Santa Clara River Watershed Monitoring Program

Friends of the Santa Clara River

Final Report

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Funding for this project has been provided in part by the U.S. Environmental Protection Agency (USEPA) pursuant to Assistance Agreement No. C9-97968201-0 and any amendments thereto which has been awarded to the State Water Resources Control Board (SWRCB) for the implementation of California's Nonpoint Source Pollution Control Program. The contents of this document do not necessarily reflect the views and policies of the USEPA or the SWRCB, nor does mention of trade names of commercial products constitute endorsement of recommendation for use.

Executive Summary

This Final Report presents the results of a volunteer citizen monitoring water quality program (Santa Clara River Monitoring Program) conducted from November 2004 to October 2007 by Friends of the Santa Clara River under State Water Resources Control Board Agreement Number 04-128-554-1 in support of the 2004 Santa Clara River Nutrient TMDL. The program consisted of monthly monitoring of the river's mainstem at six sites distributed from Soledad Canyon to just above the Victoria Avenue bridge near the City of Oxnard. Monitoring took place during 22 consecutive months with a completeness rate of over 95% for all parameters measured except for stream discharge (77%) due to high flows or extensive aquatic plant growth blanketing the stream channel. The following parameters were measured in the field: flow, temperature, dissolved oxygen, pH, conductivity, total dissolved solids, and turbidity. Grab samples were taken for dissolved inorganic nutrients that were analyzed by the Schimel Laboratory at the University of California at Santa Barbara. Nutrient analytes included ammonia-nitrogen, nitrate-nitrogen, total dissolved nitrogen, ortho-phosphate, and total dissolved phosphorus.

The program also involved public outreach to educate the public and landowners about water quality. It also communicated through newsletters to a wide range of recipients including city and county decision makers and in several newspaper articles and tabling events. A five-member Technical Advisory Committee, which met three times, oversaw the program and reviewed all documents.

This report presents a comprehensive data summary and analysis of results, and will be posted on Friends of the Santa Clara River website www.fscr.org. In general, measurements fell within expected levels with no particular outliers. Highest stream temperatures were recorded at SC02 which is below the Freeman Diversion where flows can be low due to diversions and subsequent solar heating can be high. Dissolved oxygen (DO) had relatively high standard deviation due to the diel fluctuation of that parameter. Most minimum DO values were above 6 mg/L except at the Victoria Avenue Bridge site during very low flow periods when water temperatures were sometimes high. pH varied from 7.8 to 8.9 except for one isolated value; standard deviation values were less than or equal to 0.4. As expected, turbidity varied with storm water runoff. Nutrient concentrations were relatively low, particularly at the upper most site (Soledad Canyon), with the higher values associated with the more urbanized and agricultural areas.

In general, the SCR Monitoring Program has been successful in obtaining the desired data, making the data available to the public, and completing all contract deliverables. Suggestions for improvement of the program are presented and range from increasing volunteer participation to expanding the program to the broader watershed and collaboration with other monitoring programs. The program should be continued due to the value of the long-term dataset being compiled and the uniqueness and utility of the data being gathered.

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A. Introduction

Background: The 1,618-square-mile Santa Clara River (SCR) Watershed contains numerous endangered species, extensive riparian habitats, the brackish Santa Clara River Estuary at the outlet, recreational lakes of imported water, extensive valuable agricultural beneficial uses, and some of the fastest-growing communities in California. The SCR is the object of a Nutrient Total Maximum Daily Load (TMDL) for ammonia, nitrate, nitrite and organic enrichment resulting from point- and non-point source pollutants. The SCR-TMDL was approved by the United States Environmental Protection Agency in 2004 and is now in the implementation phase. Some measurements of ammonia, nitrate and nitrite pollution were completed in anticipation of the TMDL, but extensive and ongoing monitoring to further quantify ammonia sources and demonstrate the effectiveness of non-point source control mechanisms is needed. Success of ammonia and nutrient control are critical to the preservation of one of the few remaining southern steelhead runs (a federally endangered species).

Friends of the Santa Clara River (FSCR), directed by Ron Bottorff, received a Regional Water Quality Control Board (RWQCB) grant (319) in November 2004 to conduct water quality sampling on the SCR. The funding originated wholly or in part from an USEPA Assistance Agreement (No. C9-97968201-0). The duration of the grant and monitoring program was three years. The Santa Clara River Watershed Monitoring Program (SCR-WMP) and a Quality Assurance Program Plan (QAPP) were drafted as guidance documents for the program and were approved by the RWQCB to do monthly monitoring at six sites on the river for nutrient concentrations and general water quality parameters. Sampling sites were selected for their distribution throughout the watershed and permissible and safe access by citizen monitors during low and high flows (Figure 1).

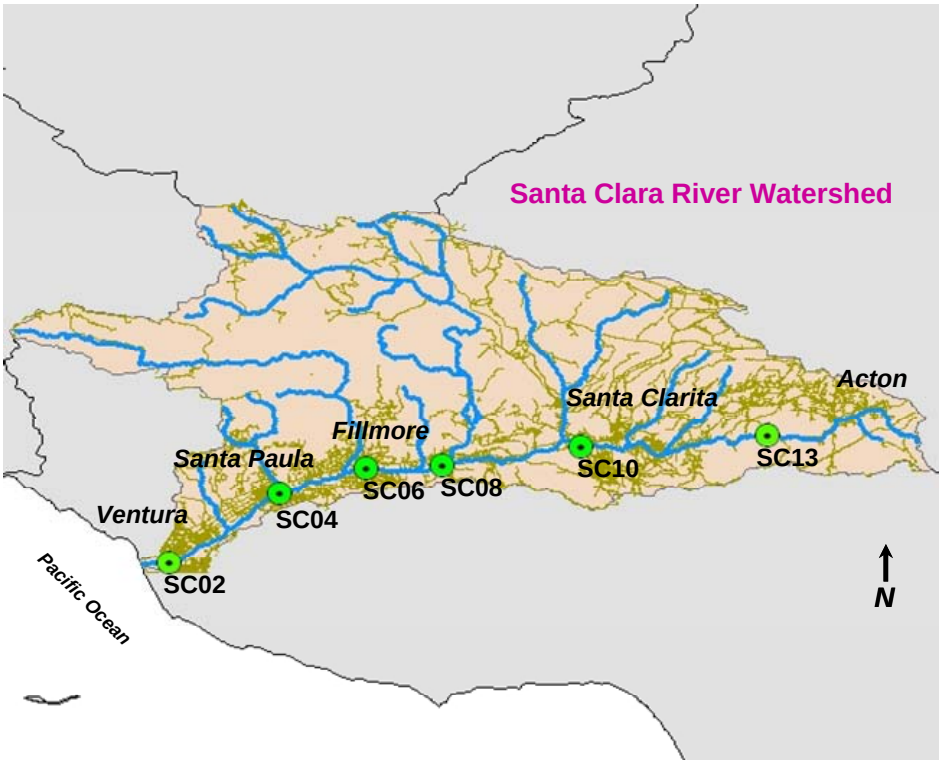

Figure 1: Monitoring locations in the SCRVMP. See Table 3 for site descriptions.

The focus of the SCR-WMP is on chemical and physical parameters as measurements of water quality in support of the Santa Clara River Nutrient TMDL that was developed by the California State Water Resources Control Board and approved by the United States Environmental Protection Agency in 2004. The program is intended to build general and specific awareness of water quality issues, aquatic resources, and pollution prevention methods. Additional activities carried out under the program included newspaper articles on best management practices for improvement of water quality and reduction of stormwater runoff pollution.

The goals of this program, as provided in the Assistance Agreement were:

- Develop and expand the base of citizen monitors for stream monitoring through training and field work, and to perform public outreach to educate the public and local landowners relative to pollutant source control.

- Acquire background nutrient data for use in estimating the success of Best Management Practices to be put in place during the first full year (2005) of the nutrient TMDL for the Santa Clara River.

- Verify ammonia concentration estimates utilized in the Santa Clara River Nutrient TMDL from non-point sources through monitoring, collecting and analyzing physical and chemical water quality parameters associated with beneficial uses on a monthly basis.

- Gather background and monitoring data, particularly on ammonia, which would be useful in the southern steelhead recovery planning effort being developed by the National Marine Fisheries Service (NMFS).

This document serves as the final report of the project and presents the results of the data and monitoring program. Its purpose is to be used for evaluation of the program by the RWQCB and to summarize the results to others of interest. A discussion of the quality assurance and control measures incorporated in the program is presented as well as recommendations for program improvements.

Water quality monitoring: All parameters monitored and analyzed as part of the SCR-WMP, type and frequency, are listed in Table 1. Two sets of field stream water quality instruments were purchased and an SCR-WMP Field Monitoring Guide (Field Guide) was written for the program. Sampling efforts were organized by the project watershed coordinator (Christina Michael), with the assistance of Tim Robinson and Leigh Ann Grabowsky, and carried out through a monthly citizens monitoring effort that began in late November 2005 and has continued for 22 consecutive months to the present (Table 2). Parameters monitored in the field using hand-held instruments were temperature, pH, turbidity, dissolved oxygen, conductivity (electrical), and total dissolved solids (a conversion through the conductivity meter, hence the results will not be analyzed below). Evidence of degraded water quality such as fine sediment and/or algae cover was also recorded. Grab samples were taken for dissolved inorganic nutrients that were analyzed at the Schimel Laboratory at University of California Santa Barbara (UCSB) following USEPA, ASTM, or well established reference standards. This was part of a collaborative effort by the Santa Barbara Coastal Long Term Ecological Research project (SBC-LTER), a National Science Foundation research project, which is studying the kelp forest ecosystems throughout the coastal waters of the mainland along the Santa Barbara channel. Nutrient components included ammonium (NH_4), nitrate (NO_3), total

dissolved nitrogen (TDN), phosphate (PO_4), and total dissolved phosphorous (TDP). In addition, stream flow was measured at every site during each sampling round by using the protocol described in the SCR-WMP Field Guide.

Table 1: Water quality constituents and monitoring design.

Parameter	Type	Frequency
Flow	Field	Monthly
Temperature	Field	Monthly
Dissolved Oxygen	Field	Monthly
pH	Field	Monthly
Conductivity	Field	Monthly
Turbidity	Field	Monthly
Odor and Visual Observations	Field	Monthly
Ammonia-Nitrogen (NH_4)	Grab-sample / UCSB Laboratory	Monthly
Nitrate-Nitrogen (NO_3)	Grab-sample / UCSB Laboratory	Monthly
Total Dissolved Nitrogen (TDN)	Grab-sample / UCSB Laboratory	Monthly
Ortho-Phosphate (PO_4)	Grab-sample / UCSB Laboratory	Monthly
Total Dissolved Phosphorous (TDP)	Grab-sample / UCSB Laboratory	Monthly

The five nutrient constituents analyzed at UCSB provided an in-kind match of $2,122 ($3.79/analyte/sample, 112 samples * 5 analytes). For reference, a commercial lab such as CRG Laboratories in Torrance charges $25 per analyte for NH_4, NO_3 and PO_4, and $45 per analyte for TDN and TDP, which would total $18,480 ($75/3 analytes/sample plus $90/2 analytes/sample, 112 samples). Hence, the financial advantage of working with UCSB was significant.

Sampling methodology: The SCR-WMP provides a comprehensive monitoring effort to examine the general well-being of the mainstem of the river from the upper watershed to the outlet. Monthly sampling provides a snapshot of water conditions that can be used in comparison between sites along the river profile as well as to assess monthly and annual variations. The sampling strategy is not event-based; hence, the data collected has limitations. The program offered an opportunity for volunteer involvement in a scientific field study that established baseline information of river mainstem conditions, created a trained citizen monitor base, and assisted in locating previously unidentified non-point sources of pollution.

The Stream Team Coordinator oversaw all aspects of the monthly monitoring. These duties included developing volunteer participation, training volunteers, coordinating monitor activities, calibrating and preparing field equipment, inventorying the data collected, and assisting in public outreach.

Table 2: Sampling dates, number of volunteers, and sites note sampled. Monthly in-kind matches by UC Santa Barbara (SBC-LTER) for nutrient sample analyses are also included.

	Date	# of Sites Sampled	# Volunteer Days	Value per Volunteer-hour*	Site Not Sampled (Why)	Inkind-match UCSB
1	11/30/2005	5	4	$300	SC02 (access problems)	$94.75
2	1/28/2006	5	4	$300	SC08 (no flow)	$94.75
3	2/11/2006	6	8	$601	-	$113.70
4	3/11/2006	6	8	$601	-	$113.70
5	4/15/2006	6	7	$526	-	$113.70
6	5/13/2006	5	9	$676	SC02 (too high to sample)	$94.75
7	6/10/2006	6	6	$450	-	$113.70
8	7/8/2006	5	7	$526	SC08 (no flow)	$94.75
9	8/12/2006	5	8	$601	SC08 (no flow)	$94.75
10	9/9/2006	6	5	$375	-	$113.70
11	10/14/2006	6	6	$450	-	$113.70
12	11/11/2006	5	9	$676	SC08 (no flow)	$94.75
13	12/9/2006	4	6	$450	SC02 (no flow), SC08 (no flow)	$75.80
14	1/13/2007	5	5	$375	SC08 (no flow)	$94.75
15	2/10/2007	5	4	$300	SC08 (no flow)	$94.75
16	3/10/2007	5	4	$300	SC08 (no flow)	$94.75
17	4/14/2007	5	5	$375	SC08 (no flow)	$94.75
18	5/5/2007	5	6	$450	SC08 (no flow)	$94.75
19	6/9/2007	5	4	$300	SC08 (no flow)	$94.75
20	7/14/2007	4	4	$300	SC02 (no flow), SC08 (no flow)	$75.80
21	8/11/2007	4	5	$375	SC02 (no flow), SC08 (no flow)	$75.80
22	9/8/2007	4	4	$300	SC02 (no flow), SC08 (no flow)	$75.80
	Total:	***112***	***128***	***$9,610***		***$2,122.40***

Notes: * 4 hours per day at the IRS value per volunteer-hour of $18.77 (2006).

In accordance with an established monthly schedule, monitors met in the City of Fillmore, near the middle of the river mainstem, from January 2005 through October, 2007. Two teams were selected, one for covering upper river sites and one for lower river sites. Both teams returned to the starting location in Fillmore to drop off the sampling equipment, samples, and datasheets.

All nutrient samples were collected in 500 ml high-density polyethylene (HDPE) bottles which were rinsed three times with deionized water before going to the field. Once a sample was taken, the bottle was tightly closed and stored on ice in a cooler until arriving at the analytical laboratory. There the samples were transferred to the laboratory supervisor who managed the analytical procedures and data tabulation.

Sampling site location: The monitoring sites were selected to obtain a relatively even geographical distribution throughout the watershed (see Figures 1 and 2 and Table 3). All sites had reasonable and safe access for measuring stream discharge during low-flow periods. All sites except for SC10 have a bridge in close proximity for high-flow sampling. Written landowner access agreements were obtained for all sites located on private land.

Figure 2: Photographs of each monitoring site.

Table 3: Monitoring sites on the Santa Clara River watershed.

#	Code	Regular Location	Alternative Location
1	SC02	River Ridge Golf Course	Victoria Street Bridge
2	SC04	South Mountain Road Bridge (Santa Paula)	From bridge
3	SC06	Hwy 23 Bridge (Fillmore)	From bridge
4	SC08	Torrey Road Bridge (Piru)	From bridge
5	SC10	W. Terminus, Santa Clarita Bikeway	Old Road Bridge
6	SC13	USFS Soledad Campground	Hwy bridge downstream

Program oversight and data review: The SCR-WMP was advised by a five-member Technical Advisory Committee (TAC) consisting of the following personnel:

Tim Robinson, Environmental Consultant; UCSB Bren School
John Melack, UCSB Bren School
Tommy Liddell, Ventura County Watershed Protection District
Erick Burres, State Water Resources Control Board Clean Water Team
Damon Wing, Ventura County Supervisor Linda Parks' Office; Environmental Consultant

The TAC reviewed the guidance documents and all monitoring data summaries as well as provided oversight for contract deliverables (Table 4). TAC meetings were held either face-to-face or by conference call (2/27/07, 7/10/07, and 10/15/07) where results were discussed and action items were set for contract completion. The TAC provided numerous comments and suggestions throughout all phases of the program which are reflected in this Final Report.

Public outreach: Outreach to the general public was carried out through three primary avenues: first, through tabling at numerous events held at various locations along the river; second, by means of articles published in the *Ventura County Sta*r and *Santa Clarita Signal*; and third, via articles and pictures about the Stream Team in *Watershed,* the newsletter of Friends of the Santa Clara River and its website, www.fscr.org. Tabling events took place at the annual Santa Clarita River Rally and Earth Day celebrations, and at Patagonia's annual Salmon Run and Earth Day events. Stream Team materials were presented at all events and sign-ups for volunteer monitoring were gathered.

B. Results and Discussion

Project deliverables: With the RWQCB approval of this Final Report, all contract deliverables will be successfully completed (Table 4).

Data summary: The SCR Stream Team monitored the SCR 22 times as of 9/24/07 at a frequency of once a month for 22 consecutive months. The completeness rate of the scheduled monitoring was above 90%, the project objective, except for flow at 77% (Table 5). Missing flow data were due to high-flow events or vegetation overgrowth in the channel making it impossible to measure stream discharge.

Table 4: Contract deliverables, schedule of due dates and their status.

Task	Deliverable	Due Date	Status
1	***Project Administration***		
1.2	Progress Report	April 10, 2005 and quarterly thereafter	2/25/2007
1.5	Contract Summary Form	November 10, 2004	Done
1.6	MBE/WBE Documentation	April 10, 2005 and quarterly thereafter	Done
1.7	Subcontractor Agreements; Solicitation Documentation	April 10, 2005 and quarterly thereafter	Done
1.8	Project Survey Form	November 10, 2007	Done
2	***Access Agreement***		
2.1	Signed Access Agreements	February 10, 2005	Done
3	***Project Assessment and Evaluation plan***		
3.1	Project Assessment and Evaluation Plan	January 30, 2005	Done
4	***QAPP and FSCR Monitoring Plan***		
4.1	Approved and Signed QAPP	January 30, 2005	Done
4.2	Approved Monitoring Plan	January 30, 2005	Done
5	***Volunteer Outreach and Training***		
5.1	Modified Field Guide	January 30, 2005	Done
5.2	Copies of Media Articles	May 10, 2005 and yearly thereafter	Done
5.3	Copies of Training Session Flyers	January 10, 2005	Done
5.4	Copies of Sign-in Sheets	February 10, 2005 & May 10, 2006	Done
5.5	Presentation Materials, Copies of Sign-in Sheets	July 10, 2005	Done
6	***Implementation of Citizen's Monitoring Program***		
6.1	List of Trained Volunteers and Copy of Certifications	February 10, 2005	Done
6.2	Selected Sites Map	January 10, 2005	Done
6.3	Monthly Sampling Schedule	January 30, 2005	Done
6.5	Data Sheets and Summary Data Reports	May 10, 2005 and quarterly thereafter	Done
7	***Draft and Final Project Reports***		
7.2	Draft Project Report	August 10, 2007	Done
7.3	Final Project Report	October 30, 2007	Done

Table 5: Percentage completeness of samples taken and analyzed during 22-months of sampling. Sites with no flow were not included.

Monitoring days	Analyts:								
	DO	***pH***	***Turb***	***SC***	***Temp***	***NH_4***	***NO_3***	***PO_4***	***Flow***
100	96	96	96	89	96	100	100	100	77

There is only one real-time USGS discharge gauge on the Santa Clara River (11109000, Santa Clara R NR Piru CA; 34°24'13", 118°44'18"). It is located in Ventura County, 0.1 miles south of Highway 126, 3 miles east of the town of Piru, and 8 miles west of intersection of Highway 126 and Interstate Highway 5 on private property owned by Newhall Farms. The site is well above SC08 and approximately 10 river miles downstream from SC10 in Santa Clarita. The discharge data from this USGS gauge is useful when looking at our sampling coverage throughout the water year in relation to baseflow and stormflow (Figure 3), and can be used to understand how the sampling frequency compared to the annual hydrograph.

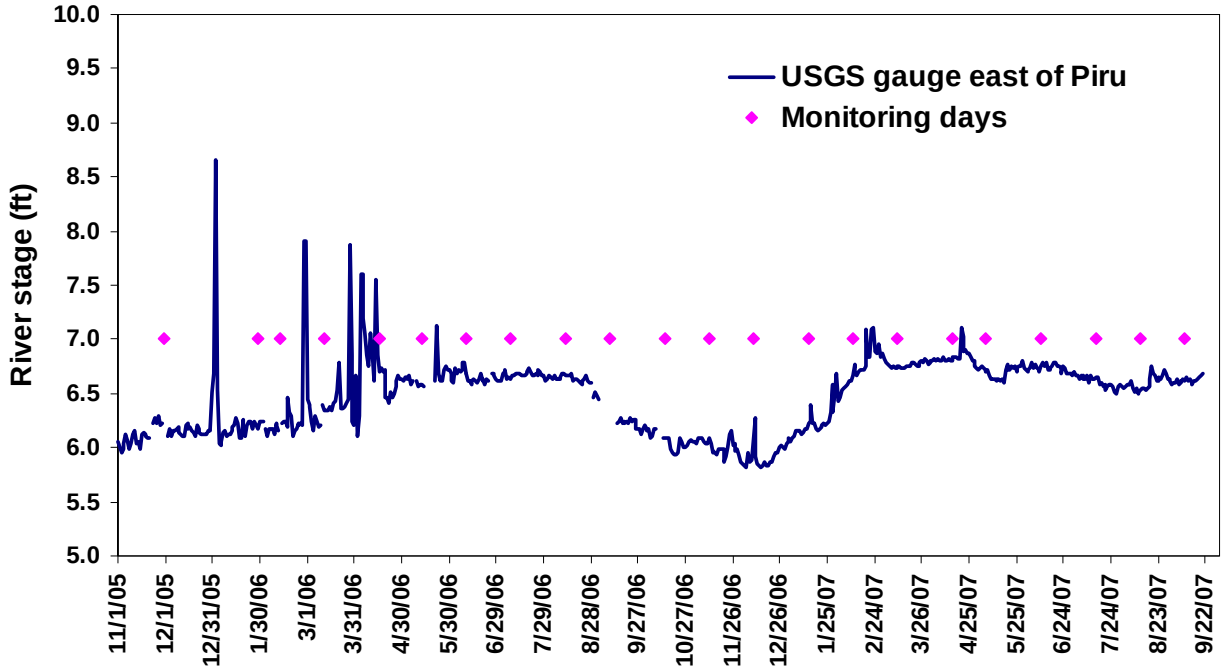

Figure 3: River stage in feet at the USGS Santa Clara River gauge east of Piru throughout the 22 months of monitoring. The monitoring days show the distribution of the sampling conducted over the duration of the project. Gaps in the flow record were as posted by the USGS.

Site analyses: Statistical summary of the results for minimum, maximum, average, median and standard deviation for all parameters by monitoring site are presented in Table 6. It is important to state that monthly data have limitations on what the information can reveal and at this frequency of monitoring significance is gained with the longer the dataset. For reference as presented in the RWQCB Basin Plan for Region 4 (1994), the mean annual dissolved oxygen concentration of all waters shall be greater than 7 mg/L, and no single determination shall be less than 5 mg/L except when natural conditions cause lesser concentrations. NO_3-N concentrations should not exceed 10 mg/L; in certain reaches the limit is 5 mg/L. 710 µM converts to 10 mg/L NO_3-N, which is the US-EPA establish drinking water standard and frequently the numeric target for stream water quality.

No particular outliers were seen. Highest stream temperatures were recorded at SC02, which is below the Freeman Diversion where flows can be low due to diversions and subsequent solar heating can be high. Dissolved oxygen (DO) had relatively high standard deviation due to the diel fluctuation of that parameter. Minimum DO values were in general above 6 mg/L except at SC02 during low flow periods (2.3 mg/L) when water temperatures can be high. Low DO measurements were also detected at the upper two sites (SC10 and SC13) in 2007, possibly due to a very low rainfall recorded that year. pH varied from 7.8 to 8.9 with one value recorded at 9.5 at SC08; standard deviations were less than or equal to 0.4. As expected, turbidity varied with storm water runoff. Nutrient concentrations were relatively low particularly at the uppermost site (SC13) and highest in the more urbanized (SC10) and agricultural areas (SC06).

Table 6: Statistical summary by monitoring site for the 22 months of sampling. The number of samples (n) taken at each site varied depending on flow; the number of visits is shown by the site code and the number of samples taken per constituent in parentheses. Variables included were temperature (Temp), dissolved oxygen (DO), pH, turbidity (Turb), specific conductance (SC), ammonium (NH_4), nitrate (NO_3), phosphate (PO_4), and river discharge (Flow).

Site	Temp	DO	pH	Turb	SC	NH_4	NO_3	PO_4	Flow
	(°C)	(mg/L)		(NTU)	25°C µS/cm	(µM)	(µM)	(µM)	(cfs)
SC02 (n=16)	*(16)*	*(16)*	*(16)*	*(16)*	*(15)*	*(16)*	*(16)*	*(16)*	*(9)*
Minimum	9.8	2.3	7.6	0	1266	nd*	nd	0.1	0.18
Maximum	31.1	10.8	8.3	642	2960	2.4	139.1	1.7	75.7
Average	19.9	8.3	8.1	44	1825	0.7	29.6	0.9	11.7
Median	19.8	8.7	8.1	1	1780	0.5	0.8	0.9	0.7
Std Deviation	5.6	1.8	0.2	160	437	0.8	49.6	0.5	25.5
SC04 (n=22)	*(21)*	*(21)*	*(21)*	*(21)*	*(19)*	*(22)*	*(22)*	*(22)*	*(17)*
Minimum	8.8	6.5	7.8	3	1163	0.2	32.4	0.3	21.7
Maximum	25.3	11.6	8.4	235	1657	5.0	153.6	2.7	316.4
Average	18.1	9.6	8.2	31	1413	1.1	114.6	1.1	106.2
Median	17.8	9.8	8.3	10	1438	1.0	118.4	1.1	74.0
Std Deviation	4.2	1.3	0.2	54	151	1.1	30.4	0.5	79.7
SC06 (n=22)	*(21)*	*(21)*	*(21)*	*(21)*	*(19)*	*(22)*	*(22)*	*(22)*	*(18)*
Minimum	9.2	7.6	8.1	1	947	0.2	13	0.1	13
Maximum	23.1	18.7	8.9	303	1431	3.9	228	2.3	230
Average	17.8	11.9	8.5	25	1317	1.1	142	0.8	62
Median	18.2	10.7	8.5	3	1361	1.0	149	0.7	38
Std Deviation	3.3	3.2	0.2	68	137	1.0	66	0.6	57
SC08 (n=8)	*(8)*	*(8)*	*(8)*	*(8)*	*(7)*	*(8)*	*(8)*	*(8)*	*(6)*
Minimum	10.1	7.0	8.1	1	809	0.0	0.0	0.02	3.7
Maximum	23.4	11.5	9.5	315	1439	4.3	158.5	9.5	244.3
Average	18.1	9.7	8.8	81	1057	1.3	41.3	2.3	69.5
Median	18.3	9.9	8.8	12	1027	0.9	23.8	1.3	19.2
Std Deviation	3.8	1.4	0.4	131	237	1.3	52.7	3.2	94.9
SC10 (n=22)	*(21)*	*(21)*	*(21)*	*(21)*	*(20)*	*(22)*	*(22)*	*(22)*	*(13)*
Minimum	13.5	3.9	7.6	0	515	0.0	81.1	0.2	1.2
Maximum	25.2	12.2	8.8	111	1269	2.6	199.3	6.7	88.3
Average	19.3	7.8	8.1	7	1084	1.0	131.2	5.0	14.1
Median	18.9	7.2	8.0	1	1115	0.7	124.6	5.5	4.4
Std Deviation	2.9	2.0	0.3	24	156	0.7	36.7	1.6	25.7
SC13 (n=22)	*(21)*	*(21)*	*(21)*	*(21)*	*(20)*	*(22)*	*(22)*	*(22)*	*(18)*
Minimum	10.3	4.8	7.7	0	363	0.0	0.0	0.3	0.7
Maximum	20.0	9.8	8.9	5	797	1.2	51.5	3.8	96.9
Average	15.2	7.8	8.2	1	677	0.4	7.6	2.0	13.5
Median	15.0	8.2	8.1	1	715	0.4	0.8	1.9	3.8
Std Deviation	2.6	1.3	0.3	1	120	0.4	14.9	0.9	25.7

*nd - non-detect (nutrients).

Variation over time at each site showed changes from wet to dry periods of the year (i.e., temperature and dissolved oxygen) and stormflow to baseflow conditions (i.e., nutrient concentrations) (Figures 4 and 5).

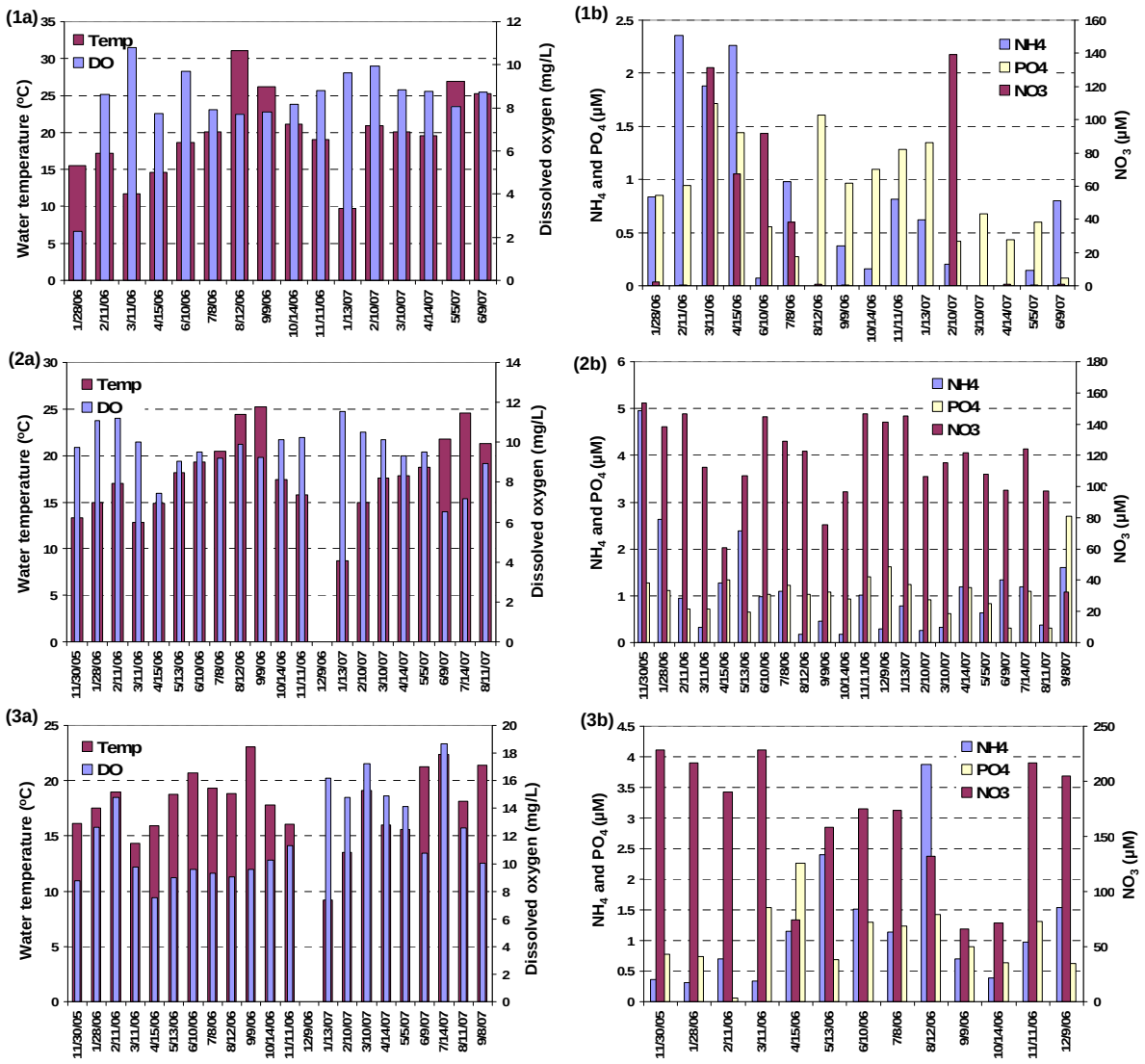

Figure 4: Temperature and dissolved oxygen (a) plus nutrient (b) data for all samples taken at (1) SC02, (2) SC04, and (3) SC06 over the sampling period.

Profile analyses: The Santa Clara River is a complex system with many natural and anthropogenic inputs and extractions. Natural stream flow is augmented at times by State Water through drinking water supplementation that reaches the river by discharge from waste water treatment plants. Reservoirs in several tributaries hold local and State Water for municipal and agricultural use. Some of that water is used for groundwater recharge that will result in elevated stream flow during conveyance of stored reservoir water downstream to infiltration basins along the Oxnard Plain in El Río (e.g., deliveries from Lake Piru to the Freeman Diversion for recharging aquifers in the Oxnard area that is being done by United Water Conservation District). This usually occurs doing the dry period of the year. Contiguous river flow from Soledad Canyon to the lagoon at the outlet of the watershed only occurs during or after a significant rainfall event and when the antecedent basin conditions are favorable for runoff. During baseflow conditions, there are reaches where the flow of the river is completely below ground due to high percolation rates into the deep alluvial deposits. These factors complicate river profile analyses for any given round of sampling.

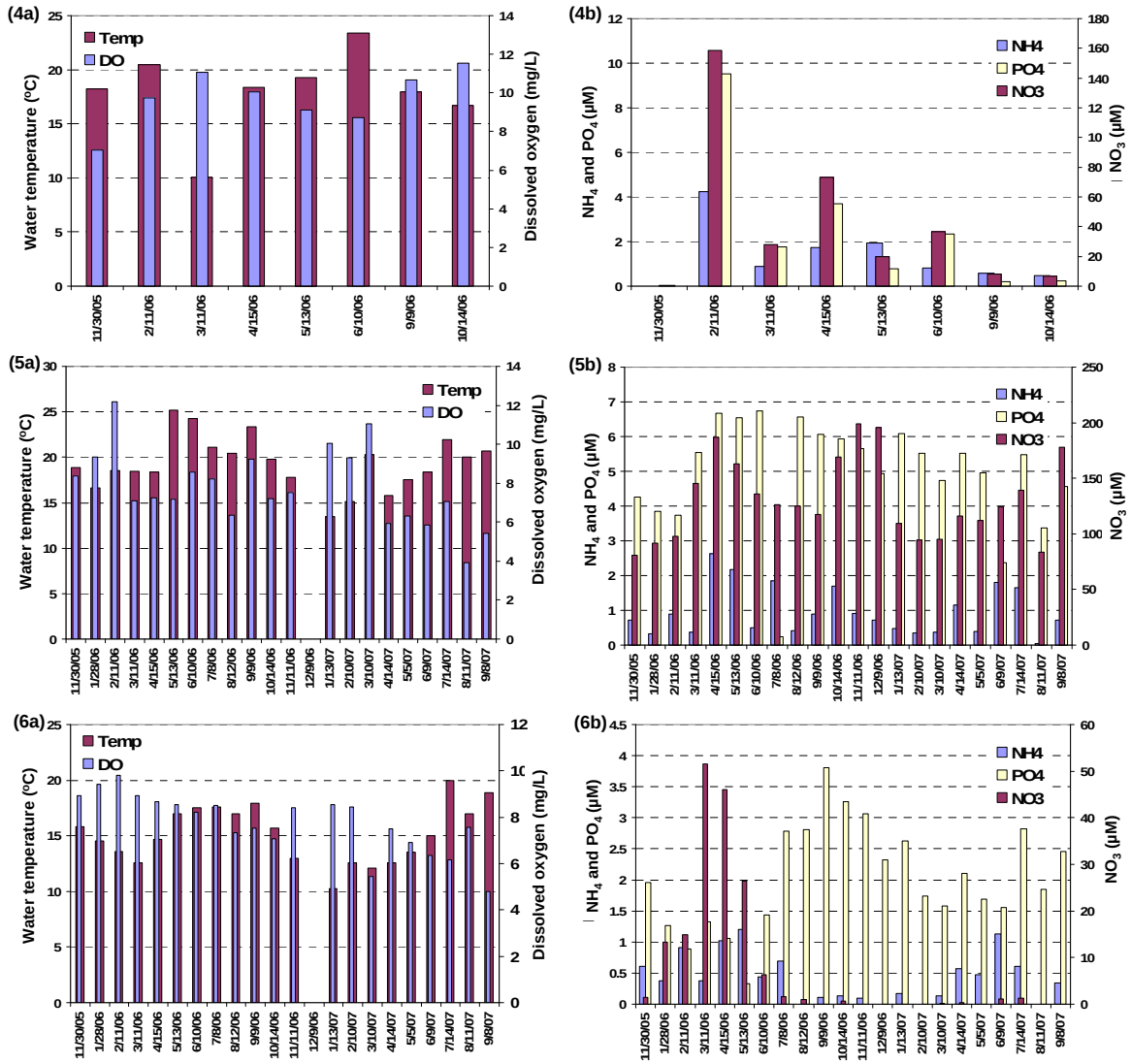

Figure 5: Temperature and dissolved oxygen (a) plus nutrient (b) data for all samples taken at (4) SC08, (5) SC10, and (6) SC13 over the sampling period.

Analyses for nutrients, the focus of this monitoring program, indicated a relatively similar pattern for each of the 22 sampling rounds for the data available (Figure 6). The uppermost site (SC13) consistently had the lowest concentration of all nutrients. Nitrate concentrations increased at SC10, decreased at SC08 possibly due to the high percolation rates along that reach, were highest at SC06, and decreased from there down. Highest concentrations occurred during wetter periods of the year when runoff was greatest (i.e., 11/05, 1/06, 2/06, 5/06, and 1-2/07). Ammonium was relatively low throughout the period with maximum values occurring during the wet months of the year. Phosphate concentrations were low through the system and monitoring period, with highest values measured at SC10 and SC08 at approximately 7 to 9 uM, respectively. High PO_4 values in February 2006 at SC08 were most likely due to very low flow with turbid water from some localized landuse activity.

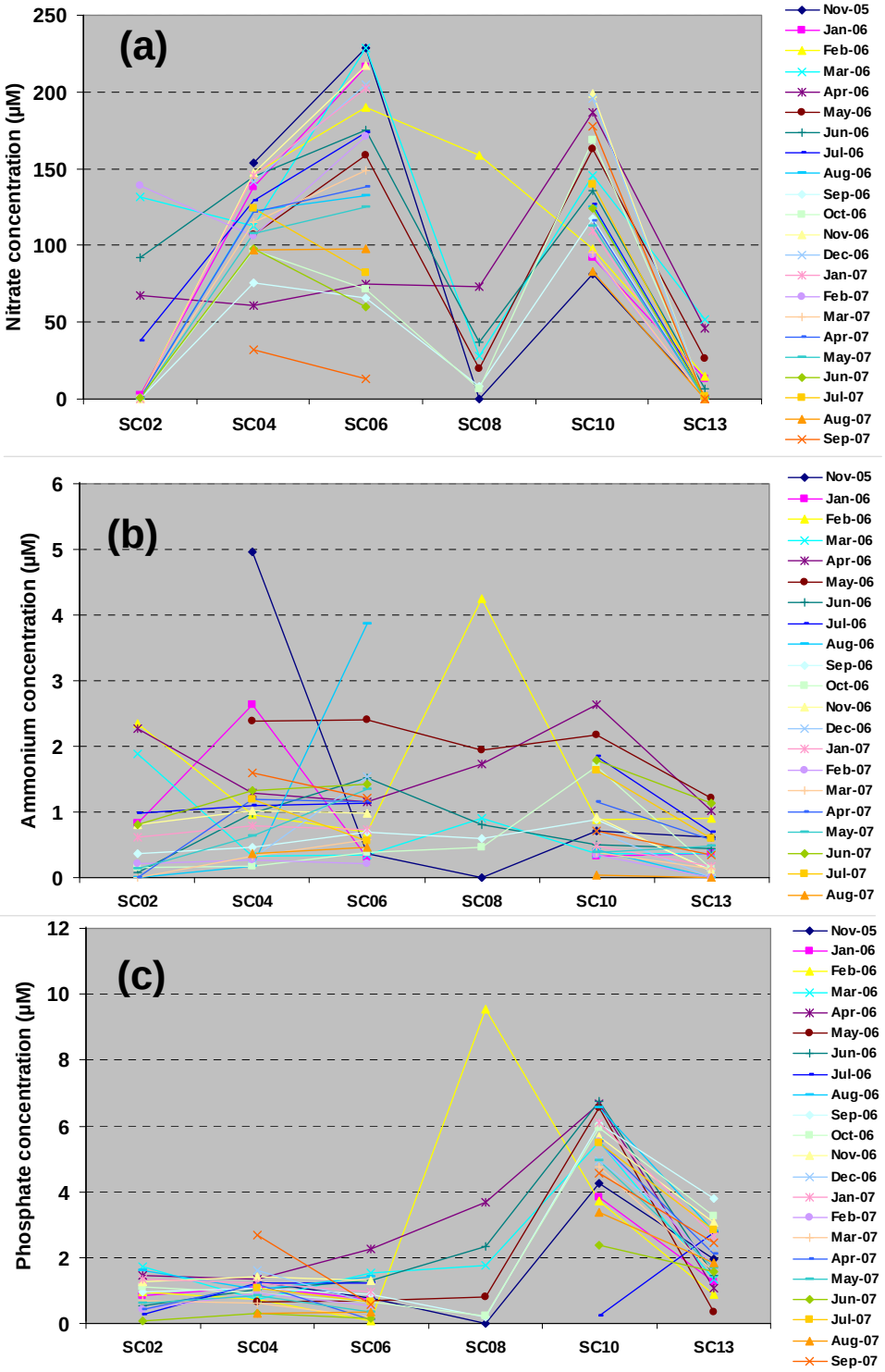

Figure 6: Nutrient concentrations from the uppermost sampling site (SC13) to the lowest site (SC02) for (a) nitrate, (b) ammonium, and (c) phosphate.

River discharge monitoring by the SCR Stream Team has been spotty due to a variety of reasons but monitoring consistency has improved with experience and time (Figure 7). The general trend showed an increase in flow from SC08 downstream past SC04 and a decrease in flow at SC02 due

to extraction of water from the river at the Freeman Diversion by United Conservation Water District for recharging the aquifers under the Oxnard Plain.

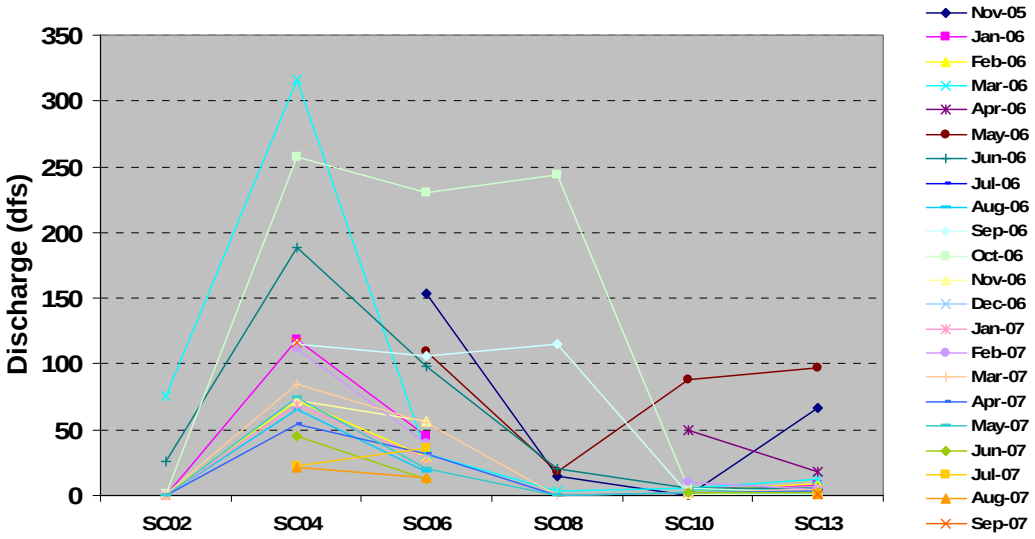

Figure 7: Discharge measured by the SCR Stream Team throughout the monitoring period.

Quality assurance and control: Erick Burres, Citizen Monitoring Coordinator from the State Water Resources Control Board's Citizen Monitoring Program of the Clean Water Team part of the Surface Water Ambient Monitoring Program (SWAMP), gave an initial orientation training to the Santa Clara River Monitoring Program director, coordinator, consultant, and Stream Team captains in November 2005 just prior to the first round of sampling. This was required before the program could begin. Mr. Burres also came to the field twice to observe our procedures and assure the program was being executed as documented. He gave us feedback at the time with no particular changes needed and written reports with minor suggestions were received thereafter.

In October 2006, Christina Michael, program coordinator for the Santa Clara River Monitoring Program, attended a quality assurance session and inter-calibration event conducted by the Los Angeles Citizen Monitoring Steering Team. The session was held at the Southern California Marine Institute (SCMI) on Terminal Island in San Pedro, California. All of the equipment used for the Santa Clara River Water Monitoring program was calibrated and tested against known standards and laboratory analytical instruments. The equipment passed the tests and was accepted under SCMI's quality assurance standards as per SCR QAPP.

All field monitoring instruments were carefully calibrated on a regular schedule. The DO meters were calibrated to elevation at each site prior to use; the membranes were changed every other month or if damaged or air bubbles were observed under the membrane. The pH meters were calibrated just prior to monthly sampling to both 7 and 10 pH using industry standard samples. Turbidity meters were calibrated monthly prior to use to both 1.0 ntu and 10.0 ntu using industry standard samples. Conductivity meters do not have to be calibrated as they are calibrated at the YSI factory prior to shipment. We do have a standard solution of 1413 µS/cm to calibrate the instrument if necessary but the standard solution has only been used to validate factory calibration each month which has resulted in satisfactory results. The **t**hermometers for air temperature were **c**hecked in October 2006 at the SCMI Lab using a water bath and a thermometer certified and traceable through the National Institute of Standard and Technology (NIST).

Random duplicate stream nutrient samples plus one blank of DI-water were sent to the Schimel Lab at UCSB to check for quality assurance (Table 7). The results were consistent with acceptable variance between duplicate samples given the expected analytical accuracies and variation from one grab sample to another taken in close temporal proximity. The blank sample came back either below detection limits or near zero for all three nutrient constituents. Analytical results of total dissolved nitrogen and phosphorous have not come in yet from UCSB.

Table 7: Duplicates and blanks taken during the 22-month sampling period.

Site	Date-time	NH_4 (µM)	NO_3 (µM)	PO_4 (µM)	Type
SC13	2/11/06 9:30	0.9	14.9	0.9	Stream
SC13	2/11/06 9:35	0.8	15.2	1.1	Stream - duplicate
SC10	3/11/06 11:40	0.4	145.5	5.5	Stream
SC10	3/11/06 11:45	0.4	142.5	5.4	Stream - duplicate
SC06	5/13/06 11:05	2.4	158.4	0.7	Stream
SC06	5/13/06 11:07	1.7	161.0	0.7	Stream - duplicate
SC08	5/13/06 12:09	1.9	19.7	0.8	Stream
SC08	5/13/06 12:11	0.8	18.8	0.8	Stream - duplicate
SC04	10/14/2006 11:30	0.2	96.6	0.9	Stream
SC04	10/14/2006 11:45	nd*	nd	0.0	Blank - DI water
SC08	10/14/2006 12:08	0.5	6.7	0.2	Stream
SC08	10/14/2006 12:08	0.3	6.3	0.2	Stream - duplicate
SC10	7/14/2007 11:15	1.6	139.4	5.5	Stream
SC10	7/14/2007 11:17	1.7	139.6	5.5	Stream - duplicate
SC04	9/8/2007 12:00	1.6	32.4	2.7	Stream
SC04	9/8/2007 12:02	1.1	30.0	0.4	Stream - duplicate

*nd - non-detect.

On May 5, 2007, split samples were taken; one bottle went to the Schimel Lab at UCSB for routine analyses and the other was sent to CRG Laboratories Inc. in Torrance, a California State- and USEPA-certified analytical laboratory that was suggested by the RWQCB (Table 8). Both laboratories analyzed the samples within 48 hours from extraction from the river. Although the analytical methods used by each laboratory were different (see foot note below the table), the results were similar in all cases. All three nutrient species were within 6 µM and 300 µS/cm for Specific Conductance. The results indicated that field and laboratory quality assurance measures and analytical methods for those four parameters were comparable and acceptable for a state-certified laboratory.

Table 8: Split samples sent to UC Santa Barbara for routine analyses and CRG Laboratories Inc. in Torrance.

Site	Date Sampled	Date Analyzed	Analyzed by	NH_4 (µM)	NO_3 (µM)	PO_4 (µM)	Sp. Cond. (25^oC µS/cm)
SC02	5/5/07	5/7/2007	UCSB/FSCR*	0.1	0.4	0.6	2099
			CRG**	nd	5.0	1.0	2200
SC04	5/5/07	5/7/2007	UCSB/FSCR	0.6	107.7	0.8	1534
			CRG	nd	105.7	1.0	1700
SC06	5/5/07	5/7/2007	UCSB/FSCR	1.3	125.3	0.3	1364
			CRG	0.7	122.1	0.3	1400
SC10	5/5/07	5/7/2007	UCSB/FSCR	0.4	112.3	5.0	1088
			CRG	nd	105.7	5.5	1200
SC13	5/5/07	5/7/2007	UCSB/FSCR	0.5	nd	1.7	750
			CRG	nd	nd	1.9	<1000

***** UCSB or Friends of the Santa Clara River.

****** CRG Marine Laboratories, Inc.

nd - no detection.

Methods: UCSB: Lachet 10-107-06-5-B, Lachet 10-107-04-1-A, Lachet 10-115-01-1-B, and YSI Conductivity Meter, respectively.
CRG: SM 4500-NH3 F, EPA 300.0, EPA 300.0, and SM 2510, respectively.

Public availability of the data and reports: All reports (Report-1 and Final Report), project guidance documents (SCR-WMP, QAPP and SCR-WMP-Field-Guide), data and outreach materials will be posted on the FSCR webpage (www.fscr.org). Contact FSCR for further information.

C. Conclusions and Recommendations

In general, the SCR Monitoring Program has been successful in executing the documented monitoring program and obtaining the desired data. This has been challenging given the travel distance between sites, the magnitude of the Santa Clara River and potential discharge, and access limitations due to private property. The wide distribution of sampling sites does not allow for monitoring of specific landuse types and only broad generalizations of sources can be inferred. The biggest challenge, though, has been recruiting volunteers. There has been a steady group of 5-6 people which has worked fine until one or several are out of town. On the other hand, having too many volunteers can be a problem as there are not enough instruments to keep everyone busy. The ideal number is 3 volunteers per team with a maximum of 5.

Suggestions for improvement of the program are as follows and should be considered for inclusion with any revisions of the SCR-WMP and QAPP:

- Improve volunteer participation.
- Look into the possibility of AmeriCorps Volunteers to assist with the program.
- Establish an organized but random method for taking duplicates and blanks samples as well as a clear documentation procedure for those samples. In addition, split samples should be sent with higher frequency to a certified analytical laboratory for verification as described in the program QAPP.
- Improve the fluidity of data transfer between the Schimel Lab at UCSB and FSCR.

- Determine a meeting frequency for the TAC.
- Further the development of the website for the SCR-WMP, particularly for data transfer.
- Consider expanding the program to include other sites of interest.
- Apply for further funding through the Supplemental Environmental Project, Los Angeles Regional Water Quality Control Board, California Department of Fish and Game, NOAA grant funding programs, etc.
- Seek collaboration with other monitoring programs on the Santa Clara River (i.e., Santa Clara River Parkway, and California Coastal Conservancy).
- Investigate collaborative efforts with local colleges (Ventura Community College and California State University Channel Islands).

D. References

California Regional Water Quality Control Board. 1994. Los Angeles Region Basin Plan (Region 4). http://www.swrcb.ca.gov/plnspols/index.html.

Friends of the Santa Clara River. 2004. Santa Clara River Watershed Monitoring Plan (WMP). Prepared by Ron Bottorff and Timothy H. Robinson. February.

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