Water Quality Research and Monitoring Program

Clean Creeks
HEALTHY BEACHES
CITY OF SANTA BARBARA

Fiscal Year FY11
Annual Report
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City of Santa Barbara

Creeks Division
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I. INTRODUCTION

The goals of the monitoring program are to:

1. Quantify the levels (concentration and flux, or load) of microbial contamination and chemical pollution in watersheds throughout the city.
2. Evaluate impacts of pollution on beneficial uses of creeks and beaches, including recreation and habitat for aquatic organisms.
3. Evaluate the effectiveness of the City's restoration and water quality treatment projects, which includes collecting baseline data for future projects.
4. Identify sources of contaminants and pollution in creeks and storm drains.
5. Evaluate long-term trends in water quality.

The underlying motivation behind the monitoring program is to obtain information that the City can use to:

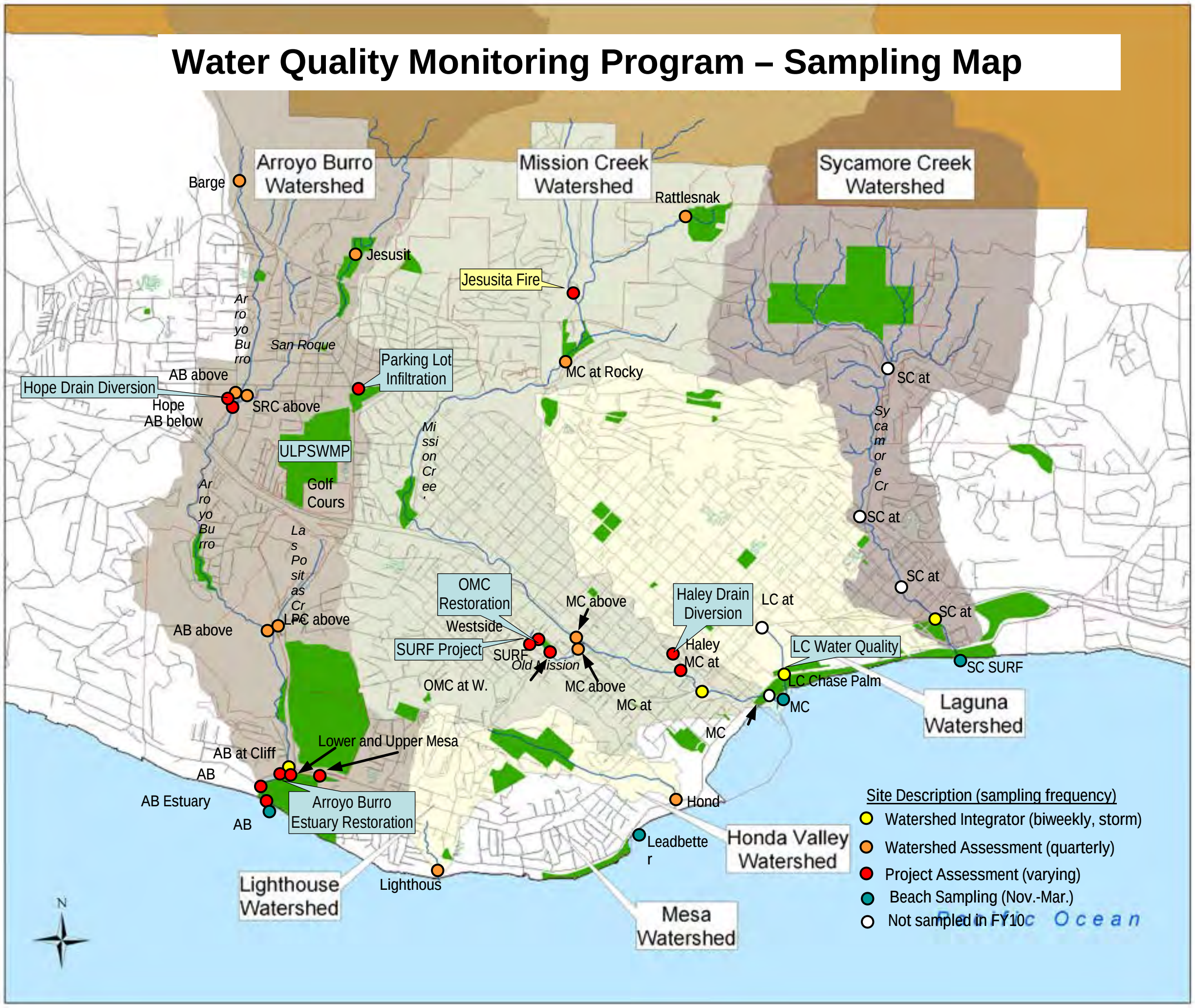
1. Develop strategies for water quality improvement, including prioritization of capital projects and outreach/education programs.
2. Communicate effectively with the public about water quality.

The following report described sampling and results that were based on the Fiscal Year 2010 Research and Monitoring Plan (Appendix A). The Research Plan is organized research questions that have been reviewed by the Creeks Advisory Committee. The Research and Monitoring Program are adaptive, and as questions are answered or modified, sampling strategies change as well.

Where possible, the report is also organized around the research questions. Many sections will be completed at the end of the Fiscal Year when yearly data sets have been compiled. Additional sections to be completed in the Annual Report include Emerging Issues and Literature Updates, Reporting, and the Recommendations for Fiscal Year 2011. ***The primary purpose of this report is to serve as an internal record of data collection and analysis. Please see the Creeks Division 2001-2006 report for a discussion of methods, information on water quality criteria, and a glossary of monitoring terms.***

The monitoring program consists of eight key elements:

1. Watershed Assessment
2. Storm Monitoring
3. Restoration and Water Quality Project Assessment
4. Beach Water Quality
5. Source Tracking/Illicit Discharge Detection
6. Creeks Walks/Clean ups
7. Bioassessment
8. Methods Development



<u>Watershed Assessment</u>

Research questions:

1. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?
2. How contaminated and/or toxic is sediment at creek outfall sites?
3. What is the impact of eutrophication on Santa Barbara creeks?

<u>Storm Monitoring</u>

Research Questions:

1. What are the highest concentrations of pollutants of concern during storm events, particularly seasonal first flush storms? Do creeks and/or storm drains in Santa Barbara have problems with toxicity during storm events?
2. What are the impacts of the Jesusita Fire on water quality?
3. What are the loads of pollutants discharged from Santa Barbara creeks during storms?
4. What are the sources and routes of pollutants during storms?
   a. How do concentrations and loads vary during storms and from site to site?
   b. Fecal indicator bacteria
   c. Slurry seal/PAHs/Foam
   d. Metals
   e. Nutrients

5. How do restoration/treatment projects impact water quality during storm events?

Restoration and Water Quality Project Assessment

The Creeks Division has completed several restoration and water quality improvement capital projects over the past several years. Project assessment is used to determine the success of projects in lowering microbial and chemical pollution levels and improving water quality for aquatic organisms. In some cases project monitoring is grant-required, and the remaining is for internal review of project success. Additional monitoring is conducted to ensure that the facility is performing as intended.

Research Questions:
1. Do Creeks Division projects result in improved water quality, as reflected in pre- and post-project, and/or, upstream to downstream, conditions?
2. What is the baseline water quality at future restoration/treatment sites?
3. What are the mechanisms of project success?
4. Are installed projects functioning correctly?

List of Projects
1. Westside SURF and Old Mission Creek Restoration
2. Arroyo Burro Restoration, including Mesa Creek daylighting
3. Hope and Haley Diversions
4. Laguna Channel Disinfection (Source Tracking)
5. Golf Course Project (Storm)
6. San Pascual Drain (Source Tracking)
7. Parking Lot LID (Storm)
8. Debris Screens (Creek Walks)
9. Mission Creek Fish Passage (Eutrophication/Dissolved Oxygen)
10. Bird Refuge

Beach water quality

Research questions:
1. How to creeks and storm drains relate to beach water quality and warnings?
2. How do other factors (kelp, tides, temperature, and beach use) relate to beach warnings?
3. What are the causes of persistent beach warnings that occur?
4. What is the risk to human health from recreation in creeks and beaches in Santa Barbara?

Source Tracking/Illicit Discharge Detection

Research questions:
1. Which subdrainages and/or contribute the greatest loads of pollutants to creeks in Santa Barbara?
2. Where, when and how is human waste and/or sewage entering storm drains and creeks?
    a. What happens to the signals of human waste and indicator bacteria levels as water moves downstream away from the source?
    b. How does presence of human waste relate to beach warnings?
3. Do rotting plant material and sediment contribute to high FIB levels in storm drains?
4. What are the impacts of reservoir flushing on metals?
5. Are new hot spots emerging?
6. Specific areas of concern: Barger Canyon, Las Positas Creek, Haley Drain

Creek Walks

Research Questions:
1. Are there new problems in creeks that need to be addressed?
2. Is the amount of trash in creeks decreasing over time?
3. Were decreases in trash observed between 1999 and 2005 due to creek flow histories or the impact of City programs?
4. Will the installation of catch basin screens lead to decreased trash observed in creeks?

II. KEY FINDINGS

Key findings will be identified in the Annual Report.

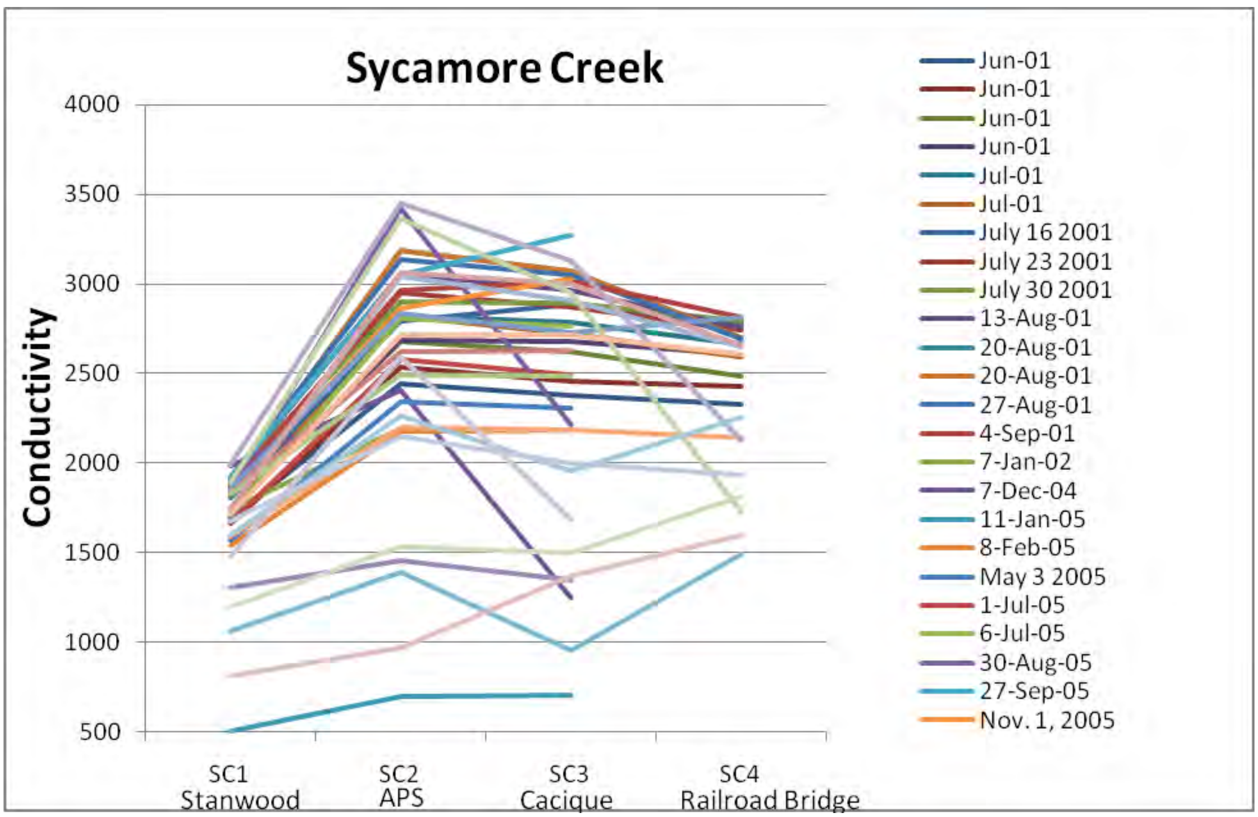
III. ROUTINE WATERSHED ASSESSMENT

IS WATER QUALITY IMPROVING?

This section will not be completed in the FY2011 report. The question will be revisited in the FY2012 Annual Report.

WHAT IS THE CAUSE OF HIGH SODIUM AND CHLORIDE IN SYCAMORE CREEK?

In 2008, Sycamore Creek was listed by the State Water Board for high sodium and chloride, under the beneficial use of Ag. Previously collected data is reviewed here:



StationID	ParameterCode	StormID	SampleStartDate	Result	Units
SC Stanwoo	Sodium, Total	SC / LC Quarterly	06/17/08	124	mg/L
SC Stanwoo	Sodium, Total	SC / LC Quarterly	09/09/08	168	mg/L
SC APS	Sodium, Total	SC / LC Quarterly	12/05/07	172	mg/L
SC APS	Sodium, Total	SC / LC Quarterly	03/11/08	185	mg/L
SC APS	Sodium, Total	SC / LC Quarterly	06/17/08	291	mg/L
SC APS	Sodium, Total	SC / LC Quarterly	09/09/08	341	mg/L
SC Cacique	Sodium, Total	SC / LC Quarterly	12/05/07	231	mg/L
SC Cacique	Sodium, Total	SC / LC Quarterly	03/11/08	184	mg/L
SC Railroa	Sodium, Total	SC / LC Quarterly	12/05/07	208	mg/L
SC Railroa	Sodium, Total	SC / LC Quarterly	03/11/08	188	mg/L
SC Railroa	Sodium, Total	SC / LC Quarterly	06/17/08	139	mg/L

StationID	ParameterCode	StormID	SampleStartDate	Result	Units
SC Stanwoo	Chloride	SC / LC Quarterly	17/Jun/2008	140	mg/L
SC Stanwoo	Chloride	SC / LC Quarterly	09/Sep/2008	270	mg/L
SC APS	Chloride	SC / LC Quarterly	05/Dec/2007	170	mg/L
SC APS	Chloride	SC / LC Quarterly	11/Mar/2008	200	mg/L
SC APS	Chloride	SC / LC Quarterly	17/Jun/2008	220	mg/L
SC APS	Chloride	SC / LC Quarterly	09/Sep/2008	270	mg/L
SC Cacique	Chloride	SC / LC Quarterly	05/Dec/2007	260	mg/L
SC Cacique	Chloride	SC / LC Quarterly	11/Mar/2008	170	mg/L
SC Railroa	Chloride	SC / LC Quarterly	05/Dec/2007	240	mg/L
SC Railroa	Chloride	SC / LC Quarterly	11/Mar/2008	170	mg/L
SC Railroa	Chloride	SC / LC Quarterly	17/Jun/2008	100	mg/L

A creek walk between Stanwood and APS will be conducted to see if we can tell what is causing the increase in conductivity, sodium, and chloride.

HOW CONTAMINATED AND/OR TOXIC IS SEDIMENT AT CREEK OUTFALL SITES?

Background

Based on recommendations from the Creeks Advisory Committee, the Creeks Division FY08 Research Plan called for quarterly sediment sampling to assess the condition of sediment downstream the integrator stations, i.e. in the estuarine portion of Mission Creek, Arroyo Burro, and Sycamore, and the lower section in Laguna Channel. However, due to the unexpected high cost of processing these samples, the decision was made to sample sediment annually. Four years of sediment data have been collected, comprised of sampling in November 2007, September 2008, August 2009, and October 2010. The Andre Clark Bird Refuge (ACBR) was sampled in 2008, 2009 (limited), and 2010. In addition, several creek sites were added for 2010 including Arroyo Burro at Torino, Las Positas Creek at Modoc, Mission Creek at Gutierrez, Sycamore Creek at Cacique, and Old Mission Creek at W. Anapamu. The first three years of sampling focused on collecting sufficient data to implement the State Waterboard's proposed Sediment Quality Objectives, which were made final in 2009. In 2010, certain compounds were not tested, and additional sites were chosen mainly to investigate potential toxicity from pyrethroid pesticides. In addition, tests were conducted for fire-related sediment deposition by testing select compounds at integrator sites.

Until recently, there were very few objectives or standards available to use when interpreting sediment chemistry data. The SQOs now apply to enclosed bays, estuaries, and coastal lagoons throughout California. Arroyo Burro Estuary, Mission Lagoon, and Sycamore Lagoon fit the definitions of coastal lagoons and estuaries. In recent years, the outfall of Laguna Channel has merged with Mission Lagoon prior to discharge to the ocean, preventing a separate sampling effort for Laguna Lagoon. Lower Laguna Channel and the Bird Refuge, which do not receive saline water, do not fit within the definition of a coastal lagoon, so they were interpreted using freshwater methods, as were the additional creek sites sampled in 2010. Although Santa Barbara Harbor fits the definition of an enclosed bay, the Waterfront Department manages that area. Similarly, some areas at the Santa Barbara airport likely qualify as estuarine sites, but the area is managed by the Airport Department.

The SQOs integrate multiple lines of evidence, including chemistry, toxicity, and biological community analysis to determine if sediment-dependent biota are protected or degraded as a result of exposure to toxic pollutants. The SQOs will also be used to determine the risk to human health from consumption of sediment-associated seafood. The approach includes the following narrative objectives and associated beneficial uses:

Beneficial Uses	Target Receptors	Narrative Objective
Estuarine Habitat Marine Habitat	Benthic Community	Pollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries of California.
Commercial and Sport Fishing Aquaculture Shellfish Harvesting	Human Health	Pollutants shall not be present in sediments at levels that will bioaccumulate in aquatic life to levels that are harmful to human health.

Methodology- Where possible, the SQO Implementation Plan was used to determine the sampling, chemistry, and toxicity methods. The ecological component, using bioassessment, has not been implemented by the Creeks Division.

Staff used a short section of wide PVC pipe, along with a flat shovel, for collecting lagoon sediment samples. The PVC pipe was pushed down into the sediment, approximately 5 cm deep. The flat shovel was slid underneath the pipe to hold the sediment inside the pipe as it was pulled toward the surface. The sediment from this first “scoop” was emptied into a bucket. A total of two scoops were collected at four different areas in each lagoon, ranging from lower to upper lagoon (for a total of 8 scoops). Once all the samples were in the bucket, the sediment was mixed thoroughly and poured into sample bottles provided by the laboratory. In 2008, sediment was collected from the Bird Refuge by Richarde Forde, from several locations throughout the lake. In other years, sediment was collected near the landing. Sediment samples were outsourced to Calscience , TestAmerica, and CRG for chemistry, and ABC labs for toxicity.

The following table shows the chemical tests required by the SQO to conduct chemistry assessment. All of the chemicals were measured in at least one year for each site. **In order to make the most conservative assessment of sediment quality in Santa Barbara, the maximum values observed for each compound over the years sampled, at each site, were used in the analyses.**

Chemical tests required to conduct the SQO Sediment Chemistry Assessment

Pollutant of Concern	Detection Limit, Units
Cadmium	n/a, mg/kg
Copper	52.8 mg/kg
Lead	26.4 mg/kg
Mercury	0.09 mg/kg
Zinc	112 mg/kg

Chlordane, alpha	µg/kg
Chlordane, gamma	µg/kg
DDDs	µg/kg
DDEs	µg/kg
DDTs	µg/kg
Dieldrin	µg/kg
p,p' DDT (4,4, DDT)	µg/kg
PAHs, high molecular weight	µg/kg
PAHs, low molecular weight	µg/kg
PCBs	µg/kg
trans nonachlor	µg/kg

For freshwater sites, an integration of chemistry data was conducted based on a 2008 report by SCCWRP. The SCCWRP report was based on MacDonald (2006). Additional tests required for this are shown in the table below. As above, **in order to make the most conservative assessment of sediment quality in Santa Barbara, the maximum values observed for each compound over the years sampled, at each site, were used in the analyses.**

Additional Tests Required to Conduct SCCWRP Freshwater Analysis

Pollutant of Concern
Arsenic
Chromium
Nickel
Dieldrin
Endrin
Helptachlor Epoxide
Lindane
Pyrethroid Pesticides

Toxicity tests were also conducted according the SQOs and SCCWRP. In 2007, 2008, and 2010, acute toxicity was tested using a ten-day survival test with *Euhaustoriaus*. In 2009 a sublethal, or chronic, test was conducted using *Mytilus galloprovincialis*. The percent survival or growth was scaled to the control, and the SQO was used to identify the toxicity category.

Results and Analysis

The following table reports the raw data and thresholds used in the analyses presented below. Highlighting indicates values that exceeded the most conservative thresholds available.

Sediment Chemistry Results 2007-2010
Shading represents cases where concentrations exceeded relevant sediment criteria.

Constituent	Units	MDL[1]	Arroyo Burro Estuary	Mission Lagoon	Sycamore Lagoon	CSI and CALRM Criteria[2]	Laguna Channel	Bird Refuge	AB Torino	LPC Modoc	MC Gutierrez	OMC W Anapaum	SC Cacique	PEC[3]
Metals, mg/kg **2007 2008 2009 2010**														
Cadmium	mg/kg	 0.14	0.513 0.405 0.75 0.373	0.179 0.173 0.16 ND	0.349 0.708 0.09 ND	NA/0.49	0.998 0.629 0.65 1.25	 0.446 0.42 0.874	 ND	 0.597	 ND	 0.251	 0.183	4.98
Copper	mg/kg		13.5 8.58 13.3 20.2	7.98 8 5.7 9.06	13.2 15.6 8.8 7.15	52.8/77	19.5 21 16.8 30.2	 57.9 19.9 58.4	 8.67	 6.97	 6.73	 7.77	 10	149
Lead	mg/kg		4.39 7.15 7.3 13.3	5.41 13.9 6.4 8.66	4.96 6.84 7.3 5.84	26/26.4	37.1 26.4 19.8 34.9	 18 10.2 29.5	 4.82	 7.17	 5.46	 7.28	 10.4	128
Mercury (not tested in 2010)	mg/kg	0.013 0.013 0.01	ND ND 0.038	ND 0.0317 ND	ND 0.0215 ND	0.09/0.58	0.0387 0.0329 0.046	0.0291 0.032						1.06
Zinc	mg/kg		39 35.1 56.5 64.6	29.7 31.4 24.6 33.2	21.8 57 32.2 24.4	112/66	109 81.3 113 186	 33.7 36.9 114	 24.4	 32.5	 23.9	 40.8	 36.2	459
Arsenic	mg/kg		2.42 3.45 6.39	2.03 2.59 4.31	2.66 4.44 3.23	n/a	3.82 3.9 5.6	 2.51 7.21	 3.32	 2.74	 3.47	 1.14	 4.62	33
Chromium	mg/kg		16 20.2 45.9	14.9 11.8 15.6	10.5 29.2 11.3	n/a	13.4 11.5 19.6	9.15 43.7	 18.8	 26.1	 9.06	 16.6	 14	111
Nickel	mg/kg		24 21.4 48	13.1 11.4 11.4	12.7 32.5 11.3	n/a	13.7 10.8 16.4	12.2 39.5	 18.1	 14.8	 8.35	 15.3	 13.4	48.6
Selenium	mg/kg	0.308 0.328	ND 1.9 0.598	ND 1.58 0.181	ND 3.95 0.223	n/a	ND 2.85 1.15	ND 2.3	 0.200	 0.257	 0.136	 0.234	 0.569	n/a
Silver	mg/kg	0.015 0.009	ND ND 0.258	ND ND 0.153	ND ND 0.222	n/a	0.229 0.33 0.408	ND 0.600	 0.274	 0.202	 0.223	 0.151	 0.236	n/a

PAHs (not tested in 2009) 2007 2008 2010	Units	MDL	Arroyo Burro	Mission	Sycamore	CSI and CALRM Criteria	Laguna	Bird Refuge	AB Torino	LPC Modoc	MC Gutierrez	OMC W Anapamu	SC Cacique	PEC
Total LMW PAHs	µg/kg	<15 for all PAHs	ND 171 124	ND 223 35	ND 129 9	85.4/1700	909 384	77						n/a
Naphthalene	µg/kg	1.39	ND 130 13.8	ND 80 4.01	ND 96 ND		20 160	ND						561
Acenaphthylene	µg/kg	1.39	ND ND ND	ND ND ND	ND ND ND		ND ND	ND						n/a
Acenaphthene	µg/kg	1.39	ND ND ND	ND ND ND	ND ND ND		140 ND	ND						n/a
Fluorene	µg/kg	1.39	ND ND 2.3	ND ND 1.64	ND 11 ND		ND ND	ND						536
Phenanthrene	µg/kg		ND ND 16.1	ND 23 7.96	ND ND 1.78		39 32	ND						1170
Anthracene	µg/kg	1.39	ND ND 3.18	ND ND 1.77	ND ND ND		50 ND	ND						845
Fluoranthene	µg/kg		ND ND 44.1	ND 67 19.7	ND ND 3.93		410 72	33						2230
Pyrene	µg/kg		ND 41 42.7	ND 53 17.9	ND 22 2.99		250 120	44						1520
Total HMW PAHs	µg/kg		ND 71 194	ND 169 104	ND 404 33	312/5500	328 1165	ND						n/a
Benzo (a) Anthracene	µg/kg		ND 18 39.4	ND 29 20.9	ND ND 6.86		54 40	ND						1050
Chrysene	µg/kg		ND 27 56.1	ND 49 26	ND 14 8.79		72 78	ND						1290
Benzo (b) Fluoranthene	µg/kg		ND ND	ND ND	ND ND		54 ND	ND						n/a

			17.1	11.1	5.21									
Benzo (k) Fluoranthene	µg/kg		ND 60 9.46	ND 16 11.4	ND 390 2.99		40 1000	ND						n/a
Benzo (a) Pyrene	µg/kg		ND ND 11.4	ND 27 6.69	ND ND 3.23		41 ND	ND						1450
Dibenz (a,h) Anthracene	µg/kg	 1.39	ND ND 15.9	ND ND 12.7	ND ND ND		ND ND	ND						n/a
Benzo (g,h,i) Perylene	µg/kg		ND 11 13.7	ND 17 10	ND ND 6.32		35 ND	ND						n/a
Indeno (1,2,3-c,d) Pyrene	µg/kg	 1.39	ND ND 23	ND 31 16.3	ND ND ND		32 47	ND						n/a
1-Methylnapthalene	µg/kg	 1.39	ND 3.89	ND ND	ND ND		ND	ND						n/a
2-Methylnapthalene	µg/kg	 1.39	ND 4.68	ND ND	ND ND		ND	ND						n/a
Total PAHs	µg/kg		ND 242 319	ND 392 139	ND 533 42		1237 1549	77						22800
Chlorinated Pesticides 2007 2008 2009 2010	**Units**	**MDL**	**Arroyo Burro**	**Mission**	**Sycamore**	**CSI and CALRM Criteria**	**Laguna**	**Bird Refuge**	**AB Torino**	**LPC Modoc**	**MC Gutierrez**	**OMC W Anapaum**	**SC Cacique**	**PEC**
Chlordane, alpha	µg/kg	4 1 0.15 1.22-6.14	ND ND 1.5	ND ND 0.45	ND ND ND	0.5/4	ND ND 1.3 12.8	 ND ND	 ND	 2.92	 ND	 5.94	 2.38	17.6
Chlordane, gamma	µg/kg	4 4 0.14 1.22-6.14	ND ND 2.7	ND ND 0.86	ND ND 0.32	0.54/n/a	12 9.7* 4.8 13.4	 ND ND	 ND	 2.24	 ND	 4.57	 2.04	17.6
DDDs, total	µg/kg	<0.68 <0.68 <0.2 1.14-6.14	ND ND 1.31	ND ND 0.16	0.37 ND ND	0.5	3.39 ND 2.9 ND	 0.33 ND	 ND	 ND	 ND	 ND	 4.95	28
DDEs, total	µg/kg	<.68 <0.68 <0.2 <1.73	ND ND 1.9 ND	ND ND 0.4 ND	0.55 ND 0.28 ND	0.5	2.6 1.2 2.3 ND	 0.98 ND	 ND	 ND	 ND	 ND	 ND	31.3

DDTs, total	µg/kg	<0.68 <0.68 <0.1 1.14-6.14	ND ND 0.51	ND ND 0.18	ND ND 0.16	0.5	0.73 ND 2.1 ND	ND ND	ND	ND	ND	ND	4.41	62.9
Total DDT	µg/kg		ND ND 3.72	ND ND 0.74	0.92 ND 0.76	n/a	6.72 1.2 7.3 ND	1.31 ND	ND	ND	\ ND	ND	9.35	572
Dieldrin	µg/kg	1.14-6.14	ND ND 2.1	ND ND 0.29	ND ND ND	na/2.7	ND ND 2.2 ND	ND ND	ND	ND	ND	ND	ND	61.8
trans-Nonachlor 2009 2010	µg/kg	1.14-6.14	2.3	0.64	0.29	4.7	2.5 11.3	ND	ND	3.77	ND	6.31	2.54	n/a
Endrin	µg/kg	1.14-6.14	ND ND	ND ND	ND ND	n/a	0.25 ND ND	ND ND	ND	ND	ND	ND	ND	207
Heptoclor epoxide	µg/kg	1.14-6.14	ND ND	ND ND	ND ND	n/a	ND ND ND	ND ND	ND	ND	ND	ND	ND	16
Lindane	µg/kg		ND ND	ND ND	ND ND	n/a	ND ND ND	ND ND	ND	ND	ND	ND	ND	4.99
All other EPA 8081A (Chlorinated Pesticides)	µg/kg		ND ND	ND ND	ND ND	n/a	ND ND	ND						n/a
Pyrethroids (EPA 8270CmNCI)	**Units**		**Arroyo Burro**	**Mission**	**Sycamore**	**CSI and CALRM Criteria**	**Laguna**	**Bird Refuge**	**AB Torino**	**LPC Modoc**	**MC Gutierrez**	**OMC W Anapaum**	**SC Cacique**	**SCCW RP LC 50**
Bifenthrin	ng/g dry	0.57-3.07	ND ND 6.7 0.972	ND ND 2.4 ND	ND ND ND ND	n/a	ND ND 7.1 6.11	3 ND ND	ND	ND	ND	2.31	ND	4.5
Cyfluthrin	ng/g dry	0.57-3.07	ND ND ND ND	ND ND ND ND	ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	13.7
Deltamethrin	ng/g dry	0.57-3.07	ND ND ND ND	ND ND ND ND	ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	9.9
Esfenvalerate	ng/g dry	0.57-3.07	ND ND ND ND	ND ND ND ND	ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	24
Lambda-cyhalothrin	ng/g dry	0.57-3.07	ND ND ND ND	ND ND ND ND	ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	5.6

Permethrin	ng/g dry	29-153	ND ND ND ND	ND ND ND ND	ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	90
All other EPA 8270	ng/g dry	0.57-3.07	ND ND ND ND	ND ND ND ND	ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	n/a
Other Pesticides and Herbicides	**Units**		**Arroyo Burro**	**Mission**	**Sycamore**	**CSI and CALRM Criteria**	**Laguna**	**Bird Refuge**	**AB Torino**	**LPC Modoc**	**MC Gutierrez**	**OMC W Anapaum**	**SC Cacique**	**SCCW RP LC 50**
EPA 8141A (Organophosphorus Pesticides) Not sampled in 2009.	µg /kg		ND ND	ND ND	ND ND	n/a	ND ND	ND						n/a
EPA 8151A (Chlorinated Herbicides) Not sampled in 2009	µg/kg		ND ND	ND ND	ND ND	n/a	ND ND	ND						n/a
Fipronil (phenylpyrazole insecticide) . Only tested in 2009, 2010	µg/kg	43-233	ND ND	ND ND	ND ND	n/a	ND ND	ND ND						n/a
Pentachlorophenol (2010)	µg/kg	57-301					ND	ND	ND	ND	ND	ND	ND	
PCBs	µg/kg		ND ND 1.13	ND ND 0.70	ND ND 1.16	11.9/325	36 ND 6.92	ND						676

-"Probable Effects Concentration" (PEC) refers to the concentration above which probable toxic effects would be predicted (Macdonald, et al., 2006).
-SCCWRP LC50 are described below and taken from the Habitat Value of Urban Streams (SCCWRP, 2008).
-"n/a" means that the compound was not included in the analysis and that no guidelines have been identified.
-Chlorinated pesticides: Alpha-BHC; Gamma-BHC; Beta-BHC; Heptachlor; Delta-BHC; Aldrin; Heptachlor Epoxide; Endosulfan I; Dieldrin; 4,4'-DDE; Endrin; Endrin Aldehyde; 4,4'-DDD; Endosulfan II; 4,4'DDT; Endosulfan Sulfate; Methoxychlor; Chlordane; Toxaphene; Endrin Ketone
-Pyrethroids (8270): Allethrin, Bifenthrin, Cyfluthrin, Cypermethrin, Danitol, Deltamethrin, Esfenvalerate, Fenvalerate, Fluvalinate, L-Cyhalothrin, Permethrin, Prallethrin, Resmethrin
Organophosphorus pesticides: Azinphos Methyl; Bolstar; Chlorpyrifos; Coumaphos; Demeton-o; Demeton-s; Diazinon; Dichlorvos; Disulfoton; Ethoprop; Fensulfothion; Fenthion; Malathion; Merphos; Methyl Parathion; Mevinphos; Naled; Phorate; Ronnel; Stirophos; Tokuthion; Trichloronate

Sediment Toxicity for Estuarine Sites (All Data Scaled to Control)

Year	Test	Endpoint	Arroyo Burro Estuary	Mission Lagoon	Sycamore Lagoon
2007	Acute, Euhastoriaus 10-day	% Survival	99	98	98
2008	Acute, Euhastoriaus 10-day	% Survival	90*	92*	95*
2009	Chronic, Mytilus	% Normal	91	90	95
2010	Acute, Euhastoriaus 10-day	% Survival	99	100	98

Sediment Toxicity for Freshwater Sites (All Data Scaled to Control)

Year	Test	Endpoint	Laguna Channel	Bird Refuge	AB Torino	LPC Modoc	MC Gutierrez	OMC W. Anapamu	SC Cacique
2007	Acute, Euhastoriaus 10-day	% Survival	100						
2008	Acute, Euhastoriaus 10-day	% Survival	92*	93*					
2009	Chronic, Mytilus	% Normal	99						
2010	Acute, Hyalella	% Survival	99	100	100	100	100	100	100

* Results are significantly different from the control ($p<0.05$).

Estuarine Sites - SWRCB Sediment Quality Objective Analysis

Chemistry Line of Evidence- The data were used to follow the steps outlined in the SQO to determine the sediment condition based on chemistry and toxicity. The chemistry LOE is used to assess the potential risk to benthic organisms from toxic pollutants in surficial sediments. The sediment chemistry LOE is intended only to evaluate overall exposure risk from chemical pollutants. This LOE does not establish causality associated with specific chemicals.

For each constituent, exposure categories are described in the following table:

Exposure Level	Score	Predicted Effect on Biota
Minimal	1	Sediment-associated contamination may be present, but exposure is unlikely to result in effects.
Low	2	Small increase in pollutant exposure that may be associated with increased effects, but magnitude or frequency of occurrence of biological impacts is low.
Moderate	3	Clear evidence of sediment pollutant exposure that is likely to result in biological effects; an intermediate category.
High	4	Pollutant exposure highly likely to result in possibly severe biological effects; generally present in a small percentage of the samples.

1. The Chemical Score Index (CSI), which predicts the degree of benthic community disturbance, was computed for each estuarine site and constituent. Maximum scores observed over four years were used in the analysis. Scores above 1 indicate constituents of concern. A weighted score each constituent is calculated, and then averaged to result in a weighted average for each site. The weighted average is used to determine the overall disturbance category, based on the SQO.

Chemical Score Index (Based on SQO)

	AB	MC	SC
Copper	1	1	1
Lead	1	1	1
Mercury	1	1	1
Zinc	1	1	1
PAHs low	2	2	2
PAHs high	1	1	2
Chlordane, alpha	3	1	1
Chlordane, gamma	3	2	2
DDDs	2	1	2
DDEs	2	1	2
DDTs	2	1	1
PCBs	1	1	1
Weighted Average	1.6	1.1	1.3
Category Assigned	Minimal	Minimal	Minimal
Score Assigned	1	1	1

2. The California Logistic Regression Model (CALRM) was used to predict the probability of sediment toxicity based on concentrations of each constituent. The maximum probability for each site is calculated, and used to identify a category of response. The maximum observed concentration observed over the three years of sampling was used for each compound and site. Probabilities of ≥ 0.33 are considered indicative of probable toxicity, and are highlighted in the table below. Cadmium was the most comment constituent to exceed.

CA Logistic Regression Model

Constituent	AB	MC	SC
Cadmium	0.47	0.11	0.45
Copper	0.10	0.04	0.08
Lead	0.18	0.19	0.09
Mercury	0.02	0.02	0.01
Zinc	0.32	0.19	0.29
PAHs, high	0.03	0.02	0.05
PAHs, low	0.07	0.08	0.06
Chlordane, alpha	0.07	0.01	0.00
Dieldrin	0.27	0.04	0.00
trans-Nonachlor	0.09	0.01	0.00
PCBs	0.05	0.01	0.01
p,p' DDT	0.01	0.00	0.00
Maximum P	0.47	0.19	0.45
Score	2	1	2
Category Assigned	Low	Minimal	Low

3. *An integration of sediment chemistry* categories is conducted by averaging the score using the two methods, and rounding up to the nearest integer.

Integration of Sediment Chemistry

Site	Chemical Score Index	California Logistic Regression Model	Average, Rounded to Nearest Integer	Integration of Sediment Chemistry Guidelines, Disturbance Category
Arroyo Burro	1	2	2	Low
Mission	1	1	1	Minimal
Sycamore	1	2	2	Low

5. *Potential for Chemically Mediated Effects* - The SQO was used to combine the chemistry and toxicity data to determine the *potential* for chemically mediated effects at each site. At all sites in all years, the toxicity tests were considered nontoxic. Therefore, it is possible that chemicals contained in the sediment at levels of concern are not bioavailable.

Potential for Chemically Mediated Effects, Determined by Chemistry and Toxicity

Site	Potential for Chemically Mediated Effects
Arroyo Burro	Minimal Potential
Mission	Minimal Potential
Sycamore	Minimal Potential

<u>Freshwater Sites – SCCWRP</u>

An integration of chemistry data, per SCCWRP, was conducted for freshwater sites. *The highest concentrations found for each constituent were used in the analysis.* First, Probably Effect Concentration (PEC; the concentration at which toxic effects are predicted) quotients were calculated by dividing the result by the PEC. PEC quotients are considered problematic when they are greater than 1, i.e. when the result exceeds the PEC. The average PEC quotient is calculated for As, Cd, Cr, Cu, Pb, Ni, Zn, total PAHs, PCBs, and sum of DDEs. Samples with a mean PEC quotient for all constituents of >0.5 are considered toxic. As shown in the table below, no sites exceeded single or grouped constituent Probable Effect Concentrations (PECs), nor did the mean PECqs exceed the threshold of 0.5.

Probable Effects Concentration Quotients (PECq)

Constituent PECq	**Laguna (n=4)**	**Bird Refuge (n=3)**	**AB Torino (n=1)**	**LPC Modoc (n=1)**	**MC Guiterrez**	**OMC W. Anapamu (n=1)**	**SC Cacique (n=1)**
Cadmium	0.25	0.18	0.00	0.12	0.00	0.05	0.04
Copper	0.20	0.39	0.06	0.05	0.05	0.05	0.07
Lead	0.29	0.23	0.04	0.06	0.04	0.06	0.08
Zinc	0.41	0.25	0.05	0.07	0.05	0.09	0.08
Arsenic	0.17	0.22	0.10	0.08	0.11	0.03	0.14
Chromium	0.18	0.39	0.17	0.24	0.08	0.15	0.13
Nickel	0.34	0.81	0.37	0.30	0.17	0.31	0.28
Total PAHs	0.07	0.00	ns	ns	ns	ns	Ns
DDEs, total	0.08	0.03	0.00	0.00	0.00	0.00	0.00
PCBs	0.05	0.00	ns	ns	ns	ns	ns
Mean PECq	0.20	0.25	0.10	0.11	0.06	0.09	0.10

For pyrethroids, the LC50 quotients (concentration/LC50) are calculated for the constituents that have LC50s, and the mean pyrethroid LC50 quotient is calculated. The mean LC50 quotients for each site, using the maximum concentration observed, is shown in the following table. There were no identified toxicity problems using this averaging method; however, the levels of bifenthrin are concerning. Toxicity tests did not reveal toxicity problems in sediments.

LC50 Quotients for Pyrethroids

Pyrethroid	**Laguna**	**Bird Refuge**	**AB Torino (n=1)**	**LPC Modoc (n=1)**	**MC Guiterrez**	**OMC W. Anapamu (n=1)**	**SC Cacique (n=1)**
Bifenthrin	1.58	0.67	ND	ND	ND	0.51	ND
Cyfluthrin	ND	ND	ND	ND	ND	ND	ND
Deltamethrin	ND	ND	ND	ND	ND	ND	ND
Esfenvalerate	ND	ND	ND	ND	ND	ND	ND
Lambda-cyhalothrin	ND	ND	ND	ND	ND	ND	ND
Permethrin	ND	ND	ND	ND	ND	ND	ND
Mean LC50 Quotient	**0.26**	**0.11**	**0**	**0**	**0**	**0.09**	**0**

Conclusions

Site Assessment - According to the analysis conducted here on estuarine sites, Arroyo Burro Estuary, Mission Lagoon, Sycamore Lagoon have "minimal potential for a chemically mediated effect on the benthic community" and the Bird Refuge and Laguna Channel are "unlikely to cause toxicity." Laguna Channel, which is almost entirely developed, has the highest concentrations of most constituents. Toxicity tests from each site had "nontoxic" results according to the SQO criteria. A bioassessment study would be required to determine if the sites are truly not impacted at a biological level. It is important to reiterate that this conclusion is based on the conservative decision to use the maximum constituent values observed over the one to four years of sampling (number of years depends on the site and constituent). Some constituents were missing from the analysis.

Constituents of concern – Compounds which exceeded the most conservative sediment quality criteria include: low molecular weight PAHs, chlorinated pesticides (chlordane, DDDs, DDEs, DDTs), cadmium, and pyrethroid pesticides (bifenthrin). These compounds have been tested in storm water runoff but with the exception of cadmium, have not been detected, likely because they are sequestered in sediments. Because most of the compounds are very insoluble in water, they can partition onto sediments and can remain there for long periods of time. The chlorinated pesticides detected are all legacy compounds, meaning they have been banned for some time and are no longer discharged to the environment. DDT was banned from use in the United States in 1972 and chlordane was banned in 1988. DDE and DDD are breakdown products of DDT. Pyrethroids have grown in use in recent years, primarily to control termites, and are highly toxic to aquatic invertebrates. Bifenthrin was detected at several sites, but criteria only exist for the freshwater sites. Polycyclic aromatic hydrocarbons (PAHs) and cadmium are likely from transportation sources, including fossil-fuel exhaust, runoff from road and parking lot seal coats, and wear of break linings.

Recommendations for FY12 Sampling
Recommendations will be completed in the following quarterly report.

References:
SWRCB SQO: http://www.swrcb.ca.gov/water_issues/programs/bptcp/docs/sediment/sed_qlty_part1.pdf

SCCWRP Analysis:
Habitat Value and Treatment Effectiveness of Freshwater Urban Wetlands, 2008.
ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/559_HabValFreshwaterUrban.pdf

Macdonald, D.D., Ingersoll, C.G., and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39, 20-31.

<u>WHAT IS THE IMPACT OF EUTROPHICATION ON SANTA BARBARA CREEKS?</u>
This section will be completed in the following quarterly report.

IV. STORM MONITORING

Additional storm monitoring data will be presented in the following quarterly report.

<u>WHAT ARE THE HIGHEST CONCENTRATIONS OF POLLUTANTS DURING FIRST FLUSH STORM EVENTS?</u>

<u>First flush sampling at integrator sites (October 6, 2010)</u>

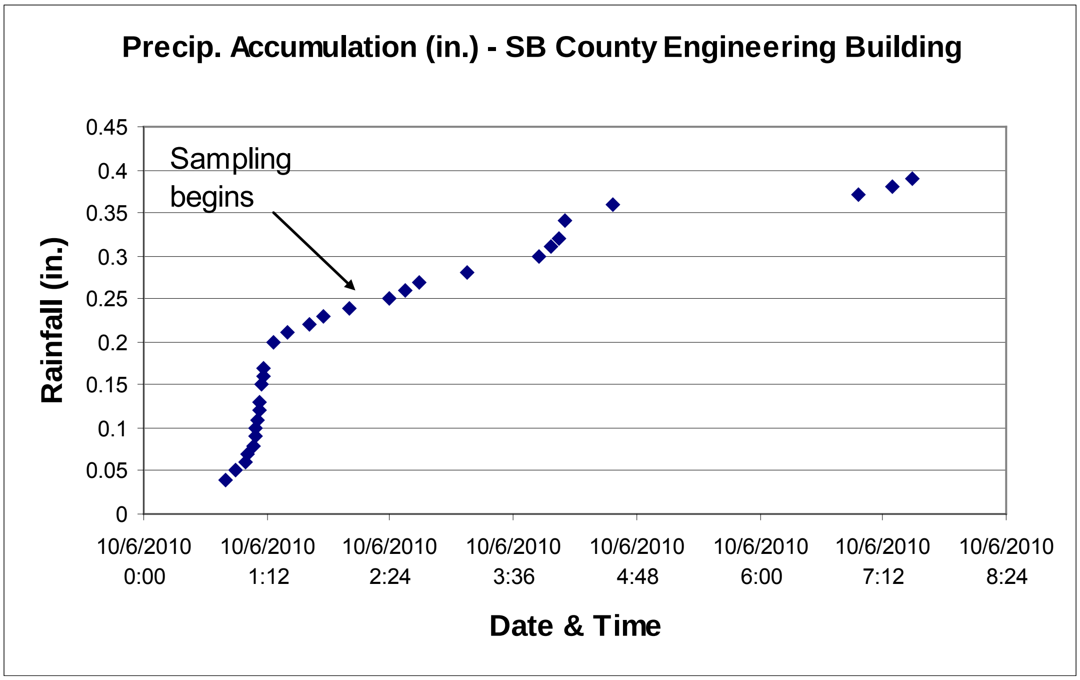
Introduction

The goal of this sampling event was to catch the “first flush” storm of the 2010-2011 water year: the first storm of the season to cause substantial runoff to the creeks. A first flush event such as this should typically produce the highest concentrations of polluted runoff of the year, as the first substantial rain washes away pollutants that have been collecting since the previous rainy season.

An early-season storm was predicted to hit the Santa Barbara area early Wednesday, October 6th. Rainfall was expected to reach 1 inch in most coastal areas, with as much as 2 inches in the coastal mountains.

At approximately 12:30 AM, when the significant rainfall was imminent, the decision was made by Jim Rumbley to come to the office and prepare for sampling.

One staff member, Jim Rumbley, participated in the sampling. Once in the field, runoff and flow were sufficient for sampling at the Catch Basin at Cota and Voluntario (CB-H07-07), Catch Basin at the corner of Gutierrez and Quarantina (CB-H08-29), MacKenzie Park parking lot drop inlet, Serena Drain, Laguna Channel at Chase Palm Park, Mission Creek at Montecito Street, Arroyo Burro at Cliff Drive, and Sycamore Creek at the railroad bridge. These sites were sampled between 1:55 AM and 7:15 AM.



Cumulative rainfall through the duration of the storm, using rainfall amounts recorded at the City of Santa Barbra Engineering Building.

This graph shows cumulative rainfall through the duration of the storm, using rainfall amounts recorded at the City of Santa Barbra Engineering Building.

Methods

At each site, samples were collected from the stream using either a) a plastic bucket and rope lowered off of a bridge or b) a plastic beaker dipped directly into the stream. The bucket and/or beaker were rinsed thoroughly at each site before use. Sample bottles were filled directly from the bucket and/or beaker in the field. In-stream parameters were measured using the Creeks multi-meters.

After sampling was completed, coolers were packed with ice and brought back to the office for pickup by the Test America courier on the same day at 2:00 PM.

The next week, rainfall totals for the October 6th storm showed that a total of 0.36 inches had fallen over the course of the storm at the County of Santa Barbara Engineering Building. The total was checked on the County of Santa Barbara Public Works website: http://contrail.onerain.com. Results from this storm study are summarized in a table below.

Results

The following table summarizes the results from the laboratory analysis. Constituents that exceeded water quality criteria are highlighted in yellow. Note that criteria used for total metals are outdated (no current criteria exist). However these outdated criteria help to illustrate the relative impacts of these pollutants. "ND" means that a constituent was not detected.

Integrator Sites

Constituent	AB Cliff (Arroyo Burro at Cliff Drive)	LC CPP (Laguna Channel at Chase Palm Park)	MC Monteci (Mission Creek at Montecito Street)	SC Railroa (Sycamore Creek at railroad bridge)	Criteria in mg/L unless otherwise noted (source)
Metals (mg/L)					
Arsenic, total	ND	ND	ND	ND	0.15 (EPA CCC, old)
Cadmium, total	ND	ND	ND	ND	.00027 (EPA CCC, old)
Calcium, total	25.7	41.9	22	111	no criteria
Chromium, total	0.013	ND	0.0088	0.025	.086 (EPA CCC, old)
Copper, total	0.019	0.049	0.036	0.018	.0094 (EPA CCC, old)
Copper, dissolved	ND	0.02	0.018	ND	need
Lead, total	ND	0.011	0.011	0.0069	.0053 (EPA CCC, old)
Mercury, total	ND	ND	ND	ND	.00091 (EPA CCC, old)
Nickel, total	0.017	0.011	0.01	0.028	.052 (EPA CCC, old)
Silver, total	ND	ND	ND	ND	
Zinc, total	0.047	0.19	0.087	0.056	.12 (EPA CCC, old)
Pesticides and Herbicides					

Chlorinated herbicides, EPA 8151A[1] (µg/L)	ND (except Pentachlorophenol - 0.097 µg/L)	ND (except Pentachlorophenol - 0.35 µg/L)	ND (except Pentachlorophenol - 0.56 µg/L)	ND (except Pentachlorophenol - 0.16 µg/L)	no criteria
Organochlorine pesticides, EPA 625(m) C[2] (ng/L)	ND	ND	ND (except Chlordane-gamma - 5.25 ng/L)	ND	no criteria
Organophosphorus Pesticides, EPA 8141A[3] (µg/L)	ND	ND	ND	ND	limited criteria[4]
Synthetic Pyrethroid Insecticides, GC/MS NCI-SIM[5] (ng/L)	ND	ND	ND	ND	no criteria
Carbaryl (Insecticide), EPA 531.1 (µg/L)	ND	ND	ND	ND	no criteria
Other					
Gasoline Range Organics (C6-C12)	ND	ND	ND	ND	need
Extractable Fuel Hydrocarbons (C13-C40)	0.66	1.3	0.96	ND	need
Toxicity - Minnows % Survival (TUa)	N/A	100% (0)	N/A	N/A	0.3 (OP)
Toxicity - Ceriodaphnia % Survival (TUa)	100% (0)	100% (0)	100% (0)	100% (0)	0.3 (OP)
Toxicity - % concentration at which 25% of Selenastrum algae growth inhibited (TUc)	100% (0)	57.03% (>1)	100% (0)	100% (0)	need
Iron, total	7.6	4.3	5.4	9.3	no criteria
Magnesium, total	10.7	15.2	6.8	53.1	no criteria
Manganese, total	0.58	0.47	0.3	0.5	no criteria
Potassium, total	5.2	9.3	7.6	8.8	no criteria
Sodium, total	18.5	52.4	13.2	85.7	no criteria

Storm Drain and LID Sites

Constituent	CB-H08-29 (Gutierrez and Quarantina)	MacKenzie (MacKenzie Park parking lot)	Serena Drain (Serena Drain at Mission Creek)	Criteria in mg/L unless otherwise noted (source)
Metals (mg/L)				
Arsenic, total	ND	ND	ND	0.15 (EPA CCC, old)
Cadmium, total	ND	ND	ND	.00027 (EPA CCC, old)
Calcium, total	17.6	6.4	9	no criteria
Chromium, total	ND	ND	ND	.086 (EPA CCC, old)
Copper, total	0.15	0.013	0.019	.0094 (EPA CCC, old)

Copper, dissolved	0.013	0.01	0.01	need
Lead, total	0.022	ND	0.0061	.0053 (EPA CCC, old)
Mercury, total	ND	ND	ND	.00091 (EPA CCC, old)
Nickel, total	0.011	ND	0.0056	.052 (EPA CCC, old)
Silver, total	ND	ND	ND	
Zinc, total	0.43	0.084	0.11	.12 (EPA CCC, old)
Pesticides and Herbicides				
Chlorinated herbicides, EPA 8151A[1] (µg/L)	ND (except Pentachlorophenol - 0.39 µg/L)	ND	ND (except Pentachlorophenol - 0.14 µg/L)	no criteria
Organochlorine pesticides, EPA 625(m) C[2] (ng/L)	ND (DCPA (Dacthal) - 7.99 ng/L)	ND (except Chlordane-alpha - 1.79 ng/L, Chlordane-gamma - 2.49 ng/L, and DCPA (Dacthal) - 8.23 ng/L)	ND (except Chlordane-alpha - 2.0 ng/L, Chlordane-gamma - 3.4 ng/L, and trans-Nonachlor - 3.29 ng/L)	no criteria
Organophosphorus Pesticides, EPA 8141A[3] (µg/L)	ND (except Malathion - 0.94 µg/L)	ND	ND	limited criteria[4]
Synthetic Pyrethroid Insecticides, GC/MS NCI-SIM[5] (ng/L)	ND	ND	ND	no criteria
Carbaryl (Insecticide), EPA 531.1 (µg/L)	ND	ND	ND	no criteria
Other				
Gasoline Range Organics (C6-C12)	ND	ND	ND	need
Extractable Fuel Hydrocarbons (C13-C40)	2.0	2.8	0.51	need
Toxicity - % Survival of minnows (TUa)	25% (>1)	50% (1)	100% (0)	0.3 (OP)
Iron, total	0.95	1.1	2.5	no criteria
Magnesium, total	3.7	2.7	2.2	no criteria
Manganese, total	0.094	0.08	0.068	no criteria
Potassium, total	9.3	12.1	3.7	no criteria
Sodium, total	13.9	4	3.4	no criteria

[1] Chlorinated herbicides (8151 A): Dalapon; Dicamba; MCPP; MCPA; Dichlorprop; 2,4-D; 2,4,5-TP; 2,4,5-T; 2,4-DB; Dinoseb, Pentachlorophenol,

[2] Organochlorine pesticides (EPA 625(m) C): 2,4'-DDD; 2,4'-DDE; 2,4'-DDT; 4,4'-DDD; 4,4'-DDE; 4,4'-DDT; Alachlor; Aldrin; Alpha-BHC; Beta-BHC; Chlordane-alpha; Chlordane-gamma; cis-Nonachlor; DCPA (Dacthal); Delta-BHC; Dicofol (Kelthane); Dieldrin; Endosulfan I; Endosulfan II; Endosulfan sulfate; Endrin; Endrin aldehyde; Endrin ketone; Fipronil; Gamma-BHC (Lindane); Heptachlor; Heptachlor epoxide; Methoxychlor; Mirex; Oxychlordane; Perthane; trans-Nonachlor

[3] Organophosphorus pesticides (8141 A): Azinphos Methyl; Bolstar (Sulprofos); Chlorpyrifos; Coumaphos; Demeton; Total (Qualitative only); Diazinon; Dichlorvos; Dimethoate, Disulfoton; EPN, Ethoprop; Famphur, Fensulfothion; Fenthion; Malathion; Parathion-methyl Parathion-ethyl; Mevinphos; Parathion, Phorate; Ronnel; Stirophos (Tetrachlorvinphos); Sulfotepp; Thionazin; Tokuthion; Trichloronate (Prothiofos). These are in the EPA method, but results were not given:
Azinphos Ethyl, Carbophenothion, Chlorfenvinphos, Chlorpyrifos Methyl, Crotoxyphos, Dichlorofenthion, Dichrotophos, Dioxathion, Ethion, Fenitrothion, Fonophos, Leptophos, Merphos, Monocrotophos, Naled, o, o, o – Triethyl, Phosmet, Phosphamidon, TEPP, Terbufos, Trichlorfon

[4] Criteria are limited. Criteria do not exist for some constituents. Criterion for Malathion (.0001 mg/L) is less than the minimum detection limit (.0012 mg/L) therefore it is unknown if criteria was exceeded. Criterion for Parathion (.000013 mg/L) was not exceeded. Criterion for Chlorpyrifos (.000041 mg/L) is less than the minimum detection limit (.0024 mg/L) therefore it is unknown if the criterion was exceeded.

[5] Synthetic Pyrethroid Insecticides (GC/MS NCI-SIM): Allethrin, Bifenthrin, Cyfluthrin, Cypermethrin, Deltamethrin, Dichloran, Esfenvalerate, Fenvalerate, L-Cyhalothrin, Pendimenthalin, Permethrin, Prallethrin, Sumithrin, Tefluthrin

Acronyms used:
EPA- USEPA's Current National Recommended Water Quality Criteria (US EPA, 2005)
EPA old – The EPA no longer provides criteria for total metals, due to effect of other water quality parameters on metal speciation and toxicity.
CTR- California Toxics Rule (US EPA, 2000). Does not supply criteria for total metals.
BP- RWQCB's Basin Plan (CA EPA, 1994). Does not distinguish between CCC and CMC.
CCC- Continuous Concentration Criteria
CMC- Continuous Maximum Concentration
OP- California Ocean Plan (CA EPA, 2005).

Discussion (Integrator Sites)

Total copper exceeded the criteria during this storm at all integrator sites. Last year, only Mission Creek at Montecito St and Sycamore Creek at Ninos exceeded the criteria. Also, total lead exceeded criteria at Sycamore Creek at the railroad bridge, Mission Creek at Montecito St, and Laguna Channel at Chase Palm Park. The only other metal that exceeded criteria was Zinc at Chase Palm Park. Samples were not taken at Sycamore during the first flush last year so comparisons are not possible for this site. Arsenic, cadmium, mercury, and silver were the only metals not detected at all during this storm.

No pyrethroids were detected this year. Last year, pyrethroids were detected at two sites.

Unlike last year's first flush sampling when no chlorinated herbicides were detected, pentachlorophenol was detected at all integrator sites. Pentachlorophenol is a wood preservative commonly used on utility poles.

Organochlorine pesticides were added to the list of constituents tested for this year, and chlordane-gamma was detected in Mission Creek at Montecito St.

The level of pentachlorophenol and chlordane-gamma in the samples did not result in increased toxicity for Fathead Minnows or Ceriodaphnia. All integrator site samples tested for toxicity resulted in 100% survival of minnows and Ceriodaphinia. The only site with toxicity results that differed from the control samples was Laguna Channel at Chase Palm Park. For the Selenastrum algae toxicity test for this site, at a sample concentration of 57.03%, 25% less algae cells were present than in the control sample.

Synthetic pyrethroid insecticides results were all non-detects. Last year, pyrethroids were detected at two sites.

Extractable Fuel Hydrocarbons (suite of petroleum products including Diesel) were detected at all integrator sites except Sycamore Creek at the railroad bridge. Gasoline Range Organics were not detected at any sites.

Discussion (LID Site)

Total copper was the only metal to exceed the criteria during this storm at MacKenzie. Last year, this site exceeded the criteria for total copper and Zinc. This year, Zinc was below the criteria.

No pyrethroids, chlorinated herbicides, or organophosphorus pesticides were detected this year. These tests were not conducted at MacKenzie last year.

Organochlorine pesticides were detected this year. Chlordane-alpha, Chlordane-gamma - 2.49 ng/L, and DCPA (Dacthal) were all detected. During a March 2011 storm, MacKenzie was sampled again for organochlorine pesticides to see if results would be replicated. Results for this sampling event were still pending during preparation of this report and will be discussed in a subsequent report.

Toxicity at the MacKenzie site resulted in 50% survival of minnows.

The results for Extractable Fuel Hydrocarbons at MacKenzie were the highest of any sites tested during this storm. Gasoline Range Organics were not detected at this site.

Discussion (Storm Drain Sites)

Unlike last year, storm drains were sampled during the first flush this year. Total copper exceeded the criteria during this storm at both storm drain sites (Serena Drain and Gutierrez/Quarantina). The only other metals that exceeded criteria were total lead and total zinc at Gutierrez/Quarantina.

No pyrethroids were detected this year.

Pentachlorophenol (chlorinated herbicide) was detected at both storm drain sites this year.

Organochlorine pesticides were detected this year. Chlordane-alpha, chlordane-gamma, trans-Nonachlor were detected at Serena Drain and DCPA (dacthal) was detected at Gutierrez/Quarantina.

One Organophosphorus pesticide (Malathion) was detected at the Gutierrez/Quarantina storm drain.

Synthetic pyrethroid Insecticides results were all non-detects.

Toxicity samples from Serena Drain resulted in 100% survival of minnows. However, only 25% of minnows survived during toxicity testing for the Gutierrez/Quarantina storm drain.

Extractable Fuel Hydrocarbons were detected at both storm drain sites. Gasoline Range Organics were not detected at any sites.

DO CREEKS AND/OR STORM DRAINS IN SANTA BARBARA HAVE PROBLEMS WITH TOXICITY DURING STORM EVENTS?

Toxicity Results from Storm Monitoring 2007-2010

	Toxicity Test (All results scaled to control)	**Unit**	**MC Montecito**	**AB Cliff**	**LC Chase Palm**	**SC Railroad**
First Flush Fall 2007	4 day acute, Fathead minnow	% Survival	100%, 0 TU(a)	95%, .41 TU(a)	100%, 0 TU(a)	not sampled-dry
First Flush Fall 2008	4 day acute, Fathead minnow	% Survival	100%, 0 TU(a)	95%, .41 TU(a)	25%, > 1 TU(a)	not sampled – lab error
First Flush Fall 2009	4 day acute, Fathead minnow	% Survival	100%, 0 TU(a)	100%, 0 TU(a)	100%, 0 TU(a)	100%, 0 TU(a)
First Flush, Fall 2010	4 day acute, Fathead Minnow	% Survival			100%	
First Flush, Fall 2010	4 Day acute, Cerodaphnia	% Survival	100%	100%	100%	100%
First Flush, Fall 2010	Chronic Selenastrum Algae Growth Bioassay	% Cell Count	100%	100%	56%, > 1 TU(a)	100%

Wet Weather Drain and Gutter Samples

All results presented as % survival (over control) and toxicity units.	Date	Test Organism	Result
Haley Drain at MC	November 27, 2006	Fathead Minnow	55% Survival
Hope Drain at AB	November 27, 2006	Fathead Minnow	0% Survival
MacKenzie Parking Lot	December 7, 2009	Fathead Minnow	0%
Parking Lot 4	October 13, 2009	Fathead Minnow	100%
MC Mission Canyon	October 13, 2009	Fathead Minnow	100%
Palermo AB	October 13, 2009	Ceriodaphnia	90% Survival, 62 % Offspring
Hwy 101 Drain at MC	April 20, 2010	Fathead Minnow	100%
Serena Drain at MC	April 20, 2010	Fathead Minnow	100%
Gutter on Stanley Dr.	April 20, 2010	Fathead Minnow	100%
Westside Drain at OMC	April 20, 2010	Fathead Minnow	100%
MacKenzie Parking Lot	October 6, 2010	Fathead Minnow	50%
Serena Drain at MC	October 6, 2010	Fathead Minnow	100%
Gutter on Gutierrez, near Recycling Center	October 6, 2010	Fathead Minnow	25%
Gutter, Cota St. Fresh slurry	October 6, 2010	Ceriodaphnia	0% survival

Copper concentrations and criteria will be reviewed in the next quarterly report.

WHAT ARE THE LOADS OF POLLUTANTS DISCHARGED FROM SANTA BARBARA CREEKS DURING STORMS?

This section will be completed in the following quarterly report.

IS THERE A PROBLEM ASSOCIATED WITH SLURRY SEALING?

In summer 2010, the Creeks Division conducted a continuation of the pilot test for toxicity due to slurry sealing. Stephanie Dolmat-Connell, along with her UCSB mentor Dr. Arturo Keller, completed the study design and field testing.

Summary of Summer 2010 Slurry Seal Testing

Stephanie Dolmat-Connell

Abstract

In the summer of 2010, the Creeks Division decided to continue the exploration of the impact of road slurry seals on water quality that it had started in October 2009 (City of Santa Barbara, 2010). The roads of Santa Barbara are on a five to eight year rotating schedule for reapplication of slurry sealant, resulting in a large number of roads resealed each year. The Creeks Division wanted to further investigate whether the sealing of streets leads to pollution in creeks, due to rain runoff over surfaces and excess contaminated sediment material reaching creeks. The October 2009 pilot project results higher showed a higher level of toxicity in simulated runoff from a recently sealed road compared to a control, and higher levels of polycyclic aromatic hydrocarbons (PAHs) in swept sediments from the slurry site compared to the control site. The Summer 2010

study expanded the 2009 pilot project to include three testing sites and plans were underway to conduct a time-series test of the sealed roads.

Preliminary results of the Summer 2010 testing suggest that runoff from recently slurried roads may have high levels of toxicity and high levels of methyl blue active substances (MBAS, indicating anionic surfactants), though the control sites also had high levels of MBAS. Only one site (De La Vina) had detectable PAHS after the roads were resealed. However, the results of the Summer 2010 investigation should be taken as inconclusive given that the testing procedure was changed mid-testing period in order to see if the results changed the toxicity levels. Indeed, the change in the procedure, which involved using the first half liter of captured water instead of discarding it, did result in higher toxicity levels (0% survival of acute ceriodaphnia). Further testing with a revised procedure that captured the first half liter of water in both the control and post-sealant tests would help to show whether asphalt-based slurry seal applied to roads in Santa Barbara contributes to toxicity in its runoff and creeks.

Prior Research

Previous research efforts have focused on the effects of coal-tar based parking lot sealcoat on water quality and PAHs. Coal-tar based sealant is much more common on the East Coast and South, whereas asphalt sealant is applied more often in California and the West Coast, both in parking lots and on roads (Van Metre et al, 2009). Research efforts in Austin, TX by the USGS found that PAH concentrations in particles washed off sealcoated parking lots were about 65 times higher than parking lots that had not been sealcoated (Mahler et al., 2005). Coal-tar based sealant can contain approximately 50% PAHs by weight (Van Metre et al., 2009), with total PAHs over 50,000 ppm, whereas asphalt-based sealants generally contain concentrations of less than 100 ppm (City of Austin, 2005). Further research conducted at the University of New Hampshire concluded that the presence of coal tar sealant increased the mass of PAHs released in runoff by over an order of magnitude (Watts et al, 2010).

However, none of the prior research has focused on either road application of sealant or asphalt-based slurry seals. The research has also not investigated the effects of surfactants in the emulsifiers required to apply the sealant, whether asphalt or coal-tar based. Surfactants are an important part of the slurry seal process; this process is outlined below:

> Asphalt (bitumen) used in road construction is a solid at room temperature and is nonpolar. In order to permit handling the asphalt in a fluid form, the asphalt is used in the form of an asphalt/water emulsion. To emulsify the asphalt and also to improve its wetting of and adhesion onto polar substrates, specific surfactants are used in the formulation of these emulsions. The surfactants used in the formulations of asphalt emulsions for road construction must play a dual role. They must first reduce the asphalt/water interfacial tension so that the asphalt can be emulsified in the water. However, when the emulsion contacts the road-building material ("aggregate"), the emulsion must wet the aggregate, and the surfactant in it must preferably adsorb onto the aggregate in such fashion as to render it hydrophobic, thereby promoting adhesion to it of the nonpolar asphalt. In addition, this preferred adsorption of the emulsifying surfactant onto the aggregate should cause the emulsion to "break," with consequent deposition of the asphalt onto the now hydrophobic aggregate surface. Since road-building aggregate is usually negatively charged, the majority of surfactants used as emulsifiers are cationic surfactants with C_{12} to C_{20} alkyl chains (Rosen and Dahanayake, 2000).

In sum, the asphalt is liquefied by dispersing it in water, and an emulsion is used so that the final strength of the road material develops as the emulsions set and water is lost (AkzoNobel, ndp). The surfactants found in slurry seals can be both cationic and anionic, as seen in the table below provided by an emulsifier manufacturer.

Typical Emulsifier Use Levels			
Emulsion Type	Emulsifier level %	Emulsion pH	Typical Emulsifier
Cationic Rapid-Setting	0.15-0.25	2-4	tallow diamine
Cationic Medium-Setting	0.3-0.6	1.5-4	tallow diamine
Cationic Slow-Setting	0.8-2.0	2-5	quaternary amine
Anionic Rapid-Setting	0.2-0.4	10.5-12	tall acid
Anionic Medium-Setting	0.4-0.8	10.5-12	tall acid
Anionic Slow-Setting	1.2-2.5	7.5-12	nonionic + lignosulphonate

Source: AkzoNobel (ndp).

City of Santa Barbara Public Works uses all cationic surfactants in the asphalt emulsions for City streets; this is due to the negative charge of the road surfaces, so that the cationic (positive charge) resurfacing binds to the negative charge (Conti, 2010). Both cationic and anionic surfactants have been found to be toxic to aquatic organisms (Sandbacka et al., 2000). There is no simple or standardized method to test for cationic surfactants, whereas for anionic surfactants, there are three EPA-approved methods for testing for the presence of MBAS.

The fact that no research has before been conducted on the surfactant and toxicity nature of the slurry seals, given the foam observed in City of Santa Barbara Creeks after rain storms, prompted the Creeks Division to focus on this aspect of the slurry seals, while also testing for potential PAHs. The pilot project from October 2009 tested one control site (the corporate yard) and one recently slurried site (within one month prior), and found that the recently slurried site contained lower concentrations of metals than runoff from the control site, had similar levels of suspended sediment to the control site, had no detectable PAHs, yet resulted in higher toxicity than the control site. The pilot project also tested swept sediments from each site and found that the recently slurried site had five times higher concentrations of low and high molecular weight PAHs compared to the control site.

Methods

The Creeks Division tested three different sites (Cota St., Sola St., and De La Vina St.) before they were slurry sealed and approximately 24 hours after they were sealed. Two of the sites (Cota and Sola) were also tested one week after the slurry seal was applied, and one site (Cota) was tested during the first flush event during the first rainfall, which occurred approximately two weeks after the road was slurry sealed. The map of the testing sites can be seen below:

At each site, an area was measured at 8' x 5', due to the length of the booms that captured the runoff water. Each site was vacuumed in advance using a new vacuum bag for each site to collect sediment samples. Twenty liters of soft water were then applied to each site via a peristaltic pump, and water was captured as it pooled into the booms and collected via another peristaltic pump. When it was not possible to collect the water via the booms (the resurfaced areas in particular were much too porous for the booms to retain water), the water was instead collected from the gutter with the booms providing a barrier in the gutter to prevent the water from moving into the storm drain. The 20L of water were applied in a systematic way across the testing site, by spraying the nozzle in a horizontally sweeping motion across the testing site, while simultaneously moving down the length of the site and then back up the length of the site. It generally took about 45 minutes to collect the 5L necessary for the testing containers. The first half liter of collected water was discarded in order to ensure that the tested water was the actual water from the test. However, for the one-week samples, the first half liter was retained in order to more accurately reflect the amount of water in a rainstorm. The 20 liters over the square footage of the test area translates into the rain equivalent of 0.2", a comparative amount to a first flush event in Santa Barbara. For the first flush event at the Cota site, actual runoff from a rain event was used instead of the simulated runoff.

The collected water went into a bucket until the 20L were fully discharged. The collected sampled water was then constantly stirred in the bucket and immediately distributed into sampling containers, for each of the following tests: Microtox, 96 hour acute ceriodaphnia survival, methyl-blue active substances (MBAS, for anionic surfactants), cationic surfactants, and PAHs.

Results

The results for each of the tests can be seen in the following chart. The tests that did not discard the first half liter of collected water are marked with a # symbol.

Site	Test Time	Acute Ceriodaphnia Survival in 100% sample (LC50)	Acute Ceriodaphnia Toxicity Units	Microtox EC50 Concentration	Microtox Toxicity Ranking Index	MBAS (mg/L)	PAHs
Sola	Control	100%	0.00	53.57%	Moderately Toxic	1.1	ND
Sola	24 hr	95%	0.41	22.66%	Highly Toxic	ND*	ND
#Sola	1 Week	0%	>1.00	72.42%	Moderately Toxic	2.0	ND
Cota	Control	100%	0.00	N/A	N/A	0.4	ND
Cota	24 hr	90%	0.59	52.22%	Moderately Toxic	0.2	ND
#Cota	1 Week	0%	>1.00	33.16%	Highly Toxic	2.4	ND
#Cota	First flush (2 weeks)	0%	>1.00	N/A	N/A	0.3	ND
DLV	Control	100%	0.00	N/A	N/A	3.3	ND
DLV	24 hr	90%	0.59	N/A	N/A	ND	0.19 ug/L Fluoranthene 0.25 ug/L pyrene

*exceeded maximum allowable hold time

The results of the # tests show a higher toxicity than the 24 hour tests most likely due to the fact that the first half liter was included in these tests. This could be explained if there is exponential leaching of the surfactant, causing the first liter of leaching to have a high concentration of toxic material. A SCCWRB study that simulated rainfall and parking lot runoff found that washoff of all constituents was strongly inversely correlated with rainfall intensity and duration, and that samples collected during the first 10 min of a rain event contained the highest constituent concentrations indicative of a first-flush event (Tiefenthaler et al., 2001).

As expected, MBAS tests for anionic surfactants were not associated with fresh slurry seals. The MBAS criteria for Central Coast inland surface waters, enclosed bays, and estuaries according to the Basin Plan is 0.2 mg/L (CCRWQCB, 1994); most of the samples exceeded this standard, including the control tests. Samples were collected to be tested for cationic surfactants, but not tested. Cationic surfactants were not tested; however, the foaming that was present after the slurry seal was applied could originate from the cationic surfactants. The pictures below demonstrate the foaming present after the slurry seal was applied compared to the control:

De La Vina 24 hrs:

Samples of water runoff from both control and test sites were collected in order to test for cationic surfactants, which were believed to be a potential contributor to the foaming noted in the collection of the samples. Samples of the slurry seal itself were also collected. Initial research was conducted at UCSB to investigate the nature of the slurry seal and whether the seal contained any cationic surfactants. The researcher found "a few soluble compounds in the slurry which are likely to be the surfactants. The concentrations were rather low (Keller, 2010). Because the project was called off, further investigation into the nature of the slurry seal was not conducted, since a significant amount of time would have been necessary to develop a method to identify the type of surfactants. Similarly, investigation into the surfactants potentially within the runoff samples was also not conducted.

Sediments for each area were collected via a bag-sealed DryVac with the expectation of testing the sediments for PAHs. However, given the conflicting results of the preliminary tests, sediment samples were not tested for PAHs, though the sediment samples have been archived. Even though the water samples showed non-detects for PAHs, PAHs both sorb to sediments as well as dissolve in water. Therefore, we could expect to potentially find PAHs in the sediments instead of dissolved in the water.

Discussion

Because the procedure changed mid-project to including the first half liter of water for sampling, there is no control that would show whether the results obtained are significant for the post-slurry seal test. If a control is tested with the first half liter included and there is significant survival for the acute ceriodaphnia test, then the case could begin to be made that the slurry seal contributes to toxicity. Without the knowledge of what happens in a control situation, however, we are unable to identify whether the slurry seal could have contributed to toxicity. Going forward, the procedure should address this discrepancy since the highest concentrations of constituents occur during the first flush period; therefore, the first half liter of water should not be discarded. The revised procedure that should be followed going forward is included as Appendix A.

Additionally, the Microtox toxicity test did not seem to produce reliable results. Three of eight Microtox tests conducted were rendered impossible to calibrate. The Microtox tests also did not seem to correspond with the findings of the acute ceriodaphnia results, conflicting with the results of the cerio five out of eight tests. The Creeks Division should assess whether in the future it would like to continue using this test as a measure of toxicity. The Creeks Division should also assess whether or not it would like to test for pH of the runoff, since pH of the surfactants can vary widely from very acidic to very basic.

Resources

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Appendix A: Revised Slurry Seal Testing Procedure

Materials needed:

- Measuring tape to measure area on street
- Cones to mark off site area
- Permanent marker/labels for sampling containers
- Broom to sweep area of debris before vacuuming
- WetDry Vacuum with new bags (if collecting sediments)
- Generator to run vacuum in the field
- Cooler with ice
- 20L jugs of soft water
- Booms
- 2 Peristaltic pumps, one with spray nozzle attached
- Collection bucket for the samples
- Acute ceriodaphnia collection container
- 40 mL bottle for surfactant and Microtox, if testing
- 200 mL bottle for PAH testing
- MBAS bottle
- pH testing, if applicable

Methods:

1) Three days before sample date, place "No Parking signs in front of testing area."
2) On sample date, gather all materials and go to site. Set up cones, and measure out an area of 8' x 5', preferably where the angle of the road is conducive to collecting water.
3) Sweep the site, then vacuum the swept sediments as well as the site area into an unused vacuum bag. Seal the vacuum bag with masking tape when you are done.
4) Place the booms down angle of where the water will be sprayed, perpendicular to the curb so that it helps stop the flow of water.
5) Spray the water using one peristaltic pump in the testing area in a methodical fashion. Collect the runoff where it gathers in front of the booms using the other peristaltic pump, and collect this water into a bucket. Continue spraying until there is no more water in the jug. Most likely, you will have accumulated one red bucketful of water (about a 2:1 or 3:1 ratio of sprayed water to collected water).
6) Transfer the collected water from the sampling bucket to the separate bottles for testing, stirring constantly before the water is poured into the sampling bottles. Place the labeled sampling bottles in the cooler.
7) The ceriodaphnia test goes to ABC Labs, PAH/MBAS bottles go to TestAmerica. Microtox, if testing, goes to El Estero lab.
8) Clean the collecting peristaltic pump out by pumping clean soft water through it for two minutes before its next use.

Results from previous testing, for comparison:

Constituent	Runoff (water samples)	
	Control (Corporate Yard)	**Fresh Slurry Seal (Portofino)**
Metals, Total (mg/L)		
Arsenic	.01	ND
Cadmium	ND	ND
Chromium	0.021	0.017
Copper	0.140	0.13
Lead	0.04	0.03
Mercury	ND	ND
Nickel	.062	0.072
Zinc	1.4	0.68
PAHs (ug/kg)		
Total LMW PAHs	ns	ND
Naphthalene	ns	ND
Acenaphthylene	ns	ND
Acenaphthene	ns	ND
Fluorene	ns	ND
Phenanthrene	ns	ND
Anthracene	ns	ND
Fluoranthene	ns	ND
Pyrene	ns	ND
Total HMW PAHs	ns	**ND**
Benzo (a) Anthracene	ns	ND
Chrysene	ns	ND
Benzo (b) Fluoranthene	ns	ND
Benzo (k) Fluoranthene	ns	ND
Benzo (a) Pyrene	ns	ND
Dibenz (a,h) Anthracene	ns	ND
Benzo (g,h,i) Perylene	ns	ND
Indeno (1,2,3-c,d) Pyrene	ns	ND
1-Methylnapthalene	ns	ND
2-Methylnapthalene	ns	ND
Total PAHs	ns	**ND**
Other		
Total suspended solids (mg/L)	210	220
Toxicity, Percent Survival	60%	0%
Toxicity, offspring produced as a percent of the control sample	11.4	0

Note: PAHs were not tested in the control runoff due to the sample bottle breaking in transit. Chronic toxicity (10-day) was tested using the organism *Ceriodaphnia*.

<u>Results, Swept Sediment</u>

Sediment swept off of the freshly sealed street:

- Had slightly lower concentrations of metals than sediment from the control site.
- Had five times higher concentrations of low and high molecular weight PAHs compared to the control site.

Constituent	Control (Corporate Yard)	Fresh Slurry Seal (Portofino)
Metals, Total (mg/L)		
Arsenic	0.84	0.062
Cadmium	0.22	0.013
Chromium	5.3	4.5
Copper	8.6	6.3
Lead	3.1	1.4
Mercury	0.033	0.033
Nickel	4.7	4.7
Zinc	93.6	25.6
Acenaphthene	ND	34
Acenaphthylene	ND	34
Anthracene	6.9	34
Fluoranthene	13	8.9
Fluorene	ND	34
Naphthalene	ND	34
Phenanthrene	18	22
Pyrene	9.3	13
Total Low Molecular Weight PAHs	**47.2**	**213.9**
1-Methylnapthalene	ND	ND
2-Methylnapthalene	ND	ND
Benzo (a) Anthracene	25	84
Benzo (a) Pyrene	ND	34
Benzo (b) Fluoranthene	9.2	40
Benzo (g,h,i) Perylene	18	34
Benzo (k) Fluoranthene	ND	34
Chrysene	ND	34
Dibenz (a,h) Anthracene	ND	34
Indeno (1,2,3-c,d) Pyrene	ND	34
Total High Molecular Weight PAHs	**52.2**	**328**
Total PAHs	**99.4**	**541.9**

Slurry Seal Storm Samples (2009 and 2010)

The following table summarizes the results from the laboratory analysis. Constituents that exceeded water quality criteria are highlighted in yellow. Note that criteria used for total metals are outdated (no current criteria exist). However these outdated criteria help to illustrate the relative impacts of these pollutants. "ND" means that a constituent was not detected. "N/A" indicates that that constituent was not tested for. Please refer to first flush results for more information about criteria acronyms.

Constituent	Palermo AB (Storm Drain at Palermo Rd Dead End)	LC LagOrt (Intersection of Laguna & Ortega)	Criteria in mg/L unless otherwise noted (source)
Metals (mg/L)			
Arsenic, total	ND	ND	.15 (EPA CCC, old)
Cadmium, total	ND	ND	.00027 (EPA CCC, old)
Calcium, total	230	170	no criteria
Chromium, total	ND	0.044	.086 (EPA CCC, old)
Copper, total	0.043	0.038	.0094 (EPA CCC, old)
Copper, dissolved	0.036	0.027	0.044, 0.091, 0.031 for these sites (EPA CCC, based on BLM)
Lead, total	ND	ND	.0053 (EPA CCC, old)
Mercury, total	ND	ND	.00091 (EPA CCC, old)
Nickel, total	0.022	0.016	.052 (EPA CCC, old)
Iron, total	0.56	1.1	no criteria
Magnesium, total	17	5.9	no criteria
Manganese, total	0.78	0.12	no criteria
Potassium, total	33	9.6	no criteria
Sodium, total	57	54	no criteria
Zinc, total	0.17	0.28	.12 (EPA CCC, old)
Other			
Total suspended solids (mg/L)	66	N/A	no criteria
Oil and grease (mg/L)	ND	N/A	Visible sheen (BP)
MBAS (mg/L)	1.2	2.6	.2 (BP)
Toxicity - % Survival (TUc)	90% (1)	100% (1)	no criteria
Toxicity - Offspring prod. as % of control (TUc)	62.3% (>2)	99% (1)	no criteria
Dissolved Organic Carbon (mg/L)	160	N/A	no criteria
Chloride (mg/L)	290	N/A	142 (BP)
Sulfate (mg/L)	240	N/A	no criteria
Polycyclic aromatic hydrocarbons (PAH), EPA 8270 C SIM[1] (μg/L)	ND	ND	no criteria

[1] Polycyclic aromatic hydrocarbons (8270 C SIM): Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Benzo(a)pyrene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-c,d)pyrene, Naphthalene, Phenanthrene, Pyrene

These are in the EPA method, but results were not given: Dibenzo(a,j)acridine, Dibenzo(a,e)pyrene, 7,12-Dimethylbenz(a)anthracene, , 1-Methylnaphthalene, 2-Methylnaphthalene

HOW DO RESTORATION/TREATMENT PROJECTS IMPACT WATER QUALITY DURING STORM EVENTS?

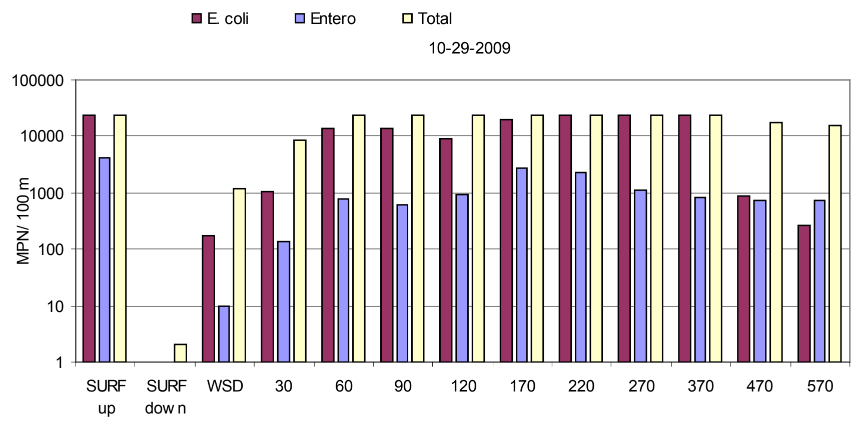
See section below for Upper Las Positas Creek results and MacKenzie Park results.

V. PROJECT SITE ASSESSMENT

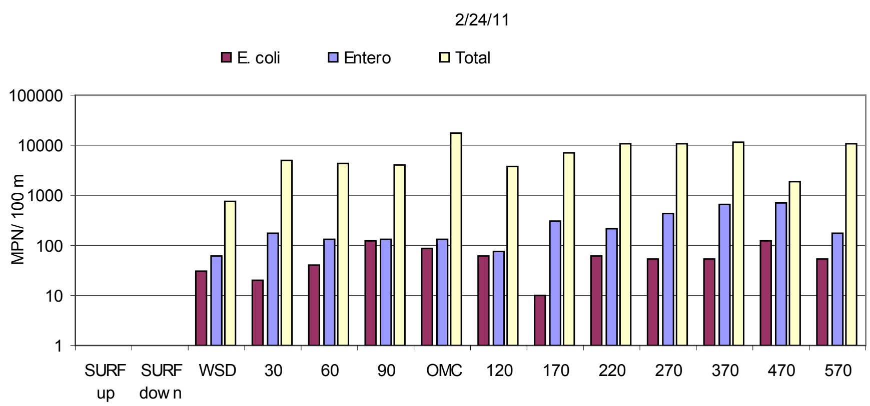
WESTSIDE SURF PROJECT

The following graphs show results from three spatial sampling intensives that were conducted to try and understand the regrowth of fecal indicator bacteria downstream of the SURF project.

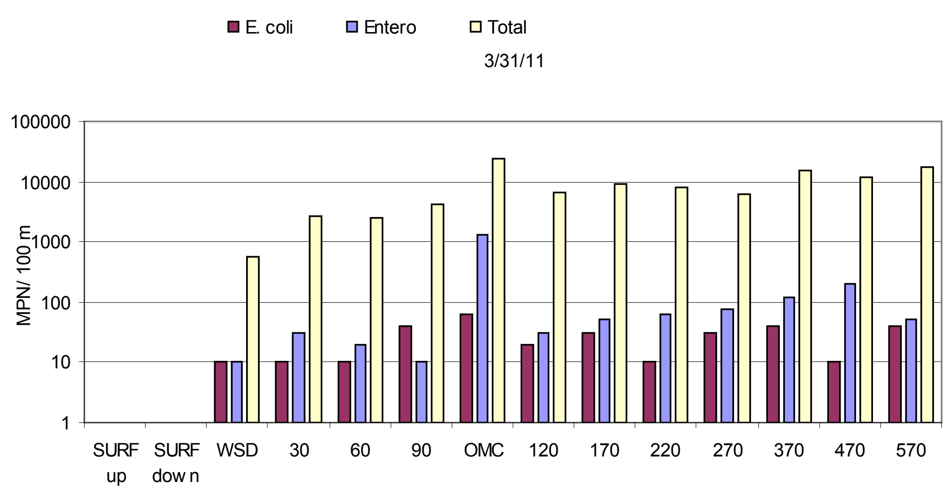
SURF ON



SURF OFF



SURF OFF



ARROYO BURRO RESTORATION, INCLUDING MESA CREEK DAYLIGHTING

This section will not be completed in the FY2012 Annual Report.

HOPE AND HALEY DIVERSIONS

This section will not be completed in the FY2012 Annual Report.

LAGUNA CHANNEL DISINFECTION (SOURCE TRACKING)

This section will not be completed in the FY2012 Annual Report.

GOLF COURSE PROJECT (STORM) - ULPC

The primary goal of monitoring the ULPC Project was to determine if concentrations of pollutants in stormwater running off the project site were diminished after the project was constructed. In addition, the change from inflow to outflow concentrations was compared for pre- and post-project conditions. Three pre-project and three post-project storms were sampled (Table 1; not all constituents were tested in all storms due to problems with sample hold times and staff error). Samples were collected at up 5-9 sampling locations for each storm (Table 2, Figure 1). Samples were processed for fecal indicator bacteria, nutrients, total metals, and total suspended solids.

Table 1. Sampling Dates

Storm ID	Storm ID
Pre-1	12/18/07
Pre-2	1/4/08
Pre-3	2/5/09
Post-1	12/18/10
Post-2	2/18/11
Post-3	3/24/11

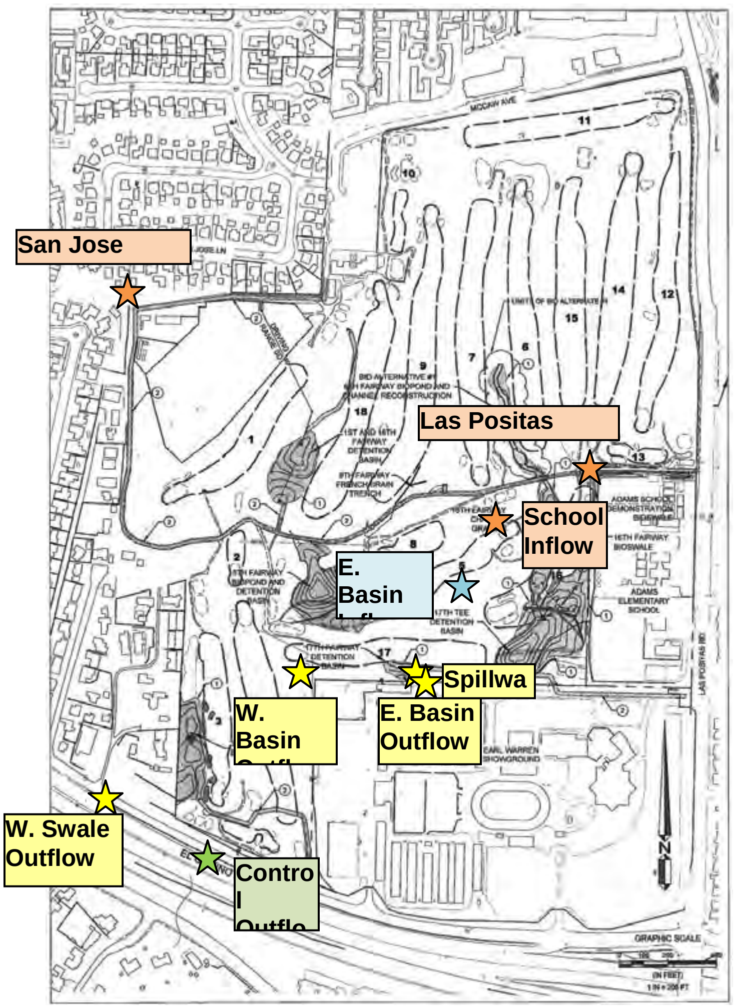


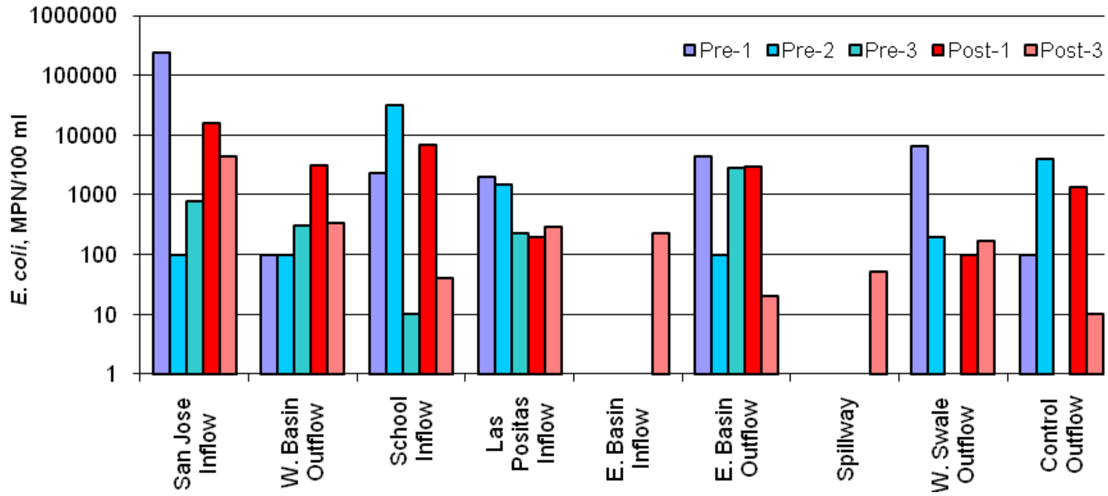
Figure 1. Project map with sampling stations. Orange represents stations for colleting inflow to the project, yellow represents sites downstream of treatment elements, green marks the control outflow site, and blue marks a site located between two treatment elements.

Table 2. Site Descriptions.

Site No. (see map)	Description
San Jose Inflow	San Jose Lane drainage. This site contains runoff from a residential neighborhood, which flows onto the golf course.
W. Basin Outflow	Golf Course, western runoff. This site is at the outlet of the West Basin, and treats runoff from the San Jose Inflow. Prior to the project, San Jose Inflow discharged in a different area.
School Inflow	Composite of Adams School drains. This is a composite of several drains that discharge behind the school.
Las Positas Inflow	Drain flowing to Adams School NE corner from Las Positas. This drain contains runoff from Las Positas Road and neighborhoods to the east.
E. Basin Inflow	Inflow to East Basin, collected in mixing zone from School/Las Positas Inflow and the E. Swale.
E. Basin Outflow	Golf course Eastern drainage. After the project was constructed, water was collected from the downstream end of the East Basin.
Spillway	Spillway from East Basin.
W. Swale Outflow	SW corner drainage, below "farm" and other homes. This site contains runoff from the Stevens Road residential area, as well as from the golf course, and is treated by a swale.
Control Outflow	SW corner of Earl Warren. This site contains runoff from the golf course and from the Earl Warren Showgrounds. It is not treated.

Results

Fecal Indicator Bacteria



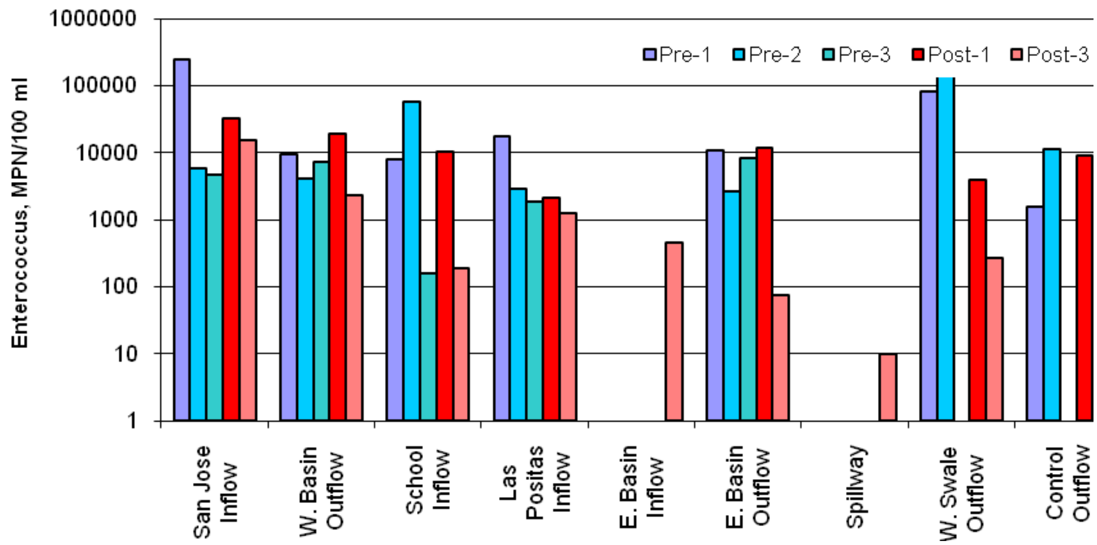


Figure 2. Fecal indicator bacteria 9FIB) concentrations at inflow and outflow sites during five storms.

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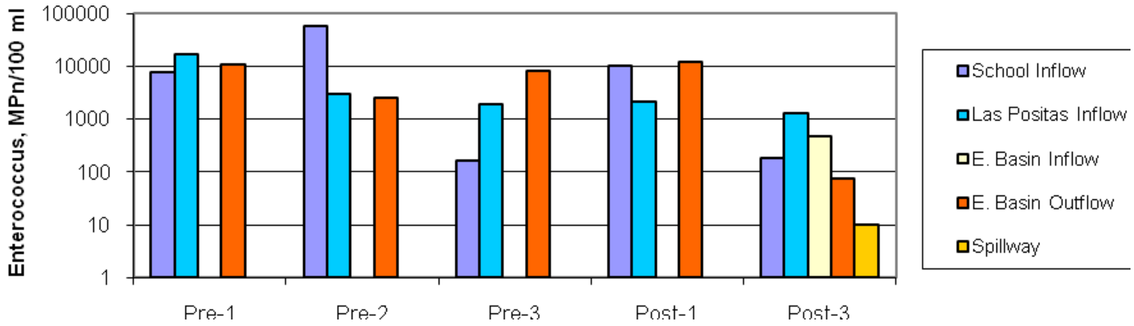


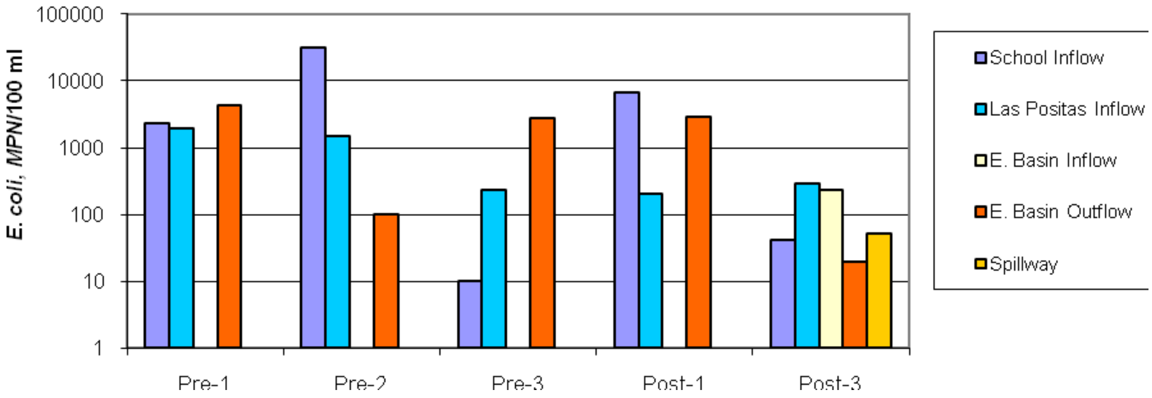
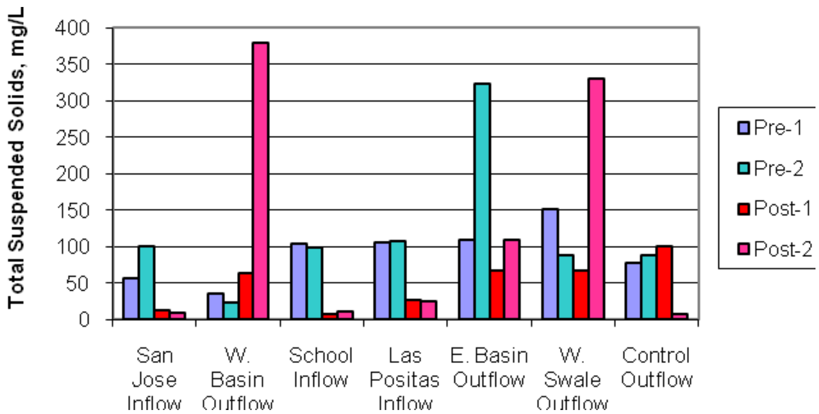


Figure 3. Fecal indicator bacteria concentrations on East side of Project.

Interpretation:

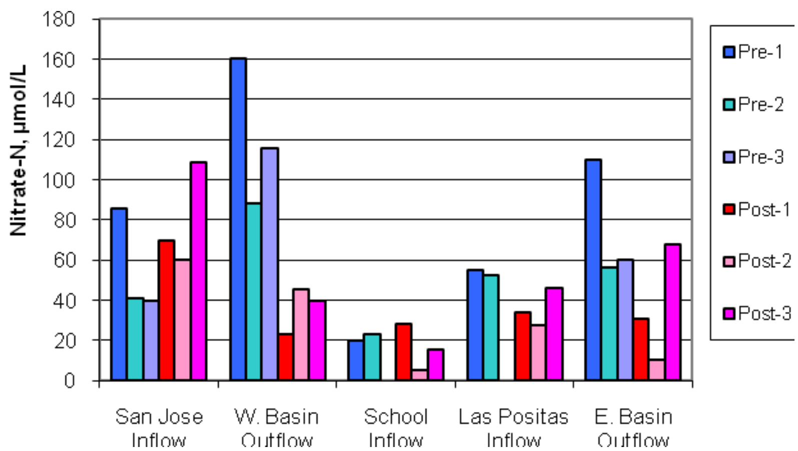
- After the project, FIB concentrations went down between San Jose Inflow and the W. Basin outflow. Prior to the project, this pattern was not observed.
- During storm Post-3, FIB concentrations went down between the East Inflow sites and the East Basin. During storm Post-1, there was still a lot of sediment runoff.
- For inflow sites, there was no pattern between pre- and post-storm indicator bacteria levels. For outflow sites, there was a suggestive pattern of lower indicator bacteria levels during storm Post-3.
- This pattern was most clear at Site 5, the outflow of the East Basin. In addition, the spillway showed even lower levels during storm Post-3.
- Note that because flow rates were not measured, it is not possible to calculate the load of indicator bacteria removed or the removal efficiency.

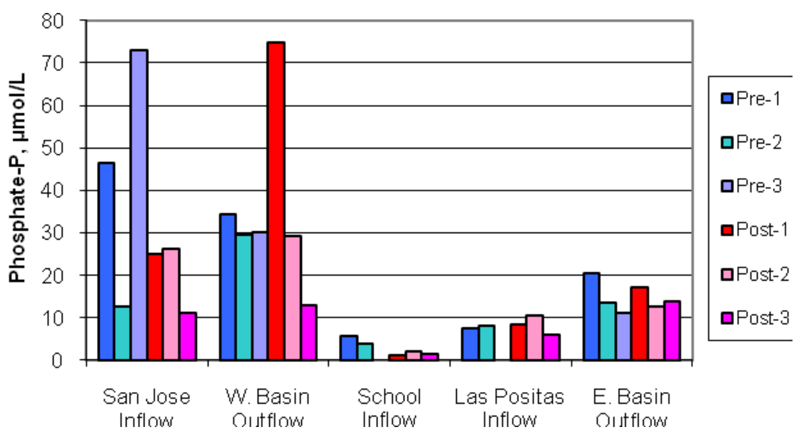
Total Suspended Solids



Interpretation: Total suspended solid patterns are difficult to interpret because the inflow concentrations were much lower during the post-project sampling.

Nutrients





Interpretation:

- At outflow sites, nitrate concentrations were generally lower in post-project samples. Phosphate reduction was not as clear.
- Phosphate concentrations are often higher in outflow sites, suggesting a source of phosphate on the golf course, i.e. fertilizer.

Recommendations

- Limit most future sampling to the east side, where treatment can be assessed by measuring upstream and downstream concentrations.
- Develop capacity to measure flow rates at key sampling locations.
- Address high nutrient concentrations in runoff from San Jose neighborhood.

SAN PASCUAL DRAIN (SOURCE TRACKING)

This section will be completed in the following quarterly report.

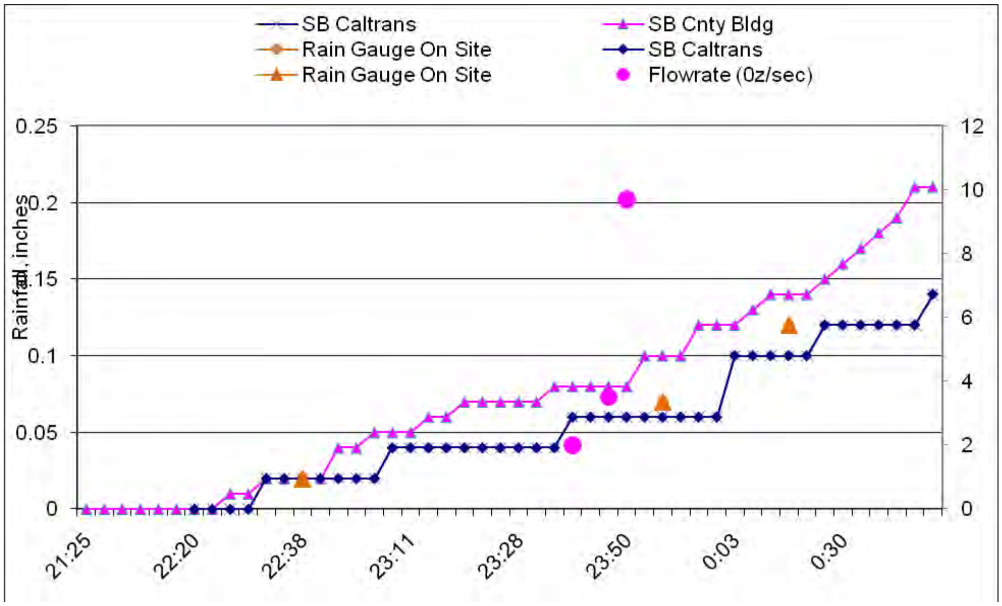
PARKING LOT LID (STORM)

May 16, 2011, Sampling by Tim Burgess to try and obtain a “Pre Project” picture of runoff. This was a short but moderate storm, approximately 0.25” in 4 hours, averaging intensity of 0.1”/hr

.

Notes

Time	OnSite Gauge	Upper Drain Flow	Observations and Notes
21:25			Sprinkling rain started in last 10 minutes
21:27			Road and parking lot surface wet (blackened). Dry under tree canopies
21:40			Road and parking lot surface wet (blackened). Dry under tree canopies
21:50			Cleared leaves and debris from around upper lot (lawn bowls) grate
22:03			small puddles starting to form. Tiny amount of flow around asphalt surface bumps (embedded rocks)
22:10			Rain shadows still under trees
22:20			Water in low pool at lip of main grate in lower lot.
22:30			Water dripping 3 drips per second into lower drain. Rain now a sprinkle (from a heavy drizzle/light sprinkle)
22:34			No gutter flow in driveways, no flow in trench drains.
22:37			Upper lot drain pipe still dry at outfall
22:38	0.02		Put out rain guage in lower lot.
22:44			These times are based on car clock. Car clock is one minute slower than phone clock.
22:49			At 10:49 pm I corrected my camera time to daylight savings time off. So pics before 10:49 are an hour and 6 minutes fast. Then I changed camera clock to match phone clock.
22:57			Rain has lightened to a slow sprinkle.
23:04			Upper lot outfall dry.
23:10			Precipitation rate increased to a regular sprinkle. No sheet flow in parking lots.
23:25			Precip rate decreased to a light sprinkle.
23:27			Water flowing down low gullies in lower lot.
23:28			Water trickling in ~ 6 drip lines into main drip inlet.
23:29			Water flowing through trench drains. Visible flow in outfall at main drain and at trench drain lines confluence manhole (the round one with slits).
23:35		2	Water flowing out of upper lot outfall. Measured flow with milk carton and timer and measured with measuring cup. Results:
23:41			Took 3 photos of lower inlet drain.
23:46		3.5	Raindrops heavier (more than a sprinkle). More like a slow rain. Upper lot outfall flow.
23:50		9.7	Flow 1/2" high at end of pipe.
23:53	0.07		Rain guage reads 0.05 inches.
23:54			Took photos of lower main drain and lower lot. Water pouring through all sides of grate. Not a heavy pour, but many heavy trickles.
0:02			No flow from DG path or fields.
0:03			Checked upper lot.
0:15	0.12		Rain guage in p-lot reads 0.1"
0:16			Leaving site.



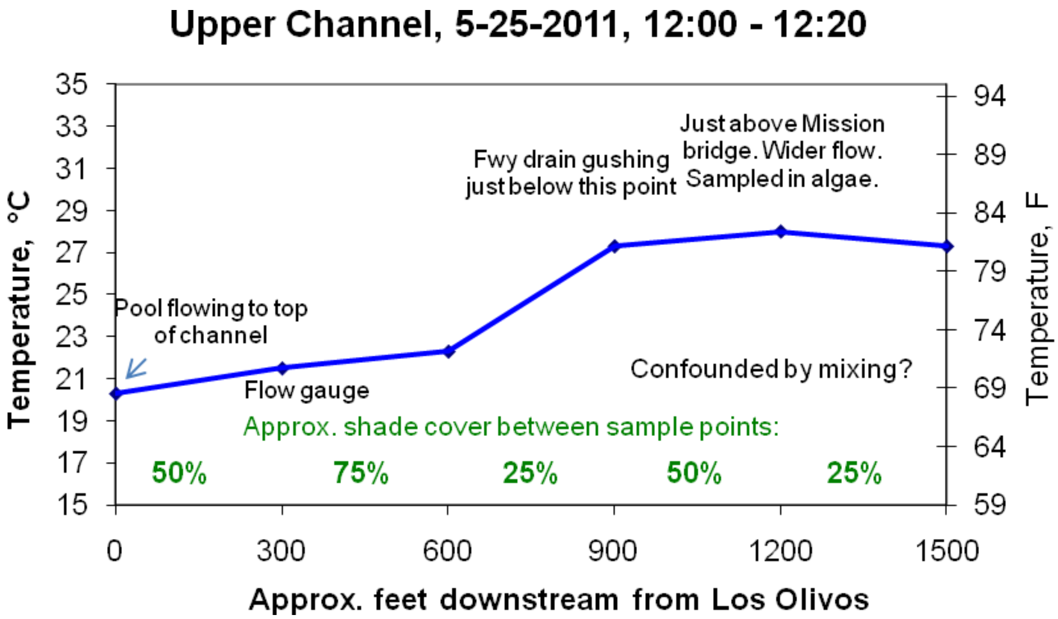
Photos – there are more in the WQ Monitoring folder for this project. The times might be off.

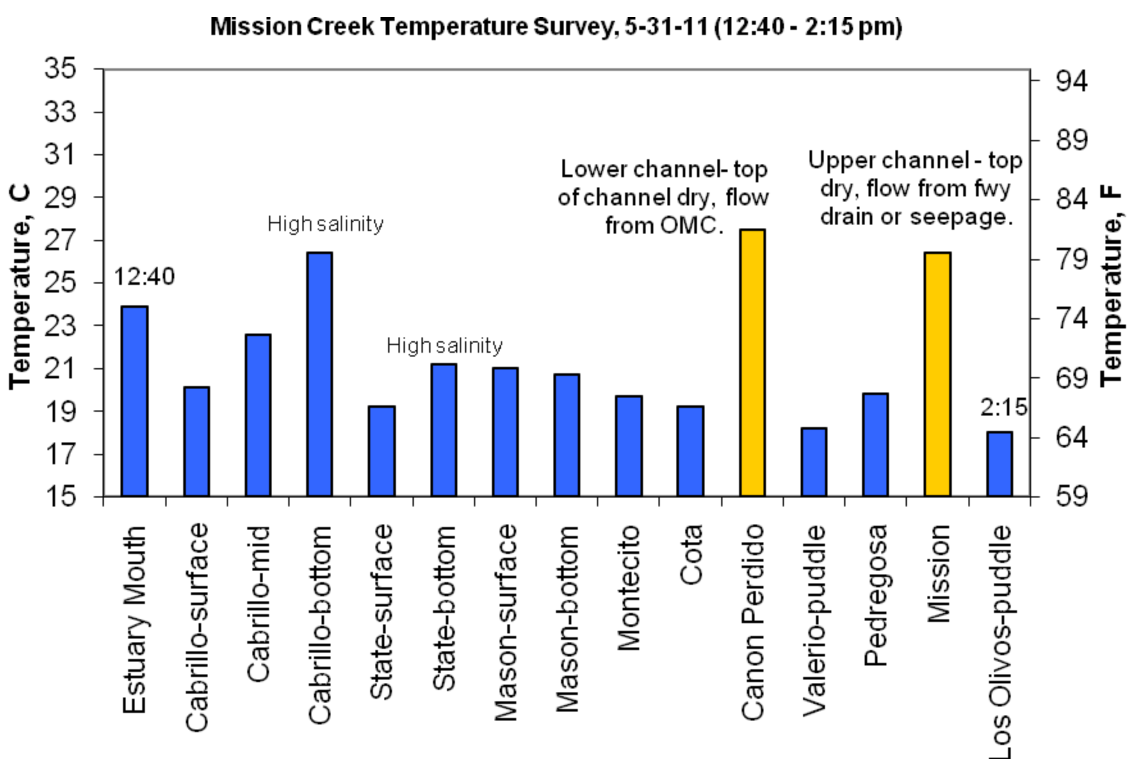
<u>DEBRIS SCREENS (CREEK WALKS)</u>

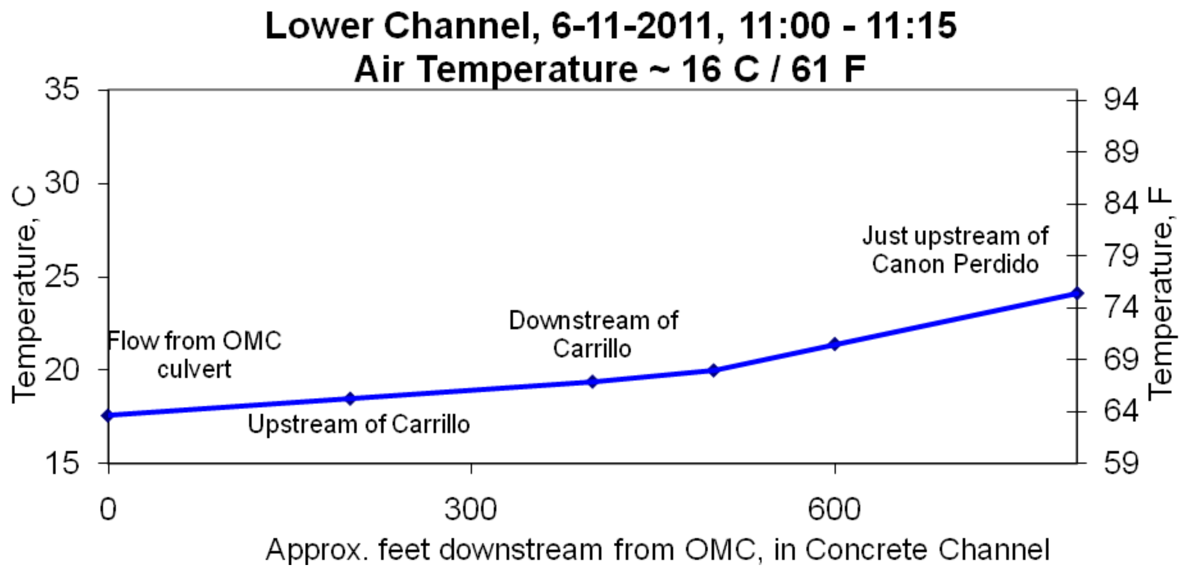
See Creek Walk Section.

MISSION CREEK FISH PASSAGE

Temperature readings, summer 2011






Lower Channel, 6-11-2011, 11:00 - 11:15
Air Temperature ~ 16 C / 61 F
Temperature, C
Temperature, F
35
30
25
20
15
94
89
84
79
74
69
64
59
Flow from OMC culvert
Upstream of Carrillo
Downstream of Carrillo
Just upstream of Canon Perdido
0
300
600
Approx. feet downstream from OMC, in Concrete Channel

ANDRE CLARK BIRD REFUGE
Creeks Division monthly monitoring early 2008 – early 2011

Sampling Sites

FIELD DATA

Conductivity, µS/cm

Station	No. of Tests	Average	Min	Max
Inflow	28	2348	2	5107
Landing	41	6403	2	11871
Outlet	46	6623	2	11077

Salinity, ppt

Station	No. of Tests	Average	Min	Max
Inflow	28	1.8	0.8	3.2
Landing	41	4.5	1.0	8.0
Outlet	46	4.7	0.8	7.6

DO Concentration, mg/L

Station	No. of Tests	Average	Min	Max
Inflow	28	5.1	0.9	11.3
Landing	41	8.2	0.0	19.2
Outlet	46	4.7	0.0	17.2

DO, % Saturation

Station	No. of Tests	Average	Min	Max
Inflow	28	51	10	125
Landing	41	98	1	220
Outlet	46	49	0	175

pH

Station	No. of Tests	Average	Min	Max
Inflow	28	7.7	6.8	9.0
Landing	41	8.3	6.1	9.0
Outlet	46	8.3	7.0	8.9

Temperature, °C

Station	No. of Tests	Average	Min	Max
Inflow	28	16.0	11.1	20.5
Landing	41	20.2	10.0	28.2
Outlet	46	18.8	10.7	25.2

Turbidity, NTU

Station	No. of Tests	Average	Min	Max
Inflow	28	10	3	34
Landing	41	52	5	233
Outlet	46	60	3	262

MICROBIOLOGY AND NUTRIENT DATA

E. coli, MPN/100 ml

Station	No. of Tests	Average	Min	Max
Inflow	29	1263	<10	>24192
Landing	35	282	<10	2140
Outlet	36	383	<10	2142

Enterococcus, MPN/100 ml

Station	No. of Tests	Average	Min	Max
Inflow	29	839	20	14136
Landing	35	223	<1	2613
Outlet	36	360	<10	4352

Total coliform, MPN/100 ml

Station	No. of Tests	Average	Min	Max
Inflow	29	16312	2187	>24192
Landing	35	20921	233	>24192
Outlet	36	20315	181	>24192

Biological Oxygen Demand, 5-day, mg/L

Station	No. of Tests	Average	Min	Max
Inflow	23	4	0	10
Landing	27	29	3	141
Outlet	26	30	4	108

Chlorophll a, μG/L

Station	No. of Tests	Average	Min	Max
Inflow	27	19	2	100
Landing	34	282	2	1200
Outlet	34	285	2	1200

Ammonium, µM/L

Station	No. of Tests	Average	Min	Max
Inflow	11	2.9	0.0	7.0
Landing	14	188.5	0.0	1903.6
Outlet	14	187.2	0.0	1899.2

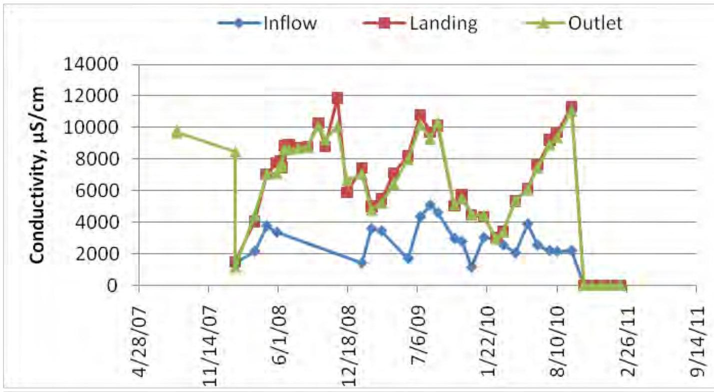
Nitrate, µM/L

Station	No. of Tests	Average	Min	Max
Inflow	11	68.4	0.0	558.5
Landing	14	2.7	0.0	30.0
Outlet	14	8.1	0.0	92.1

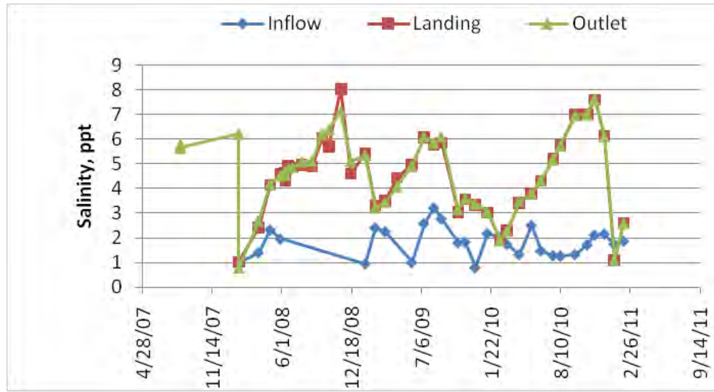
Phosphate, µM/L

Station	No. of Tests	Average	Min	Max
Inflow	11	19.5	11.3	35.5
Landing	14	6.6	0.4	32.5
Outlet	14	7.1	0.3	30.3

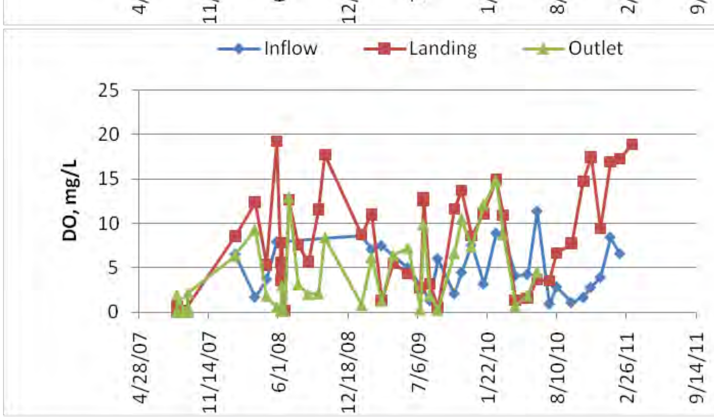
PLOTS-FIELD



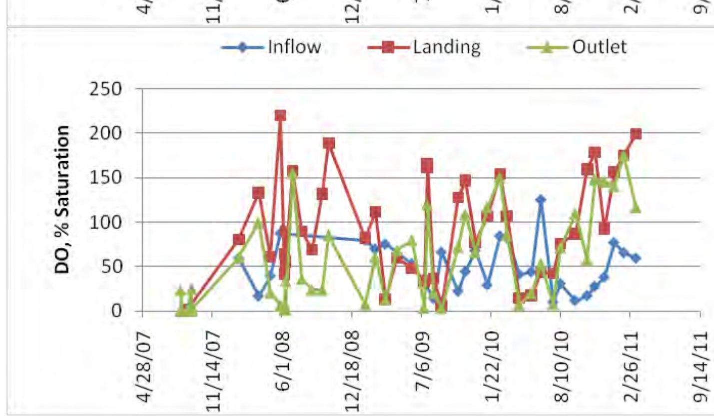
Inflow
Landing
Outlet
Conductivity, µS/cm
0
2000
4000
6000
8000
10000
12000
14000
4/28/07
11/14/07
6/1/08
12/18/08
7/6/09
1/22/10
8/10/10
2/26/11
9/14/11



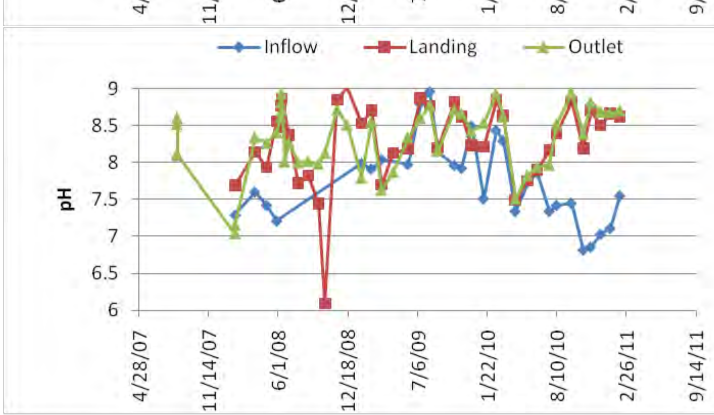
Inflow
Landing
Outlet
Salinity, ppt
0
1
2
3
4
5
6
7
8
9
4/28/07
11/14/07
6/1/08
12/18/08
7/6/09
1/22/10
8/10/10
2/26/11
9/14/11



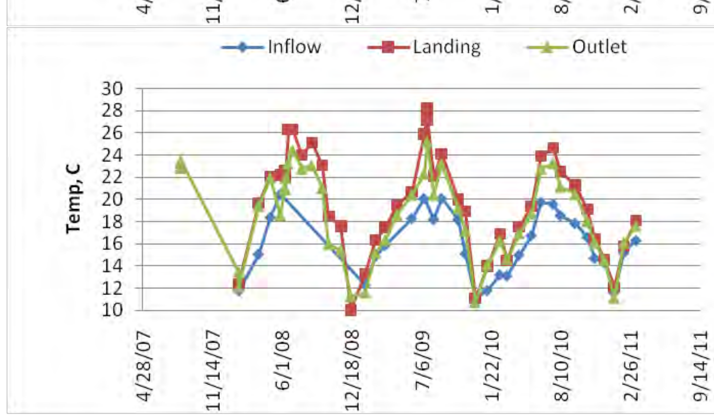
Inflow
Landing
Outlet
DO, mg/L
0
5
10
15
20
25
4/28/07
11/14/07
6/1/08
12/18/08
7/6/09
1/22/10
8/10/10
2/26/11
9/14/11



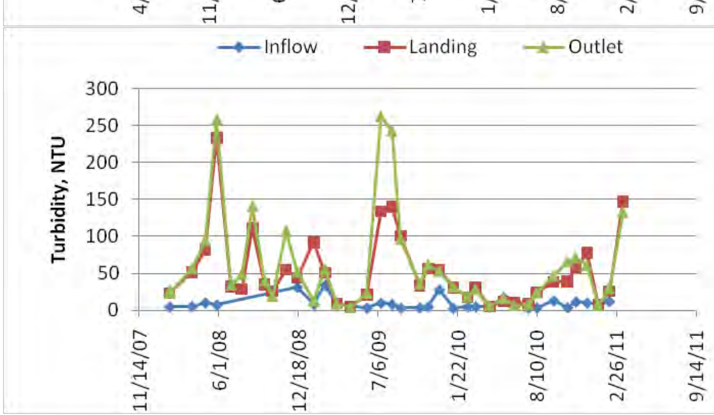
Inflow
Landing
Outlet
DO, % Saturation
0
50
100
150
200
250
4/28/07
11/14/07
6/1/08
12/18/08
7/6/09
1/22/10
8/10/10
2/26/11
9/14/11



Inflow
Landing
Outlet
pH
6
6.5
7
7.5
8
8.5
9
4/28/07
11/14/07
6/1/08
12/18/08
7/6/09
1/22/10
8/10/10
2/26/11
9/14/11

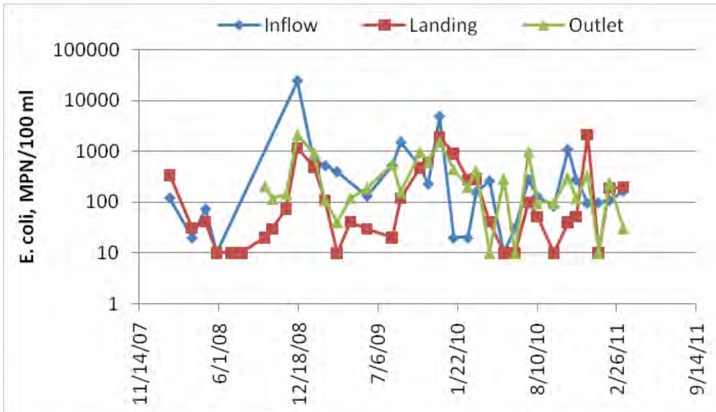


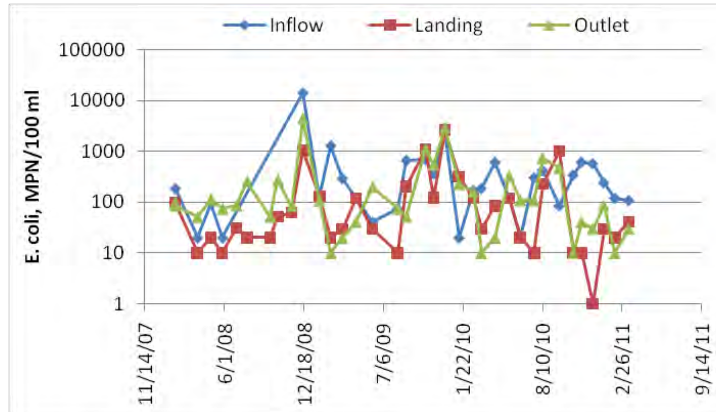
Inflow
Landing
Outlet
Temp, C
10
12
14
16
18
20
22
24
26
28
30
4/28/07
11/14/07
6/1/08
12/18/08
7/6/09
1/22/10
8/10/10
2/26/11
9/14/11



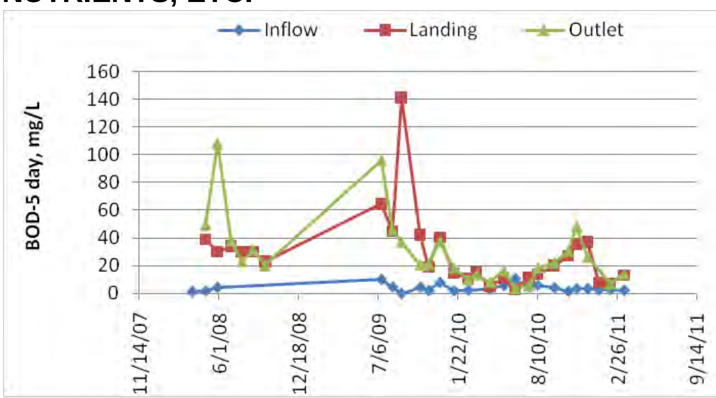
Inflow
Landing
Outlet
Turbidity, NTU
0
50
100
150
200
250
300
11/14/07
6/1/08
12/18/08
7/6/09
1/22/10
8/10/10
2/26/11
9/14/11

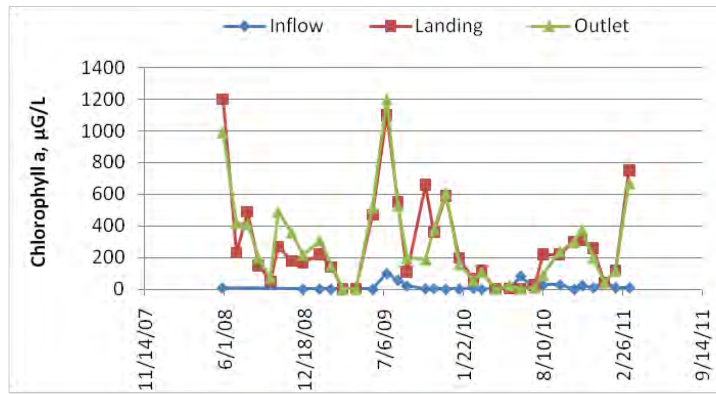
FIB

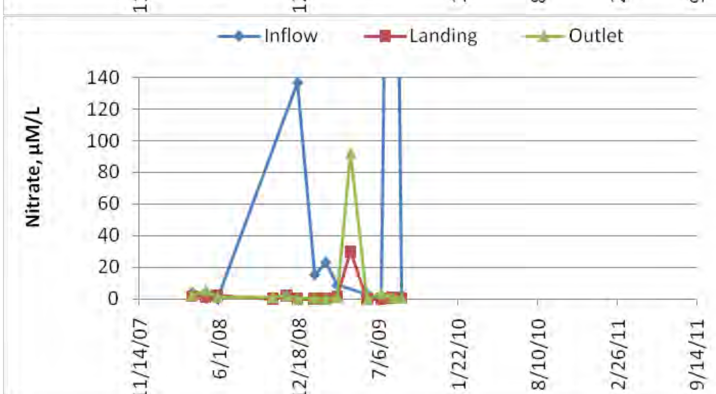


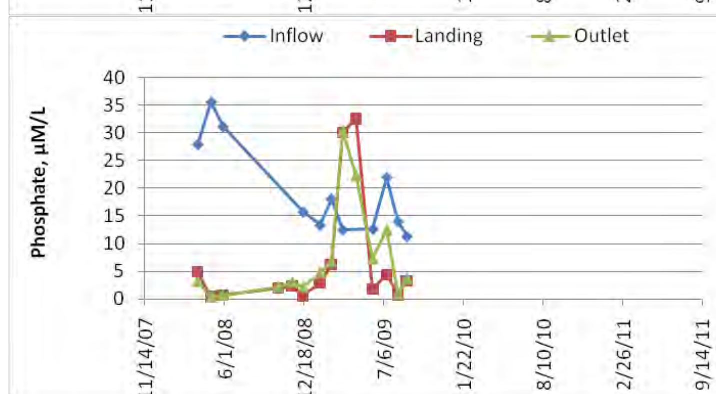


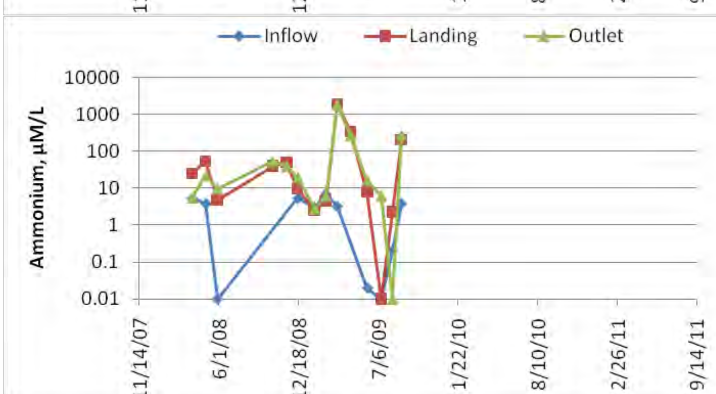
NUTRIENTS, ETC.











Bird Refuge Microbial Augmentation - Pilot Study Report

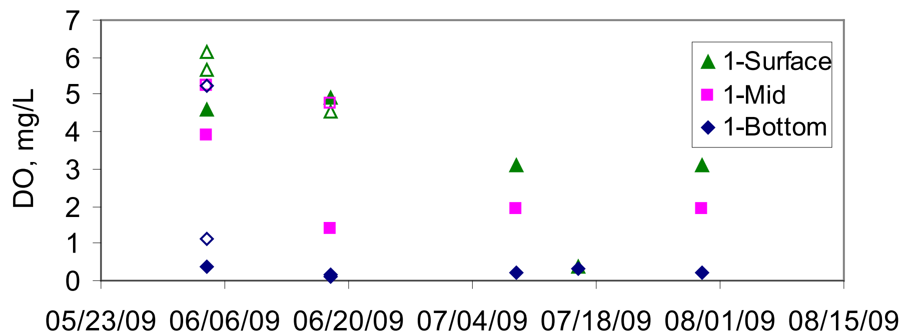
Summary: This pilot study tested the efficacy of using microbial augmentation and aeration in reducing sludge depth, increasing oxygen levels, decreasing odors, and increasing water clarity in the Andre Clark Bird Refuge. The program will employed weekly mixing and microbial augmentation, via the Parks boat, in the southwestern arm (the “Outlet Arm”) of the Andre Clark Bird Refuge. Sludge depth, oxygen concentration, temperature and odor were be monitored during the study.

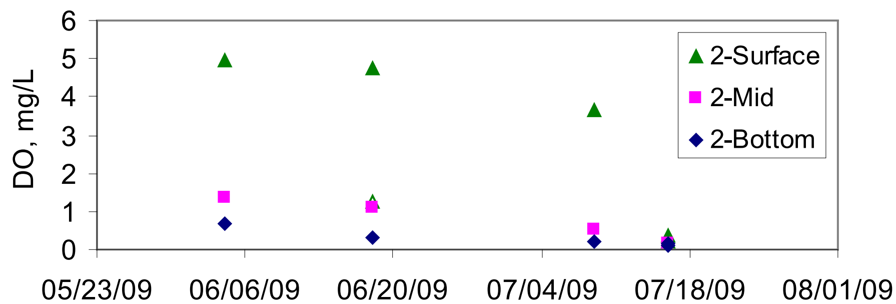
Specs:

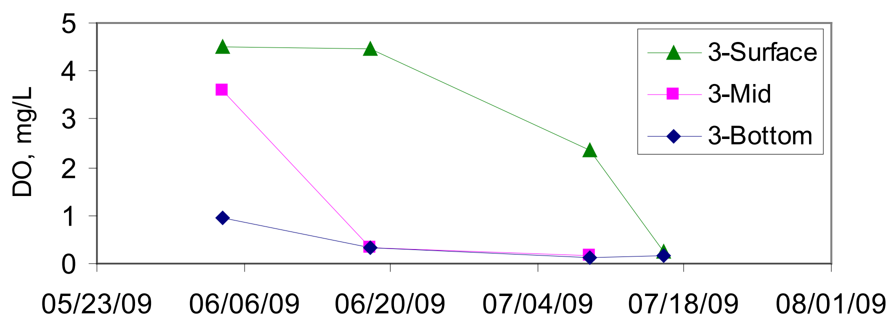
Area: 105 385 sq. ft. in the Outlet Arm.
Treatment: Weekly addition of microbes plus mixing via motor boat and chain
Start date: June 1, 2009
End date: August 31, 2009
Predicted Rate: 12” of sludge removal at 1”/week
Monitor: water depth, sludge depth, water clarity (“Secchi depth”), and dissolved oxygen.
Cost:
Microbes: $187/wk * 12 wk = $2244
Supplies: ?
Sediment testing: ? (Creeks pays?)

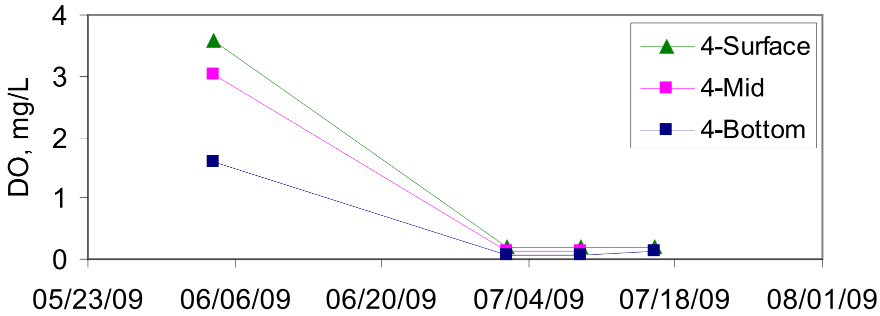
Weekly Routine

- Day 1 (Wednesday?): Brew microbes
  - At Annex Yard
  - Mix __ gallons of microbes with __ gallons of water in trash can
  - Mix well
  - Turn on heater and aerator
  - Cover?
- Day 2 (Thursday?): Apply microbes
  - Pick up boat, trailer
  - Fill 3 (?) 4-gallon buckets 3/4 way full with microbe mix, put lids on tightly
  - Take boat out to Outlet Arm
  - Do one pass slowly without chain, measuring DO and sludge depth at each of four locations
  - Do multiple passes up and down the outlet arm.
  - For each pass, on the way out, use chain to stir up bottom, on the way back use chain to stir up and also pour in the microbe mix
  - It will probably take 5-10 passes or so? The width is 100 – 140' I will talk to the company to see what our grid should look like.
- If it looks like the dissolved oxygen is getting too low, we'll add a day of mixing (Monday?)









MIXING

1. During the first day of application, sufficient mixing took place to make DO levels high at the bottom.
2. Subsequently, not enough mixing took place.
3. In July, no amount of mixing would have helped, due to low DO levels at the surface.

WATER and SEDIMENT DEPTH

In the outlet arm of the Bird Refuge, water depth averaged 1.55', sludge (watery sediment) depth averaged 0.54', and sediment depth (depth to which a pole could be pushed by hand) averaged 6.8'. There was no change during the pilot study.

Sediment Testing – Collected from outlet and landing

Shading represents cases where concentrations exceeded relevant sediment criteria.

Constituent	Units	MDL[1]	Bird Refuge	PEC[3]
Metals, mg/kg 2007 2008 2009 2010				
Cadmium	mg/kg	 0.14	 0.446 0.42 0.874	4.98
Copper	mg/kg		 57.9 19.9 58.4	149
Lead	mg/kg		 18 10.2 29.5	128
Mercury (not tested in 2010)	mg/kg	0.013 0.013 0.01	0.0291 0.032	1.06
Zinc	mg/kg		 33.7 36.9 114	459
Arsenic	mg/kg		 2.51 7.21	33
Chromium	mg/kg		9.15 43.7	111
Nickel	mg/kg		12.2 39.5	48.6
Selenium	mg/kg	0.308 0.328	ND 2.3	n/a
Silver	mg/kg	0.015 0.009	ND 0.600	n/a
PAHs 2007 (not tested in 2009)	**Units**	**MDL**	**Bird Refuge**	**PEC**

Constituent	Units	MDL[1]	Bird Refuge	PEC[3]
2008 **2010**				
Total LMW PAHs	µg/kg	<15 for all PAHs	77	n/a
Naphthalene	µg/kg	1.39	ND	561
Acenaphthylene	µg/kg	1.39	ND	n/a
Acenaphthene	µg/kg	1.39	ND	n/a
Fluorene	µg/kg	1.39	ND	536
Phenanthrene	µg/kg		ND	1170
Anthracene	µg/kg	1.39	ND	845
Fluoranthene	µg/kg		33	2230
Pyrene	µg/kg		44	1520
Total HMW PAHs	µg/kg		ND	n/a
Benzo (a) Anthracene	µg/kg		ND	1050
Chrysene	µg/kg		ND	1290
Benzo (b) Fluoranthene	µg/kg		ND	n/a
Benzo (k) Fluoranthene	µg/kg		ND	n/a
Benzo (a) Pyrene	µg/kg		ND	1450
Dibenz (a,h) Anthracene	µg/kg	1.39	ND	n/a
Benzo (g,h,i) Perylene	µg/kg		ND	n/a
Indeno (1,2,3-c,d) Pyrene	µg/kg	1.39	ND	n/a

Constituent	Units	MDL[1]	Bird Refuge	PEC[3]
1-Methylnapthalene	µg/kg	1.39	ND	n/a
2-Methylnapthalene	µg/kg	1.39	ND	n/a
Total PAHs	µg/kg		77	22800
Chlorinated Pesticides **2007** **2008** **2009** **2010**	**Units**	**MDL**	**Bird Refuge**	**PEC**
Chlordane, alpha	µg/kg	4 1 0.15 1.22 - 6.14	ND ND	17.6
Chlordane, gamma	µg/kg	4 4 0.14 1.22 - 6.14	ND ND	17.6
DDDs, total	µg/kg	<0.68 <0.68 <0.2 1.14 - 6.14	0.33 ND	28
DDEs, total	µg/kg	<.68 <0.68 <0.2 <1.73	0.98 ND	31.3
DDTs, total	µg/kg	<0.68 <0.68 <0.1 1.14 - 6.14	ND ND	62.9
Total DDT	µg/kg		1.31 ND	572
Dieldrin	µg/k			61.8

Constituent	**Units**	**MDL[1]**	**Bird Refuge**	**PEC[3]**
	g	 1.14 - 6.14	ND ND	
trans-Nonachlor 2009 2010	µg/kg	1.14 - 6.14	ND	n/a
Endrin	µg/kg	 1.14 - 6.14	ND ND	207
Heptoclor epoxide	µg/kg	 1.14 - 6.14	ND ND	16
Lindane	µg/kg		ND ND	4.99
All other EPA 8081A (Chlorinated Pesticides)	µg/kg		ND	n/a
Pyrethroids (EPA 8270CmNCl)	**Units**		**Bird Refuge**	**SCC WRP LC 50**
Bifenthrin	ng/g dry	0.57 - 3.07	3 ND ND	4.5
Cyfluthrin	ng/g dry	0.57 - 3.07	ND ND ND	13.7
Deltamethrin	ng/g dry	0.57 - 3.07	ND ND ND	9.9
Esfenvalerate	ng/g dry	0.57 - 3.07	ND ND ND	24
Lambda-cyhalothrin	ng/g dry	0.57 -	ND ND ND	5.6

Constituent	Units	MDL[1]	Bird Refuge	PEC[3]
		3.07		
Permethrin	ng/g dry	29-153	ND ND ND	90
All other EPA 8270	ng/g dry	0.57 - 3.07	ND ND ND	n/a
Other Pesticides and Herbicides	**Units**		**Bird Refuge**	**SCCWRP LC 50**
EPA 8141A (Organophosphorus Pesticides) Not sampled in 2009.	µg /kg		ND	n/a
EPA 8151A (Chlorinated Herbicides) Not sampled in 2009	µg/kg		ND	n/a
Fipronil (phenylpyrazole insecticide) . Only tested in 2009, 2010	µg/kg	43-233	ND ND	n/a
Pentachlorophenol (2010)	µg/kg	57-301	ND	
PCBs	µg/kg		ND	676

-"Probable Effects Concentration" (PEC) refers to the concentration above which probable toxic effects would be predicted (Macdonald, et al., 2006).
-SCCWRP LC50 are described below and taken from the Habitat Value of Urban Streams (SCCWRP, 2008).
-"n/a" means that the compound was not included in the analysis and that no guidelines have been identified.
-Chlorinated pesticides: Alpha-BHC; Gamma-BHC; Beta-BHC; Heptachlor; Delta-BHC; Aldrin; Heptachlor Epoxide; Endosulfan I; Dieldrin; 4,4'-DDE; Endrin; Endrin Aldehyde; 4,4'-DDD; Endosulfan II; 4,4'DDT; Endosulfan Sulfate; Methoxychlor; Chlordane; Toxaphene; Endrin Ketone
-Pyrethroids (8270): Allethrin, Bifenthrin, Cyfluthrin, Cypermethrin, Danitol, Deltamethrin, Esfenvalerate, Fenvalerate, Fluvalinate, L-Cyhalothrin, Permethrin, Prallethrin, Resmethrin
Organophosphorus pesticides: Azinphos Methyl; Bolstar; Chlorpyrifos; Coumaphos; Demeton-o; Demeton-s; Diazinon; Dichlorvos; Disulfoton; Ethoprop; Fensulfothion; Fenthion; Malathion; Merphos; Methyl Parathion; Mevinphos; Naled; Phorate; Ronnel; Stirophos; Tokuthion; Trichloronate

Sediment Toxicity (All Data Scaled to Control)

Year	Test	Endpoint	Bird Refuge
2008	Acute, Euhastoriaus 10-day	% Survival	93*
2010	Acute, Hyalella	% Survival	100

* Results are significantly different from the control ($p<0.05$).

VI. BEACH WATER QUALITY

High numbers of beach warnings at Arroyo Burro were during summer 2010 were addressed in the FY2010 Annual Report. Data from the first and second quarter of FY11 are presented below. Time series and interpretation will be included in the following quarterly report.

AB411 Beach Water Quality Criteria

Total Coliform (TC)	Fecal coliform (FC)	Enterococcus (ENT)	TC:FC, when TC>1000
10,000 MPN/100 ml	400 MPN/100 ml	104 MPN/100 ml	0.1

Beach Sampling Results

Date	AB Beach	E. Beach-MC	E. Beach- SC	Leadbetter	Comments
03/29/10	0	0	0	0	
4/5/2010	Warning	Warning	Warning	0	.38 inches of rain on April 5th
4/7/2010	0	0	0	#N/A	
4/12/2010	Warning	Warning	Warning	0	.9 inches of rain on April 12th
4/14/2010	Warning	Warning	Warning	#N/A	
4/19/2010	0	Warning	0	0	
4/21/2010	#N/A	Warning	#N/A	#N/A	.56 on April 21st
4/26/2010	0	0	0	0	
5/3/2010	0	0	0	0	
5/10/2010	0	0	0	0	
5/17/2010	0	0	0	Warning	
5/19/2010	#N/A	#N/A	#N/A	0	
5/24/2010	0	0	0	0	
5/31/2010	Warning	0	0	0	
6/2/2010	0	#N/A	#N/A	#N/A	
6/7/2010	0	0	0	0	
6/14/2010	0	0	0	0	
6/21/2010	Warning	0	0	0	
6/23/2010	0	#N/A	#N/A	#N/A	
6/28/2010	0	0	0	0	
7/6/2010	0	0	0	0	
7/12/2010	0	0	0	0	
7/19/2010	Warning	0	0	0	
7/21/2010	0	#N/A	#N/A	#N/A	
7/26/2010	Warning	0	0	Warning	
7/28/2010	Warning	#N/A	#N/A	#N/A	
8/2/2010	0	0	0	0	
8/9/2010	0	0	0	0	
8/16/2010	Warning	0	0	0	
8/23/2010	0	0	0	Warning	
8/25/2010	#N/A	#N/A	#N/A	0	
8/30/2010	Warning	0	0	0	
9/1/2010	Warning	#N/A	#N/A	#N/A	
9/7/2010	Warning	Warning	0	0	
9/13/2010	0	0	0	Warning	
9/15/2010	#N/A	#N/A	#N/A	Warning	
9/20/2010	Warning	0	0	0	
9/22/2010	0	#N/A	#N/A	#N/A	
9/27/2010	Warning	Warning	0	Warning	

Date	AB Beach	E. Beach-MC	E. Beach- SC	Leadbetter	Comments
9/29/2010	0	#N/A	#N/A	0	
10/4/2010	Warning	0	0	0	0.06" rain in the morning, no resample
10/11/2010	0	0	0	0	
10/18/10	Warning	0	0	0	light rain during this day and previous two days
10/20/10	Warning	#N/A	#N/A	#N/A	
10/25/10	Warning	Warning	Warning	Warning	
10/27/10	0	0	0	0	
TOTAL AB411	18	8	4	7	
11/1/2010	Warning	0	0	0	1.01" of rain on Oct 30th
11/8/2010	0	Warning	0	Warning	.16" of rain on this day
11/10/2010	#N/A	Warning	#N/A	0	
11/15/2010	0	0	0	0	
11/22/2010	0	Warning	0	0	1.44 inches of rain total on Nov. 20-21
11/23/2010	Warning	Warning	0	0	
11/29/2010	0	0	0	0	
12/6/2010	Warning	Warning	Warning	Warning	.55" of rain on this day
12/8/2010	Warning	0	0	0	
12/13/2010	0	0	0	0	

Quarter 3

1/3/2011	Warning	Warning	Warning	Warning	.93" of rain on this day
1/5/2011	Warning	0	0	0	
1/10/2011	0	0	0	0	
1/18/2011	Warning	0	#N/A	0	
1/20/2011	0	#N/A	#N/A	#N/A	
1/24/2011	0	0	0	0	
1/31/2011	0	Warning	0	0	.2" of rain on this day
2/2/2011	#N/A	0	#N/A	#N/A	
2/7/2011	0	Warning	0	0	
2/9/2011	#N/A	0	#N/A	#N/A	
2/14/2011	0	Warning	0	0	lagoon open
2/22/2011	0	Warning	0	0	1.6" of rain on Feb. 19 & 20
2/28/2011	0	Warning	0	0	1.5" of rain on Feb. 26
3/2/2011	#N/A	Warning	#N/A	#N/A	lagoon open
3/7/2011	0	Warning	0	0	lagoon open
3/9/2011	#N/A	0	#N/A	#N/A	
3/14/2011	Warning	Warning	0	0	lagoon open
3/16/2011	Warning	0	#N/A	#N/A	lagoon open
3/21/2011	0	0	0	0	
3/28/2011	0	0	0	0	

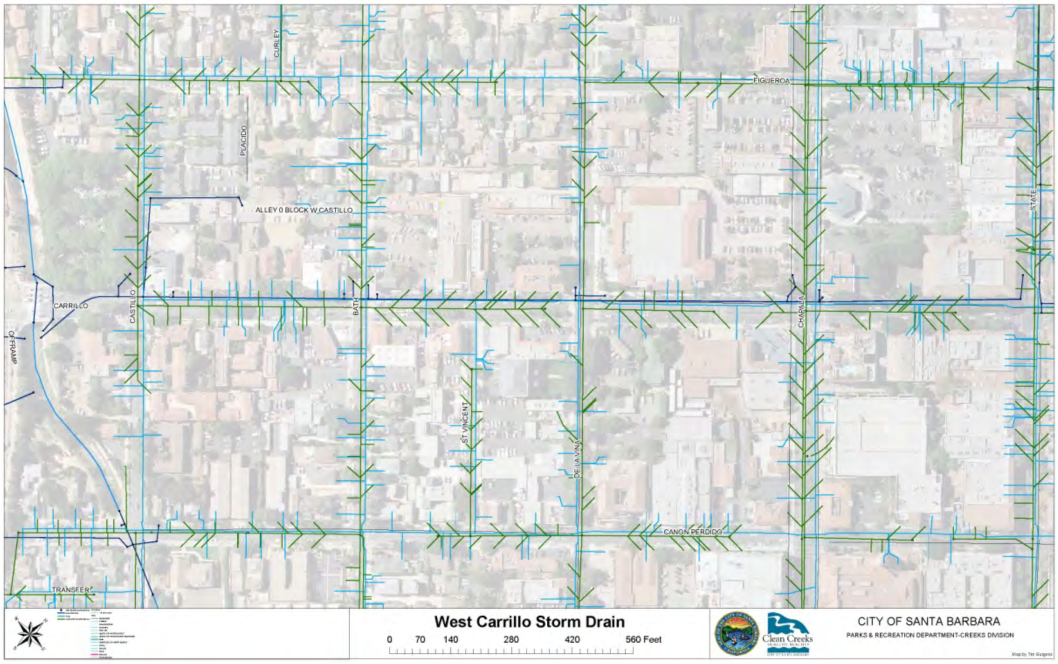
VII. SOURCE TRACKING/ILLICIT DISCHARGE DETECTION

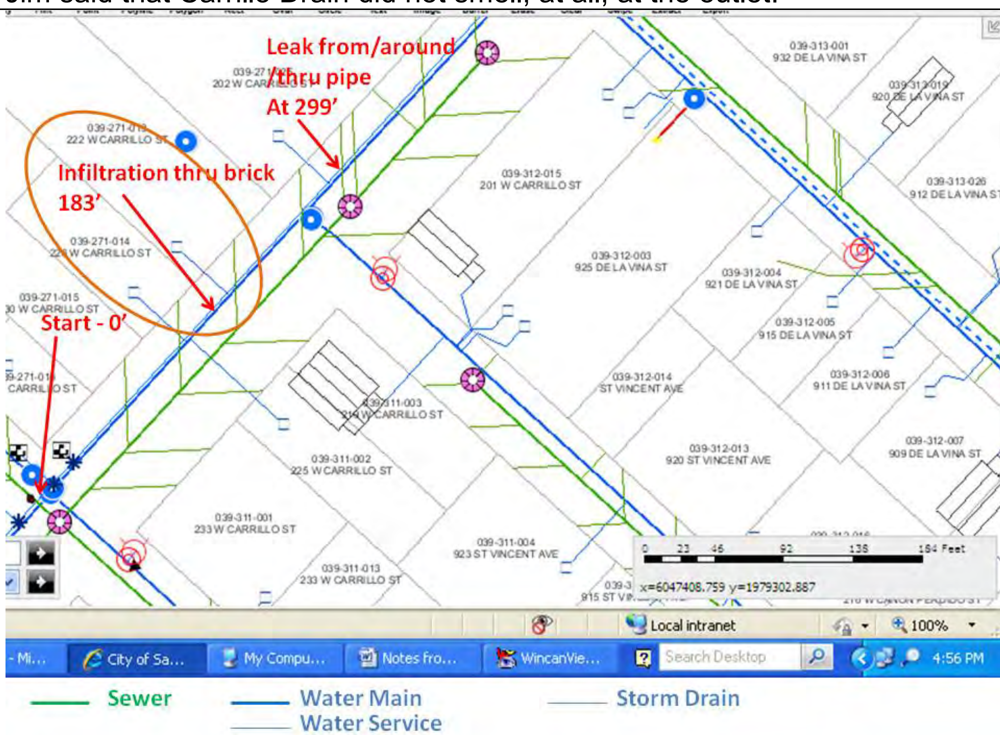
The Final Report has been published from the WERF Project.

	CARRILLO DRAIN June 2011	
Date	**Observations**	**Sample Results (summary) All FIB units are MPN/100 ml**
Early June	Creek looked clean.	
Thursday, June 16	TB and GJ saw tp, brown stuff, below the drain outfall. Jim came to sample. Jim talked to Manual about spills or breaks, and there haven't been any. Jim saw a piece of corn in the channel.	**Oulet** 5.4 mg/L ammonia, very high FIB
Monday, June 20	Carrillo Drain sampled for FIB and ammonia. Trickle of turbid (estimate >100 NTU) water coming out of drain. Smaller amount of solids visible in creek channel than on Thursday.	**Outlet** Low ammonia (<2), High for FIB (> 241,000 for all three groups).
Wednesday, June 22	By JR: Tim and I walked from State St. to Mission Creek along Carrillo St. checking for evidence of a sewage dump in every catch basin and Parking lot drain along the line. We did not see any flow or toilet paper in any of the catch basins or parking lot drains. However, we did smell what we both thought was sewage in the catch basins at Bath & Carrillo and at Castillo & Carrillo. The discharge into Mission Creek from the Carrillo Storm Drain was milky white in color. The flow from this drain increased noticeably while we were there, but was never more than a trickle. I thought the discharge from this drain smelled like Pine Sol. Tim thought he smelled sewage. Jim asked WW to help with televising.	
Thursday, June 23	JR contacted WW with photos and sampling results. WW wants to meet before televising. WW sent a mtg request for the following Thurs. JM calling private plumbers.	
Thursday, June 23	JM- I just collected samples from upstream, the drain, and downstream. It really smells like sewage – more like El Estero than straight rotten eggs. There is the characteristic grey filamentous bacteria of sewage … but I saw no toilet paper. The grey goes all the way down the MC channel to the ladder.	**Outlet** FIB (TC >2.4 x 10^7,, EC = 4.2 x 10^5, ENT = 4.4 x 10^5) and Ammonia (9 mg/L)
Thursday, June 23,	TB checked with Jim Jenkins and it looks like there may have been fire hydrant flushing in the area, which could have caused the tp to flow out. JM contacted Trish Holden to suggest they sample soon.	
Friday, June 24,	Received quote from Propipe.	
Monday, June 27,	Received results from Thurs. sampling. Jim collected samples in the morning. Getting more quotes for cctv. UCSB met Jim at 12:30 to collect samples. Jim observed pooled up water at the discharge, swirling with little particles, including chunks of something, including one kernel of corn. Darrel at El Estero lab thought the smell was consistent with sewage.	**Outlet** Ammonia 7.6 mg/L, FIB TC >24 x 10^6, EC 1.8 x10^6, ENT 3.1 x 10^5

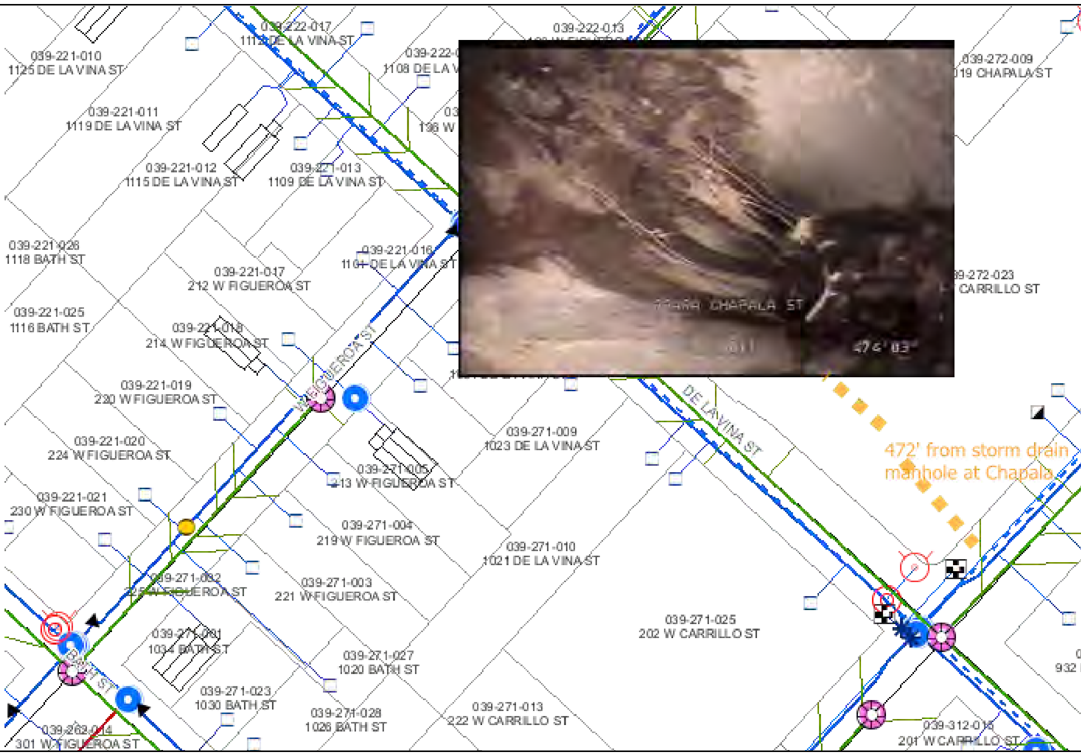
Tuesday, June 28,	Checked old MST data - four samples collected 2006, 1 in 8/06 was strongly positive for HBM, 3 in 9/06 were negative. Jared (UCSB) and Jim sampled at Chapala manhole and outlet. Emergency PO for Advanced Sewage Technologies (AST).	**Chapala:** Ammonia 32.4 mg/L FIB TC 2.4×10^6, EC 2.0×10^6, ENT 2.0×10^5 **Outlet** Ammonia 4.23 mg/L FIB TC 5.4×10^6, EC 1.9×10^5, ENT 1.2×10^5
Wednesday, June 29,	6/29/11 Carrillo St. Storm Drain CCTV by AST Summary: 1) <u>Section from Chapala towards State (upstream)</u>: (site of yesterday's sample that was very high in ammonia and indicator bacteria). Pooled water from manhole up a ways. Water is clear, lots of leaves underneath. Then pool ends, bottom is moist sediment, with lots of roots. Never see flowing or pooled water again. Then at 140' too many roots to continue. No corn or paper towels or flocculent grey matter observed in entire reach. 2) <u>Chapala towards De La Vina (downstream):</u> Pooled water, down to sediment/rocks. Intermittent rocks, pooled water, rocks, until a bit of a drop off or sill. No visible water input except for one spot that was wet. Below sill, water is flowing slowly. No obvious input or solids. At 475 feet, camera flipped and retrieved. 3) <u>Bath towards De La Vina (upstream):</u> Several pipes crossing in this section. At 22' and other spots, rags and/or paper towels observed, along with corn kernels. Grey slime, sloughing off, and flocculent material in water. At two spots, water was seen entering. At 174', it was dripping through bricks. At 299' water was dripping from some sort of pipe embedded in the roof of the storm drain. At both sites, it looks like there is signs of higher flow coming out and hitting the opposite side of the storm drain. The grey material, paper towels, and corn were not observed above this spot (except a short distance where the camera was pushing water up the pipe). According to MAPS, which we know is not perfectly accurate with regards to angle of laterals, 299' is right where a lateral coming out of the Radio Square (202 W. Carrillo) hits the storm drain. The lateral appears to be under the parking lot of the shopping center. (Lateral SL-F09-367, APN 039-271-025)	
Thurs, June 30	**Urine Info:** JM - How much pee would it take to get the concentrations of ammonia we found there? Carol at El Estero told me that most of the ammonia in ww influent is from urine ... and urine makes up a tiny percentage of ww, so it got me thinking. If my calculations are correct (along with my wikipedia-informed assumptions), urine would contain urea, that when converted to ammonia, would be at a concentration of 5000 mg/L. So a few pees into the stagnant puddle might get us to 35 mg/L. **SLIP /Code Info** JM- The Sewer Lateral Inspection Program is interesting - it looks to me like we have enough info for WW to require the property owner to TV their laterals. http://www.santabarbaraca.gov/Resident/Licenses_Permits/SLIP/Section_1.htm	

	"nothing in the above guidelines shall prevent the City from requiring a more timely (or immediate) response if the sewer lateral is causing an on-going threat to public health or safety. An example of such a threat is a cross connection with a storm drain, or an overflow into the public right-of-way." TB- **14.46.020 Maintenance of Private Building Sewer Laterals.** A. MAINTENANCE OF BUILDING SEWER LATERALS. Each Owner shall maintain his or her Building Sewer Lateral(s) free of displaced joints, open joints, root intrusion, substantial deterioration of the line, cracks, leaks, inflow, or infiltration of extraneous water, root intrusion, grease and sediment deposits, or any other similar conditions, defects, or obstructions likely to cause or increase the chance for blockage of the Building Sewer Lateral. C. GENERAL MAINTENANCE REQUIREMENTS. The maintenance obligation imposed by this Section shall be in addition to and supplemental of the general private sewer system maintenance obligations imposed by Section 14.44.160 of this Code. (Ord. 5396, 2006.) 14.46.030 Building Sewer Inspections – Access to Premises. The Public Works Director or the City Health Officer (or any designated representative thereof) is hereby authorized to inspect any Building Sewer Lateral in use within the City and connected to the City sewer system for the following purposes: 1. To determine the size, depth, and location of any sewer connection. 2. To determine the **end outlet** of any sewer connection by depositing harmless testing materials in any plumbing fixture attached thereto and flushing the same, if necessary. TB - There is a lot more relevant language about sewer lateral requirements in the entire 14.46 section: http://www.santabarbaraca.gov/Documents/Municipal_Code/03_Individual_Titles/SBMC_TITLE_14_Water_and_Sewers.pdf If that is a sewer lateral, then the property owner is required to replace it. If that is a water service line, then I believe also that the property owner would be required to fix it, based on section 14.20 (waste of water). Either way, it needs to be fixed.	
Thurs	Meeting with WW (Chris and Manual), Creeks (Jim, Cameron, Jill M), Streets (Rick). - Manual brought (and taught) how to get old sewer plans and reports. Interestingly, he just talked to a plumber about the site. The lateral from SpudNuts was blocked, camera could not get through. The lateral from the old Carrows was just televised and it's clean. - Chris did not think it necessarily looked like sewage. - At the end of the meeting, we agreed to work together to dye test SpudNuts. Jim set up the Rhodamine probe.	

		
Friday July 1	Jim put the rhodamine probe in the manhole at Bath. Three colors of dye were used in the three different buildings on that property. Each building is on its own lateral (Jim talked to brand new property owner – happened to be on site). SpudNuts and five other toilets in that building had green dye (probably fluorscein). After putting in the dye, Cameron and Jim went down to the creek and saw this (left is drain, right is Canon Perdido an hour or so later):   WW immediately sandbagged the drain and started pumping the sewage to a vactor. A repair was made, but it might be only a 5' sleeve. Tim thinks we should dye test again. Manual said they would flush it from De La Vina to Bath. No beach warnings during this period.	
Sat.	Brandon Steets said that the lagoon was closed on Saturday morning, and he was concerned about seeing it open the following Monday (July 4th) According to Rich Hanna, lifeguards saw that lagoon was full and closed to the	

	ocean until at least 6 pm, then open when the lifeguards arrived at 8:00 am Monday morning. Tide of 5.9 overnight.	
Tues. 7/5	Debrief Mtg with CB,GJ, TB, JR, JM to discuss leak at 182’, cleaning the drain, and the Greyhound. - Found out that WW has a video of dye coming out in the storm drain. Jim will ask them for it and will ask if they do any confirmation testing. - The fix was temporary and all laterals will be replaced before the street is chipsealed in August. - PW sent out an email to Council and Directors saying that they had found and fixed a sewer leak! - Jim will look at site and sample. - We will not flush or clean the drain at this point. - Jill and Jim will investigate the Greyhound – pour water in parking lot DI, see where it comes out, and sample for ammonia. - Jill will email Water Resources to see if they are interested in/can resolve whether the leak is water (email sent, Cathy says she will forward to Rocky). Will also check sewer laterals in area. - Followup with EHS? Tim? Jim said that Carrillo Drain did not smell, at all, at the outlet.	
		
	Leak 182.	

Weds. 7/6/11	From JR conversation with MR. Lateral was connected four feet down the line from the manhole. Was a leak. The reason we weren't seeing solids was because there was a pocket that had a dam, so water was spilling over. They did find the Y (where it enters the sewer main). Require lateral upgrade to 6' pipe by August. They called EHS and OES. Jim and Jill to Greyhound – - Upon arrival, noted that curb drain on Carrillo was wet. Sampled that water. Very stinky (ammonia?). Talked to guy sweeping lot, in Spanish, and I think he said that he washes the parking lot every third day with "Pinol." I think he said that the area is used as a bathroom. We took photos of this outlet. My estimate of sewage outfall from Spudnuts was ~1,000/day (8 hours a day, 2 gpm based on Jim's measurement).	**Ammonia:** Greyhound drains to Carrillo (pooled): 13.2/mg/L Chapala (flushed): 54.9 mg/L
Thurs. 7/7	Found a sewage at Leak 282. WW went out there early to CCTV, after noting that it looked slimy during the previous cctv operation. They sandbagged the Bath MH, and we planned to use the probe, and asked them to use red dye (rhodamine). We ran a water main to the SD to increase the flow (probe was at drain outlet). Then we moved the probe to the Bath MH. The camera was trained right on the drip. They flushed with red a few times. We didn't' see it, but we did see the drips pick up in rate – almost to a trickle. They were just about to stop, as they had seen the dye reach the sewer main. All of a sudden they saw a little pink. Then they went back with green and flushed again – BAM – plain as day. They are working to fix the situation, and shut off water to the building.	
Thurs. 7/7	Sent to WW (cc toth) Hi Manual, There is one more spot from our CCTV survey of Carrillo Drain that could show sewage entering the storm drain. I had in my notes from the first block that we surveyed (Chapala to almost DeLaVina) that there was a spot with "the most water we had seen yet" (but this was before checking the block with SpudNuts and CVS). I went back and looked at the footage, and also checked MAPS, and there is a sewer lateral right there, coming from Ralphs. I don't know if it's active. Here is the location with an inset picture from the video. Just tilt your head a little to see it. I've attached the picture file as well. What do you think? Thanks, Jill	



Thanks, Manuel, I concur with your assessment of our involvement/timing with on-going storm drain investigative program activities.

Cameron, our last meeting held was very informative and productive. Based upon the great work your staff is doing in investigating the city's storm drain system, I believe it would be good if we could meet on a regular basis – monthly, quarterly—to share information, coordinate, and update each other on activities taking place in our utility systems.

Perhaps we could all meet together sometime in late July or early August to discuss on-going activities that involve our respective work teams. Let me know what you think about us meeting on a regular basis, thanks, Chris

From: Romero, Manuel
Sent: Thursday, July 07, 2011 3:09 PM
To: Murray, Jill
Cc: Toth, Christopher J; Johnson, George; Rumbley, James L.; Benson, Cameron
Subject: RE: Third Leak in Carrillo Storm Drain

Jill,
At this time we will not be available to assist you with conducting a dye test of the Ralphs property to determine if they are contributing to this unknown/potential sewer lateral discharge source within the City's storm drainage system.

Currently wastewater collection staff are unable to provide assistance with ongoing storm drainage analysis which require the usage of our sewer vactor trucks and cctv inspection van. We have an ongoing extensive workload which requires our full attention. I am available to provide you sewer tracing dye and guidance in regards to conducting effective dye testing procedures if requested.

If you are able to conclusively determine that you receive tracing dye from within

	the storm drainage system, please notify me as soon as possible so we could determine how we could help resolve this potential issue to everyone's satisfaction. Thx, ***Manuel Romero***	
Tuesday 7/12	Jim and Jill went to look for the sewer plan, per Manual's suggestion, for Ralph's. -The original (1629) only has one perpendicular lateral at 140' from DLV (lat. 2 on map, I think) - The plan we looked at for Ralph's was hard to decipher but it looks like the active lateral is 2 or 3 (on map), 4" - The Ralph's plan had two notes -- "Sewer Lateral shown on City of Santa Barbara Log Report 3-21-00" -- Improvements in Public Right of Way in Public Works drawing C-1-2004. We looked at this one and it was impossible to tell which lateral was active. There was a note about capping inactive laterals. Also something about adding a 3" line for future. - Jim found a Public Works permit (PBW2000-00341). A sewer tap & Connection activity listed in this permit from 10-18-2000 stated, "City performed 2 taps to main line along Carrillo St. Davis Construction placed 4" class 200 water pipe, full stick, over Water Main. And SDR35 pvc to ROW." This is suggesting that the leak might NOT be from their active lateral – if the active lateral is 2 or 3, and the new sewer line was placed over the water main, then it shouldn't be leaking at 472' (from Chapala) Emailed Manual to ask for help with info. 	
	George – I would be hesitant to believe the design plans as absolute truth. Often during construction things change and abandoned lines don't always get abandoned. You might try looking at the " as built" plans but remember even "as built" plan are sometimes inaccurate. Tim - Could it come from the parking lot vault? It wasn't flowing but it was wet right? Maybe that is from periodic pumping from the underground parking garage	

	sump vault. Or intermittent irrigation from the landscape French drains or roof downspout drainage, with AC condensate occasionally pumped. Or, I wouldn't rule out the possibility that a supposedly abandoned sewer lateral was tapped for use for a plumbing fixture (toilet, sink, etc.) I missed a lot of the dialogue last week, so these could have already been ruled out. But just in case, there it is.	
	Thinking – we should get this done by August, so that if they need to fix it they can when the street is torn up.	

VIII. CREEK WALKS/CLEANUPS

This section will be completed in the following quarterly report.

IX. BIOASSESSMENT

The following text is excerpted from the Annual Bioassessment Report completed by Ecology Consultants. Specific questions addressed in the report are the impact of the fire on BMI communities and whether there is an artificial lowering of IBI scores at low-gradient sites due to fundamental differences in habitat structure.

Executive Summary

Introduction

This report summarizes the results of the 2010 Southern Coastal Santa Barbara Creeks Bioassessment Program, an effort funded by the City of Santa Barbara and County of Santa Barbara. Ecology Consultants, Inc. (Ecology) prepared the report, and serves as the City and County's consultant for the Program. This is the 11th year of the Program, which began in 2000. The purpose of the Program is to assess and monitor the biological integrity of creeks in the study area as they respond through time to natural and human influences. The Program involves annual collection and analysis of benthic macroinvertebrate (BMI) samples and other pertinent physiochemical and biological data in study creek reaches using U.S. Environmental Protection Agency (USEPA) endorsed rapid bioassessment techniques. BMI samples are analyzed in the laboratory to determine BMI abundance, composition, and diversity. Scores and classifications of biotic integrity are determined for study streams using the Index of Biological Integrity (IBI) that was developed for the study area by Ecology. The IBI is a system that yields a numeric score and classifies the biological integrity of a stream as Very Poor, Poor, Fair, Good, or Excellent based on the BMI community present in the stream, as determined by completing a bioassessment survey and associated laboratory and analytical work. Seven "core BMI metrics" are calculated and used to determine the IBI score. Each core metric is highly sensitive to human disturbance, and collectively they represent different aspects of the BMI community including diversity, composition, and trophic group representation. By condensing complex biological data into an easily understood score and classification of biological integrity, the IBI serves as an effective tool for the City and County in monitoring the overall condition of local creeks, and taking appropriate watershed management actions.

Study Area

The study area encompasses approximately 60 km of the southern Santa Barbara County coast from the Rincon Creek watershed at the Santa Barbara/Ventura County line west to Gaviota Creek. There are approximately 40 1st to 5th order coastal streams along this stretch of coast, all of which drain the southern face of the Santa Ynez Mountains. A total of 51 stream study reaches in 20 watersheds have been surveyed on one or more occasions during the springs and summers from 2000 to 2010. 25 stream study reaches were surveyed this year.

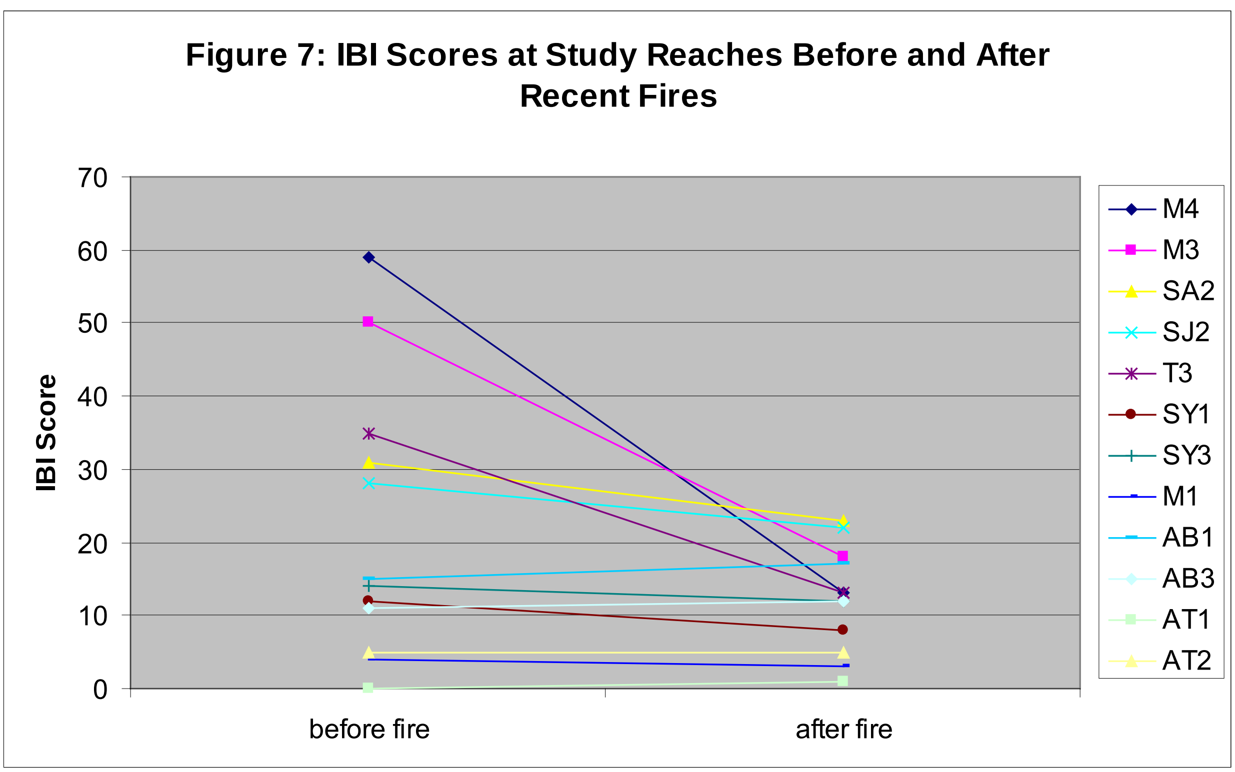
Methods

Physiochemical and biological data for the study reaches was gathered through a combination of methods including field surveys, laboratory analyses, spatial data analyses using geographic information system software, and review of United States Geological Survey (USGS) 7.5-minute quadrangle maps and recent aerial photographs. The seven IBI core metrics were calculated for each study reach, and IBI scores and classifications of biological integrity were determined.

Results

Overall, IBI scores at the study creeks were similar in range compared to the past four years (2006-2009). However, three recent wildfires (Gap, Tea, and Jesusita) coupled with scouring storm flows the following winters presumably caused noticeable losses in IBI scores at several of the affected study reaches in 2009 and 2010. This was particularly the case at study reaches M3 and M4 in the upper Mission Creek watershed following the Jesusita fire, which burned over 70 percent of the upper Mission Creek watershed. IBI scores at M3 and M4 were in the Good range in May 2009 just days before the fire, and were sharply lower (46 points lower at M4, 32 points lower at M3) and in the Poor range this past spring. The drops in IBI score at these study reaches are attributable to lower insect and EPT family diversity and lower percentage of sensitive BMI taxa and shredders and predators compared to before the fire. It will be interesting to track the recovery of these streams from the impacts of the fires over time.

Key Figures:



In addition, the issue of gradient was addressed.

Stream Gradient and IBI Score

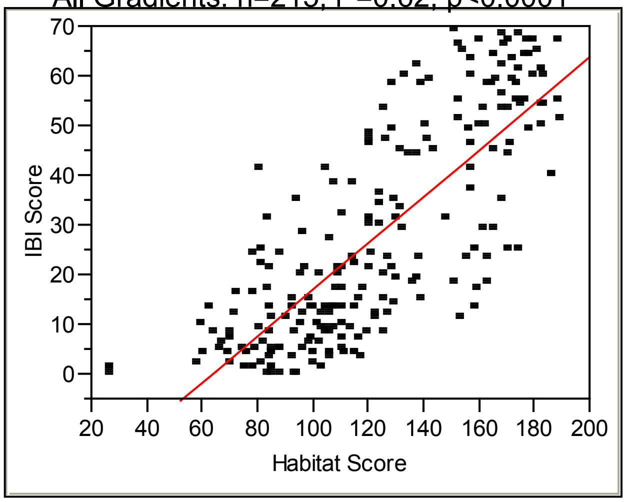
All of the low gradient (0.02 or less) perennial streams in the study area are at least moderately impacted by human development. This makes it difficult if not impossible to establish reference conditions for low gradient streams in the study area. This brings the question of whether the IBI is reliable in assessing the condition of low gradient streams. Effort has been made over the years to sample low gradient sites in the best condition possible, including study reaches in Rincon Creek (RIN0 and RIN1), San Jose Creek (SJ2), Tecolote Creek (T2 and T3), Dos Pueblos Creek (DP1), Refugio Creek (R1), El Capitan Creek (EC1), and Gaviota Creek (GAV1 and GAV2), all of which have been in the MOD DIST category (i.e., based on habitat assessment score and watershed land use) for most or all years studied. Numerous REF study reaches of moderate gradient (0.03-0.04) have also been studied (e.g., C3, MY2, R2, AH1, and SO1).

Statistical tests of the available data (i.e., 2000 to 2010) were performed to evaluate relationships between IBI score and level of human disturbance in different gradient classes, including low gradient (n=129), moderate gradient (n=47), high gradient (n=39), low gradient + moderate gradient (n=176), and all gradients (n=215). Figure 8 shows linear regression analyses of IBI score (dependent variable) vs. habitat assessment score (independent variable) for the above gradient classes. For all of the gradient classes, IBI score increases significantly with increasing habitat assessment score. Not surprisingly, the relationship is strongest for the all gradients group (r^2=0.62, p=0.0001), which has the largest sample size and greatest range of conditions (i.e., with respect to gradient and disturbance). Results are also highly significant for the low gradient (r^2=0.36, p=0.0001), moderate gradient (r^2=0.48, p=0.0001), and low + moderate gradient (r^2=0.57, p=0.0001) groups. The high gradient reaches also had a statistically significant positive relationship between IBI score and habitat assessment score, but it was considerably weaker with lower r^2 (0.13) and higher p (0.02).

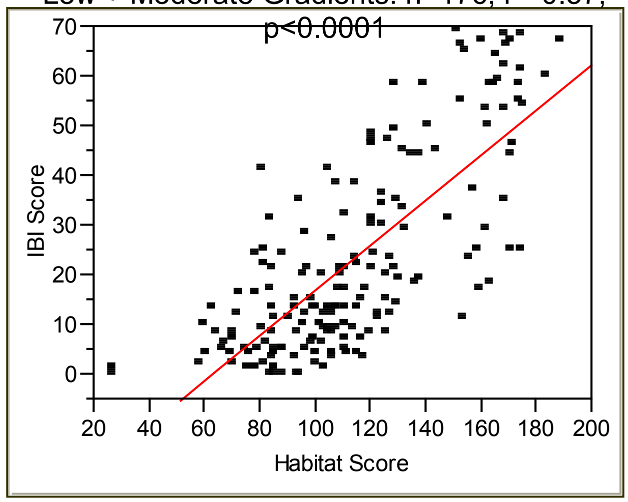
Figure 9 shows analyses of variance (ANOVA) that compare mean IBI score among the disturbance groups (i.e., REF, MOD DIST, and HIGH DIST) within the same gradient classes evaluated in the linear regressions. Results mirror those of the regression analyses; IBI scores decreased with increasing human disturbance (i.e., from REF to MOD DIST to HIGH DIST). Differences in means were highly significant for the all gradients (r^2=0.68, p=0.0001), low gradient (r^2=0.46, p=0.0001), moderate gradient (r^2=0.62, p=0.0001), and low + moderate.

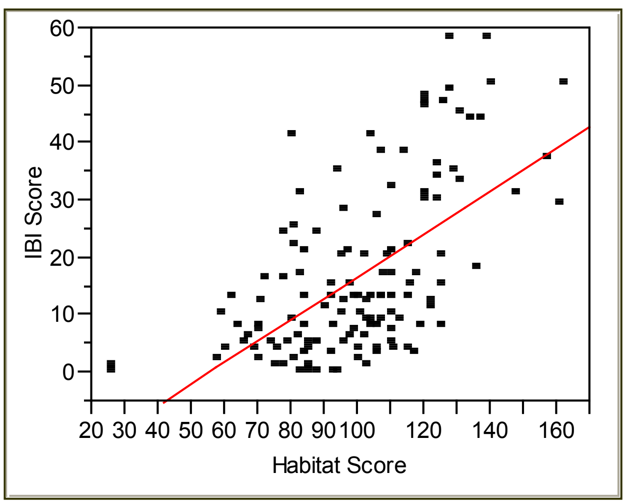
Figure 8: Linear Regressions of IBI Score (Dependent Variable) vs. Habitat Assessment Score (Independent Variable) by Gradient

All Gradients: n=215, r^2=0.62, p<0.0001

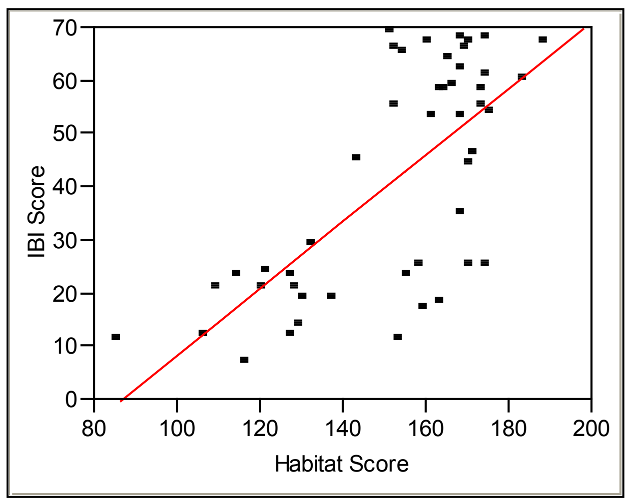


Low + Moderate Gradients: n=176, r^2=0.57, p<0.0001





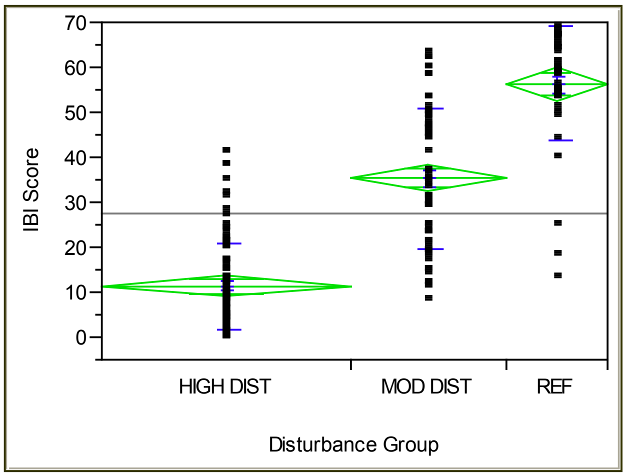
Low Gradient: n=129, r^2=0.36, p<0.0001



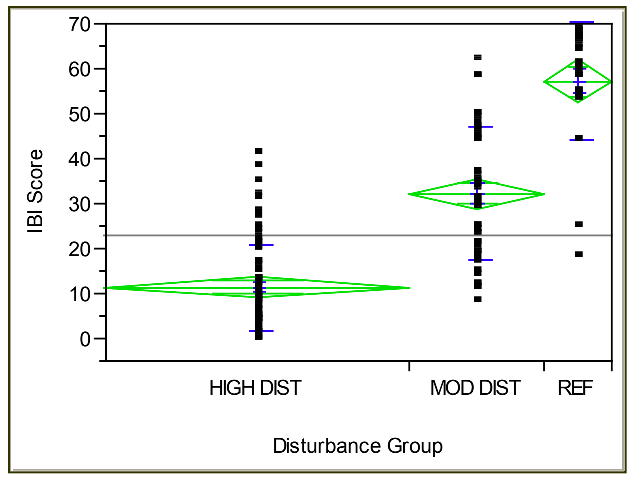
Moderate Gradient: n=47, r^2=0.49, p<0.0001

FIG 9: ANOVAs of IBI Score by Disturbance Group by Gradient

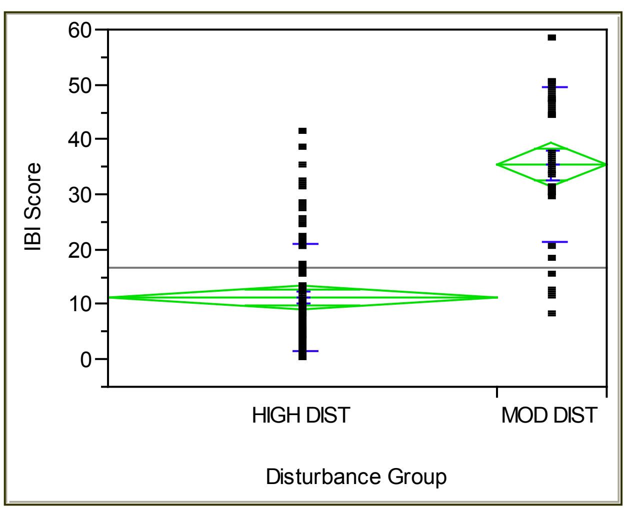
Means and distributions of IBI scores for study reach groups are represented for different gradient classes. Top and bottom of diamonds are the 95 percent confidence limits, and the center lines are the means. The lower and upper lines are the 25 percent and 75 percent quantiles. The p value is for the ANOVA where IBI score is the dependent variable and disturbance category is the independent variable.



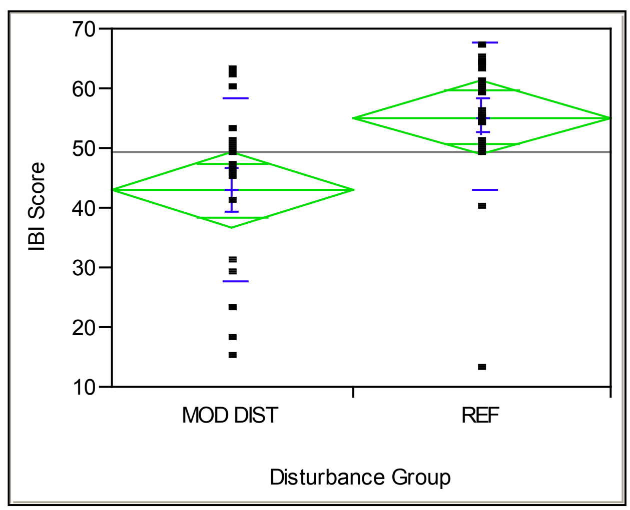
All Gradients: n=215, r^2=0.68, $p<0.0001$



Low +Moderate Gradients: n=176, r^2=0.66, $p<0.0001$



Low Gradient: n=129, r^2=0.46, $p<0.0001$



High Gradient: n=39, r^2=0.17, $p=0.01$

gradient groups (r^2=0.66, p=0.0001). Results were significant but less so for the high gradient group (r^2=0.17, p=0.01).

In summary, there is a strong positive relationship between IBI score and habitat assessment score for all gradient classes, as indicated by the linear regressions and ANOVAs. The above analyses do not indicate that variability in stream gradient impairs the reliability of the IBI in assessing the biological integrity of study area streams.

X. METHODS DEVELOPMENT

This section will be completed in the following quarterly report.

XI. REGULATORY CHANGES, EMERGING ISSUES, AND LITERATURE UPDATES

This section will be completed in the following quarterly report.

XII. RECOMMENDATIONS

This section will be completed in the Annual Report.

APPENDIX B. FY11 RESEARCH AND MONITORING PLAN

City of Santa Barbara Creeks Division
Water Quality Monitoring Program

FY11 RESEARCH PLAN

The goals of the monitoring program are to:

1. Quantify the levels (concentration and flux, or load) of microbial contamination and chemical pollution in watersheds throughout the city.
2. Evaluate impacts of pollution on beneficial uses of creeks and beaches, including recreation and habitat for aquatic organisms.
3. Evaluate the effectiveness of the City's restoration and water quality treatment projects, which includes collecting baseline data for future projects.
4. Identify sources of contaminants and pollution in creeks and storm drains.
5. Evaluate long-term trends in water quality.

The underlying motivation behind the monitoring program is to obtain information that the City can use to:

1. Develop strategies for water quality improvement, including prioritization of capital projects and outreach/education programs.
2. Communicate effectively with the public about water quality.

PROGRAM ELEMENTS AND QUESTIONS

A. Watershed Assessment

Research questions:

1. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?
2. How contaminated and/or toxic is sediment at creek outfall sites?
3. What is the impact of eutrophication on Santa Barbara creeks?

B. Storm Monitoring

Research Questions:

1. What are the highest concentrations of pollutants of concern during storm events, particularly seasonal first flush storms? Do creeks and/or storm drains in Santa Barbara have problems with toxicity during storm events?
2. What are the impacts of the Jesusita Fire on water quality?
3. What are the loads of pollutants discharged from Santa Barbara creeks during storms?
4. What are the sources and routes of pollutants during storms?
    a. How do concentrations and loads vary during storms and from site to site?
        - Fecal indicator bacteria
        - Slurry seal/PAHs/Foam
        - Metals
        - Nutrients
5. How do restoration/treatment projects impact water quality during storm events?

C. Restoration and Water Quality Project Assessment

The Creeks Division has completed several restoration and water quality improvement capital projects over the past several years. Project assessment is used to determine the success of projects in lowering microbial and chemical pollution levels and improving water quality for aquatic organisms. In some cases project monitoring is grant-required, and the remaining is for internal review of project success. Additional monitoring is conducted to ensure that the facility is performing as intended.

Research Questions:

1. Do Creeks Division projects result in improved water quality, as reflected in pre- and post-project, and/or, upstream to downstream, conditions?
2. What is the baseline water quality at future restoration/treatment sites?
3. What are the mechanisms of project success?

4. Are installed projects functioning correctly?

List of Projects

1. Westside SURF and Old Mission Creek Restoration
2. Arroyo Burro Restoration, including Mesa Creek daylighting
3. Hope and Haley Diversions
4. Laguna Channel Disinfection (Source Tracking)
5. Golf Course Project (Storm)
6. San Pascual Drain (Source Tracking)
7. Parking Lot LID (Storm)
8. Debris Screens (Creek Walks)
9. Mission Creek Fish Passage (Eutrophication/Dissolved Oxygen)
10. Bird Refuge

D. Beach water quality

Research questions:

1. How to creeks and storm drains relate to beach water quality and warnings?
2. How do other factors (kelp, tides, temperature, and beach use) relate to beach warnings?
3. What are the causes of persistent beach warnings that occur?
4. What is the risk to human health from recreation in creeks and beaches in Santa Barbara?

E. Source Tracking/Illicit Discharge Detection

Research questions:

1. Which subdrainages and/or contribute the greatest loads of pollutants to creeks in Santa Barbara? (CBI)
2. Where, when and how is human waste and/or sewage entering storm drains and creeks?
    a. What happens to the signals of human waste and indicator bacteria levels as water moves downstream away from the source?
    b. How does presence of human waste relate to beach warnings?
3. Do rotting plant material and sediment contribute to high FIB levels in storm drains?
4. What are the impacts of reservoir flushing on metals?
5. Are new hot spots emerging?
6. Specific areas of concern: Barger Canyon, Las Positas Creek, Haley Drain

F. Creeks Walks/Clean ups

Research Questions:

1. Are there new problems in creeks that need to be addressed?
2. Is the amount of trash in creeks decreasing over time?
3. Were decreases in trash observed between 1999 and 2005 due to creek flow histories or the impact of City programs?
4. Will the installation of catch basin screens lead to decreased trash observed in creeks?

G. Bioassessment

The biological assessment element is used to assess and monitor the biological integrity of local creeks as they respond through time to natural and human influences.

Research Questions:

1. What is the baseline of biological integrity for benthic macroinvertebrates in creeks?
2. Are there differences between upper watershed and lower watershed sites?
3. Are there differences among watersheds?
4. How does the biological integrity in our creeks change over time?
5. How does the biological integrity respond to water quality and restoration projects?

H. Methods Development

1. Can we use the following potential new tools?
    a. Can a chemical fingerprint be used to identify types of sources?
    b. Can the Microtox assay be used?
    c. Can screening kits be used?

d. K-9 forensics?

PROGRAM ELEMENT and QUESTIONS	CONSTITUENTS/METHODS	SITES	FREQUENCY	PROJECTED COST
A. Watershed Assessment				
1. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?	Indicator bacteria, field parameters, flow	Integrator Sites Honda and Lighthouse	Biweekly Quarterly	$3,024
2. How contaminated and/or toxic is sediment at creek outfall sites?	Metals, PAHs, Toxicity, Herbicides, Pesticides, including Pyrethroids. Add transnonachlor and sublethal toxicity.	Estuarine or lower creek sites	Yearly, in late summer	$8,760
B. Storm Monitoring				
1. What are the highest concentrations of pollutants of concern during storm events, particularly seasonal first flush storms? Do creeks and/or storm drains in Santa Barbara have problems with toxicity during storm events?	Metals, Herbicides, Pesticides, Nutrients, Oil and Grease, Toxicity	Integrator Sites and four storm drains	Yearly, first flush. Collect creek samples early during runoff event. Collect drain samples second.	$9,256
2. What are the impacts of the Jesusita Fire on water quality.?	Metals, PAHs, Sediment, Nutrients, field parameters, toxicity	Mission Canyon at Mission. Mission at Montecito later in storm.	Yearly, first flush.	$1,500
3. What are the loads of pollutants discharged from Santa Barbara creeks during storms?	Metals	Arroyo Burro at Cliff (location of flow gauge and autosampler)	Conduct composite sampling according to Caltrans (2008) during a 1" forecasted storm.	$850
4. What are the sources and routes of pollutants during storms?	Fecal indicator bacteria, Sediment, MBAS (or cationic surfactants), PAHs. Visual observation for foam during storm event.	Arroyo Burro at Cliff Simulated rain and runoff from recently sealed parking lots and/or streets.	Conduct composite sampling according to Caltrans (2008) during a 1" forecasted storm.	$3,745
5. How do restoration/treatment projects impact water quality during storm events?	Bacteria, nutrients, metals, sediment Bacteria, nutrients, metals, sediment, oil and grease, MBAS and toxicity	Seven sites at Golf Course Parking Lot Four	Three storms post project for Golf Course. First flush for Parking Lot 4.	$4,737

PROGRAM ELEMENT and QUESTIONS	CONSTITUENTS/METHODS	SITES	FREQUENCY	PROJECTED COST
C. Restoration and Water Quality Project Assessment				
1. Westside SURF and Old Mission Creek Restoration (see annual report for details)	Indicator bacteria and field parameters	SURF up, SURF down, Westside Drain, OMC at W. Anapamu, 10 sites between Westside Drain and W. Anapamu	Weekly for SURF operation, biweekly for downstream impacts, and quarterly for regrowth study	$4,509
2. Arroyo Burro Restoration, including Mesa Creek daylighting (Suspension of quarterly testing until results from biweekly testing warrant a change).	Indicator bacteria and field parameters	AB at Cliff, Mesa upper, Mesa lower, AB Estuary upper, AB Estuary Mouth, AB Surf	Biweekly	$4212
3. Hope and Haley Diversions	Indicator bacteria and field parameters	Hope Diversions, Haley Pump	Biannual	$108
4. Laguna Channel Disinfection (Source Tracking)	Indicator bacteria and field parameters	Laguna at Chase Palm (already covered by routine)	Biweekly	Included above.
5. Golf Course Project (Storm)	See storm monitoring			Included above.
6. Parking Lot LID (Storm)	See storm monitoring			Included above.
7. Debris Screens (Creek Walks)	See creek walks			No lab cost.
8. Mission Creek Fish Passage (Eutrophication/Dissolved Oxygen)	Dissolved Oxygen, pH, temperature, conductivity	MC Lagoon, MC upper reaches	Install probes for summer months, collect data continuously	No lab cost.
9. Bird Refuge	Indicator bacteria, chlorophyll a, nutrients, and field parameters	Bird Refuge Inflow, Landing and Outlet	Monthly	$1,884
D. Beach water quality				
1. How to creeks and storm drains relate to beach water quality and warnings, along with other factors such as kelp, tides, temperature (air,	Multivariate statistical model on retrospective data. Also see source tracking.			No lab cost.

PROGRAM ELEMENT and QUESTIONS	CONSTITUENTS/METHODS	SITES	FREQUENCY	PROJECTED COST
creek, ocean), beach use?				
2. Is growth on sediment and/or kelp responsible for beach warnings?	Sample plan to be determined.			$2,700
3. What are the causes of persistent beach warnings that occur?	Conduct additional surveillance and sampling (indicator bacteria and/or DNA techniques) up creek and within estuaries when persistent warnings occur			$1,350
4. What is the risk to human health from recreation in creeks and beaches in Santa Barbara?	Use forthcoming epidemiology studies in Southern California to conduct simple model of illness rates at Santa Barbara beaches.			No lab cost.
E. Source Tracking/Illicit Discharge Detection				
1. Which subdrainages and/or contribute the greatest loads of pollutants to creeks in Santa Barbara? (CBI)	Source Tracking Grant			Grant funded..
2. Where, when and how is human waste and/or sewage entering storm drains and creeks?	Source Tracking Grant			Grant funded.
3. What happens to the signals of human waste and indicator bacteria levels as water moves downstream away from the source?	Source Tracking Grant			Grant funded.
4. How does presence of human waste relate to beach warnings?	Source Tracking Grant			Grant funded.
5. Do rotting plant material and sediment contribute to high FIB levels in storm drains?	Work with Streets Division to conduct pilot study on catch basin and storm drain cleaning on indicator bacteria levels.	Possible site: Montecito St. in Laguna Channel Watershed. Ideal sites are located at terminal upstream end of storm drain, with easy access for cleaning and sampling.	Monthly.	$2,700
6. What are the impacts of reservoir flushing on metals?	Metals, sediment.	Rattlesnake Creek and Reservoir outlet.	Single event.	$575

PROGRAM ELEMENT and QUESTIONS	CONSTITUENTS/METHODS	SITES	FREQUENCY	PROJECTED COST
7. Are new hot spots emerging?	Observation, enforcement.	Serena Drain and others		
8. Specific areas of concern: Barger Canyon Las Positas Creek Lower Mission Mid Arroyo Burro	Chemical fingerprint (Fluoride, potassium, ammonium, boron, MBAS) , indicator bacteria	Barger Canyon (5 sites upstream) Las Positas Creek (Modoc to Arroyo Burro, 5 sites) Lower Mission (5 sites between OMC and Montecito Street) Mid Arroyo Burro (5 sites SRC and LPC)	Quarterly	$12,000
F. Creeks Walks/Clean ups				
1. Are there new problems in creeks that need to be addressed?	Creek clean ups			No lab cost.
2. Is the amount of trash in creeks decreasing over time?	Weight of trash removed each year.			No lab cost.
3. Were decreases in trash observed between 1999 and 2005 due to creek flow histories or the impact of City programs?	Continue measuring and marking GPS coordinates of trash in Old Mission Creek and Lower Mission Creek (Oak Park to beach).			No lab cost.
4. Will the installation of catch basin screens lead to decreased trash observed in creeks?	See 3.			No lab cost.
G. Bioassessment	See Bioassessment Proposal and Reports.			No lab cost.
H. Methods Development				
1. Can a chemical fingerprint be used to identify types of sources?	Chemical fingerprint (Fluoride, potassium, ammonium, boron, MBAS)	Fingerprint sources: groundwater, city water, reclaimed water, irrigation runoff, wastewater influent.		$3,000
2. Can the Microtox assay be used?	Investigate costs and options.			No lab cost.
3. Investigate field screening kits.	Investigate costs and options.			
4. K-9 forensics?	Investigate costs and options.			No lab cost.

PROGRAM ELEMENT and QUESTIONS	CONSTITUENTS/METHODS	SITES	FREQUENCY	PROJECTED COST
TOTAL LAB COST				$64,910