Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Watershed Monitoring and Assessment Program

Monitoring and Assessment Summary Report
Santa Clara Basin Creeks (2002-2007)

September 15, 2007

EOA inc.

EXECUTIVE SUMMARY

The Santa Clara Valley Urban Runoff Pollution Prevention Program (Program) has conducted monitoring in local creeks since 2002 to comply with requirements specified in its National Pollutant Discharge Elimination System (NPDES) permit (Permit) issued in 2001 by the San Francisco Bay Regional Water Quality Control Board (Water Board). The Program developed a Multi-Year Receiving Waters Monitoring Plan (Multi-Year Plan) defining monitoring and assessment activities designed to assess the condition of beneficial uses in creeks within the Santa Clara Valley. Seventy-three sampling locations in 11 watersheds were monitored between 2002 and 2007.

In years 2002 and 2003, water samples were collected during three seasonal time periods, including dry season (June-October) hydrological cycle, wet season (January-March) hydrological cycle, and spring/decreasing hydrograph season (April–May). During the subsequent four years of monitoring, water samples were collected only during the dry and wet season. Water samples were analyzed for physio-chemical, chemical (i.e., metals, nutrients and anions, and organophosphate pesticides), acute and chronic toxicity and pathogen indicators. Sediment samples were collected during the first two monitoring years in the dry season and were analyzed for metals, organochlorine pesticides, PCBs and PAHs. Benthic macroinvertebrate (BMI) bioassessments and physical habitat assessments (PHAB) were conducted during the spring/decreasing hydrograph season (April/May). Fish bioassessments were conducted during the dry season (October). Watersheds were generally monitored for two consecutive years. Bioassessments were generally conducted at all sampling locations, with the exception of water bodies with highly modified channels and low elevation sites with concrete-lined channels.

The results of the water quality sampling were compared to the Water Quality Objectives identified in the San Francisco Bay Regional Water Quality Control Board 1995 Basin Plan (Basin Plan) and the California Toxics Rule (CTR), which identifies numeric criteria for priority pollutants in the State of California. Nutrient concentrations were evaluated using Recommended USEPA criteria. Diazinon concentrations were evaluated using TMDL targets for San Francisco Bay urban creeks. BMI bioassessments results were evaluated using a preliminary Benthic Index for Biological Integrity (B-IBI) for creeks in Santa Clara County. Ranges of B-IBI scores were assigned to five condition categories: very good, good, fair, marginal and poor.

Results were analyzed and interpreted on a countywide and watershed basis. Based on preliminary Benthic Index of Biotic Integrity (B-IBI) scores, benthic macroinvertebrate (BMI) assemblages indicate that aquatic life in sites located in the upper reaches of Stevens, Permanente and Adobe Creek watersheds and Upper Penitencia Creek and Saratoga Creek subwatersheds are in fair to very good condition, compared to all sites assessed in the Santa Clara Basin. These sites generally had optimal physical habitat assessment (PHAB) scores and received drainage from undeveloped or minimally developed lands within County or City Parks and Open Space Districts. Many reaches of these creeks also support a cold water fish community (i.e., rainbow trout/steelhead). Of all watersheds sampled, Saratoga Creek had the greatest number of sites rated in the fair to very good condition category (n=5), and two of these sites were located in urbanized areas.

B-IBI scores generally decreased with decreasing elevation, suggesting that the effects of urbanization have likely impacted BMI communities over time. Poor physical habitat condition and greater human disturbance to the riparian corridor characterizes sites in the lower and middle reaches that occur along the Santa Clara Valley floor. Despite low B-IBI scores in some creek reaches, however, warm water fish communities were observed in some watersheds (e.g., Stevens, Saratoga, Adobe and Matadero Creeks). Condition of these fish communities was variable, with 1-3 native fish species typically present and distributions that varied across watersheds due to differences in flow regime during the dry season.

Natural variation in B-IBI scores was observed in two ways. First, B-IBI scores were lowest at sites located in smaller-sized watersheds characterized as having intermittent stream flow (e.g., Adobe, Calabazas, Matadero and Thompson Creeks), with the exception of uppermost site on Adobe Creek. This finding suggests that intermittent creeks may naturally have lower B-IBI scores, and thus may not be comparable to sites with perennial flow. Secondly, B-IBI scores varied from year to year at individual sites, likely indicating natural biological responses to variations in precipitation, hydrology and temperature. Average B-IBI scores were used to estimate site condition over a two year period, however, additional year(s) of monitoring will likely increase the accuracy of B-IBI scoring.

Water quality data results indicate that numeric water quality objectives (WQOs), criteria and TMDL targets for metals and organic compounds were generally met in all creeks sampled. Specifically, over 90% of samples met WQOs/criteria for metals and there were no exceedences of TMDL targets for diazinon. For physio-chemical measurements, 93% of all samples met WQOs for dissolved oxygen concentrations for cold water habitat and 82% of all samples met WQOs for pH. Acute toxicity of water flea and/or minnow only occurred in 2% and 10% of all samples, respectively. Water and sediment quality results to-date do not show significant correlations with B-IBI scores.

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1.0 INTRODUCTION

The Santa Clara Valley Urban Runoff Pollution Prevention SCVURPPP (SCVURPPP)[1] developed a Multi-Year Receiving Waters Monitoring Plan (Multi-Year Plan) in 2001 in compliance with requirements specified in its National Pollutant Discharge Elimination System (NPDES) permit (Permit) issued by the San Francisco Bay Regional Water Quality Control Board (Water Board). The Multi-Year Plan defines monitoring and assessment activities scheduled for completion in 2002-2010. Monitoring conducted under the Multi-Year Plan is designed to assess the condition of beneficial uses (i.e., aquatic life and recreational) in creeks within the Santa Clara Basin.

This report provides a summary of data collected during the first five years (FY 02-03 to FY 06-07) of the Multi-Year Plan. Data for each fiscal year have previously been reported and are available on the SCVURPPP website (www.scvurppp.org). Data were evaluated to assess the condition of aquatic life and recreational uses in creeks within the Santa Clara Basin. Results of analyses conducted on a countywide basis are used to develop preliminary conclusions and lessons learned that are intended to inform future monitoring efforts conducted by the SCVURPPP.

1.1 Overview of SCVURPPP Monitoring and Assessment Program

1.1.1 Multi-Year Receiving Waters Monitoring Plan

In 2002, the SCVURPPP developed the Multi-Year Plan that defines water quality monitoring and watershed assessment activities in eleven Santa Clara Basin watersheds. Monitoring activities to date have focused on freshwater creeks in these watersheds. The Multi-Year Plan describes types of environmental indicators to be used and the timing and frequency of monitoring to be conducted for each watershed over an eight year time period. Specific information describing watershed characteristics and overall sampling design, including sampling locations and parameters, are identified in Annual Monitoring Plans developed in March of each year. The Multi-Year Plan (Version 2.0) was revised in March 2004 to: 1) more fully integrate the monitoring activities identified in the Plan with the SCVURPPP's need to conduct watershed assessments, and 2) allow for additional follow-up monitoring activities that will help better identify sources of pollutants or causes of impacts to beneficial uses.

The Multi-Year Plan (Version 2.0) identifies five major goals intended to guide the SCVURPPP's monitoring and assessment activities.

1. Develop a better understanding of the chemical, biological, and physical characteristics of water bodies and watersheds relevant to the SCVURPPP, which will help inform decisions about future management actions and help clarify and resolve urban runoff related issues within watersheds.
2. Assess baseline water quality conditions in representative watersheds within SCVURPPP boundaries to evaluate urban runoff impacts and help solve creek drainage basin-specific water quality problems.
3. Assess whether specific pollutants of concern are found in urban runoff discharges and impact water quality in local water bodies and the San Francisco Bay.
4. Evaluate the effectiveness of existing urban runoff pollution prevention and control Best Management Practices (BMPs) and recommend improvements.
5. Evaluate overall SCVURPPP effectiveness over time.

[1]The Santa Clara Valley Urban Runoff Pollution Prevention SCVURPPP is comprised of Santa Clara County, thirteen municipalities and the Santa Clara Valley Water District (i.e., Co-permittees).

1.1.2 Monitoring and Assessment Approach

The SCVURPPP monitoring and assessment approach includes parameters that may be categorized into two tiers; screening-level monitoring and assessments (i.e. Tier I) and investigative monitoring (i.e., Tier II). Screening level monitoring and assessments include more general measurements made at various sampling locations, providing an initial characterization of the physical, chemical, and biological integrity of a particular waterbody.

Screening level monitoring is conducted in each watershed identified in the Multi-Year Plan for one to two fiscal years on a rotating watershed basis. Investigative monitoring or studies include more detailed measurements typically taken in a more defined area (e.g., stream reach). Investigative monitoring is intended to address specific questions of impairment, such as: 1) what is the cause of the potential impairment, and 2) what is the potential source of the pollutant identified? Table 1 provides a few examples indicators and parameters used by the SCVURPPP for monitoring.

Table 1. Examples of SCVURPPP monitoring indicators and parameters, with associated beneficial uses.

Indicator	Parameter Measured
Aquatic Life	
Physio-chemical	Water temperature, DO, pH, conductivity, stream velocity
Chemical	Total and dissolved metals
	Nutrients and anions
	Organic compounds (e.g., pesticides, PCBs, PAHs)
	Suspended sediment concentration
Aquatic Toxicity	3 species bioassays
Rapid Bioassessments	Benthic macroinvertebrates and fish community assemblage
Physical Habitat	Visual physical habitat assessment
Recreational Use	
Microorganisms	Total and fecal coliform, *Enterococcus, E coli*

The SCVURPPP collected two types of screening level indicators during the implementation of the Multi-Year Plan: (1) aquatic life use indicators and (2) recreation use indicators. The SCVURPPP selected freshwater benthic macroinvertebrate (BMI) and fish communities as primary indicators of aquatic life use condition in Santa Clara County creeks. Fish communities were assessed when present and in creeks that do not support species such as steelhead, which are federally protected.

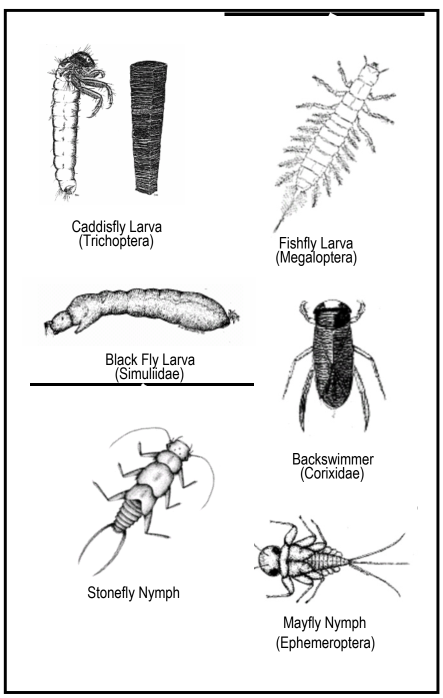

Figure 1. Examples of BMIs used by the SCVURPPP as indicators of aquatic life use condition.

BMIs are composed primarily of insect larvae (Figure 1), mollusks, and worms. They are an essential link in the aquatic food web, providing food for fish and consuming algae and aquatic vegetation (Karr and Chu, 1999). The presence and distribution of BMIs can vary across geographic locations based on elevation, creek gradient, and substrate (Barbour et al., 1999). These organisms are sensitive to disturbances in water and sediment chemistry, and physical habitat, both in the stream channel and along the riparian zone. Because of their relatively long life cycles (approximately one year) and limited migration, BMIs are particularly susceptible to site-specific stressors (Barbour et al., 1999).

Microbiological water analysis is typically carried out to safeguard the health of a community by testing for possible fecal pollution, the source of microorganisms causing waterborne disease. Indicators of recreational use are microbiological organisms that coexist with pathogens in the fecal environment and are easier and less expensive to test for than pathogens. For these reasons, indicator organisms are often the focus of water analyses rather than pathogens. The SCVURPPP uses total coliform, fecal coliform, *Enterococcus*, and *E. coli* organisms as screening level indicators of beneficial uses related to recreation (i.e., REC-1 and REC-2).

1.2 Watersheds Monitored by SCVURPPP

There are 13 major watersheds within SCVURPPP jurisdictional boundaries (Figure 2). Since 2002, the SCVURPPP has conducted monitoring and assessment activities in all watersheds illustrated in Figure 2, with the exception of San Francisquito Creek and the Guadalupe River[2].

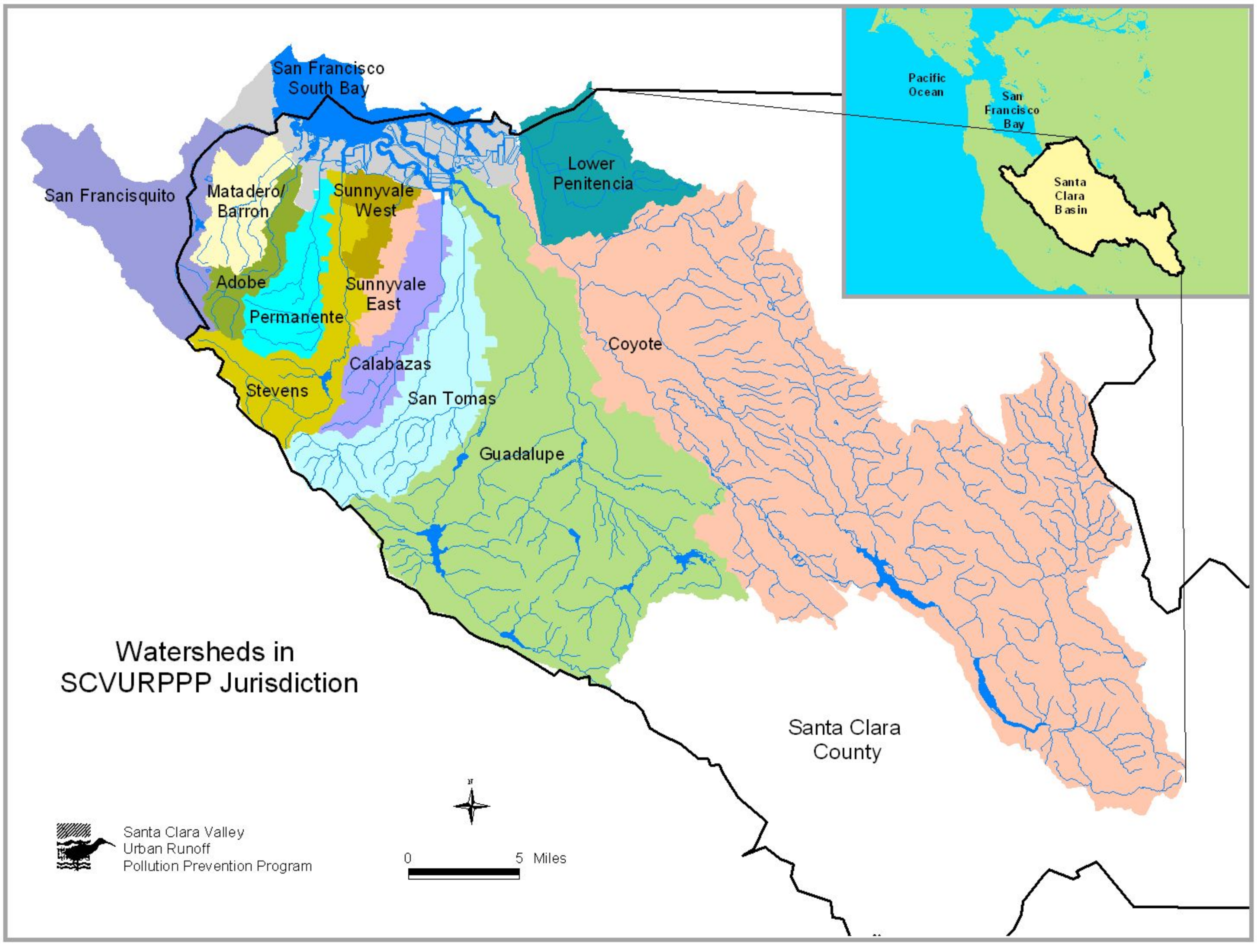

Figure 2. Watersheds within SCVURPPP jurisdictional boundaries. The western portion of San Francisquito Creek watershed is in San Mateo County.

1.3 Designated Beneficial Uses

Beneficial Uses in Santa Clara Valley creeks are designated by the Water Board and are defined as water resources that are protected by State law. Uses include aquatic life, recreation, human consumption, and habitat. Table 2 lists Beneficial Uses designated by the Water Board (1995) for water bodies monitored by the SCVURPPP.

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[2] SCVURPPP did not conduct monitoring in Guadalupe River or San Francisquito Creek watersheds due to extensive monitoring efforts being conducted in these watersheds by other agencies and stakeholder groups.

Table 2. Beneficial uses designated in the *Water Quality Control Plan for the San Francisco Bay Basin* for Santa Clara Valley creeks monitored by SCVURPPP.

WATER BODY	AGR	COLD	FRSH	GWR	MIGR	NAV	RARE	REC-1	REC-2	SPWN	WARM	WILD
Coyote Cr		E			E		E	P	E	E	E	E
San Felipe Cr		P						P	P	P	E	E
Calabazas Cr	E	E		E		E		E	E		E	E
Saratoga Cr	E	E	E	E				E	E		E	E
Stevens Cr		E	E		E			E	E	P	E	E
Permanente Cr		E						E	E	E		E
Matadero Cr		E			E			E	E	E	E	E

AGR - Agriculture
COLD = Cold Fresh Water Habitat
FRSH = Freshwater Replenishment
GWR - Groundwater Recharge
MIGR = Fish Migration
MUN = Municipal and Domestic Water Supply
NAV = Navigation
RARE= Preservation of Rare and Endangered Species
REC-1 = Water Contact Recreation
REC-2 = Non-contact Recreation
SPWN = Fish Spawning
WARM = Warm Freshwater Habitat
WILD = Wildlife Habitat

P = Potential Use
E = Existing Use
L = Limited Use

1.4 Monitoring Design and Sampling Locations

1.4.1 Monitoring Design

The types of aquatic life and recreational use indicators and associated parameters measured by SCVURPPP are shown in Table 1. Specific methods for each parameter are described in Appendix A. During the first two years monitoring (FY 02-03 and FY 03-04), water samples were collected during three seasonal/hydrological time periods: 1) dry season (June-October), wet season (January-March), and spring/decreasing hydrograph season (April – May). During the subsequent three years of monitoring (FY 04-05 through FY 06-07), water samples were collected only during the dry and wet seasons. Water samples were analyzed for physio-chemical, chemical (i.e., metals, nutrients and anions, and organophosphate pesticides), toxicity and microorganism parameters. Sediment samples were collected during the first two monitoring years in the dry season and were analyzed for metals, organochlorine pesticides, PCBs and PAHs). Kinnetic Laboratories, Inc. (KLI) collected all water and sediment samples.

Benthic macroinvertebrate (BMI) bioassessments and physical habitat assessments (PHAB) were conducted each year during the spring/decreasing hydrograph season (April – May). Fish bioassessments were conducted during the end of the dry season (October). EOA, Inc. conducted all bioassessments and physical habitat assessments. Scott Cressey & Associates conducted the fish surveys.

With the exception of FY 02-03, creeks within each watershed were monitored for two consecutive years. In most cases only a subset of sampling locations were monitored during the second year. Bioassessments were generally conducted at all sampling locations where water chemistry was monitored, with the exception of creek reaches with highly modified channels (e.g., Lower Penitencia Creek, Barron Creek and Sunnyvale Channels) and low elevation sites with concrete-lined channels (e.g., San Tomas Aquino, Calabazas and Matadero Creeks).

1.4.2 Site Locations

As illustrated in Table 3 and Figure 3, 73 sampling locations in the following 11 watersheds were monitored between FY 02-03 and FY 06-07 (# of sampling sites in parenthesis):

1. Adobe Creek (6)
2. Barron Creek (1)
3. Matadero Creek (4)
4. Permanente Creek (6)
5. Stevens Creek (8)
6. San Tomas Aquino Creek (11) *(8 in Saratoga)*
7. Calabazas Creek (5)
8. Sunnyvale East Channel (2)
9. Sunnyvale West Channel (1)
10. Coyote Creek (24) *(6 in Lower Silver-Thompson and 8 in Upper Penitencia)*
11. Lower Penitencia Creek (5).

Ten sites in the Coyote Creek mainstem were also sampled during FY 06-07 for sediment chemistry, sediment toxicity and BMI bioassessments. Sediment and BMI data collected from Coyote Creek mainstem are not discussed in this report, rather presented the *Pilot Sediment Quality Triad Report* (SCVURPPP 2007a).

Sampling locations were identified based on a number of factors, including: 1) sites that represented a wide range of watershed characteristics; 2) sites previously monitored; 3) sites that appear to have potential for Beneficial Uses (e.g., water contact or non-contact recreational); 4) reaches that have limited or no data; and 5) sites that were accessible.

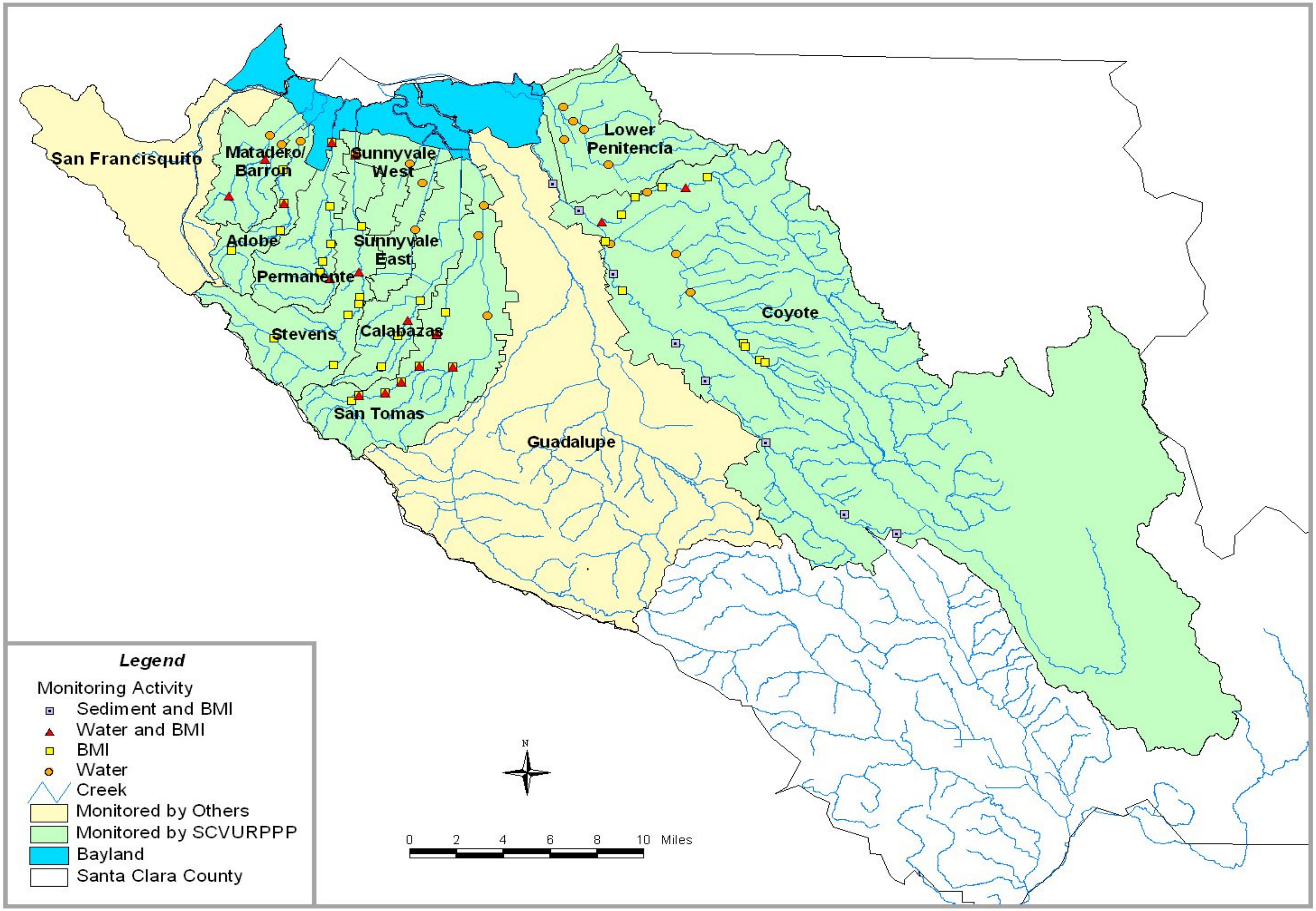

Figure 3. Sampling Sites Monitored by SCVURPPP between FY 02-03 and FY 06-07.

Table 3. Sampling site locations and monitoring parameters for 73 sites monitored by SCVURPPP between FY 02-03 and FY 06-07.

Waterbody	SWAMP ID	Alias ID	Description	Latitude	Longitude	FY02-03	FY03-04	FY04-05	FY05-06	FY06-07
Adobe Creek Watershed (ADO)										
Adobe Creek	205ADO020	A-1	Adobe Cr at Middlefield Rd.	37.42136	122.11131		WQ	WQ		
Adobe Creek	205ADO030	A-2	Adobe Cr at Terman Park.	37.40190	122.12420		BMI	BMI		
Adobe Creek	205ADO040	A-3	Adobe Cr at Edith Ave.	37.37990	122.12330		WQ, BMI	BMI		
Adobe Creek	205ADO045	A-3.5	Adobe Cr at Manresa Lane.	37.37097	122.11831			WQ,F		
Adobe Creek	205ADO050	A-4	Adobe Cr at Foothill College	37.36100	122.12520		BMI	BMI		
Adobe Creek	205ADO060	A-5	Adobe Cr at Hidden Villa Farm	37.34760	122.16270		BMI	BMI		
Barron Creek Watershewd (BAR)										
Baron Creek	205BAR020	B-1	Barron Cr at Park Blvd.	37.41867	122.12578			WQ	WQ	
Calabazas Creek Watershed (CAL)										
Calabazas Creek	205CAL020	C-1	Calabazas Cr at Arques Ave.	37.27100	122.04606			WQ	WQ	
Calabazas Creek	205CAL050	C-2	Calabazas Cr at Creekside Park	37.31570	122.01650			BMI	BMI	
Calabazas Creek	205CAL060	C-3	Calabazas Cr at Blaney Ave.	37.30270	122.02550			WQ, BMI	WQ, BMI	
Calabazas Creek	205CAL070	C-4	Calabazas Cr at De Anza Blvd.	37.29220	122.03350			BMI	BMI	
Calabazas Creek	205CAL080	C-5	Calabazas Cr at Pierce Rd.	37.27160	122.04530			BMI		
Coyote Creek Watershed (COY)										
Coyote Creek	205COY060	COY1	Coyote Cr at Montague	37.39540	121.91485					SQ, BMI
Coyote Creek	205COY080	COY2	Coyote Cr at Oakland Ave	37.37778	121.89455					SQ, BMI
Coyote Creek	205COY170	COY3	Coyote Cr at Watson Park	37.35719	121.87377					BMI
Coyote Creek	205COY240	COY4	Coyote Cr at William St Park	37.33575	121.86707					SQ, BMI
Coyote Creek	205COY250	COY5	Coyote Cr at Kelley Park	37.32444	121.85983					BMI
Coyote Creek	205COY330	COY6	Coyote Cr at Yerba Buena Rd	37.29000	121.81801					SQ, BMI
Coyote Creek	205COY350	COY7	Coyote Cr at Shady Oaks Park	37.26498	121.79468					SQ, BMI
Coyote Creek	205COY400	COY8	Coyote Cr at Metcalf Rd	37.22429	121.74741					SQ, BMI
Coyote Creek	205COY440	COY9	Coyote Cr above Osier Ponds	37.17674	121.68610					SQ, BMI
Coyote Creek	205COY460	COY10	Coyote Cr at Cochrane	37.16457	121.64510					SQ, BMI
Upper Penitencia Creek	205COY090	UP-1	Upper Penitencia Cr at Flea Market	37.37080	121.87660	WQ, BMI				
Upper Penitencia Creek	205COY100	UP-2	Penitencia Cr at Jackson Road	37.37500	121.86140	BMI				
Upper Penitencia Creek	205COY110	UP-3	Upper Penitencia Cr at Summerview	37.38690	121.85120	BMI				
Upper Penitencia Creek	205COY115	UP-2	Upper Penitencia Cr at White Road	37.39053	121.84213	WQ				
Upper Penitencia Creek	205COY120	UP-4	Upper Penitencia Cr at Talent Ave	37.39400	121.83070	BMI				

Waterbody	SWAMP ID	Alias ID	Description	Latitude	Longitude	FY02-03	FY03-04	FY04-05	FY05-06	FY06-07
Upper Penitencia Creek	205COY130	UP-5	Upper Penitencia Cr at Quail Hollow	37.39420	121.81250	WQ, BMI				
Upper Penitencia Creek	205COY140	UP-6	Upper Penitencia Cr at Live Oak Br	37.40090	121.79550	BMI				
Lower Silver Creek	205COY180	LS-1	Lower Silver Cr at Wooster Ave.	37.35548	121.87052	WQ				
Lower Silver Creek	205COY190	LS-2	Lower Silver Cr at Murtha Drive	37.34930	121.81937	WQ				
Thompson Creek	205COY200	T-1	Thompson Cr at Quimby Road	37.32423	121.80757	WQ				
Thompson Creek	205COY221	T-1	Tompson Cr at Villages Pkwy	37.29020	121.76610	BMI				
Thompson Creek	205COY223	T-2	Thompson Cr at Silver Oak	37.28800	121.76420	BMI				
Thompson Creek	205COY227	T-3	Thompson Cr at Flowering Meadow	37.27940	121.75320	BMI				
Thompson Creek	205COY230	T-4	Thompson Cr at Meadowlands Lane	37.27750	121.74910	BMI				
Lower Penitencia Creek Watershed (LPA)										
Calera Creek	205LPA020	CA-1	Calera Cr at Milpitas Blvd.	37.44635	121.90863	WQ				
Berryessa Creek	205LPA035	B-1	Berryessa Cr at Milpitas Blvd.	37.43745	121.90048	WQ				
Los Coches Creek	205LPA040	LC-1	Los Coches Cr at Los Coches St	37.43198	121.89207	WQ				
Berryessa Creek	205LPA060	B-2	Berryessa Cr at Cropley Avenue	37.40837	121.87240	WQ				
Lower Penitencia Creek	205LPA100	LP-1	Lower Penitencia Cr at Corning Ave.	37.42475	121.90745	WQ				
Matadero Creek Watershed (MAT)										
Matadero Creek	205MAT020	M-1	Matadero Cr at Park Blvd.	37.42461	122.13514			WQ		
Matadero Creek	205MAT030	M-2	Matadero Cr at Laguna Ave.	37.40920	122.13820			WQ, BMI, F	WQ, BMI	
Matadero Creek	205MAT040	M-3	Matadero Cr at Stanford Boundry	37.39431	122.16244			WQ, F		
Matadero Creek	205MAT050	M-4	Matadero Cr at Arastradero Rd	37.38410	122.16570			WQ, BMI	WQ, BMI	
Permanente Creek Watershed (PER)										
Permanente Creek	205PER010	PER010	Permanente Cr at Charleston	37.42083	122.08664				WQ, BMI	BMI
Permanente Creek	205PER025	PER025	Permanente Cr at Barbara Av	37.37789	122.08767				BMI	BMI
Permanente Creek	205PER050	PER050	Permanente Cr at Fremont Av	37.35294	122.08619				BMI	BMI
Permanente Creek	205PER060	PER060	Permanente Cr upstream I-280	37.34111	122.09203				BMI	BMI
Permanente Creek	205PER070	PER070	Permanente Cr at Rancho San Antonio Park	37.33017	122.08661				WQ, BMI	WQ, BMI
Permanente Creek	205PER080	PER080	West Branch Permanente Cr in RAS Open Sp	37.33353	122.09414				BMI	BMI
San Tomas Aquino Watershed (SAR and STQ)										
Saratoga Creek	205SAR030	S-1	Saratoga Cr at Cabrillo.	37.35978	121.97247		WQ	WQ		
Saratoga Creek	205SAR040	S-2	Saratoga Cr at Bollinger	37.30830	121.99660		BMI	BMI		

Waterbody	SWAMP ID	Alias ID	Description	Latitude	Longitude	FY02-03	FY03-04	FY04-05	FY05-06	FY06-07
Saratoga Creek	205SAR050	S-3	Saratoga Cr at Prospect Rd.	37.29390	122.00300		WQ, BMI	BMI		
Saratoga Creek	205SAR060	S-4	Saratoga Cr at Crestbrook Dr.	37.27220	122.01630		BMI	WQ, BMI		
Saratoga Creek	205SAR070	S-5	Saratoga Cr at Oak Hollow.	37.26150	122.02960		WQ, BMI	BMI		
Saratoga Creek	205SAR080	S-6	Saratoga Cr at Toll Gate Rd.	37.25410	122.04200		BMI	WQ, BMI		
Saratoga Creek	205SAR090	S-7	Saratoga Cr at Pierce Rd.	37.25230	122.06260		WQ, BMI	BMI		
Saratoga Creek	205SAR110	S-8	Bonjetti Cr at Hwy 9	37.24840	122.06810			BMI		
San Tomas Aquino	205STQ020	ST-1	San Thomas Cr at Scott Blvd.	37.38017	121.96842		WQ	WQ		
San Tomas Aquino	205STQ040	ST-2	San Thomas Cr at Starbird Park.	37.30658	121.96417		WQ			
San Tomas Aquino	205STQ060	ST-3	San Thomas Cr at Westmont.	37.27197	121.99039		WQ, BMI	BMI		
Stevens Creek Watershed (STE)										
Stevens Creek	205STE020	STE010	Stevens Cr at La Avenida	37.41300	122.06858				WQ, BMI	BMI
Stevens Creek	205STE040	STE040	Stevens Cr below Diversion Channel	37.36481	122.06239				BMI	BMI
Stevens Creek	205STE060	STE060	Stevens Cr at Barranca	37.33453	122.06425				WQ, BMI	WQ, BMI
Stevens Creek	205STE064	STE064	Stevens Cr at Blackberry Farm	37.31761	122.06314				BMI	BMI
Stevens Creek	205STE065	STE065	Stevens Cr at McClellan Ranch	37.31325	122.06378				WQ	BMI
Stevens Creek	205STE070	STE070	Stevens Cr at Chestnut Picnic Area	37.30567	122.07214				BMI	BMI
Stevens Creek	205STE100	STE100	Stevens Cr at Moss Rock	37.27233	122.08253				BMI	BMI
Stevens Creek	205STE110	STE110	Stevens Cr at MPOSD	37.28911	122.12881				BMI	BMI
Sunnyvale Channels (SVE and SVW)										
Sunnyvale East	205SVE010	SU-1	Sunnyvale East Chan. at Ahwanhee	37.39439	122.01667			WQ	WQ	
Sunnyvale East	205SVE020	SU-2	Sunnyvale East Chan. at Daffodil Ct.	37.36311	122.02133			WQ		
Sunnyvale West	205SVW010	SU-3	Sunnyvale West Chan. at Mathilda	37.40711	122.02614			WQ	WQ	

2.0 METHODS

2.1 Rapid Bioassessments

Benthic macroinvertebrate (BMI) sampling was conducted during all sampling years utilizing the California Stream Bioassessment Procedures (CSBP) protocols for low and high gradient streams (CDFG 1999, 2003). The field and laboratory protocols described in the CSBP, however, have evolved during implementation of the Multi-Year Plan. These changes include reducing the total square footage of stream substrate sampled at each reach (18 ft^2 to 9 ft^2) and the addition of new protocols for sampling low gradient reaches. Changes in laboratory procedures include compositing all subsamples into a single sample and reducing number of organisms for identification (900 to 500). The methods described below are based on the protocols most recently implemented by the SCVURPPP as described in CDFG (2003).

2.1.1 BMI Field Sampling

Each bioassessment sampling site consisted of approximately a 100-meter reach of the channel. Based on CDFG methods (1999, 2003), riffle habitat was sampled at most sites, as it generally has the most diverse community of BMIs. A low gradient protocol was also used at low elevation sites that had minimal or no riffle habitat. For these sites, three transects were randomly selected using a random number table and samples were taken across a range of habitat types (i.e., runs, glides) found at each transect. The high gradient protocol was used at sites that contained at least 3 riffle habitats. If more than three riffles occurred within the reach, 3 riffles were randomly selected using a random number table. Within each selected riffle, a transect location for sampling was randomly chosen.

Starting with the downstream riffle (variety of potential habitats for low gradient), the benthos of three 1 ft^2 areas along each transect were disturbed by manually rubbing coarse substrate followed by 'kicking' the upper layers of substrate to dislodge any remaining invertebrates into a D-frame kick net. Material collected in all three 1 ft^2 areas was then transferred into a 500-ml wide-mouth jar containing approximately 200 ml of 95% ethanol. This technique was repeated for each of the three transects in each monitoring sampling station. The three samples per station were combined into one composite sample at the laboratory.

2.1.2 BMI Laboratory Processing and Analysis

Bioassessment Services, Inc. laboratory was contracted for processing all BMI samples collected. Based on CDFG (1999, 2003) each sample was rinsed in a standard no. 35 sieve (0.02 in; 0.5 mm) and transferred to a tray with twenty, 4 $in.^2$ (26 cm^2) grids for subsampling. Benthic material in the subsampling tray was transferred from randomly selected grids (or half grids if BMI densities were high) to petri dishes where the BMIs were removed systematically with the aid of a stereomicroscope and placed in vials containing 70% ethanol and 2% glycerol. At least 500 BMIs were subsampled from a minimum of three grids. If there were more BMIs remaining in the last grid after 500 were archived, then the remaining BMIs were tallied and archived in a separate vial. This was done to assure a reasonably accurate estimate of BMI abundance based on the portion of benthos in the tray that was subsampled. These "extra" BMIs were not included in the taxonomic lists and metric calculations.

Subsampled BMIs were identified using taxonomic keys (Kathman and Brinkhurst 1998, Merritt and Cummins 1996, Stewart and Stark 1993, Thorp and Covich 2001, Wiggins 1996) and unpublished references. The subsampled BMIs identified from each sample were archived in labeled vials with a mixture of 70% ethanol and 2% glycerol. A standard level of taxonomic effort was used as specified in the California Aquatic Macroinvertebrate Laboratory Network (CAMLnet) short list of taxonomic effort, January 2003 revision.

2.1.3 Physical Habitat Assessment

Physical habitat quality was assessed by EOA, Inc. at each BMI monitoring site using the U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocol (Barbour et al., 1999). These qualitative habitat assessments were conducted at each sampling reach following bioassessment sampling. The assessment consists of ten qualitative parameters that assess the condition of instream physical habitat and riparian buffer area. Assessment scores can range from 0 to 200, with high scores representing higher habitat quality.

2.1.4 Fish Community Field Sampling

Scott Cressey and Associates sampled fish communities at selected locations using a Smith-Root model LR-24 electrofisher and a single pass method. Stream sites (i.e., sections) sampled ranged from 250 feet to 300 feet in length. Captured fish were held in a bucket of water for species identification, enumeration, measuring fork length (mm) and weight (grams). Other data types recorded at each sampling station were: maximum water depth; habitat types; dominant substrate; water temperature and time; dissolved oxygen; electrical conductivity; pH and stream velocity.

2.1.5 BMI Data Quality Assessment

Duplicate samples were collected at 10% of sites sampled each year to evaluate precision of field sampling methods. In addition, 10% of the total number of samples were submitted to CDFG's Aquatic Bioassessment Laboratory for independent assessment of taxonomic accuracy, enumeration of organisms and conformance to standard taxonomic level.

2.1.6 Data Analysis and Interpretation

A variety of metrics can be calculated for BMI samples to allow interpretation of taxonomic data received from an entomologist. A metric is "a measure of the biota that changes in a predictable way with increased human influence" (Barbour et al. 1999). The CalEDAS data management system can produce a total of 71 metrics. These metrics can be categorized into five main types:

- Richness Measures (total number of distinct taxa);
- Composition Measures (distribution of individuals among taxonomic groups and includes measures of diversity);
- Tolerance/Intolerance Measures (reflects the relative sensitivity of the assemblage to disturbance);
- Functional Feeding Groups (shows the balance of feeding strategies in the aquatic assemblage);
- Abundance (estimates total number of organisms in sample based on a nine sq. ft. sampling area).

Benthic Index of Biotic Integrity

An Index of Biotic Integrity (IBI) is an index that reduces complex information about biological community structure into a simple numerical value based on metric scores. Typically, separate metrics are used from each of these categories to develop a multi-metric index (e.g., IBI) for a particular region of interest to assess the biological condition in creeks.

Barbour *et al*. (1999) identify six general steps involved in the development of an IBI:

1. Classify stream types into classes and select reference sites
2. Select potential metrics
3. Evaluate metrics to select most robust ones
4. Score metrics and combine scores into IBI
5. Assign rating categories to IBI score ranges
6. Evaluate IBI and refine

Benthic macroinvertebrate IBIs (B-IBIs) have previously been developed for Southern and Northern California wadable streams. Additionally, a preliminary B-IBI was recently developed by the Contra Costa Clean Water Program (CCCWP) to evaluate BMI bioassessment data collected over a five year time period for the Contra Costa Monitoring and Assessment Program (CCMAP). The steps used to develop these IBIs provide the basic framework to develop a preliminary B-IBI to evaluate bioassessment sites in Santa Clara Creeks. The development of the draft preliminary Contra Costa and Santa Clara B-IBIs is a preliminary step in the development of a San Francisco Bay regional B-IBI, a project currently being conducted by participating urban runoff programs involved in the Bay Area Macroinvertebrate Bioassessment Information (BAMBI) Network. The Bay Area B-IBI will fill a geographic gap that existing between watershed areas represented by the Northern and Southern California B-IBIs.

Metrics Used in Other B-IBIs

Benthic Indices of Biotic Integrity (B-IBIs) were recently developed for Northern California (i.e., Coastal Oregon border to Marin County) and Southern California (i.e., Coastal Mexico Border to Monterey County) using the steps described above (Ode et al., 2005; Rhen and Ode, 2006). Eight metrics were selected for the Northern California B-IBI and seven for the Southern California B-IBI out of total possible of seventy-one metrics. The preliminary B-IBI in Contra Costa County used five metrics from the eleven possible metrics used in the Northern and Southern California B-IBIs. (Table 4).

Table 4. Metrics selected for development of the Southern and Northern California, and Contra Costa County B-IBIs.

B-IBI Metric	Southern California	Northern California	Contra Costa County
Coleoptera Richness	x	x	
EPT Richness	x	x	x
Predator Richness	x		
Diptera Richness		x	x
% Collector individuals	x		x
% Noninsect Taxa		x	x
% Tolerant	x	x	
% Intolerant Taxa	x	x	
% Non-Gastropoda Scraper Individuals		x	
% Predator Taxa	x		x
% Shredder Taxa		x	

Reference Site Selection

Reference sites are reaches of creeks that have "reference conditions" representing the desired state of stream health for a region of interest. For creeks in urban areas that may be greatly impacted by a wide range of human disturbances, reference sites are often defined as an area that is "least disturbed" or "best attainable" within a given region. Once candidate reference stations have been identified, these are used to characterize the range of biotic conditions expected for minimally disturbed sites. Deviation from this range can then be used as an indication that non-reference stations may be impacted.

Information collected during BMI bioassessments conducted by the SCVURPPP was used to identify reference sites for Santa Clara Basin creeks. In addition to qualitative physical habitat scores, best professional judgment was used to identify eight "least disturbed" potential reference sites. These sites were typically in the upper reaches of five different watersheds (Table 5).

Please note that variation in BMI assemblages due to natural factors (e.g., elevation) that have not been fully evaluated during the development of the Preliminary B-IBI for Santa Clara County can have direct implications on the development and interpretation of IBI scores. Ideally, reference conditions are developed for each set of sampling sites with significantly different BMI assemblages due to natural conditions. This process is currently underway in the development of the B-IBI for San Francisco Bay Area creeks.

Table 5. Reference Sites selected during development of the preliminary B-IBI for Santa Clara County.

Creek	Station Code	Location	PHAB Score
Adobe	205ADO060	Adobe Cr at Hidden Villa Farm	157
Saratoga	205SAR070	Saratoga Cr at Oak Hollow.	150
Saratoga	205SAR080	Saratoga Cr at Toll Gate Rd.	156.5
Saratoga	205SAR090	Saratoga Cr at Pierce Rd.	169.5
Bonjetti	205SAR110	Bonjetti Cr at Hwy 9	170
Stevens	205STE110	Stevens Cr at MPOSD	159
Permanente	205PER080	West Branch Permanente Cr in Open Space	149.5
Upper Penitencia	205COY140	Upper Penitencia Cr at Live Oak Br	128

Metrics Screening and Selection

Selection of bioassessment metrics for an IBI is a critical phase in the creation of an IBI and typically undergoes the most revision in subsequent refinement of an index. Metrics may differ from region to region, but typically share common characteristics. Most critically, "core" metrics should be able to discriminate between known reference sites and sites with known impacts. The steps used for selecting suitable metrics in the development of both Northern and Southern California B-IBIs was based on the United States Environmental Protection Agency's (EPA) recommendations (Barbour *et al*. 1999, Hughes *et al*. 1998, McCormick *et al*. 2001). Between the two B-IBIs, 11 core metrics were selected out of a total of 71 possible metrics.

The same 11 core metrics were used as a starting point for the development of the preliminary B-IBI for Santa Clara County. These 11 metrics were tested for their power to discriminate between reference and test sites. Based on the results of the screening process, the following 5 "core" metrics were selected for inclusion in the preliminary Santa Clara County B-IBI:

1. EPT Richness
2. Diptera Richness
3. Predator Richness
4. Percent Collector Individuals
5. Percent Noninsect Taxa

Defining Scoring Ranges of Core Metrics

Metric scoring ranges were defined using techniques described in Hughes *et al*. (1998) and McCormick *et al*. (2001). Statistical properties of the distribution of metric scores for both reference and test stations were used to define cutoffs for each of the 5 metrics selected using the following criteria: 1) any station with a metric value of less than the 5th percentile of the test stations was assigned a "0" score, 2) any site with a metric value of greater than the 25th percentile of the reference stations was assigned a "10" score. The range between these values was divided into 9 equal portions and assigned values between 1 and 9. Table 6 presents the scoring ranges for the five metrics included in the preliminary Santa Clara County B-IBI.

Calculation of the B-IBI

After the core metrics have all been assigned scoring ranges, the B-IBI score for each site is calculated by summing the component metric scores. The distribution of resulting B-IBI scores for all stations is then divided into scoring categories that define thresholds of biotic condition (Table 6). Scoring categories for the preliminary Santa Clara B-IBI were established by using the 25th percentile of total IBI scores at reference stations to set the boundary between the "Good" and "Fair" scoring ranges. Then the top end of the scale was divided into two equal sections ("Good" and "Very Good") and the bottom end of the scale was divided into three equal sections ("Fair", "Marginal" and "Poor").

Table 6. Scoring ranges for the five metrics included in the preliminary Santa Clara County B-IBI and scoring categories used to define biotic condition.

IBI Score	EPT Taxa	% Non-Insecta Taxa	# Diptera Taxa	# Predator Taxa	% Collectors
10	≥21	0 - 11	>10	≥12	0 - 48
9	19-20	12 - 19	10	11	49 - 54
8	17-18	20 - 26	9	10	55 - 60
7	15-16	27 - 32	8	9	61 - 66
6	13-14	33 - 39	7	8	67 - 72
5	11-12	40 - 46	6	7	73 - 78
4	9-10	47 - 53	5	6	79 - 84
3	7-8	54 - 60	4	5	85 - 90
2	5-6	61 - 67	3	4	91 - 96
1	3-4	68 - 74	2	3	97 - 99
0	≤2	75 -100	<2	≤2	100

B-IBI Scoring Categories				
Very Good	**Good**	**Fair**	**Marginal**	**Poor**
50-46	45-40	39-26	25-13	12-0

2.2 Water and Sediment Field Sampling and Laboratory Analysis

2.2.1 Physio-chemical Measurements

Conventional water quality parameters of temperature, pH, conductivity, and dissolved oxygen (D.O.) were measured with portable field instruments. During water quality sampling events, temperature, pH, and, conductivity were measured with an YSI Model 63 handheld instrument, and D.O. was measured with an YSI Model 58 portable D.O. meter. In addition, water velocity was measured in feet/second with a Global Water FP101 flow meter.

Water quality was measured during the BMI bioassessments using a multi-parameter probe YSI model 600XL Sonde with a 650 MDS data logger. Stream velocity was measured at each sample riffle using a Global Water FP201 flow meter. Water quality was measured during fish bioassessments using YSI 200 (D.O.); Oaklon pHTester 1 (pH); and Oakon ECTester (conductivity). Stream velocity was measured at each sample riffle using a Marsh-McBirney electromagnetic current velocity meter

2.2.2 Water and Sediment Chemistry

Water quality samples were collected directly into sample bottles as close to midstream as possible. Following collections, the samples were directly stored on ice and maintained at a temperature of 4°C until delivered to the laboratory. Water samples were analyzed for nutrients and anions, suspended sediment, metals (total and dissolved), and organophosphate pesticide concentrations. Analytical laboratory methods, reporting limits and holding times for chemical water quality parameters are shown in Appendix A.

Sediment quality samples were collected with a Tefzel-coated spoon, lifted slowly through any overlying water and placed into a Tefzel-coated stainless steel pan. The sample was then homogenized and distributed to the sample containers. Analytical laboratory methods, reporting limits and holding times for chemical sediment quality parameters are shown in Appendix A.

2.2.3 Aquatic Toxicity Testing

Aquatic toxicity testing was conducted on samples collected during dry and wet seasons at selected locations. Three species bioassays were conducted on the water flea (*Ceriodaphnia dubia*), the fathead minnow (*Pimephales promelas*) and a green alga (*Selenastrum capricornutum*) with acute and chronic endpoints. ToxScan performed all tests for water toxicity. Analytical laboratory methods, reporting limits and holding times for the samples used for toxicity testing are shown in Appendix A. Detailed description of methods is provided in SCVURPPP (2006).

2.2.4 Pathogen Indicators

To screen for potential human health risks associated with waterborne pathogens, water samples were collected at selected locations and analyzed by BioVir Laboratories, Inc. for concentrations of total and fecal coliform, *Enterococcus* and *E coli*. Initial field reconnaissance indicated these stations had potential public access with potential for contact water recreation. Laboratory methods, reporting limits and holding times for the samples analyzed for bacteria are shown in Appendix A. Detailed description of methods is provided in SCVURPPP (2006).

2.2.5 Data Quality Assessment

Quality Assurance/Quality Control (QA/QC) activities associated with the field data collection and laboratory analyses are described in more detail in the SCVURPPP *Draft Quality Assurance Project Plan (QAPP)*. The major goal for these QA/QC procedures is to have representative, comparable, accurate and precise data, to the extent possible under the given limitations. QA/QC activities associated with water quality field sampling and laboratory analysis included the following:

- Employing analytical chemists trained in the procedures to be followed;
- Adherence to documented procedures, USEPA methods (Table 11) and written SOPs;
- Calibration of analytical instruments;
- Use of quality control samples, internal standards, surrogates, and SRMs
- Complete documentation of sample tracking and analysis.

Data validation was performed in accordance with the National Functional Guidelines for Organic Data Review (EPA540/R-99/008) and Inorganic Data Review (EPA540/R-01/008).

2.2.6 Data Analysis and Interpretation

Water quality objectives (WQOs) listed in the Basin Plan (Water Board 1995) are either narrative or numerical. Narrative objectives present general descriptions of water quality that must be attained through pollution control measures and watershed management. Numerical WQOs describe pollutant concentrations and the physical/chemical conditions of the water itself. These objectives are designed to represent the maximum amount of pollutants that can remain in the water column without causing any adverse effects on organisms using the aquatic habitat and on people consuming those organisms or water (Water Board 1995). Additional water quality criteria have also been established by the U.S. EPA in the California Toxics Rule (CTR), which were subsequently adopted by the State of California (USEPA 2000a). Numerical WQOs and criteria used to assess water quality data collected by the SCVURPPP are listed in Table 7.

It is important to note that WQOs for bacterial indicators are based on five consecutive samples that are equally spaced over a 30-day period. The SCVURPPP collected water samples 2-3 times each year and thus do not meet the sampling requirements stated in the WQOs. In addition, there are two important issues when evaluating bacterial indicator organisms: 1) the correlation between bacterial indicator organisms and pathogens of public health concern is subject to debate; and 2) potential for human exposure to the water bodies of interest must be considered. Microbial risk assessments typically involve characterizing both water quality and exposure, with regards to the specific pathogens of concern.

Nutrient (i.e., total nitrogen, total phosphorus, and chlorophyll a) concentrations were evaluated using recommended U.S. EPA guidelines for rivers and streams within Aggregate Ecoregion III-Xeric West (USEPA 2000b) (Table 7). It is important to note that these standards are based on existing data sources across 11 western states and applicability to local conditions has not been assessed. The EPA-recommended nutrient guidelines were used in this report for comparison purposes only.

Diazinon, an organophosphate pesticide, was evaluated using the target concentrations developed for the Total Maximum Daily Load (TMDL) for Diazinon in Bay Area Creeks (Table 7).

Metal concentrations in sediment were evaluated using sediment quality guidelines developed by MacDonald (2000). Specifically, measured values were compared with guideline values associated with Probable Effect Concentration (PEC) (Table 8), which represent concentrations above which one would expect to observe some degree of toxic response. These guidelines are based on sediment chemistry and biological effects data that typically represents some type of threshold above (or below) which there has been shown a predictable effect on biota. These guidelines were used in this report for comparison purposes only.

Table 7. Numerical water quality objectives (WQOs), standards and criteria listed in either the San Francisco Bay Basin Plan (Water Board 1995) or the California Toxics Rule (CTR) (USEPA 2000a), USEPA recommended criteria (USEPA 2000b) and TMDL targets.

Monitoring Parameter/Analyte	1995 Basin Plan Water Quality Objective	California Toxics Rule (CTR) Criterion Continuous Concentration (CCC)[2]	U.S. EPA Recommended Criteria for Nutrients	TMDL target
Physio-Chemical				
Dissolved Oxygen (mg/L)				
Warm water habitat	5.0			
Cold water habitat	7.0			
pH	> 6.5 or < 8.5			
Nutrients				
Total Nitrogen (mg/L)			0.38	
Total Phosphorus (mg/L)			0.022	
Chlorophyll a (ug/L)			1.78	
Metals (ug/L)				
Cadmium[3]	-	2.2[4]		
Chromium (VI)[5,6]	-	11		
Copper[4,6]	-	9.0[5]		
Lead[4,6]	-	2.5[5]		
Nickel[4,6]	-	52		
Mercury	0.025	-		
Selenium	-	5[6]		
Silver[4,6]	-	3.4[7]		
Zinc[4,6]	-	120[5]		
Pesticides				
Diazinon (ug/L)				0.10
Bacterial Indicators				
Full Body Contact Recreation				
Total Coliform (MPN/100mL)	no sample >10,000	-		
Fecal Coliform (MPN/100mL)	90th percentile < 400	-		
Enteroccocus (CFU/100mL)	151[8]	-		
E coli (CFU/100mL)	576[7]			
Partial Body Contact Water Recreation				
Fecal Coliform (MPN/100mL)	90th percentile < 4000	-		

[2] Criteria continuous Concentration (CCC) equals the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects.
[3] Criteria for these metals are expressed as a function of the water-effect ratio (WER).
[4] Freshwater aquatic life criteria for metals are expressed as a function of total hardness (mg/L) in the water body. Values displayed in the table correspond to a total hardness of 100 mg/L.
[5] These criteria are expressed in terms of the dissolved fraction of the metal in the water column.
[6] Selenium criteria were promulgated for all San Francisco Bay/Delta waters in the National Toxics Rule (NTR). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and Sacramento-San Joaquin Delta.
[7] Value is the Criteria Maximum Concentration (CMC), which equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time (1 hour) without deleterious effects.
[8] U.S. EPA bacteriological criteria for water contact recreation in "infrequently used areas".

Table 8. Probable and Threshold Effects Concentration for Total Recoverable Metals in Sediments and Total Detectable PCBs (MacDonald et al 2000).

Contaminant	Probable Effects Concentration (PEC)	Threshold Effects Concentration (TEC)
Arsenic (mg/kg)	33	9.79
Cadmium (mg/kg)	4.98	0.99
Chromium (mg/kg)	111	43.4
Copper (mg/kg)	149	31.6
Lead (mg/kg)	128	35.8
Mercury (mg/kg)	1.06	0.18
Nickel (mg/kg)	48.6	22.7
Zinc (mg/kg)	459	121
PCBs (µg/kg)	676	59.8

3.0 RESULTS

The following section provides a summary of the results from monitoring conducted by the SCVURPPP's between FY 02-03 and FY 06-07.

3.1 BMI Bioassessment Data

Between April 2003 and April 2007, 69 benthic macroinvertebrate (BMI) bioassessments were conducted at 41 creek sites located in 7 major watersheds (Note: This does not include bioassessments conducted in the Coyote mainstem (n=10) during FY 06-07). Approximately 39,000 BMIs within 334 distinct taxa were identified in the BMI samples.

3.1.1 Most Dominant Taxa

Approximately 75% of the organisms identified during the bioassessments belonged to one of five distinct taxa (Table 9). Moderately pollution tolerant non-biting midges and Baetid Mayflies accounted for over 50% of the organisms. Segmented worms and blackflies, also moderately pollution tolerant, accounted for nearly 20% of the organisms. These taxa were also listed as four of the five most dominant taxa identified in Contra Costa County creeks (EOA. 2007). A relatively common riffle beetle, *Optioservus sp.*, was the fifth most dominant taxa identified in Santa Clara County sampling stations. Approximately 60% of the *Optioservus* organisms were identified from samples collected in Saratoga Creek watershed.

Table 9. Five most dominant taxa identified in BMI samples collected between 2002 and 2007.

Taxon	Taxonomic Group	Common Name	Tolerance Value (0-10)*	% of All Organisms
Chironomidae	Diptera	Non-biting Midges	6	31.0
Baetis sp.	Ephemeroptera	Baetid Mayflies	5	21.3
Oligochaeta	Annelida	Segmented Worms	5	11.4
Simulium sp.	Diptera	Black Flies	6	8.3
Optioservus sp.	Coleoptera	Beetles	4	2.3
			Total	**74.3**

*Tolerance values range from 0-10, 0 = the least tolerant and 10 = the most tolerant to stress (e.g., pollution).

3.1.2 Functional Feeding Groups (FFGs)

BMI taxa are classified into functional feeding groups (FFGs) based on their feeding mechanisms. Major types of FFGs include collector-gatherers, collector-filterers, scrapers, shredders and predators. Collector-filterers and collector-gatherers depend upon fine particulate organic matter (FPOM) for their primary food resource. Filterers obtain fine suspended material from the water column, while collector-gatherers, also called deposit-feeders, generally gather fine materials, including plant, animal, and fungal detritus, from the surfaces of substrates. Scrapers (grazers) depend upon attached periphyton (i.e., algae and associated flora and fauna) that develops on submerged substrates for their primary food resource. Shredders depend upon coarse particulate organic matter (CPOM) for their primary food resource. CPOM is any material greater than about 1 mm in diameter; examples include twigs, leaves, fruits and flowers of terrestrial or aquatic vegetation. Lastly, predators attack living prey organisms.

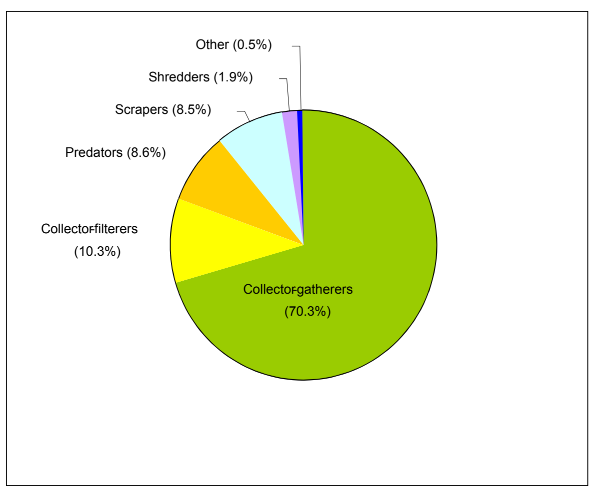

Figure 4. Composition of functional feeding groups for BMIs in Santa Clara County.

An imbalance in the BMI community structure may occur when creek conditions are stressed. Generalists, such as collector-gatherers and collector-filterers, have a broader range of acceptable food materials than specialists (Cummins and Klug 1979), and thus are more tolerant to stressors that might alter availability of certain food. Specialized feeders, such as scrapers, shredders and predators are typically considered the more sensitive types of BMIs and typical indicators of healthy streams. The composition of FFGs from the BMI communities collected from sampling stations in Santa Clara County are shown in Figure 4. Collectors accounted for over 80% of the organisms.

3.1.3 Condition of Aquatic Life Use

Results of the preliminary B-IBI show that approximately 15% of the sampling sites were in good or very good condition; 68% in fair or marginal condition; and 17% in poor condition (Figure 5). The sites rated good or very good were typically the higher elevation sites that occurred in four watersheds: 1) Upper Penitencia Creek, 2) Saratoga Creek, 3) Stevens Creek, and 4) Adobe Creek. Five of these sites were located in Saratoga Creek watershed, including two sites downstream of the City of Saratoga. The remaining five sites were downstream of areas protected by Open Space Districts or County Park land. A majority of the sites that rated “poor” were in reaches that were low gradient (e.g., Stevens and Permanente) or had intermittent flow conditions (e.g., Calabazas, Adobe and Matadero Creek).

B-IBI scores for each site and sampling event are presented in Figures 6 and 7. Box plots indicate the range and median scores for those sites that were sampled two years.

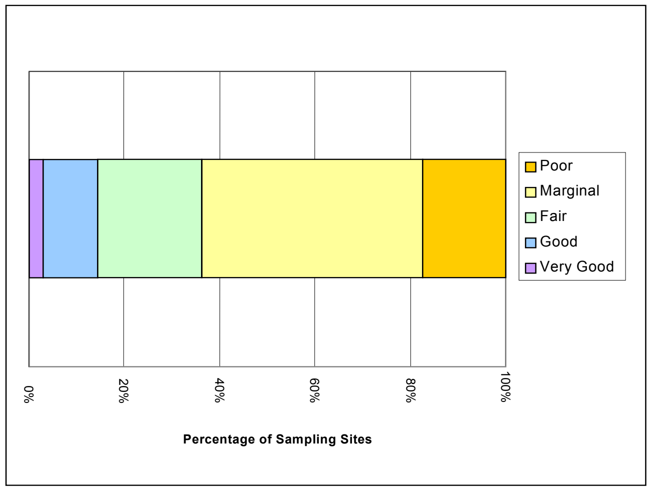

Figure 5. Percent of BMI sampling sites that fall within the five B-IBI scoring categories.

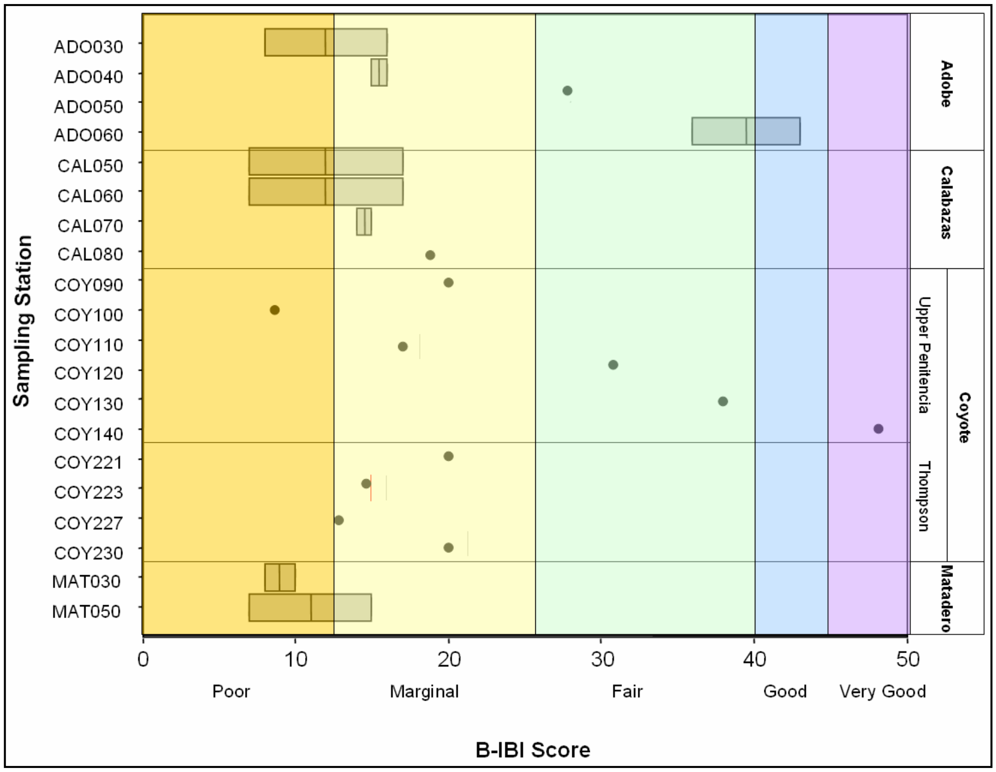

Figure 6. Preliminary B-IBI scores for Adobe, Calabazas, Upper Penitencia, Thompson, and Matadero Creek stations sampled between 2002 and 2007. The range and median score is shown for sites sampled two years.

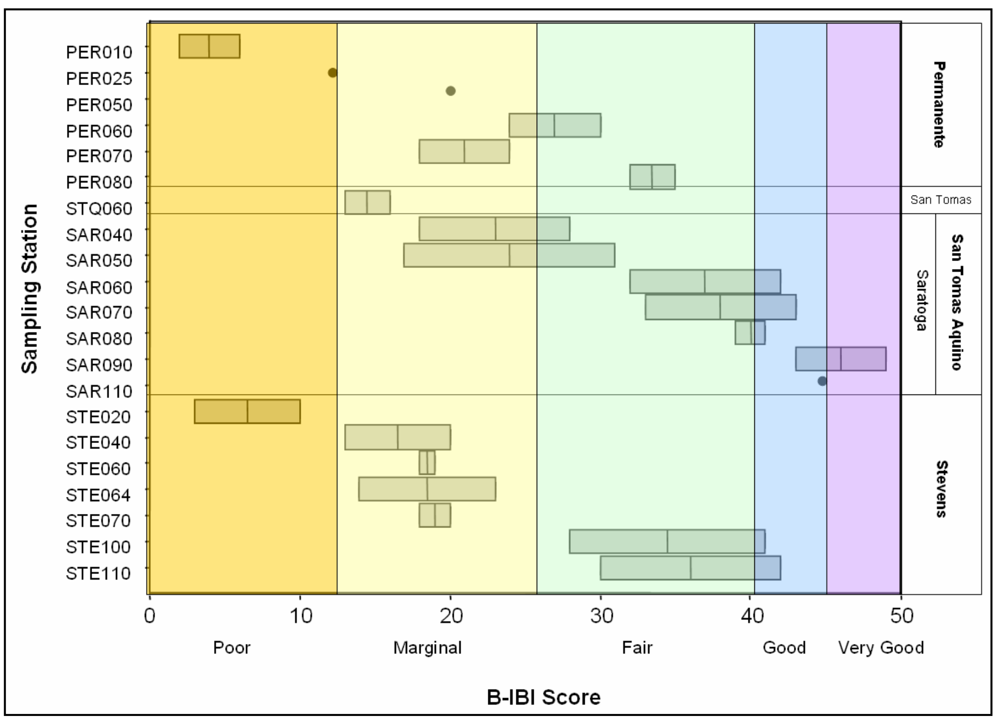

Figure 7. Preliminary B-IBI scores for Permanente, San Tomas Aquino (including Saratoga Creek) and Stevens Creek stations sampled between 2002 and 2007. The range and median score is shown for sites sampled two years.

The condition of aquatic life uses on a watershed scale was also assessed. Average metric scores were used in the calculation of B-IBI at a watershed scale. Box-whisker plots indicate the range and median scores for the B-IBI scores in each watershed (Figure 8). B-IBI scores were highly variable at some sites over a two year sampling period. For example, B-IBI scores for two sites in Saratoga Creek changed from good to fair between 2004 and 2005 sampling events. Conversely, B-IBI scores for two sites in Stevens Creek changed from fair to good between 2006 and 2007. Variation in IBI scores may reflect natural variation in BMI community associated with such factors as temperature and precipitation. For example, 2006 had large storm events late in the year, compared to a relatively mild winter in 2007. Additionally, episodic events (e.g., illegal discharges) can also impact B-IBI scores.

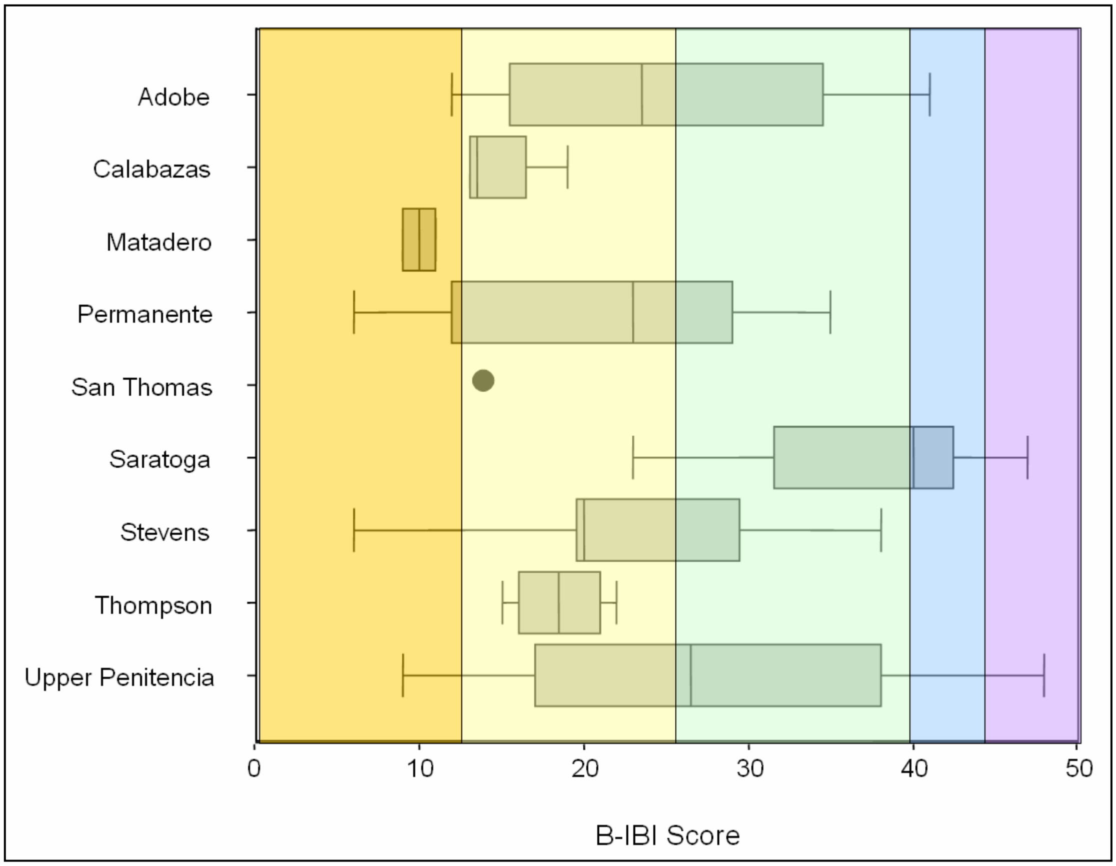

Figure 8. Ranges of Index of Biotic Integrity (IBI) scores grouped by watershed. Minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box) IBI scores for each watershed are shown.

3.1.4 Variables Explaining Biological Integrity

BMI Communities may be affected by a variety of human disturbances (e.g., urbanization, stream modification, dams) as well as natural (e.g., elevation, hydrology, substrate quality, food availability). In the Santa Clara Valley, potential impacts to creeks can occur at the local and sub-watershed scale. For example, urbanization is a watershed scale impact that can adversely affect the biological integrity of creeks. Generally, in the San Francisco Bay Area, urbanization increases with decreasing elevation. As a result, elevation may be used as an indicator of urbanization, although several natural factors (e.g., substrate size and channel widths) may also be correlated with elevation and affect B-IBI scores. Regardless, a linear regression between B-IBI scores and elevation shows a significant correlation between the two variables ($r^2 = 0.51$, $p< 0.05$).

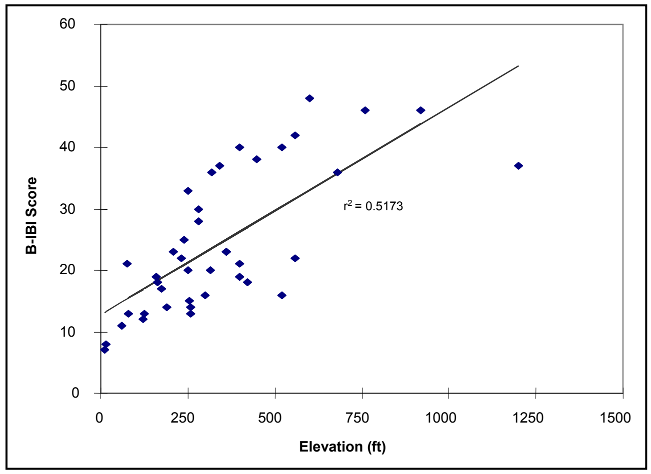

Figure 9. Comparison of IBI scores and elevation at sites sampled between 2002 –2007.

At the local scale, physical habitat characteristics such as, substrate composition and embeddedness, bank stability, channel alteration and riparian buffer widths may influence BMI assemblages. These parameters were qualitatively assessed at each sampling station using the physical habitat assessment (PHAB) procedures included in the U.S. Environmental Protection Agency's (EPA) Rapid Bioassessment Protocol (Barbour et al., 1999). PHAB scores can range from 0 to 200 (the higher the score the greater the habitat quality).

To assess whether a signifcant correlation exists between reach-scale physical habitat and biological integrity, a regression analysis was conducted using PHAB and B-IBI scores. Figure 11 illustrates that PHAB and B-IBI scores are significantly correlated ($r^2 = 0.42$, $p< 0.05$). The lack of stronger correlation may be partially explained by other factors that are difficult to evaluate during PHAB assessments (e.g., changes in hydrology due to imperviousness, water quality impacts). In addition, more quantitative measurements of habitat characteristics may be needed to better understand the effects of reach-scale physical habitat on BMI community assemblages.

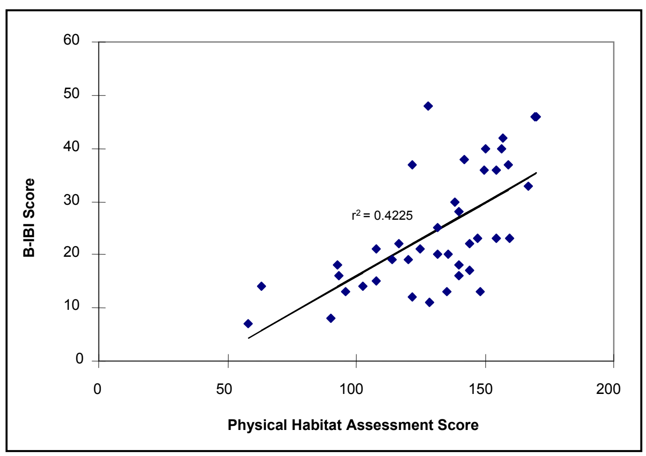

Figure 10. Comparison of IBI scores and PHAB scores at sites sampled between 2002 –2007.

3.2 Fish Bioassessment Data

Fish community sampling was conducted at 12 stream locations in four watersheds during fall 2004 and 2005. A total of 765 fish were captured and identified and total lengths and weights were measured for each fish. Four native fish species were captured during the survey include rainbow trout, California roach, Sacramento sucker and stickleback. Five non-native fishes were captured across three sites, which included green sunfish, bluegill, goldfish and mosquito fish.

The distribution of a fish community in Adobe, Matadero and Permanente Creeks were highly limited due to intermittent flow conditions. Fish were captured or observed in a short reach of Adobe Creek downstream I-280; in Matadero Creek between Bol Park and Arastradero Road; and in Permanente Creek upstream of I-280. Fish were observed in Saratoga Creek upstream of Bollinger Road to Sanborn County Park.

Fish surveys were not conducted in Stevens and Upper Penitencia Creeks due to presence of federally protected steelhead. Fish sampling was also not conducted in watersheds that appeared to not support any native fish communities due to poor habitat (e.g., Sunnyvale Channels) or intermittent flow conditions (e.g., Barron Creek and Calabazas Creek).

Table 10. Composition of fish captured at12 sampling stations in 2004 and 2005.

Station ID	Creek	Date	Percent species composition					Total No. fish
			RCH	STB	SSK	RT	NN	
ADO030	Adobe	Oct-04	40	65	52			157
MAT040	Matadero	Oct-04	136	15	39		2	192
MAT050	Matadero	Oct-04	17	7			1	25
SAR060	Saratoga	Oct-04	80		9	11		101
SAR070	Saratoga	Oct-04			26	74		27
SAR080	Saratoga	Oct-04			40	60		97
SAR090	Saratoga	Oct-04				100		43
SAR100	Bonjetti	Oct-04				100		53
PER050	Permanente	Oct-05	No fish captured					
PER060	Permanente	Oct-05	6		48			54
PER070	Permanente	Oct-05	14				2	16
PER080	Permanente	Oct-05	No fish captured					

RT = Rainbow trout, STB = Stickleback, RCH = California roach, SSK = Sacramento sucker, NN = Non-native

3.3 Water Sampling Data

In the following section, water quality results were organized by major watershed. Saratoga Creek data results were grouped under San Tomas Aquino (STQ) watershed. Sunnyvale East and West data results were grouped under a single Sunnyvale Channel (SVC), with the exception of metal and diazinon concentrations (Figures 17-19).

3.3.1 <u>Physio-chemical Parameters</u>

Physio-chemical measurements were made *in situ* during a total of 200 sampling events at 63 sites. All measurements were taken during non-storm events in daylight hours. The distribution of water temperature measurements (n=200) across ten watersheds is shown in Figure 11a. Water temperature measurements ranged from minimum of 7.0 °C to maximum of 26.3 °C across all sites. The highest (17.5°C) and lowest (13.7°C) average temperatures occurred in Sunnyvale Channels and Adobe Creek watersheds, respectively. Distribution of temperature measurements across three seasonal time periods is shown in Figure 11b. Average temperatures were similar during the winter and spring season (12.1 °C and 13.6 °C, respectively) and higher during summer season (18.2 °C).

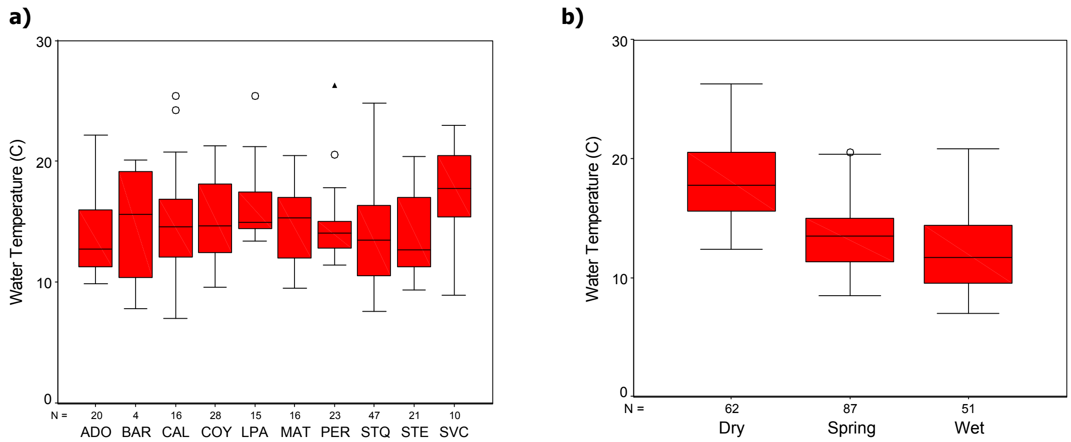

Figure 11. Water temperature ranges grouped by watershed (a) and by season (b). Minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box) are presented. Circles are outliers (values between 1.5 to 3 box lengths) and triangles are extremes (values greater than 3 box lengths).

Dissolved oxygen measurements (n=187) ranged from a minimum of 4.1 mg/L to greater than 20 mg/L across the ten watersheds (Figure 12a). Ninety-three percent of the measurements were greater than 7.0 mg/L. There were fourteen measurements taken at ten sites that were less than 7.0 mg/L and four measurements taken at three sites that were less than 5.0 mg/L. Distribution of dissolved oxygen measurements across three seasonal time periods is shown in Figure 12b. Average dissolved oxygen concentrations were lowest during the dry season (9.5 mg/L) and highest during the spring season (11.7 mg/L).

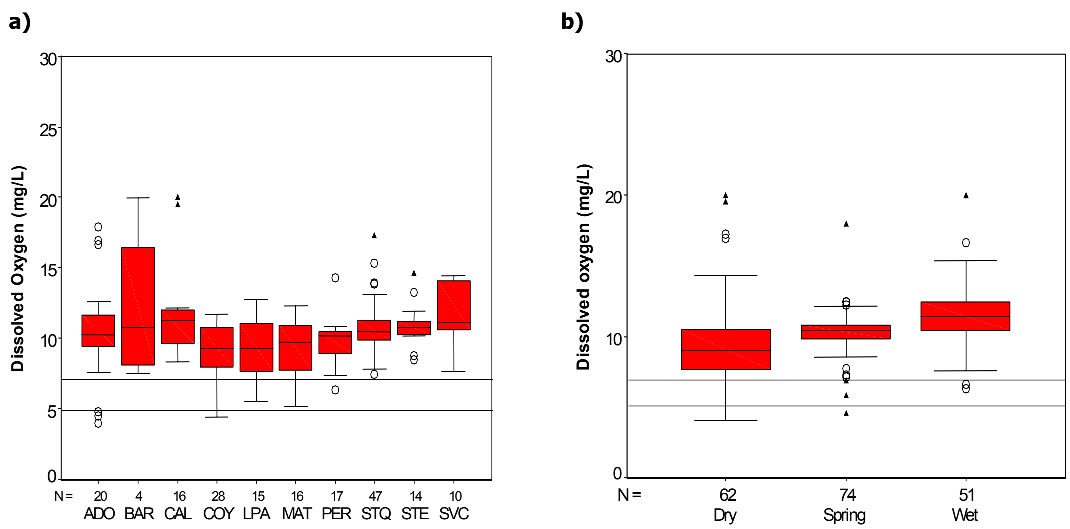

Figure 12. Dissolved oxygen ranges grouped by watershed (a) and by season (b). Minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box) are presented. Circles are outliers (values between 1.5 to 3 box lengths) and triangles are extremes (values greater than 3 box lengths). Lines in each graph show the Quality Objectives (WQOs) for dissolved oxygen in cold and warm habitats are shown.

Measurements of pH (n=200) ranged from a minimum of 6.6 to maximum of 9.5 across the ten watersheds (Figure 13a). Eighty-two percent of the pH measurements were greater than 6.5 and less than or equal to 8.5. There were twelve measurements of 8.75 or greater taken at six sites, four of which occurred at the lowest elevation sites in Adobe Creek, Barron Creek, Calabazas Creek and Sunnyvale West Channel watersheds.

Conductivity measurements ranged from minimum or 44 uS/cm (STE020) to 3707 uS/cm (PER010) across the ten watersheds (Figure 13b). Seventy-eight percent of the samples were less than 1000 uS/cm. Approximately 10 percent of the samples were greater than 1200 uS/cm, with a majority of these samples taken at the lowest elevation site in Lower Penitencia Creek, Lower Silver Creek and Permanente Creek. One exception, however, was Matadero Creek, which had four of the five highest conductivity measurements (1455-2793 uS/cm) taken at three different sites in the watershed.

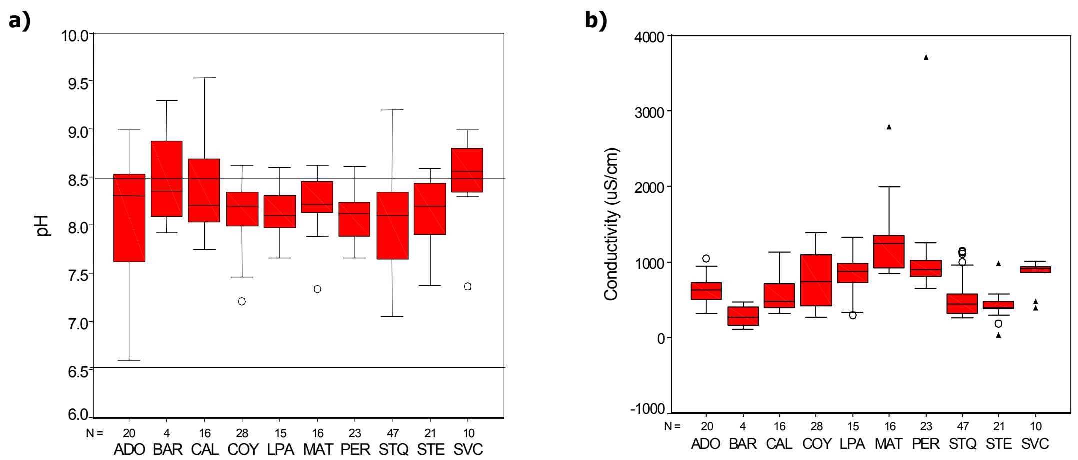

Figure 13. Ranges for pH (a) and conductivity (b) grouped by watershed. Minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box) are presented. Circles are outliers (values between 1.5 to 3 box lengths) and triangles are extremes (values greater than 3 box lengths). Lines in graph a) show the Water Quality Objectives for pH.

3.3.2 Chemical Parameters

Nutrients and Anions

Nutrient and anion concentrations were analyzed for 118 water samples taken at 40 sites. All samples were taken during non-storm events in daylight hours. Distribution of total nitrogen (Nitrite-N + Nitrate-N and Kjeldahl-N) and Nitrate-N concentrations for water samples collected in the ten watersheds is shown in Figure 14a. All but one sample exceeded EPA criteria of Total Nitrogen recommended for streams in Xeric West - Ecoregion III (0.38 mg/L). The highest average concentrations by watershed for both Total Nitrogen and Nitrate-N occurred in samples collected in Sunnyvale Channels and Coyote Creek (i.e., Upper Penitencia and Lower Silver Creeks), 5.4 and 4.4 mg/L, and 4.0 and 3.5 mg/L, respectively. Nitrite-N concentrations were below reporting limits (0.10 mg/L) for all sampling events.

The distribution of total unionized ammonia concentrations for water samples collected across the ten watersheds is shown in Figure 14b. Approximately 93% of the samples were below the Water Quality Objective of 0.025 mg/L. The highest concentration (0.11 mg/L) was measured in Calabazas Creek (CAL030). The eight samples with concentrations higher then 0.025 mg/L occurred in Calabazas (CAL030); San Tomas Creek (STQ040), Sunnyvale East (SVE020), Sunnyvale West (SVW010) and Barron Creek (BAR010).

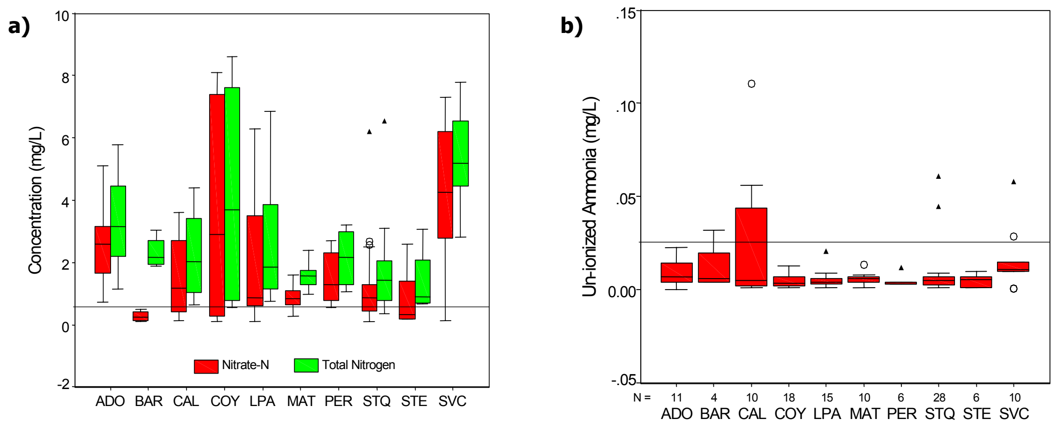

Figure 14. Ranges for Total Nitrogen and Nitrate-N (a) and Un-ionized Ammonia (b) grouped by watershed. Minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box) are presented. Circles are outliers (values between 1.5 to 3 box lengths) and triangles are extremes (values greater than 3 box lengths). Lines in each graph show USEPA recommended criteria for total nitrogen (a) and the Water Quality Objective (WQO) for unionized ammonia (b).

Distribution of Total Phosphorus and Orthophosphate-P concentrations for water samples collected in the ten watersheds is shown in Figure 15a. All but three samples exceeded EPA criteria of Total Phosphorus recommended for streams in Ecoregion III (.022 mg/L). The highest average concentrations by watershed for Total Phosphorus and Orthophosphate-P occurred in samples collected in Barron Creek, 0.72 and 0.42 mg/L, respectively.

Figure 15b shows concentrations of chlorophyll a for samples collected in all watersheds (n=118). Approximately 77% of the samples exceeded EPA criteria of chlorophyll a recommended for streams in Ecoregion III (1.78 ug/L). The highest average concentrations by watershed for chlorophyll a occurred in samples collected in Barron Creek and Sunnyvale Channels, 60 and 30.75 ug/L, respectively.

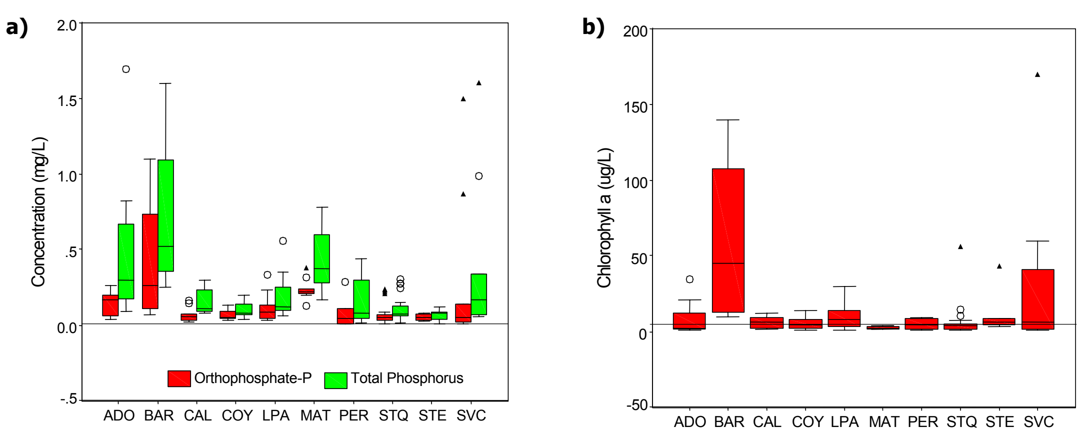

Figure 15. Ranges for Total Phosphorus and Orthophosphate-P (a) and Chlorophyll a (b) grouped by watershed. Minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box) are presented. Circles are outliers (values between 1.5 to 3 box lengths) and triangles are extremes (values greater than 3 box lengths). Lines in each graph show the USEPA recommended criteria for total phosphorus and chlorophyll a.

Distribution of chloride and sulfate concentrations for water samples collected in the ten watersheds is shown in Figure 16. The highest average concentrations by watershed for both chloride and sulfate occurred in samples collected in Matadero Creek, 98.2 and 390.7 mg/L, respectively.

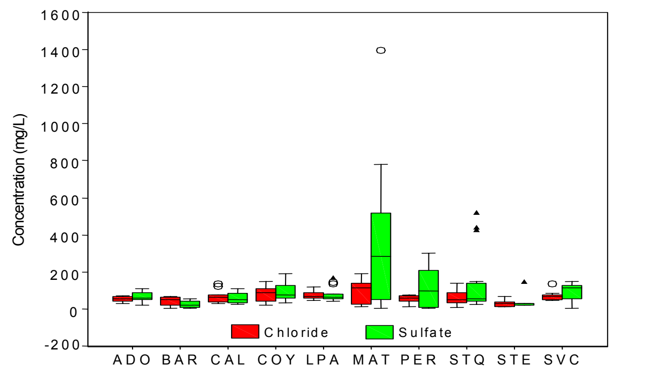

Figure 16. Ranges for sulfate and chloride concentrations grouped by watershed. Minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box) are presented.

Metals

Eighty-two water samples collected at 27 sites were analyzed for total and dissolved metal concentrations. All samples were taken during non-storm events in daylight hours. Distribution of metal concentrations for the water samples collected across the ten watersheds are shown in Figures 17 and 18. The WQO is shown in each figure. For metals with standards requiring adjustments for hardness, the standard at hardness of 100 mg/L is displayed. There were no exceedences in water quality criteria for arsenic, cadmium, chromium, lead, mercury, nickel, silver and zinc during the 6 years of monitoring.

There were eight criteria exceedences for two metals (copper and selenium). There were three exceedences for copper criteria (two in Barron Creek (BAR010) and one in Saratoga Creek (SAR050)); and, five exceedences for selenium (three in Permanente Creek (PER070); one in Lower Penitencia Creek (LPA100); and one in Sunnyvale West Channel (SVW010)).

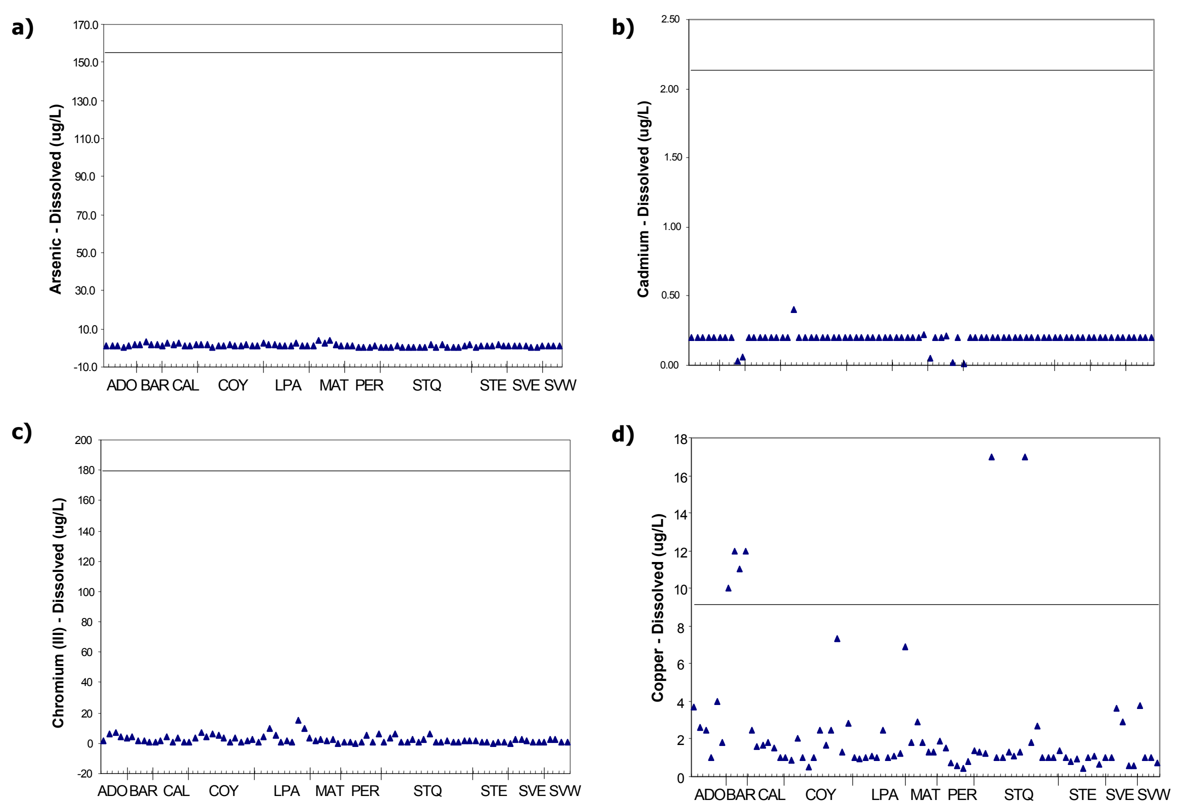

Figure 17. Distribution of arsenic (a), cadmium (b), chromium (III) (c) and copper (d) concentrations across watersheds. Lines in each graph show WQO for each metal. Standards for cadmium, chromium and copper are based on hardness values of 100 mg/L $CaCO_3$. Note: 90% of samples were below reporting limits for cadmium (0.2 ug/L). See Appendix A for reporting limits for all metals.

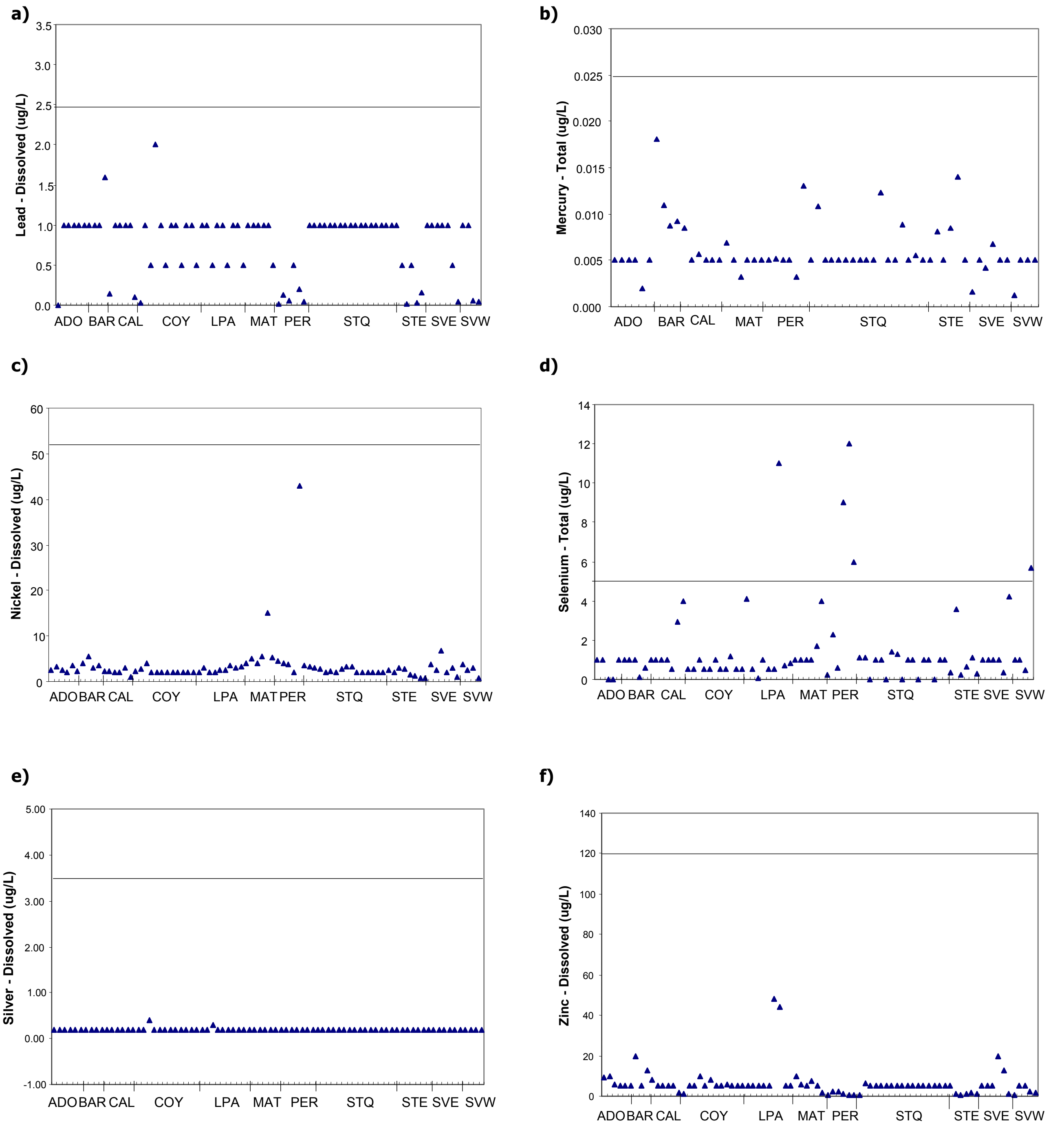

Figure 18. Distribution of lead (a), mercury (b), nickel (c), selenium (d), silver (e) and zinc (f) concentrations across watersheds. Lines in each graph show the WQO for each metal. Standards for lead, nickel, silver and zinc are based on hardness values of 100 mg/L $CaCO_3$.. Most samples for lead, silver and zinc were below reporting limits. See Appendix A for reporting limits for all metals.

Organphosphate Pesticides

Eighty-two water samples collected at 27 sites were analyzed for suite of orthophosphate pesticide concentrations. Diazinon concentrations for all samples are shown in Figure 19. The highest concentration (0.05 ug/L) occurred in Berryessa Creek (205LPA060). All samples were below the TMDL target for diazinon in urban creeks draining into the San Francisco Bay (0.1 ug/L).

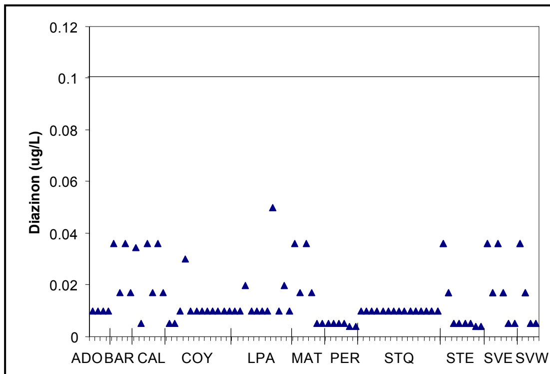

Figure 19. Range of diazinon concentrations across watersheds. TMDL target (0.1 mg/L) is presented.

3.3.3 Aquatic Toxicity

Toxicity tests with acute and chronic endpoints were conducted on 42 water samples collected at 17 sites in eight watersheds. Toxicity tests were conducted using three aquatic species: *Ceriodaphnia dubia* (water flea), *Pimephales promelas* (fathead minnow), and *Selenastrum capricornutum* (green alga). For the purposes of this report, toxicity was defined as a statistically significant reduction in survival or growth/reproduction for one or more of the three species tested. Acute toxicity (i.e., decrease in survival) of water flea and minnow was observed in 2% and 10%, respectively, of all samples (Figure 20). Acute toxicity of fathead minnow occurred in samples collected during the dry season at four sites: COY090, STQ020, STE060 and PER070. Chronic toxicity for fathead minnow occurred in 10% of all samples and for both water flea and green alga in 36% of all samples (Figure 21).

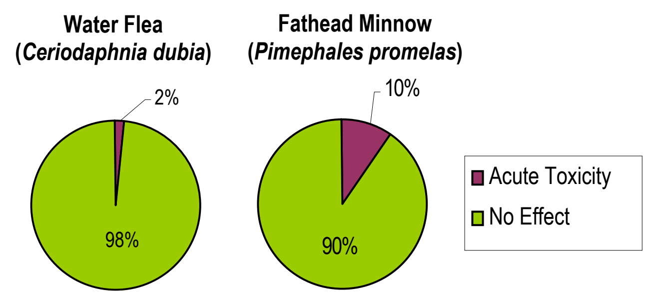

Figure 20. Percent of 42 creek water samples exhibiting acute toxicity to *Ceriodaphnia dubia* and/or *Pimphales promelas*.

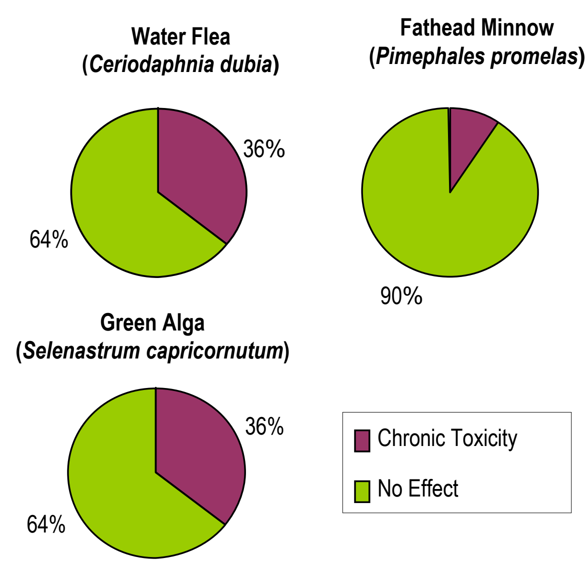

Figure 21. Percent of 42 water samples exhibiting chronic toxicity for water flea, fathead minnow and green algae.

3.3.4 Pathogen Indicators

Pathogen indicator concentrations were measured in 94 water samples collected at 32 sites in nine watersheds. The concentrations of total and fecal coliforms in all sites is shown in Figure 22. All water samples had total coliform concentrations that were less than the Water Quality Objective for Water Contact Recreation of 10,000 MPN/100mL.

Approximately 50% of the water samples had fecal coliform concentrations the exceeded Water Quality Objective for Water Contact Recreation for 90th percentile of 400 MPN/100mL. The highest fecal coliform concentrations observed, 9,000 and 3,000 MPN/100mL, were in San Tomas Aquino (STQ020) and Matadero Creeks (MAT030), respectively.

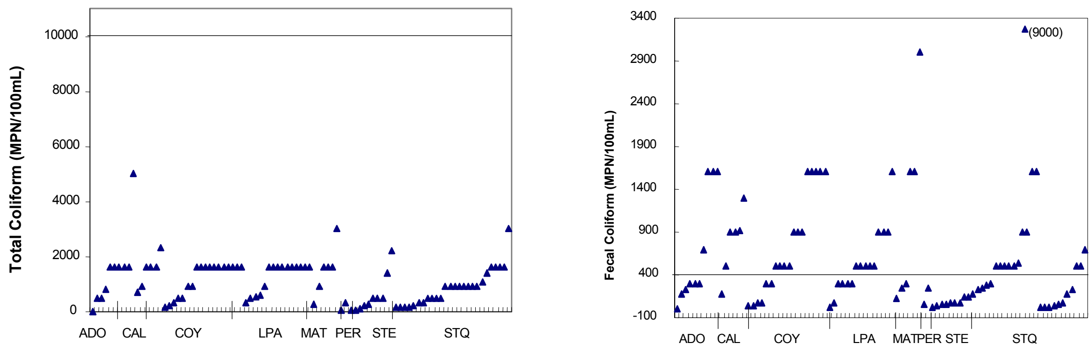

Figure 22. Range of total and fecal coliform concentrations across watersheds. Lines in each graph show the WQOs for total (a) and fecal coliform (b) in water with contact recreation.

The concentrations of *Enterococcus* and *E. coli* in all sites are shown in Figure 24. Approximately 60% of the water samples had *Enterococcus* concentrations that exceeded the Water Quality Objective for Water Contact Recreation in "infrequently used areas" (151 CFU/100mL). The highest concentrations of *Enterococcus* observed, 6100 and 3600 CFU/100mL, were in Adobe Creek (ADO030) and Upper Penitencia Creek (COY090), respectively. Water samples were analyzed for *E. coli* during the last two monitoring years (n=16). *E. coli* concentrations exceeded the Water Quality Objective for Water Contact Recreation in "infrequently used areas" (576 CFU/100mL) in 19% of the samples.

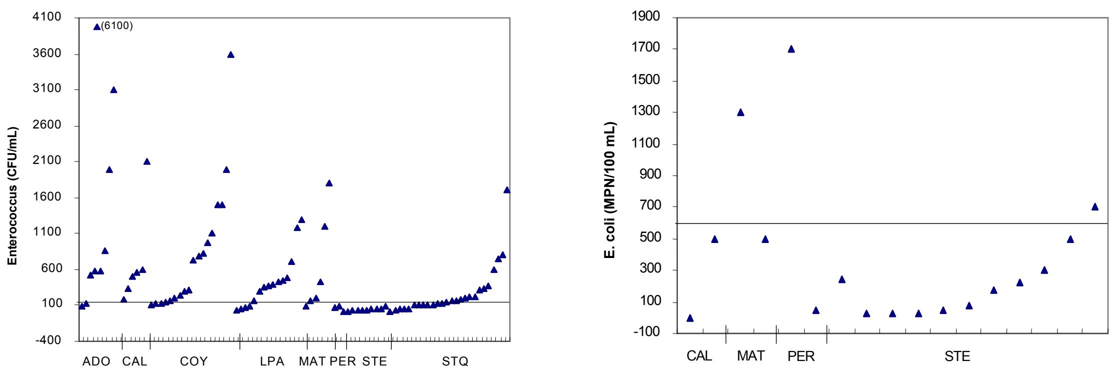

Figure 23. Range of *Enterococcus* and *E coli* concentrations across watersheds. Lines in each graph show the WQOs for water contact recreation in "infrequently used areas".

3.4 Sediment Quality Data

3.4.1 Metals

Bedded sediment samples were collected at seven sites in five watersheds. Figure 24 shows the range and median metal concentrations for each site. Metal concentrations observed did not exceed the Probable Effects Concentration (PEC) guidelines described by MacDonald (2000), with the exception of nickel. Five sediment samples collected from Coyote tributaries (Lower Penitencia Creek and Adobe Creek) exceeded the PEC values for nickel (48.6 mg/kg). Zinc had the greatest range in concentrations among all sites sampled.

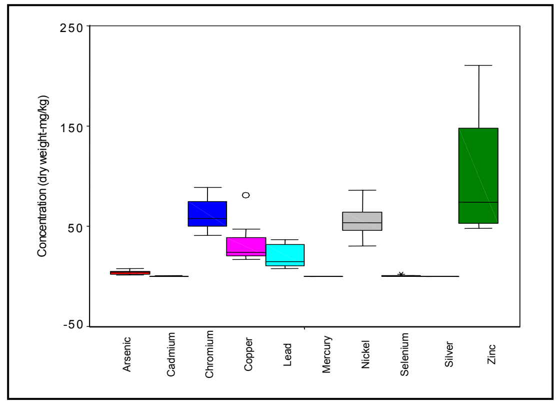

Figure 24. Metal concentrations in sediment samples collected in seven watersheds. Minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box) are presented.

3.4.2 Organic Compounds

Total PCB concentrations measured in sediment samples collected from seven sites ranged from < 0.1 to 16.3 ug/Kg dry weight (Figure 25). Total PAH concentrations ranged from 4.3 to 474 ug/Kg dry weight. The highest concentration for both occurred in Lower Silver Creek (COY180).

The distribution of organochlorine pesticide concentrations measured from sediment samples collected at 7 sites is shown in Figure 26. DDD and DDT pesticide concentrations ranged from 0.1 to 26 ug/Kg dry weight, with the highest concentration occurring in Lower Silver Creek (COY180). Chlordane, aldrin and dieldrin concentrations ranged from no detection to 4.0 ug/Kg dry weight, with the highest concentration (g-chlordane) occurring in Lower Silver Creek (COY180).

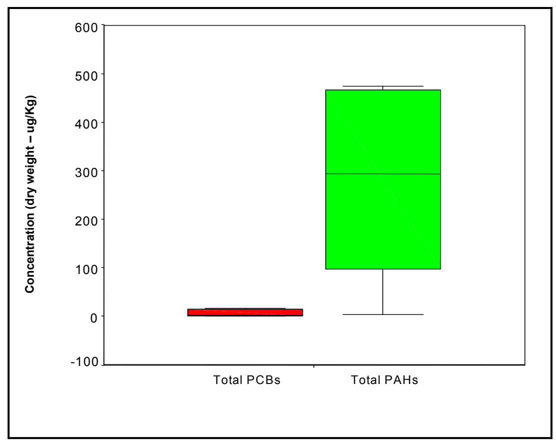

Figure 25. Total PCBs and PAHs concentrations in sediment samples collected in seven watersheds. Minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box) are presented

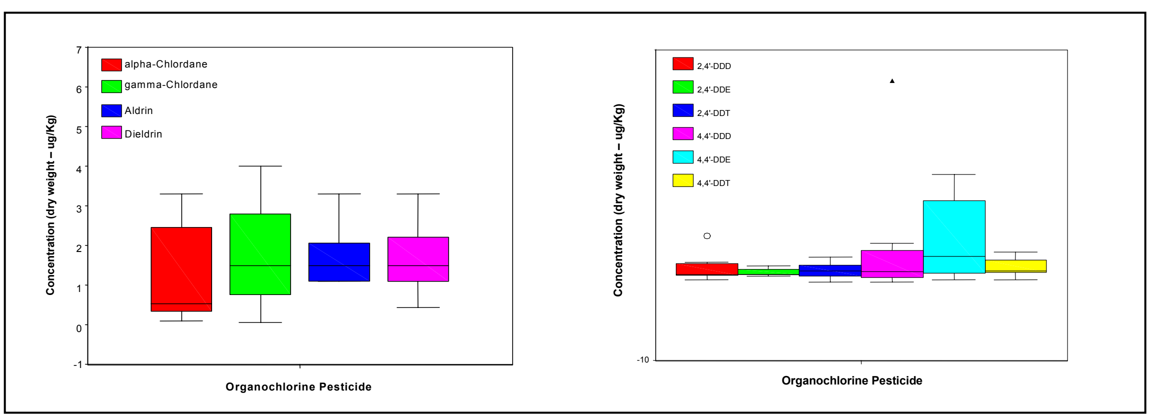

Figure 26. Organochlorine pesticide concentrations in sediment samples collected in seven watersheds. Minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box) are presented. Circles are outliers (values between 1.5 to 3 box lengths) and triangles are extremes (values greater than 3 box lengths).

4.0 CONCLUSIONS

The following preliminary conclusions are based on screening level data collected by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) between 2002 and 2007. A summary of countywide observations and conclusions for each watershed sampled by SCVURPPP are provided. Recommendations based on these observations and conclusions are presented in Section 5.0.

4.1 Countywide Observations

4.1.1 Condition of Aquatic Life

Based on preliminary Benthic Index of Biotic Integrity (B-IBI) scores, benthic macroinvertebrate (BMI) assemblages indicate that aquatic life in sites located in the upper reaches of Stevens, Permanente and Adobe Creek watersheds and Upper Penitencia Creek and Saratoga Creek subwatersheds are in fair to very good condition, compared to all sites assessed in the Santa Clara Valley. These sites generally had optimal physical habitat assessment (PHAB) scores and received drainage from undeveloped or minimally developed lands within County or City Parks and Open Space Districts. Many of these creek reaches also support a cold water fish community (i.e., rainbow trout/steelhead). Of all watersheds sampled, Saratoga Creek had the greatest number of sites rated in the fair to very good condition category (n=5), and two of these sites were located in urbanized areas.

B-IBI scores generally decreased with elevation, suggesting that the effects of urbanization have likely impacted BMI communities overtime. Poor physical habitat condition and greater human disturbance to riparian corridor characterizes sites in the lower and middle reaches that occur along the Santa Clara Valley floor. Despite low B-IBI scores in some creek reaches, however, warm water fish communities were observed in some watersheds (e.g., Stevens, Saratoga, Adobe and Matadero Creeks).

Natural variation in B-IBI scores was observed in two ways. First, B-IBI scores were lowest at sites located in smaller-sized watersheds characterized as having intermittent stream flow (e.g., Adobe, Calabazas, Matadero and Thompson Creeks), with the exception of the uppermost site on Adobe Creek. This finding suggests that intermittent creeks may naturally have lower B-IBI scores, and thus may not be comparable to sites with perennial flow. Secondly, B-IBI scores varied from year to year at individual sites, likely indicating natural biological responses to variations in precipitation, hydrology and temperature. Average B-IBI scores were used to estimate site condition over a two year period, however, additional year(s) of monitoring will likely increase the accuracy of B-IBI scoring.

Water quality data results indicate that numeric water quality objectives (WQOs), criteria and TMDL targets for metals and organic compounds were generally met in all creeks sampled. Specifically, over 90% of samples met WQOs/criteria for metals and there were no exceedences of TMDL targets for diazinon. For physio-chemical measurements, 93% of all sampling events met WQOs for dissolved oxygen concentrations for cold water habitat and 82% of all sampling events met WQOs for pH. Acute toxicity of water flea and/or minnow only occurred in 2% and 10% of sampling events, respectively. Chronic toxicity for both water flea and green alga occurred in 36% of all samples. Water and sediment quality results to-date do not show significant correlations with B-IBI scores. It is important to note however, that limited number of samples and episodic nature of toxicity and/or pollutant concentrations may underestimate impact on the biotic communities.

4.1.2 Recreational Use

Pathogen indicator data often exceeded water quality criteria for contact recreation based on fecal coliform concentrations (50% of all sampling events) and *Enterococcus* (60% of all sampling events). Water quality samples, however, were not collected frequently enough to determine if criteria were met or not. Although pathogen indicator monitoring sites were selected in areas with high potential for public access, potential risk to exposure was generally very low due to absence of pools and low stream flows during the summer season.

4.2 Watershed Specific

4.2.1 Coyote Creek

Aquatic Life Use

Upper Penitencia Creek and Thompson Creek, two significant tributaries to Coyote Creek, were monitored by the SVURPPP between 2002 and 2007. Existing data suggest that condition of aquatic life in the un-urbanized portion of Upper Penitencia Creek within and upstream of Alum Rock Park is very good. BMI sampling stations within Alum Rock Park had some of the highest preliminary B-IBI scores in the Santa Clara Basin. Additionally, Upper Penitencia creek supports the largest population of steelhead in Santa Clara County (Liedy et al. 2005). Previous assessment by Stillwater Sciences (2006) identified lack of overwintering habitat as a significant limiting factor for steelhead production in Upper Penitencia Creek in Alum Rock Park. The condition of aquatic life in the four sites located in the primarily urban portions of the watershed was marginal to fair. The capacity to support cold water rearing habitat in these creek reaches may be reduced by low summer stream flows and high water temperatures (Stillwater Sciences 2006).

The sampling stations in Thompson Creek had marginal B-IBI scores. These stations were selected above and below watershed areas that were recently developed. Although physical habitat scores were higher in the upper two sites, condition of aquatic life was consistently rated marginal across all sites. BMIs at these sites may be impacted by intermittent stream flow during the summer season. Biological communities were not sampled in Lower Silver Creek due to an existing flood control project.

Based on the limited SCVURPPP dataset, metal concentrations and physio-chemcial parameters measured in water samples collected from both tributaries did not exceed water quality criteria. One water sample collected from the furthest downstream site on Upper Penitencia Creek (COY090) did exhibit chronic toxicity for all three species and acute toxicity for fathead minnow in one sample. Additionally, water samples collected from Lower Silver Creek contained some of the highest concentrations of total nitrogen and Nitrate-N concentrations compared to all other watersheds.

Recreational Use

Pathogen indicator data collected in Upper Penitencia and Lower Silver-Thompson Creeks were below water quality criteria for contact recreation. The site where pathogen indicators were collected in Upper Penitencia Creek appeared to have moderate potential for both public access and risk to exposure. Public access and risk to exposure in sites within Lower Silver-Thompson Creek appear to be extremely low.

4.2.2 Lower Penitencia Creek

Aquatic Life Use

Aquatic life uses have not been formally designated by the Water Board for creeks in the Lower Penitencia Creek watershed. The lower reaches of these creeks are highly modified (concrete-lined or earth levees) and the middle and upper reaches have minimal if any flow during the dry season. BMIs were not sampled in these creeks because protocols for sampling low gradient/modified creeks were not established when SCVURPPP monitoring was conducted in this watershed (FY 02-03). Sampling results from creeks sampled in Lower Penitencia Creek watershed indicate that water quality criteria were generally met, with the exception of one exceedence of selenium from one water sample at site LPA100. Chronic toxicity for all three species also occurred in water samples collected from LPA100.

Recreational Use

Limited pathogen indicator data collected in Lower Penitencia and Berryessa Creeks (and its tributaries) were below water quality criteria for contact recreation. Public access and risk to exposure in sites within Lower Penitencia Creek watershed appear to be extremely low.

4.2.3 Adobe Creek Watershed

Aquatic Life Use

Although no aquatic life uses have been designated by the Water Board for Adobe Creek, the results of fish community sampling indicate that a warm water fishery is present in a limited area upstream of the Redwood Preserve. The lack of deep pools, low flows during the summer and physical fish barriers are likely the biggest limiting factor for native warm water fish populations in Adobe Creek. B-IBI and physical habitat assessment scores show Adobe Creek, downstream of Foothill Community College, was in marginal condition. In contrast, the condition of aquatic life in Hidden Villa Farms was rated good, despite intermittent flow conditions. The upper site was selected as a reference site for development of the B-IBI because of its high habitat quality and relatively undisturbed and protected headwaters. Water quality sampling results generally met water quality criteria, with the exception of low dissolved oxygen measurements (< 5.0 mg/L) and pH (9.0) measured at two sites (ADO030 and ADO045).

Recreational Use

Pathogen indicator data were below water quality criteria for both contact and non-contact recreation. The site where bacterial indicators were collected (205ADO045) appeared to have moderate potential for both public access and risk to exposure. Public access and risk to exposure upstream and downstream of this site also appear to be low.

4.2.4 Matadero/Barron Creek Watersheds

Aquatic Life Use

The Basin Plan designates several Beneficial Uses for Matadero Creek associated with aquatic life uses, including COLD, WARM, MIGR and SPWN. The results from fish community monitoring indicate that WARM Uses are supported to some extent in the middle reach of Matadero Creek. In contrast, B-IBI scores indicate that the condition of aquatic life in sampling sites within the same reach is poor. At this time, it is not clear why the BMI results were inconsistent with fish bioassessment data. One explanation is that poor substrate quality (i.e., high percent fines and embeddedness) measured at these sites may be impacting BMI communities more strongly than the native warm water fish community. Filling of interstitial spaces of channel substrate may displace benthic macroinvertebrates not adapted to excessive fine sediment. In contrast, warm water native fish species may utilize larger areas of stream channel to meet wider range of habitat needs.

Although water quality sampling results for Matadero Creek sites generally met water quality criteria, suboptimal water quality was observed in MAT050 for both years during the summer season (i.e., high conductivity, total hardness, TDS and sulfate concentrations). It is not clear if these conditions were caused by non-urban runoff discharges from adjacent and/or upstream land uses, or if they represent natural conditions during the dry season.

The Water Board has not designated beneficial uses for Barron Creek. Although bioassessments and fish sampling were not conducted in Barron Creek, intermittent flow conditions and absence of suitable habitat (i.e., deep pools or stream connectivity) suggest that the creek does not likely support a warm water native fish community. Water quality sampling results generally met all numeric criteria, with the exception of copper and pH (9.3). In addition, total phosphate (1.6 mg/L) and chlorophyll a (140 ug/L) concentrations measured at site BAR010 were second highest compared to all other sites sampled in the Santa Clara Valley.

Recreational Use

Matadero Creek is designated for both contact (REC-1) and non-contact (REC-2) recreation. Pathogen indicator data were collected during two years at site MAT020 located in a city park with high potential for public access and exposure. These data show fecal coliform concentrations are higher than water quality criteria for contact and non-contact recreation. In addition, *E. coli* and *Enterococcus* concentrations at site

MAT020 during the dry season events were above the U.S. EPA's suggested bacteriological criteria for water contact recreation at "infrequently used areas". Additional investigations relative to characterizing exposure are needed to better determine waterborne pathogen-related risk at this site. Public access and exposure appear to be very low in the remaining creek areas. Bacterial indicator data were not collected in Barron creek due to low public access and risk to exposure throughout the watershed.

4.2.5 San Tomas Aquino Creek Watershed

Aquatic Life Use

The Basin Plan designates COLD, WARM and WILD beneficial uses for Saratoga Creek, the largest tributary to San Tomas Aquino Creek. Results of the two years of monitoring indicate that Saratoga Creek is supporting both COLD and WARM Uses. WARM Use is supported downstream of site SAR060 (Crestbrook Ave), where the fish community was dominated by native warm water fishes. Sites in this reach had B-IBI scores that were rated in the marginal condition category. In sites upstream of SAR060, the fish community was dominated by rainbow trout and had B-IBI scores ranging from fair to very good. Physical habitat assessment results indicated high levels of fine sediment and embeddedness in the upper reaches of the watershed. However, a follow-up study that evaluated potential impacts from sediment on rainbow trout populations in Saratoga Creek indicate that trout populations appear to be healthy and not limited by fine sediment (SCVURPPP 2007b). Water quality sampling results at Saratoga Creek sites met all water quality criteria, with the exception of one exceedence of copper at site SAR050.

Beneficial uses have not been designated for San Tomas Aquino Creek. Screening level monitoring results indicate that WARM uses may be supported in some creek reaches, although habitat is extremely limited due to the highly modified channel. Water quality sampling results met all water quality criteria, with the exception of pH measured during two events at site STQ040. Chronic toxicity of all three species and acute toxicity of fathead minnow, however was observed at site STQ020.

Recreational Use

Both contact (REC-1) and non-contact (REC-2) beneficial uses for recreation are designated for Saratoga Creek. Pathogen indicator concentrations at three sites were below water quality criteria for water contact and non-contact recreation, with the exception of fecal coliform concentrations at site S-1, which were slightly higher than the criteria for water contact recreation. In addition, *Enterococcus* data collected at a high majority of Saratoga Creek sites were below U.S. EPA's suggested bacteriological criteria for water contact recreation at "infrequently used areas". Although all Saratoga Creek sites did not appear to have a high potential for access and/or exposure, additional investigations relative to characterizing exposure and evaluating *E. coli* concentrations in water are needed to better determine waterborne pathogen-related risks at sites in this watershed. No water samples collected in San Tomas Aquino were analyzed for bacterial indicators because public access and potential exposure appear to be very low in this system.

4.2.6 Permanente Creek Watershed

Aquatic Life Use

The Basin Plan designates COLD, SPWN and WILD beneficial uses in Permanente Creek. Results from two years of monitoring indicate that the condition of aquatic life is marginal to fair at sites upstream of I-280. Specifically, rainbow trout were documented in the upper reach, but abundance appears to be low compared to similar Santa Clara Valley creeks (i.e., Saratoga). Relatively low numbers of rainbow trout may be related to the small drainage size, low flow conditions or fine sediment deposition observed in the upper reach. B-IBI scores at the three sites above I-280 were rated fair, with the exception of site PER070, which was rated marginal. Physical habitat assessment scores were relatively good at all three upper sites, ranging from 140 to 160. It is not clear if the lower B-IBI scores at site PER070 are related to local habitat conditions (e.g., excess fine sediment) or reduced water quality. Site PER070 is downstream of the Hansen Cement Plant.

The warm and cold water fish communities at the three Permanente Creek sites downstream of I-280 appear to be minimal due to intermittent flow conditions. Additionally, B-IBI scores at these sites were poor to marginal, likely the result of intermittent flow conditions, poor substrate quality and habitat complexity.

Water quality sampling results for all sites in Permanente Creek generally met all water quality criteria, with the exception of three exceedences of selenium concentrations at site PER070. In addition, chronic toxicity of water flea and green algae and acute toxicity of fathead minnow occurred in water samples collected at site PER070.

Recreational Use

Both contact (REC-1) and non-contact (REC-2) beneficial uses for recreation are designated for Permanente Creek. Water samples collected at site PER080 (Rancho San Antonio County Park) indicate that microbial indicators fecal and total coliform, *E. coli* and *Enterococcus* were well below water quality criteria for both REC-1 and REC-2 Uses during summer and winter sampling events.

4.2.7 <u>Stevens Creek Watershed</u>

The Basin Plan designates COLD, MIGR, SPWN, WARM and WILD Beneficial Uses for Stevens Creek. Results from two years of monitoring and previous studies indicate that steelhead are common to abundant in the six mile reach below the dam, and rainbow trout have been documented upstream of the reservoir. Stevens Creek also supports a native warm water fish community, including California roach, Sacramento suckers and stickleback. A previous sediment assessment (Stillwater Sciences 2004) concluded that fish passage barriers and a lack of overwintering habitat are significant limiting factors for steelhead production in Stevens Creek below the reservoir.

Preliminary B-IBI scores suggest that the condition of aquatic life is greatly reduced below the dam. B-IBI scores at site STE070 (22) were substantially lower than the two sites directly upstream of the dam (35 and 38). All three sites had no to minimal urban influence and high PHAB scores (155-159). The lower B-IBI scores are likely related to altered hydrologic and temperature regimes and the reduced transport of coarse substrate and food resources by the dam. The four sites downstream of STE070 were rated as marginal (B-IBI scores 18-20) and the lowest elevation site (STE020) was rated poor. Most of these sites occur in highly developed reaches of Stevens Creek characterized as heavily incised channels and narrow riparian buffer zone widths.

Water quality samples from sites in the Stevens Creek watershed met all numeric water quality criteria. However, chronic toxicity of water flea and green algae and acute toxicity of fathead minnow was observed in water samples collected at site STE060.

Recreational Use

Both contact (REC-1) and non-contact (REC-2) beneficial uses for recreation are designated for Stevens Creek. Indicator bacterial levels from three sites (STE020, STE064 and STE065) were below the water quality criteria. In contrast, *Enteroccocus* at all three sites and *E. coli* concentration levels at STE020 during the summer event were higher than US EPA's suggested bacteriological criteria for "infrequently used areas". Additional investigations relative to characterization of bacterial indicator levels based on exposure risk are needed at site STE020.

4.2.8 <u>Calabazas Creek Watershed</u>

Aquatic Life Use

The Basin Plan designates COLD, WARM and WILD beneficial uses for Calabazas Creek. Results from two years of monitoring were not conclusive in assessing whether aquatic life uses are supported in this water body. Data suggest that much of the creek has an intermittent flow regime during the dry season with unsuitable habitat (i.e., lack of deep pools or stream connectivity) to support a warm water native fish community. Additionally, B-IBI scores indicate that the condition of aquatic life in Calabazas Creek is marginal. Based on a limited dataset, it appears that the relatively low B-IBI scores are likely caused by a combination of intermittent flow conditions, poor substrate quality and habitat complexity. Water samples generally met all water quality criteria, with the exception of three samples with elevated pH (> 9.0). In addition, chronic toxicity of water flea and green algae and acute toxicity of water flea occurred in water samples collected at site CAL020.

Recreational Use

Both contact (REC-1) and non-contact (REC-2) beneficial uses for recreation have been designated for Calabazas Creek. Samples for bacterial indicators were collected and enumerated at site CAL060 (located in Calabazas Park) during two consecutive years. Site CAL060 appears to have a high potential for both public access and potential exposure, although activities appear to be associated with REC-2 rather than REC-1. Fecal coliform concentrations during the dry season events of both years were slightly above the water quality criteria for partial contact recreation. In addition, *E. coli* and *Enterococcus* concentrations were slightly above the U.S. EPA's suggested bacteriological criteria for water contact recreation at "infrequently used areas" during the fall sampling event for both years. Additional investigations relative to characterizing exposure are needed to better determine waterborne pathogen-related risks at this site.

4.2.9 Sunnyvale East/West Channel Watersheds

There are no designated Beneficial Uses for the Sunnyvale Channels. The results from two years of monitoring were not conclusive for assessing the condition of aquatic life uses in Sunnyvale East and West Channel watersheds. Additionally, the upper reaches of the channels have intermittent flow during the dry season and limited habitat (i.e., deep pools or stream connectivity), suggesting that a warm water native fish community is not likely present in these reaches. Water quality sampling results generally met all water quality criteria with the exception of selenium in one water sample collected at site SVW010.

5.0 RECOMMENDATIONS

The following recommendations are based on preliminary screening level data collected by the SCVURPPP. Recommendations are designed to assist the Program and other water quality monitoring programs (e.g., SWAMP) in future creek monitoring efforts in the Santa Clara Basin:

- Continue to conduct bioassessments in Santa Clara Basin creeks using benthic macroinvertebrates (BMIs) as indicators of the condition of aquatic life. Additionally, conduct bioassessments at selected reference sites to evaluate potential natural variation in BMI communities due to hydrology and creek gradient. Bioassessments conducted over time will provide better estimate of aquatic life use condition at reference sites and thus, increase accuracy of B-IBI scoring at non-reference sites.

- Continue to develop tools for assessing the condition of aquatic life in the context of all creeks within the San Francisco Bay Area (i.e., Draft B-IBI for San Francisco Bay Area Creeks). Developing a regional B-IBI will allow the SCVURPPP to compare biological integrity in Santa Clara Basin creeks to other Bay Area creeks.

- Evaluate recently developed bioassessment protocols to determine the most appropriate methodology (i.e., targeted riffle vs. multi-habitat) to use in Santa Clara Basin creeks. In addition, evaluate and supplement physical habitat measurements used in concert with these protocols. Collection of more detailed measurements of physical habitat may be useful for understanding what stressors are impacting BMI communities.

- Implement recently developed bioassessment protocols at monitoring sites that are located in highly modified and/or low gradient reaches to assess aquatic life use condition.

- Implement a sediment quality triad (SQT) approach in Santa Clara Basin creeks that entails the analysis of bedded sediment chemistry, sediment toxicity, BMIs and PHAB data. The SQT approach is designed to better evaluate relationships between BMIs and stressor variables and identify the causes of aquatic life impacts.

- Conduct follow-up studies (e.g., Toxicity Identification Evaluations) to identify causes of acute water or sediment toxicity. To allow for a higher likelihood of success, studies should be focused on samples that cause significant toxicity to test organisms (e.g. less than 50% survival and consistently demonstrate repeat toxicity).

- Develop tools to better evaluate the potential for human health risk at sites where exposure is relatively high and elevated concentrations of pathogen indicators have been observed. Conduct more frequent sampling at locations where exposure is relatively high.

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APPENDIX A. CHEMICAL, MICROBIOLOGICAL AND TOXICITY TESTING METHODS, REPORTING LIMITS AND HOLDING TIMES FOLLOWED BY SCVURPPP FROM FY 02-03 TO FY 06-07 (N/A – NOT APPLICABLE).

Analyte	Analytical Method	Reporting Limit	Hold Time
NUTRIENTS AND ANIONS			
Orthophosphate-P (mg/L)	EPA 365.3	0.01	48 hours
Total Phosphorus (mg/L)	EPA 365.2	0.01	28 days
Total Dissolved Solids (mg/L)	EPA 160.1	1.0	7 days
Total Organic Carbon (mg/L)	EPA 415.1	1.0	28 days
Dissolved Organic Carbon (mg/L)	EPA 415.1	1.0	28 days
Total Ammonia as Nitrogen (mg/L)	EPA 350.1	0.10	28 days
Total Kjeldahl Nitrogen (mg/L)	EPA 351.3	0.10	28 days
Nitrite Nitrogen (mg/L)	EPA 300.0	0.10	48 hours
Nitrate Nitrogen (mg/L)	EPA 300.0	0.10	48 hours
Alkalinity as $CaCO_3$ (mg/L)	EPA 310.1	1.0	14 days
Total Hardness (mg/L)	EPA 130.2	25	6 months
Chloride (mg/L)	EPA 300.0	5.0	28 days
Sulfate (mg/L)	EPA 300.0	1.0	28 days
Chlorophyll (ug/L)	SM 10200H	1.0	14 days
SUSPENDED SEDIMENT CONCENTRATION (mg/L)	ASTM D3977-97C	1	7 days
TOTAL RECOVERABLE METALS (ug/L)			
Aluminum	EPA 200.8	25	6 months
Arsenic	EPA 206.3TR	0.50	6 months
Boron	EPA 200.8	5.0	6 months
Cadmium	EPA 200.8	0.20	6 months
Chromium	EPA 200.8	1.0	6 months
Copper	EPA 200.8	1.0	6 months
Lead	EPA 200.8	1.0	6 months
Manganese	EPA 200.8	1.0	6 months
Mercury	EPA 245.7	0.0050	28 days
Nickel	EPA 200.8	2.0	6 months
Selenium	EPA 270.3	1.0	6 months
Silver	EPA 200.8	0.20	6 months
Zinc	EPA 200.8	5.0	6 months
DISSOLVED METALS (ug/L)			
Aluminum	EPA 200.8	25	6 months
Arsenic	EPA 206.3D	0.50	6 months
Cadmium	EPA 200.8	0.20	6 months
Chromium	EPA 200.8	1.0	6 months
Copper	EPA 200.8	1.0	6 months
Lead	EPA 200.8	1.0	6 months
Manganese	EPA 200.8	1.0	6 months
Nickel	EPA 200.8	2.0	6 months
Selenium	EPA 270.3D	1.0	6 months
Silver	EPA 200.8	0.20	6 months
Zinc	EPA 200.8	5.0	6 months
ORGANOPHOSPHATE PESTICIDES (ug/L)	EPA 8141A	0.0100-0.100	7 days – extraction 40 days - analyze
BACTERIAL CONCENTRATIONS			
Total Coliform (MPN/100 ml)	SM9221B&E	2 MPN/100 ml	6 hours
Fecal Colifom (MPN/100 ml)	SM9221B&E	2 MPN/100 ml	6 hours
Enterococcus (CFU/100 ml)	EPA 1600	2 CFU/100 ml	6 hours
E. coli (CFU/100 ml)	EPA 1600	2 CFU/100 ml	6 hours
TOXICITY TESTING			
Ceriodaphnia dubia	EPA-821-R-02-013	NA	36 hours
Pimephales promelas	EPA-821-R-02-013	NA	36 hours
Selenastrum capricornutum	EPA-821-R-02-013	NA	36 hours

APPENDIX B. PRELIMINARY BENTHIC INDEX OF BIOTIC INTEGRITY (B-IBI) CALCULATION TABLES FOR SANTA CLARA BASIN CREEKS.

Waterbody Name	Site	Collection Date	EPT Taxa	IBI Score	% Non-Insecta Taxa	IBI Score	Number Diptera Taxa	IBI Score	Number Predator Taxa	IBI Score	% Collectors	IBI Score	Total IBI Score
Adobe Creek	205ADO030	4/6/2004	3	1	18	9	4	3	4	2	98	1	**16**
Adobe Creek	205ADO030	4/13/2005	2	0	20	8	2	1	0	0	100	0	**9**
Adobe Creek	205ADO040	4/6/2004	3	1	42	5	6	5	5	3	97	1	**15**
Adobe Creek	205ADO040	4/11/2005	2	0	18	9	5	4	3	1	95	2	**16**
Adobe Creek	205ADO050	4/5/2004	7	3	33	7	7	6	7	5	62	7	**28**
Adobe Creek	205ADO050	4/11/2005	5	2	22	8	9	8	8	6	82	4	**28**
Adobe Creek	205ADO060	4/5/2004	22	10	13	9	7	6	13	10	59	8	**43**
Adobe Creek	205ADO060	4/11/2005	13	6	11	10	9	8	8	6	72	6	**36**
Calabazas Creek	205CAL050	4/19/2005	1	0	53	4	5	4	8	6	90	3	**17**
Calabazas Creek	205CAL050	5/1/2006	1	0	60	3	2	1	5	3	98	1	**8**
Calabazas Creek	205CAL060	4/19/2005	1	0	50	4	2	1	4	2	97	1	**8**
Calabazas Creek	205CAL060	5/1/2006	3	1	27	7	5	4	6	4	98	1	**17**
Calabazas Creek	205CAL070	4/19/2005	4	1	38	6	3	2	6	4	96	2	**15**
Calabazas Creek	205CAL070	5/8/2006	2	0	30	7	4	3	4	2	97	2	**14**
Calabazas Creek	205CAL080	4/21/2005	7	3	20	8	4	3	5	3	92	2	**19**
Upper Penitencia Creek	205COY090	4/30/2003	5	2	44	5	7	6	7	5	92	2	**20**
Upper Penitencia Creek	205COY100	4/30/2003	6	2	52	4	2	1	3	1	94	2	**10**
Upper Penitencia Creek	205COY110	5/2/2003	4	1	55	3	5	4	9	7	94	2	**17**
Upper Penitencia Creek	205COY120	5/2/2003	10	4	34	6	9	8	11	9	84	4	**31**
Upper Penitencia Creek	205COY130	5/6/2003	17	8	18	9	10	9	10	8	87	3	**37**
Upper Penitencia Creek	205COY140	5/6/2003	28	10	14	9	14	10	18	10	49	9	**48**
Thompson Creek	205COY221	5/5/2003	1	0	43	5	10	9	5	3	95	2	**19**
Thompson Creek	205COY223	5/5/2003	2	0	36	6	7	6	3	1	92	2	**15**
Thompson Creek	205COY227	5/5/2003	1	0	43	5	6	5	3	1	91	2	**13**
Thompson Creek	205COY230	5/2/2003	1	0	28	7	7	6	7	5	92	2	**20**
Matadero Creek	205MAT030	4/13/2005	1	0	50	4	3	2	5	3	98	1	**10**

Waterbody Name	Site	Collection Date	EPT Taxa	IBI Score	% Non-Insecta Taxa	IBI Score	Number Diptera Taxa	IBI Score	Number Predator Taxa	IBI Score	% Collectors	IBI Score	Total IBI Score
Matadero Creek	205MAT030	5/8/2006	1	0	60	3	3	2	4	2	98	1	**8**
Matadero Creek	205MAT050	4/13/2005	1	0	69	1	3	2	4	2	94	2	**7**
Matadero Creek	205MAT050	5/8/2006	2	0	53	4	5	4	7	5	92	2	**15**
Permanente Creek	205PER010	5/12/2006	1	0	63	2	2	1	0	0	100	0	**3**
Permanente Creek	205PER010	4/16/2007	2	0	58	3	3	2	1	0	99	1	**6**
Permanente Creek	205PER025	5/12/2006	1	0	25	8	4	3	1	0	99	1	**12**
Permanente Creek	205PER050	5/12/2006	4	1	13	9	7	6	4	2	95	2	**20**
Permanente Creek	205PER050	4/16/2007	2	0	42	5	6	5	9	7	86	3	**20**
Permanente Creek	205PER060	5/11/2006	11	5	25	8	8	7	9	7	86	3	**30**
Permanente Creek	205PER060	4/20/2007	7	3	38	6	4	3	7	5	65	7	**24**
Permanente Creek	205PER070	5/11/2006	5	2	33	7	4	3	6	4	93	2	**18**
Permanente Creek	205PER070	4/20/2007	6	2	13	9	5	4	4	2	62	7	**24**
W.B. Permanente Creek	205PER080	5/11/2006	14	6	22	8	9	8	15	10	86	3	**35**
W.B. Permanente Creek	205PER080	4/20/2007	9	4	29	7	5	4	9	7	47	10	**32**
San Tomas Aquino Creek	205STQ060	4/6/2004	4	1	44	5	4	3	5	3	97	1	**13**
San Tomas Aquino Creek	205STQ060	4/21/2005	3	1	36	6	4	3	7	5	98	1	**16**
Saratoga Creek	205SAR040	4/7/2004	5	2	25	8	4	3	5	3	91	2	**18**
Saratoga Creek	205SAR040	4/21/2005	5	2	30	7	5	4	7	5	47	10	**28**
Saratoga Creek	205SAR050	4/7/2004	10	4	21	8	7	6	9	7	72	6	**31**
Saratoga Creek	205SAR050	4/14/2005	6	2	50	4	3	2	6	4	78	5	**17**
Saratoga Creek	205SAR060	4/8/2004	18	8	18	9	8	7	12	10	55	8	**42**
Saratoga Creek	205SAR060	4/14/2005	13	6	25	8	5	4	10	8	68	6	**32**
Saratoga Creek	205SAR070	4/8/2004	17	8	20	8	8	7	13	10	44	10	**43**
Saratoga Creek	205SAR070	4/21/2005	9	4	27	7	7	6	9	7	53	9	**33**
Saratoga Creek	205SAR080	4/9/2004	17	8	19	9	8	7	10	8	50	9	**41**
Saratoga Creek	205SAR080	4/22/2005	15	7	19	9	9	8	11	9	72	6	**39**
Saratoga Creek	205SAR090	4/9/2004	23	10	9	10	14	10	11	9	37	10	**49**

Waterbody Name	Site	Collection Date	EPT Taxa	IBI Score	% Non-Insecta Taxa	IBI Score	Number Diptera Taxa	IBI Score	Number Predator Taxa	IBI Score	% Collectors	IBI Score	Total IBI Score
Saratoga Creek	205SAR090	4/22/2005	18	8	18	9	10	9	11	9	66	7	**42**
Bonjetti Creek	205SAR110	4/22/2005	20	9	11	10	9	8	10	8	47	10	**45**
Stevens Creek	205STE020	5/12/2006	1	0	57	3	2	1	1	0	100	0	**4**
Stevens Creek	205STE020	4/16/2007	3	1	72	1	1	0	6	4	83	4	**10**
Stevens Creek	205STE040	5/15/2006	2	0	27	7	4	3	3	1	96	2	**13**
Stevens Creek	205STE040	4/26/2007	5	2	36	6	7	6	6	4	91	2	**20**
Stevens Creek	205STE060	5/15/2006	3	1	40	5	5	4	5	3	68	6	**19**
Stevens Creek	205STE060	4/26/2007	5	2	42	5	4	3	6	4	83	4	**18**
Stevens Creek	205STE064	5/15/2006	4	1	35	6	5	4	6	4	58	8	**23**
Stevens Creek	205STE064	4/26/2007	6	2	42	5	4	3	3	1	90	3	**14**
Stevens Creek	205STE070	5/16/2006	2	0	38	6	3	2	2	0	20	10	**18**
Stevens Creek	205STE070	4/27/2007	6	2	28	7	6	5	5	3	85	3	**20**
Stevens Creek	205STE100	5/16/2006	15	7	17	9	5	4	7	5	87	3	**28**
Stevens Creek	205STE100	4/27/2007	21	10	13	9	9	8	12	10	79	4	**41**
Stevens Creek	205STE110	5/16/2006	18	8	12	9	6	5	6	4	79	4	**30**
Stevens Creek	205STE110	4/27/2007	23	10	12	9	7	6	11	9	60	8	**42**