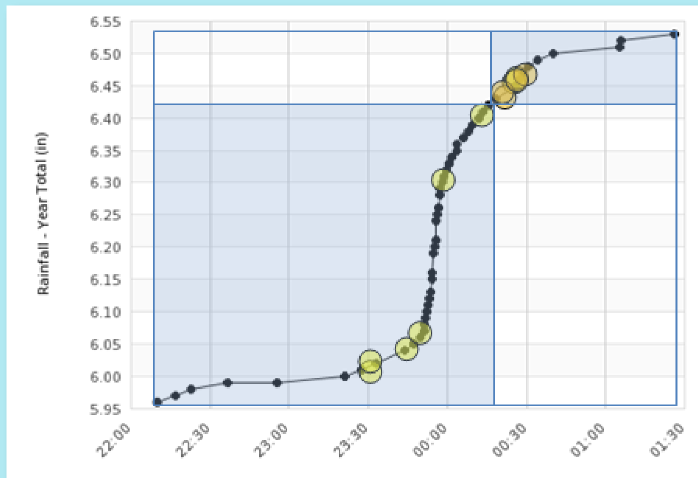
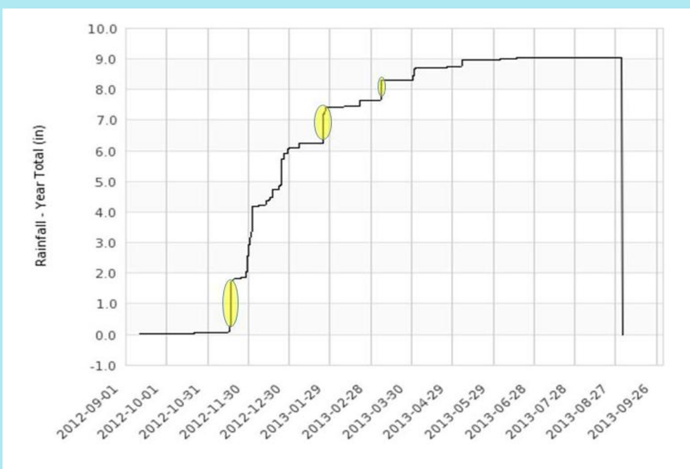
Fiscal Year 2014
Annual Water Quality Report





Low Impact Development Project Monitoring

City of Santa Barbara
Creeks Division
June 1, 2015

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Clean Creeks
HEALTHY BEACHES
CITY OF SANTA BARBARA

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INTRODUCTION

The following report described sampling and results that were based on the Fiscal Year 2014 Research and Monitoring Plan (Appendix A). The Research Plan is organized around program elements and research questions that have been reviewed by the Creeks Advisory Committee (CAC). The Research and Monitoring Program is adaptive, and as questions are answered or modified, sampling strategies change as well. The program elements and research questions are provided below. Where possible, the report is organized around the research questions. ***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.***

WATER QUALITY MONITORING PROGRAM GOALS

The goals of the monitoring program are to:

1. Meet monitoring requirements for grants.
2. Meet General Permit monitoring requirements.
3. Quantify the levels (concentration, flux, or load) of microbial contamination and chemical pollution in watersheds throughout the city.
4. Evaluate impacts of pollution on beneficial uses of creeks and beaches, including recreation and habitat for aquatic organisms.
5. Evaluate the effectiveness of the City's restoration and water quality treatment projects, which includes collecting baseline data for future projects.
6. Identify sources of contaminants and pollution in creeks and storm drains.
7. 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.

CHANGES FOR FISCAL YEAR 2014

This year's plan represents a major change in the Research and Monitoring Program due to regulatory requirements in the new Phase II Small MS4 General Permit (General Permit). In addition, the State has become more rigorous in monitoring requirements for grant-funded projects. Some of the specific requirements for General Permit monitoring are yet to be determined (see below). In addition, the Creeks Division has begun several new projects that require baseline monitoring. Therefore, the main changes in the upcoming year are:

1. Update the program goals and elements to include meeting grant and General Permit requirements.
2. Update the program based on new General Permit requirements for Illicit Discharge Detection and Elimination (IDDE) and Monitoring, including the development of a State-

certified Quality Assurance Project Plan and submittal of monitoring data to a Waterboard database.
3. Focus the FY 2013 Water Quality Report on wrapping up data analyses for monitoring efforts that will not be maintained, especially for restoration and water quality improvement projects.
4. Update Source Tracking to focus on Laguna Channel Watershed, pathogens, and the UCSB SIPP project.
5. Update Project Assessment to focus on the Bird Refuge, Mission Lagoon Restoration, Upper Arroyo Burro Restoration, and Las Positas Creek Restoration Projects.

KEY FINDINGS

BEACH WARNINGS

Drought conditions have led to a reduction in beach warnings, based on weekly indicator bacteria tests by Santa Barbara County, at Arroyo Burro Beach and East Beach at Mission Creek. During 2012 and 2013, Arroyo Burro Beach and East Beach at Mission Creek had half as many warnings posted compared to years with normal rainfall amounts. The reduction in wet weather beach warnings is due to fewer rain events, with associated discharge of high levels of indicator bacteria, whereas the reduction in dry weather warnings is due lower base flows and less frequent lagoon breaching (opening) during dry years.

Previous data analysis by the Creeks Division has demonstrated the impact of lagoon openings on beach warnings. When closed, the sand berms act to slow and filter creek discharges. During years with less rainfall, low summer base flow in creeks leads to more frequent closing of sand berms by waves and longshore currents. Deliberate breaching by beachgoers can always occur, but the berms close more quickly during periods when lagoon inputs are lower. The frequencies of beach warnings at Leadbetter Beach and East Beach at Sycamore Creek are less sensitive to yearly rainfall because the creeks located at these beaches rarely discharge directly to the ocean, except during larger storms.

FIRST FLUSH STORM MONITORING

Storm monitoring was conducted during the first storm of the year (“first flush”) on February 26, 2014 (the latest first flush storm since the Creeks Division began sampling). Samples were collected from the integrator sites (most downstream location above tidal influence) at Arroyo Burro, Mission Creek, Laguna Creek, and Sycamore Creek. Samples were also collected at four sites where runoff enters the Bird Refuge. Samples were tested for metals, hydrocarbons, surfactants, nutrients, and toxicity, with most results being low or normal for our creeks. As seen previously, almost all pesticides and herbicides were not detected. However, three newer pesticides were found consistently in the samples. Dichloran, a pyrethroid pesticide used as a fungicide on food crops, was found in all eight samples. Sumithrin, a pyrethroid used most frequently in mosquito abatement products, was found at six sites, including two discharges to the Bird Refuge. As discussed below, this compound was also found during sediment testing of Bird Refuge samples in FY 14. Last, imadochlorid, a neonicotinoid pesticide known to harm bees, was found in all four integrator sites tested (because this was the first year that neonicotinoids were tested, only the integrator sites were sampled for imatochlorid). Due to the consistent results across sampling sites, despite different land uses, these results are possibly suspect and may be due to laboratory problems. Follow up sampling will be conducted in FY 15 to determine if sumithrin and imatochlorid continue to be detected, and if so, what the impacts and sources may be.

Imidacloprid

As discussed above, the neonicotinoid pesticide imidacloprid was found at all four integrator sites during the first flush sampling event. Imidacloprid is thought to harm pollinators and cause colony collapses in honeybees. When the storm monitoring results were received, concentrations were compared to the US EPA toxicity thresholds for aquatic organisms, and it appeared that creek levels were far too low to cause toxicity problems. However, recent research in Europe, where the use of neonicotinoid compounds have been blocked by a moratorium, has shown that imidacloprid may be responsible for large-scale reductions in aquatic insect populations and subsequent reductions in bird species that feed on insects. The Creeks Division has followed up on this potential concern with outreach and additional testing. A segment about the pesticide on City TV's Inside Santa Barbara was produced. Results from limited dry-weather sampling showed no imidacloprid in non-storm flows. Additional storm testing was conducted in November 2014 and results will be shared during the June 2015 update to the Committee.

BIRD REFUGE

High nutrient levels, shallow depths, and low levels of dissolved oxygen are key water quality issues at the Bird Refuge. Eutrophic conditions (an increase in algal growth and die-off, resulting in low dissolve oxygen) can lead to the release of noxious odors. The most recent "stink event" occurred in June 2012. In September 2012, the Parks and Recreation Department began a pilot project to test the ability of enhanced circulation to improve water quality and prevent noxious odors at the Bird Refuge. The Creeks Division has continued to monitor the pilot project and seasonal water quality patterns.

Two years of weekly sampling in the Bird Refuge have demonstrated very consistent algal blooms, with subsequent die-off and decay. Despite periods with extremely low dissolved oxygen levels throughout the water column, extending from the sediment-water interface to the water surface for up to two weeks at a time, no large stink events have occurred. It is likely that high levels of certain types of bacteria that consume hydrogen sulfide and methane, gases which contribute to odors, may be responsible for preventing odors. During Winter 2013, a high population of zooplankton, called *Daphnia*, developed. The zooplankton were able to consume the algae present and the water was relatively clear for two months. This pattern has not been repeated thus far in 2014.

Summer sediment sampling at five sites in the Bird Refuge was conducted to inform potential future projects, such as dredging. As discussed above, one pesticide found across the samples was the pyrethroid pesticide sumithrin, which is used predominantly in mosquito abatement products. Despite extensive research about pesticide use in the local area, no sources of sumithrin were identified. The

Vector Control District has relied on bio-control methods for mosquito control over the past several years and chemical products have not been used. In FY 15, further testing will be conducted in order to investigate the sumithrin results.

PERMIT REQUIREMENTS

Work conducted in support of the Phase II General Permit monitoring requirements include consultation with the Regional Board about monitoring requirements.

GRANT REQUIREMENTS

Calculations were completed for the Parking Lot Stormwater Infiltration Project.

PROGRAM ELEMENTS AND RESEARCH QUESTIONS

GRANT PROJECT MONITORING REQUIREMENTS

1. Parking Lot Storm Water Treatment Demonstration Project
    a. Calculate the load of pollutants infiltrated during 2013-14 rain events at six parking lot sites, based on Event Mean Concentration results from FY 2013 results.
    b. Maintain HOBO data loggers and graph results.
    c. Provide information for grant reporting.
    d. Monitor and report according to approved Monitoring Plan/Quality Assurance Project Plan

NPDES PERMIT REQUIREMENTS: PHASE II SMALL MS4 GENERAL PERMIT.

Many new requirements are specified in the General Permit. Requirements relevant to the Research and Monitoring Program have been copied from the General Permit and pasted below.

1. Illicit discharge, detection and elimination.

E.9.a. Outfall Mapping

(i) **Task Description** – Within the second year of the effective date of the permit, the Permittee shall create and maintain an up-to-date and accurate outfall map[15]. The map may be in hard copy and/or electronic form or within a geographic information system (GIS) the development of the outfall map shall include a visual outfall inventory involving a site visit to each outfall. Renewal Permittees that have an existing up-to-date outfall map that includes the minimum requirements specified in Section E.9.a.(ii)(a-e) are not required to re-create the outfall map. This does not exempt Renewal Permittees with an existing outfall map from conducting the field sampling specified in Section E.9.c.

(ii) **Implementation Level** - The outfall map shall at a minimum show:

(a) The location of all outfalls[16] that are operated by the Permittee within the urbanized area, drainage areas, and land use(s) contributing to those outfalls that are operated by the Permittee, and that discharge within the Permittee's jurisdiction to a receiving water. Each mapped outfall shall be located using coordinates obtained from a global positioning system (GPS) and given an individual alphanumeric identifier, which shall be noted on the map. Photographs or an electronic database shall be utilized to provide baseline information and track operation and maintenance needs over time.

(b) The location (and name, where known to the Permittee) of all water bodies receiving direct discharges from those outfall pipes.

(c) Priority areas, including, but not limited to the following:

1) Areas with older infrastructure that are more likely to have illegal connections and a history of sewer overflows or cross-connections
2) Industrial, commercial, or mixed use areas;
3) Areas with a history of past illicit discharges;
4) Areas with a history of illegal dumping;
5) Areas with onsite sewage disposal systems;
6) Areas upstream of sensitive water bodies;
7) Areas that drain to outfalls greater than 36 inches that directly discharge to the ocean; and
8) Other areas that are likely to have illicit discharges

The priority area list shall be updated annually.

(d) Field sampling stations

(e) The permit boundary

Submerged outfalls or other outfalls that may pose a threat to public safety and/or that are inaccessible are not required to be inventoried.

E.9.c. Field Sampling to Detect Illicit Discharges

(i) **Task Description –** Within the second year of the effective date of the permit (e.g. while conducting the outfall inventory under Section E.9.a.), the Permittee shall sample

any outfalls that are flowing or ponding more than 72 hours after the last rain event. The Permittee shall also conduct dry weather sampling (more than 72 hours since the last rain event) of outfalls annually identified as priority areas.

(ii) **Implementation Level –** The Permittee shall:

(a) Conduct monitoring[17] for the following indicator parameters identified in Table 1 to help determine the source of the discharge. Alternatively, the Permittee may select parameters based on local knowledge of pollutants of concern in lieu of sampling for the parameters listed in Table 1. Modifications and associated justifications shall be identified within SMARTS prior to conducting field sampling as specified in Section E.9.c.(i).

Table 1. Indicator Parameters

Indicator Parameters Used to Detect Illicit Discharges					
Parameter	Discharge Types It Can Detect				Laboratory/Analytical Challenges
	Sewage	Washwater	Tap Water	Industrial or Commercial Liquid Wastes	
Ammonia	●	◉	○	◉	Can change into other nitrogen forms as the flow travels to the outfall
Color	◉	◉	○	◉	
Conductivity	◉	◉	○	◉	Ineffective in saline waters
Detergents – Surfactants	●	●	○	◉	Reagent is a hazardous waste
Fluoride*	○	○	●	◉	Reagent is a hazardous waste Exception for communities that do not fluoridate their tap water
Hardness	◉	◉	◉	◉	
pH	○	◉	○	◉	
Potassium	◉	○	○	●	May need to use two separate analytical techniques, depending on the concentration
Turbidity	◉	◉	○	◉	

● Can almost always (>80% of samples) distinguish this discharge from clean flow types (e.g., tap water or natural water). For tap water, can distinguish from natural water.
◉ Can sometimes (>50% of samples) distinguish this discharge from clean flow types depending on regional characteristics, or can be helpful in combination with another parameter
○ Poor indicator. Cannot reliably detect illicit discharges, or cannot detect tap water
N/A: Data are not available to assess the utility of this parameter for this purpose.
Data sources: Pitt (
*Fluoride is a poor indicator when used as a single parameter, but when combined with additional parameters (such as detergents, ammonia and potassium), it can almost always distinguish between sewage and wash water.

(b) Verify that indicator parameters, as specified in Table 2. Action Level Concentrations for Indicator Parameters are not exceeded. Alternatively, the Permittee may tailor Table 2 to align with parameters based on local knowledge of pollutants of concern. Modifications and associated justifications shall be identified within SMARTS prior to conducting field sampling as specified in Section E.9.c.(i).

Table 2. Action Level Concentrations for Indicator Parameters

Indicator Parameter	Action Level Concentration
Ammonia	>= 50 mg/L
Color	>= 500 units
Conductivity	>= 2,000 µS/cm
Hardness	<= 10 mg/L as CaCO3 or >= 2,000 mg/L as CaCO3
pH	<= 5 or >=9
Potassium	>= 20 mg/L
Turbidity	>= 1,000 NTU

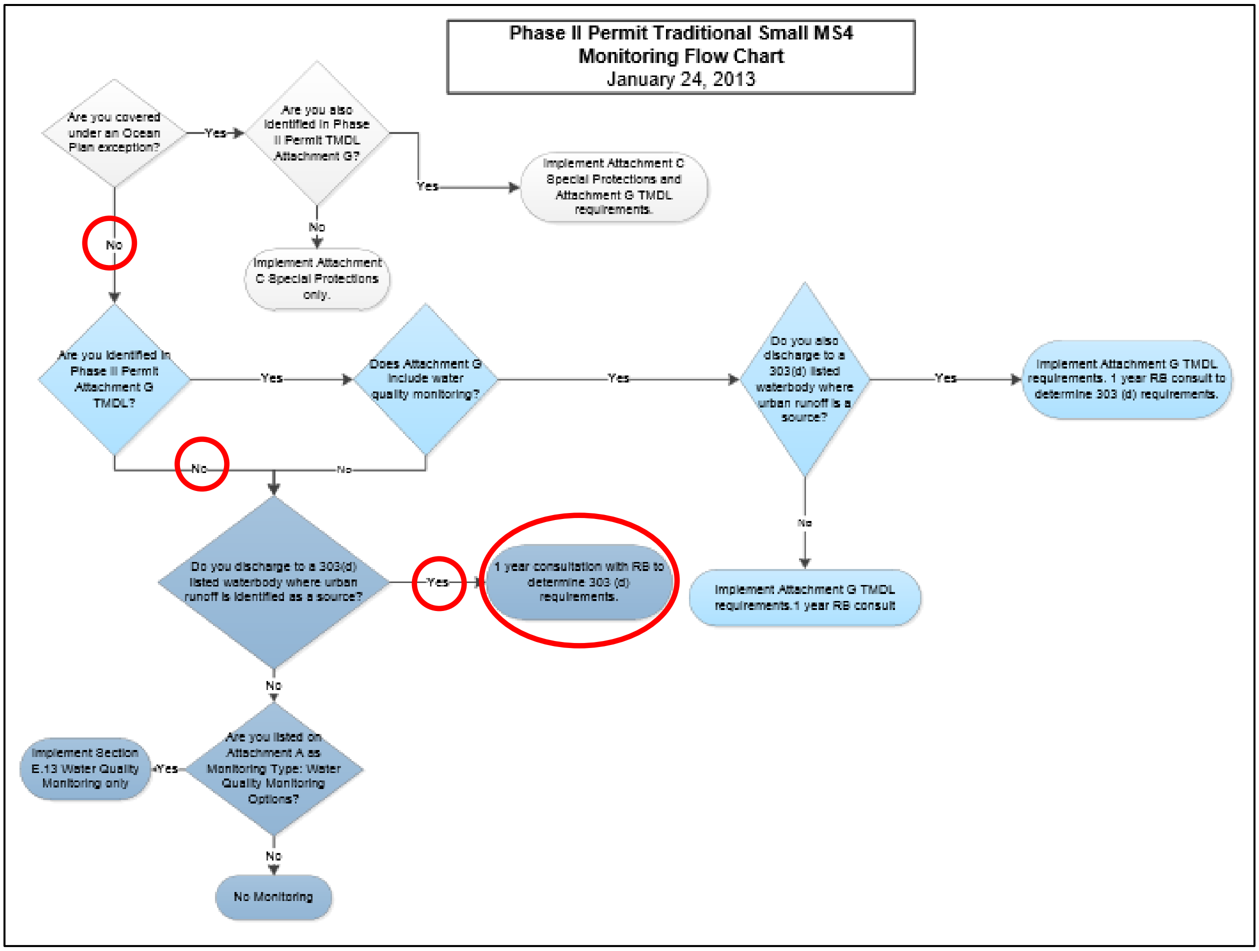
(c) Conduct follow up investigations per Section E.9.d. if the action level concentrations are exceeded.

[14] The Permittee shall use the Center for Watershed Protection's guide on Illicit Discharge Detection and Elimination (IDDE): A Guidance Manual for Program Development and Technical Assistance (available at www.cwp.org) or equivalent when developing an IDDE program. Guidance can also be found at: http://cfpub.epa.gov/npdes/stormwater/idde.cfm.
[15] The Permittee may utilize existing forms such as the CWP Outfall Reconnaissance Inventory/Sample Collection Field Sheet while conducting the mapping inventory and Field Sampling as specified below, in Section E.9.c.(http://cfpub.epa.gov/npdes/stormwater/idde.cfm).
[16] Submerged outfalls or other outfalls that may pose a threat to public safety and/or that are inaccessible are not required to be inventoried.

[17] A description of indicator parameter sampling equipment is described in Chapter 12: Indicator Monitoring in the CWP IDDE: Guidance Manual found at: http://www.epa.gov/npdes/pubs/idde_manualwithappendices.pdf. Sampling may be conducted using field test kits.

GENERAL PERMIT MONITORING.

The Monitoring section of the General Permit provides a flow chart and narrative description of many different potential monitoring requirements. According to the flow chart (with red added to show Creeks Division status) and description pasted below, the Creeks Division fits in the category of requiring 303(d) monitoring; however, the specific monitoring requirements will be determined after consultation with the Regional Board.



E.13.c. 303(d) Monitoring

All Permittees that discharge to waterbodies listed as impaired on the 303(d)[28] list where urban runoff is listed as the source, shall consult with the Regional Water Board within one year of the effective date of the permit to assess whether monitoring is necessary and if so, determine the monitoring study design and a monitoring implementation schedule. Permittees shall implement monitoring of 303(d) impaired water bodies as specified by the Regional Water Board Executive Officer.

The following table shows the 2010 303(d) listings for water bodies in the City of Santa Barbara. Red font indicates that urban runoff is listed as the source of the impairment.

Table 1. 2010 303(d) listings (red font indicates urban runoff as a source)

WATER BODY NAME	POLLUTANT	POLLUTANT CATEGORY	POTENTIAL SOURCES
Arroyo Burro Creek	Escherichia coli (E. coli)	Pathogens	Golf course
Arroyo Burro Creek	Escherichia coli (E. coli)	Pathogens	Urban Runoff/Storm Sewers
Arroyo Burro Creek	Escherichia coli (E. coli)	Pathogens	Natural Sources
Arroyo Burro Creek	Fecal Coliform	Pathogens	Golf course activities
Arroyo Burro Creek	Fecal Coliform	Pathogens	Natural Sources
Arroyo Burro Creek	Fecal Coliform	Pathogens	Urban Runoff/Storm Sewers
Mission Creek (Santa Barbara County)	Escherichia coli (E. coli)	Pathogens	Transient encampments
Mission Creek (Santa Barbara County)	Escherichia coli (E. coli)	Pathogens	Urban Runoff/Storm Sewers
Mission Creek (Santa Barbara County)	Escherichia coli (E. coli)	Pathogens	Habitat Modification
Mission Creek (Santa Barbara County)	Escherichia coli (E. coli)	Pathogens	Hydromodification
Mission Creek (Santa Barbara County)	Fecal Coliform	Pathogens	Habitat Modification
Mission Creek (Santa Barbara County)	Fecal Coliform	Pathogens	Transient encampments
Mission Creek (Santa Barbara County)	Fecal Coliform	Pathogens	Hydromodification
Mission Creek (Santa Barbara County)	Fecal Coliform	Pathogens	Urban Runoff/Storm Sewers
Mission Creek (Santa Barbara County)	Low Dissolved Oxygen	Nutrients	Hydromodification
Mission Creek (Santa Barbara County)	Low Dissolved Oxygen	Nutrients	Removal of Riparian Vegetation
Mission Creek (Santa Barbara County)	Low Dissolved Oxygen	Nutrients	Habitat Modification
Mission Creek (Santa Barbara County)	Low Dissolved Oxygen	Nutrients	Source Unknown
Mission Creek (Santa Barbara County)	Unknown Toxicity	Toxicity	Urban Runoff/Storm Sewers
Pacific Ocean at Arroyo Burro Beach	Enterococcus	Pathogens	Source Unknown
Pacific Ocean at Arroyo Burro Beach	Total Coliform	Pathogens	Source Unknown
Pacific Ocean at East Beach – Mission Ck.	Fecal Coliform	Pathogens	Source Unknown
Pacific Ocean at East Beach – Mission Ck.	Total Coliform	Pathogens	Agriculture
Pacific Ocean at East Beach – Mission Ck.	Total Coliform	Pathogens	Unknown Nonpoint Source
Pacific Ocean at East Beach – Mission Ck.	Total Coliform	Pathogens	Urban Runoff/Storm Sewers
Pacific Ocean at East Beach – Mission Ck.	Total Coliform	Pathogens	Nonpoint Source
Pacific Ocean at East Beach – Mission Ck.	Enterococcus	Pathogens	Source Unknown
Pacific Ocean at East Beach –Sycamore Ck.	Enterococcus	Pathogens	Source Unknown
Pacific Ocean at Leadbetter Beach	Total Coliform	Pathogens	Source Unknown
Sycamore Creek	Chloride	Salinity	Source Unknown
Sycamore Creek	Fecal Coliform	Pathogens	Transient encampments
Sycamore Creek	Fecal Coliform	Pathogens	Natural Sources
Sycamore Creek	Fecal Coliform	Pathogens	Urban Runoff/Storm Sewers
Sycamore Creek	Sodium	Salinity	Source Unknown

Note that upon consultation with Regional Board Staff, the Creeks Division may also be required to conduct Receiving Water Monitoring and/or Special Studies, as described in the General Permit.

a. Quality Assurance Project Plan

Where applicable, the Permittee shall prepare, maintain, and implement a Quality Assurance Project Plan (QAPP) in accordance with the Surface Water Ambient Monitoring Program. All monitoring samples shall be collected and analyzed according to the Program QAPP developed for the purpose of compliance with this Order. SWAMP Quality Assurance Program Plan (2008) is available at:

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/qaprp082209.pdf

A formatted Microsoft Word document that includes guidelines and boilerplate language for developing the permit QAPP is available at:

http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa

Water quality data shall be uploaded to SMARTS and must conform to California Environmental Data Exchange Network (CEDEN) Minimum Data Templates format. CEDEN Minimum Data Templates are also available at: http://ceden.org/

b. Reporting

(iii) **Reporting –** By the second year Annual Report, the Permittee shall complete and have available a report (50 page maximum) that includes a summary of baseline data collections and discussion of monitoring program results;

By the fifth year Annual Report, the Permittee shall complete and have available a report (50 page maximum) that includes a comparison of data collection to baseline data, and discussion of monitoring program results.

At a minimum, the second and fifth year Annual Reports shall include the following information:

(a) The purpose of the monitoring, brief contextual background and a brief description of the study design and rationale.
(b) Sampling site(s) locations, including latitude and longitude coordinates, water body name and water body segment if applicable. Sampling design, including sampling protocol, time of year, sampling frequency and length of sampling.
(c) Methods used for sample collection: list methods used for sample collection, sample or data collection identification, collection date, and media if applicable.
(d) Results of data collection, including concentration detected, measurement units, and detection limits if applicable.
(e) Quantifiable assessment, analysis and interpretation of data for each monitoring parameter.
(f) Comparison to reference sites (if applicable), guidelines or targets
(g) Discussion of whether data collected addresses the objective(s) or question(s) of study design
(h) Quantifiable discussion of program/study pollutant reduction effectiveness.

c. Water quality data submittal.

> Water quality data shall be uploaded to SMARTS and must conform to California Environmental Data Exchange Network (CEDEN) Minimum Data Templates format. CEDEN Minimum Data Templates are also available at: http://ceden.org/

The Creeks Division will review the data submittal requirements and answer the following questions:

- Which data should be submitted to CEDEN?
- Should the existing Creeks WQ Database be modified to support CEDEN submittal?
- Should separate databases be maintained?

WATERSHED ASSESSMENT

Research questions:

1. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?
2. Are pharmaceutical and personal care products (PPCPs) reaching creeks via irrigation runoff and reclaimed water main breaks?
3. Is contaminated groundwater at cleanup sites reaching creeks?
4. What are the background daily cycles of water flow in Santa Barbara creeks? Is there a daily pumping in or removal of water from Arroyo Burro?
5. Are new or emerging contaminants detected in dry weather conditions?

STORM MONITORING

Research Questions:

1. What are the highest concentrations of pollutants of concern during storm events, particularly seasonal first flush storms?
2. What new or emerging contaminants should be tested? PPCPs from reclaimed.
3. Is runoff from coal tar sealed parking lots more toxic than runoff from asphalt sealed parking lots?
4. How do restoration/water quality treatment projects impact water quality during storm events (see Section E)?

RESTORATION AND WATER QUALITY PROJECT ASSESSMENT

Overall Research Questions:

1. What is the baseline water quality at future restoration, LID, and/or treatment sites, particularly as they relate to project design and assessment of project performance?
2. Do Creeks Division treatment projects result in improved water quality, as reflected in pre- and post-project, and/or, upstream to downstream, conditions?

3. Do Low Impact Development (LID)/infiltration projects result in pre-development runoff patterns? What are the loads of pollutants prevented from entering surface water from LID projects?
4. What are the mechanisms of project success?
5. Are installed projects continuing to function correctly?

Projects and Specific Questions

1. Westside SURF and Old Mission Creek Restoration
   a. Is the UV disinfection equipment functioning?
   b. What percentage of flow in Westside Storm Drain is the facility treating?
   c. Have habitat scores and index of biological integrity (IBI) scores in Bohnett Park improved?
2. Arroyo Burro Restoration, including Mesa Creek Daylighting
   a. How does Arroyo Burro Estuary biological integrity compare to other estuaries in the area?
3. Hope and Haley Diversions
   a. Are human waste markers still found in Hope and Haley Storm Drains?
   b. What are the loads of fecal indicator bacteria (FIB) that are diverted to the sanitary sewer by these projects?
4. Upper Las Positas Creek Project Performance (Storm) and Operation (Dry weather)
   a. Do treatment elements (Adams bioswale, East Basin, West Basin) reduce pollutant concentrations during storms?
   b. What is the quality of water discharged during spillover conditions (East Basin, West Basin)?
   c. What are the temporal and spatial patterns of pH, temperature, DO, and conductivity in the East Basin during dry weather?
   d. What is the quality of water released prior to storm events from the East Basin and West Basin (field parameters, FIB, nutrients, metals, hydrocarbons, pesticides, and toxicity)? What are the conditions downstream during releases?
5. McKenzie Park Storm Water Treatment Retrofit (Storm)
   a. Are basins functioning correctly?
   b. Is the design storm fully infiltrated?
   c. What are rainfall, storage, and draw down patterns?
6. Debris Screens (Creek Walks)
   a. Has the installation of catch basin screens lead to decreased trash observed in creeks?
7. Mission Creek Fish Passage (Dissolved Oxygen)
   a. What are the conditions in creek segments where fish spend time waiting for passage conditions (above or below passages)?
8. Mission Lagoon Restoration and Laguna Channel Disinfection
   a. Lagoon Inputs
      i. What are the nutrient and FIB inputs from the El Estero Drain?
      ii. Have human waste signals been eliminated from Laguna Channel inputs? (See Section F)
   b. Lagoon Water Quality
      i. What are the water quality conditions in the lagoon (DO, temperature, turbidity), at the surface and near the bottom?

    ii. How do parameters respond to lagoon breaching and closing?
    iii. How does macro-algae cover and biomass change after the lagoon is closed?
    iv. What is the biological integrity of Laguna Channel sediment? (see Section H)
  c. What is the daily (weekly) condition of the estuary? Lagoon status, color, amount of floating algae?
9. Storm Water Infiltration Retrofit Projects (Prop 84). See Section A.
10. Andre Clark Bird Refuge
    a. What is the cause of stink events?
    b. How is the pilot project performing? Does bioaugmentation help?
    c. What are the sources of nutrients during dry and wet weather?
    d. Can increased microbial degradation of organic material in sediment lead to increased water depth?
    e. What is the sediment quality in relation to dredging costs?
11. Las Positas Creek Restoration Project
    a. What are the flow patterns in dry and wet weather?
12. Upper Arroyo Burro Restoration
    a. Is water being pumped from creek or adjacent groundwater?
    b. What is the historical water quality?
    c. Identify any data gaps.

SOURCE TRACKING/ILLICIT DISCHARGE DETECTION

Research questions:

1. Conduct IDDE investigation per General Permit (Section B).
2. What are the causes of persistent beach warnings that occur?
3. Will Laguna Channel and the East Side Storm Drain show that human waste markers have been eliminated after sewer line repair work is completed? See also Hope and Haley Drains above.
4. Are there pathogens present in Santa Barbara creeks? Are SB beaches suitable for Quantitative Microbial Risk Assessment (QMRA)?
5. What types of waste signals are seen in Arroyo Burro, and can outreach effect changes? (UCSB SIPP Project)
6. Is RV dumping a consistent problem in Santa Barbara?
    a. What is the scale of RV dumping (time, volume, percent of RVs in town)?
    b. How does RV dumping scale to other fecal inputs, e.g. leaking sewers?
7. Specific areas of concern: Barger Canyon, Las Positas Creek, Haley Drain
8. Develop a list of action limits for field parameters.

CREEKS WALKS/CLEAN UPS

Research Questions:

1. Outfall screening, per guidance in Section B.
2. Can we see anything unusual in lower Arroyo Burro, regarding flow patterns?
3. Is the amount of trash in creeks decreasing over time?
4. Has the installation of catch basin screens lead to decreased trash observed in creeks?

5. Can we see any impairment to San Roque Creek, leading to drop in bioassessment scores?

BIOASSESSMENT

Research Questions:

1. How does the biological integrity in our creeks change over time, in response to environmental variation?
2. How does the biological integrity respond to water quality and restoration projects?
3. What is the biological integrity of estuaries in Santa Barbara?
4. What is the biological integrity of Laguna Channel? (In support of Mission Lagoon Restoration Project)

GRANT PROJECT MONITORING REQUIREMENTS

PARKING LOT STORM WATER TREATMENT DEMONSTRATION PROJECT

OVERVIEW

The data collected allowed for an estimate of the pollutant loads infiltrated by the Project during rain events after construction. The City measured the Project's benefits by monitoring the storm water runoff for pollutants and toxicity at each site before construction to determine the pollutant loads associated with each site and establish a baseline condition. Monitoring was completed according to the approved LID Storm Water Infiltration Project Monitoring Plan/QAPP. A sampling location was identified for each site where storm water runoff could be collected. Sampling took place at each of the six sites during three different storms. Grab samples were collected during two storms, and composites were collected during a third storm. Samples were tested for hydrocarbons, metals, bacteria, toxicity, TSS, and nutrients. All sample results were averaged to obtain event mean concentrations (EMC). The EMCs were compared among sites, and in general there were no significant differences. Therefore, a City-wide EMC for each pollutant was used in calculating load reduction. Load reductions were calculated per inch of rainfall and for the entire rain year following construction.

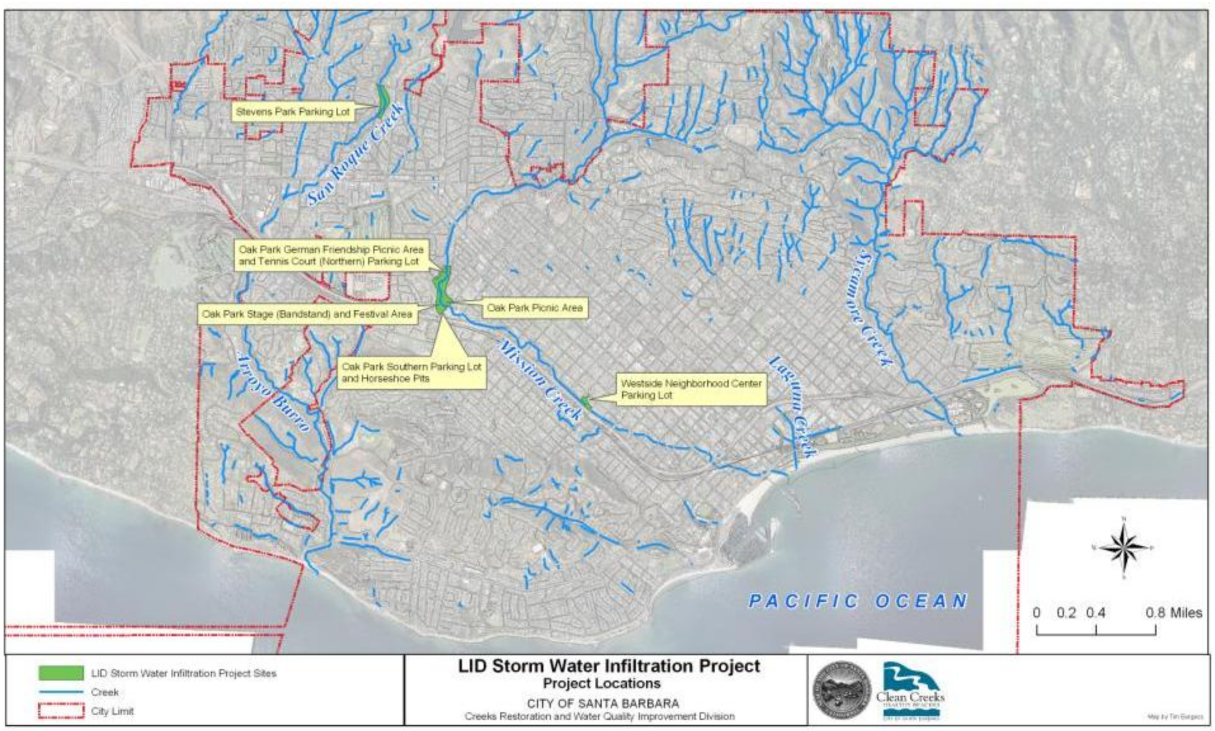


Figure 1.Map of project area.

Table 2. Constituents Included in Load Reduction Monitoring

Parameter Group	Lab Reporting Limit	Central Coast Waterboard Basin Plan Objective
Fecal Indicator Bacteria	1 MPN/100 ml	From AB 411, rather than Basin Plan: Total Coliform: 1000 MPN/100 ml E. coli: 400 MPN/100 ml Enterococcus: 104 MPN/100 ml
Organic Carbon (Dissolved)	1 mg/L	
Nutrients		Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.
Nitrate (as N)	0.11 mg/L	
TKN	0.5 mg/L	
Total Nitrogen	0.05 mg/L	
Total Phosphorus	0.05 mg/L	
Total Petroleum Hydrocarbons - Diesel	0.5 mg/L	Waters shall not contain oils, greases, waxes, or other similar materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect beneficial uses
Total Suspended solids	1 mg/L	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Total Metals [1]		
Arsenic	0.02 mg/L for all except	
Cadmium	0.0002 mg/L for mercury.	0.03 mg/L
Chromium		0.05 mg/L
Copper		0.03 mg/L
Iron		
Lead		0.03 mg/L
Manganese		
Mercury		0.0002 mg/L
Nickel		0.4 mg/L
Silver		
Zinc		0.2 mg/L
Surfactants	0.1 mg/L	0.2 mg/L
Chlorinated Pesticides (8151A)		
2,4,5-TP	1-400 µg/L[2]	
2,4-D		0.01 mg/L
2,4-DB		0.1 mg/L
Dalapon		
Dicamba		
Dichlorprop		
Dinoseb		
MCPA		
MCPP		
Toxicity	0	All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Current 303(d) evaluations use the criteria of test results being significantly different than the control.

[1] Aluminum and selenium were proposed in the MP/QAPP but were not tested. Iron and sodium were not included in the MP/QAPP but are included here.

[2] Reporting limits in some samples were high due to dilutions performed for sample analysis.

The following figures show the sampling location at each project site. One sampling site was been selected at each parking lot in the Project area (Figure 1). Each site was selected to provide runoff that is inclusive of or representative of runoff from the parking lot retrofit, while excluding runoff that will not be infiltrated by the Project. Sampling sites were observed during dry weather, and in some cases prepared for sampling by digging out areas to place sample vessels for runoff collection. The sample locations have been documented with GPS coordinates (Table X) and are mapped below (red arrows in Figure X-Figure X).

Table 3. Sampling Locations.

Site Name	Sample Site Code	Latitude	Longitude
Oak Park Main Parking Lot	OAK MAIN	34.427949	-119.727058
Oak Park Picnic Area	OAK PICNIC	34.428207	-119.727083
Oak Park Stage Area	OAK STAGE	34.427902	-119.727787
Oak Park Tennis Court	OAK TENNIS	34.428207	-119.727083
Stevens Park	STEVENS PK	34.446730	-119.735201
Westside Neighborhood Center	WS NEIGHBO	34.419245	-119.710821

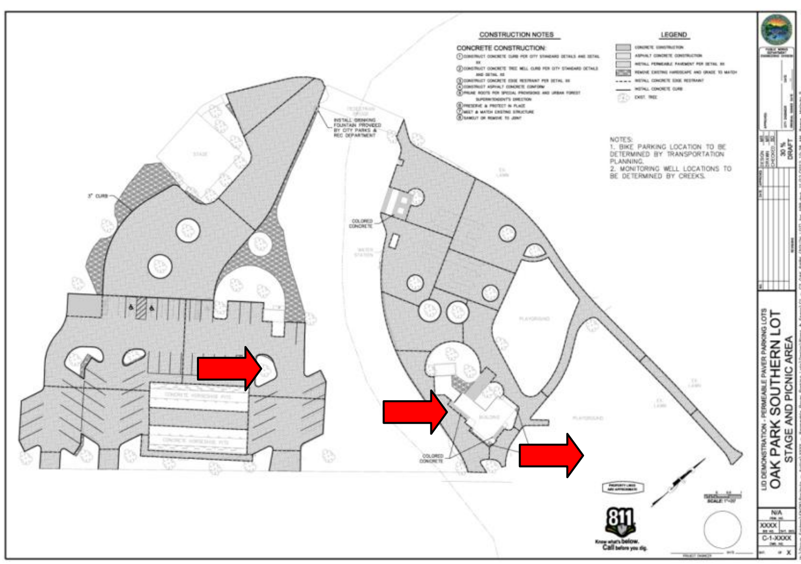


Figure 2. Oak Park Stage Area (left arrow), Oak Park Main Parking Log (center arrow), and Oak Park Picnic Area (right arrow) sites with sampling locations.

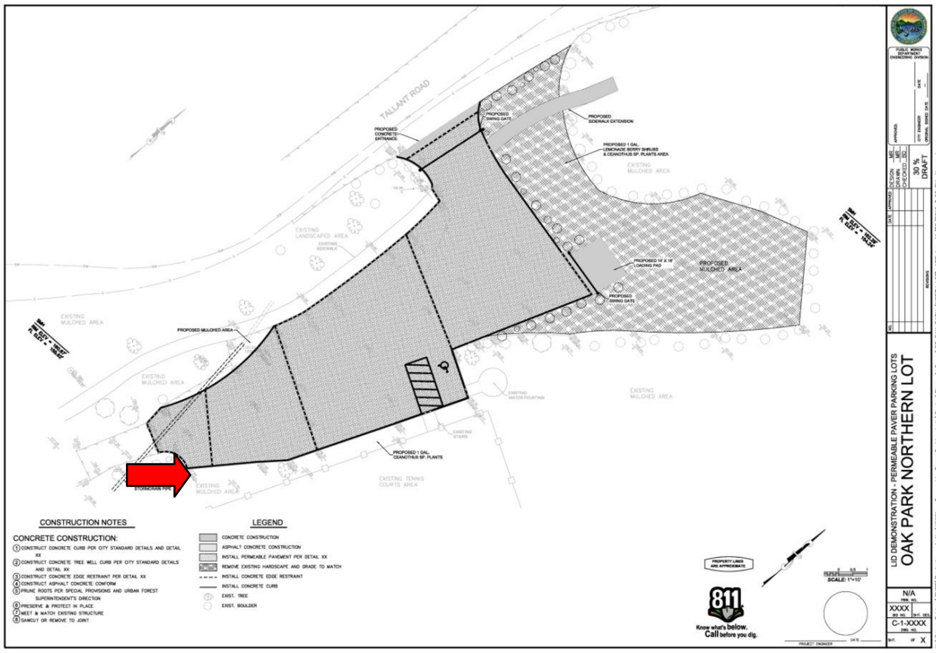


Figure 3. Oak Park Tennis Court with sampling location.

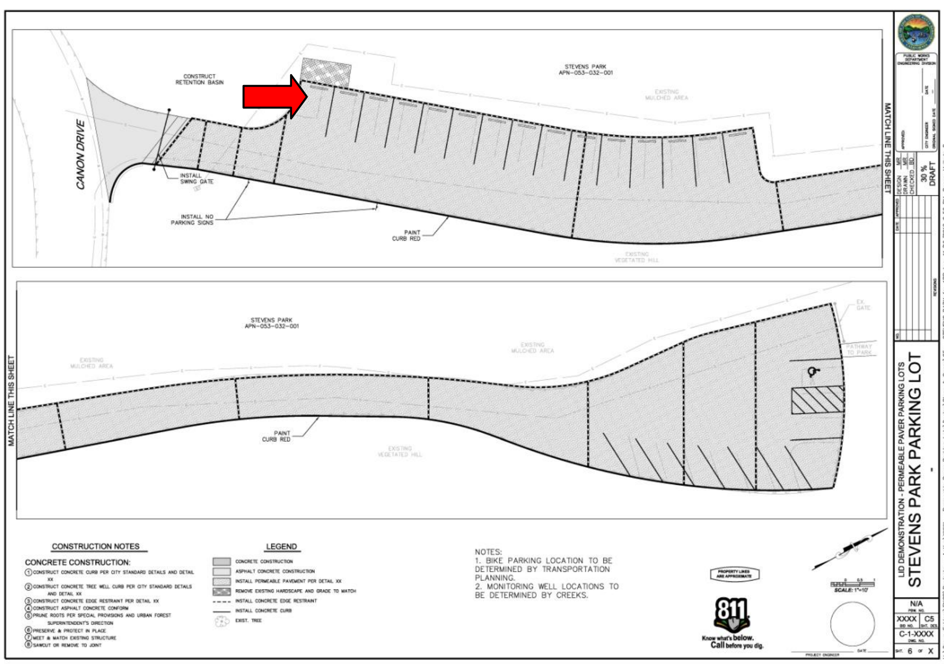


Figure 4. Stevens Park with sampling location.

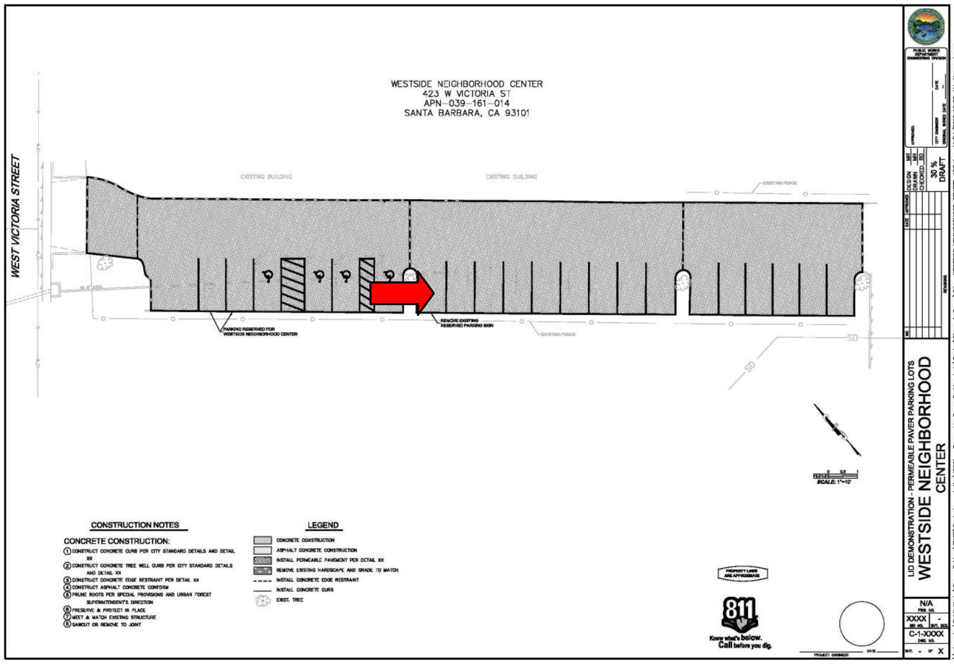


Figure 5. Westside Neighborhood Center with sampling location.

Despite below-average rainfall, samples were collected and composited during three storms (Table 4). Rainfall patterns show that the storms were representative of rainfall throughout the year (Figure 6). Due to small storms and rapidly changing forecasts, only one storm was able to be sampled as a composite, and rather than three time points, the composite included two time points.

Table 4. Summary of Sampled Storms

Storm Number, Total Rainfall in Storm	Date	Grab or Composite	Time(s) samples collected for composite	In. rainfall at each sample time point
1, 1.70”	11/17/2012	Grab	4:40 am – 5:25 am	0.6”
2, 1”	1/24/2013	Grab	9:30 am -11:35 am	1”
3, 0.6”	3/7/2013	Composite	11:32 pm - 12:15 am, 12:15 am – 12:35 am	0.25” 0.45”

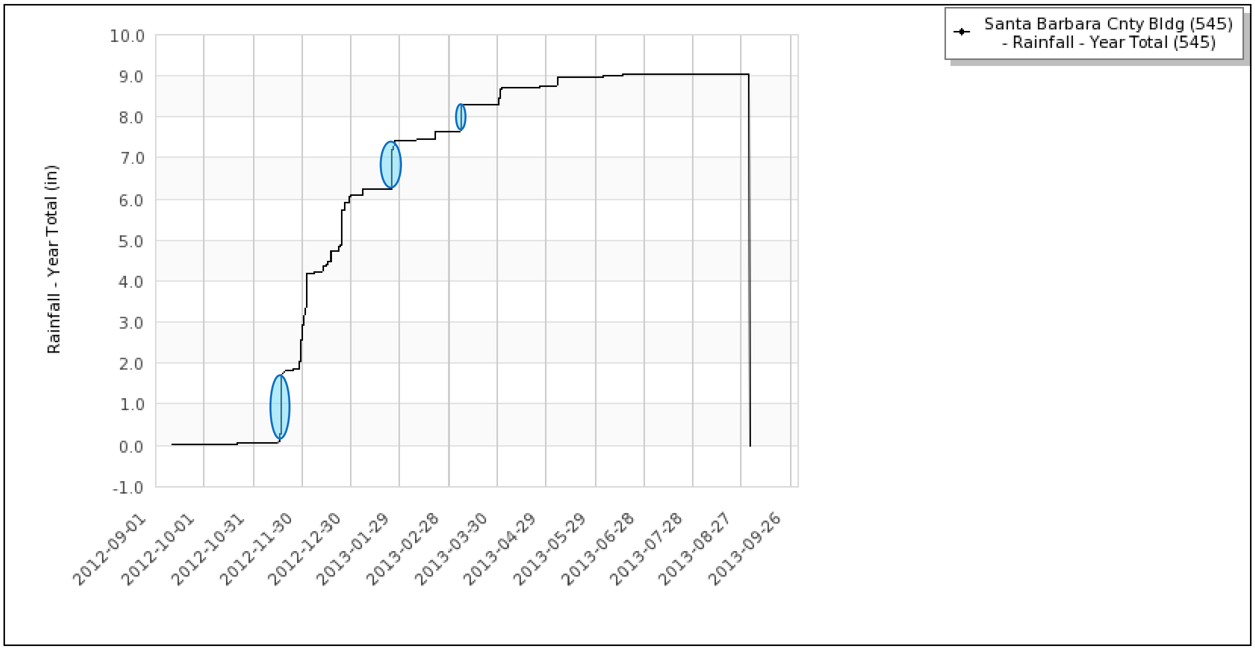


Figure 6. Total rain accumulation in Water Year 2012-2013. Blue ovals indicate sampled events.

Storms 1 ("first flush," or the earliest rainfall in the water year) and 2 were collected as grab samples, as shown in Table XX and Figures XX-XX.

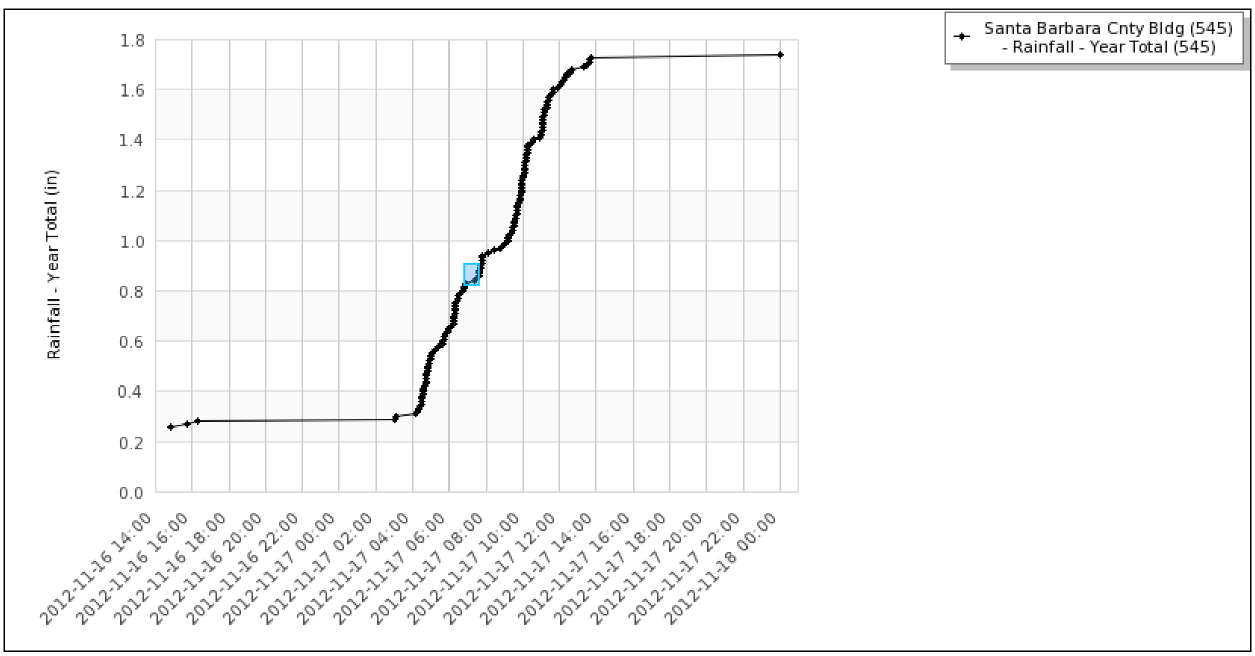


Figure 7. Total rainfall and sample collection times during Storm 1.

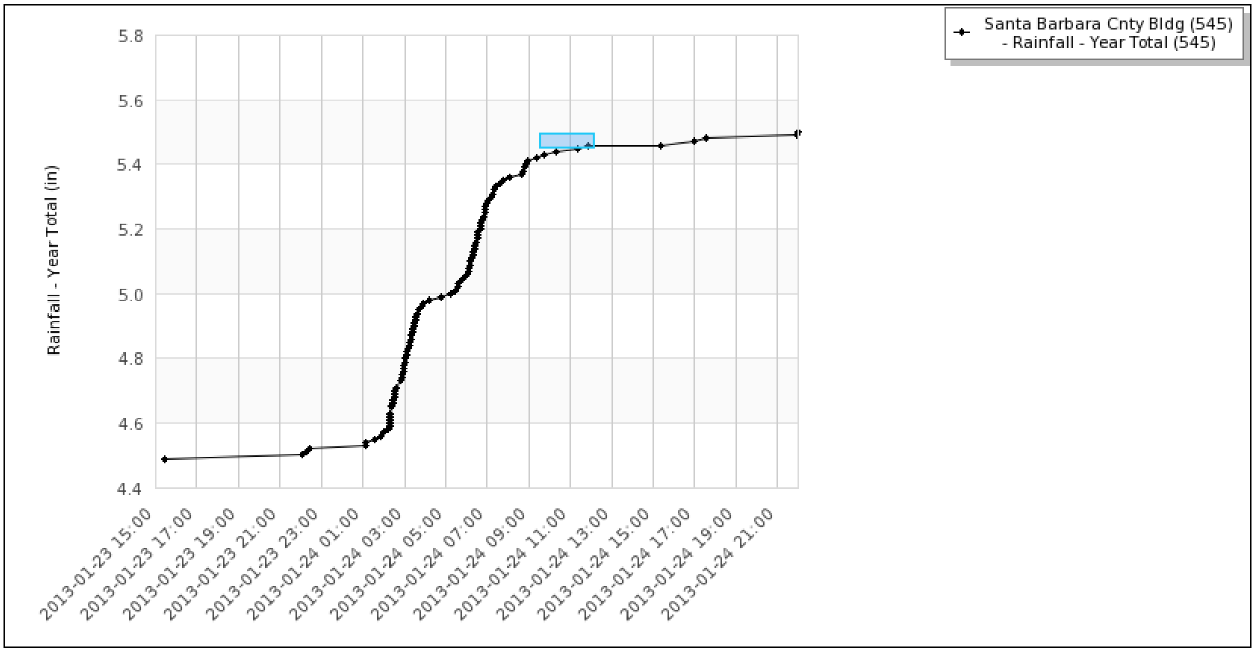
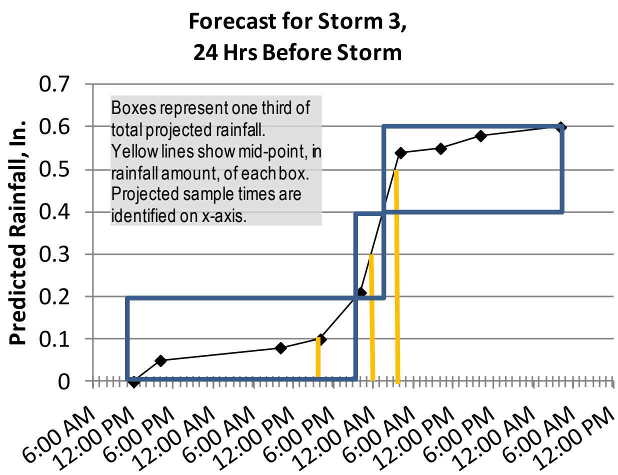


Figure 8. Total rainfall and sampling times during Storm 2.

Storm 3 was sampled as a composite, with two time points sampled at each site. Table XX and Figure XX show the method used to plan sampling time points, how the changing forecast affected sampling plans, and the actual sampling time points. Although three samples were planned, only two were collected due to the rapidly dissipating storm. Figure XX also shows that for a typical sigmoidal storm (slow arrival, one heavier rain period, and an attenuation period), the rainfall-weighted sampling leads to samples being collected relatively close together in time.

Table 5. **Predicted and Actual Sampling Times for Composite Sampling During Storm 3.**

	Prediction Day Before Storm		Prediction Day of Storm		Actual Storm Event	
	Rain, In.	Time	Rain, In.	Time	Rain, In.	Time
Total Rain	0.60		0.27		0.60	
Total Rain/3	0.20		0.09		0.2	
1st sample	0.10	4:00 pm	0.045	10:00 pm	0.05-0.45	~12 am
2nd sample	0.30	11:30 pm	0.14	12:30 am	0.45-0.55	12:15 am
3rd sample	0.50	4:00 am	0.23	4:00 am	NA	NA



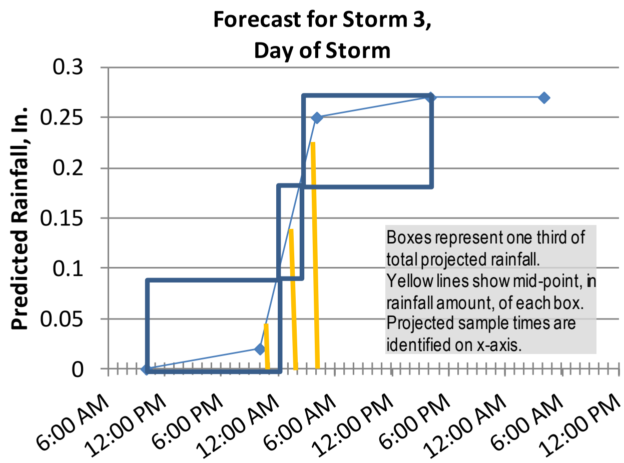


Figure 9. Graphical representation of rainfall-weighted composite sampling.

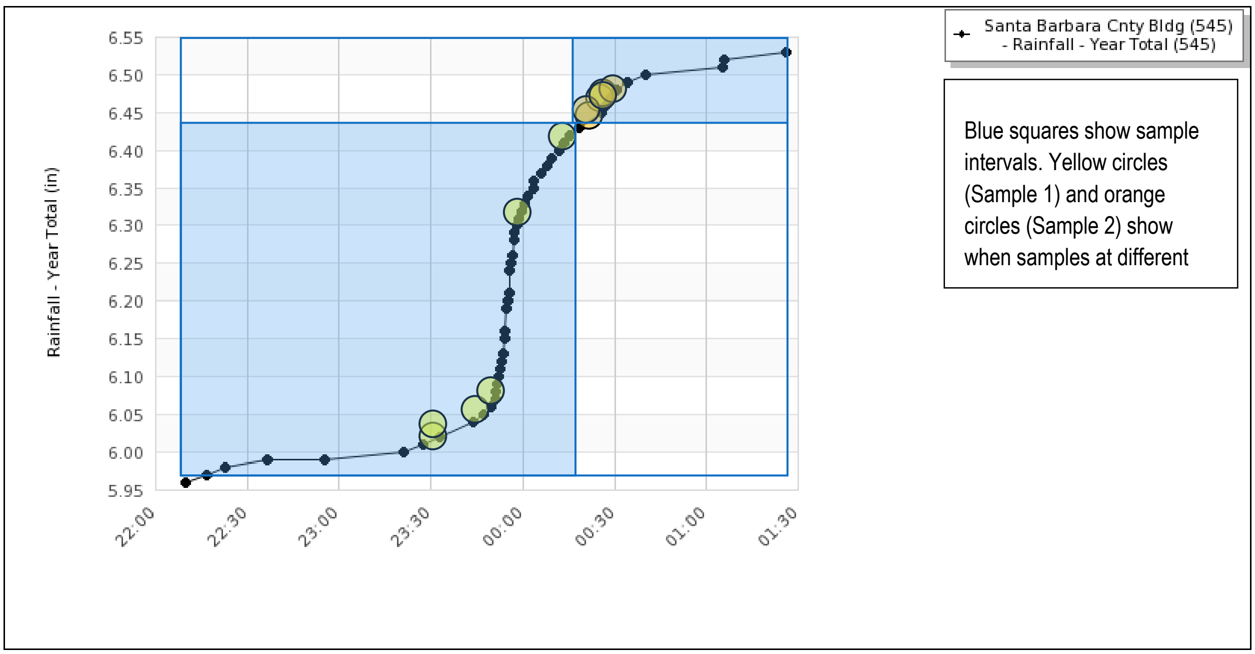


Figure 10. **Total rainfall and sampling times during Storm 3.**

RESULTS

FECAL INDICATOR BACTERIA

Fecal indicator bacteria were tested only in Storm 1. Samples collected during Storm 2 and Storm 3 were not tested for fecal indicator bacteria because of staff resource limitations.

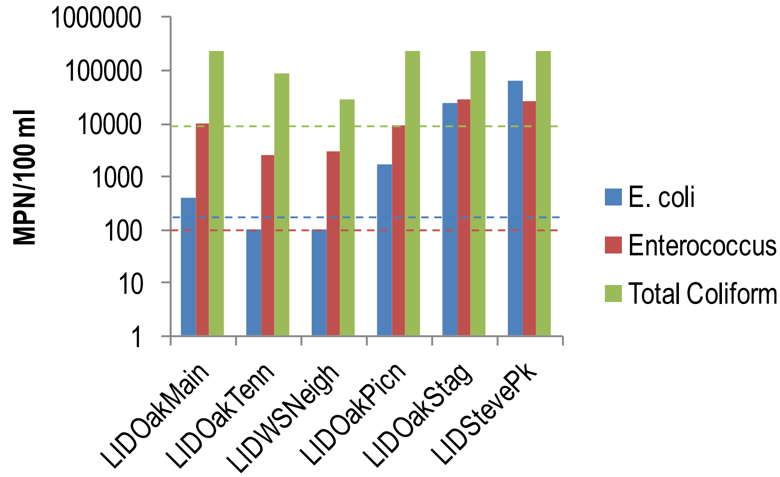


Figure 11. Fecal indicator bacteria results for Storm 1. Dashed lines represent the AB 411 standards for each bacterial group.

TOTAL ORGANIC CARBON

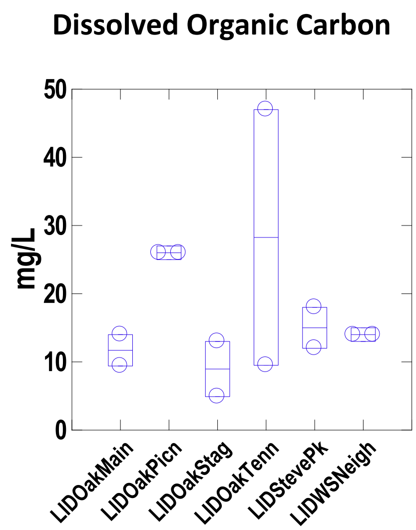


Figure 12. Total organic carbon for Storm 1 and 3. Box plots show range and calculated median of the two storms.

NUTRIENTS

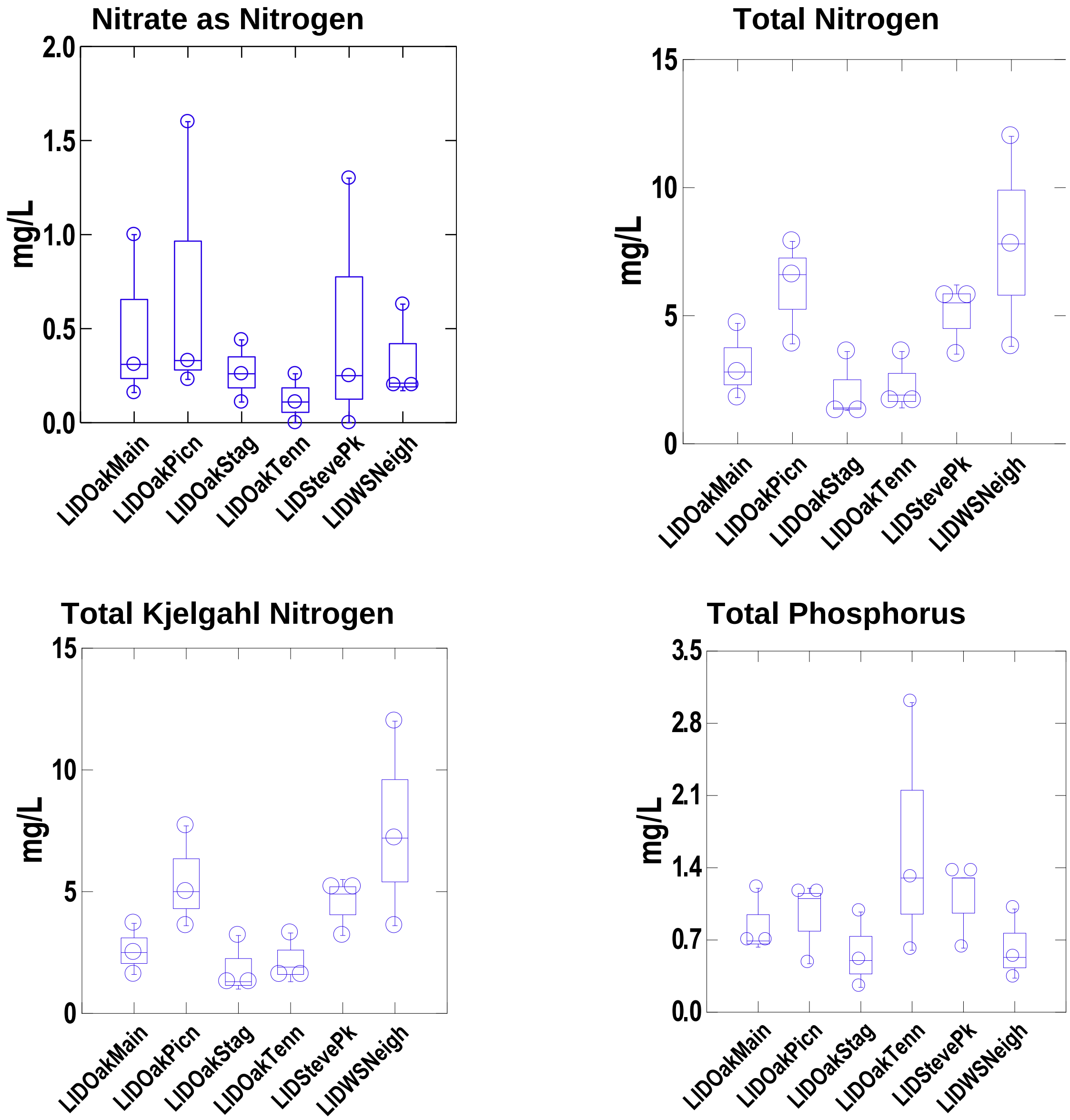


Figure 13. Nutrient results for Storms 1-3. Box plots show range and median of the three storms.

HYDROCARBONS

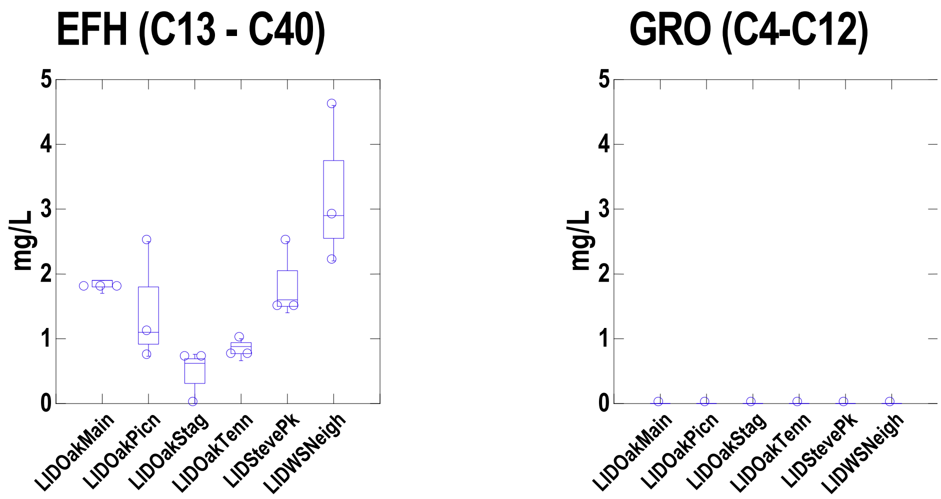


Figure 14. Hydrocarbon results for Storms 1-3. EFH refers to extractable fuel hydrocarbons; GRO refers to Gasoline Range Organics. All GRO results were nondetect (plotted as 0; MDL = 0.05 mg/L). Box plots show range and median of the three storms.

TOTAL SUSPENDED SOLIDS

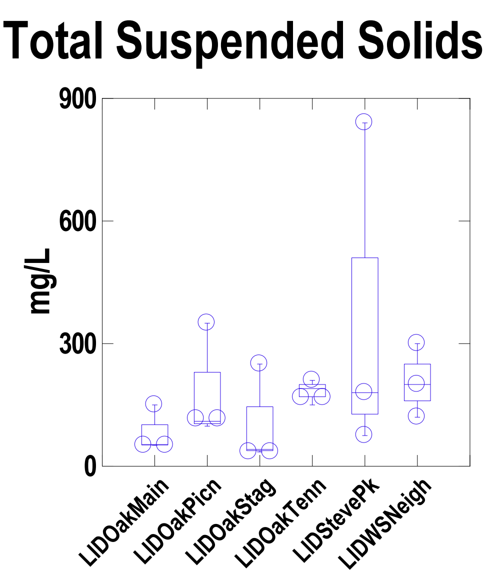
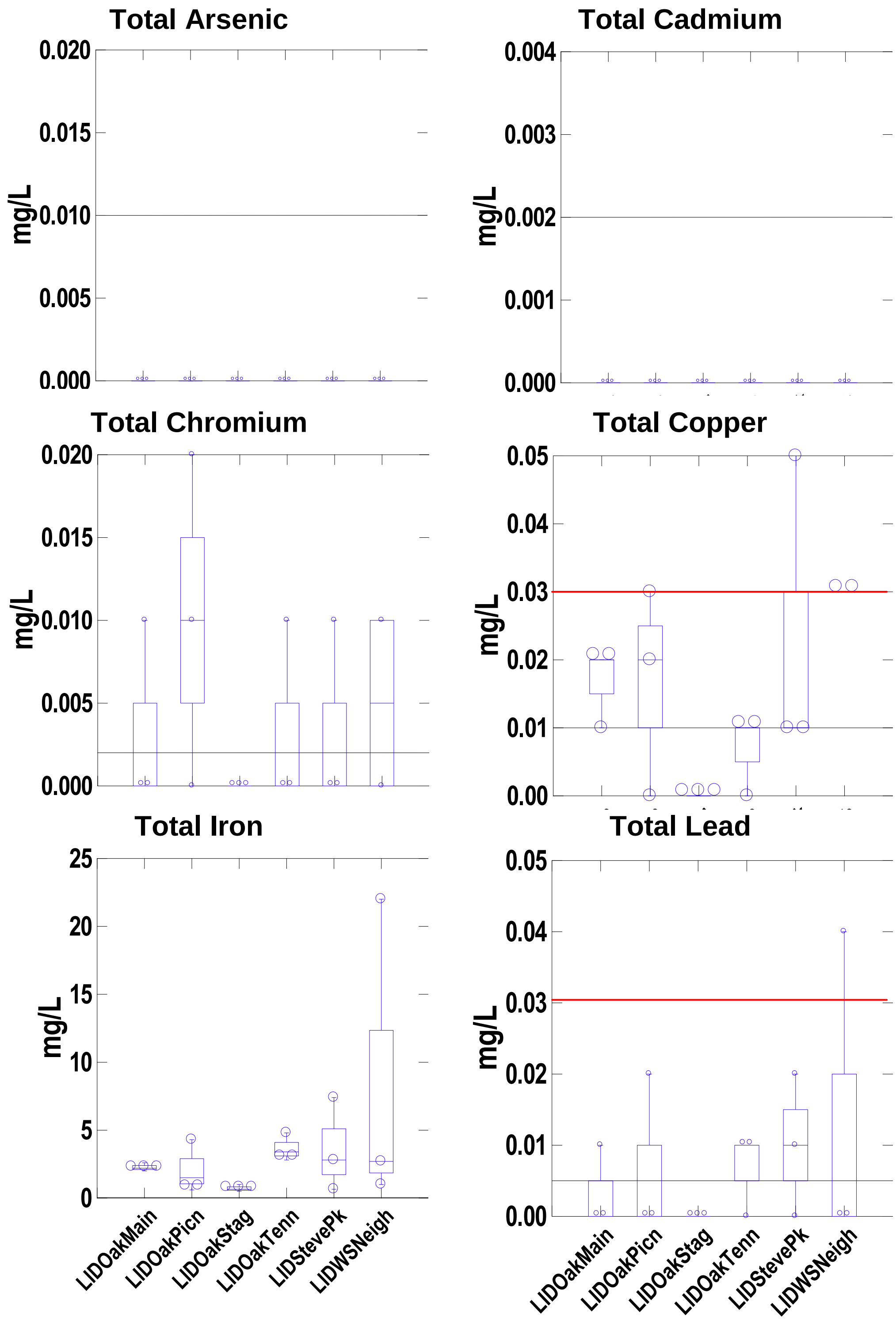


Figure 15. Total suspended solids (TSS) results for Storms 1-3. Box plots show range and median of the three storms.

TOTAL METALS



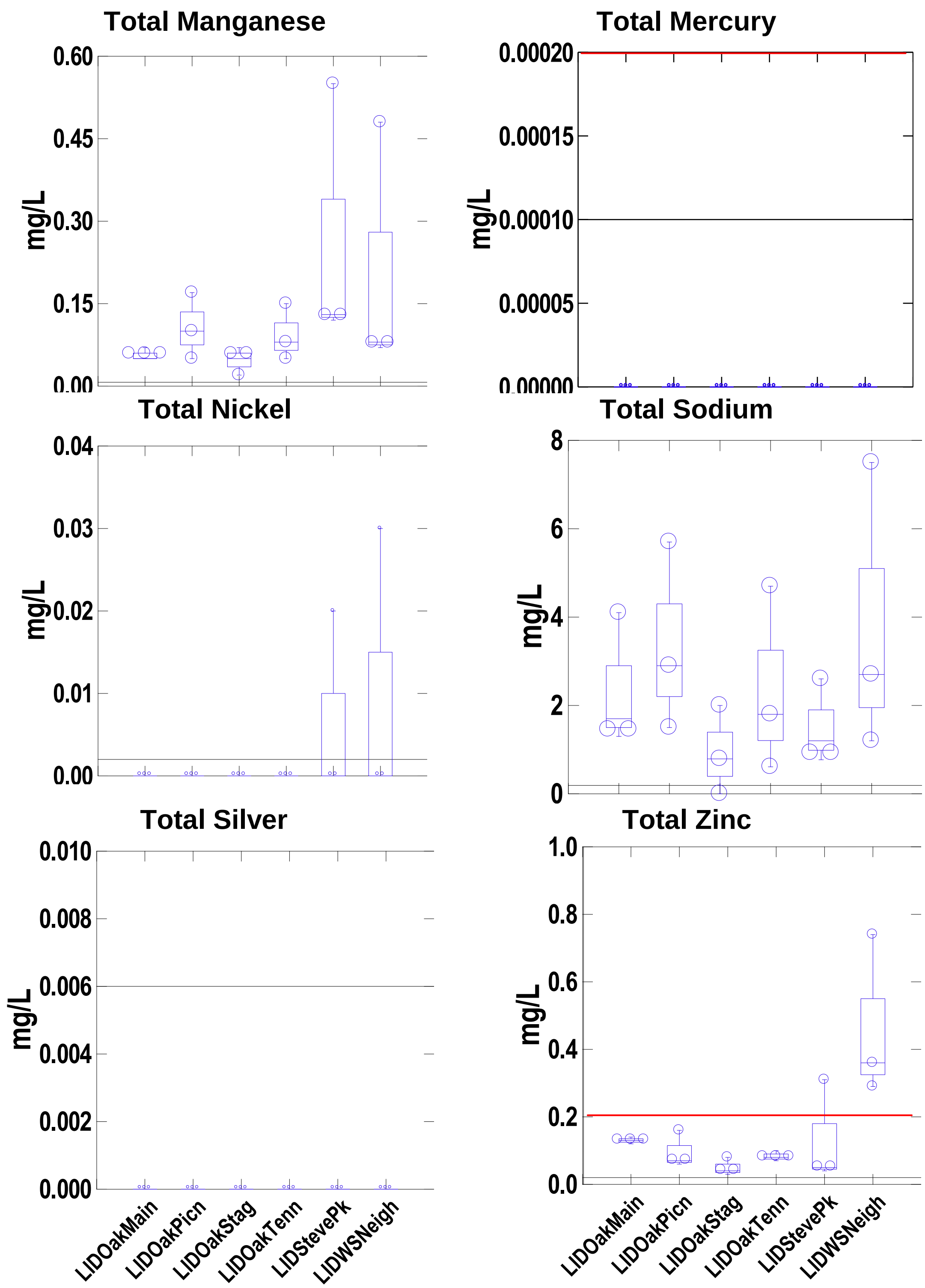


Figure 16. Total metals results for Storms 1-3. Box plots show range and median of the three storms. Horizontal black lines show reporting limits. Red lines show Basin Plan objectives where available. Cadmium and chromium have objectives that are higher than the values shown on the vertical axes; see Table 2 for objectives.

SURFACTANTS

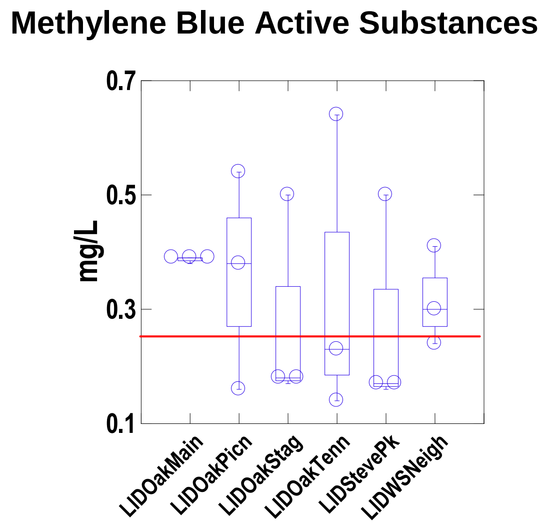


Figure 17. Surfactant results for Storms 1-3. Box plots show range and median of the three storms. Horizontal black lines show reporting limits. Red line shows Basin Plan objective.

CHLORINATED PESTICIDES

No chlorinated pesticides (2,4-D, 2,4-DB, Dalapon, Dicamba, Dichlorprop, Dinoseb, MCPA and MCPP) were detected in samples collected from every site during Storm 1. Due to the expense and consistent non-detects, additional samples from Storms 2 and 3 were not tested for chlorinated pesticides.

TOXICITY

Samples were tested for acute toxicity (5-day fathead minnow) during Storms 1 and 3. Storm 2 was not tested due to insufficient sample volume.

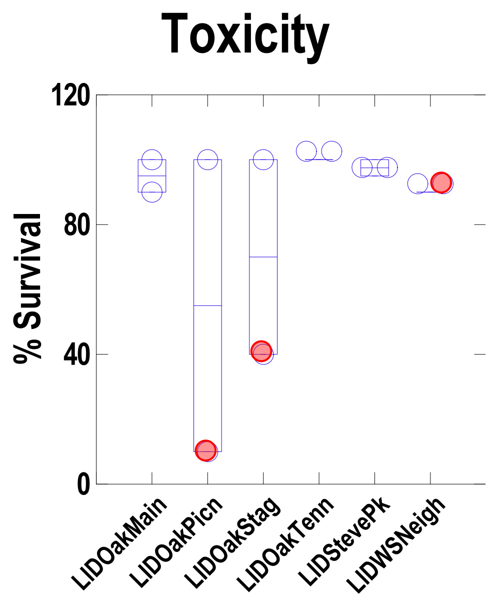


Figure 18. Toxicity results for Storms 1 and 3. Box plots show range and calculated median of the two storms. Red circles show data points that are significantly different than the control.

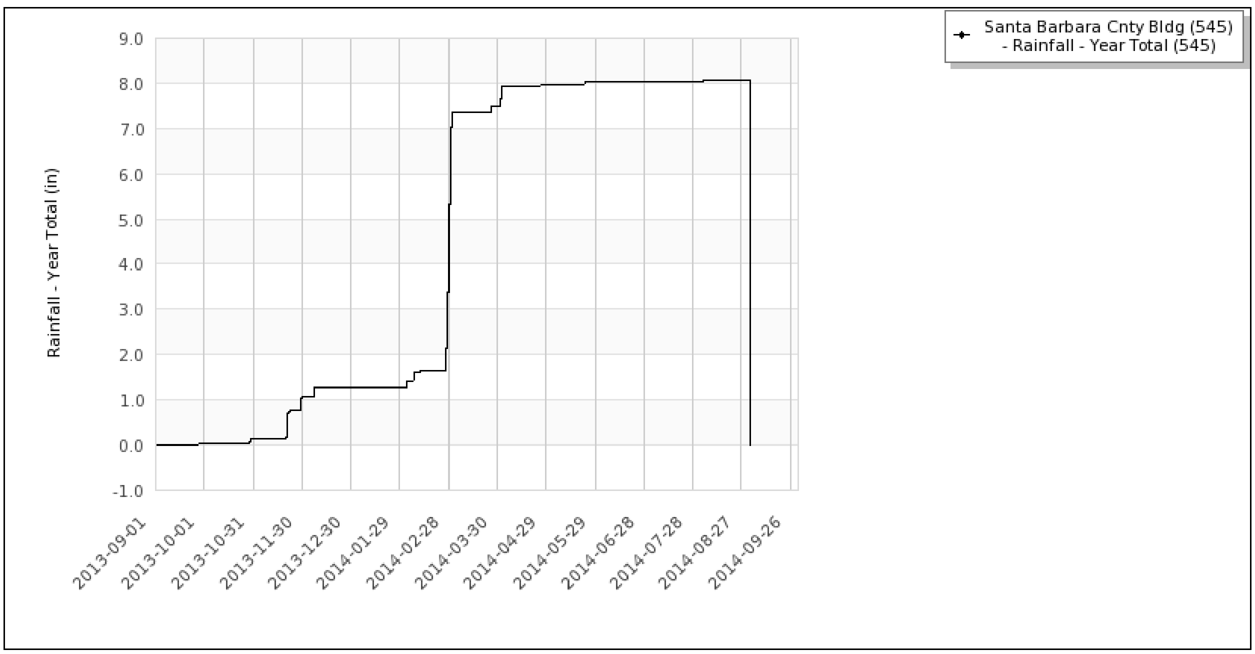


Figure 19. Rainfall during the 2013-2014 Rain Year.

DATA FROM WATER LEVEL LOGGERS

Water level loggers were placed in the monitoring ports during storm events in order to measure the depth of the water as it rose from heavy rainfall and fell from infiltration into the subgrade soil below. This data confirmed that all of the water was infiltrated and did not overflow from the basins. The minimum depth of the basins is 18 inches and the graphs show that the water level never reached that level. The rise and fall of the water is plotted against rainfall accumulation and shown in the graphs below (Figure 20, Figure 21, Figure 22, **Error! Reference source not found.**, and Figure 24).

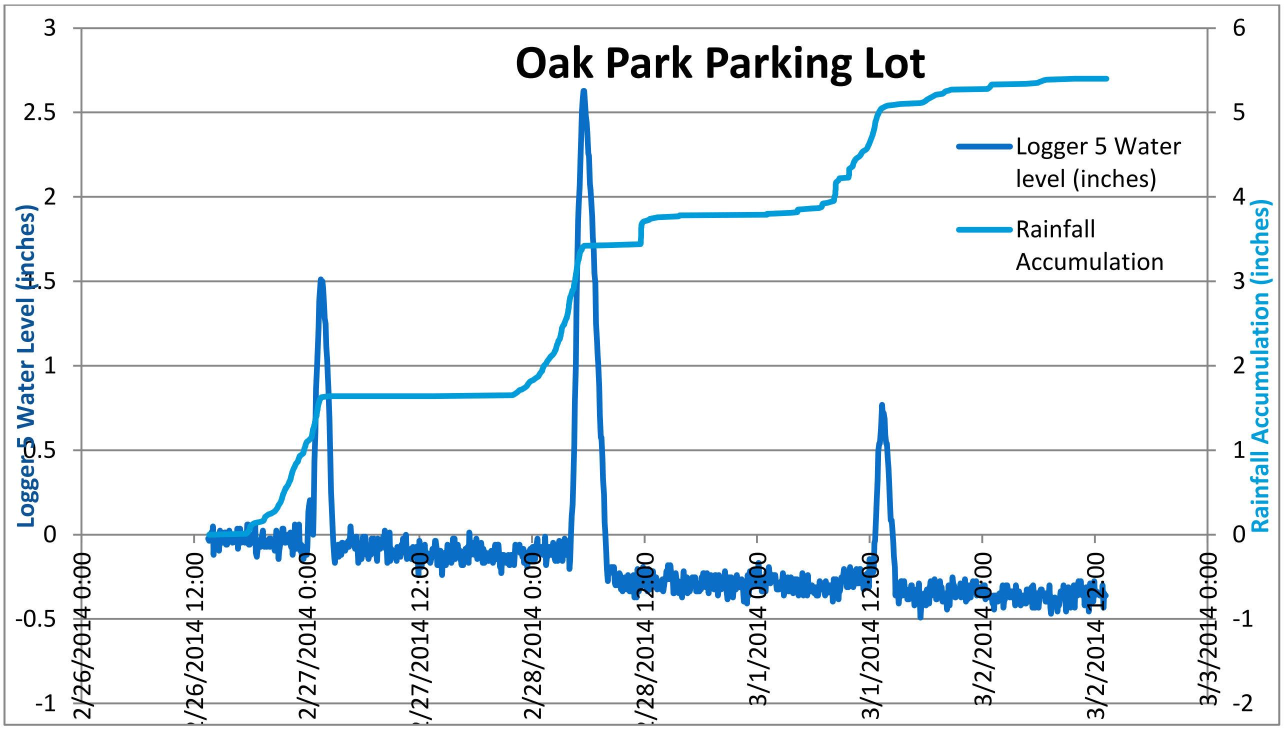


Figure 20. Graph showing water level in basin during three consecutive periods of rainfall over an approximate four day period (March 26 – April 2, 2014). Total rainfall accumulation was 5.40 inches.

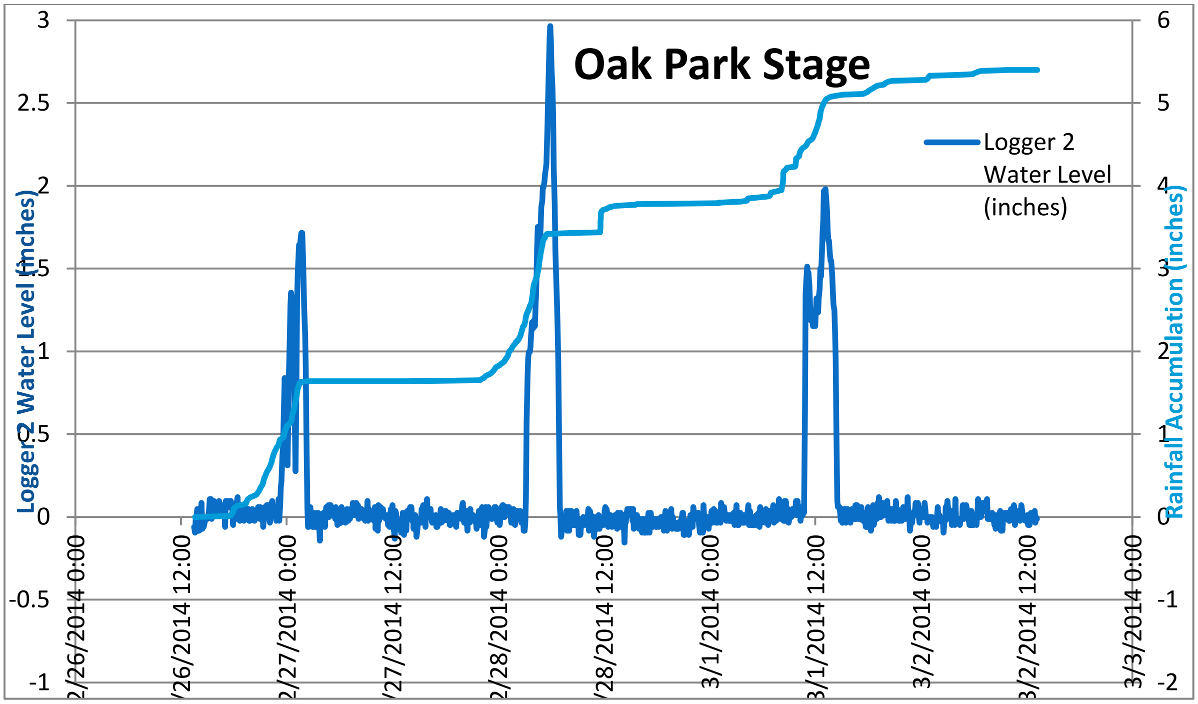


Figure 21. Graph showing water level in basin during three consecutive periods of rainfall over an approximate four day period (March 26 – April 2, 2014). Total rainfall accumulation was 5.40 inches.

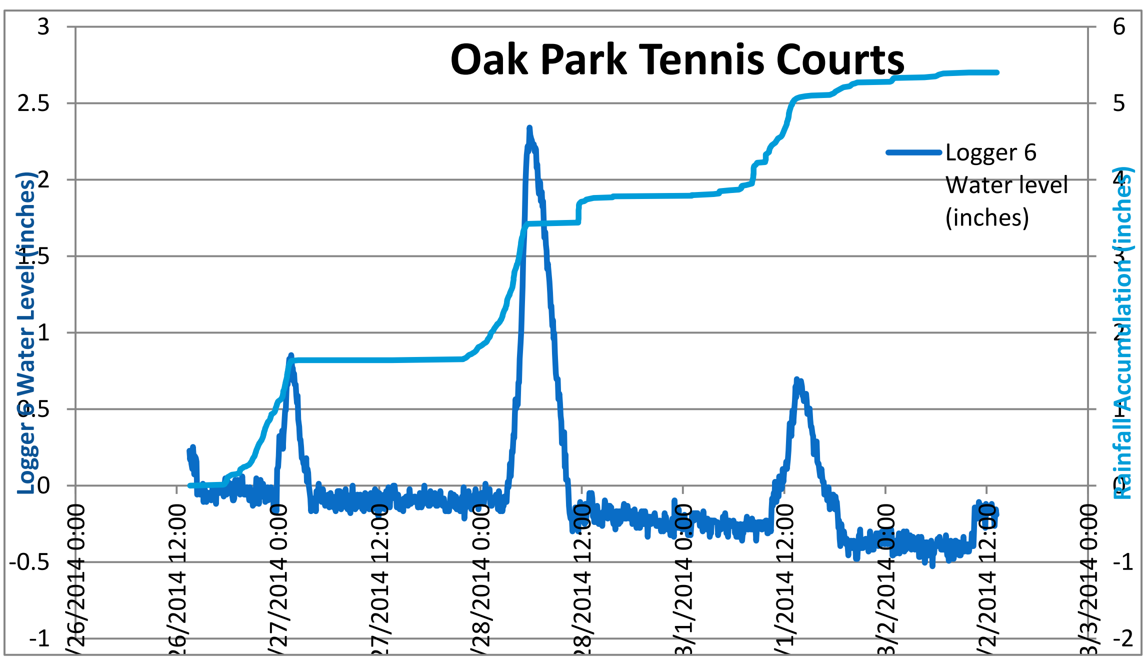


Figure 22. Graph showing water level in basin during three consecutive periods of rainfall over an approximate four day period (March 26 – April 2, 2014). Total rainfall accumulation was 5.40 inches.

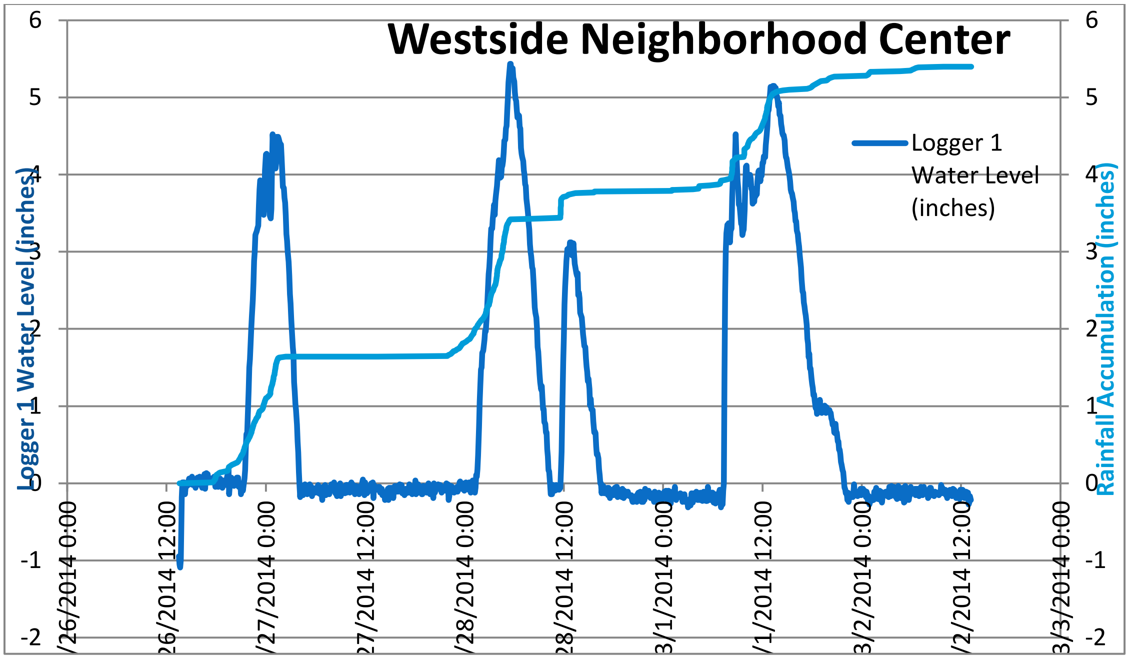


Figure 23. Graph showing water level in basin during three consecutive periods of rainfall over an approximate four day period (March 26 – April 2, 2014). Total rainfall accumulation was 5.40 inches.

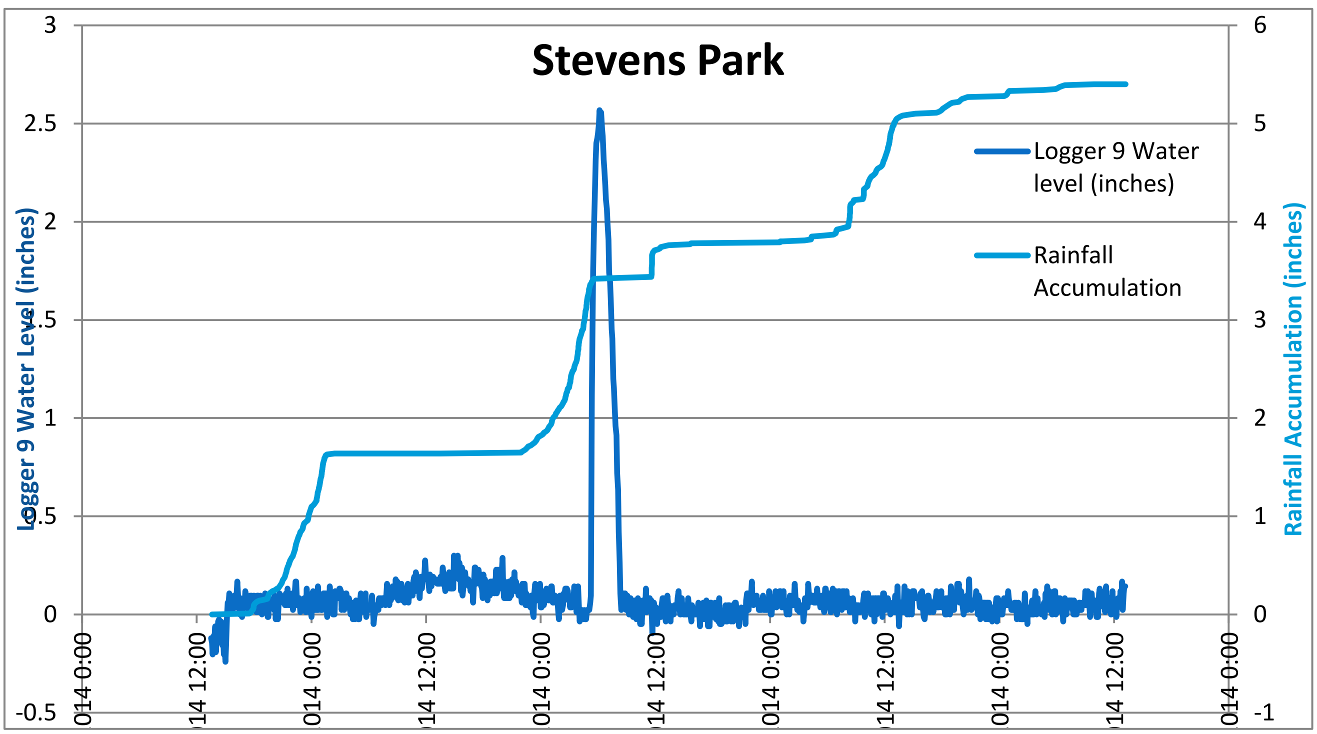


Figure 24. Graph showing water level in basin during three consecutive periods of rainfall over an approximate four day period (March 26 – April 2, 2014). Total rainfall accumulation was 5.40 inches.

DATA EVALUATION

Runoff from the parking lots sites contained fecal indicator bacteria, dissolved organic carbon, nutrients, petroleum hydrocarbons, sediment, metals, and surfactants. No chlorinated pesticides were detected.

Exceedances of AB 411 standards occurred in all total coliform and all enterococcus tests. Four of 6 samples exceeded the standard for *E. coli*. Of 18 samples tested for metals, four exceeded Basin Plan objectives for total copper, one exceeded for total lead, and four exceeded for total zinc. The greatest number of metal exceedances occurred at the Westside Neighborhood Center. Twelve of eighteen samples exceeded for surfactants, with the highest result over six times the Basin Plan objective. Toxicity was very high in two samples. One sample from Oak Picnic showed 10% survival, one of the lowest values ever recorded by the Cityy. Toxicity was significantly different from the control in 3 of 12 samples.

POLLUTANT LOAD REDUCTION

Using pollutant data collected before the project was built, and infiltration volumes calculated in the year after the project was built, load reductions were calculated for all parameters with detections (toxicity data is not included). Visual comparison showed no consistent difference among sites or storms; therefore, a City-wide, year-long event mean concentration (EMC) was calculated for each parameter (Table XX). A total area for all of the project sites was calculated (Table XX).

Assuming complete infiltration, which was confirmed using level loggers in monitoring wells, the load reduction is equal to the EMC multiplied times the volume of rainfall after the project. First, a load reduction per inch of rainfall (Table XX) was calculated:

$$\text{Load Reduction } (M/L) = \text{EMC } (M/L^3) * \text{Area } (L^2)$$

where M=Mass and L=Length

This is the equation used to calculate load in kg:

$$\text{Load Reduction } (kg/in) = \text{EMC}(g/m^3) * \text{Total Area } (m^2) * 0.0254(m/in)$$

This value can be used in future estimates of load reduction (Table XX). For the post-project water year (2013-2014), the yearly rainfall total of 8.0” was used.

Total load reduction (Table XX) was calculated as the amount using EMC * Total Area * Rainfall Depth,

$$\text{Total Load Reduction } (M/T) = \text{EMC } (M/L^3) * \text{Area } (L^2) * \text{Rainfall Depth/Year } (L/T)$$

where M=Mass, L=Length and T=Time

This is the equation used to calculate thee Water Year 2013-2014 Load Reduction in kg:

$$\textit{Load Reduction (kg/yr)}=EMC(g/m)^3 * \textit{Total Area } (m^2) * 0.0254(m/in) * 8.0 \textit{ in/yr}$$

Table 6. Load Reduction from Combined LID Parking Lot Sites

Pollutant	Event Mean Concentration, mg/L unless noted	Load Reduction per Inch of Rain Infiltrated, kg[1]	Total Load Reduction, 2013-2014 Rain Year, kg[1,2]
Fecal Indicator Bacteria[3,4]			
E. coli	1060 MPN/100 ml	414,500 MPN	2,034,000 MPN
Enterococcus	9735 MPN/ml	3,807,000 MPN	18733416 MPN
Total coliform	>241,920 MPN/100 ml	>94,600,000 MPN	>465,600,000 MPN
Organic Carbon, Dissolved	17	6.8	33
Nutrients			
Nitrate (as N)	0.41	0.16	0.79
Total Kjeldahl Nitrogen	4.0	1.6	7.8
Total Nitrogen	4.4	1.7	8.6
Total Phosphorus	0.94	0.26	1.8
Hydrocarbons-EFH (C13 - C40)	1.6	0.63	3.1
Total Suspended solids	190	74	360
Metals Chromium	0.0060	0.0022	0.01
Copper	0.018	0.0072	0.04
Iron	3.5	1.4	6.7
Lead	0.0070	0.0026	0.01
Manganese	0.13	0.051	0.25
Nickel	0.0030	0.0011	0.01
Sodium	2.4	0.938	4.6
Zinc	0.16	0.062	0.31
Surfactants	0.33	0.128	0.63

[1] Uses total area of 9470.16 m^2.

[2] Uses total rainfall of 8.0 in.

[3] For fecal indicator bacteria, median concentrations were used.

[4] For total coliform bacteria, the median was greater than the maximum quantification limit.

GENERAL PERMIT REQUIREMENTS

MONITORING

A consultation with the Regional Board was completed in April 2014. The City proposed sampling strategies for Special Studies and 303(d) Monitoring that were met with support from the Regional Board.

WATERSHED ASSESSMENT

LONG TERM TRENDS-IMPACT OF DROUGHT

Sustained period of low rain:

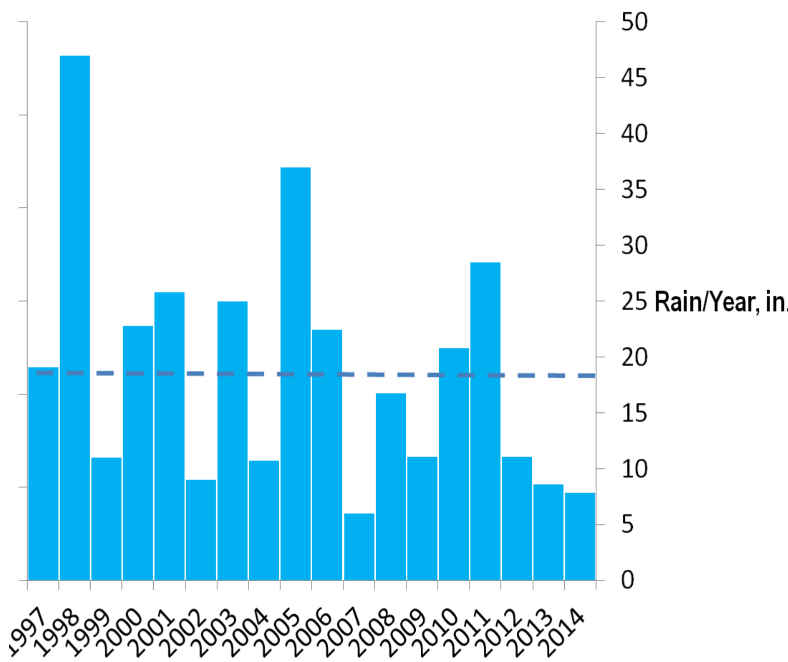


Figure 25. Annual rainfall 1997-2014 at El Estero in Santa Barbara.

How unusual is the 2012-2014 California drought?

Daniel Griffin , Kevin J Anchukaitis

DOI: 10.1002/2014GL062433

For the past three years (2012-2014), California has experienced the most severe drought conditions in its last century. But how unusual is this event? Here we use two paleoclimate reconstructions of drought and precipitation for Central and Southern California to place this current event in the context of the last millennium. We demonstrate that while 3-year periods of persistent below-average soil moisture are not uncommon, the current event is the most severe drought in the last 1200 years, with single year (2014) and accumulated moisture deficits worse than any previous continuous span of dry years. Tree-ring chronologies extended through the 2014 growing season reveal that precipitation during the drought has been anomalously low but not outside the range of natural variability. The current California drought is exceptionally severe in the context of at least the last millennium and is driven by reduced though not unprecedented precipitation and record high temperatures.

"…the current level is the most severe drought in the last 1200 years, with single year (2014) deficits … worse than any previous span of dry years." (Geo. Phys. Res. Lett., *in press*)

SUMMARY OF IMPACTS TO CREEKS

- Decreasing groundwater, flow in creeks.
- Groundwater and flow should return with average year.
- Some sites dry for long periods.
- Beach warnings reduced.
- Fecal indicator bacteria levels in creeks unchanged.
- Biological integrity lower, but within range of other stressors.

GROUNDWATER AND CREEK FLOW

Graphing from Al Leydecker, shown in figure below. The figure shows that shallow groundwater and creek base flow has decreased steadily. Shallow groundwater responds quickly to rain events.

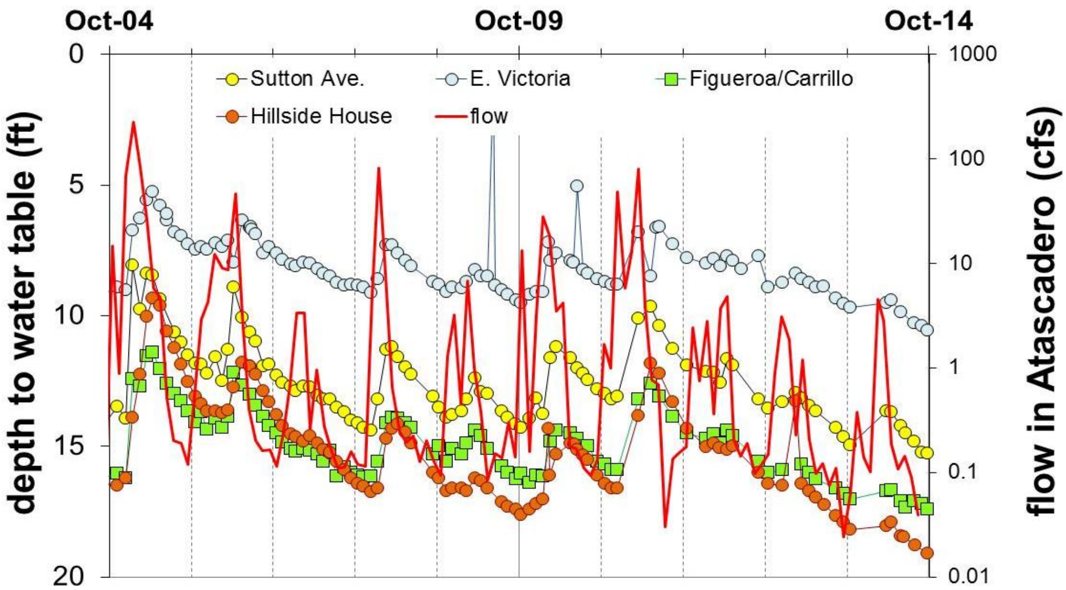


Figure 26. Shallow groundwater and creek flow, from Al Leydecker.

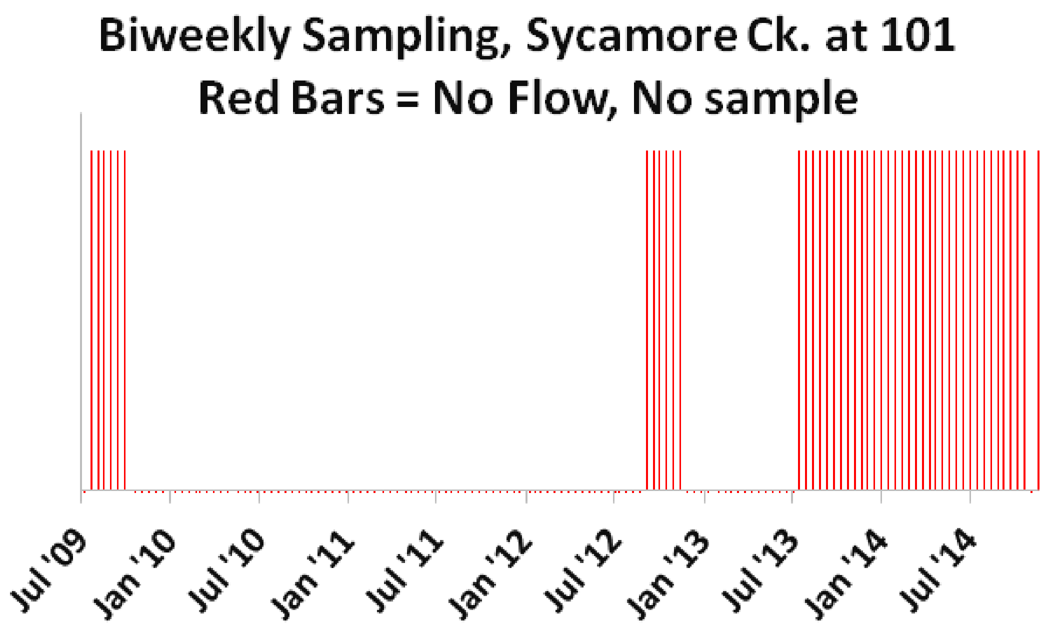


Figure 27. Long dry periods at integrator site for Sycamore Creek.

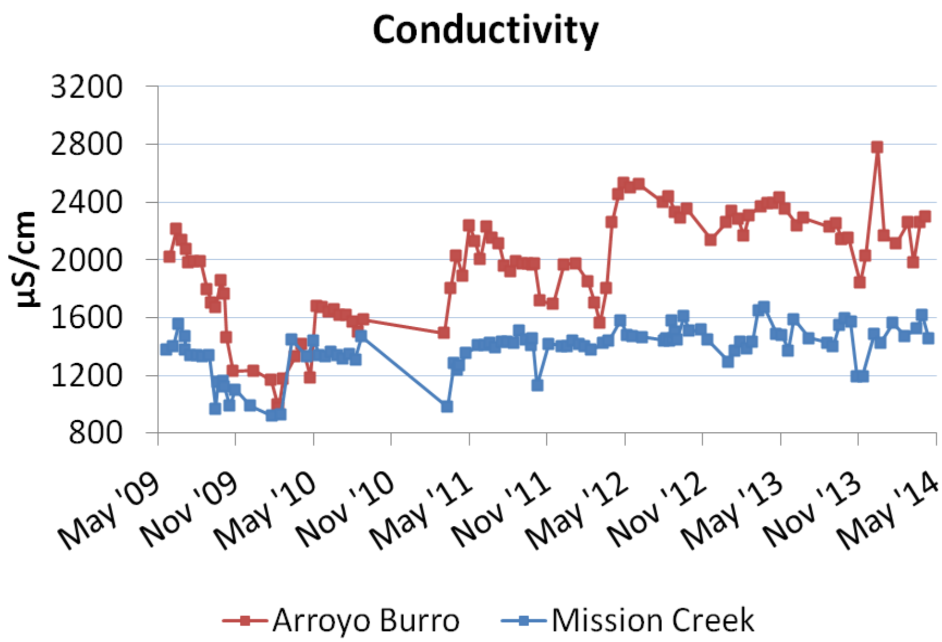
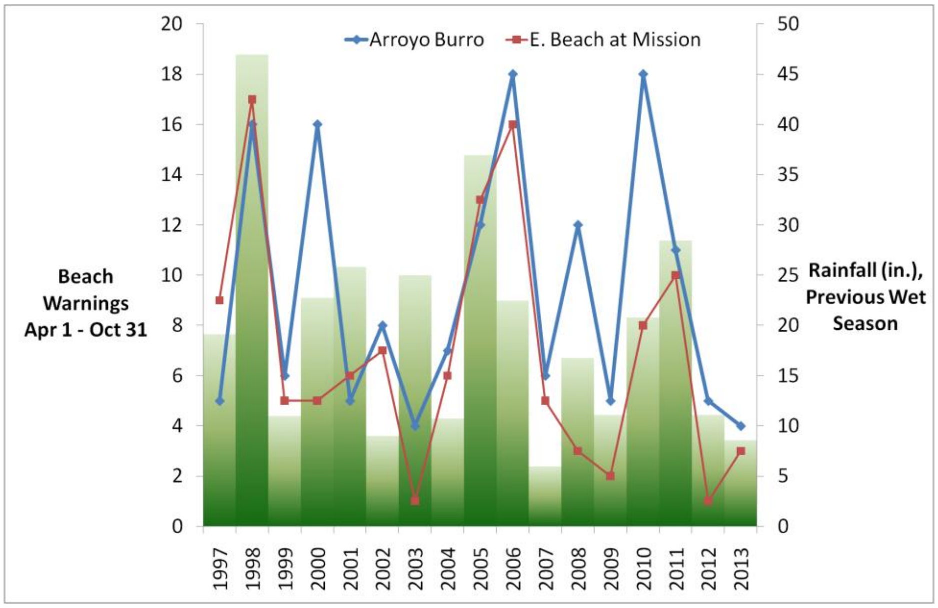


Figure 28. Arroyo Burro showing increased conductivity during drought, whereas Mission Creek is less sensitive.

BEACH WARNINGS

- 50% fewer beach warnings at Arroyo Burro and E. Beach at Mission during drought.
- Fewer storms, fewer lagoon breachings in dry weather.



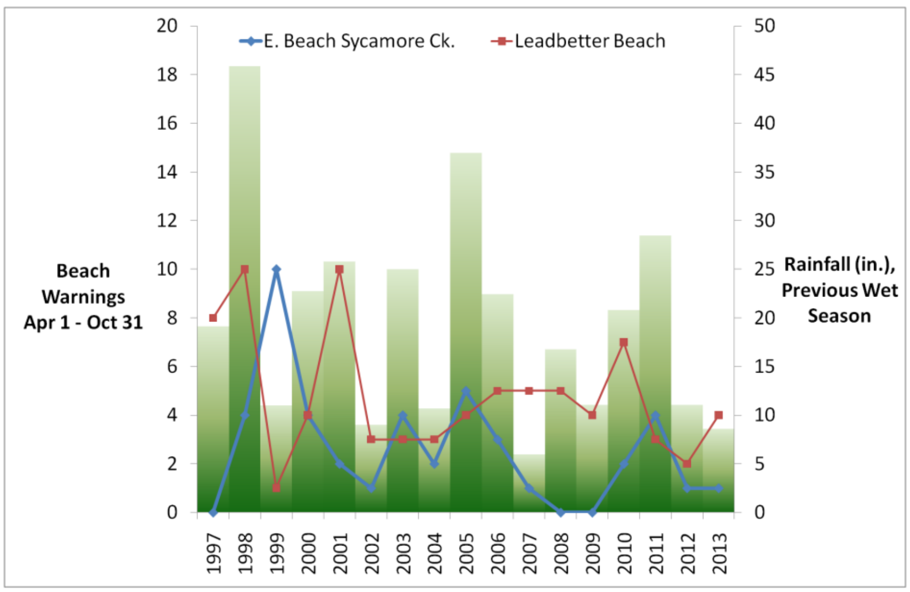


Figure 29. AB411 Beach Warnings and Annual Rainfall.

- Arroyo Burro and Mission Creek show increased warnings following wet winters.
- Leadbetter and E. Beach at Sycamore Ck. are less responsive due to fewer lagoon breachings.
- During dry weather, open lagoons lead to warnings.
- Sand berms diffuse and filter FIB.

Figure 30. Arial photos show typical lagoon status.

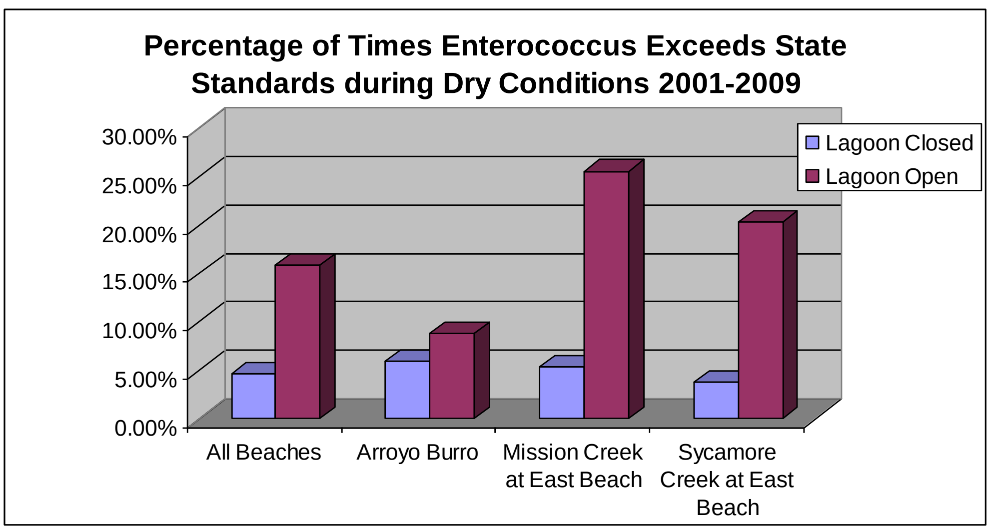


Figure 31. Increased likelihood of beach warnings when lagoons are open during dry weather.

Santa Barbara County		Summer Dry (April-Oct)	Winter Dry (Nov-Mar)	Wet Weather Year-Round
		County "Beach Bummer" names appear in bold.		
Arroyo Burro Beach		A	C	C
Leadbetter Beach		A	B	A+
East Beach	Mission Creek	A	B	F
	Sycamore Creek	A	A	A

Figure 32. Worse wet weather grades for beaches with lagoons that open frequently.

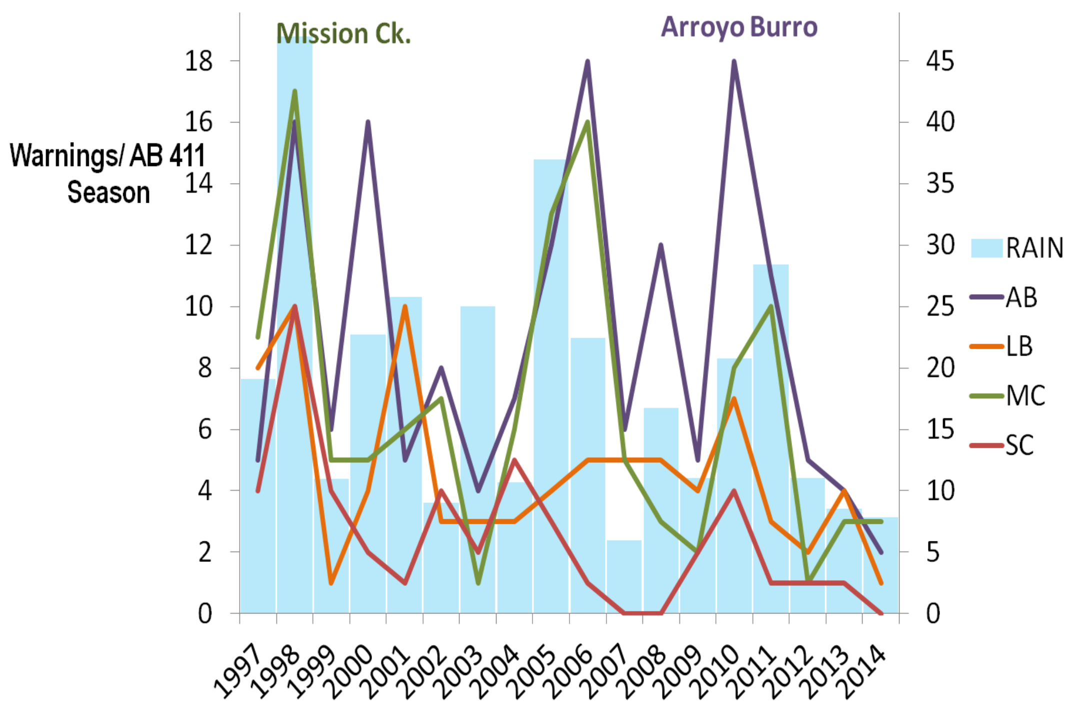


Figure 33. Rainfall and beach warnings for all creeks.

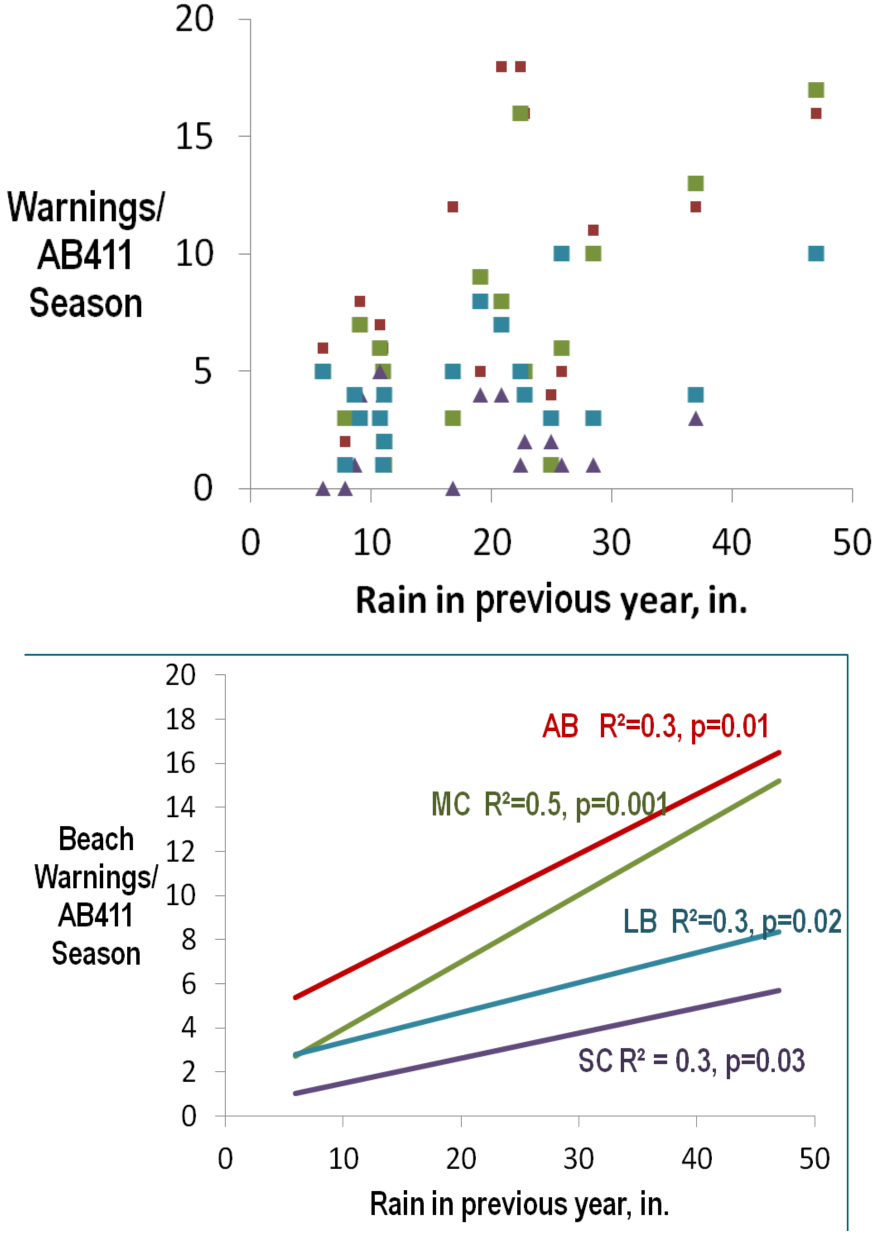


Figure 34. Correlations between annual rainfall and beach warnings during AB 411 season, showing the enormous impact that weather has on water quality (as assessed by FIB).

CREEK INDICATOR BACTERIA LEVELS

Creek indicator bacteria levels have not substantially responded to drought.

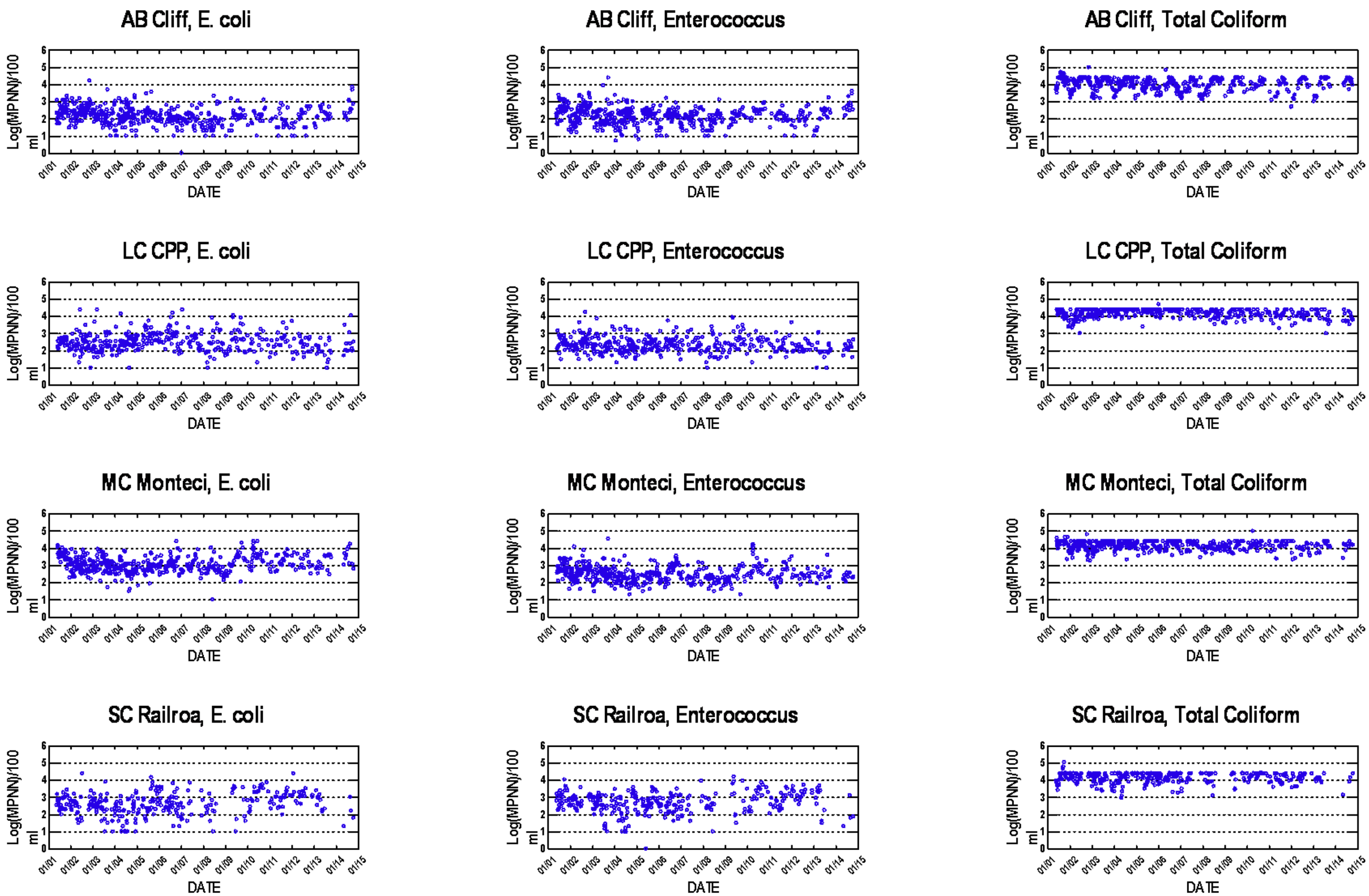


Figure 35. Long term trends of indicator bacteria levels at main integrator stations.

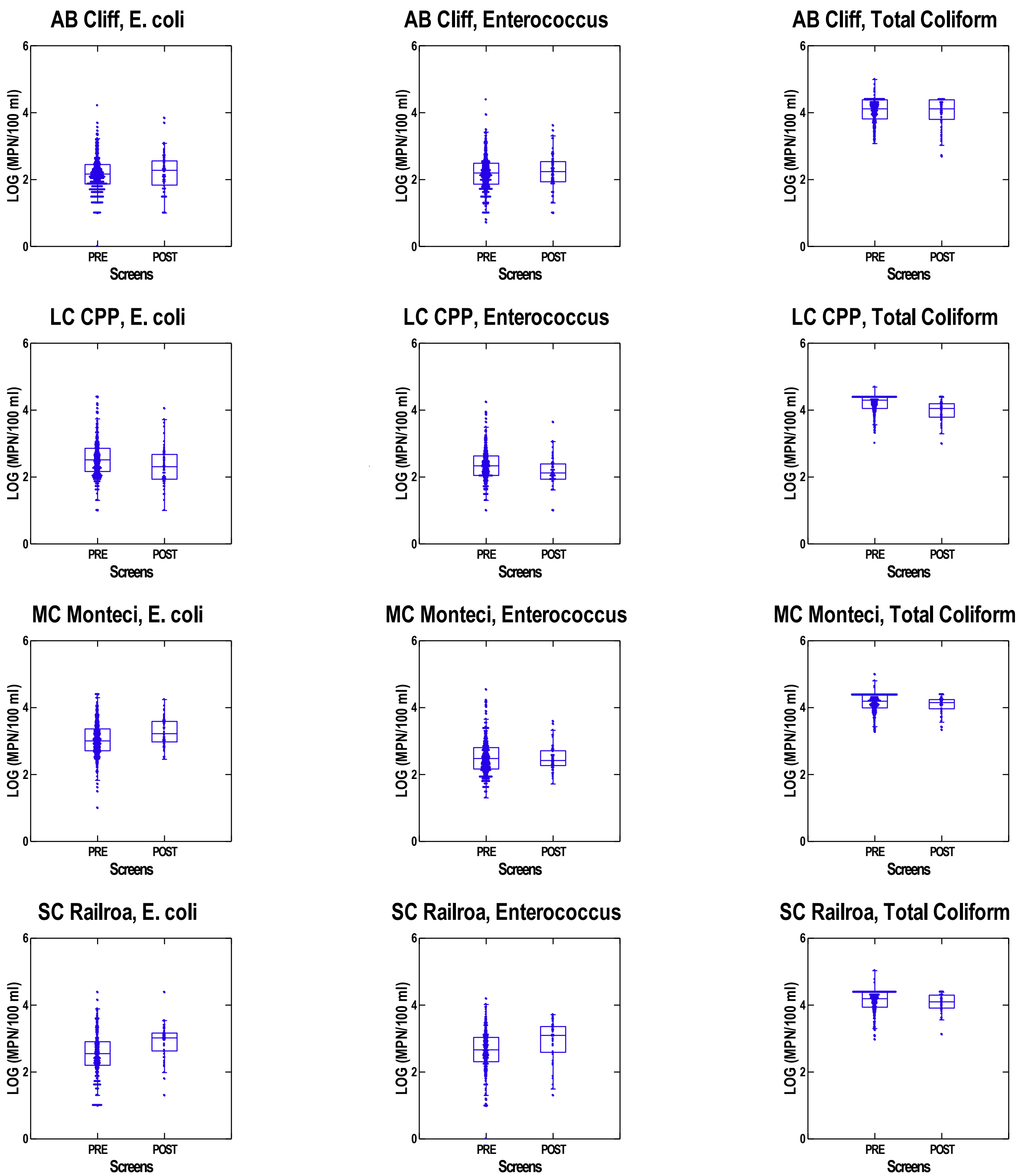
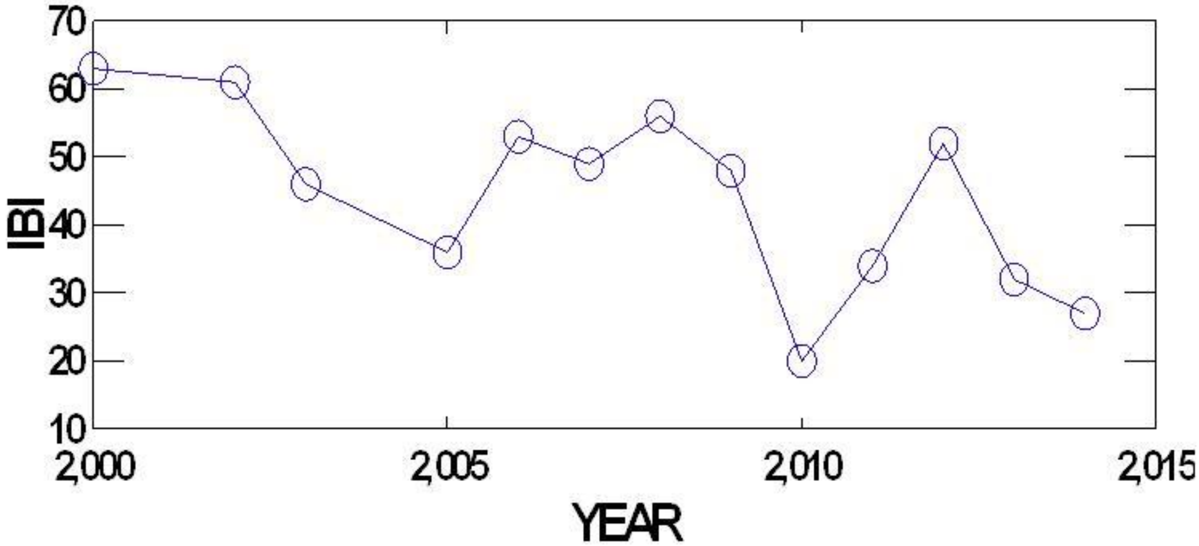


Figure 36. Update of analysis from previous WQ report showing lack of consistency in drought and/or storm drain screens. Sycamore creek increase may be due to fewer sample numbers or seasonal bias due to lack of flow.



- Most sites have relatively low IBI in 2014.
- Other stressors (fire, scouring) equally important.

NEW AND EMERGING CONTAMINANTS DETECTED IN DRY WEATHER

No neonicotinoid pesticides were detected in dry weather, as described in wet weather section on neonicotinoids.

STORM MONITORING

FIRST FLUSH

- February 26, 2014 (very late)
- 4 Integrator sites (AB, MC, Laguna, Sycamore)
- 4 sites where runoff enters Bird Refuge
- Metals, hydrocarbons, surfactants, nutrients, sediment, pesticides, and toxicity.
- Most found at low levels.
- Most pesticides not detected, concern about exceptions.

<u>Dicloran</u>

- Pyrethroid detected at all 8 sites
- Fungicide on food crops, no OTC products

<u>Sumithrin</u>

- Pyrethroid detected at 6 sites, also found in Bird Refuge sediments
- Not included in most pyrethroid tests
- Used in mosquito abatement and household products
- None used by Vector Control or registered in County

NEW AND EMERGING CONTAMINANTS

NEONICOTINOID PESTICIDES: NOT JUST A BEE PROBLEM

After years of testing for pesticides in urban runoff, and having spot detections of various compounds here and there, the City of Santa Barbara Creeks Division is now seeing neonicotinoids in every sample we collect. At the same time, there is more research coming out almost weekly about their potential impact on ecosystems, leading some scientists to say they are the "new DDT" (without the human-harm component).

Summary

The neonicotinoids have rapidly become the most widely used pesticides globally, and are used for agriculture, structural pest control, pet care, and home garden care. Systemic poisons, the neonicotinoids have been implicated for harming pollinators throughout the world. The United State Environmental Protection Agency (US EPA) and the California Department of Pesticide Regulation (CA DPR) are both reevaluating the registration of neonicotinoid pesticides with a focus on pollinator impacts. However, there is new and compelling evidence that the neonicotinoids are widespread in surface waters, are toxic at levels far below existing toxicity thresholds, and are likely harming aquatic and riparian ecosystems worldwide through trophic effects. With most research conducted on inland agricultural areas, there are almost no data on impacts to urban or coastal streams, coastal estuaries, and the marine environment. Imidacloprid, the most widely used neonicotinoid in California, was detected repeatedly in a pilot test of urban stormwater runoff in Santa Barbara, CA, at levels suggested to cause ecotoxicity. Given the neonicotinoids' widespread use, documented ecotoxicity, and demonstrated presence in surface waters, it is urgent that the CA DPR and US EPA include ecological risk assessment of aquatic ecosystems in the their current reviews of neonicotinoids. Because both agencies are under legal pressure to complete the reevaluations relatively quickly, the window for consideration of aquatic impacts is narrow.

Background: Neonicotinoid Pesticides, Impacts to Pollinators, and Legislation

Neonicotinoids are a relatively new class of pesticide that have rapidly gained market share. First registered in the US in 1994, neonicotinoids are now the most widely used pesticides worldwide (van Lexmond et al. 2015). Agricultural use throughout the United States has grown rapidly in both geographic range and dosing (Fig. 1; USGS 2015). In addition, neonicotinoids are used in non-agricultural applications such as structural pest control (termites, ants), professional landscaping, home garden care, and pet treatments (fleas and ticks). In California, imidacloprid accounts for most of the neonicotinoid used (Fig. 2; Simon-Delso et al. 2015).

For agricultural and garden uses, seeds are treated with the pesticides, and the entire plant tissue becomes toxic to insects. Soil and roots are also doused, with the goal of plant uptake. When target insects eat or suck from the plant tissue, they are quickly paralyzed and killed; because the pollen also contains the poison, honey bees can be inadvertently harmed. At low concentrations, the neurotoxin effects the navigation and foraging ability of insects (Feltham et al. 2014), leading to potential declines in pollinator populations.

In 2013 the European Union began a two-year moratorium on some uses of neonicotinoids in order to assess their acute and chronic effects on bee colonies, larvae, behaviour, and the risks posed by sub-lethal doses. The California Legislature recently passed a bill (AB 1789; Williams) specifying a timeline for the reevaluation of neonicotinoid registration in California. The bill will "provide the impetus to complete the scientific studies and review needed to formulate sound policy on regarding the use of neonicotinoid pesticides and their possible interaction with the health of honey bees." The US EPA is also currently reviewing the neonicotinoids; existing work plans do not mention runoff or aquatic organisms (US EPA 2010). The Natural Resources Defense Council has filed a petition against the US EPA and asked for the evaluation to be completed in 2015; AB 1789 requires the CA DPR completion by July 2018.

Neonicotinoids and Impacts on Nontarget Aquatic Organisms

Neonicotinoid pesticides impact non-target organisms and ecosystems in addition to pollinators. The Task Force on Systemic Pesticides published an overview (Fig. 3, Sánchez-Bayo 2014), conclusion (Van der Sluijs et al. 2014), and a special issue of *Environmental Science and Pollution Research* in January 2015 (van Lexmond et al. 2015), citing substantial cause for concern about the impacts to aquatic organisms. Neonicotinoids have far longer environmental half lives than stated in original pesticide registration documents and their extremely high solubility leads to rapid leaching to waterways during storm events, including in the Midwest of the United States (Hladik et al., 2013), and in irrigated California (Starner and Goh 2011). Ecotoxicity has been demonstrated in assays with wide range of toxicity thresholds; while existing US EPA guidance for imidacloprid is 1 µg/L, a recent review recommended a chronic toxicity threshold for imidacloprid in surface waters at 35 ng/L, or 1/25th of the US EPA threshold (Morrissey et al. 2015). Correlative studies have shown that concentrations of imidacloprid at 13 ng/L can lead to lowered abundances of macroinvertebrates (Van Dijk et al. 2013) and at 20 ng/L can lead to lower diversity in birds that feed on them (Hallman et al. 2014).

The City of Santa Barbara (City of SB) recently found that imidacloprid is pervasive in urban runoff. Samples were collected during two storm events, and included four urban creek sites located just above coastal estuaries and sites where runoff was collected directly from paved surfaces (Fig. 4). Every sample collected during wet weather (n=12) and tested for neonicotinoids (imidacloprid, clothianidin, and thiamethoxam) was positive only for imidacloprid (Table 1). The concentrations were well below the US EPA's acute and chronic toxicity thresholds, yet the median concentration in wet weather of 20 ng/L is right in line with documented ecotoxicological effects.

Given the neonicotinoids' widespread use, documented ecotoxicity, the demonstrated presence in surface waters, it is urgent that the CA DPR and US EPA include ecological risk assessment of aquatic ecosystems in the their current reviews of neonicotinoids.

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Van der Sluijs, J. P., Amaral-Rogers, V., Belzunces, L. P., van Lexmond, M. B., Bonmatin, J. M., Chagnon, M., ... & Wiemers, M. (2015). Conclusions of the Worldwide Integrated Assessment on the risks of neonicotinoids and fipronil to biodiversity and ecosystem functioning. *Environmental Science and Pollution Research*, *22*(1), 148-154.

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van Lexmond, M. B., Bonmatin, J. M., Goulson, D., & Noome, D. A. (2015). Worldwide integrated assessment on systemic pesticides. *Environmental Science and Pollution Research*, *22*(1), 1-4.

Figure 1. Change in agricultural use of imidacloprid, 1994-2014 (USGS 2015).

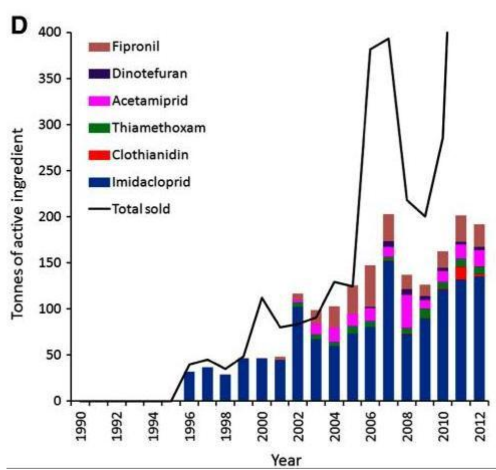


Figure 2. Trend in the quantity of neonicotinoid insecticides and fipronil used in California from 1990. Figure taken directly from Simon-Delso et al. (2015).

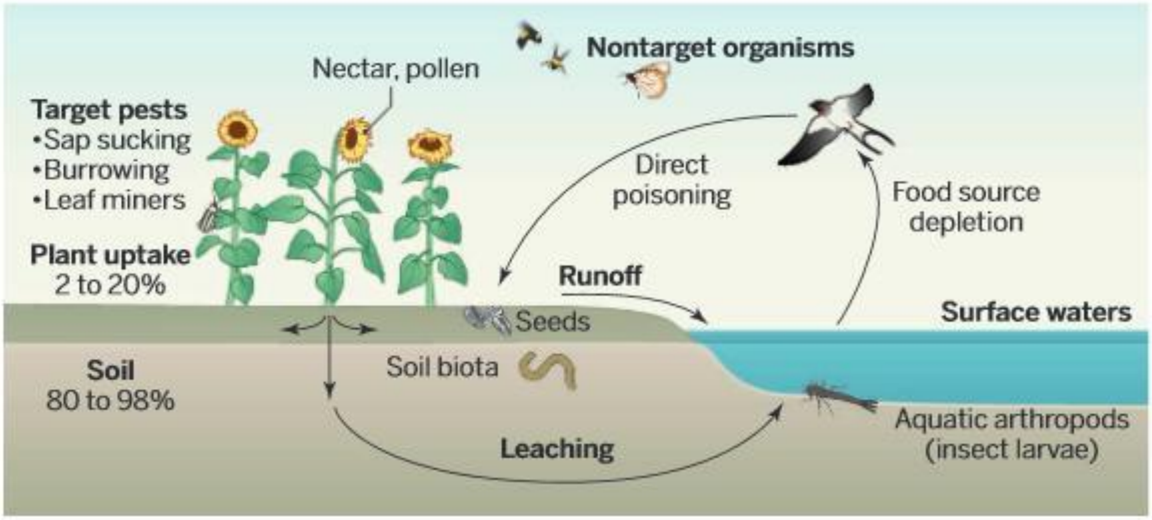


Figure 3. Neonicotinoids and pathways of environmental contamination. Reproduced directly from Sánchez-Bayo (2014).

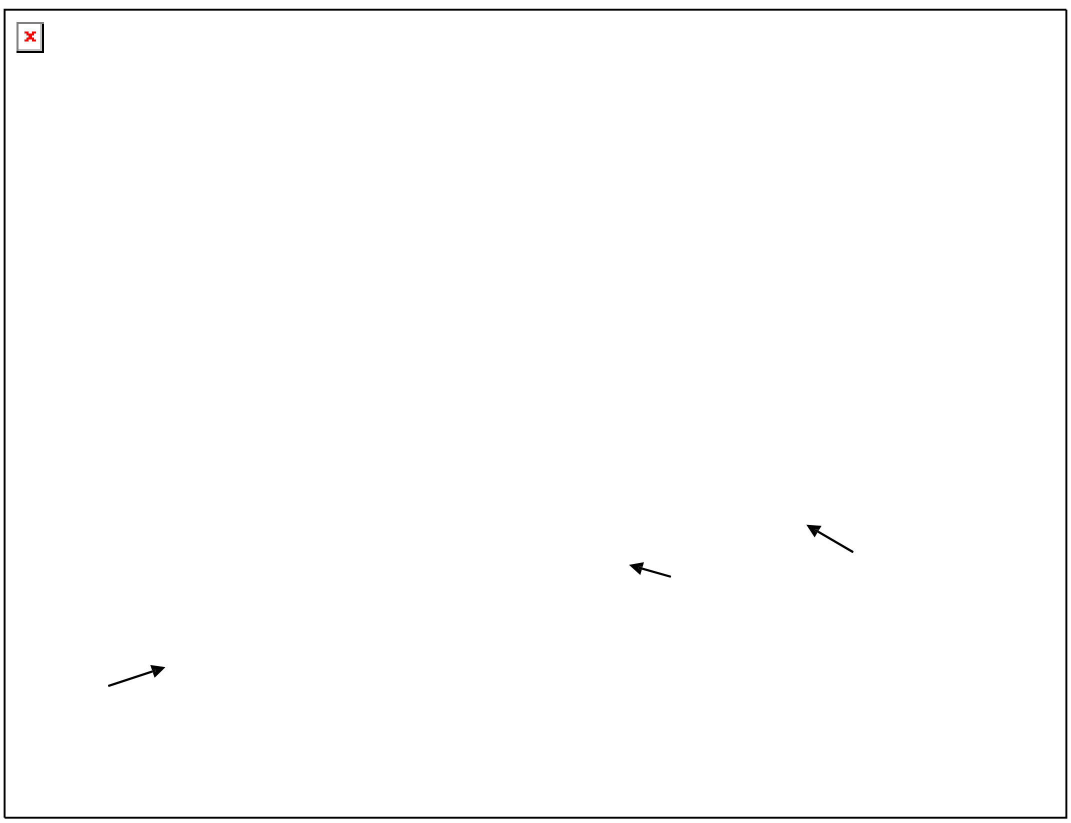


Figure 4. Neonicotinoid sampling locations in the City of Santa Barbara.

Table 1. Imidacloprid Sampling Results – City of Santa Barbara, Calendar Year 2014

Table 1. Imidacloprid Sampling Results – City of Santa Barbara, Calendar Year 2014

		Imidacloprid, ng/L[1]								
		Creek Sites				Direct Runoff Sites				
Date	Hydrology	AB Cliff	MC Monteci	LC CPP	SC Railroa	LID Quar N	LID Quar S	LID VC	LID AliceKe	MDL[4]
2/27/2014	2nd storm, ~1.5” rain	22	25	25	8	n.s.[2]	n.s.	n.s.	n.s.	5
8/19/2014	Dry	ND[3]	ND	ND	ND	n.s.	n.s.	n.s.	n.s.	5
12/2/2014	2nd storm, ~2" of rain	31	19	76	15	4.7	11	16	28	2

[1] Other neonicotinoids were below detection limits (compound, MDL ng/L): Clothianidin, 2.3; Thiamethoxam 1.9.
[2] No sample collected.
[3] No detection.
[4] Minimum detection limit.

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

Bird Refuge storm results will be included in the next annual report.

RESTORATION AND WATER QUALITY PROJECT ASSESSMENT

BIRD REFUGE

During FyY14:

- Frequent algal blooms (high DO).
- Subsequent decay (low DO).
- No *Daphnia* bloom this year.
- No stink events.
- One extreme pink event, where DO was very low but there was almost no odor. The odor present was musty, garlicky, but not like rotten eggs.
- Sulfur bacteria were likely consuming hydrogen sulfide.



Weekly sampling from a kayak by the watershed stewards showed the following seasonal pattern, and the late first flush is evident (February 2014).

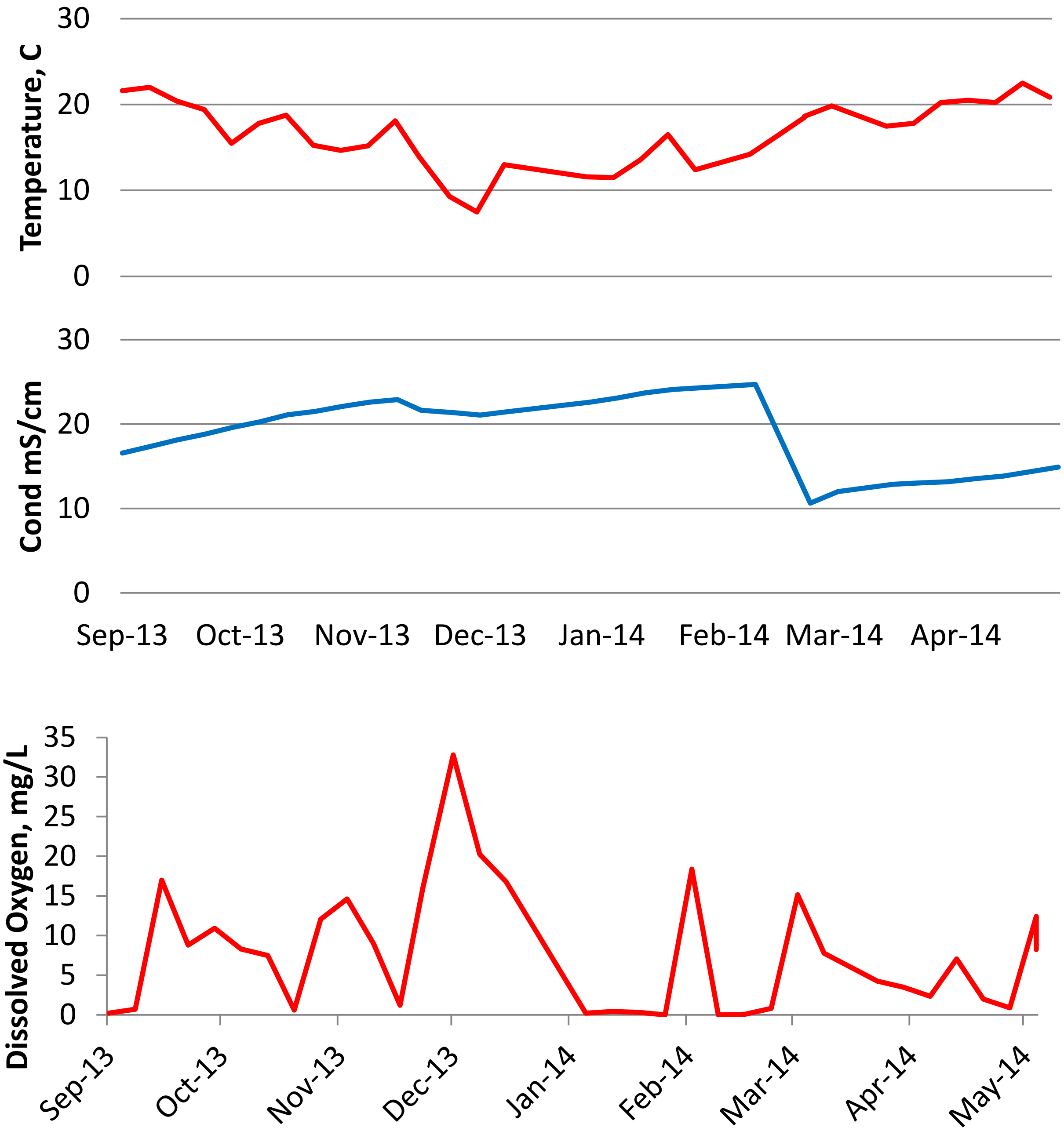


Figure 37. Seasonal pattern of temperature, conductivity and dissolved oxygen in the Bird Refuge during FY 14.

Sonde deployments show more detail:

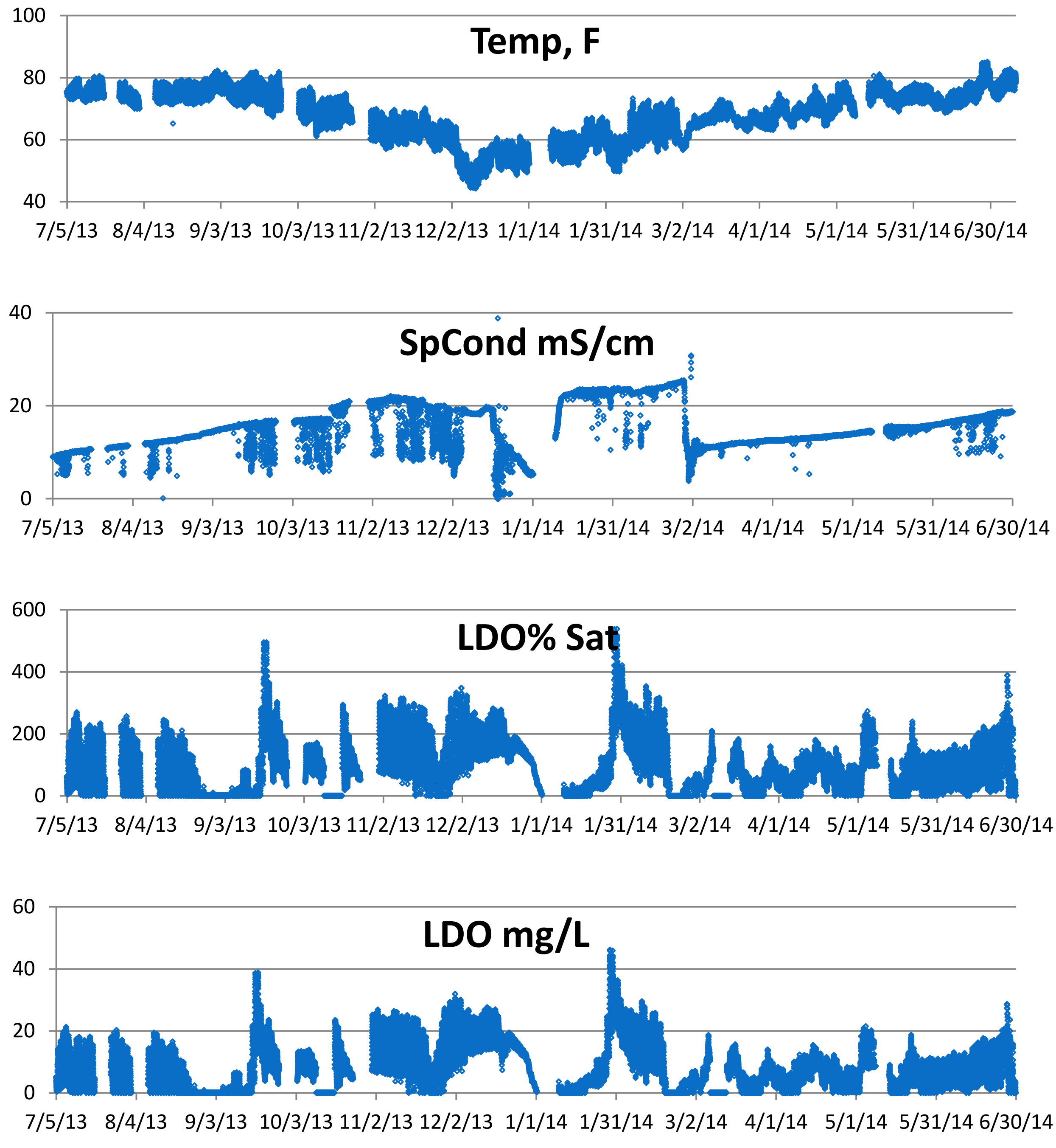
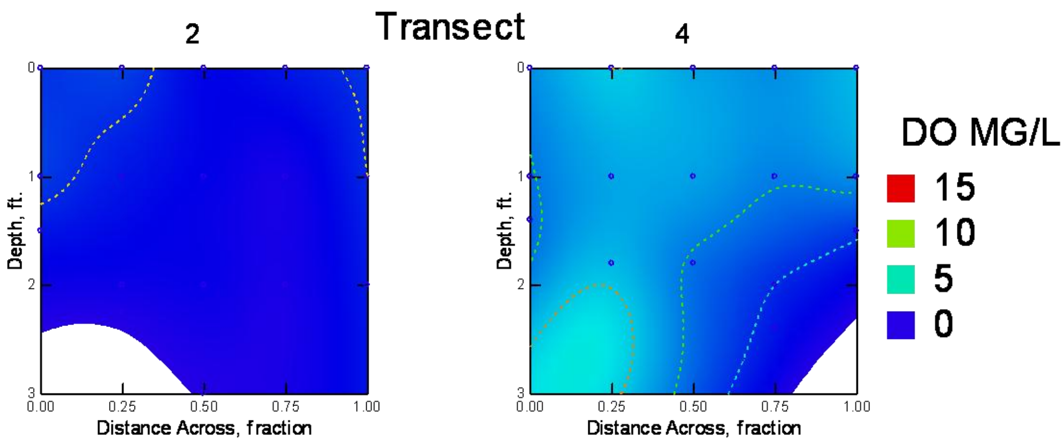


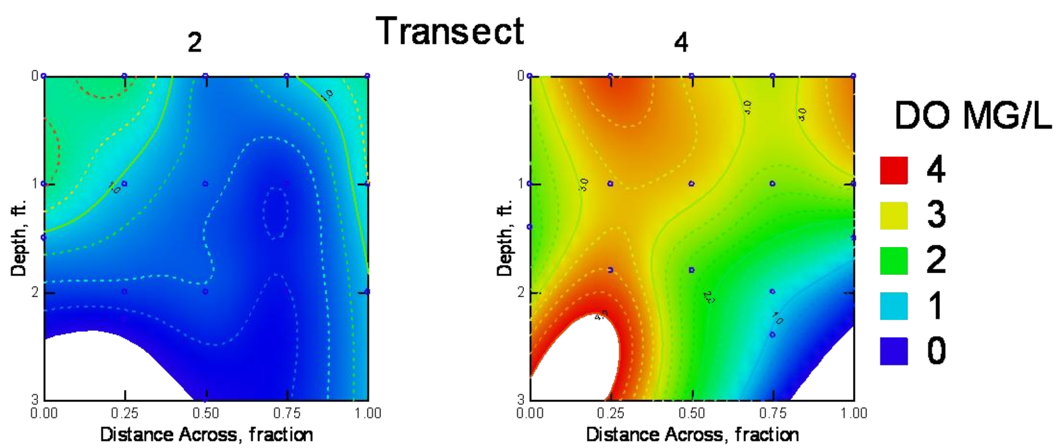
Figure 38. Data from sonde deployments in the outlet arm.

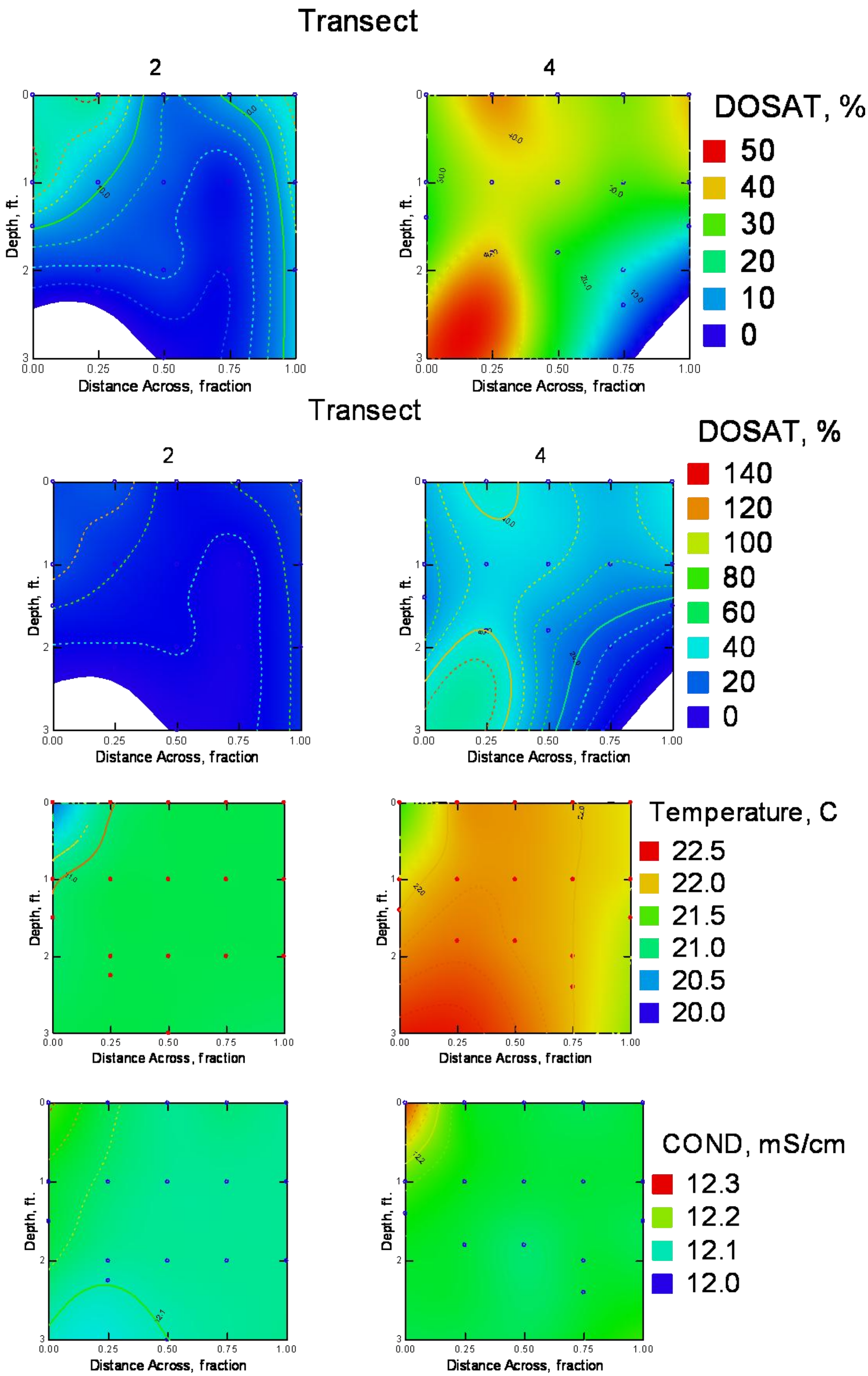
Event 43 August 1, 2013

- Brownish red water color

Transcect 2	Open Transect
• pH = 9.5, Alk = 720 ppm, Hardness >1000 ppm, Nitrite = 0, Nitrate = 10 ppm, H2S = 10 ppm, H2S test = 0.5 ppm • Greasy sheen on water, possibly from Bactipur application • Secchi: 6 inches	• pH = 9.5, Alk = 720 ppm, Hardness >1000 ppm, Nitrite = 0, Nitrate = 0, H2S = 8 ppm, aH H2S test = 0.5 ppm • Fewer beetles, swallows, mosquitoes. • Secchi: 6 inches



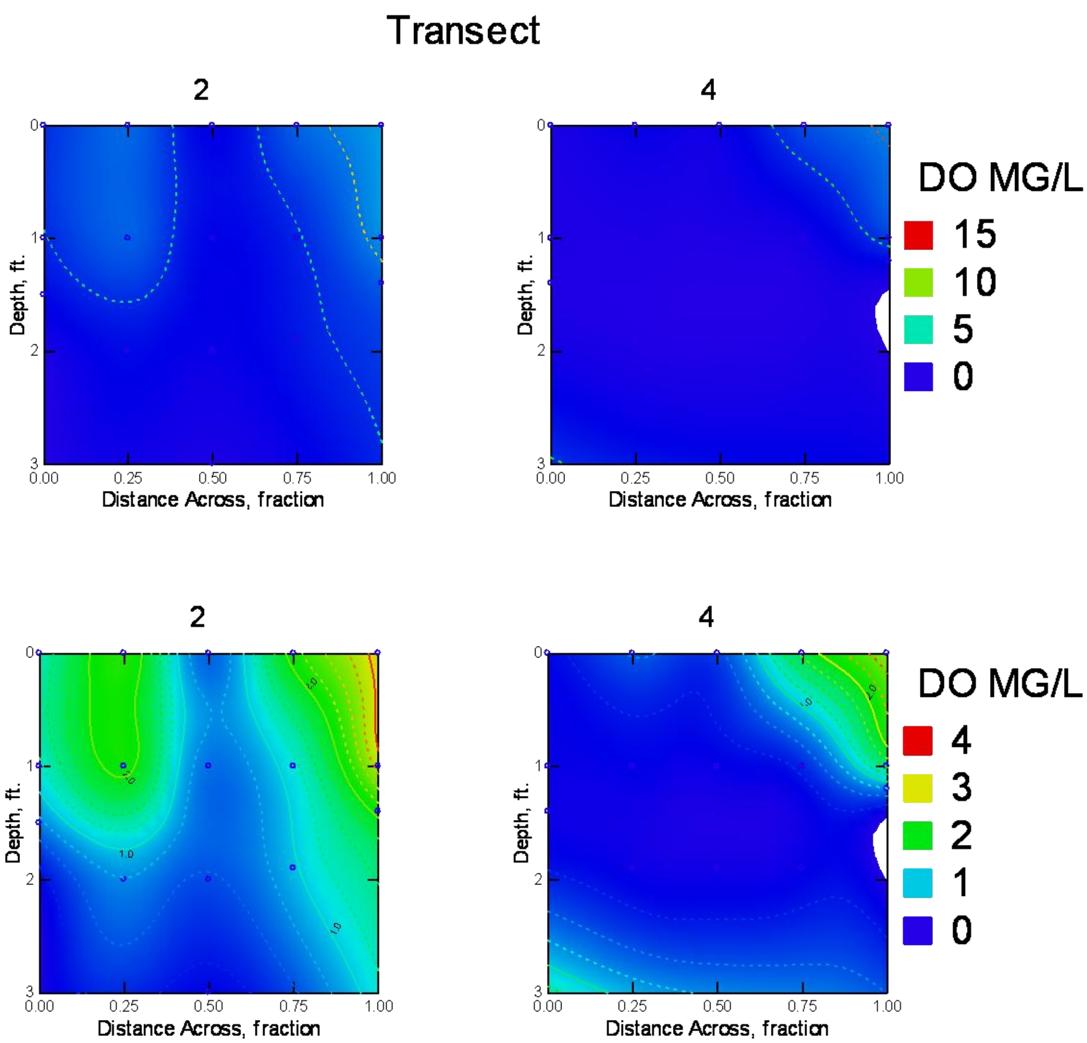


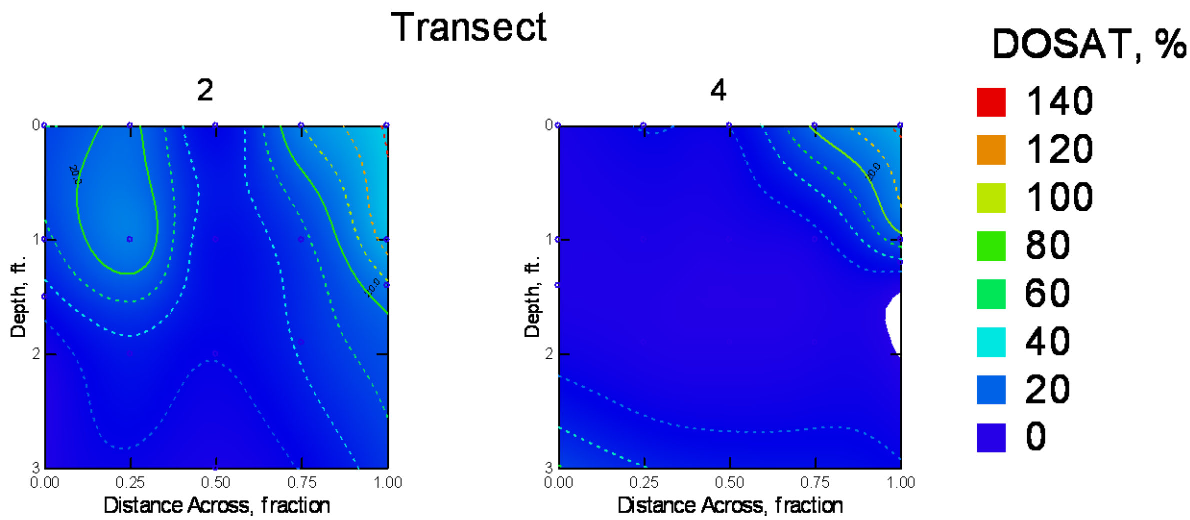

Transect
2
4
DOSAT, %
50
40
30
20
10
0
Depth, ft.
Distance Across, fraction
Transect
2
4
DOSAT, %
140
120
100
80
60
40
20
0
Temperature, C
22.5
22.0
21.5
21.0
20.5
20.0
COND, mS/cm
12.3
12.2
12.1
12.0

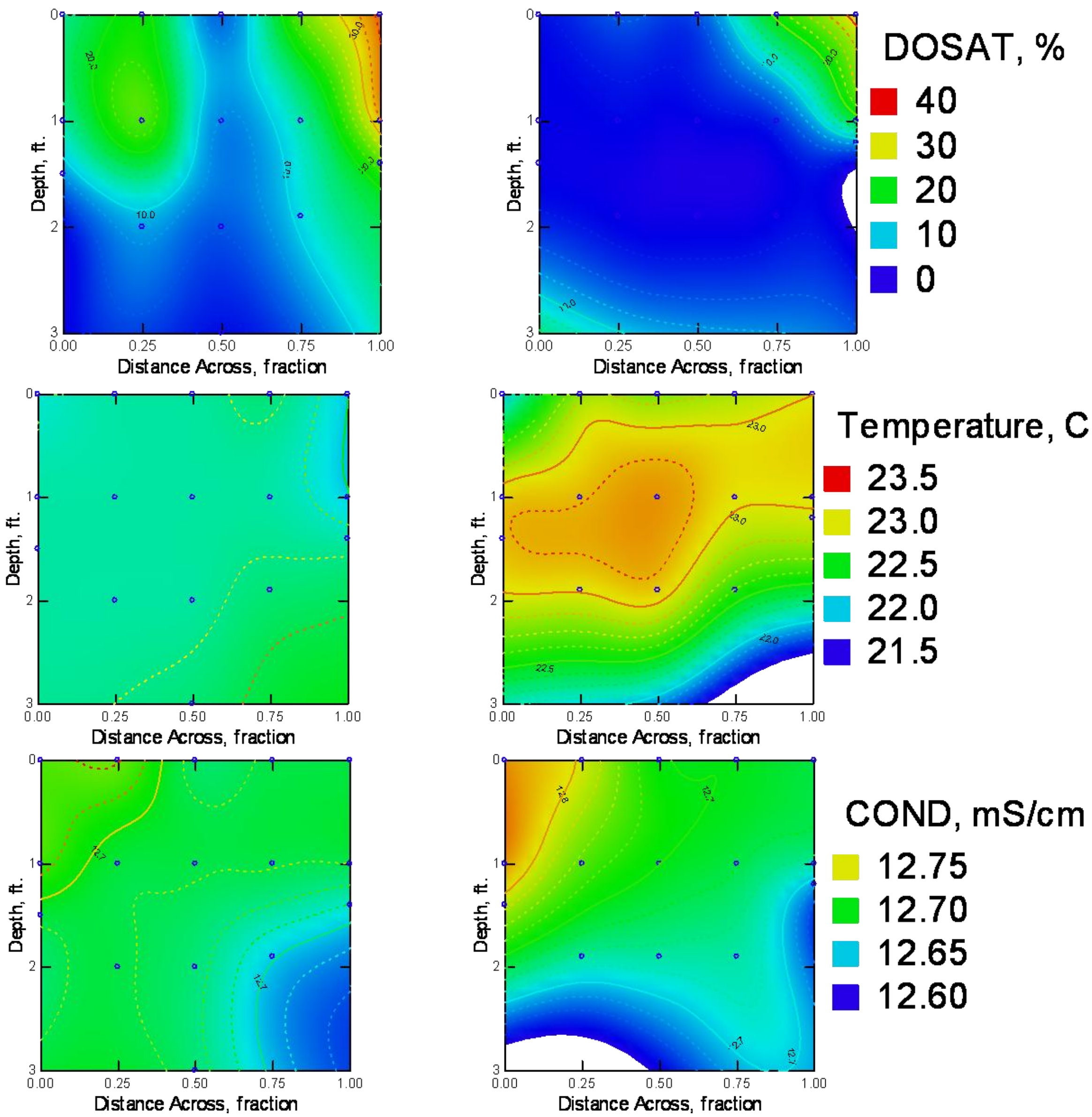
Event 44, August 8, 2013

- Brownish water color
- Sunny and cool with light wind
- Secchi at weir: 5 inches

Transect 2	**Open Transect**
• pH = 9.5, Alk = 300 ppm, Hardness >1000 ppm, Nitrite = 0, Nitrate = 0, H2S = 5 ppm, aH H2S test = 0.5 ppm • Fewer beetles, fewer mosquitoes • Oily sheen possibly from Bactapur • Secchi: 4 inches	• pH = 9.5, Alk = >720 ppm, Hardness >1000 ppm, Nitrite = 0, Nitrate = 0, H2S = 5 ppm, aH H2S test = 0.5 ppm • Fewer beetles, swallows, mosquitoes • Secchi: 5 inches



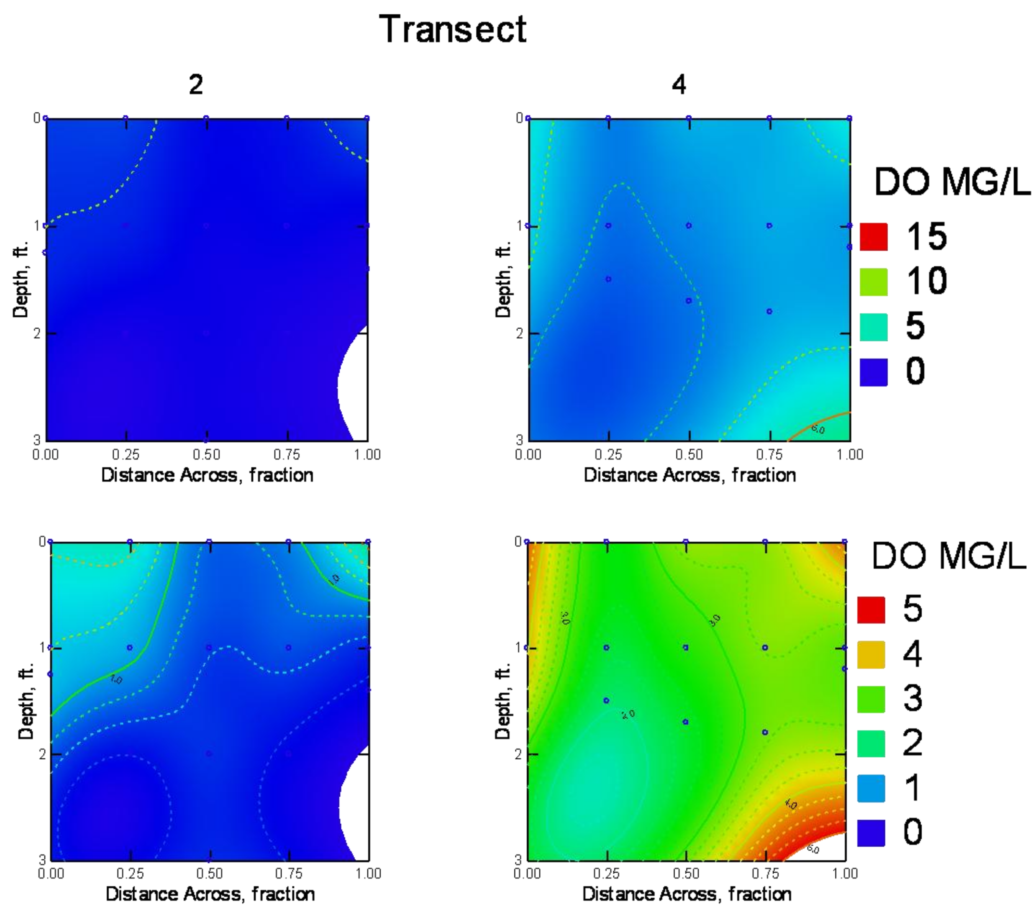

Transect
2
4
DOSAT, %
140
120
100
80
60
40
20
0
Depth, ft.
Distance Across, fraction
0
1
2
3
0.00
0.25
0.50
0.75
1.00

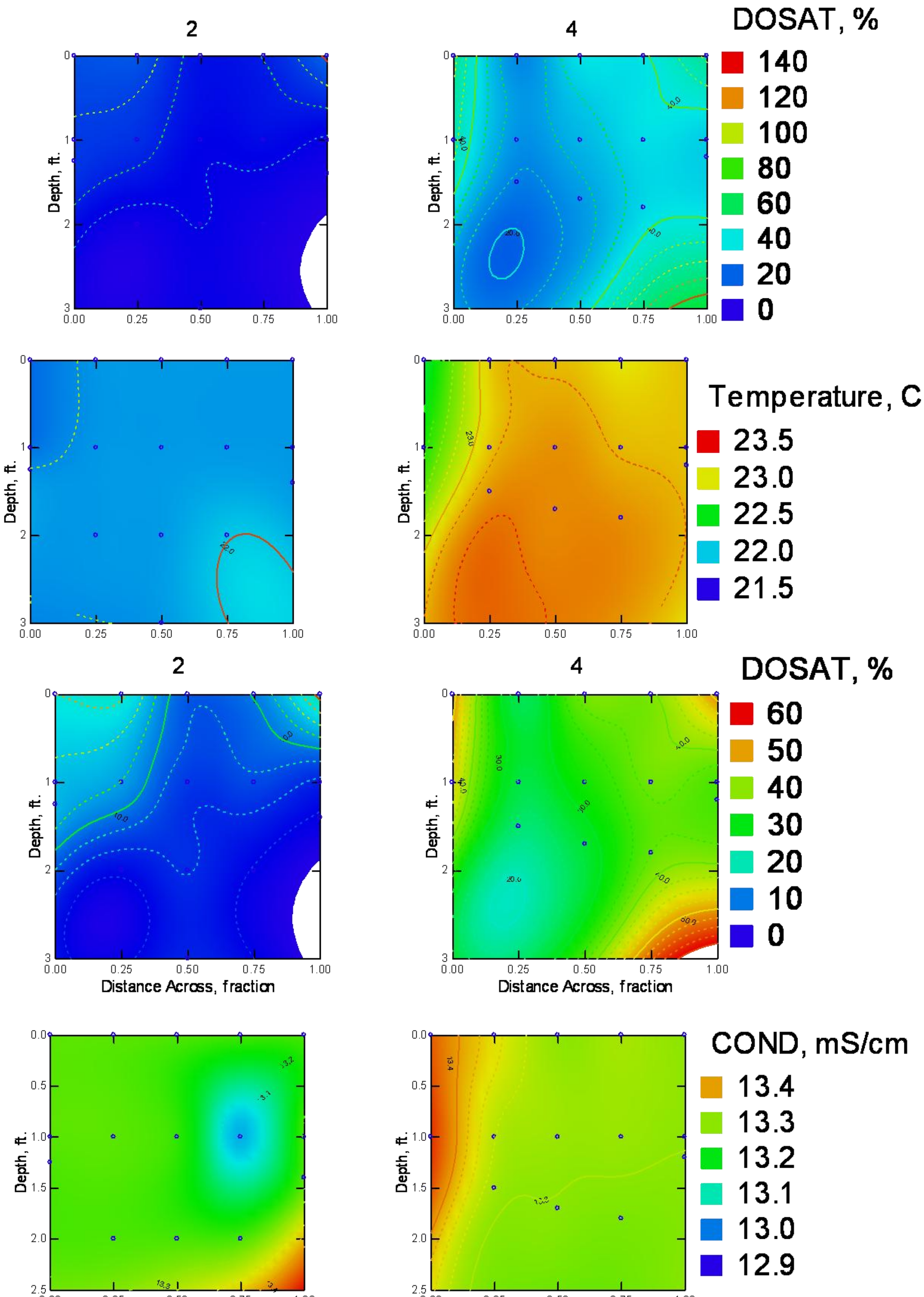

DOSAT, %
40
30
20
10
0
Temperature, C
23.5
23.0
22.5
22.0
21.5
COND, mS/cm
12.75
12.70
12.65
12.60
Depth, ft.
Distance Across, fraction
0.00
0.25
0.50
0.75
1.00

Event 45, August 15, 2013

- Brownish water color
- Cloudy and cool
- Secchi at weir: 3 inches

Transect 2	Open Transect
• pH = 9.5, Alk = 720 ppm, Hardness >1000 ppm, Nitrite = 0, Nitrate = 0, • Water possibly greasy from Bactapur • Secchi: 4 inches	• pH = 9.5, Alk = 720 ppm, Hardness >1000 ppm, Nitrite = 0, Nitrate = 0, • Lots of floating green algae • Very few mosquito casings • No signs of fish • Turtle in road, trying to escape bird refuge? • Dead rat in water by island • Very few birds in the water, none eating • Secchi: 3.5 in




2
4
DOSAT, %
140
120
100
80
60
40
20
0
Depth, ft.
Temperature, C
23.5
23.0
22.5
22.0
21.5
2
4
DOSAT, %
60
50
40
30
20
10
0
Distance Across, fraction
Distance Across, fraction
COND, mS/cm
13.4
13.3
13.2
13.1
13.0
12.9

MISSION LAGOON RESTORATION

Watershed stewards continued to survey the Mission Lagoon on a weekly basis. Data will be checked for quality control and presented in the next report.

SOURCE TRACKING

MICROBIAL SOURCE TRACKING IN ARROYO BURRO WATERSHED

From May 2014 Staff Report to the CAC:

The Creeks Division has worked for a decade in collaboration with Dr. Patricia Holden from UCSB on using microbial source tracking to investigate sources of fecal indicator bacteria to beaches and creeks in Santa Barbara. Previously, the Committee has received presentations on several microbial source tracking projects, including the UCSB Microbial Source Tracking Study (Mission and Arroyo Burro Watersheds), the Laguna Watershed Study, the Canine and Microbial Source Tracking Study, and the Microbial Source Tracking Protocol Development Project. These projects were funded with grants to the Creeks Division from the State Water Board's Clean Beaches Initiative Grant Program, the Switzer Foundation, and the Water Environment Research Foundation, along with Measure B.

The research presented in this report was funded by a grant from the State Water Board's Clean Beaches Initiative Grant Program directly to UCSB as part of the Source Identification Protocol Project. The City is a stakeholder in the project, and suggested Arroyo Burro as a target watershed due to low grades on Heal the Bay's Beach Report Card. Despite the identification and elimination of leaking sewage reaching the creek in previous projects, indicator bacteria levels and associated beach warnings have persisted, suggesting a nonhuman source of indicator bacteria. Dr. Jared Ervin, a Postdoctoral Research Associate at UCSB working with Dr. Holden, led the design and execution of the Arroyo Burro component of the Source Identification Protocol Project.

UCSB Research on Microbial Source Tracking In Arroyo Burro

The following abstract summarizes a manuscript, entitled "Microbial Source Tracking in a Coastal Suburban Watershed Reveals Canines as Significant yet Controllable Sources of Fecal Contamination," that has been submitted for publication by UCSB:

> Elevated levels of fecal indicator bacteria (FIB), including *E. coli* and enterococci, trigger coastal beach advisories and signal public health risks. Solving FIB pollution in suburban coastal watersheds is challenging, as there are many potential sources. The Arroyo Burro Watershed in Santa Barbara, CA is an example, with its popular, but chronically FIB-contaminated beach. To address, a microbial source tracking (MST) study was performed, beginning with historical data evaluation and field reconnaissance. Surface waters and beach sand, wrack, and groundwater were then sampled over two years. FIB

were quantified, and DNA was analyzed for host-associated fecal markers. Surf zone FIB were only elevated when the coastal lagoon was discharging. Among the fecal sources into the lagoon, including upstream human sources and coastal birds, canines were the most important. Canine sources included input via upstream creek water, which significantly decreased after creek-side residences were educated about proper pet waste disposal, and direct inputs to the lagoon and surf zone, where dog waste could have been tidally exchanged with the lagoon. Based on this study, canine waste can be an influential, yet controllable, fecal source to suburban coastal beaches.

In summary:

- Dog waste marker found at AB (creek, lagoon and beach), shown to decrease in creek after outreach. (UCSB)
- Not solely responsible for beach warnings:
  - *No beach warnings when lagoon closed, even though dog marker found in surf zone.*
- Outreach did not decrease FIB.