 -	-	6.60
Naphthalenes, C2 -	-	8.82
Naphthalenes, C3 -	7.22	7.11
Naphthalenes, C4 -	2.90	3.21
Perylene	-	9.40
Phenanthrene	7.06	6.00
Phenanthrene/Anthracene, C1 -	14.40	8.70
Phenanthrene/Anthracene, C2 -	26.20	11.00
Phenanthrene/Anthracene, C3 -	23.00	10.90
Phenanthrene/Anthracene, C4 -	10.30	8.49
Pyrene	9.44	5.64
Trimethylnaphthalene, 2,3,5-	-	1.39

Table 27. Individual polychlorinated biphenyl congeners in sediment. – indicates the sample was below the MDL. Concentrations are in µg kg^{-1}.

Analyte	403STCEST 14/Nov/2001	MDL	RL	403STCBQT 13/Jan/2003	MDL	RL
PCB 008	-	0.144	0.288	-	0.118	0.237
PCB 018	-	0.144	0.288	-	0.118	0.237
PCB 027	-	0.144	0.288	-	0.118	0.237
PCB 028	-	0.144	0.288	-	0.118	0.237
PCB 029	-	0.144	0.288	-	0.118	0.237
PCB 031	-	0.144	0.288	-	0.118	0.237
PCB 033	-	0.144	0.288	-	0.118	0.237
PCB 044	-	0.144	0.288	-	0.118	0.237
PCB 049	-	0.144	0.288	-	0.118	0.237
PCB 052	0.193	0.144	0.288	-	0.118	0.237
PCB 056	-	0.144	0.288	-	0.118	0.237
PCB 060	-	0.144	0.288	-	0.118	0.237
PCB 066	0.197	0.144	0.288	-	0.118	0.237
PCB 070	0.231	0.144	0.288	-	0.118	0.237
PCB 074	-	0.144	0.288	-	0.118	0.237
PCB 087	0.178	0.144	0.288	-	0.118	0.237
PCB 095	0.177	0.144	0.288	-	0.118	0.237
PCB 097	-	0.144	0.288	-	0.118	0.237
PCB 099	-	0.144	0.288	-	0.118	0.237
PCB 101	0.185	0.144	0.288	-	0.118	0.237
PCB 105	-	0.144	0.288	-	0.118	0.237
PCB 110	0.288	0.144	0.288	0.16	0.118	0.237
PCB 114	-	0.144	0.288	-	0.118	0.237
PCB 118	0.256	0.144	0.288	0.12	0.118	0.237
PCB 128	-	0.144	0.288	-	0.118	0.237
PCB 137	-	0.144	0.288	-	0.118	0.237
PCB 138	0.198	0.144	0.288	-	0.118	0.237
PCB 141	-	0.144	0.288	-	0.118	0.237
PCB 149	-	0.144	0.288	-	0.118	0.237
PCB 151	-	0.144	0.288	-	0.118	0.237
PCB 153	-	0.144	0.288	-	0.118	0.237
PCB 156	-	0.144	0.288	-	0.118	0.237
PCB 157	-	0.144	0.288	-	0.118	0.237
PCB 158	-	0.144	0.288	-	0.118	0.237
PCB 170	-	0.144	0.288	-	0.118	0.237
PCB 174	-	0.144	0.288	-	0.118	0.237
PCB 177	-	0.144	0.288	-	0.118	0.237
PCB 180	-	0.144	0.288	-	0.118	0.237
PCB 183	-	0.144	0.288	-	0.118	0.237
PCB 187	-	0.144	0.288	-	0.118	0.237
PCB 189	-	0.144	0.288	-	0.118	0.237
PCB 194	-	0.144	0.288	-	0.118	0.237
PCB 195	0.155	0.144	0.288	-	0.118	0.237
PCB 200	0.192	0.144	0.288	-	0.118	0.237
PCB 201	-	0.144	0.288	-	0.118	0.237
PCB 203	-	0.144	0.288	-	0.118	0.237
PCB 206	-	0.144	0.288	-	0.118	0.237
PCB 209	-	0.144	0.288	-	0.118	0.237
PCB AROCLOR 1248	-	19.5	36	-	11.83	29.56
PCB AROCLOR 1254	-	7.79	14.4	-	4.730	11.825
PCB AROCLOR 1260	-	7.79	14.4	-	4.730	11.825

Table 28. Organochlorine (OCP) and organophosphate (OPP) pesticide concentrations in tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds in ng g^{-1} wet weight. Since the MDL for each analyte varies from sample to sample, the maximum MDL is listed. – indicates the sample was below the MDL. Values in bold type exceed the established criteria listed in Table 31.

	Site	403CAL004	403STCBQT	403STCCTC	403STCEST	403STCPRU	403STCSSP	403STCSTP	MDL
	Date	01/Nov/2001	10/Feb/2003	01/Nov/2001	01/Nov/2001	01/Nov/2001	01/Nov/2001	01/Nov/2001	
Analyte	Category								
Chlordane, cis	OCP	1.240	-	-	-	-	-	-	0.714
Chlordane, trans	OCP	0.811	-	-	-	-	-	-	0.403
Total chlordane (using only detected values)		3.619	0.000	0.706	0.000	0.000	0.000	0.000	-
Total chlordane (using ½ MDLs)		4.547	1.740	2.174	1.689	1.663	1.642	1.690	-
Chlorpyrifos	OPP	11.154	-	8.687	2.988	-	3.504	-	0.834
Dacthal	OCP	22.308	-	1.869	-	-	-	-	0.630
DDD(o,p')	OCP	2.956	-	-	-	-	-	-	0.766
DDD(p,p')	OCP	7.121	-	1.314	0.930	-	1.628	-	0.897
DDE(o,p')	OCP	0.680	-	-	-	-	-	-	0.670
DDE(p,p')	OCP	39.390	1.955	16.279	15.066	10.710	10.519	5.765	0.574
DDT(o,p')	OCP	1.505	-	-	-	-	-	-	1.013
DDT(p,p')	OCP	5.257	-	-	-	-	-	-	2.465
Total DDT (using only detected values)		56.910	1.955	17.593	15.996	10.710	12.147	5.765	-
Total DDT (using ½ MDLs)		57.505	5.304	20.593	19.053	14.162	15.120	9.274	-
Diazinon	OPP	-	-	7.592	-	-	-	-	6.740
Dieldrin	OCP	1.318	-	-	-	-	-	-	0.419
HCH, gamma	OCP	0.339	-	-	-	-	-	-	0.339
Heptachlor epoxide	OCP	0.755	-	-	-	-	-	-	0.503
Nonachlor, trans	OCP	1.568	-	0.706	-	-	-	-	0.387
Oxadiazon	OCP	2.675	2.035	182.500	-	-	-	-	0.933
Toxaphene	OCP	**73.476**	-	-	-	-	-	-	7.977

Table 29. Concentrations of polynuclear aromatic hydrocarbons (PAH) in the tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds in ng g^{-1} wet weight. – indicates the sample was below the MDL.

Site	403CAL004	403STCBQT	403STCCTC	403STCEST	403STCPRU	403STCSSP	403STCSTP
Date	11/01/2001	10/Feb/2003	11/01/2001	11/01/2001	11/01/2001	11/01/2001	11/01/2001
MDL/RL	0.99	1.00	0.99	0.99	1.00	0.84	0.99
Analyte							
Acenaphthene	-	-	-	-	-	-	-
Acenaphthylene	-	-	-	-	-	-	-
Anthracene	-	-	-	-	-	-	-
Benz[a]anthracene	-	-	1.11	1.55	-	-	-
Benzo(a)pyrene	-	-	-	-	-	-	-
Benzo(b)fluoranthene	-	-	-	-	-	-	-
Benzo(e)pyrene	-	-	1.72	-	-	-	2.09
Benzo(g,h,i)perylene	-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	-	-	-
Biphenyl	-	-	-	-	-	-	-
Chrysene	-	-	7.30	1.02	-	-	5.36
Chrysenes, C1 -	-	-	7.67	2.41	2.07	2.08	13.56
Chrysenes, C2 -	-	-	4.40	-	-	-	13.77
Chrysenes, C3 -	-	-	2.67	-	-	-	12.43
Dibenz(a,h)anthracene	-	-	-	-	-	-	-
Dibenzothiophene	-	-	-	-	-	-	-
Dibenzothiophenes, C1 -	-	-	1.82	-	-	-	-
Dibenzothiophenes, C2 -	1.76	12.63	5.63	1.38	-	-	3.53
Dibenzothiophenes, C3 -	-	11.46	6.10	-	-	-	7.03
Dimethylnaphthalene, 2,6-	-	-	-	-	-	-	-
Fluoranthene	-	-	1.93	-	-	-	-
Fluoranthene/Pyrenes, C1 -	2.61	8.98	11.61	3.14	1.14	1.72	12.28
Fluorene	-	-	-	-	-	-	-
Fluorenes, C1 -	1.64	13.14	-	-	-	-	-

Site	403CAL004	403STCBQT	403STCCTC	403STCEST	403STCPRU	403STCSSP	403STCSTP
Date	11/01/2001	10/Feb/2003	11/01/2001	11/01/2001	11/01/2001	11/01/2001	11/01/2001
MDL/RL	0.99	1.00	0.99	0.99	1.00	0.84	0.99
Analyte							
Fluorenes, C2 -	1.88	46.65	1.93	1.56	2.05	1.35	1.80
Fluorenes, C3 -	9.52	11.24	13.51	7.75	5.88	3.92	12.50
Indeno(1,2,3-c,d)pyrene	-	-	-	-	-	-	-
Methylnaphthalene, 1-	-	-	-	-	-	-	-
Methylnaphthalene, 2-	-	-	-	-	-	-	-
Methylphenanthrene, 1-	-	12.05	0.99	-	-	-	-
Naphthalene	1.08	-	1.04	1.35	1.17	0.93	1.63
Naphthalenes, C1 -	-	-	-	-	-	-	1.02
Naphthalenes, C2 -	1.94	15.48	1.07	-	-	0.90	-
Naphthalenes, C3 -	4.19	50.15	3.08	1.18	1.34	1.26	2.97
Naphthalenes, C4 -	1.74	44.53	2.53	-	1.00	-	2.66
Perylene	-	-	-	-	-	-	1.58
Phenanthrene	1.18	20.73	1.38	-	-	1.03	-
Phenanthrene/Anthracene, C1 -	11.15	87.31	12.19	9.49	1.96	3.89	8.31
Phenanthrene/Anthracene, C2 -	2.89	95.78	16.64	3.06	2.29	1.85	17.40
Phenanthrene/Anthracene, C3 -	1.47	54.53	17.16	2.39	2.29	1.29	33.94
Phenanthrene/Anthracene, C4 -	4.12	8.47	16.57	6.94	2.23	3.14	22.51
Pyrene	2.11	9.49	6.02	1.23	-	-	2.66
Trimethylnaphthalene, 2,3,5-	-	-	-	-	-	-	-

Table 30. Concentrations of polychlorinated biphenyl congeners in the tissue of *Corbicula fluminea* deployed in the Calleguas Creek (CAL) and Santa Clara River (STC) watersheds in ng g^{-1} wet weight. – indicates the sample was below the MDL.

Site	403CAL004	403STCBQT	403STCCTC	403STCEST	403STCPRU	403STCSSP	403STCSTP
Date	01/Nov/2001	10/Feb/2003	01/Nov/2001	01/Nov/2001	01/Nov/2001	01/Nov/2001	01/Nov/2001
MDL	1.2658	1.67	1.3405	1.6083	1.0908	1.447	1.4055
RL	5.063	3.34	5.362	6.433	4.363	5.788	5.622
Analyte							
PCB 008	-	-	-	-	-	-	-
PCB 018	-	-	-	-	-	-	-
PCB 027	-	-	-	-	-	-	-
PCB 028	0.1069	-	-	-	0.1170	0.0985	-
PCB 029	-	-	-	-	-	-	-
PCB 031	-	-	-	-	0.1251	0.1146	-
PCB 033	-	-	-	-	-	-	-
PCB 044	0.2449	-	0.2081	0.2474	0.2727	0.2365	0.1285
PCB 049	0.1264	-	-	-	-	-	-
PCB 052	0.2683	-	0.1292	0.1854	0.1494	0.1367	-
PCB 056	-	-	-	-	-	-	-
PCB 060	-	-	-	-	-	-	-
PCB 066	0.2800	-	0.2183	0.1649	0.1962	0.1601	0.1101
PCB 070	0.1732	-	0.1489	0.1488	0.1845	0.1206	0.1122
PCB 074	0.1794	-	-	-	-	-	-
PCB 087	-	-	0.1329	0.1023	0.1620	0.1374	-
PCB 095	0.6763	-	0.3241	0.3509	0.3897	0.3330	0.2343
PCB 097	0.1747	-	0.1818	0.1717	0.1953	0.1749	0.1037
PCB 099	0.5460	-	0.1840	0.1866	0.1863	0.1461	-
PCB 101	0.7496	-	0.3526	0.3980	0.4149	0.3611	0.2080
PCB 105	0.8970	-	0.1686	0.1302	0.1476	0.1260	-
PCB 110	0.5998	-	0.3687	0.3615	0.4293	0.3685	0.2208
PCB 114	-	-	-	-	-	-	-
PCB 118	0.6497	-	0.5300	0.4737	0.5238	0.4971	0.3479
PCB 128	0.1412	-	0.1051	-	-	-	-
PCB 137	-	-	-	-	-	-	-
PCB 138	1.5522	-	0.6468	0.7502	0.6363	0.6003	0.4331
PCB 141	0.2434	-	-	-	-	-	-

Site	403CAL004	403STCBQT	403STCCTC	403STCEST	403STCPRU	403STCSSP	403STCSTP
Date	01/Nov/2001	10/Feb/2003	01/Nov/2001	01/Nov/2001	01/Nov/2001	01/Nov/2001	01/Nov/2001
MDL	1.2658	1.67	1.3405	1.6083	1.0908	1.447	1.4055
RL	5.063	3.34	5.362	6.433	4.363	5.788	5.622
Analyte							
PCB 149	1.7862	-	0.5095	0.4191	0.3870	0.3002	0.1541
PCB 151	0.5827	-	-	-	-	-	-
PCB 153	2.6286	0.1214	1.4819	1.3764	1.3680	1.1926	1.0224
PCB 156	-	-	-	-	-	-	-
PCB 157	-	-	-	-	-	-	-
PCB 158	-	-	-	-	-	-	-
PCB 170	0.2223	-	-	-	-	-	-
PCB 174	0.2777	-	-	-	-	-	-
PCB 177	0.3026	-	-	-	-	-	-
PCB 180	0.7784	-	0.2650	0.2182	0.2241	0.1936	0.1761
PCB 183	0.3182	-	-	-	-	-	-
PCB 187	0.7160	-	0.2672	0.2933	0.2502	0.2030	0.1505
PCB 189	-	-	-	-	-	-	-
PCB 194	-	-	-	-	-	-	-
PCB 195	-	-	-	-	-	-	-
PCB 200	0.1755	-	-	-	-	-	-
PCB 201	-	-	-	-	-	-	-
PCB 203	0.1576	-	-	-	-	-	-
PCB 206	-	-	-	-	-	-	-
PCB 209	-	-	-	-	-	-	-
PCB AROCLOR 1248	-	-	-	-	-	-	-
PCB AROCLOR 1254	14.5860	-	6.4970	6.1380	5.8500	5.4270	-
PCB AROCLOR 1260	-	-	-	-	-	-	-
Total PCBs (using only detected values)	15.5548	0.1214	6.2225	5.9787	6.3594	5.5007	3.4016
Total PCBs (using ½ MDL)	16.5421	2.3584	7.6904	7.5242	7.7829	6.9065	5.1479

Table 31. Established Office of Environmental Health Hazard Assessment (OEHHA) screening values for organic chemicals in tissue. All values are in ng g^{-1} wet weight.

Analyte	OEHHA Screening Value
Total chlordane	30
Chlorpyrifos	10,000
Total DDT	100
Diazinon	300
Dieldrin	2.0
HCH gamma (Lindane)	30
Heptachlor epoxide	4.0
Total PCBs	20
Toxaphene	30

4.9 Toxicity

Acute and chronic water column toxicity were detected in the CAL watershed. Acute toxicity, indicated by significant *Ceriodaphnia dubia* mortality, occurred in 4 of 12 samples (Figure 58). *C. dubia* reproduction was significantly reduced in 2 samples, indicating chronic toxicity. Less toxicity was indicated in the *Pimephales promelas* tests; acute toxicity was indicated at one site and chronic toxicity was indicated at another site. The 403CAL004 sample was acutely toxic to *Holmesimysis costata* but had no effect on *Strongylocentrotus purpuratus* development. Overall, acute and/or chronic toxicity occurred in 62% of the CAL watershed samples; 38% of the samples had no toxic effects.

Acute and chronic water column toxicity were also detected in the STC watershed. Significant *Ceriodaphnia dubia* mortality occurred in 8 samples taken at 6 sites, most of which were located along the mainstem of the STC (Figure 58). *C. dubia* reproduction was significantly reduced in another 8 samples taken from 7 sites. Five of these sites were located in the northern portion of the PRU sub-watershed. Only 1 sample, 403STC004, was acutely toxic to *Pimephales* promelas; this sample was also chronically toxic to *C. dubia*. Only 403STCNRB was chronically toxic to *P. promelas*. Sediments from 403STCBQT were acutely toxic to *Hyalella azteca.* Overall, acute and/or chronic toxicity occurred in 37% of the STC watershed samples; 63% of the samples had no toxic effects. *C. dubia* data from the 30 stations sampled in 2003 indicate that 66.7% of STC streams had no toxicity, 20% had chronic toxicity, and 13.3% had acute toxicity. In 2003, no toxicity was indicated by *P. promelas*.

The TIE for 403STCBQT indicated that diazinon was the probable cause of toxicity. The TIE for 403CAL004 was inconclusive due to confounding toxicity by artificial salts. Full TIE results are available in Appendix B.

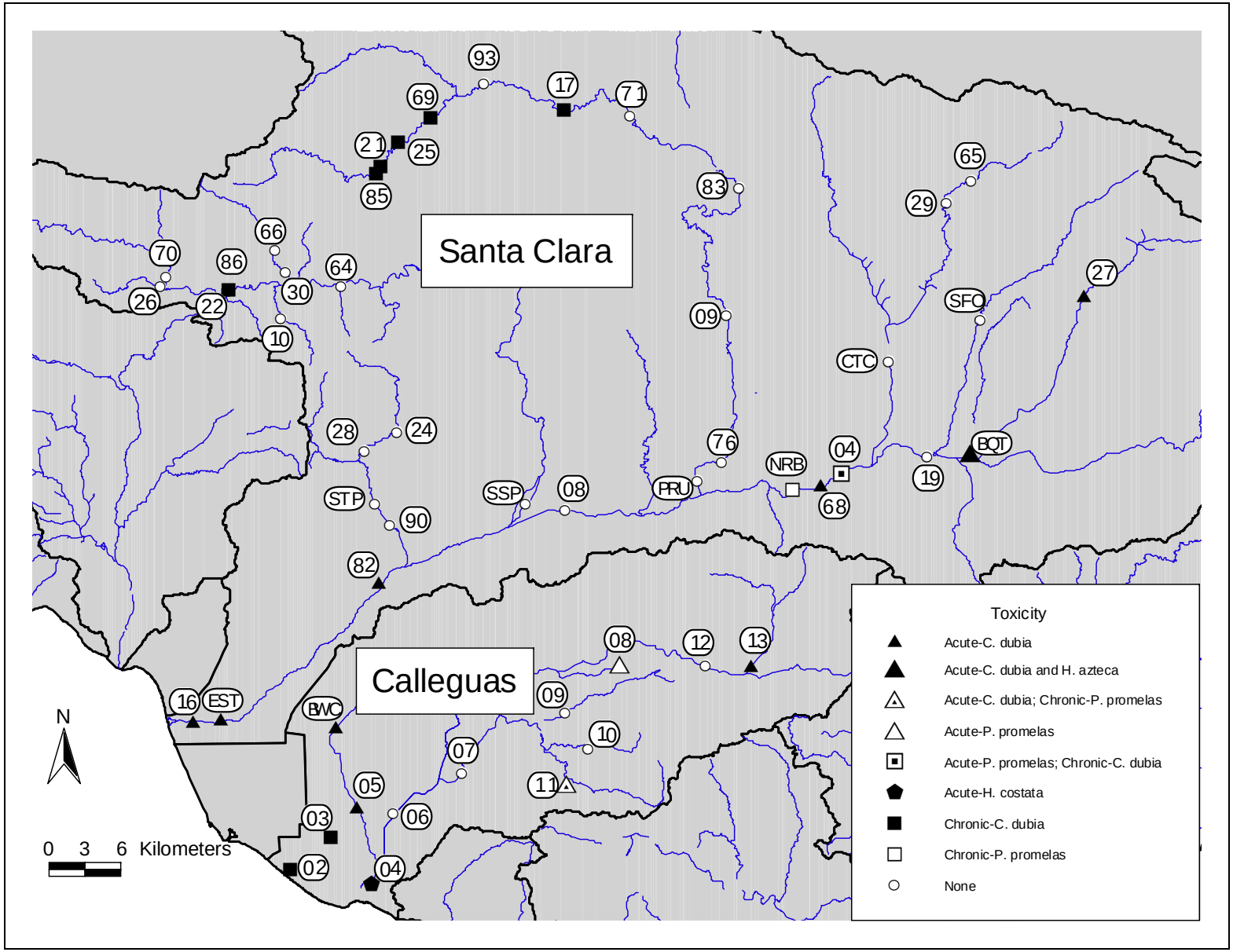


Figure 58. Toxicity in the Calleguas Creek and Santa Clara River watersheds.

4.10 Bioassessment

Taxonomic richness varied from a low of 6.7 ± 1.3 (mean ± SE) in the CAL watershed to a high of 39.7 ± 1.2 in the STC watershed (Figure 59). For sites sampled in both 2001 and 2003, taxonomic richness was usually higher in 2001, though in some cases the difference were probably not significant.

Generally, when taxonomic richness was high, % dominant taxon was low (Figure 60). Percent dominant taxon ranged from 15.0 ± 1.3 to 88.6 ± 5.0 in the STC watershed and was equally high in the CAL watershed (88.2 ± 5.7). For sites sampled in both 2001 and 2003, the pattern was opposite that of taxonomic richness, with % dominant taxon usually higher in 2003.

Ephemeroptera, plecoptera, and tricoptera (EPT) taxa varied from 0 in the CAL watershed to 16.0 ± 0.6 in the STC watershed (Figure 61). For sites sampled in both 2001 and 2003, there were some indications that EPT taxa was lower in 2003 than in 2001. Overall, EPT taxa was higher in the STC watershed than in the CAL watershed.

Overall, ecological condition in the CAL and STC watersheds varied from very poor to good (Figure 62) based on the southern California IBI developed by Ode et al. (unpublished data, Appendix C). Seventeen samples scored as Very Poor and another 17 scored as Poor. The remaining 26 samples scored as Fair or Good. None was Very Good. All of the CAL sites were Very Poor to Poor (Figure 63). With the exception of 430STCSTP, all of the STC subwatershed outlets and the watershed outlet were Very Poor to Poor. Additionally, many STC mainstem sites were Very Poor to Poor. Fair and Good sites primarily occurred in the tributaries above the integrator sites. Data from the 30 stations sampled in 2003 indicate that the majority of the STC watershed was in fair to good condition (Table 32).

Table 32. Distribution of index of biotic integrity (IBI) categories among streams in the Santa Clara River watershed.

IBI Category	% of Streams
Very Poor	2.27
Poor	20.43
Fair	27.24
Good	15.89
Very Good	0

Sites that were sampled twice generally produced similar scores each time, indicating that ecological condition may not have changed greatly between sampling events. The IBI is designed to apply from April–November. We have applied it to samples taken throughout the year but care should be taken when making any decisions based upon data collected December-March.

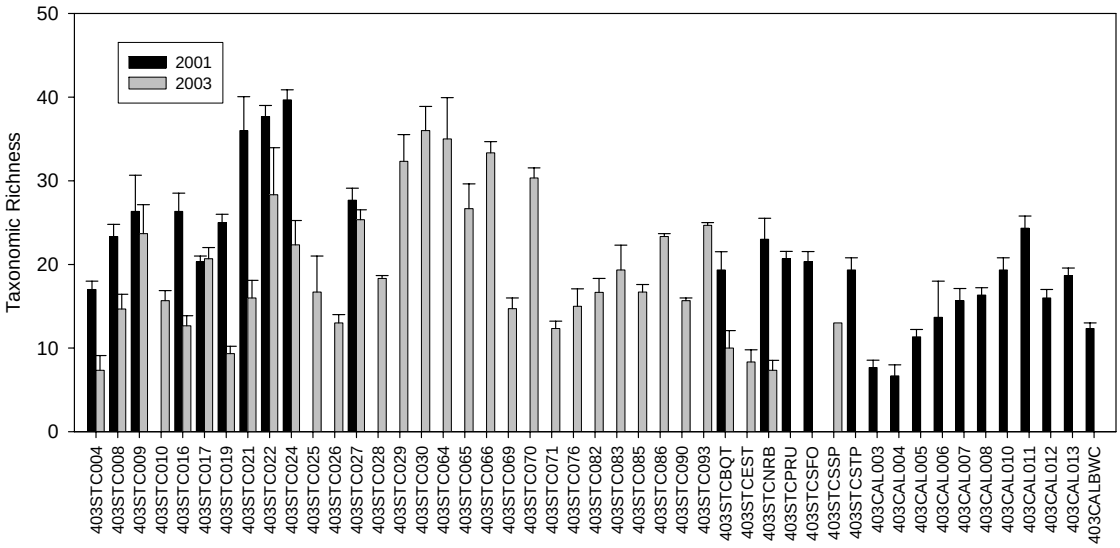


Figure 59. Taxonomic richness at sites in the Calleguas Creek and Santa Clara River watersheds.

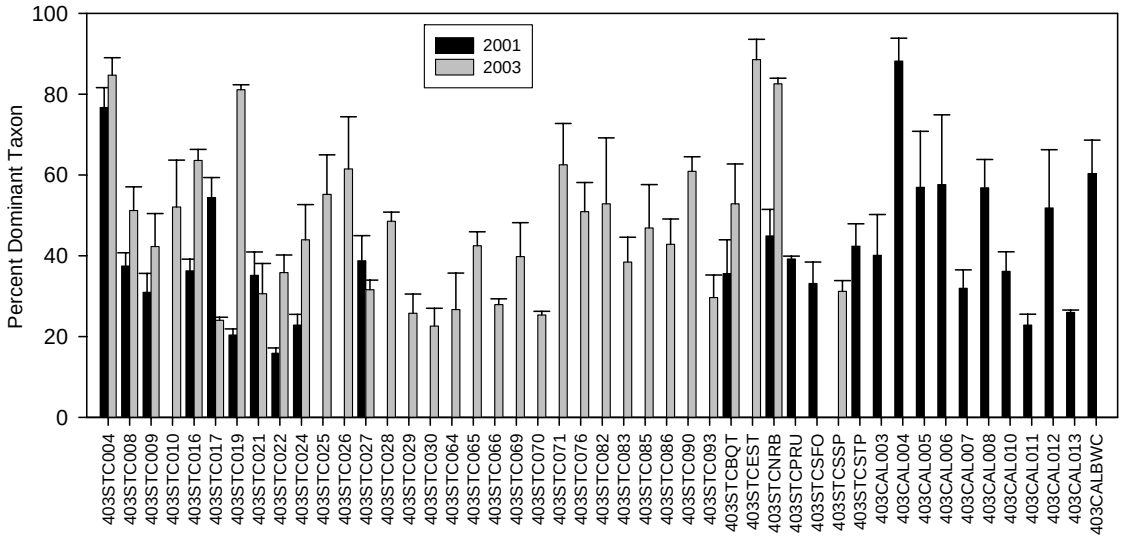


Figure 60. Percent dominant taxon at sites in the Calleguas Creek and Santa Clara River watersheds.

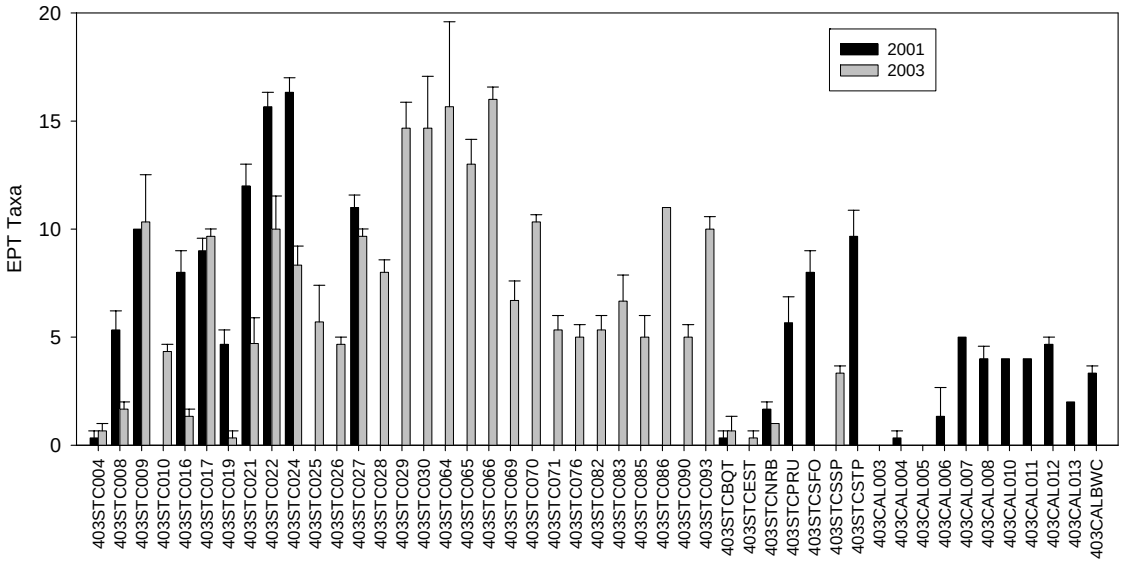


Figure 61. EPT taxa at sites in the Calleguas Creek and Santa Clara River watersheds.

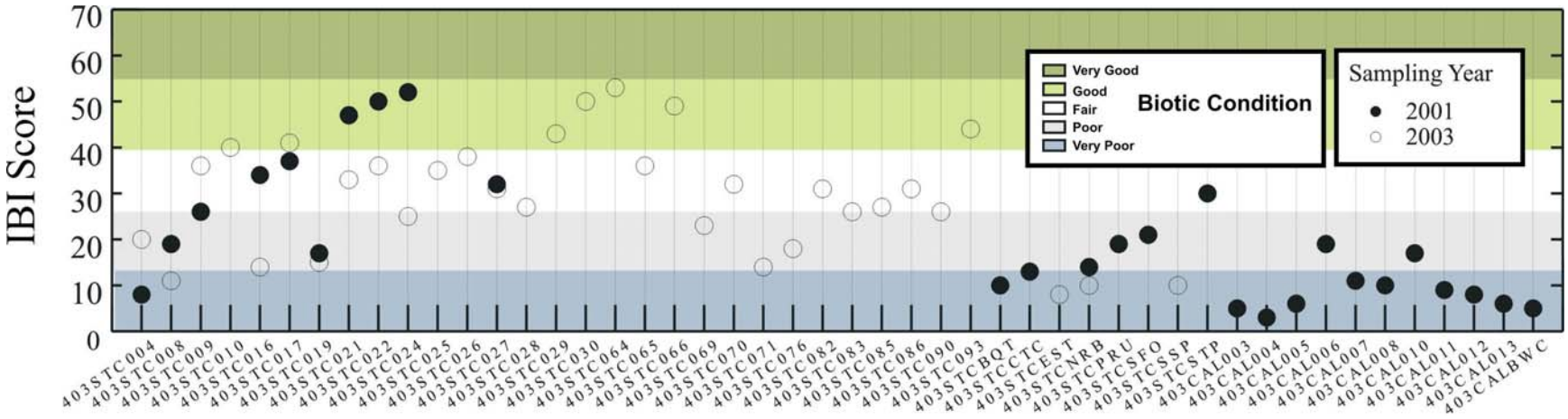


Figure 62. Index of biotic integrity (IBI scores) for sites in the Santa Clara River and Calleguas Creek watersheds.

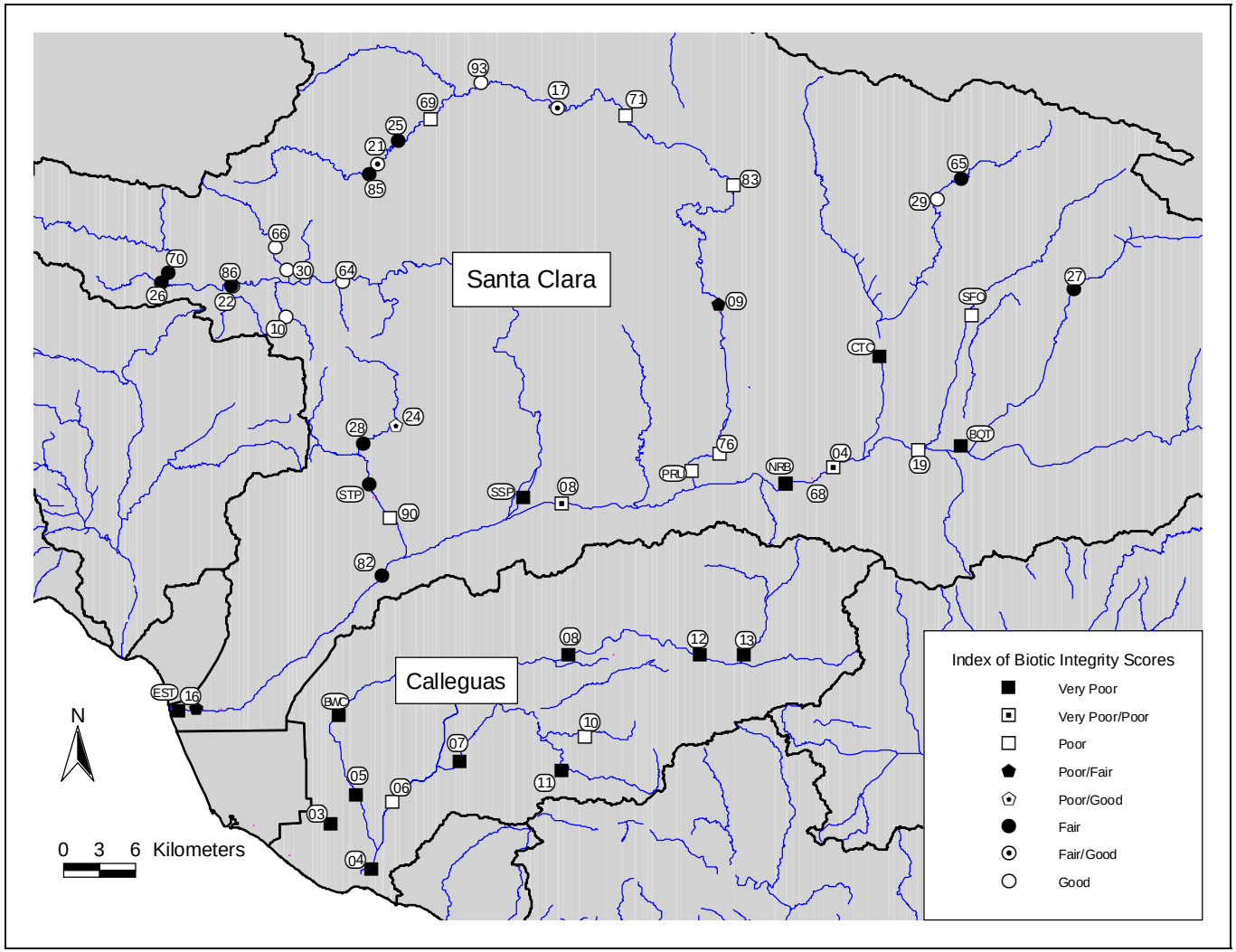


Figure 63. Bioassessment results at sites in the Calleguas Creek and Santa Clara River watersheds. Index of Biotic Integrity scores were divided into four categories: very poor, poor, fair and good. Sites that were sampled twice have two categories listed if the scores were different.

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5 LIMITATIONS

Several sites in this study were sampled twice, but most were sampled only once. No inference about the temporal extent of potential water quality problems at any site can be made, and the representativeness of each sample is unknown. Additional sampling would be needed to determine the true nature of any impairment. At many stations metals and organics were not sampled. In these cases, speculation as to the cause of toxicity and poor benthic community structure is severely limited. Sampling all constituents at all sites would greatly enhance the potential to gain a more complete understanding of the cause of impairments and potential impacts to aquatic life.

The field and laboratory methods employed also limit the usefulness of the data collected in this study. DO was measured in % saturation but Basin Plan criteria are stated in mg l^{-1}. Thus, the DO data collected in this study cannot be compared to established objectives. Summations of chlordane, DDT, and PCBs were performed two ways: using only the detected values, and using ½ the MDL value for values below the MDL. The latter method is the more conservative estimate because it presents the worst case scenario of the two methods. The current MDLs for these constituents may be too high to allow meaningful comparisons to established criteria. For example, the USEPA 4-d average criterion for toxicity to aquatic life for total DDT is 0.001 μg l^{-1}. The MDLs for the ortho and para isomers of DDD, DDE, and DDT and for DDMU are 0.001-0.002 μg l^{-1}. If a sample is below the MDL for each of the compounds used in the summation, and ½ the MDL is used as the value for each, the calculated value for total DDT is 0.004 μg l^{-1}. the same situation arose in summation of chlordane and PCBs. MDLs that are low relative to established criteria would permit a more conclusive assessment of whether or not an impairment exists.

6 SUMMARY

Table 33 summarizes the results of this study by listing the constituents and parameters that did not meet established water quality objectives or may indicate water quality problems for each site. To be conservative, summations using ½ the MDLs were used in determining whether total chlordane, total DDT, or total PCBs did not meet criteria. Additionally, when two possible thresholds were suggested, the most protective threshold was used for comparison.

Calleguas Creek Watershed

Overall, the data collected in the CAL watershed indicate a number of conventional water quality concerns, and the findings are consistent with the 2002 303(d) listings. Ten of 13 sites had DO concentrations <90% saturation (Figure 3). pH was low at three sites (Figure 5). Inorganic N concentrations exceeded Basin Plan objectives at 7 sites: total NH_3-N at 403CAL008, and NO_3-N at 6 sites located in the western portion of the CAL watershed (Figure 15). PO_4-P concentrations exceeded USEPA recommended limits at 11 sites and not one of the sites was as low as the USEPA Ecoregion III reference condition for total P

(Figure 16A). Chloride concentrations exceeded either Basin Plan objectives or the USEPA 4-d average criterion for toxicity to aquatic life at 6 sites distributed throughout the watershed (Figure 21). Boron exceeded Basin Plan objectives at two sites, sulfate at 4 sites, and TDS at 6 sites. The majority of these sites were located in the eastern half of the watershed (Figures 19, 23, 25).

Water column aluminum concentrations at 11 of 13 sites exceeded either the Basin Plan objective or the USEPA 4-d average criterion for toxicity to aquatic life. Metals in *Corbicula fluminea* tissue from 403CAL004 were relatively low within the context of this study; only arsenic exceeded USFWS guidelines. CAL watershed sediments were not analyzed for metals and *C. fluminea* were deployed at only one station. Thus it is not possible to assess long term accumulation of metals in sediments or aquatic organisms.

At 12 of 13 sites in the CAL watershed, organic compounds were present at levels exceeding criteria established to protect human and aquatic life (Tables 19 and 20). Chlorpyrifos exceeded the California DFG 1-h and 4-d average criteria for toxicity to aquatic life at 9 sites; diazinon exceeded both respective criteria at 9 sites and the 4-d average at one site. Chlordane, DDT, PCBs and HCH beta exceeded established criteria at 403CAL004, and toxaphene accumulated in *Corbicula fluminea* tissues at this site to a level exceeding the OEHHA screening value. Azinphos methyl and parathion methyl were also present at levels exceeding established criteria. Many other organic compounds were detected in the CAL watershed but were either present at levels below established criteria or we were unable to find criteria with which to compare measurements.

Toxicity was widespread throughout the CAL watershed. Eight of 13 sites had either chronic or acute toxicity. Although the TIE was inconclusive, water column chemistry suggests that aluminum, chlorpyrifos, and diazinon, which were elevated above established criteria at many sites, may have been responsible. Concurrence between multiple toxicity tests at a site was rare, indicating that different factors may be causing toxicity at different sites.

Of the 11 sites sampled for bioassessment, IBI scores were Very Poor and Poor, indicating degraded ecological condition. Potential causes of poor benthic community structure are toxicity, organics pollution, and metals pollution. DO concentrations at < 90 % saturation may also contribute to poor IBI scores. Lastly, elevated concentrations of inorganic constituents may have had a direct effect on the benthic community; for example, high concentrations of ammonia can be toxic to aquatic organisms. Alternately, biostimulatory substances such as nitrogen and phosphorus stimulate growth of primary producers, which can reduce habitat quality through changes in species composition and DO depletion and thereby negatively impact the biota. Additional studies of metals and organic compounds in sediments and bioaccumulation in tissue may provide further insight on the causes of poor benthic community structure.

Santa Clara River Watershed

Similar indicators of potential conventional water quality concerns were seen in the STC watershed as in the CAL watershed. DO saturation was <90% at 15 of 38 sites, which were

distributed throughout the watershed. pH was high at four sites. Inorganic N concentrations exceeded Basin Plan objectives at 7 sites: total and un-ionized NH_3-N at 3 sites, total NH_3-N at one site, un-ionized NH_3-N at one site, and NO_3-N at two sites. Four of the 5 sites where NH_3-N exceeded Basin Plan thresholds were clustered along the mainstem of the river from 403STCNRB to –BQT (Figure 12). NO_3-N concentrations exceeded1 mg l^{-1} in the same area (Figure 15). PO_4-P concentrations exceeded USEPA recommended limits at 13 sites. TDS concentrations exceeded Basin Plan objectives at 12 sites, many of which were in the Santa Paula and Piru sub-watersheds (Figure 25). Sulfate exceeded Basin Plan objectives at 10 of the 12 sites where TDS was elevated (Figure 23). Chloride was elevated at 7 sites in the eastern half of the watershed(Figure 21) and boron was elevated at three sites on Piru Creek (Figure 19). The findings for chloride, NO_3-N, NH_3-N and TDS are consistent with the 2002 303(d) listings.

Metals in sediment, tissue and water were only measured at the integrator sites. However the presence of metals in these matrices at the integrator sites at levels exceeding established criteria suggests that metals pollution may occur throughout the STC watershed. Water column aluminum concentrations exceeded USEPA criteria for toxicity to aquatic life at 4 sites but aluminum was not present at elevated levels in sediments or tissues. Tissue samples showed bioaccumulation of arsenic at levels exceeding OHEEA screening values and USFWS guidelines at 7 sites, and copper was also elevated at one of these sites (403STCBQT). Sediment metals were elevated above SQGs at three sites: cadmium at 403STCPRU, copper and lead at –CTC, and a suite of metals at –SFO. Compared to other samples and SQGs, sediment metals were very high at 403STCSFO, which is downstream of a reservoir that was treated with metals to control biofouling. Sediment, tissue and water samples each indicated different metals that may be of concern. This demonstrates the utility of this approach at detecting contaminants that accumulate in sediments or tissue and yet may not be detected in the water column.

Organic compounds were also only measured at integrator sites. Similar to metals, the presence of organic compounds in water samples from integrator sites at levels exceeding established criteria suggests that organics pollution also occurs throughout the watershed. DDT and PCBs exceeded established criteria at all the integrator sites. Chlordane was elevated at three sites. Chlorpyrifos and diazinon were elevated at 403STCBQT along with azinphos methyl, and they were elevated at –CTC along with mirex. Chlorpyrifos was elevated at –EST, and diazinon and PAHs were elevated at –NRB. Sediments were analyzed for organics at only two sites: none were found at 403STCBQT, but DDE (p,p') and DDT (p,p') were elevated relative to SQGs at –EST. No organics in tissues were elevated above OEHHA screening values.

Toxicity occurred at 13 sites in the STC watershed and was primarily limited to two areas: the mainstem of the river and the northern portion of the Piru Creek sub-watershed. The cause of toxicity at many of these sites is unknown because metals and organics were not sampled. Toxicity was detected in samples from only two integrator sites: 403STCBQT and –EST. A number of factors could have contributed to toxicity at –BQT but the TIE indicated that diazinon was the probable cause of toxicity. At –EST, toxicity may have been caused by DDT, PCBs, chlorpyrifos, or arsenic.

The bioassessment data indicate that ecological condition was at least fair at about half of the sites, with the condition at the other half being poor or very poor. IBI scores were Good at 6 sites, Fair at 13 sites, Poor at 11 sites and Very Poor at 7 sites. One site was not sampled. At 41% of sites where IBI scores were low, chronic or acute toxicity was detected, however, toxicity was also detected at 37% of sites with Fair and Good IBI scores. Toxicity is not a likely cause of poor benthic community condition at the integrator sites, many of which had Very Poor or Poor IBI scores, because samples from only two of these 8 sites indicated toxicity. Other influences on benthic community structure throughout much of the watershed are unknown because metals and organics were not sampled. It is also unlikely that decreased DO availability contributed to poor benthic community structure because 6 of the randomly selected sites with DO < 90 % saturation had fair or good IBI scores. Pollution by metals and organics may have contributed to the poor quality of the benthic communities at the integrator sites. However, the ability to draw conclusions about the effects of metals or organics on benthic community structure is limited because these constituents were not measured at many of the sites with Fair or Good IBI scores.

Study Evaluation

This study identified a number of potential concerns in the CAL and STC watersheds and covered the four activities intended by SWAMP listed on page 1 of this report:

- The information provided by this study will assist in effective management of the State's water resources.
- Sampling methods, analytical procedures, DQOs and data reporting were consistent within the Los Angeles Region and consistent with Regions throughout the state.
- Spatial trends in water quality were analyzed. With additional future sampling, temporal trends will be analyzed.
- Data collected in this study will be used in the 303(d) listing process.

From the information contained in this and future reports, the LARWQCB will be able to determine the percentage of streams in a watershed or region that support their designated beneficial uses, and how that percent is changing over time.

Goals for monitoring in both watersheds were met. In the CAL watershed, the extent of toxicity was documented and possible causes identified. The extent of inorganic constituent impairments, such as nutrients and chloride, was determined. Problems associated with nutrients could be investigated in future studies with additional measurements of benthic primary production. In the STC watershed, the probabilistic sampling design allowed inferences to be made about much of the watershed that was previously uninvestigated. A broad picture of inorganic constituents, toxicity, and bioassessment is now available for the watershed. Future concurrent sampling of metals and organics throughout the watershed would help to identify causes of toxicity and poor benthic community structure.

Table 33. Various parameters in different categories are listed if they exceeded established or proposed criteria at a given site or indicated toxicity or poor ecological condition. S=sediment, T=tissue, W=water, X=not sampled.

	Field Measurements	Conventional water chemistry	Metals			Organics			Toxicity		Bioassessment
Site	**W**	**W**	**S**	**T**	**W**	**S**	**T**	**W**	**S**	**W**	
CALLEGUAS CREEK WATERSHED											
403CAL002	DO	NO_3, PO_4, Chloride	X	X	Aluminum	X	X		X	Chronic	NS
403CAL003	DO	NO_3, PO_4	X	X	Aluminum	X	X	Chlorpyrifos	X	Chronic	Very Poor
403CAL004	DO	NO_3, PO_4	X	Arsenic	Aluminum	X	Toxaphene	Chlordane, DDT, Chlorpyrifos, Diazinon, HCH beta, PCBs	X	Acute	Very Poor
403CAL005		NO_3, PO_4	X	X	Aluminum	X	X	Chlorpyrifos, Diazinon Azinphos methyl	X	Acute	Very Poor
403CAL006	DO	NO_3, PO_4, Chloride, TDS	X	X	Aluminum	X	X	Chlorpyrifos, Diazinon	X	None	Poor
403CAL007	DO pH	PO_4	X	X	Aluminum	X	X	Chlorpyrifos	X	None	Very Poor
403CAL008	DO	NH_3, PO_4, Sulfate, TDS	X	X	Aluminum	X	X	Chlorpyrifos, Diazinon, Parathion methyl	X	Acute	Very Poor
403CAL009	DO	PO_4, TDS	X	X		X	X	Chlorpyrifos, Diazinon	X	None	NS
403CAL010	DO pH	PO_4, Chloride, Sulfate, TDS	X	X		X	X	Chlorpyrifos, Diazinon, Azinphos methyl	X	None	Poor
403CAL011	pH	PO_4	X	X	Aluminum	X	X	Diazinon, Azinphos methyl	X	Acute	Very Poor
403CAL012	DO	Boron, Chloride, Sulfate, TDS	X	X	Aluminum	X	X	Diazinon, Parathion methyl	X	None	Very Poor

	Field Measurements	Conventional water chemistry	Metals			Organics			Toxicity		Bioassessment
Site	**W**	**W**	**S**	**T**	**W**	**S**	**T**	**W**	**S**	**W**	
403CAL013	DO	PO_4, Boron, Chloride, Sulfate, TDS	X	X	Aluminum	X	X	Diazinon, Parathion methyl	X	Acute	Very Poor
403CALBWC		NO_3, Chloride	X	X	Aluminum	X	X	Chlorpyrifos, Diazinon	X	Acute	Very Poor
SANTA CLARA RIVER WATERSHED											
403STC004		NH_3, PO_4, Chloride	X	X	X	X	X	X	X	Acute	Very Poor
403STC008	DO	NO_3, PO_4, Sulfate, TDS	X	X	X	X	X	X	X	None	Very Poor
403STC009	pH	Chloride	X	X	X	X	X	X	X	None	Poor
403STC010			X	X	X	X	X	X	X	None	Good
403STC016	DO	NO_3, PO_4	X	X	X	X	X	X	X	Acute	Poor
403STC017	DO,pH	NH_3, Boron	X	X	X	X	X	X	X	Chronic	Fair
403STC019	DO	PO_4, Chloride	X	X	X	X	X	X	X	None	Poor
403STC021	DO	Sulfate, TDS	X	X	X	X	X	X	X	Chronic	Fair
403STC022		Sulfate, TDS	X	X	X	X	X	X	X	None	Fair
403STC024			X	X	X	X	X	X	X	None	Poor
403STC025		Sulfate, TDS	X	X	X	X	X	X	X	Chronic	Fair
403STC026	DO		X	X	X	X	X	X	X	None	Fair
403STC027		PO_4	X	X	X	X	X	X	X	Acute	Fair

Site	Field Measurements	Conventional water chemistry	Metals			Organics			Toxicity		Bioassessment
	W	W	S	T	W	S	T	W	S	W	
403STC028			X	X	X	X	X	X	X	None	Fair
403STC029	DO		X	X	X	X	X	X	X	None	Good
403STC030		PO_4	X	X	X	X	X	X	X	None	Good
403STC064			X	X	X	X	X	X	X	None	Good
403STC065	DO		X	X	X	X	X	X	X	None	Fair
403STC066		PO_4	X	X	X	X	X	X	X	None	Good
403STC068		NH_3, PO_4	X	X	X	X	X	X	X	Acute	NS
403STC069		Sulfate, TDS	X	X	X	X	X	X	X	Chronic	Poor
403STC070		PO_4, Sulfate, TDS	X	X	X	X	X	X	X	None	Fair
403STC071		Boron, TDS	X	X	X	X	X	X	X	None	Poor
403STC076			X	X	X	X	X	X	X	None	Poor
403STC082			X	X	X	X	X	X	X	Acute	Fair
403STC083		Chloride	X	X	X	X	X	X	X	None	Poor
403STC085		Sulfate, TDS	X	X	X	X	X	X	X	Chronic	Fair
403STC086		PO_4, Sulfate, TDS	X	X	X	X	X	X	X	Chronic	Fair
403STC090			X	X	X	X	X	X	X	None	Poor
403STC093	DO	Boron, Sulfate, TDS	X	X	X	X	X	X	X	None	Good

	Field Measurements	Conventional water chemistry	Metals			Organics			Toxicity		Bioassessment
Site	**W**	**W**	**S**	**T**	**W**	**S**	**T**	**W**	**S**	**W**	
403STCBQT	pH	NH_3, PO_4, Chloride		Arsenic, Copper	Aluminum			Chlordane, DDT, Azinphos methyl, Chlorpyrifos, Diazinon, PCBs	Acute	Acute	Very Poor
403STCCTC	DO	PO_4, Chloride, Sulfate, TDS	Copper, Lead	Arsenic	Aluminum	X		DDT, Chlorpyrifos, Diazinon, Mirex, PCBs	X	None	Very Poor
403STCEST	DO			Arsenic		DDE,DDT		DDT, Chlorpyrifos, PCBs	X	Acute	Very Poor
403STCNRB	DO	NH_3, PO_4, Chloride		Arsenic	Aluminum	X	X	Chlordane, DDT, Diazinon, PAHs, PCBs	X	None	Very Poor
403STCPRU	DO,pH		Cadmium	Arsenic	Aluminum	X		DDT, PCBs	X	None	Poor
403STCSFO	DO		Arsenic, Chromium, Copper, Lead, Mercury, Nickel, Zinc			X	X	DDT, PCBs	X	None	Poor
403STCSSP	DO			Arsenic		X		DDT, PCBs	X	None	Very Poor
403STCSTP		TDS		Arsenic		X		Chlordane, DDT, PCBs	X	None	Fair

7 REFERENCES

Anderson, B. S., V. de Vlaming, K. Larsen, L. S. Deanovic, S. Birosik, D. J. Smith, B. M. Phillips, and R. S. Tjeerdema. 2002. Causes of ambient toxicity in the Calleguas Creek watershed of southern California. *Environmental Monitoring and Assessment* **78:** 131-151.

Aquatic Bioassessment Laboratory (ABL). 2003. Surface waters ambient monitoring program: probabilistic reconnaissance activities for the Santa Clara River watershed 2001-2003. California Department of Fish and Game, Office of Spill Prevention and Response. 24 pp.

Brodberg, R. K., and G. A. Pollock. 1999. Prevalence of selected target chemical contaminants in sport fishing from two California lakes: public health designed screening study. California Environmental Protection Agency. Sacramento, CA.

California Regional Water Quality Control Board Los Angeles Region (CRWQCB LAR). 1994. Water quality control plan Los Angeles Region: Basin plan for the coastal watersheds of Los Angeles and Ventura Counties. California Regional Water Quality Control Board, Los Angeles Region. Monterey Park, CA.

Los Angeles Regional Water Quality Control Board (LARWQCB). 2001. Watershed Management Initiative Chapter. December 2001.

Los Angeles Regional Water Quality Control Board (LARWQCB). 2002. Surface water ambient monitoring program: workplan for FY 2000/01, 2001/02, and 2002/03. June 30, 2002 edition. 124 pp.

Marshack, J. B. 2003. A compilation of water quality goals. Regional Water Quality Control Board, Central Valley Region. Sacramento, CA.

MacDonald, D. D., C. G. Ingersoll, and T. A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Archives of Environmental Contamination and Toxicology* **39:** 20-31.

McFarland, M., S.England, and M.C.Hamilton. 1995. Assessment of the integrity of chemicals in environmental samples over and extended period of time. Fraser River Action Plan. DOE FRAP 1996-27. Prepared for Environment Canada, Pacific Region, Vancouver, B.C.

Puckett, M. 2002. Quality Assurance Management Plan for the State of California's Surface Water Ambient Monitoring Program. California Department of Fish and Game. Monterey, CA.

U.S. Environmental Protection Agency (USEPA). 1986. Quality Criteria for Water (The Gold Book). EPA 440/5-96-001. Office of Water, Regulations and Standards. Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1997. Test Methods for Evaluating Solid Waste, Third Edition (Update III). EPA SW-846. Office of Solid Waste. Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 2000. Ambient water quality criteria recommendations. Information supporting the development of state and tribal nutrient criteria for rivers and streams in nutrient ecoregion III. EPA-822-B-00-016. Office of Water, Office of Science and Technology. Washington, D.C.

APPENDIX A.
ANALYTICAL METHODS AND DETECTION LIMITS

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Table A-1. Laboratory methods used for analyses of chemical constituents in sediment and water. Tissue data is not included because it is not currently in the database but will be in the near future. At that time, this information will be available for tissue as well. AMS: Applied Marine Sciences, Inc.; DFG-WPCL: California Department of Fish and Game-Fish & Wildlife Water Pollution Control Laboratory; MPSL-DFG: California Department of Fish and Game-Marine Pollution Studies Laboratory; SFL: Sierra Foothills Laboratory, Inc.; UCD-GC: University of California, Davis-Granite Canyon Marine Laboratory.

Analyte	Laboratory	Method
SEDIMENT		
Acenaphthene	DFG-WPCL	EPA 8270M
Acenaphthylene	DFG-WPCL	EPA 8270M
Aldrin	DFG-WPCL	EPA 8081A
Aluminum	MPSL-DFG	EPA 1638M
Aluminum	MPSL-DFG	EPA 200.8
Anthracene	DFG-WPCL	EPA 8270M
Arsenic	MPSL-DFG	EPA 1638M
Arsenic	MPSL-DFG	EPA 200.8
Benz(a)anthracene	DFG-WPCL	EPA 8270M
Benzo(a)pyrene	DFG-WPCL	EPA 8270M
Benzo(b)fluoranthene	DFG-WPCL	EPA 8270M
Benzo(e)pyrene	DFG-WPCL	EPA 8270M
Benzo(g,h,i)perylene	DFG-WPCL	EPA 8270M
Benzo(k)fluoranthene	DFG-WPCL	EPA 8270M
Biphenyl	DFG-WPCL	EPA 8270M
Cadmium	MPSL-DFG	EPA 1638M
Cadmium	MPSL-DFG	EPA 200.8
Chlordane, cis-	DFG-WPCL	EPA 8081A
Chlordane, trans-	DFG-WPCL	EPA 8081A
Chlordene, alpha-	DFG-WPCL	EPA 8081A
Chlordene, gamma-	DFG-WPCL	EPA 8081A
Chlorpyrifos	DFG-WPCL	EPA 8081A
Chromium	MPSL-DFG	EPA 1638M
Chromium	MPSL-DFG	EPA 200.8
Chrysene	DFG-WPCL	EPA 8270M
Chrysenes, C1 -	DFG-WPCL	EPA 8270M
Chrysenes, C2 -	DFG-WPCL	EPA 8270M
Chrysenes, C3 -	DFG-WPCL	EPA 8270M
Copper	MPSL-DFG	EPA 1638M
Copper	MPSL-DFG	EPA 200.8
Dacthal	DFG-WPCL	EPA 8081A
DCBP(p,p')	DFG-WPCL	EPA 8081A
DDD(o,p')	DFG-WPCL	EPA 8081A
DDD(p,p')	DFG-WPCL	EPA 8081A
DDE(o,p')	DFG-WPCL	EPA 8081A
DDE(p,p')	DFG-WPCL	EPA 8081A
DDMU(p,p')	DFG-WPCL	EPA 8081A
DDT(o,p')	DFG-WPCL	EPA 8081A
DDT(p,p')	DFG-WPCL	EPA 8081A
Diazinon	DFG-WPCL	EPA 8081A
Dibenz(a,h)anthracene	DFG-WPCL	EPA 8270M

Analyte	Laboratory	Method
Dibenzothiophene	DFG-WPCL	EPA 8270M
Dibenzothiophenes, C1 -	DFG-WPCL	EPA 8270M
Dibenzothiophenes, C2 -	DFG-WPCL	EPA 8270M
Dibenzothiophenes, C3 -	DFG-WPCL	EPA 8270M
Dieldrin	DFG-WPCL	EPA 8081A
Dimethylnaphthalene, 2,6-	DFG-WPCL	EPA 8270M
Endosulfan I	DFG-WPCL	EPA 8081A
Endosulfan II	DFG-WPCL	EPA 8081A
Endosulfan sulfate	DFG-WPCL	EPA 8081A
Endrin	DFG-WPCL	EPA 8081A
Fine-ASTM,Clay	AMS	ASTM D422
Fine-ASTM,Silt	AMS	ASTM D422
Fluoranthene	DFG-WPCL	EPA 8270M
Fluoranthene/Pyrenes, C1 -	DFG-WPCL	EPA 8270M
Fluorene	DFG-WPCL	EPA 8270M
Fluorenes, C1 -	DFG-WPCL	EPA 8270M
Fluorenes, C2 -	DFG-WPCL	EPA 8270M
Fluorenes, C3 -	DFG-WPCL	EPA 8270M
Gravel-ASTM	AMS	ASTM D422
HCH, alpha	DFG-WPCL	EPA 8081A
HCH, beta	DFG-WPCL	EPA 8081A
HCH, delta	DFG-WPCL	EPA 8081A
HCH, gamma	DFG-WPCL	EPA 8081A
Heptachlor	DFG-WPCL	EPA 8081A
Heptachlor epoxide	DFG-WPCL	EPA 8081A
Hexachlorobenzene	DFG-WPCL	EPA 8081A
Indeno(1,2,3-c,d)pyrene	DFG-WPCL	EPA 8270M
Lead	MPSL-DFG	EPA 1638M
Lead	MPSL-DFG	EPA 200.8
Manganese	MPSL-DFG	EPA 1638M
Manganese	MPSL-DFG	EPA 200.8
Mercury	MPSL-DFG	DFG SOP 103
Mercury	MPSL-DFG	EPA 200.8
Methoxychlor	DFG-WPCL	EPA 8081A
Methylnaphthalene, 1-	DFG-WPCL	EPA 8270M
Methylnaphthalene, 2-	DFG-WPCL	EPA 8270M
Methylphenanthrene, 1-	DFG-WPCL	EPA 8270M
Mirex	DFG-WPCL	EPA 8081A
Moisture	DFG-WPCL	EPA 8081A
Moisture	DFG-WPCL	EPA 8082
Moisture	DFG-WPCL	EPA 8270M
Moisture	MPSL-DFG	EPA 200.8
Naphthalene	DFG-WPCL	EPA 8270M
Naphthalenes, C1 -	DFG-WPCL	EPA 8270M
Naphthalenes, C2 -	DFG-WPCL	EPA 8270M
Naphthalenes, C3 -	DFG-WPCL	EPA 8270M
Naphthalenes, C4 -	DFG-WPCL	EPA 8270M
Nickel	MPSL-DFG	EPA 1638M
Nickel	MPSL-DFG	EPA 200.8

Analyte	Laboratory	Method
Nonachlor, cis-	DFG-WPCL	EPA 8081A
Nonachlor, trans-	DFG-WPCL	EPA 8081A
Organic Carbon,Total	AMS	EPA 9060
Oxadiazon	DFG-WPCL	EPA 8081A
Oxychlordane	DFG-WPCL	EPA 8081A
Parathion, Ethyl	DFG-WPCL	EPA 8081A
Parathion, Methyl	DFG-WPCL	EPA 8081A
PCB 008	DFG-WPCL	EPA 8082
PCB 018	DFG-WPCL	EPA 8082
PCB 027	DFG-WPCL	EPA 8082
PCB 028	DFG-WPCL	EPA 8082
PCB 029	DFG-WPCL	EPA 8082
PCB 031	DFG-WPCL	EPA 8082
PCB 033	DFG-WPCL	EPA 8082
PCB 044	DFG-WPCL	EPA 8082
PCB 049	DFG-WPCL	EPA 8082
PCB 052	DFG-WPCL	EPA 8082
PCB 056	DFG-WPCL	EPA 8082
PCB 060	DFG-WPCL	EPA 8082
PCB 066	DFG-WPCL	EPA 8082
PCB 070	DFG-WPCL	EPA 8082
PCB 074	DFG-WPCL	EPA 8082
PCB 087	DFG-WPCL	EPA 8082
PCB 095	DFG-WPCL	EPA 8082
PCB 097	DFG-WPCL	EPA 8082
PCB 099	DFG-WPCL	EPA 8082
PCB 101	DFG-WPCL	EPA 8082
PCB 105	DFG-WPCL	EPA 8082
PCB 110	DFG-WPCL	EPA 8082
PCB 114	DFG-WPCL	EPA 8082
PCB 118	DFG-WPCL	EPA 8082
PCB 128	DFG-WPCL	EPA 8082
PCB 137	DFG-WPCL	EPA 8082
PCB 138	DFG-WPCL	EPA 8082
PCB 141	DFG-WPCL	EPA 8082
PCB 149	DFG-WPCL	EPA 8082
PCB 151	DFG-WPCL	EPA 8082
PCB 153	DFG-WPCL	EPA 8082
PCB 156	DFG-WPCL	EPA 8082
PCB 157	DFG-WPCL	EPA 8082
PCB 158	DFG-WPCL	EPA 8082
PCB 170	DFG-WPCL	EPA 8082
PCB 174	DFG-WPCL	EPA 8082
PCB 177	DFG-WPCL	EPA 8082
PCB 180	DFG-WPCL	EPA 8082
PCB 183	DFG-WPCL	EPA 8082
PCB 187	DFG-WPCL	EPA 8082
PCB 189	DFG-WPCL	EPA 8082
PCB 194	DFG-WPCL	EPA 8082

Analyte	Laboratory	Method
PCB 195	DFG-WPCL	EPA 8082
PCB 200	DFG-WPCL	EPA 8082
PCB 201	DFG-WPCL	EPA 8082
PCB 203	DFG-WPCL	EPA 8082
PCB 206	DFG-WPCL	EPA 8082
PCB 209	DFG-WPCL	EPA 8082
PCB AROCLOR 1248	DFG-WPCL	EPA 8081A
PCB AROCLOR 1254	DFG-WPCL	EPA 8081A
PCB AROCLOR 1260	DFG-WPCL	EPA 8081A
Perylene	DFG-WPCL	EPA 8270M
Phenanthrene	DFG-WPCL	EPA 8270M
Phenanthrene/Anthracene, C1 -	DFG-WPCL	EPA 8270M
Phenanthrene/Anthracene, C2 -	DFG-WPCL	EPA 8270M
Phenanthrene/Anthracene, C3 -	DFG-WPCL	EPA 8270M
Phenanthrene/Anthracene, C4 -	DFG-WPCL	EPA 8270M
Pyrene	DFG-WPCL	EPA 8270M
Sand-ASTM,Coarse	AMS	ASTM D422
Sand-ASTM,Fine	AMS	ASTM D422
Sand-ASTM,Medium	AMS	ASTM D422
Silver	MPSL-DFG	EPA 1638M
Silver	MPSL-DFG	EPA 200.8
Tedion	DFG-WPCL	EPA 8081A
Toxaphene	DFG-WPCL	EPA 8081A
Trimethylnaphthalene, 2,3,5-	DFG-WPCL	EPA 8270M
Zinc	MPSL-DFG	EPA 1638M
Zinc	MPSL-DFG	EPA 200.8
WATER		
Acenaphthene	DFG-WPCL	EPA 8270M
Acenaphthene	DFG-WPCL	EPA 8310M
Acenaphthylene	DFG-WPCL	EPA 8270M
Acenaphthylene	DFG-WPCL	EPA 8310M
Aldrin	DFG-WPCL	EPA 8081A
Alkalinity as CaCO3	DFG-WPCL	QC 10303311A
Aluminum,Total	MPSL-DFG	EPA 1638M
Ametryn	DFG-WPCL	EPA 619
Ammonia as N	DFG-WPCL	EPA 350.3
Anthracene	DFG-WPCL	EPA 8270M
Anthracene	DFG-WPCL	EPA 8310M
Arsenic,Total	MPSL-DFG	EPA 1638M
Aspon	DFG-WPCL	EPA 8141A
Atraton	DFG-WPCL	EPA 619
Atrazine	DFG-WPCL	EPA 619
Azinphos ethyl	DFG-WPCL	EPA 8141A
Azinphos methyl	DFG-WPCL	EPA 8141A
Benz(a)anthracene	DFG-WPCL	EPA 8270M
Benz(a)anthracene	DFG-WPCL	EPA 8310M
Benzo(a)pyrene	DFG-WPCL	EPA 8270M
Benzo(a)pyrene	DFG-WPCL	EPA 8310M

Analyte	Laboratory	Method
Benzo(b)fluoranthene	DFG-WPCL	EPA 8270M
Benzo(b)fluoranthene	DFG-WPCL	EPA 8310M
Benzo(e)pyrene	DFG-WPCL	EPA 8270M
Benzo(e)pyrene	DFG-WPCL	EPA 8310M
Benzo(g,h,i)perylene	DFG-WPCL	EPA 8270M
Benzo(g,h,i)perylene	DFG-WPCL	EPA 8310M
Benzo(k)fluoranthene	DFG-WPCL	EPA 8270M
Benzo(k)fluoranthene	DFG-WPCL	EPA 8310M
Biphenyl	DFG-WPCL	EPA 8270M
Biphenyl	DFG-WPCL	EPA 8310M
Bolstar	DFG-WPCL	EPA 8141A
Boron	SFL	SM 4500BB
Cadmium,Total	MPSL-DFG	EPA 1638M
Carbophenothion	DFG-WPCL	EPA 8141A
Chlordane, cis-	DFG-WPCL	EPA 8081A
Chlordane, trans-	DFG-WPCL	EPA 8081A
Chlordene, alpha-	DFG-WPCL	EPA 8081A
Chlordene, gamma-	DFG-WPCL	EPA 8081A
Chlorfenvinphos	DFG-WPCL	EPA 8141A
Chloride	DFG-WPCL	EPA 300.0
Chlorophyll a	MPSL-DFG	EPA 445.0M
Chlorophyll a	SFL	SM 10200H-2b
Chlorpyrifos	DFG-WPCL	ELISA SOP 3.3
Chlorpyrifos	DFG-WPCL	EPA 8141A
Chlorpyrifos	UCD-GC	ELISA SOP 3.3
Chlorpyrifos methyl	DFG-WPCL	EPA 8141A
Chromium,Total	MPSL-DFG	EPA 1638M
Chrysene	DFG-WPCL	EPA 8270M
Chrysene	DFG-WPCL	EPA 8310M
Chrysenes, C1 -	DFG-WPCL	EPA 8270M
Chrysenes, C2 -	DFG-WPCL	EPA 8270M
Chrysenes, C3 -	DFG-WPCL	EPA 8270M
Ciodrin(Crotoxyphos)	DFG-WPCL	EPA 8141A
Copper,Total	MPSL-DFG	EPA 1638M
Coumaphos	DFG-WPCL	EPA 8141A
Dacthal	DFG-WPCL	EPA 8081A
DDD(o,p')	DFG-WPCL	EPA 8081A
DDD(p,p')	DFG-WPCL	EPA 8081A
DDE(o,p')	DFG-WPCL	EPA 8081A
DDE(p,p')	DFG-WPCL	EPA 8081A
DDMU(p,p')	DFG-WPCL	EPA 8081A
DDT(o,p')	DFG-WPCL	EPA 8081A
DDT(p,p')	DFG-WPCL	EPA 8081A
Demeton-s	DFG-WPCL	EPA 8141A
Diazinon	DFG-WPCL	EPA 8141A
Diazinon	UCD-GC	ELISA SOP 3.3
Dibenz(a,h)anthracene	DFG-WPCL	EPA 8270M
Dibenz(a,h)anthracene	DFG-WPCL	EPA 8310M
Dibenzothiophene	DFG-WPCL	EPA 8270M

Analyte	Laboratory	Method
Dibenzothiophenes, C1 -	DFG-WPCL	EPA 8270M
Dibenzothiophenes, C2 -	DFG-WPCL	EPA 8270M
Dibenzothiophenes, C3 -	DFG-WPCL	EPA 8270M
Dichlofenthion	DFG-WPCL	EPA 8141A
Dichlorvos	DFG-WPCL	EPA 8141A
Dicrotophos	DFG-WPCL	EPA 8141A
Dieldrin	DFG-WPCL	EPA 8081A
Dimethoate	DFG-WPCL	EPA 8141A
Dimethylnaphthalene, 2,6-	DFG-WPCL	EPA 8270M
Dimethylnaphthalene, 2,6-	DFG-WPCL	EPA 8310M
Dioxathion	DFG-WPCL	EPA 8141A
Disulfoton	DFG-WPCL	EPA 8141A
Endosulfan I	DFG-WPCL	EPA 8081A
Endosulfan II	DFG-WPCL	EPA 8081A
Endosulfan sulfate	DFG-WPCL	EPA 8081A
Endrin	DFG-WPCL	EPA 8081A
Endrin Aldehyde	DFG-WPCL	EPA 8081A
Endrin Ketone	DFG-WPCL	EPA 8081A
Ethion	DFG-WPCL	EPA 8141A
Ethoprop	DFG-WPCL	EPA 8141A
Famphur	DFG-WPCL	EPA 8141A
Fenchlorphos	DFG-WPCL	EPA 8141A
Fenitrothion	DFG-WPCL	EPA 8141A
Fensulfothion	DFG-WPCL	EPA 8141A
Fenthion	DFG-WPCL	EPA 8141A
Fluoranthene	DFG-WPCL	EPA 8270M
Fluoranthene	DFG-WPCL	EPA 8310M
Fluoranthene/Pyrenes, C1 -	DFG-WPCL	EPA 8270M
Fluorene	DFG-WPCL	EPA 8270M
Fluorene	DFG-WPCL	EPA 8310M
Fluorenes, C1 -	DFG-WPCL	EPA 8270M
Fluorenes, C2 -	DFG-WPCL	EPA 8270M
Fluorenes, C3 -	DFG-WPCL	EPA 8270M
Fonofos (Dyfonate)	DFG-WPCL	EPA 8141A
Hardness as CaCO3	DFG-WPCL	SM 2340C
HCH, alpha	DFG-WPCL	EPA 8081A
HCH, beta	DFG-WPCL	EPA 8081A
HCH, delta	DFG-WPCL	EPA 8081A
HCH, gamma	DFG-WPCL	EPA 8081A
Heptachlor	DFG-WPCL	EPA 8081A
Heptachlor epoxide	DFG-WPCL	EPA 8081A
Hexachlorobenzene	DFG-WPCL	EPA 8081A
Indeno(1,2,3-c,d)pyrene	DFG-WPCL	EPA 8270M
Indeno(1,2,3-c,d)pyrene	DFG-WPCL	EPA 8310M
Lead,Total	MPSL-DFG	EPA 1638M
Leptophos	DFG-WPCL	EPA 8141A
Malathion	DFG-WPCL	EPA 8141A
Manganese,Total	MPSL-DFG	EPA 1638M
Mercury,Total	MPSL-DFG	EPA 1631B

Analyte	Laboratory	Method
Mercury,Total	MPSL-DFG	EPA 1631E
Merphos	DFG-WPCL	EPA 8141A
Methidathion	DFG-WPCL	EPA 8141A
Methoxychlor	DFG-WPCL	EPA 8081A
Methylnaphthalene, 1-	DFG-WPCL	EPA 8270M
Methylnaphthalene, 1-	DFG-WPCL	EPA 8310M
Methylnaphthalene, 2-	DFG-WPCL	EPA 8270M
Methylnaphthalene, 2-	DFG-WPCL	EPA 8310M
Methylphenanthrene, 1-	DFG-WPCL	EPA 8270M
Methylphenanthrene, 1-	DFG-WPCL	EPA 8310M
Mevinphos	DFG-WPCL	EPA 8141A
Mirex	DFG-WPCL	EPA 8081A
Molinate	DFG-WPCL	EPA 8141A
Naled(Dibrom)	DFG-WPCL	EPA 8141A
Naphthalene	DFG-WPCL	EPA 8270M
Naphthalene	DFG-WPCL	EPA 8310M
Naphthalenes, C1 -	DFG-WPCL	EPA 8270M
Naphthalenes, C2 -	DFG-WPCL	EPA 8270M
Naphthalenes, C3 -	DFG-WPCL	EPA 8270M
Naphthalenes, C4 -	DFG-WPCL	EPA 8270M
Nickel,Total	MPSL-DFG	EPA 1638M
Nitrate as N	DFG-WPCL	EPA 300.0
Nitrate as N	DFG-WPCL	EPA 353.3
Nitrate as N	DFG-WPCL	QC 10107041B
Nitrite as N	DFG-WPCL	FR 8507
Nitrite as N	DFG-WPCL	QC 10107041B
Nonachlor, cis-	DFG-WPCL	EPA 8081A
Nonachlor, trans-	DFG-WPCL	EPA 8081A
OrthoPhosphate as P	DFG-WPCL	EPA 365.3
OrthoPhosphate as P	DFG-WPCL	QC 10115011M
Oxadiazon	DFG-WPCL	EPA 8081A
Oxychlordane	DFG-WPCL	EPA 8081A
Parathion, Ethyl	DFG-WPCL	EPA 8141A
Parathion, Methyl	DFG-WPCL	EPA 8141A
PCB 005	DFG-WPCL	EPA 8082
PCB 008	DFG-WPCL	EPA 8082
PCB 015	DFG-WPCL	EPA 8082
PCB 018	DFG-WPCL	EPA 8082
PCB 027	DFG-WPCL	EPA 8082
PCB 028	DFG-WPCL	EPA 8082
PCB 029	DFG-WPCL	EPA 8082
PCB 031	DFG-WPCL	EPA 8082
PCB 033	DFG-WPCL	EPA 8082
PCB 044	DFG-WPCL	EPA 8082
PCB 049	DFG-WPCL	EPA 8082
PCB 052	DFG-WPCL	EPA 8082
PCB 056	DFG-WPCL	EPA 8082
PCB 060	DFG-WPCL	EPA 8082
PCB 066	DFG-WPCL	EPA 8082

Analyte	Laboratory	Method
PCB 070	DFG-WPCL	EPA 8082
PCB 074	DFG-WPCL	EPA 8082
PCB 087	DFG-WPCL	EPA 8082
PCB 095	DFG-WPCL	EPA 8082
PCB 097	DFG-WPCL	EPA 8082
PCB 099	DFG-WPCL	EPA 8082
PCB 101	DFG-WPCL	EPA 8082
PCB 105	DFG-WPCL	EPA 8082
PCB 110	DFG-WPCL	EPA 8082
PCB 114	DFG-WPCL	EPA 8082
PCB 118	DFG-WPCL	EPA 8082
PCB 128	DFG-WPCL	EPA 8082
PCB 137	DFG-WPCL	EPA 8082
PCB 138	DFG-WPCL	EPA 8082
PCB 141	DFG-WPCL	EPA 8082
PCB 149	DFG-WPCL	EPA 8082
PCB 151	DFG-WPCL	EPA 8082
PCB 153	DFG-WPCL	EPA 8082
PCB 156	DFG-WPCL	EPA 8082
PCB 157	DFG-WPCL	EPA 8082
PCB 158	DFG-WPCL	EPA 8082
PCB 170	DFG-WPCL	EPA 8082
PCB 174	DFG-WPCL	EPA 8082
PCB 177	DFG-WPCL	EPA 8082
PCB 180	DFG-WPCL	EPA 8082
PCB 183	DFG-WPCL	EPA 8082
PCB 187	DFG-WPCL	EPA 8082
PCB 189	DFG-WPCL	EPA 8082
PCB 194	DFG-WPCL	EPA 8082
PCB 195	DFG-WPCL	EPA 8082
PCB 200	DFG-WPCL	EPA 8082
PCB 201	DFG-WPCL	EPA 8082
PCB 203	DFG-WPCL	EPA 8082
PCB 206	DFG-WPCL	EPA 8082
PCB 209	DFG-WPCL	EPA 8082
Perylene	DFG-WPCL	EPA 8270M
Phenanthrene	DFG-WPCL	EPA 8270M
Phenanthrene	DFG-WPCL	EPA 8310M
Phenanthrene/Anthracene, C1 -	DFG-WPCL	EPA 8270M
Phenanthrene/Anthracene, C2 -	DFG-WPCL	EPA 8270M
Phenanthrene/Anthracene, C3 -	DFG-WPCL	EPA 8270M
Phenanthrene/Anthracene, C4 -	DFG-WPCL	EPA 8270M
Pheophytin a	SFL	SM 10200H-2a
Phorate	DFG-WPCL	EPA 8141A
Phosmet	DFG-WPCL	EPA 8141A
Phosphamidon	DFG-WPCL	EPA 8141A
Prometon	DFG-WPCL	EPA 619
Prometryn	DFG-WPCL	EPA 619
Propazine	DFG-WPCL	EPA 619

Analyte	Laboratory	Method
Pyrene	DFG-WPCL	EPA 8270M
Pyrene	DFG-WPCL	EPA 8310M
Secbumeton	DFG-WPCL	EPA 619
Selenium,Total	MPSL-DFG	EPA 1638M
Silver,Total	MPSL-DFG	EPA 1638M
Simazine	DFG-WPCL	EPA 619
Simetryn	DFG-WPCL	EPA 619
Solids,Total Dissolved	DFG-WPCL	SM 2540C
Sulfate	DFG-WPCL	EPA 300.0
Sulfotep	DFG-WPCL	EPA 8141A
Tedion	DFG-WPCL	EPA 8081A
Terbufos	DFG-WPCL	EPA 8141A
Terbuthylazine	DFG-WPCL	EPA 619
Terbutryn	DFG-WPCL	EPA 619
Tetrachlorvinphos	DFG-WPCL	EPA 8141A
Thiobencarb	DFG-WPCL	EPA 8141A
Thionazin	DFG-WPCL	EPA 8141A
Tokuthion	DFG-WPCL	EPA 8141A
Trichlorfon	DFG-WPCL	EPA 8141A
Trichloronate	DFG-WPCL	EPA 8141A
Trimethylnaphthalene, 2,3,5-	DFG-WPCL	EPA 8270M
Trimethylnaphthalene, 2,3,5-	DFG-WPCL	EPA 8310M
Zinc,Total	MPSL-DFG	EPA 1638M

Table A-2. List of the number of samples taken in water and sediment, with the number of samples below the MDL, the MDL, RL and units for each analyte. Tissue data is not included because it is not currently in the database but will be in the near future. At that time, this information will be available for tissue as well.

	WATER					SEDIMENT					TISSUE				
Analyte	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**
Acenaphthene	11	11	0.02	0.05	µg l^{-1}										
Acenaphthylene	11	11	0.02	0.05	µg l^{-1}										
Aldrin	11	11	0.001	0.002	µg l^{-1}	2	2	0.374	1.44	ng/g	7	7			ng/g
Aluminum						9		0.05	0.1	mg/kg	7				mg/kg
Aluminum, Total	22		0.05	0.1	µg l^{-1}										
Ammonia as N	63	18	0.05	0.1	mg/l										
Anthracene	11	11	0.02	0.05	µg l^{-1}										
Arsenic						9		0.05	0.1	mg/kg	7				mg/kg
Arsenic, Total	22		0.05	0.1	µg l^{-1}										
Aspon	22	22	0.03	0.05	µg l^{-1}										
Azinphos ethyl	22	22	0.03	0.05	µg l^{-1}										
Azinphos methyl	22	18	0.03	0.05	µg l^{-1}										
Benz(a)anthracene	11	10	0.02	0.05	µg l^{-1}										
Benzo(a)pyrene	11	10	0.02	0.05	µg l^{-1}										
Benzo(b)fluoranthene	11	11	0.02	0.05	µg l^{-1}										
Benzo(e)pyrene	11	11	0.02	0.05	µg l^{-1}										
Benzo(g,h,i)perylene	11	11	0.02	0.05	µg l^{-1}										
Benzo(k)fluoranthene	11	10	0.02	0.05	µg l^{-1}										
Biphenyl	11	11	0.02	0.05	µg l^{-1}										
Bolstar	22	22	0.03	0.05	µg l^{-1}										
Boron	63		0.02	0.1	mg/l										
Cadmium						9		0.002	0.01	mg/kg	7				mg/kg
Cadmium, Total	22		0.002	0.01	µg l^{-1}										
Carbophenothion	22	15	0.03	0.05	µg l^{-1}										
Chlordane, cis	11	11	0.001	0.002	µg l^{-1}	2	2	1.03	1.44	ng/g	7	6			ng/g
Chlordane, trans	11	11	0.001	0.002	µg l^{-1}	2	2	0.582	1.44	ng/g	7	6			ng/g
Chlordene, alpha	11	8	0.001	0.002	µg l^{-1}	2	2	0.397	0.72	ng/g	7	7			ng/g
Chlordene, gamma	11	10	0.001	0.002	µg l^{-1}	2	2	0.369	0.72	ng/g	7	7			ng/g
Chlorfenvinphos	22	22	0.03	0.05	µg l^{-1}										
Chloride	63		0.2	0.35	mg/l										
Chlorophyll a	63	1	0.5	20	µg l^{-1}										

	WATER					SEDIMENT					TISSUE				
Analyte	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**
Chlorpyrifos	22	10	0.02	0.05	µg l^{-1}	2	1	1.2	1.44	ng/g	7	3			ng/g
Chlorpyrifos methyl	22	22	0.02	0.05	µg l^{-1}										
Chromium						9		0.03	0.05	mg/kg	7				mg/kg
Chromium, Total	22		0.03	0.05	µg l^{-1}										
Chrysene	11	10	0.02	0.05	µg l^{-1}										
Ciodrin(Crotoxyphos)	22	21	0.03	0.05	µg l^{-1}										
Copper						9		0.003	0.01	mg/kg	7	7			mg/kg
Copper, Total	22		0.003	0.01	µg l^{-1}										
Coumaphos	22	21	0.04	0.05	µg l^{-1}										
Dacthal	11	7	0.001	0.002	µg l^{-1}	2	1	0.91	0.73	ng/g	7	5			ng/g
DCBP(p,p')						2	2	1.15	14.4	ng/g	7	7			ng/g
DDD(o,p')	11	9	0.001	0.002	µg l^{-1}	2	2	1.11	1.44	ng/g	7	6			ng/g
DDD(p,p')	11	11	0.001	0.002	µg l^{-1}	2	2	1.3	1.44	ng/g	7	3			ng/g
DDE(o,p')	11	11	0.001	0.002	µg l^{-1}	2	2	0.968	2.88	ng/g	7	6			ng/g
DDE(p,p')	11	7	0.001	0.002	µg l^{-1}	2	1	0.83	2.88	ng/g	7				ng/g
DDMU(p,p')	11	11	0.001	0.002	µg l^{-1}	2	2	1.73	4.32	ng/g	7	7			ng/g
DDT(o,p')	11	11	0.001	0.002	µg l^{-1}	2	2	1.46	4.32	ng/g	7	6			ng/g
DDT(p,p')	11	6	0.002	0.005	µg l^{-1}	2	1	3.56	7.2	ng/g	7	6			ng/g
Demeton-s	22	21	0.04	0.05	µg l^{-1}						7				
Diazinon	22	4	0.005	0.02	µg l^{-1}	2	2	9.73	28.8	ng/g	7	6			ng/g
Dibenz(a,h)anthracene	11	11	0.02	0.05	µg l^{-1}										
Dichlofenthion	22	17	0.03	0.05	µg l^{-1}										
Dichlorvos	22	22	0.03	0.05	µg l^{-1}										
Dicrotophos	22	13	0.03	0.05	µg l^{-1}										
Dieldrin	11	10	0.001	0.002	µg l^{-1}	2	2	0.605	0.72	ng/g	7	6			ng/g
Dimethoate	22	15	0.03	0.05	µg l^{-1}										
Dimethylnaphthalene, 2,6-	11	11	0.02	0.05	µg l^{-1}										
Dioxathion	22	4	0.03	0.05	µg l^{-1}										
Disulfoton	22	6	0.01	0.05	µg l^{-1}										
Endosulfan I	11	11	0.001	0.002	µg l^{-1}	2	2	1.55	2.88	ng/g	7	7			ng/g
Endosulfan II	11	10	0.001	0.002	µg l^{-1}	2	2	2.88	14.4	ng/g	7	7			ng/g
Endosulfan sulfate	11	5	0.001	0.002	µg l^{-1}	2	2	2.88	14.4	ng/g	7	7			ng/g
Endrin	11	11	0.001	0.002	µg l^{-1}	2	2	1.35	2.88	ng/g	7	7			ng/g
Endrin Aldehyde	11	9	0.002	0.005	µg l^{-1}										

	WATER					SEDIMENT					TISSUE				
Analyte	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**
Endrin Ketone	11	8	0.002	0.005	µg/l										
Ethion	22	22	0.02	0.05	µg/l										
Ethoprop	22	22	0.03	0.05	µg/l										
Famphur	22	22	0.03	0.05	µg/l										
Fenchlorphos	22	22	0.03	0.05	µg/l										
Fenitrothion	22	22	0.03	0.05	µg/l										
Fensulfothion	22	22	0.03	0.05	µg/l										
Fenthion	22	19	0.03	0.05	µg/l										
Fine-ASTM, Clay						9		-88	-88	%					
Fine-ASTM, Silt						9		-88	-88	%					
Fluoranthene	11	11	0.02	0.05	µg/l										
Fluorene	11	11	0.02	0.05	µg/l										
Fonofos (Dyfonate)	22	22	0.02	0.05	µg/l										
Gravel-ASTM						9		-88	-88	%					
Hardness as CaCO3	25		1	1	mg/l										
HCH, alpha	11	11	0.001	0.002	µg/l	2	2	0.685	0.72	ng/g	7	7			ng/g
HCH, beta	11	10	0.001	0.002	µg/l	2	2	0.887	1.44	ng/g	7	7			ng/g
HCH, delta	11	10	0.001	0.002	µg/l	2	2	0.518	2.88	ng/g	7	7			ng/g
HCH, gamma	11	9	0.001	0.002	µg/l	2	2	0.49	0.72	ng/g	7	6			ng/g
Heptachlor	11	11	0.001	0.002	µg/l	2	2	0.743	1.44	ng/g	7	7			ng/g
Heptachlor epoxide	11	11	0.001	0.002	µg/l	2	2	0.726	0.72	ng/g	7	6			ng/g
Hexachlorobenzene	11	7	0.0005	0.001	µg/l	2	2	0.156	0.43	ng/g	7	7			ng/g
Indeno(1,2,3-c,d)pyrene	11	11	0.02	0.05	µg/l										
Lead						9		0.006	0.01	mg/kg	7				mg/kg
Lead, Total	22		0.006	0.01	µg/l										
Leptophos	22	22	0.03	0.05	µg/l										
Lipid											7				%
Malathion	22	16	0.03	0.05	µg/l										
Manganese						9		0.003	0.01	mg/kg	7				mg/kg
Manganese, Total	22		0.003	0.01	µg/l										
Mercury						9		0.075	0.16	mg/kg	6				mg/kg
Mercury, Total	22		0.09	0.2	ng/l										
Merphos	22	22	0.03	0.05	µg/l										
Methidathion	22	21	0.03	0.05	µg/l										

	WATER					SEDIMENT					TISSUE				
Analyte	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**
Methoxychlor	11	8	0.001	0.002	µg/l	2	2	2.13	4.32	ng/g	7	7			ng/g
Methylnaphthalene, 1-	11	11	0.02	0.05	µg/l										
Methylnaphthalene, 2-	11	11	0.02	0.05	µg/l										
Methylphenanthrene, 1-	11	11	0.02	0.05	µg/l										
Mevinphos	22	15	0.03	0.05	µg/l										
Mirex	11	10	0.001	0.002	µg/l	2	2	1.36	2.16	ng/g	7	7	15.1819	48.248	ng/g
Moisture						2		-88	-88	%	7		-88.0000	-88	%
Molinate	22	22	0.1	0.2	µg/l										
Naled(Dibrom)	22	18	0.03	0.05	µg/l										
Naphthalene	11	11	0.02	0.05	µg/l										
Nickel						9		0.006	0.01	mg/kg	7				mg/kg
Nickel, Total	22	3	0.006	0.01	µg/l										
Nitrate as N	63	2	0.09	0.23	mg/l										
Nitrite as N	63	19	0.01	0.03	mg/l										
Nonachlor, cis	11	10	0.001	0.002	µg/l	2	2	1.41	1.44	ng/g	7	7			ng/g
Nonachlor, trans	11	9	0.001	0.002	µg/l	2	2	0.559	1.44	ng/g	7	5			ng/g
OrthoPhosphate as P	63		0.05	0.05	mg/l										
Oxadiazon	11	7	0.001	0.002	µg/l	2	2	1.35	1.44	ng/g	7	4			ng/g
Oxychlordane	11	10	0.001	0.002	µg/l	2	2	0.53	1.44	ng/g	7	7			ng/g
Parathion, Ethyl	22	17	0.03	0.05	µg/l	2	2	1.21	2.88	ng/g	7	7			ng/g
Parathion, Methyl	22	11	0.01	0.05	µg/l	2	2	2.19	5.76	ng/g	7	7			ng/g
PCB 005	11	11	0.001	0.002	µg/l										
PCB 008	11	7	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 015	11	5	0.001	0.002	µg/l										
PCB 018	11	5	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 027	11	7	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 028	11	11	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	4	1.67	6.433	ng/g
PCB 029	11	5	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 031	11	6	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	5	1.67	6.433	ng/g
PCB 033	11	6	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 044	11	8	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 049	11	9	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	6	1.67	6.433	ng/g
PCB 052	11	7	0.001	0.002	µg/l	2	1	0.144	0.29	ng/g	7	2	1.67	6.433	ng/g
PCB 056	11	9	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g

	WATER					SEDIMENT					TISSUE				
Analyte	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**
PCB 060	11	9	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 066	11	10	0.001	0.002	µg/l	2	1	0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 070	11	11	0.001	0.002	µg/l	2	1	0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 074	11	11	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	6	1.67	6.433	ng/g
PCB 087	11	11	0.001	0.002	µg/l	2	1	0.144	0.29	ng/g	7	3	1.67	6.433	ng/g
PCB 095	11	10	0.001	0.002	µg/l	2	1	0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 097	11	7	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 099	11	8	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	2	1.67	6.433	ng/g
PCB 101	11	8	0.001	0.002	µg/l	2	1	0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 105	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	2	1.67	6.433	ng/g
PCB 110	11	9	0.001	0.002	µg/l	2		0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 114	11	8	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 118	11	10	0.001	0.002	µg/l	2		0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 128	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	5	1.67	6.433	ng/g
PCB 137	11	7	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 138	11	10	0.001	0.002	µg/l	2	1	0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 141	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	6	1.67	6.433	ng/g
PCB 149	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 151	11	9	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	6	1.67	6.433	ng/g
PCB 153	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7		1.67	6.433	ng/g
PCB 156	11	5	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 157	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 158	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 170	11	9	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	6	1.67	6.433	ng/g
PCB 174	11	11	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	6	1.67	6.433	ng/g
PCB 177	11	11	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	6	1.67	6.433	ng/g
PCB 180	11	11	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 183	11	7	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	6	1.67	6.433	ng/g
PCB 187	11	7	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	1	1.67	6.433	ng/g
PCB 189	11	9	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 194	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 195	11	10	0.001	0.002	µg/l	2	1	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 200	11	10	0.001	0.002	µg/l	2	1	0.144	0.29	ng/g	7	5	1.67	6.433	ng/g
PCB 201	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g

	WATER					SEDIMENT					TISSUE				
Analyte	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**	**# Samples**	**#<MDL**	**MDL**	**RL**	**Units**
PCB 203	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	6	1.67	6.433	ng/g
PCB 206	11	9	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	7	1.67	6.433	ng/g
PCB 209	11	10	0.001	0.002	µg/l	2	2	0.144	0.29	ng/g	7	6	1.67	6.433	ng/g
PCB AROCLOR 1248						2	2	19.5	36	ng/g	7	6	1.67	6.433	ng/g
PCB AROCLOR 1254						2	2	7.79	14.4	ng/g	7	1	1.67	6.433	ng/g
PCB AROCLOR 1260						2	2	7.79	14.4	ng/g	7	6	1.67	6.433	ng/g
Phenanthrene	11	10	0.02	0.05	µg/l										
Pheophytin a	32		0.5	20	µg/l										
Phorate	22	19	0.03	0.05	µg/l										
Phosmet	22	22	0.03	0.05	µg/l										
Phosphamidon	22	19	0.03	0.05	µg/l										
Pyrene	11	11	0.02	0.05	µg/l										
Sand-ASTM, Coarse						9		-88	-88	%					
Sand-ASTM, Fine						9		-88	-88	%					
Sand-ASTM, Medium						9		-88	-88	%					
Selenium											7				mg/kg
Selenium, Total	22		0.05	0.1	µg/l										
Silver						9		0.008	0.01	mg/kg	7				mg/kg
Silver, Total	22	6	0.008	0.01	µg/l										
Solids, Total Dissolved	63		10	12	mg/l										
Sulfate	63		0.5	1	mg/l										
Tedion	10	5	0.001	0.002	µg/l	2	2	1.06	2.88	ng/g	7	7			ng/g
Terbufos	22	21	0.03	0.05	µg/l										
Tetrachlorvinphos	22	20	0.03	0.05	µg/l										
Thiobencarb	22	17	0.1	0.2	µg/l										
Thionazin	22	22	0.04	0.05	µg/l										
Tokuthion	22	21	0.03	0.05	µg/l										
Toxaphene						2	2	1.15	28.8	ng/g	7	6			ng/g
Trichlorfon	22	22	0.03	0.05	µg/l										
Trichloronate	22		0.03	0.05	µg/l										
Trimethylnaphthalene, 2,3,5-	11	10	0.02	0.05	µg/l										
Zinc						9		0.02	0.05	mg/kg	7				mg/kg
Zinc, Total	22		0.02	0.05	µg/l										

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APPENDIX B.
TOXICITY IDENTIFICATION EVALUATION

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Toxicity Identification Evaluation Results
Region 4 - Station 403CAL004
Surface Water Ambient Monitoring Program

By the University of California, Davis - Department of Environmental Toxicology

Marine Pollution Studies Laboratory
34500 Coast Route One, Granite Canyon
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Submitted to the Los Angeles Regional Water Quality Control Board – Region 4

January 2003

Introduction

A water sample collected from Region 4 as part of the Surface Water Ambient Monitoring Program (SWAMP) was tested for toxicity to *Holmesimysis costata* using established testing protocols. Because the sample was significantly toxic to the test organism, a toxicity identification evaluation (TIE) was conducted. TIEs are designed to proceed in three phases. The purpose of a Phase 1 TIE is to characterize the cause of toxicity. Information from the Phase 1 characterization may then be used in subsequent Phase 2 (identification) and Phase 3 (confirmation) TIEs. Based on the results of series of initial toxicity tests with various species, a Phase 1 and a Phase 2 TIE were conducted to investigate the causes of toxicity. This report presents the data obtained from these TIEs, including the mean percent survival of mysids after exposure to various TIE treatments, water quality measurements of test solutions, and copies of the original data sheets and quality assurance forms.

Methods

Sample Handling and Testing

A water sample was collected from Station 403CAL004 on October 31, 2001, under the supervision of Gary Ichikawa (California Department of Fish and Game). This sample was transported on ice and in the dark to the Marine Pollution Studies Laboratory at Granite Canyon for initial toxicity testing, which began on November 14, 2001. Because this sample produced significant toxicity to *H. costata*, it was decided that a TIE would be conducted on a sample to be collected at a later date during similar weather conditions that produced the first sample. The TIE sample was collected on October 1, 2002 under the

supervision of Tracy Viergutz (Los Angeles Regional Water Quality Control Board), and the first initial test with *H. costata* was initiated on October 2, 2002. The salinity of the samples was increased from 2‰ to 34‰ by adding Tropic Marin© artificial sea salts. Another initial test with *H. costata* was initiated on October 9, and the *H. costata* TIE was conducted on October 15, 2002. Additional tests with *Hyalella azteca* and *Ceriodaphnia dubia* were conducted with unsalted sample following the *H. costata* TIE.

TIE Methods

The following Phase 1 TIE treatments were performed on a dilution series of each sample (US EPA 1996). Sample concentrations in the first TIE were 0 (treatment blank), 50, and 100%. The treatment blank was control water that underwent the same manipulation as the sample.

Treatments:

• Baseline - Toxicity test on un-manipulated sample. Concentrations were chosen to bracket the effect concentration of the sample and might differ from initial test.

• Centrifugation - Used to determine whether toxicants are associated with particles. Also used as a pretreatment step for the column treatments. Because TIEs were conducted on pore water that was extracted via centrifugation, this treatment served as the Baseline.

• Aeration - Samples are aerated to determine if their toxicity is due to volatile compounds or surfactants.

• EDTA (Disodium Ethylenediaminetetraacetic acid) - EDTA is an organic chelating agent that preferentially binds with divalent metals, such as copper, nickel, lead, zinc, cadmium, mercury, and other transition metals to form non-toxic complexes. It will not complex with anionic forms of metals such as selenids, chromates and hydrochromates.

• Graduated pH - This treatment is designed to determine if pH dependent toxicants are responsible for the observed toxicity. It is different from the pH shift in that the pH is sustained for the duration of the test. Ammonia, sulfide and the toxicity of some metals change with pH. By looking at toxicity over a range of pH values, we may be able to determine the cause of observed toxicity.

• C18 Column - The C18 Column is designed to remove non-polar organic compounds from the sample. In the manipulation, reverse phase liquid chromatography is applied to extract nonionic organic toxicants from the aqueous sample. Column can be eluted with methanol and resulting eluate tested to determine if substances removed by the column are indeed toxic.

• C18 Column with EDTA – This treatment is designed to detect multiple causes of toxicity. After non-polar organics are removed with the C18 Column, metals are chelated with EDTA.

• Cation Column - The Cation Column is designed to remove metals from the sample. Column can be eluted with 1N hydrochloric acid (HCl) and resulting eluate tested to determine if substances removed by the column are indeed toxic.

• PBO (Piperonyl Butoxide) - PBO is a metabolic inhibitor that removes the toxicity associated with metabolically activated pesticides such as diazinon and chlorpyrifos. An increase of toxicity with the PBO

treatments can indicate the presence of non-metabolically activated compounds such as pyrethroid pesticides.

In addition to the standard Phase 1 treatments, we investigated the influence of ion imbalance on *H. costata*. We used a salinity-toxicity relationship computer model (Gas Research Institute, Chicago, IL) to predict the toxic effects of ion concentrations.

Mysid and *H. azteca* exposures were conducted in 20 mL glass scintillation vials (10 replicates) containing 10 mL treated sample and one organism. Exposures with *C. dubia* were conducted in 50 mL beakers (5 replicates) containing 15 mL of sample. All exposures were conducted for 96 hours, following US EPA 1993.

Physical and Chemical Measurements

Water quality parameters of dissolved oxygen, pH and salinity were measured using a Hach SensION© selective ion meter with appropriate electrodes; and ammonia was measured using a Hach 2010 spectrophotometer. Temperature was measured using a continuously recording thermograph and thermometer. Concentrations of the organophosphate pesticides chlorpyrifos and diazinon were measured using enzyme-linked immunosorbent assays (ELISA, Strategic Diagnostics Inc, Newark, DE). Ion analysis was conducted by CRG Laboratories (Torrance, CA) using ICP-MS.

Data Interpretation

Treatment blanks were evaluated to determine if sample manipulations added toxic artifacts. Treatment data were then compared to one another using the toxic unit approach. Toxic units (TU) were calculated by dividing 100 by the LC50 calculated from each treatment dilution series. More toxic units indicate a more toxic sample.

Results and Discussion

The first initial test produced significant mortality at the 100% concentration, but because the Tropic Marin© Salt Control was below the acceptability criterion of 75% a second test was conducted (Table 1). The second test also produced significant toxicity with acceptable controls. Both initial tests with mysids had fairly weak toxicity signals, 1.1 and 1.4 toxic units. A Phase 1 TIE was initiated the following week, but test organisms were adversely affected by the artificial salts, and the test was considered invalid (data not shown). All of the water quality parameters were within acceptable ranges for *H. costata* (Table 2). This test organism has a history of questionable performance in artificial salts, but generally performs well in Tropic Marin. Because of the weak toxicity signals in the initial tests with *H. costata*, and the variable performance with artificial salts, freshwater organisms were utilized to assess the toxicity of the sample.

The original conductivity of the sample was 4060 μS/cm, or a salinity of approximately 2‰. The conductivity was within the acceptable tolerance range for *H. azteca* and *C. dubia* acute tests. These freshwater crustaceans are sensitive to pesticides and are reasonable surrogates for the marine mysid. The sample was tested at full strength and also at 50% for *H. azteca*. Neither organism exhibited a toxic response to the sample (Table 1). No chlorpyrifos was detected and the diazinon was 0.049 μg/L, well below the effect thresholds for the organisms. All water quality parameters were within acceptable ranges for these organisms (Table 2).

Table 1. Mean percent survival of *H. costata*, *H. azteca*, and *C. dubia* from initial screening tests with Station 403CAL004.

Initial Test	Toxic Units	Percent Sample					
		0% (DC)	0% (TM)	10%	25%	50%	100%
H. costata 1	1.1	90	70	100	100	100	40
H. costata 2	1.4	100	90	100	100	80	20
H. azteca		100				100	100
C. dubia		96					100

Table 2. Water quality measurements initial toxicity exposures with Station 403CAL004.

Initial Test	Water Quality Parameter					
	pH	Dissolved Oxygen (mg/L)	Salinity (‰)	Conductivity (μS/cm)	Total Ammonia (mg/L)	Un-ionized Ammonia (mg/L)
H. costata 1	8.13	8.10	35.3	NA	ND	ND
H. costata 2	8.15	8.35	35.0	NA	0.1	0.003
H. azteca	8.17	9.96	NA	4060	ND	ND
C. dubia	8.11	9.60	NA	4150	ND	ND

Because toxicity was noted in the *H. costata* tests but not the tests with the freshwater organisms, we investigated the possibility that an imbalance of essential ions was causing the observed toxicity. We used a marine salinity-toxicity relationship (MSTR) model to predict the toxicity of the sample based on the concentrations of eleven ions or compounds. Because the MSTR model predicts toxicity to *Americamysis bahia*, we assumed the ion sensitivities between the species were similar. Concentrations of ions were measured in the sample and then summed with the concentrations in Tropic Marin (Table 3). The resulting concentrations were entered into the MSTR model and toxicity was predicted. Based on the bicarbonate activity, which was calculated from the measured concentration as alkalinity, mysid survival was predicted to be 0%.

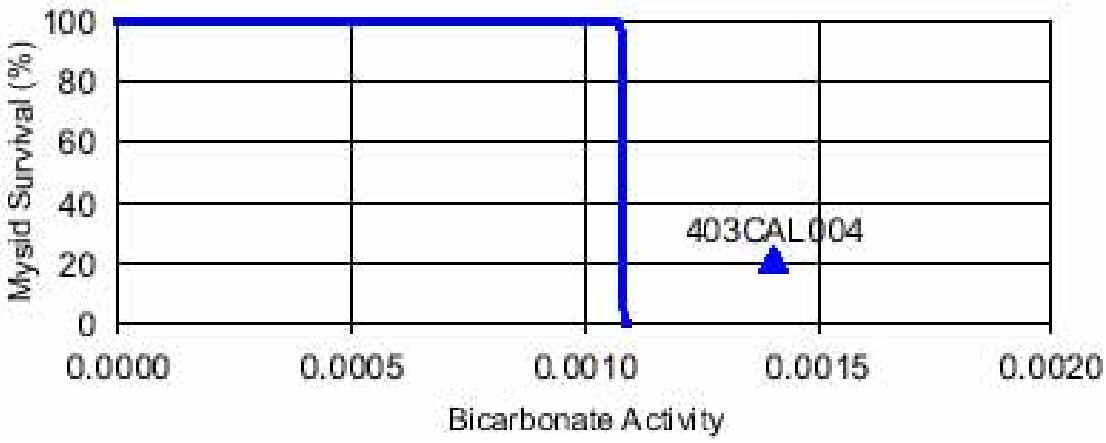
Alkalinity is a measure of the capacity of water to neutralize acids. Alkaline compounds such as bicarbonates, carbonates, and hydroxides remove hydrogen ions and lower the acidity of the water (thereby increasing pH). They usually do this by combining with the hydrogen ions to make new compounds. Rocks and soils, salts, certain plant activities, and certain industrial wastewater discharges influence alkalinity. The average alkalinity of seawater is 115 mg/L as CaCO3 and the reported alkalinity of Tropic Marin is 90 mg/L as CaCO3. The measured alkalinity of the salted water sample was 416 mg/L. The bicarbonate activity, calculated from pH and other test conditions, was 0.0014, and was greater than the toxicity threshold of 0.0011 (Figure 1).

Table 3. Ion concentrations for Station 403CAL004 and Tropic Marin artificial sea salt, and total ion concentrations used in MSTR toxicity prediction model.

	Concentration in mg/L		
Ion or Compound	403CAL004	Tropic Marin[1]	Total
Sodium	46.4	10877.6	10924
Potassium	1.94	380.7	382.6
Calcium	11.6	390.4	402
Magnesium	12.4	1196	1208.4
Strontium	0.183	7.5	7.68
Chloride	43.4	18878.5	18921.9
Bicarbonate Alkalinity	297	90	416[2]
Sulfate	663	2157.1	2820.1
Bromide	0.338	67.3[3]	67.638
Boron	0.079	4.2	4.279

[1] Atkinson and Bingman (19xx). [2] Measured concentration. [3] Seawater concentration from Stumm and Morgan (1980).

Figure 1. Mysid survival versus bicarbonate activity. Triangle indicates survival and bicarbonate activity in sample.



Conclusion

Water collected from Station 403CAL004 was weakly toxic to *H. costata* in two initial tests and not toxic to *H. azteca* and *C. dubia*. Results of the *H. costata* tests, including the Phase 1 TIE were confounded by toxicity from artificial salts. Because of this toxic artifact, the TIE results were considered invalid. Because of the weak toxic signal and the lack of toxicity to sensitive freshwater organisms, toxicity due to ion imbalance was investigated using a marine salinity-toxicity relationship model. This model predicted the observed toxicity based on the concentration and subsequent activity of bicarbonate.

References

Atkinson MJ, Bingman C. 1997. Elemental composition of commercial seasalts. J. Aquariculture Aquatic Sciences. 8: 39-43.

Stumm W, Morgan JJ. 1981. Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters. 2nd Edition. John Wiley and Sons, New York, NY. 780 pp.

United States Environmental Protection Agency. 1993. Methods for measuring acute toxicity of effluents and receiving water to freshwater and marine organisms, 4th edition. EPA 600/4-91/002. Technical Report. Washington, DC.

United States Environmental Protection Agency. 1996. Marine Toxicity Identification Evaluation (TIE), Phase I Guidance Document. Office of Research and Development. EPA/600/R-95/054. Washington, DC.

Toxicity Identification Evaluation Results
Region 4 - Station 403STCBQT

Surface Water Ambient Monitoring Program

By the University of California, Davis - Department of Environmental Toxicology

Marine Pollution Studies Laboratory
34500 Coast Route One, Granite Canyon
Monterey, CA 93940

Submitted to the Los Angeles Regional Water Quality Control Board – Region 4

January 2004

Introduction

A water sample collected from Region 4 as part of the Surface Water Ambient Monitoring Program (SWAMP) was tested for toxicity to *Ceriodaphnia dubia* using established testing protocols. Because the sample was significantly toxic to the test organism, a toxicity identification evaluation (TIE) was conducted. TIEs are designed to proceed in three phases. The purpose of a Phase 1 TIE is to characterize the cause of toxicity. Information from the Phase 1 characterization may then be used in subsequent Phase 2 (identification) and Phase 3 (confirmation) TIEs. Based on the result of an initial toxicity test, a Phase 1 TIE, with an additional Phase 2 treatment, was conducted to investigate the causes of toxicity. This report presents the data obtained from the TIE, including the mean percent survival of daphnids after exposure to various TIE treatments and water quality measurements of test solutions.

Methods

Sample Handling and Testing

A water sample was collected from Station 403STCBQT on November 15, 2001, under the supervision of Gary Ichikawa (California Department of Fish and Game). This sample was transported on ice and in the dark to the Marine Pollution Studies Laboratory at Granite Canyon for initial toxicity testing, which began on November 16, 2001. Because this sample produced significant toxicity to *C. dubia*, it was decided that a TIE would be conducted on the remainder of the sample. The *C. dubia* TIE was conducted on November 20, 2001.

TIE Methods

The following Phase 1 TIE treatments were performed on a dilution series of each sample (US EPA 1991). Sample concentrations were 0 (treatment blank), 25, and 50%. The treatment blank was control water that underwent the same manipulation as the sample.

Treatments:

• Baseline - Toxicity test on un-manipulated sample. Concentrations were chosen to bracket the effect concentration of the sample and might differ from initial test.

• Centrifugation - Used to determine whether toxicants are associated with particles. Also used as a pretreatment step for the column treatments. Because TIEs were conducted on pore water that was extracted via centrifugation, this treatment served as the Baseline.

• Aeration - Samples are aerated to determine if their toxicity is due to volatile compounds or surfactants.

• EDTA (Disodium Ethylenediaminetetraacetic acid) - EDTA is an organic chelating agent that preferentially binds with divalent metals, such as copper, nickel, lead, zinc, cadmium, mercury, and other transition metals to form non-toxic complexes. It will not complex with anionic forms of metals such as selenids, chromates and hydrochromates.

• pH Shift - Changes in pH can affect solubility, polarity, volatility, stability and speciation of a compound, thereby affecting its bioavailability and toxicity. Shifting pH is designed to determine how much sample toxicity can be attributed to volatile, sublateable or oxidizeable compounds. Shifts in pH can also be combined with Aeration or solid-phase extraction with the C8 Column.

• C18 Column - The C18 Column is designed to remove non-polar organic compounds from the sample. In the manipulation, reverse phase liquid chromatography was applied to extract nonionic organic toxicants from the aqueous sample. The Column was eluted with a series of methanol concentrations, and resulting eluates tested to determine if substances removed by the column were indeed toxic.

• PBO (Piperonyl Butoxide) - PBO is a metabolic inhibitor that removes the toxicity associated with metabolically activated pesticides such as diazinon and chlorpyrifos. An increase of toxicity with the PBO treatments can indicate the presence of non-metabolically activated compounds such as pyrethroid pesticides.

Exposures with *C. dubia* were conducted in 50 mL beakers (3 replicates) containing 15 mL of sample. All exposures were conducted for 96 hours, following US EPA 1993.

Physical and Chemical Measurements

Water quality parameters of dissolved oxygen, pH and salinity were measured using a Hach SensION© selective ion meter with appropriate electrodes; and ammonia was measured using a Hach 2010 spectrophotometer. Temperature was measured using a continuously recording thermograph and

thermometer. Concentrations of the organophosphate pesticides chlorpyrifos and diazinon were measured using enzyme-linked immunosorbent assays (ELISA, Strategic Diagnostics Inc, Newark, DE).

Data Interpretation

Treatment blanks were evaluated to determine if sample manipulations added toxic artifacts. The concentration that demonstrated the greatest resolution was then examined to determine which treatments reduced or added back toxicity.

Results and Discussion

The initial test produced significant mortality at the 100% concentration (Table 1). The concentration of diazinon was high enough to cause the observed toxicity in the initial test (LC50 for *C. dubia* = 0.335 μg/L, Bailey et al. 1997). All TIE treatment blanks were considered acceptable except for the PBO treatment. All of the water quality parameters were within acceptable ranges for *C. dubia* (Table 2).

Toxicity was completely removed by the C8 Column treatment, indicating that a non-polar organic was the primary cause of toxicity (Table 1). Serial elution of the column returned a portion the toxicity in the 80% methanol fraction. ELISA analysis of the treatments indicated complete removal of the diazinon signal in the C8 Column treatment and partial return of diazinon in the 80% methanol fraction. The amount of diazinon returned in the 80% methanol fraction was commensurate with the amount of toxicity observed in this treatment. A reduction of diazinon toxicity should have been observed in the PBO treatment, but because of blank toxicity, this treatment might have been compromised.

References

Bailey HC, Miller JL, Miller MJ, Wiborg LC, Deanovic L, Shed T. 1997. Joint acute toxicity of diazinon and chlorpyrifos toe *Ceriodaphnia dubia*. *Environ Toxicol Chem* 16: 2304-2308.

U.S. Environmental Protection Agency. 1991. Methods for aquatic toxicity identification evaluations. EPA 600/6-91/003. Office of Research and Development. Washington, DC.

United States Environmental Protection Agency. 1993. Methods for measuring acute toxicity of effluents and receiving water to freshwater and marine organisms, 4th edition EPA 600/4-91/002 Technical Report Washington, DC

Table 1. Mean percent survival of *C. dubia* from initial and final TIEs with Station 403STCBQT. NA indicates not analyzed, ND indicates non-detect.

	Percent Sample				Chlorpyrifos	Diazinon
Treatment	0%	25%	50%	100%	(μg/L)	(μg/L)
Initial Test	100	NA	NA	0	0.077	1.685
Final Test						
Baseline	100	100	0	NA	ND	0.884
EDTA	93	87	0	NA	ND	0.887
Aeration	100	100	0	NA	ND	1.025
Centrifuge	100	87	0	NA	ND	0.986
C8 Column	93	100	100	NA	ND	ND
Eluate 25%	100	NA	100	NA	ND	ND
Eluate 50%	100	NA	100	NA	ND	ND
Eluate 75%	100	NA	100	NA	ND	ND
Eluate 80%	100	NA	44	NA	ND	0.426
Eluate 85%	100	NA	100	NA	ND	0.174
Eluate 90%	100	NA	93	NA	ND	ND
Eluate 95%	100	NA	100	NA	ND	ND
Eluate 100%	100	NA	100	NA	ND	ND
pH 3	100	100	7	NA	ND	0.654
pH 8	100	67	0	NA	ND	0.945
pH 11	100	100	0	NA	ND	0.884
PBO	47	0	0	NA	ND	0.870

Table 2. Water quality measurements from initial and final TIEs with Station 403STCBQT. NA indicates not analyzed.

Treatment	Water Quality Parameter				
	pH	Dissolved Oxygen (mg/L)	Conductivity (μS/cm)	Total Ammonia (mg/L)	Un-ionized Ammonia (mg/L)
Initial Test	10.40	8.4	1119	0.05	0.046
Final Test					
Baseline	9.73	8.48	629	NA	NA
EDTA	9.76	8.65	771	NA	NA
Aeration	9.63	8.75	657	NA	NA
Centrifuge	9.81	8.81	643	NA	NA
C8 Column	9.49	9.00	631	NA	NA
Eluate 25%	8.23	8.39	135	NA	NA
Eluate 50%	8.23	8.74	143	NA	NA
Eluate 75%	7.49	8.37	144	NA	NA
Eluate 80%	8.02	8.42	140	NA	NA
Eluate 85%	8.04	8.38	135	NA	NA
Eluate 90%	8.04	8.49	137	NA	NA
Eluate 95%	8.04	8.52	137	NA	NA
Eluate 100%	8.04	8.37	134	NA	NA
pH 3	9.80	8.52	1015	NA	NA
pH 8	8.20	8.58	670	NA	NA
pH 11	9.70	8.72	745	NA	NA
PBO	9.78	8.73	624	NA	NA

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APPENDIX C.
BIOASSESSMENT

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Introduction

Assemblages of freshwater organisms (e.g. fish, macroinvertebrates, periphyton) are commonly used to assess the biological condition of streams, lakes and wetlands. Aquatic organisms reside in these environments for a period of a few months to several years, and the composition of aquatic communities reflects a cumulative response to multiple stressors over time. Biological monitoring provides more complete information about environmental quality than physical or chemical monitoring because it is the only direct measure of ecological condition. Freshwater macroinvertebrates often undergo predictable, species specific responses to anthropogenic changes in local habitat and landscape condition, and multimetric indices of biotic integrity (IBIs) are often used to characterize those responses and to establish thresholds of ecological impairment. Such multimetric indices have been developed for fish (Karr *et al.* 1986, Hughes et al. 1998, Moyle & Randall 1998, Simon 1999, McCormick *et al*. 2001), periphyton (Pan *et al*. 1996, Pan *et al*. 2000 Hill *et al.* 2000) and benthic macroinvertebrates (Kerans & Karr 1994; DeShon 1995, Barbour *et al.* 1996, Klemm *et al*. 2003).

The California Department of Fish and Game's Aquatic Bioassessment Laboratory recently developed an IBI for the Southern California Coastal region (SCIBI; Ode *et al.* 2004). The SCIBI is applicable to all wadeable streams in the region bounded by the Monterey Peninsula and the California/ Mexico border and from the California coastline inland to the extent of the Southern California Coast Ranges. Scoring categories representing biotic condition were established on the basis of the distribution of scores for relatively unimpaired (reference) sites in this region. This IBI was used to characterize the biotic condition of 48 sites sampled in the Santa Clara and Calleguas Creek watersheds.

Materials and Methods

Macroinvertebrate Collection
Benthic macroinvertebrate samples were collected according to the California Stream Bioassessment Protocol (CSBP, Harrington 2003). The CSBP is a standardized protocol for assessing biological and physical/habitat conditions of wadeable streams in California, and is a regional adaptation of the national Rapid Bioassessment Protocols (Barbour *et al.* 1999). A CSBP reach is defined as a set of at least five riffles from which three are randomly selected and sampled. A transect was defined in the upper third of each riffle, and three separate areas of 2 ft^2 each were disturbed along the transect upstream of a 1ft. wide D-frame net and composited. A total of 18ft^2 of substrate was sampled per reach. In the laboratory, 900 organisms were subsampled (300 organisms from each of three transects, which were processed separately) and identified to standard taxonomic effort levels (www.dfg.ca.gov/cabw/camlnetste.pdf).

Calculating the Index of Biotic Integrity

To apply the SCIBI, we first reduced all 900 count CSBP subsamples to 500 count subsamples by random selection of taxa so that metrics were scored on the basis of even subsampling effort across all sites. Then we calculated the 7 metrics comprising the SCIBI: Number of Coleoptera taxa; Number of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa; Number of Predator

Taxa; Percent Collector-filterer and Collector-gatherer taxa; Percent Intolerant Individuals; Percent NonInsect Taxa and Percent Tolerant Taxa (Table 1).

To apply the SCIBI, all sites were to be assigned to one of the two ecoregions in the southern California coastal region: the Southern California Mountains and the Southern California Chaparral and Oak Woodlands. Approximately half the sites fell in either ecoregion (Figure 1). All metric values were converted into metric scores according to the ranges presented in Table 1 and these scores were summed to calculate the IBI score for each site.

Results

Scores for each site are presented in Figure 2 and Table 2.

Acknowledgements

ABL field biologists (Mike Dawson, Shawn McBride and Jennifer York) collected the biological data. ABL taxonomists (Dan Pickard, Doug Post, Brady Richards and Joe Slusark) performed all of the taxonomy.

Literature Cited

Barbour, M.T., J Gerritson, G.E. Griffith, R. Frydenborg, E. McCarron, J.S. White and M.L. Bastian. 1996. A framework for biological criteria for Florida streams using benthic macroinvertebrates. Journal of the North American Benthological Society 15:185-211.

Barbour, M.T., J. Gerritsen, B.D. Snyder and J.B. Stribling. 1999. Revision to rapid bioassessment protocols for use in stream and rivers: periphyton, BMIs and fish. EPA 841-D-97-002. U.S. Environmental Protection Agency. Washington DC.

Hill, B.H., A.T. Herlihy, P.R. Kaufmann, R.J. Stevenson, F.H. McCormick and C.B. Johnson. 2000. The use of periphyton assemblage data as an index of biotic integrity. Journal of the North American Benthological Society 19:50-67.

Hughes, R.M., P.R. Kaufmann, A.T. Herlihy, T.M. Kincaid, L. Reynolds, and D.P. Larsen. 1998. A process for developing and evaluating indices of fish assemblage integrity. Canadian Journal of Fisheries and Aquatic Sciences 55: 1618-1631.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6: 21-27.

Karr, J.R. K.D. Fausch, P.L. Angermeyer, P.R. Yant and I.J. Schlosser. 1986. Assessment of biological integrity in running waters: a method and its rationale. Illinois Natural History Survey Special Publication No. 5.

Kerans, B.L. and J.R. Karr. 1994. A benthic index of biotic integrity (B-IBI) for rivers of the Tennessee Valley. Ecological Applications 4: 768-785.

Klemm, D.J. and J.M. Lazorchak. 1994. Environmental Monitoring and Assessment Program, Surface Water and Region 3 Regional Monitoring ad Assessment Program, 1994 Pilot Laboratory Methods Manual for Streams. US EPA, Office of Research and Development. EPA/620/R-94/003.

Klemm, D.J., K.A. Blocksom, F.A. Fulk, A.T. Herlihy, R.M. Hughes, P.R. Kaufmann, D.V. Peck, J.L. Stoddard, W.T. Thoeny, M.B. Griffith and W.S. Davis. 2003. Development and evaluation of a macroinvertebrate biotic integrity index (MBII) for regionally assessing Mid-Atlantic Highland streams. Environmental Management 31:656-669.

McCormick, F.H., R.M. Hughes, P.R. Kaufmann, D.V. Peck, J.L. Stoddard, and A.T. Herlihy. 2001. Development of an index of biotic integrity for the Mid-Atlantic Highlands Region. Transactions of the American Fisheries Society 130: 857-877.

Moyle, P.B and P.J. Randall. 1998. Evaluating the biotic integrity of watersheds in the Sierra Nevada, California. Conservation Biology 12:1318-1326.

Ode, P. R., A.C. Rehn and J.T. May. 2004. A southern coastal California macroinvertebrate index of biotic integrity. In prep.

Omernik, J.M. 1995. "Ecoregions: A framework for environmental management." in: Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. W. Davis and T. Simon (eds.) Lewis Publishers, Chelsea, MI.

Pan, Y., R.J. Stevenson, B.H. Hill, A.T. Herlihy and C.B. Collins. 1996. Using diatoms as indicators of ecological conditions in lotic systems: a regional assessment. Journal of the North American Benthological Society 15:481-494.

Pan, Y.R., R.J. Stevenson, P. Vaithiyanathan, J. Slate, & C.J. Richardson. 2000. Using experimental and observational approaches to determine causes of algal changes in the Everglades. Freshwater Biology 43:1-15.

Table 1. Metrics scoring table for the SoCal IBI. Values for Southern California Mountains ecoregion are listed under the "8" columns and values for the Southern California Chaparral and Oak Woodlands ecoregion are listed under the "6" columns.

Metric Score	N_Coleop_T	N_EPT_T		N_Pred_T	P_CFCG_I		P_Int_I		P_NonIns_T	P_Tol_T
	All Sites	6	8	All Sites	6	8	6	8	All Sites	All Sites
10	>5	>17	>18	>12	0-59	0-39	25-100	42-100	0-8	0-4
9		16-17	17-18	12	60-63	40-46	23-24	37-41	9-12	5-8
8	5	15	16	11	64-67	47-52	21-22	32-36	13-17	9-12
7	4	13-14	14-15	10	68-71	53-58	19-20	27-31	18-21	13-16
6		11-12	13	9	72-75	59-64	16-18	23-26	22-25	17-19
5	3	9-10	11-12	8	76-80	65-70	13-15	19-22	26-29	20-22
4	2	7-8	10	7	81-84	71-76	10-12	14-18	30-34	23-25
3		5-6	8-9	6	85-88	77-82	7-9	10-13	35-38	26-29
2	1	4	7	5	89-92	83-88	4-6	6-9	39-42	30-33
1		2-3	5-6	4	93-96	89-94	1-3	2-5	43-46	34-37
0	0	0-1	0-4	0-3	97-100	95-100	0	0-1	47-100	38-100

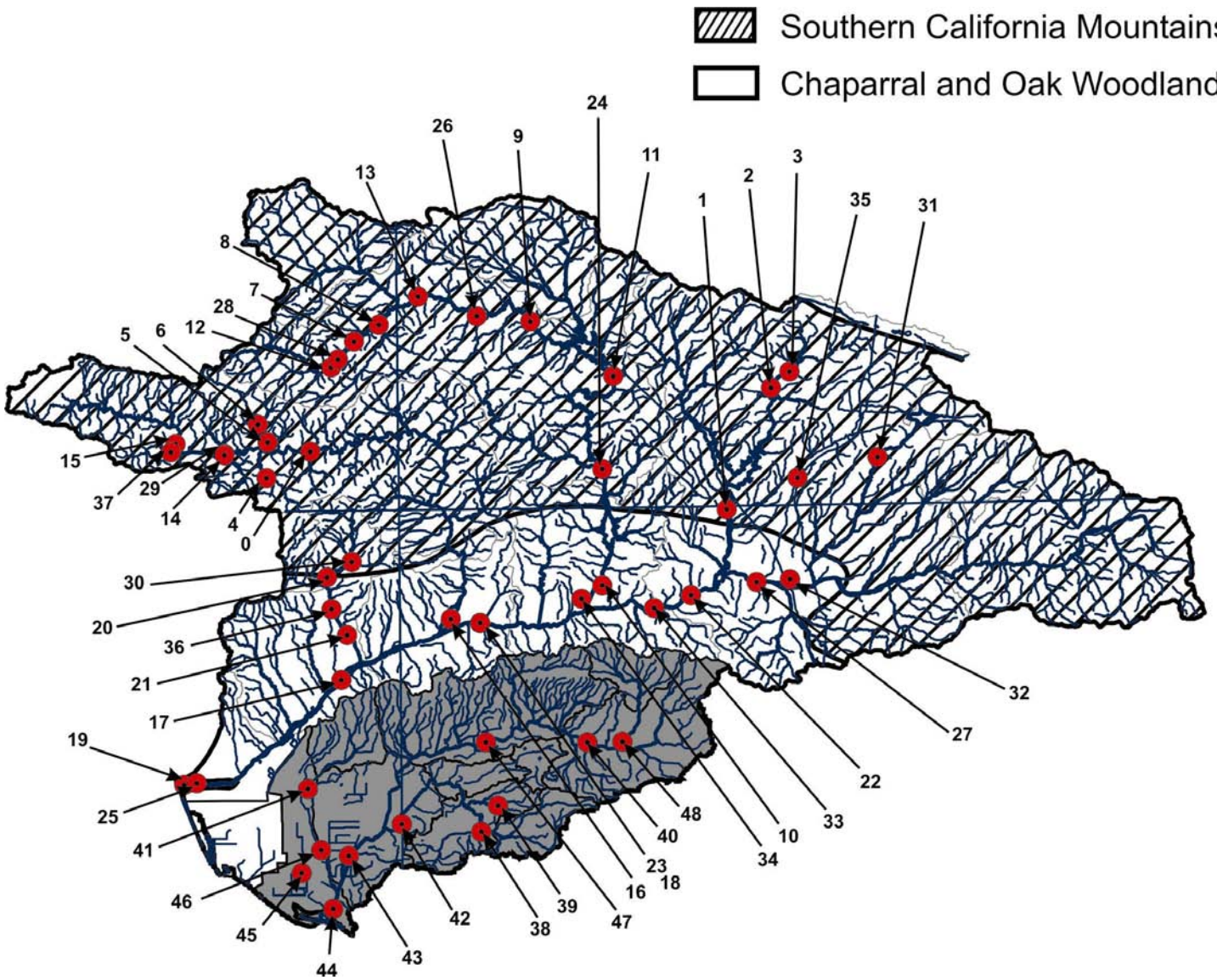

Figure 1. Sites sampled for bioassessment in the Santa Clara River and Calleguas Creek watersheds. Stations are coded; SWAMP IDs are provided in Table 2.

Table 2. List of codes used in Figure 1 with corresponding SWAMP IDs.

Code	SWAMP ID
0	403STC064
1	403STCCTC
2	403STC029
3	403STC065
4	403STC010
5	403STC030
6	403STC066
7	403STC025
8	403STC069
9	403STC071
10	403STC076
11	403STC083
12	403STC085
13	403STC093
14	403STC086
15	403STC070
16	403STCSSP
17	403STC082
18	403STC008
19	403STCEST
20	403STC028
21	403STC090
22	403STC004
23	403STC008
24	403STC009
25	403STC016
26	403STC017
27	403STC019
28	403STC021
29	403STC022
30	403STC024
31	403STC027
32	403STCBQT
33	403STCEST
34	403STCPRU
35	403STCSFO
36	403STCSTP
37	403STC026
38	408CAL011
39	408CAL010
40	408CAL012
41	408CALBWC
42	408CAL007
43	408CAL006
44	408CAL004
45	408CAL003
46	408CAL005
47	408CAL008
48	408CAL013

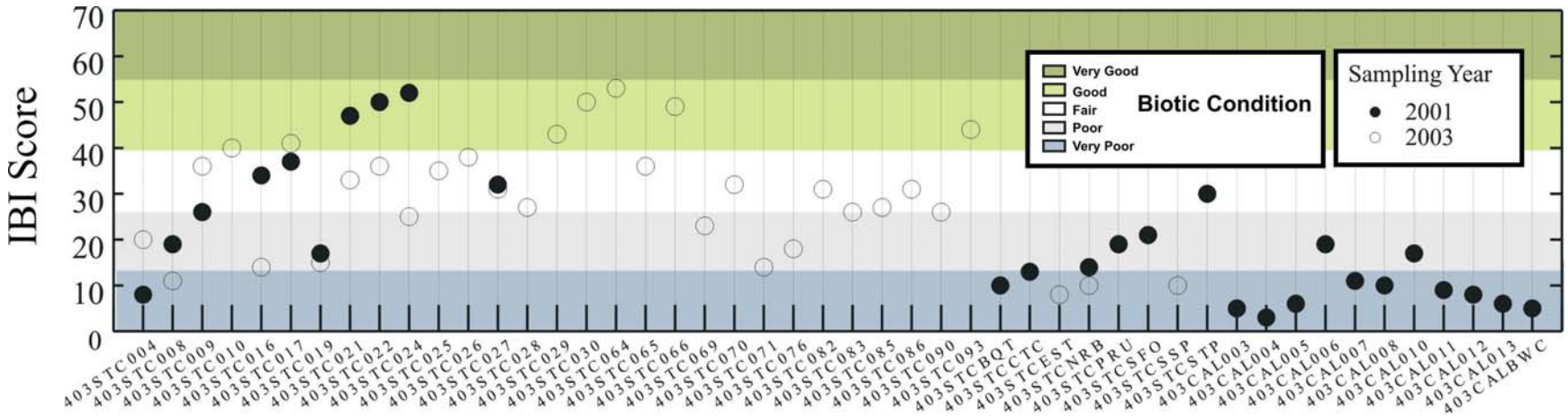

Figure 2. Index of biotic integrity (IBI scores) for sites in the Santa Clara River and Calleguas Creek watersheds.