CITY OF LONG BEACH

STORMWATER MONITORING REPORT 2013/2014

NPDES Permit No. CAS004003

July 2014

KINNETIC LABORATORIES INCORPORATED

CITY OF LONG BEACH
DEPARTMENT OF PUBLIC WORKS

STORM WATER MANAGEMENT
CITY OF LONG BEACH

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STORM WATER/ENVIRONMENTAL COMPLIANCE DIVISION

July 12, 2014

The City of Long Beach is pleased to submit the Fourteenth (14th) Annual, "Stormwater Monitoring Report, 2013/2014" in compliance with Order No. 99-060 of the Municipal National Pollutant Discharge Elimination System (NPDES) Permit No. CAS004003, (CI8052).

We have worked collaboratively with our contractor Kinnetic Laboratories, Inc., and their subcontractors to produce a report that we believe contains extremely useful information for the City and the Los Angeles Regional Water Quality Control Board/State Water Resources Control Board. As required in our permit, all analyses were conducted at laboratories certified for such analyses by the Department of Health Services or approved by the Executive Officer in accordance with US EPA guidelines procedures or as specified in this Monitoring Program.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluated the information submitted.

Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility, of a fine and imprisonment for known violations.

Executed on the 12th of July, 2014
at Long Beach, California.

Anthony Arevalo
Storm Water/Environmental Compliance Officer

7-12-2014
Date

Cc: Ara Maloyan, Director of Public Works
Derek Wieske, Acting City Engineer

AA:aa
2014 AMR Cover Ltr.doc

CITY OF LONG BEACH

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ACRONYMNS AND ABBREVIATIONS LIST

ASTM - American Society for Testing and Materials
BMP - Best Management Practice
BOD- Biological Oxygen Demand
CCC – Criterion Continuous Concentration
CD - Compact Disk
CFU - Colony Forming Units
CMC – Criterion Maximum Concentration
COD - Chemical Oxygen Demand
CRWQCB – California Regional Water Quality Control Board
CTR - California Toxics Rule
DDD - dichloro (p-chlorophenyl)ethane
DDE - dichloro (p-chlorophenyl)ethylene
DDT - dichlorodiphenyl trichloroethane
DF - dilution factor
DI - Deionized
DL - Detection Limit (considered the same as RL)
DO - Dissolved Oxygen
EC_{50} - Concentration causing effects to 50% of the test population
EDTA - ethylene diamine triacetic acid
EMC - Event mean concentration
GIS - Geographic Information System
IC_{25} - Concentration causing 25% inhibition in growth or reproduction
IC_{50} - Concentration causing 50% inhibition in growth or reproduction
ICID - Illegal Connection Illicit Discharge
ICP-MS - Inductively Coupled Plasma-Mass Spectrometry
KLASS - Kinnetic Laboratories Automated Sampling System
KLI - Kinnetic Laboratories, Inc.
LC_{50} - Bioassay concentration that produces 50% lethality
LDPE - Low Density Polyethylene
LOEC - Lowest Observed Effect Concentration
MBAS - methylene-blue-active substances
ML – Minimum level as defined in State Implementation Plan
MPN- Most Probable Number
MS4 - Multiple Separate Storm Sewer System
NPDES – National Pollutant Discharge Elimination System
NOEC - No observed effect concentration
NTU - nephelometric turbidity units
PCB - Polychlorinated biphenyls
PDF - Portable Document Format
PMSDs - Percent Minimum Significant Differences
ppb - Parts per Billion
ppt – Parts per Thousand
Q - Flow
QA/QC - Quality Assurance/Quality Control
RL - Reporting Limit (considered the same as DL)
RPD - Relative Percent Difference

sf - Square Feet
SIP – State Implementation Plan
SM- Standard Methods for the Examination of Water and Wastewater
SOP - Standard Operating Procedure
SRM - Standard Reference Material
STS - sodium tetradecyl sulfate
SWRCB-State Water Resource Control Board
TDS – Total Dissolved Solids
TIE – Toxicity Identification Evaluation
TKN - Total Kjeldahl Nitrogen
TOC - Total Organic Carbons
TPH - total petroleum hydrocarbons
TSS – Total Suspended Solids
TU - Toxicity Unit
TU_a – Acute Toxicity Unit (1/LC_{50} or EC_{50})
TU_c – Chronic Toxicity Unit (1/NOEC)
USEPA - U.S. Environmental Protection Agency
WQO - Water Quality Objective
WQS - Water Quality Standard

EXECUTIVE SUMMARY

This report provides a summary of the results of the thirteenth year of monitoring conducted under the terms of Order No. 99-060 of the National Pollutant Discharge Elimination Systems Municipal Permit No. CAS004003 (CI 8052) for City of Long Beach. Included in this report is a synthesis of key elements of the entire data set. The following section provides a summary of the background and purpose of the monitoring program. This is followed by a summary of key findings based upon the full duration of monitoring starting in early 2000 and going through May, 2014.

BACKGROUND AND PURPOSE

Under the terms of Order No. 99-060, the City of Long Beach was required to conduct a water quality monitoring program for stormwater and dry weather discharges through the City's municipal separate storm sewer system (MS4) beginning in the 1999/2000 wet weather season. The permit was initially issued for the term of five years. At the end of the initial five years, the City was directed by the Regional Water Quality Control Board to continue operating under the 1999 permit until further notice. The City of Long Beach has voluntarily participated in development of Watershed Management Programs (WMPs) and Coordinated Integrated Monitoring Programs (CIMPs) for three separate watershed management groups under the LA County MS4 Permit (Order R4-2012-0175). Issuance of the new permit (Order No. R4-2014-0024) will guide monitoring efforts for the remaining watersheds within the City of Long Beach. CIMPs submitted for the initial three watershed groups (Los Cerritos Channel, Lower Los Angeles River and the Lower San Gabriel River) have submitted. Monitoring under these three CIMPs is expected to start during the summer of 2015. An Integrated Monitoring Plan (IMP) remains to be developed under the new City of Long Beach NPDES Permit for areas not addressed by the three CIMPs developed with other jurisdictions under the County's NPDES Permit. An IMP is expected to be submitted to the Regional Board for review no later than February 6, 2015. Until approval and implementation of monitoring required under each CIMP and the City's IMP, monitoring will continue to be conducted in accordance with the existing monitoring program

Major elements incorporated in the current monitoring and reporting program include 1) mass emission monitoring during storm events, 2) monitoring of dry weather discharges at each mass emission site, and 3) special studies. Special studies were included in the original permit to provide the flexibility necessary to allow the program to respond to new issues or concerns that might arise in the course of routine monitoring or as the result of emerging topics in stormwater science. Special studies were generally intended to improve assessment of impacts on receiving water, identify sources and sinks for contaminants, and assess compliance with TMDL targets and water quality objectives. The City has been very proactive in the development of a variety of special studies during the past 14 years. In addition, the City has incorporated analysis of additional pollutants of concern based upon changes that have occurred with respect to pesticides that are available for residential use. Noteworthy among these changes was the inclusion of pyrethroid pesticides (starting in 2010/2011) as a pollutant of concern as these have largely replaced diazinon and chorpyrifos for pest control in urban watersheds. Starting this 2013/2014 year, the pesticide fipronil and its degradates have been added by the City as it is another emerging pesticide of concern along with pyrethroids. Data from the monitoring program is intended to support decisions necessary to refine Best Management Practices (BMPs) for the reduction of pollutant loading and the protection and enhancement of beneficial use of the receiving waters.

Mass emission monitoring is specified to be conducted at four sites during four wet weather storm events each year. Monitoring sites specified in the permit are as follows:

- Dominguez Gap Pump Station
- Bouton Creek
- Belmont Pump Station
- Los Cerritos Channel

Mass emission monitoring program is intended to characterize stormwater discharges, identify contaminants of concern and develop pollutant load estimates for each major watershed. Monitoring is required to be conducted during the first significant rainfall event of the season. Flow-rated, whole storm composite samples are obtained at each site and analyzed for major constituents of concern which including conventional constituents, total and dissolved metals, organochlorine pesticides, organophosphate pesticides and, in the past three years, pyrethroid pesticides. Toxicity testing using sea urchin fertilization tests and water flea survival and reproduction tests is required to be conducted on composite stormwater samples from three of the four mass emission sites. Phase 1 Toxicity Identification Evaluations (TIEs) are required to be performed on all samples that exhibit toxicity in excess of predetermined trigger values. The TIE process is used to identify the likely contaminants contributing to the observed toxicity.

Dry weather monitoring consists of inspections conducted at each mass emission site and the collection and analysis of dry weather discharges over 24-hour periods. Monitoring is required to be conducted twice during each dry season. Sampling is typically conducted in September just prior to the storm season and in May after several weeks of no rain. This element of the program is intended to assist in identification of pollutants of concern, assess the impacts that these pollutants might have on biological communities in the receiving waters and identify the sources of these contaminants such that they can be effectively controlled or eliminated. Dry weather discharge samples are subjected to the same chemical analysis and toxicity testing procedures as used for stormwater monitoring.

The purpose of this report is to transmit the results of the monitoring conducted in accordance with the City of Long Beach's NPDES permit. Results are summarized for both the current monitoring season (2013/2014) and over the life of the permit to assist in the evaluation of spatial and temporal trends.

SUMMARY OF RESULTS

The 2013/2014 wet weather season was characterized by extremely low rainfall. Only 4.43 inches of rain was recorded at the Long Beach Daugherty Airport. Rainfall at the four monitoring sites ranged from just 3.88 inches at the Dominguez Gap Pump Station to 4.45 inches at the Los Cerritos Channel monitoring site at Stearns Street. This season, predicted rainfall frequently did not meet the minimum criteria established to mobilize field crews for monitoring, especially early on. Either the forecasted rainfall was less than 0.25 inches within 12 to 24 hours before the event or wet weather conditions preceded the event that prevented monitoring. Regional Board staff had previously requested that monitoring events were preceded by at least seven days of dry weather as defined by less than 0.1 inches. Overall, this was the third driest year since the inception of the program in 1999.

Two dry weather inspections/monitoring events were conducted during the 2013/2014 monitoring year. These surveys are conducted during the summer dry weather period at three of four mass emission stations. Dry weather monitoring was not conducted at the Belmont Pump Station as a dry weather flow diversion is in place. This is the fourth year that dry weather flows have been monitored at the Dominguez Gap Pump Station. Prior to completion of the wetland treatment system at the Dominguez Gap Pump Station, dry weather flows were fully infiltrated near the point where the storm drain entered the infiltration basin. Dry weather discharges from the Dominguez Pump Station now consist primarily of treated water that is drawn from the Los Angeles River and passed through constructed wetlands to provide both treatment and to enhance the constructed wetland habitat. Due to the methods of operation, dry weather flows are not consistent at this site due to challenges in balancing flows being diverted from the Los Angeles River with the pumps that direct treated water back into the River.

When crews arrived to configure the monitoring equipment for the second of the two dry weather surveys at the Dominguez Gap Pump Station, water levels in the sump of the Dominguez Gap Pump Station were found to be very low and the summer pump was not operating. As a result, the equipment was not set up to take a 24-hour composite sample.

Due to the low seasonal rainfall, only a single storm event (February 27, 2014) was successfully sampled for the full suite of chemical and bioassay tests at all four stations this season. In addition, sampling during one storm event at the Belmont Pump Station (February 3, 2014) and two events at Bouton creek and the Los Cerritos Channel (December 19-20, 2013 and February 3, 2014) produced enough sample volume to run a partial suite of chemical analyses but no toxicity testing. One additional event at Bouton Creek and Los Cerritos Channel (April 4, 2014) produced enough sample volume to run the full suite of chemical analyses but no toxicity testing. Total rainfall in all three partial events was less than or close to 0.25 inches of rain.

Wet Weather Chemical and Bacterial Results

Benchmark reference values have often been exceeded for dissolved forms of copper, lead and zinc throughout the life of the permit (Kinnetic Laboratories, Inc., 2013). For stormwater discharges, the CTR (USEPA, 2000) freshwater acute criteria are the most applicable benchmarks for all sites. Copper and zinc have often exceeded benchmark criteria at all but the Dominguez Gap Pump Station site. This year dissolved copper exceeded the CTR chronic freshwater and saltwater criteria at each site but the CTR chronic freshwater criterion for dissolved zinc was only exceeded in runoff from the Los Cerritos Channel site. Although dissolved zinc concentrations were lowest at the Los Cerritos Channel site, this site was also characterized by very low hardness (16 mg/L) which contributed to the exceedance.

Benchmarks for total metals are available in the LA Area Basin Plan for potential municipal water sources and in the California Ocean Plan (SWRCB, 2006). Concentrations of aluminum commonly exceeds the Basin Plan criterion due to the high sediment content in stormwater runoff. Aluminum is the most abundant metal measured in California soils. Concentrations range from 5.9 to 10.6 percent which is roughly twice as high as that of iron. Due to the abundance of both aluminum and iron in soils, these metals are often used to normalize other trace metal concentrations to help interpret whether they are present at background levels or whether concentrations are enhanced by anthropogenic sources. Ocean Plan Criteria were exceeded for copper, lead, and zinc. Although anthropogenic sources of these three metals are significant, background levels associated with sediment loads are also substantial.

Other than bacteria, few other constituents have exceeded benchmark values. During all storm events all sites measured pH values that were within the range of 6.5-8.5, and an excursion measured during the 2012/2013 season at the Belmont Pump site was not repeated. Other conventional constituents such as conductivity, chloride, and TDS were somewhat elevated in water from the Belmont Pump Station.

Chlorinated pesticides are typically not measured at high concentrations in stormwater due to both strong associations with sediment and the fact that most have been banned for over 20 years. Despite this fact, chlordane compounds have been detected in a large percentage of the samples. Discharges from the Belmont Pump Station have most commonly had the highest levels of these compounds. Chlorinated pesticides including chlordane were not detected this year. Consistency of chlorinated compounds in discharges from this watershed still remains a concern. Continued detection of low concentrations of chlordane compounds would suggest that either some limited use of chlordane may be occurring or the degradation of legacy applications of chlordane has not occurred at rates that one would expect. These low levels may also be continuing to contribute loads to the receiving water sediments. One of the primary components of technical chlordane, alpha-chlordane, is one of the compounds that is incorporated into the chemical testing conducted for California's Sediment Quality Objectives. Repeated detection of chlordane compounds are a concern since a 303(d) listing (CRWQCB 2006) is still in effect for sediments within the estuary of the Los Cerritos Channel.

Pyrethroid pesticides have been detected consistently for the past three years, and for this present 2013/2013 season, at all sites with the exception of the Dominguez Pump site at levels exceeding UC Davis Criterion Maximum Concentrations (CMC) values. The pesticide fipronil and its degradates was analyzed for the first time this 2012/2014 season and was detected at all for monitoring sites, but only the Belmont Pump site had a concentration above the EPA Aquatic Life Benchmark level of 11 ng/L. Fipronil varies greatly in toxicity to different organisms and has a LC_{50} of 17,700 ng/L for *Ceriodaphnia dubia* and 140 ng/L for the mysid *Americamysis bahia*.

Dry Weather Chemical and Bacterial Results

The City's NPDES Permit requires two dry weather inspections and sampling events to be conducted at each of the four mass emission stations during the summer dry weather period.

Site inspection during dry weather monitoring are conducted at all monitoring locations to determine if water is present and whether water is flowing or just ponded. If flowing water is evident at any one of the mass emission sites, *in situ* water quality measurements, flow estimates, and composite water samples are taken along with general observations of site conditions.

Belmont Pump Station dry weather flows have been diverted to the sanitary sewer system since December 2009. Inspections are conducted at this site during the dry weather surveys but no sampling has been conducted since the Low Flow Diversion (LFD) was activated. At approximately the same time, the Dominguez Gap infiltration basin was modified into a wetland treatment system designed to provide a range of both environmental and recreational benefits. Since construction was completed, the Dominguez Gap Pump Station has been discharging water to the Los Angeles River during dry weather periods. This discharge consists primarily of water that has been diverted from the River and passed through the wetland treatment system. Flow through the wetlands is intended to be maintained by a summer/sump pump at the Dominguez Gap Pump Station that is intended to balance flows being diverted into the wetlands from the Los Angeles River.

Dry weather flows in Bouton Creek and the Los Cerritos Channel notably declined in recent years. The dry weather flows at both of these sites appear to have stabilized at these lower levels. Prior to the 2009/2010 monitoring season, dry weather flows in Bouton Creek were not sufficient to flush seawater from the creek for three consecutive events. As a result, the location for dry weather monitoring was relocated 1,250 feet upstream from the primary site location at the LADPW Alamitos Yard. Field observations and measurements taken at the new site indicate that this new location will be permanently maintained for purposes of the dry season measurements. Outfalls located along the creek from Alamitos Yard to California State University Long Beach were observed to determine if any major dry weather discharges were missed by moving the site upstream. No discharges were identified from downstream storm drains during these tests.

Copper measured in dry weather flows from the Los Cerritos Channel was found to be well within the established dry weather TMDL limits. Although the concentration of total recoverable copper was near the TMDL limit, loads were far below the TMDL limitation due to the much reduced dry weather flows in the Los Cerritos Channel.

Overall, data continue to demonstrate consistent, high quality discharges from the Dominguez Gap Pump Station. Both the wetlands and detention provided by this site are credited with providing stormwater treatment that allows discharges to the Los Angeles River to meet acceptable water quality standards under most conditions. In fact, dry weather discharges from the Dominguez Gap Pump Station are consistently shown to improve water quality in the Los Angeles River water that is passed through the wetlands during the dry season. Metals in these discharges meet the receiving water quality criteria and are consistently better than water quality measurements taken at the Los Angeles River Wardlow monitoring site by the Coordinated Monitoring Program (CMP).

The treatment provided by the wetlands and detention of dry weather discharges has also resulted in water that has frequently met bacterial water quality standards, as was the case for this present 2013/2014 monitoring season. The overall dry weather water quality discharges tended to meet all applicable standards including trace metal concentrations required by the Los Angeles River metals TMDL.

TMDLs

The Los Cerritos Channel Metals TMDL established Waste Load Allocations (WLAs) for total copper, lead and zinc during wet weather and total copper during dry weather. Total lead limits were based upon maintenance of historical concentrations. Total lead concentrations and loads remain compliant with the TMDL limits.

Wet weather flows in the Los Cerritos Channel are subject to TMDL limits for total recoverable copper, lead and zinc. Lead remained well below TMDL limits but both copper and zinc continue to exceed TMDL limits during storm events. Over the past two years, copper loads have exceeded WLAs by a factor of 1.9 to 8. Similarly, zinc loads have exceeded wet weather WLAs by a factor of 1.4 to 5.9. For the present 2013/2014 season, copper loads (Table 31) exceeded WLAs by 3.0 to 5.6 times the limit while zinc loads exceeded WLAs by 2.6 to 3.6 times the limit.

During dry weather periods, both concentrations and loads of total copper are declining. This has resulted in dry weather copper loads within the Los Cerritos Channel declining to levels that are less than 20% of the WLA.

The Dominguez Gap Pump Station discharges both wet and dry weather flows to the Los Angeles River. Metals TMDLs are established for copper and lead during both wet and dry weather. Metals TMDLs exist for cadmium and zinc during wet weather only. In a total of 38 monitored storm events, concentrations of total cadmium have never exceeded 0.55 mg/L and the median concentration has been 0.26 mg/L. Thus cadmium limits are currently being met with the median concentrations running an order of magnitude below the WLA of 3.1 ug/L. A review of time-series plots for both lead and zinc concentrations in stormwater runoff indicates that both these metals are exhibiting a general decline over the past 14 years and both are consistently within the established TMDL goals. Concentrations of copper remain near the TMDL WLA of 17 ug/L. In recent years, concentrations of total copper met the WLA for the Los Angeles River at Wardlow in discharges associated with two out of four storm events.

The Los Angeles River Nitrogen TMDL has set limits for ammonia-N for both 1-hour averages (8.7 ug/L) and 30-day averages (2.4 mg/L) for MS4 discharges within Reach 1. In addition, nitrate-N and nitrate/nitrite-N limits were both established at 8.0 mg/L for a 30-day average. The median concentration of ammonia-N in water from the Dominguez Gap Pump Station is 0.18 mg/L during dry weather and 0.38 mg/L during wet weather discharges. Concentrations of nitrate-N in dry weather discharges have never exceeded 1.9 mg/L and all wet weather discharges have had concentrations of less than 1.4 mg/L. Thus all discharges from the Dominguez Gap Pump Station continue to achieve the WLAs established for nitrogen compounds. Furthermore, total nitrogen (TKN plus nitrate/nitrite-N) concentrations typically range between 2.0 and 3.0 mg/L with the highest measured concentration being reported at 5.02 mg/L during a wet weather discharge.

Toxicity Results

Although no significant daphnid mortality was observed at any of the three sites during the single storm event, chronic toxicity was evident in 100% of the sea urchin fertilization tests during this storm season. The magnitude of the toxicity was sufficient to trigger a Toxicity Identification Evaluation (TIE) on all the samples taken from the single storm event. Results of the TIE indicated that toxicity was most likely caused by cationic metals.

Comparisons of the actual toxicity versus expected toxicity calculated from the concentrations of key toxicants provided conflicting evidence. Concentrations of dissolved metals, particularly zinc, measured in stormwater samples during the event were not present in concentrations that would be expected to cause toxicity.

Dry weather samples continue to show a lack of toxicity for both the daphnid and sea urchin fertilization test.

INTRODUCTION

The City of Long Beach received an NPDES Permit issued by the California Regional Water Quality Control Board, Los Angeles Region on 30 June 1999 (Order No 99-060, NPDES No. CAS004003, [CI 8052]). This order defined Waste Discharge Requirements for Municipal Stormwater and Urban Runoff discharges within the City of Long Beach. Specifically, the permit regulates discharges from municipal separate storm sewer systems (MS4s), also called storm drain systems, into receiving waters of the Los Angeles Basin.

The discharges from the MS4 system consist of surface runoff (non-stormwater and stormwater) from various land uses in the hydrologic drainage basins within the City. Approximately 44% of the land area discharges to the Los Angeles River, 7% to the San Gabriel River, and the remaining 49% drains directly to Long Beach Harbor and San Pedro Bay (City of Long Beach Municipal Stormwater Permit, CRWQCB, 1999). The quality and quantity of these discharges vary considerably and are affected by the hydrology, geology, and land use characteristics of the watersheds; seasonal weather patterns; and frequency and duration of storm events. Impairments or threatened impairments of beneficial uses of water bodies in Long Beach include the ocean beaches west of the Belmont Pier and the Los Angeles River estuary, Los Angeles River Reach 1 and Reach 2, Alamitos Bay, El Dorado Lake, the San Gabriel River Estuary, San Gabriel River Reach 1, Coyote Creek, Colorado Lagoon and the Los Cerritos Channel.

A number of TMDLs have been implemented or are under development in the 303(d) listed water bodies that receive runoff from the City of Long Beach (Table 1). Metals, bacteria and trash are the most common targets of these TMDLs although organochlorine pesticides, PCBs, PAHs and nitrogen compounds are also a concern in some segments. The TMDLs and 303(d) listing in Table1 are only those that currently impact the City or that will need to be addressed in the very near future.

ANNUAL PROGRAM ADJUSTMENTS

The 1999 NPDES permit requires the City of Long Beach to prepare, maintain, and update if necessary a monitoring plan. The original monitoring plan required the City to monitor three (Year 1) and four (Years 2 through 5) discharge sites draining representative urban watersheds (mass emission sites) during the program. Flow, chemical analysis of water quality, and toxicity were to be monitored at each of these sites for four representative storm events each year. During the dry season, inspections and monitoring of these same discharge sites were to be carried out, with the same water quality characterization and toxicity tests to be run. In addition, one receiving water body (Alamitos Bay) was to be monitored during the first two years of the program for bacteria and toxicity. Monitoring at the Alamitos Bay site was to be conducted during both the wet and the dry seasons and was to be used to document the effect of a dry weather diversion. In the early years of the program, the annual report was reviewed and adjustments were made based upon discussions with Regional Board staff.

Although no recommended changes have been provided by the Regional Board staff in recent years, the City has continued to make improvements to the program in response to changing conditions. Pesticides use has changed substantially since this program was started in 2000. Organophosphate pesticides were identified to routinely exert toxicity in stormwater runoff. Diazinon and chlorpyrifos were the primary toxicants. The California Stormwater Quality Association (CASQA) led an effort to get these pesticides removed from use. In the meantime, pyrethroid pesticides have become the most common pesticides used in the urban environment and are also highly toxic in both the water column during storms and later in the benthic environment where they tend to bind to sediments. This present year (2013/2014), fipronil was added to the analyte list by the City of Long Beach. Evolution of the program is summarized in Table 2. The program has remained relatively stable since 2011.

Table 1. Impaired Water Bodies with Established TMDLs or those Scheduled for Development.

Water Body	Pollutant	Basin Plan Amendment/ Board Resolution	Approval or Effective Date
Los Angeles River	Metals Metals reconsideration	2007-14 R10-003	October 29, 2008 March 23, 2012
	Trash	2007-12	September 23, 2008
	Bacteria	2010-007	March 23, 2012
	Nitrogen Compounds & Related Effects	2012-010	March 24, 2004
Los Angeles River Reach 1	Cyanide, Diazinon	303 (d) listed	TMDL action expected to be complete by 2019
Alamitos Bay	Bacteria	303 (d) listed	TMDL action expected to be complete by 2019
El Dorado Lakes	Copper	TMDL Equivalent CAO No. R4-2012-003	TMDL applied as single regulatory action January 10, 2012
San Gabriel River	Metals and Selenium	2006-14	Effective March 26, 2007
San Gabriel River Estuary	Dioxins, nickel, dissolved oxygen	303 (d) listed	TMDL action expected to be complete by 2012
San Gabriel River Reach 1	Coliform bacteria	303 (d) listed	TMDL action expected to be complete by 2019
Coyote Creek	Coliform, diazinon, pH	303 (d) listed	TMDL action expected to be complete by 2019
Colorado Lagoon	Organochlorine Pesticides, PCBs, Sediment Toxicity, PAHs, and Metals	R09-005	July 28, 2011
Los Angeles and Long Beach Harbors	Organochlorine Pesticides, PCBs, Sediment Toxicity, PAHs, and Metals	R11-008	March 23, 2012
Los Angeles River Estuary (Queensway Bay)	Sediment Only -Chlordane, DDT, Lead, PCBs, Zinc, Sediment Toxicity	Included in R11-008	March 23, 2012
Los Cerritos Channel, freshwater portion	Metals	EPA TMDL 38254	March 17, 2010
Los Cerritos Channel	Ammonia, pH, trash, bis(2,ethylhexyl)phthalate, chlordane (sediment), coliform bacteria	303 (d) listed	TMDL action expected to be complete by 2019 Ammonia – 2015 pH -2021
City of Long Beach Coastal Beaches and Los Angeles River Estuary	Bacteria	EPA	March 26, 2012

1. EPA – U. S. Environmental Protection Agency, Region 9

Note: 303(d) listings without current TMDL actions are highlighted.

Table 2. Summary of the City of Long Beach Stormwater NPDES Monitoring and Reporting Program with Annual Adjustments.

1999 Monitoring and Reporting Program
Mass Emission Site Monitoring
• Monitor 3 mass emission sites (Belmont Pump Station, Bouton Creek and Dominguez Gap Pump Station) during the 1st year of the permit. Add a 4th mass emission site (Los Cerritos Channel) during the 2nd and subsequent years. Flow-rated composite samples to be obtained during 4 storm events at each site and analyzed for:
✓ Conventionals, total and dissolved metals, semivolatile organic compounds, organochlorine pesticides, organophosphate pesticides, herbicides and MBTE.
✓ Toxicity testing using mysids, sea urchin and water flea.
✓ Phase 1 Toxicity Identification Evaluations (TIEs) to be conducted when 3 consecutive wet weather or 2 consecutive dry weather samples from the same monitoring station show toxicity.
✓ Grab samples for indicator bacteria and oil and grease.
Dry season inspections and monitoring to be conducted at each mass emission site 2 times per year. Sampling of dry weather flows to be conducted over 24-hour periods to provide representative samples. Samples from each site to be tested consistent with stormwater monitoring.
Receiving Waters
• Conduct receiving water quality monitoring in Alamitos Bay for the first two years of the program to document effects of a dry weather diversion. Testing to consist of indicator bacteria and toxicity.
Special Studies
• Conduct a special study to examine characteristics of stormwater runoff from parking lots (one year only).
2001 - M&R Program Modifications
• List of constituents and reporting limits modified for consistency with minimum levels (MLs) listed in the State's *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays and Estuaries of California* (SIP).
• TIE triggers altered to enhance opportunities for defining toxicity whenever it occurs.
• Use of the mysid toxicity test reduced to include only the first event of the season.
2002 - M&R Program Modifications
• Suspend toxicity monitoring at the Dominguez Pump Station monitoring site.
• Suspend monitoring of semivolatile organic compounds.
• Conduct a pilot plume monitoring program in Alamitos Bay to document the horizontal and vertical extent of the stormwater plume in the receiving waters, measure the concentration of selected metals and organophosphate pesticides at four points in the plume and conduct sea urchin bioassay tests to document potential toxicity in the plume.
• Immediate upstream investigations were to be conducted if elevated pH was detected during dry weather surveys at mass emission monitoring sites in order to document the source or cause.
2003 - M&R Program Modifications
• Suspend analyses of parameters infrequently detected and/or typically detected at low levels.
• Continue the pilot plume monitoring program targeting the first storm of the season.
• Adjust TIE triggers – TIEs to be conducted using water flea when toxicity exceeds 2 toxicity units (TUs). TIEs to be conducted using sea urchins when toxicity exceeds 3 TUs.
• Change monitoring strategy to emphasize sampling during early season events.
• Monitor TSS and stormwater flow for all storm events at all four mass emission sites.
2004 - M&R Program Modifications
• Recommended setting minimum of 7 days between monitored events.
• Include daily records of rainfall for current and previous seasons in report.
• Submit draft work plan for identification of PBT sources to Stormwater Monitoring Coalition (SMC) for input and participation.
2005 – 2006 M&R Program Modifications
• No changes; continue with current program.
2007 - M&R Program Modifications
• Completed PBT source study in the Colorado Lagoon storm drains and suspended Stormwater Runoff Plume Monitoring in Alamitos Bay.

Table 2. Summary of the City of Long Beach Stormwater NPDES Monitoring and Reporting Program with Annual Adjustments. (continued)

2008 - M&R Program Modifications
• City independently implemented two Special Studies in the Los Cerritos Channel to investigate the source and fate of constituents of concern in the freshwater the watershed and the estuarine segments.
2009 - M&R Program Modifications
• No changes, continue with current program
2010 - M&R Program Modifications
• City independently implemented two Special Studies in the Los Cerritos Channel to investigate the source and fate of constituents of concern in the freshwater, watershed and estuarine segments.
2011 - M&R Program Modifications
• Triazine pesticides were eliminated from the program per recommendations from the last three years. Pyrethroid pesticides were added to the analytical suite since these compounds have been shown to be frequently associated with sediment toxicity in streams and bays subject to stormwater runoff from urban and agricultural regions. • Long term, continuous measurement of pH and temperature was implemented in the Los Cerritos Channel to document seasonal and diurnal fluctuations as well as response to stormwater runoff.
2012 - M&R Program Modifications
• No additional modifications were made to the 2012 M&R program. Pyrethroid pesticides added to the analytical suite during the previous year were maintained as part of the base program due to the common occurrence of these analytes in stormwater discharges and known impacts that these compounds may have on both water column toxicity and sediment toxicity.
2013 - M&R Program Modifications
• No additional modifications were made to the 2012 M&R program. Pyrethroid pesticides added to the analytical suite in 2011 were maintained as part of the base program due to the common occurrence of these analytes in stormwater discharges and known impacts that these compounds may have on both water column toxicity and sediment toxicity.
2014 - M&R Program Modifications
• Additional modifications were made to the 2014 M&R program. Analysis of fipronil and its' degradates were added to the analytical list as an expansion of the pyrethroid analyses. This analyte is recognized as an emerging contaminant of concern in stormwater runoff. It was added to the analytical list in order to allow for an initial assessment of concentrations present in both urban runoff and dry weather discharges and the geographic extent of potential areas of concern. This screening is intended to help determine if BMPS should be considered or if use of this pesticide in the urban environment warrants further evaluation.

STUDY AREA DESCRIPTION

The following sections describe the regional setting. This includes the general geographic characteristic, the storm drain system, annual rainfall and climate as well as population trends experienced over the life of the current NPDES permit.

GEOGRAPHY

The City of Long Beach is located in the center and southern part of the Los Angeles Basin (Figure 1) and is part of the highly urbanized Los Angeles region. In addition to residential and other uses, the City also encompasses heavy industrial and commercial areas and includes a major port facility, one of the largest in the United States. The City's waterfront is protected from the open Pacific Ocean by the extensive breakwater encircling the outer Harbor area of the Port of Los Angeles/Port of Long Beach complex. The waterfront includes port facilities along with a downtown commercial/residential area that includes small boat marinas, recreational areas, and convention facilities. Topography within the City boundaries can be generally characterized as low relief. The City of Long Beach completely surrounds Signal Hill which is the most prominent topographic feature (Figure 2) in the region. Signal Hill has a population of approximately 11,411 residents[1] and is currently regulated under the Los Angeles County MS4 NPDES permit.

MAJOR WATERSHEDS

Major water bodies receiving stormwater discharges from the City of Long Beach include the Los Angeles River located near the western boundary of the City, the San Gabriel River located near the eastern boundary, and the Outer Harbor of the Los Angeles/Long Beach area. The City of Long Beach has fifteen pump stations that discharge into the Los Angeles River, and one pump station that discharges into the San Gabriel River. Receiving water sub-areas of importance include the extensive Alamitos Bay, heavily developed for marina and recreational uses, and the Inner Harbor areas of the City, heavily developed as port facilities. Other receiving water sub-areas include the Los Angeles River, El Dorado Lake, Los Angeles River Reach 1 and Reach 2, San Gabriel River Estuary, San Gabriel River Reach 1, Colorado Lagoon, and Los Cerritos Channel. These areas also include coastal shorelines, including Alamitos Bay Beaches, Belmont Shore Beach, Bluff Park Beach, and Long Beach Shore. The drainage from the City is characterized by major creeks or storm channels, usually diked and/or concrete lined such as the Los Cerritos Channel that is located fully in the City of Long Beach but has contributions from storm drains that originate well to the north of the City boundary. The Los Cerritos Channel is separated into a freshwater environment to the north of East Atherton Street and an estuarine portion that extends to the south and discharges into the Marine Stadium and Alamitos Bay. Other such regional drains include:

- Coyote Creek, which passes through a small portion of Long Beach before it discharges to the San Gabriel River;
- Heather (Clark) Channel and Los Cerritos Line E (Palo Verde Channel) that both enter Long Beach from the City of Lakewood and discharge into the Los Cerritos Channel; and the
- Artesia-Norwalk Drain that enters Long Beach from Hawaiian Gardens and discharges into Coyote Creek.

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[1] State of California, Department of Finance, *E-1 Population Estimates for Cities, Counties and the State with Annual Percent Change — January 1, 2013 and 2014.* Sacramento, California, May 2014.

The four City of Long Beach mass emission monitoring sites address runoff from 32% of entire City (Figure 3). The monitoring sites also capture stormwater runoff and dry weather flows from portions of Signal Hill and a number of other cities that are within the Los Cerritos Channel watershed. The total area of the watersheds monitored by the City of Long Beach program covers over 22,300 acres which is equivalent to 68% of the total area of the City of Long Beach.

ANNUAL RAINFALL AND CLIMATE

The City of Long Beach is located in the semi-arid Southern California coastal area and receives significant rainfall on a seasonal basis. The rain season generally extends from October through April, with the heavier rains more likely in the months of November through March (see Figure 11 for average rainfall by month and seasonal total rainfall as measured at the Long Beach Airport). The long-term average (1971-2000) rainfall for October through April (wet season) at the Long Beach Airport is 12.27 inches per year (http://mole.nacse.org/prism/nn/ - Prism Data Extractor accessed June 2010). Average annual rainfall for the entire year is 12.94 inches.

The City lies in the Los Angeles Plain, which is south of the Santa Monica and San Gabriel Mountains and west of the San Jose and the Puente Hills. The Los Angeles River is the largest river/stream on the Plain and it drains the San Fernando Valley and much of the San Gabriel Mountains (Miles and Goudey, 1998). The climate is mild, with a 30-year average temperature of 18.5 °C (65.3°F) at the Long Beach Daugherty Airport (NCDC/NOAA, 2004).

POPULATION AND LAND USE CHARACTERISTICS

The population of the City of Long Beach was estimated at 470,292 residents on January 1, 2014 (State of California Department of Finance, 2014[2]) and the total population of the County of Los Angeles, in which it resides, was estimated at 10,041,797 residents. These latest estimates utilize the 2010 census as the base year. Prior to 2010, population estimates were still being based upon the 2000 census data with adjustments developed from driver's license applications. The apparent decline in population between 2009 and 2010 is simply the result of an improved data set (Figure 4). The City's population is estimated to have increased by 0.5 percent over the past year which exceeds the estimated average annual growth rates of just 0.27 percent over the last 15 years. The overall low growth rate was due largely to a period of stagnation in the estimated growth rates of the City between 2005 and 2009. Growth still remained below the state-wide population increase which was estimated at 0.9 percent for the past year.

The independent City of Signal Hill, located on a promontory, is surrounded by the City of Long Beach. In January of 2010, Signal Hill's population was estimated to be 11,022. The population was estimated to have increased to 11,411 by January 2014. Stormwater from the City of Signal Hill discharges to the Los Angeles River, the Los Angeles River Estuary and the Los Cerritos Channel.

The City of Long Beach has a total area of 32,865 acres (Table 3). Of that total, 16,208 acres (49%) are classified as residential, 7,874 acres (24%) as commercial, 2,404 acres (7%) as industrial, 2,655 (8%) as mixed urban, and 2,937 acres (9%) as open space (SCAG, 2005). Open space is dominated by a number of golf courses and parks. Agriculture and water each represent roughly 1% of the City.

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[2] State of California, Department of Finance, *E-1 Population Estimates for Cities, Counties and the State with Annual Percent Change — January 1, 2013 and 2014.* Sacramento, California, May 2014.

Land use within specific watersheds selected by the City of Long Beach for mass emission monitoring are described in more detail in the Monitoring Program section of this report.

Four years ago, the City of Sacramento surpassed current population estimates for the City of Long Beach. In 1999, the City of Long Beach had the fifth largest population of all cities in the California. As a result of this slow growth, the City of Long Beach was previously surpassed in total population by Fresno. Long Beach is currently ranked as the sixth most populated city in the California.

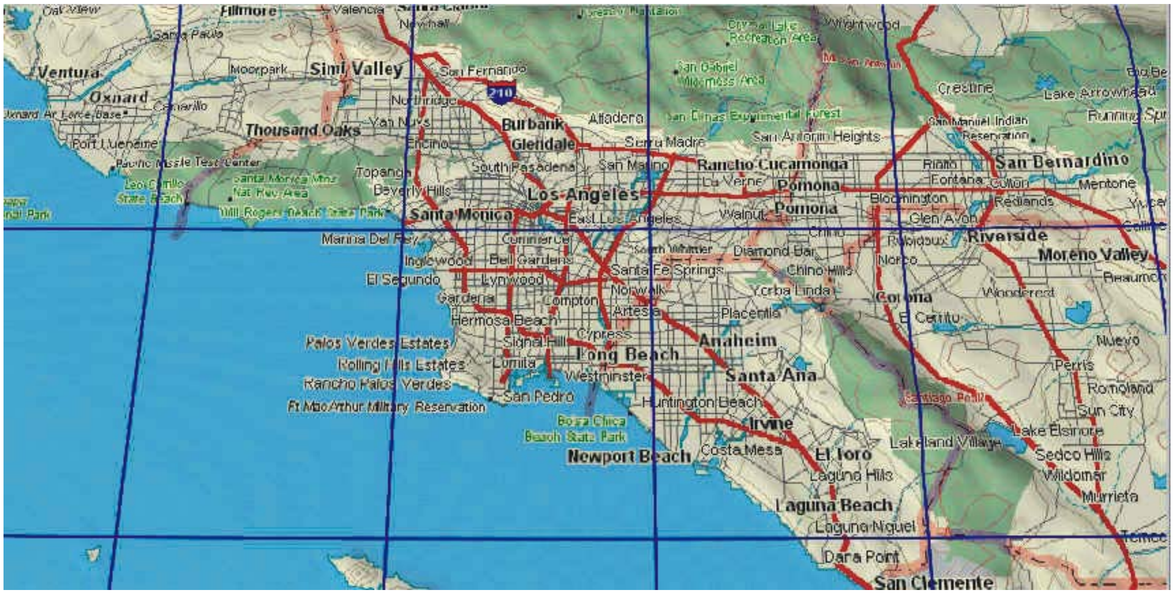


Figure 1. **Los Angeles Basin. (Source: 3-D TopoQuads, Copyright 1999, Del Lorme, Yarmouth, ME 04096)**

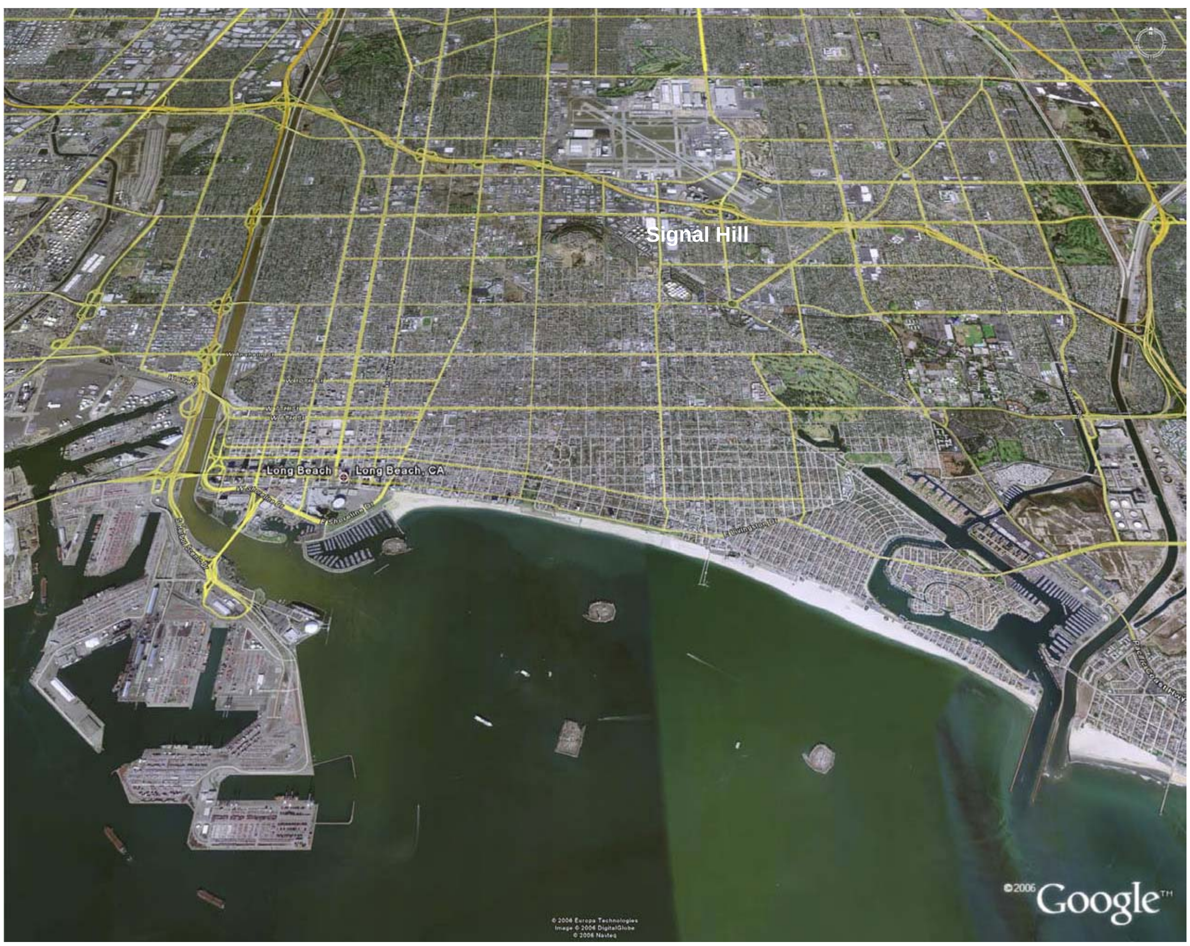


Figure 2. **City of Long Beach. (Source: Google Earth Pro, 2006)**

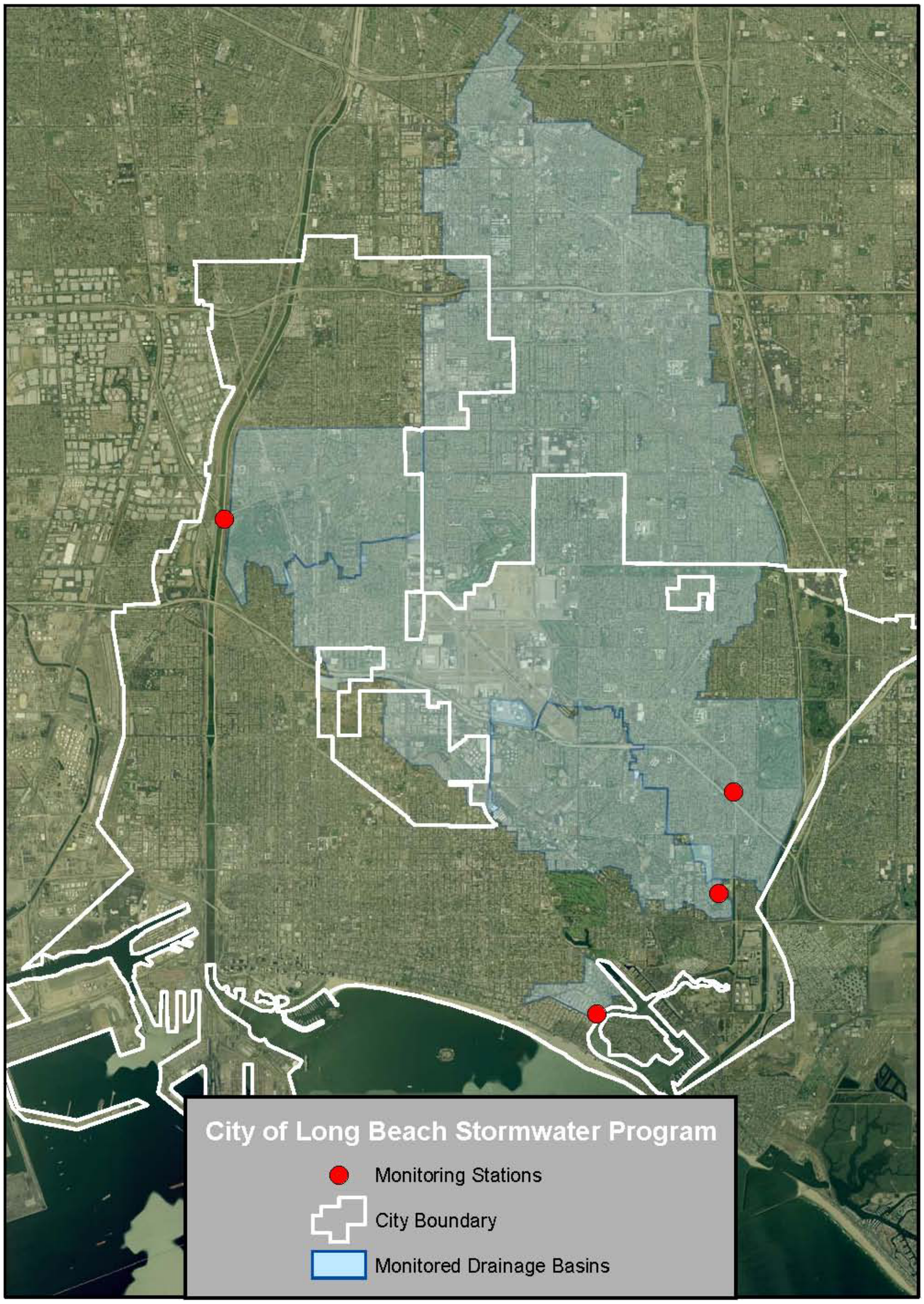
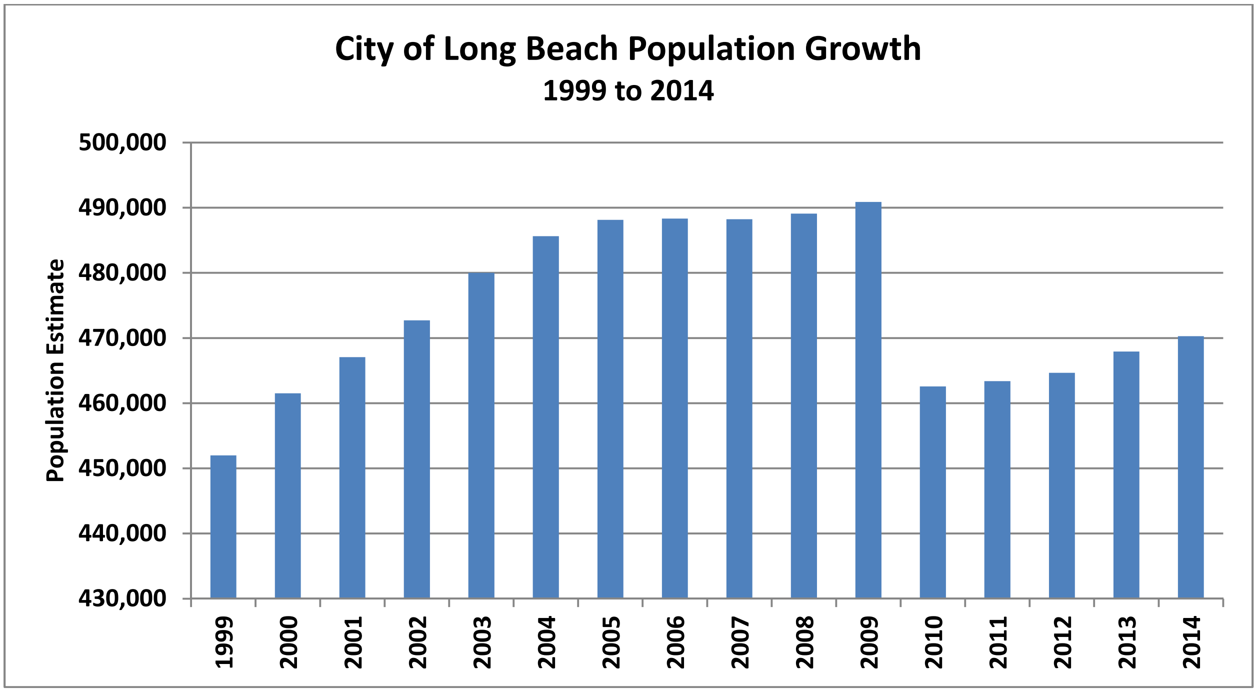


Figure 3. City of Long Beach and Drainage Basins and Mass Emission Monitoring Sites.



(Note: The apparent drop in the population estimate between2009 and 2010 reflects resetting to the 2010 census)

Figure 4. **City of Long Beach Population Growth over the Past Fifteen Years.**

Table 3. **Total Area by Land Use for the City of Long Beach and Monitored Watersheds within the City Limits.**

Land Cover Type	Entire City	Belmont Pump Station	Bouton Creek	Los Cerritos Channel within City	Los Cerritos Channel Entire Watershed	Dominguez Gap
Agriculture	338	0	0	18	137	8
Commercial	7,874	29	824	1,987	2,669	240
High Density Residential	12,608	80	1,047	3,884	1,229	1,153
Low Density Residential	3,600	83	191	216	9,279	305
Industrial	2,404	0	19	672	1,620	6
Mix Urban	2,655	4	183	472	1,666	16
Open Space	2,937	7	62	717	1,098	354
Water	449	0	0	5	18.9	0
TOTAL	**32,865**	**203**	**2,326**	**7,972**	**17,716**	**2,082**

Data from SCAG derived from 2005 land use coverage.

MONITORING PROGRAM

This section of the report provides a complete description of the basic monitoring program including detailed program objectives, details with respect to each monitoring site and monitoring equipment, monitoring procedures, analytical methods and toxicity testing methods.

MONITORING PROGRAM OBJECTIVES

The stated long-term objectives of the stormwater monitoring program were established in the 1999 NPDES permit. These include:

1. Estimate annual mass emissions of pollutants discharged to surface waters through the MS4;
2. Evaluate water column and sediment toxicity in receiving waters;
3. Evaluate impact of stormwater/urban runoff on marine life in receiving waters;
4. Determine and prioritize pollutants of concern in stormwater;
5. Identify pollutant sources on the basis of flow sampling, facility inspections, and ICID (Illegal Connection Illicit Discharge) investigations; and
6. Evaluate BMP effectiveness.

Since initiation of the Long Beach Stormwater Monitoring Study in 1999, the core of the program has been development of accurate measurements of pollutant loads from mass emission sites and determining the chemical and toxicological characteristics of these discharges during both storm events and dry weather periods. A number of special studies have been conducted to address individual elements of the long-term objectives. The primary objectives of monitoring conducted during the 2013/2014 monitoring period include:

1. Obtain monitoring data from four (4) storm events for each mass emission station.
2. Carry out dry weather inspections and obtain samples of dry weather flow at each of the three mass emission stations. Perform this dry weather work twice during the dry season that extends from May through October.
3. Perform chemical analyses for the specified suite of analytes at the appropriate detection limits for all stormwater samples collected.
4. Perform toxicity testing of the stormwater samples collected, and Toxicity Identification Evaluations (TIEs) if warranted by the toxicity results at a given site. No toxicity testing was required for water from the Dominguez Gap Pump Station monitoring site.
5. Report the above results and evaluate the monitoring data with respect to receiving water quality criteria.

MONITORING SITE DESCRIPTIONS

The four sites for mass emissions monitoring were originally selected by the City of Long Beach with the assistance of the Southern California Coastal Water Research Project (SCCWRP), with input from the Los Angeles Department of Public Works, the environmental community, and with the approval of the Regional Water Quality Control Board. These sites were then specified in the NPDES permit after an analysis of the drainage basins and receiving waters. They were selected to be representative of the stormwater discharges from the City's storm drain system, as well as to be practical sites to carry out stormwater and dry weather monitoring.

The four mass emission monitoring sites are routinely monitored as part of the City's stormwater program. The general locations of the drainage basins sampled by each of these sites and each monitoring location are shown on Figure 3. The latitude and longitude of each site are shown in Table 4. Brief descriptions of each drainage basin and land use are provided in the following sections.

Belmont Pump Station

This site collects water from Basin 23 that covers 213 acres. Land use in the basin is 80% residential, 14% commercial, 0% industrial, 2% mixed urban, and 3% open space (Figure 5). This basin is located in the southeastern portion of the City and is bounded on the north, south, east, and west by Colorado Street, Division Street, Ultimo Avenue and Belmont Avenue respectively. The Belmont Pump Station is located at 222 Claremont Avenue.

Changing Out Sample Bottles at the Belmont Pump Station

Runoff enters the forebay of the facility via a nine-foot diameter underground pipe. A trash rack catches debris before water drops four feet into the sump area. A small summer/sump pump exists at this facility. Prior to 2007, this pump turned on every evening at around 2300 hours and discharged approximately two feet of water that had accumulated in the sump the previous day due to dry weather flows. Starting in 2007, all summer and winter dry weather flows were diverted to the sanitary system. Initially this was performed by a temporary pumping system. Installation of a permanent dry weather diversion system was completed at this site in December, 2009.

Four main pumps are available to remove water during storm events. The summer/sump pump is operational only during storm events to handle low flows and to lower the sump level once the main pumps are turned off. A rain gauge located at the pump station is used to deactivate the sump pump and to stop further diversion of water to the sanitary system. Stormwater discharges are directed into Alamitos Bay.

The storm monitoring equipment at this site is interfaced with all five pumps to determine when each pump is activated and shut down. Water depth and pump discharge curves are then used to calculate discharges from this site for use in pacing the sampling equipment. An update of the monitoring equipment at this site was completed in 2009 along with improved stormwater monitoring software. Water depths within the sump are monitored using a bubbler level meter. This site currently is monitored remotely via a standard telephone line with a modem.

Bouton Creek

This site collects water from Basin 20 which encompasses 2,326 acres. Basin 20 is 53% residential, 35% commercial, 1% industrial, 8% mixed urban and 3% open space (Figure 6). Much of the commercial land within this drainage area consists of the California State University at Long Beach campus. This basin is located in the east central portion of the City and is bounded on the north, south, east, and west by Spring Street, 8th Avenue, the Los Cerritos Channel and Redondo Avenue, respectively. The sampling station is located a short distance upstream from the point of discharge into Los Cerritos Channel, along side of the Alamitos Maintenance Yard of the Los Angeles County Public Works Department.

Stormwater Runoff at the Bouton Creek Monitoring Station

At the wet weather sampling station, Bouton Creek is an open, concrete box channel measuring 35 feet in width and 8.5 feet in depth. The elevation of the channel bed is approximately one inch lower at the side than the center. Bouton Creek flows into the estuarine portion of the Los Cerritos Channel at a distance of about one-quarter mile downstream of the monitoring site. Based on numerous observations of conductivity at various tides, this site has been documented to be subject to saltwater influence whenever tide levels exceed three feet and stream discharges are not sufficient to displace the saline waters. The automatic sampling equipment was therefore configured and programmed to measure and quantify directional flow (upstream or downstream) as well as to measure the conductivity of the water at three elevations. This allows the sampler to obtain flow-composited samples of only freshwater discharges, avoiding tidal contributions by using real-time conductivity sensors.

The upstream flow of freshwater is quantified and used to correct discharge calculations. An area velocity and depth sensor is mounted on the invert of the box channel near the center of flow. Two conductivity sensors were mounted on the wall of the channel near the bottom and 12 inches above the bottom. The third conductivity sensor and the sample intake are mounted on a floating arm to keep them near the surface.

Refurbishment of most equipment at this site was mostly completed in 2009. The autosampler remains scheduled for replacement when sufficient funds are available. The refrigeration unit was repaired this year after the thermostat was found to have failed.

Location of Dry Weather Sampling Site in Bouton Creek

A secondary sampling site was selected several years ago for purposes of dry weather sampling in the Bouton Creek watershed and to avoid tidal flows. The dry weather sampling location was positioned 1,250 feet upstream at a point where the channel first daylights from under the California State University at Long Beach parking lot. This site was first sampled during the October 2009 dry weather sampling event. For several years prior to 2009, declining dry weather flows combined with increased algal growth in the channel prevented complete flushing of saltwater from the channel before the flood tide would again inundate the site with saltwater. This was resulting in elevated conductivity in the dry weather samples due to residual saltwater. The residual saltwater residue became excessive for purposes of both bioassay testing and chemical analysis for determination of dry weather loads. The elevated conductivity of water collected at the original site precluded continued collection and analysis of representative dry weather samples at this site for the two years prior to the October 2009 event. Based upon continued low flow conditions, this site was designated as the permanent location for any further dry weather testing.

Los Cerritos Channel

The entire Los Cerritos Channel watershed is estimated at 17,716 acres (Figure 7). This watershed includes 7,972 acres within the City of Long Beach, which is approximately 45 percent of the entire watershed. Land use within the City of Long Beach's portion of the watershed consists of 52% residential, 25% commercial, 8% mixed urban and 3% open space (Figure 8). Aggregated data from the Southern California Association of Governments (SCAG) 2005 land use dataset indicates that the entire Los Cerritos Watershed is 93% urban (approximately 60% residential, 22% commercial, 4% mixed urban, and 6% industrial). Open space accounts for 6% of land use and agriculture is <1% of land use.

This monitoring station serves as both a mass emission monitoring site for the City of Long Beach stormwater monitoring program and as the compliance point for the Los Cerritos Metals TMDL. The stormwater monitoring station is installed in a steel utility box located on the west side of the channel south of Stearns Street. Flow sensors and sampling tubing are installed on the bottom of the large concrete lined channel. Flow rates are based upon measured water levels and a stage-flow rating curve from an adjacent gauging station that is no longer in service.

Stormwater Runoff at the Los Cerritos Channel Monitoring Station

This site was the first to receive a new Campbell Scientific 1000 datalogger/control unit along with an updated Kinnetic Laboratories stormwater monitoring program. The only remaining major upgrade requirement at this site is replacement of the 12-year old autosampler and modem. When this site is upgraded, internet modems will be installed in order to further improve communications. These final upgrades are planned to occur as soon as budgets permit.

This sampling site is normally above tidewater influences. During extreme tides that have typically occur during the dry weather surveys, this site can be impacted by backwater conditions. This has been remedied in recent years by scheduling dry weather sampling for periods that have less extreme tidal ranges.

Dominguez Gap Pump Station

The sampling station located at the Dominguez Gap Pump Station is intended to monitor Basin 14. As part of the Dominguez Gap/DeForest Wetland project, the drainage for Basin 14 was modified so that runoff from north of Market Street would be directed to the Market Street Pump Station and DeForest Wetlands and runoff from the portion of Basin 14 located south of Market Street continued to drain to the Dominguez Gap Pump Station and treatment wetlands. The two areas were further separated by elimination of a connection between the two infitration basins at Del Amo. The Dominguez Gap Pump Station and Wetlands now has a contributing watershed of 2,082 acres (Figure 9). Land use in this watershed is 70% residential, 12% commercial, 17% open space and 1% mixed urban. Much of the open space is a golf course that borders the wetland. The basin is located in the northwestern portion of Long Beach just east of the Los Angeles River and is bounded on the north, south, east, and west by Market Street, Roosevelt Road, the railroad, and the Los Angeles River respectively.

The Dominguez Gap Pump Station and adjacent infiltration/detention basin underwent major renovations during the summer of 2006 and through most of the 2007/2008 wet season. For the last six years of the monitoring program, wetland vegetation has been fully developed and the temporary water quality changes observed during the construction phase are no longer evident.

During dry weather periods, water is diverted from the Los Angeles River at the upper end of the wetlands. The system was designed for water to be siphoned across to the Western Basin of the Dominguez Gap system where further infiltration capacity was to be provided. From there it flows to the Dominguez Gap Pump Station where the summer pump is intended to discharge at a maximum rate of about five cubic feet per second (cfs) during dry weather periods. This pump is not instrumented such that reasonable estimates of dry weather loads can be calculated. In addition, it is manually operated such that actual run times are not available for development of even rough load calculations.

View of Dominguez Gap Pump Station Intake Bay and Wetland Vegetation (2009)

Constructed Wetlands North of the Dominguez Gap Pump Station (2009)

The stormwater monitoring equipment at this site is located within the pump station. The refrigerated automatic sampler utilizes a peristaltic pump to collect water from the pump station's sump. All five major pumps have been individually instrumented to detect when each pump is activated and to measure pump speed (RPMs) while the pumps are being operated. Flow is calculated based upon pump discharge curves and water elevations in the sump as measured with a pressure transducer to determine instantaneous head. Flow from each pump is summed to determine discharge rates at any one point in time. Under normal operation, it is highly unusual for the full complement of pumps to be activated.

Major upgrades and modifications to the monitoring equipment at this site were completed in 2010. A new Campbell CR1000 datalogger/control module was installed along with new autosampler head for the refrigeration unit. New stormwater monitoring software was developed to operate the site.

Management of water levels within the wetlands has been determined to play a critical role in attainment of TMDL requirements for Jurisdiction 1. Discussions with the County have emphasized the benefits of operating water levels to benefit both the wetland habitat and minimize mass emissions of trace metals and other contaminants to (or back to) the Los Angeles River.

MONITORING STATION DESIGN AND CONFIGURATION

Each of the four land use stations monitored in Long Beach is equipped with Kinnetic Laboratories Automatic Sampling System (KLASS). Figure 10 illustrates the configuration of a typical KLASS. This system consists of several commercially available components that Kinnetic Laboratories has integrated and programmed into an efficient flow-based stormwater compositing sampler.

The integral components of this system consist of an acoustic Doppler flow meter and/or a pressure transducer, a datalogger/controller module, cellular or landline telecommunications equipment, a rain gauge, and a peristaltic sampler. Campbell CR-1000 datalogger/control modules and updated monitoring software are now installed at each site. The system installed at Bouton Creek also incorporates several conductivity cells for distinguishing tidal flow from fresh water runoff. Equipment installed at pump stations incorporate a variety of sensors to monitor individual pump activity and head pressures.

All equipment is installed with intakes and sensors securely mounted, tubing and wires in conduits, and all above ground instruments protected within security enclosures or pump houses. The previous section described specific equipment configurations at each site.

All materials used in the collection of stormwater samples and in contact with the samples meet strict criteria in order to prevent any form of contamination of the sample. These materials allow both inorganic and organic trace toxicant analyses from the same sampler and composite bottle. Only the highest grade of borosilicate glass is suitable for both trace metal and organic analyses from the same composite sample bottle. All intake hoses are constructed of Teflon® which provides both rigidity against collapse at high head differentials and is non-contaminating for both organics and inorganics. The intake hoses are removed each year, subjected to protocol cleaning, and blanked to assure that they do not have any residual contamination.

All bottles and hoses are cleaned according to EPA-approved protocols consistent with approved methodology for analysis of stormwater samples (USEPA, 1983). These bottles and hoses are then evaluated through a blanking process to verify that the hoses and composite bottles were contamination-free and appropriately cleaned for analyses of both inorganic and organic constituents.

FIELD MONITORING PROCEDURES

The following sections provide a summary of the field methods and procedures used to collect and process data for both the wet and dry weather surveys.

Wet Weather Monitoring

Stormwater runoff is collected using two primary methods. Flow-weighted composite sampling is conducted to collect water in sufficient volumes to allow for both chemical analysis and toxicity testing. A few contaminants such as bacteria and oil and grease are required to be sampled using grab sampling methods and thus reflect conditions only at the time of sampling.

Composite Sample Collection

A priority objective of the storm monitoring is to maximize the percent storm capture of the composite sample, while ensuring that the composite bottle collects enough water to support all the required analyses. The goal is to collect flow-weighted composite samples from 100% of the flow resulting from a rainfall event. This monitoring program requires volumes of 20 to 30 liters of sample from each of the four mass emission sites to meet these analytical and toxicological needs as well as quality assurance/quality control needs. Approximately 40 liters is necessary for sites that are sampled in duplicate. Such high sample volumes require that the composite bottles be replaced multiple times over the course of an event.

The status of each monitoring site is continuously tracked from an office command and control center (Storm Control) located at Kinnetic Laboratories' Santa Cruz facility. The Storm Control computer can be securely accessed from any location with internet access. Station data are downloaded, and the stations are controlled and reprogrammed remotely through telecommunication links. Weather information, including Doppler displays of rainfall for each area being monitored, are also available on screen at the Storm Control center. Personnel monitoring the centralized Storm Control system are in contact by cellular phone with the field crews to provide guidance and updates on the status of each sampling site so that sites can be serviced and bottles changed as soon as possible after they fill.

When a storm is likely, all stations are made ready to sample. This preparation includes entering the correct volume of runoff required for each sample aliquot ("Volume to Sample"), setting the automatic sampler and the datalogger to sampling mode, pre-icing the composite sample bottles not associated with refrigerated samplers, and performing a general equipment inspection. A brief physical inspection of the equipment is made if possible to make certain that there were no obvious problems such as broken conduit, a kinked hose, debris, or physical damage to in-stream sensors.

Once a storm event ends, the stations are shut down either on site or remotely by Storm Control. The station is left ready for the next storm event in case there is insufficient time for a maintenance visit between storms. Data are retrieved remotely via telecommunications from the datalogger on a daily basis throughout the wet weather season. During storm events, data are downloaded either on demand or at intervals of 15 minutes to an hour.

All water samples are kept chilled (4°C) and transferred to the analytical laboratories within holding times. Prior to sample shipping, sub-sampling from the composite container into sample containers is accomplished using protocol cleaned Teflon® and silicone sub-sampling hoses and a peristaltic pump. Using a large, Teflon® coated magnetic stirrer, all composite water is first mixed together thoroughly and then continuously mixed while the sub-sampling takes place. All sub-sampling takes place at a staging area associated with Kinnetic Laboratories, Inc. Long Beach office. Documentation accompanying samples to the laboratories includes Chain of Custody forms, and Analysis Request forms (complete with detection limits).

Grab Sampling

During each storm event, grab sampling procedures are used to collect water for analysis of oil and grease, total and fecal coliform, and enterococcus. The timing of grab sampling efforts is often driven by the short holding times for the bacterial analyses. The ability to deliver samples to the microbiological laboratory within the 6-hour holding time is always a major consideration.

Except at the pump stations, all grab samples are taken as near to the center of flow as possible or at least in an area of sufficient velocity to ensure good mixing. At both the Dominguez Gap and Belmont Pump stations, grabs are taken from the sump. A specially constructed sampling pole is required to obtain samples at most sites. Poles used are fitted with special bottle holders to secure the sampling containers. Care is taken not to overfill the oil and grease sample containers as these contain preservative.

Configuration of Grab Pole used for Oil & Grease and Fecal Indicator Bacteria Sampling

Dry Weather Monitoring

The City's NPDES Permit requires two dry weather inspections and sampling events be conducted at each of the four mass emission stations during the summer dry weather period.

Site inspections are conducted at all sites to determine if water is present and whether water is flowing or just ponded. If flowing water is evident at any one of the mass emission sites, *in situ* water quality measurements, flow estimates, and composite water samples are obtained along with general observations of site conditions.

Dry weather flows from the Belmont Pump Station have been diverted to the sanitary sewer system since the summer of 2007. During the same general time period, the Dominguez Gap wetland basin was modified into a wetland treatment system designed to provide a range of both environmental and recreational benefits. During dry weather periods, flow through the wetlands is intended to be maintained by a summer pump that discharges water back to the Los Angeles River.

Dry weather sampling differs slightly at each monitoring site due to the unique characteristics and constraints at each location. Monitoring at the Los Cerritos Channel site is conducted by extending an intake hose to a low flow channel and setting the equipment to take a full 24-hour composite sample. The automatic peristaltic pump sampler is programmed to collect aliquots every half hour during the sampling period.

The Bouton Creek site experiences tidal influences which limit the times at which sampling can be performed. Dry weather sampling is conducted during periods when extreme low tides allow the tidal water to drain from the channel so that flows are limited primarily to dry weather discharges. A composite sample is collected over a 30-minute period preceding tidal waters reentering the channel to isolate sampling to just the freshwater discharge. Salinity is monitored during a period of roughly two hours before tidal waters reenter the channel in order to determine when the dry weather (freshwater) flows comprise at least 90% of the flow.

Prior to the 2009/2010 monitoring season, dry weather flows in Bouton Creek were not sufficient to flush seawater from the creek for three consecutive events. The salinity remained at or above 10 ppt which would be toxic to one of the toxicity test species and could not be considered representative of dry weather discharges from the watershed. As of the 2009/2010 surveys, the sampling location was moved 1,250 feet upstream from the primary site location at the LADPW Alamitos Yard to the point where Bouton Creek emerges from under the California State University at Long Beach (CSULB) campus. Equipment for the Bouton Creek wet weather monitoring station is temporarily removed and deployed at the upstream location for dry weather sampling. During the dry weather monitoring effort, outfalls located along the creek from Alamitos Yard to CSULB are observed to insure that no major dry weather discharges are missed as a result of moving the site upstream. No dry weather discharges have been recorded downstream of the new sampling site since it was relocated.

Due to reconfiguration of the Dominguez Gap Treatment Wetlands, the 2009/2010 season was the first time that dry weather discharges were documented and sampled. Prior to that time, dry weather discharges were occasionally evident in small pools around the outfall but no water ever passed through the infiltration basin to be discharged to the Los Angeles River. Since redevelopment of the Treatment Wetlands, circulation through the treatment system has tended to be erratic with the larger pumps often being used to adjust water levels. In recent years, management of water levels has improved but still experiences large fluctuations in water levels due to issues with balancing incoming flow from the Los Angeles River with treated water being discharged back to the River by the summer/sump pump.

LABORATORY ANALYSES

The water quality constituents selected for this program were established based upon the requirements of the City of Long Beach NPDES permit for stormwater discharges as modified through the annual review process. All analyses were conducted at laboratories certified for such analyses by the Department of Health Services or approved by the Executive Officer and in accordance with current EPA guideline procedures or as specified in this Monitoring Program. Analytical methods are based upon approved USEPA methodology. The following sections detail laboratory methods for chemical and biological testing.

Analytical Suite and Methods

Conventional, bacteriological, and chemical constituents selected for inclusion in this stormwater quality program are presented in Table 5. Analytical method numbers, holding times, and reporting limits are also indicated for each analysis.

Laboratory QA/QC

Quality Assurance/Quality Control (QA/QC) activities associated with laboratory analyses are detailed in Appendix A.

The laboratory QA/QC activities provide information needed to assess potential laboratory contamination, analytical precision and accuracy, and representativeness. Analytical quality assurance for this program included the following:

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

Internal laboratory quality control checks included the use of internal standards, method blanks, matrix spike/spike duplicates, duplicates, laboratory control spikes and Certified Reference Materials (CRMs).

Data validation was performed in accordance with the USEPA Functional Guidelines for Low Level Concentration Organic Data Review (USEPA, 2001), USEPA Functional Guidelines for Inorganic Data

Review (USEPA, 2004), and Guidance on the Documentation and Evaluation of Trace Metals Data Collected for the Clean Water Act Compliance Monitoring-Draft (USEPA, 1996).

Toxicity Testing Procedures

Upon receipt at the laboratory, stormwater discharge and receiving water samples were stored at 4°C and in the dark until used in toxicity testing. Toxicity testing was commenced within 36 hours of sample collection for most samples. The relative toxicity of each discharge sample was evaluated using two chronic test methods: the water flea (*Ceriodaphnia dubia*) reproduction and survival test (freshwater) and the purple sea urchin (*Strongylocentrotus purpuratus*) fertilization test (marine). Each of the methods for these tests is recommended by the USEPA for the measurement of effluent and receiving water toxicity. Water samples were diluted with laboratory water to produce a concentration series using procedures specific to each test method. Further details are provided in Appendix B.

Water Flea Reproduction and Survival Test

Toxicity tests using the water flea, *Ceriodaphnia dubia*, were conducted in accordance with methods recommended by USEPA (2002). The test procedure consists of exposing 10 *C. dubia* neonates (less than 24 hours old and 8 hour range in age) to the samples for approximately seven days. One animal is placed in each of 10 individual polystyrene cups containing approximately 20 mL of test solution. The test temperature was 25 $\pm$ 1 °C and the photoperiod consisted of a 16 hours light: 8 hours dark cycle. Daily water changes were accomplished by transferring each individual to a fresh cup of test solution; water quality measurements and observations of survival and reproduction (number of offspring) are made at this time also. Prior to transfer, each cup is inoculated with food (200 µL of a 1:1 mixture of *Selenastrum* culture, density of approximately 3.5×10^7 cells/mL, and YCT).

The test organisms for the *Ceriodaphnia dubia* tests are obtained from in-house cultures. The laboratory water used for cultures, controls, and preparation of sample dilutions is a moderately hard freshwater, prepared with diluted mineral water (8 parts Nanopure, 2 parts Perrier®). Test samples are poured through a 60 µm Nitex screen in order to remove indigenous organisms prior to preparation of the test concentrations. Serial dilutions of the test sample are prepared, resulting in test concentrations of 100, 50, 25, 12.5, and 6.25 %.

The quality assurance program for this test consists of two components. First, a negative control sample (laboratory water) is included in all tests, and this control is used for all sample comparisons and to meet test acceptability criteria. This control also helps document the overall health of the test organisms. Second, a positive control is conducted, which consists of a reference toxicant test and a concentration series of copper chloride ($CuCl_2$). Since this organism is cultured in-house, EPA guidelines only require monthly reference toxicant tests to be conducted. These monthly tests are performed to monitor the overall test sensitivity and precision of the organisms. Monthly survival and reproduction results are compared to historical results, through the use of control charts which track the sensitivity of the organisms. Any significant difference in organism sensitivity to the historical mean is noted in the final report. Also, any deviations from the EPA protocols or performance criteria are noted in the final report.

Sea Urchin Fertilization Test

All discharge and receiving water samples of stormwater are also evaluated for toxicity using the purple sea urchin fertilization test (USEPA 1995). This test measures toxic effects on sea urchin sperm, which are expressed as a reduction in their ability to fertilize eggs. The test consists of a 20-minute exposure of sperm to the samples. Eggs are then added and given 20 minutes for fertilization to occur. The eggs are then preserved and examined later with a microscope to assess the percentage of successful fertilization. Toxic effects are expressed as a reduction in fertilization percentage. Purple sea urchins (*Strongylocentrotus purpuratus*) used in the tests are field collected near Point Loma, San Diego, CA by Nautilus staff. The tests are conducted in glass shell vials containing 10 mL of solution at a temperature of 15 $\pm$ 1 °C. Five replicates are tested at each sample concentration.

All samples are adjusted to a salinity of 34‰ for the fertilization test. Previous experience has determined that many commercially available sea salt mixes are toxic to sea urchin sperm. Therefore, the salinity for the urchin test is adjusted by the addition of hypersaline brine. The brine is prepared by partially freezing natural seawater. Since the addition of brine dilutes the sample, the highest stormwater concentration that could be tested for the sperm cell test usually ranges between 60 and 70% of the environmental sample. The adjusted samples are then diluted with seawater to produce test concentrations of 60-70, 50, 25, 12.5, and 6.25%.

Seawater controls (20 µm filtered natural seawater from Scripps Institution of Oceanography) and brine control samples (deionized water mixed with the same volume of brine as the high concentration of sample) are included in each test series for quality control purposes. Water quality parameters (temperature, dissolved oxygen, pH, and salinity) are measured on the test samples to ensure that the experimental conditions remain within desired ranges and do not create unintended stress on the test organisms. In addition, since these urchins are caught in the wild, a reference toxicant test is included with each stormwater or dry weather event. The reference toxicant test is used to evaluate the overall health of the test organisms and to compare the sensitivity to historical control chart results. Each reference toxicant test consists of a concentration series of copper chloride with five replicates tested per concentration.

Toxicity Identification Evaluations (TIEs)

Phase I TIEs are to be conducted in order to determine the characteristics of the toxicants present are if either stormwater or dry weather runoff samples exhibit substantial toxicity (> 2 TU_a for *Ceriodaphnia*, > 3 TU_a for sea urchins). Testing procedures used for Phase I TIEs utilize acute measurements thus use of acute toxic units was determined to be appropriate measures for determining if adequate toxicity is present to justify further testing.

The TIE process involves an array of treatments designed to selectively remove or neutralize classes of compounds (e.g., metals, nonpolar organics) and thus the toxicity that may be associated with them. Treated samples are then tested to determine the change in toxicity.

Prior to evaluation of toxicity changes, an untreated aliquot of sample is tested to confirm persistence of the originally-noted toxicity. If toxicity in this “baseline” sample decreases to levels below the original trigger point, further toxicity tests are not performed and the TIE is abandoned.

Four or five treatments have been typically applied to each sample. These treatments include particle removal, trace metal chelation, nonpolar organic extraction, organophosphate (OP) deactivation (except urchins) and chemical reduction. With the exception of the organics extraction, each treatment is applied independently on a salinity-adjusted sample. A control sample (lab dilution water) is included with each type of treatment to verify that the manipulation itself was not causing toxicity. If the TIE is not conducted concurrently with the initial testing of a sample, then a reduced set of concentrations of untreated sample is tested at the time of the TIE to determine the baseline toxicity and control for changes in toxicity attributable to sample storage.

Ethylene diamine tetraacetic acid (EDTA), a chelator of metals, is added at a concentration of 60 mg/L to the marine test samples. EDTA additions to the *Ceriodaphnia* samples are based upon sample hardness (USEPA 1991). Sodium thiosulfate (STS), a treatment that reduces oxidants such as chlorine and also decreases the toxicity of some metals is added to a concentration of 50 mg/L to separate portions of each environmental sample. STS additions to the *Ceriodaphnia* samples are set at 500, 250 and 125 mg/L. The EDTA and sodium thiosulfate treatments are given one to three hours to interact with the sample prior to the start of toxicity testing. Piperonyl butoxide, which inhibits activation of organophosphate pesticides is added at four concentrations (125, 250, 500 and 750 mg/L) for *Ceriodaphnia.*

Samples are centrifuged for 30 min at 3000 X g if needed to remove particle-borne contaminants and tested for toxicity. A portion of the centrifuged sample is also passed through a 360 mg Sep-Pak™ C-18 solid phase extraction column in order to remove nonpolar organic compounds. C-18 columns have also been found to remove some metals from aqueous solutions.

DATA ANALYSES

A major focus of the data analysis is to develop a better understanding of long-term trends and the major factors that affect concentrations of key constituents of concern in discharges from the mass emission sites. Understanding these factors is an important step towards the design and implementation of optimal BMPs for controlling these loads. The following sections address procedures used to analyze both the chemical and toxicological datasets.

Chemical Data Analysis

For the past 14 years, data analysis has focused on visual examination of trends in the Event Mean Concentration (EMCs) for key metals, organophosphates and bacteria. Visual assessment has clearly illustrated the decline of diazinon and chlorpyrifos that resulted from removal of these pesticides from the market.

Further screening was conducted three years ago to examine potential functional relationships between concentrations of primary metals of concern and factors expected to influence concentrations in stormwater. Predictor variables included total rain (inches), antecedent dry weather (days), antecedent rain (inches), peak rainfall intensity (inches/hour), rainfall duration (hours), and suspended soids. An initial Pearson correlation matrix was developed to further screen predictor variables.

Multiple linear regression was then applied using a stepwise process to identify statistically significant ($p< 0.05$) multivariate linear regression equations relating runoff quality to predictor parameters for each pollutant. Predictor variables were incorporated into the regression using a forward stepwise process using only those variables that were significantly ($p<0.05$) correlated with analyte concentrations. Regression equations were developed for constituents where a multiple linear regression could be derived with an overall r^2 value of 0.4 or higher. Multiple regression analysis was not repeated this year since the relatively small incremental increase in data over the past three years would not be expected to substantially alter the results.

Box plots are used as a primary method of summarizing the distributional characteristics of the data. The "box" comprised the interquartile range (IQR) defined as the mid-spread or middle 50% of a data set. It is a measure of statistical dispersion and is equal to the difference between the upper (Q3) and lower quartiles (Q1) with the median being directly in the middle of the two. The line dividing the box represents the median value of the data set (http://en.wikipedia.org/wiki/Quartile).

The following description of how the interquartile range for the box plots produced for this report were calculated is from a paper produced by Jon Peltier. It is available at the following URL:

http://peltiertech.com/Utility20/Documentation20/Quartiles_for_Box_Plots.pdf.

Mr. Peltier gives a general approach to calculating the interquartile range from an ordered (ranked) set of numbers using the cumulative distribution function (CDF) method. The CDF method has been found to calculate a consistent interquartile range even when every data point in a data set is duplicated. This "doubling" causes many other methods to fail to reproduce the same quartiles and they become inconsistent at some level of doubling. The CDF method is therefore tolerant to ties in an ordered data set. Since it is common for chemistry and bacteria data to have tied or duplicate values the CDF method was used for generation of descriptive data for all box plots. The CDF technique is also the default quartile method used by the statistics package SAS, where it's called "Empirical Distribution Function with Rounding".

Toxicological Analysis

The toxicity test results were normalized to the control response in order to facilitate comparisons of toxicity between experiments. Normalization was accomplished by expressing the test responses as a percentage of the control value. Four statistical parameters (NOEC, LOEC, median effect, and TU_c) were calculated to describe the magnitude of stormwater toxicity. The NOEC (highest test concentration not producing a statistically significant reduction in fertilization or survival) and LOEC (lowest test concentration producing a statistically significant reduction in fertilization or survival) were calculated by comparing the response at each concentration to the dilution water control. Various statistical tests were used to make this comparison, depending upon the characteristics of the data. Water flea survival and reproduction data were usually tested against the control using Fisher's Exact and Steel's Many-One Rank test, respectively. Sea urchin fertilization was evaluated for significant differences using Dunnett's multiple comparison test, provided that the data met criteria for homogeneity of variance and normal distribution. Data that did not meet these criteria were analyzed by the non-parametric Steel's Many-One Rank or Wilcoxon's tests.

Measures of median effect for each test were calculated as the LC_{50} (concentration producing a 50% reduction in survival) for water flea survival, the EC_{50} (concentration effective on 50% of eggs) for sea urchin fertilization, or the IC_{50} (concentration inhibitory to 50% of individuals) for water flea reproduction as well as the IC_{25}. The LC_{50} or EC_{50} was calculated using probit analysis, the trimmed Spearman-Karber method or linear interpolation (bootstrap). The IC_{25} and IC_{50} were calculated using probit or linear interpolation analysis. All procedures for calculation of median or percentile effects followed USEPA guidelines.

The toxicity results were also expressed as chronic Toxic Units (TU_c) and acute Toxic Units (TU_a). Chronic TUs were calculated as: 100/NOEC, while Acute TUs were calculated as 100/LC or EC_{50} for water fleas or 100/EC_{50} for urchins. Increased values of toxic units indicate relatively greater toxicity, whereas greater toxicity for the NOEC, LOEC, and median effect statistics is indicated by a lower value.

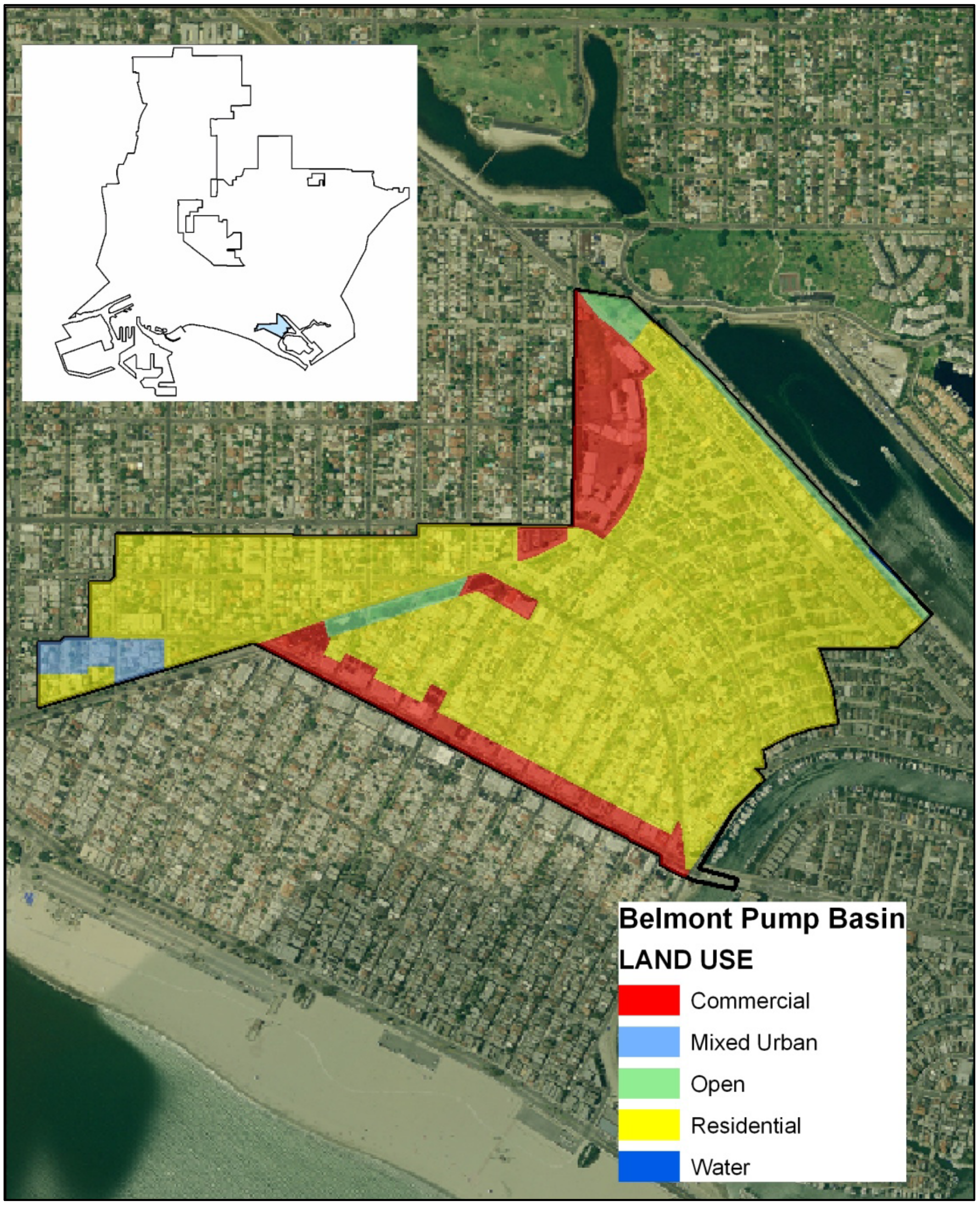


Figure 5. Land Use within the Belmont Pump Station Drainage Basin.

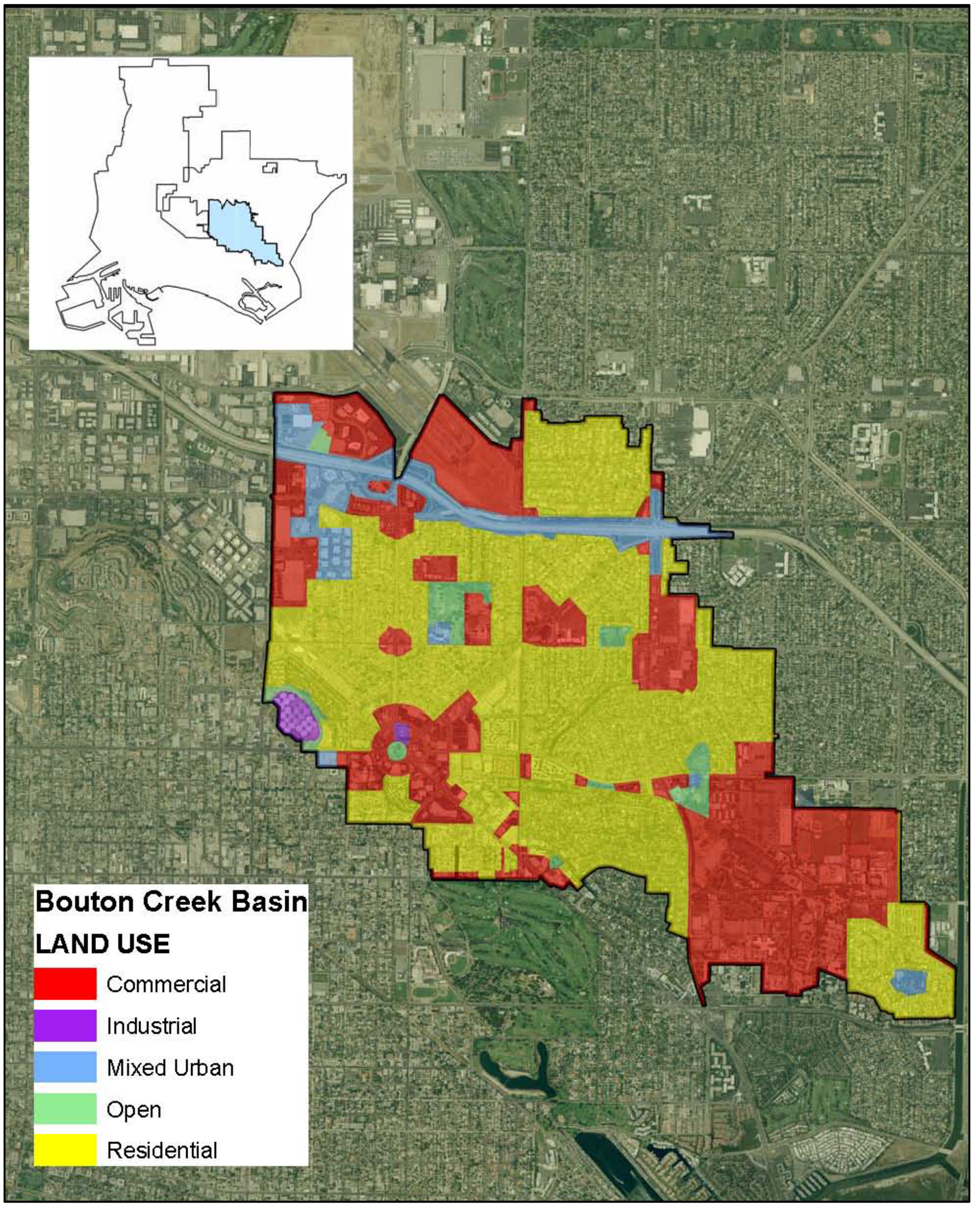


Figure 6. Land Use within the Bouton Creek Drainage Basin

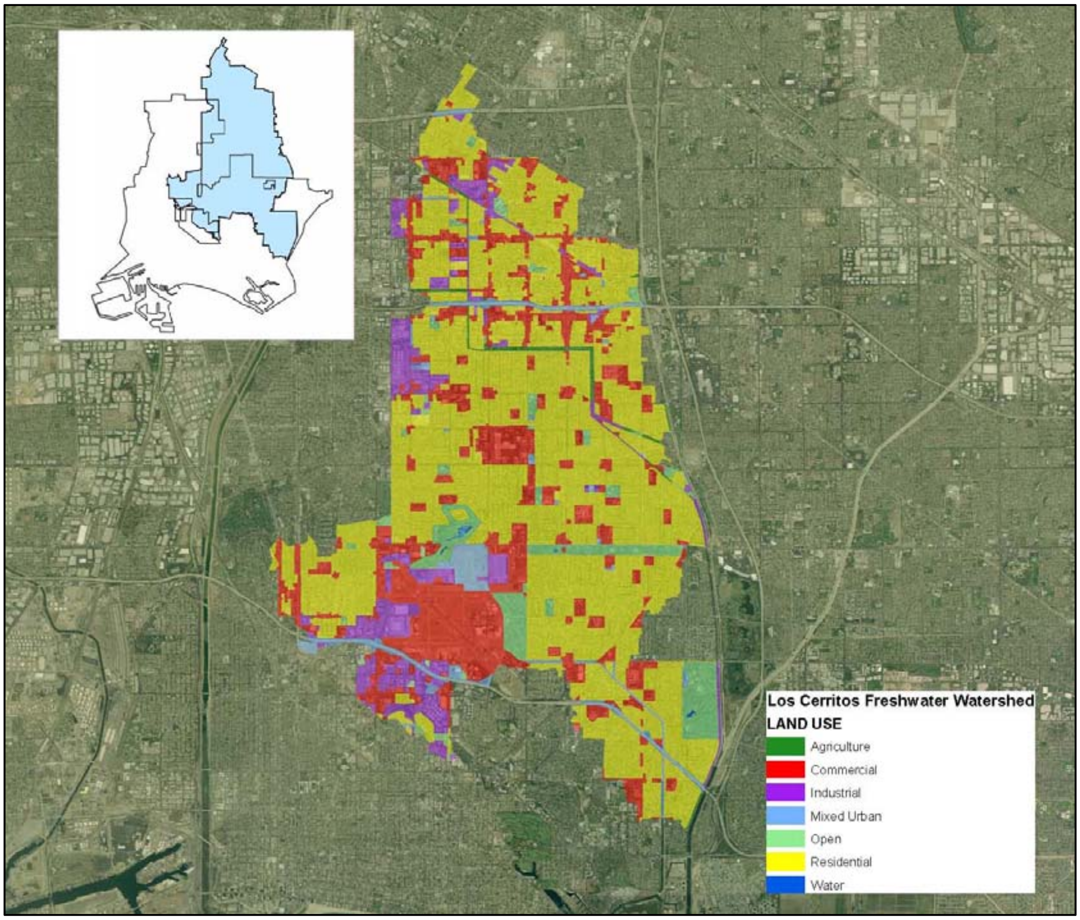


Figure 7. Land Use within the Entire Los Cerritos Channel Drainage Basin.

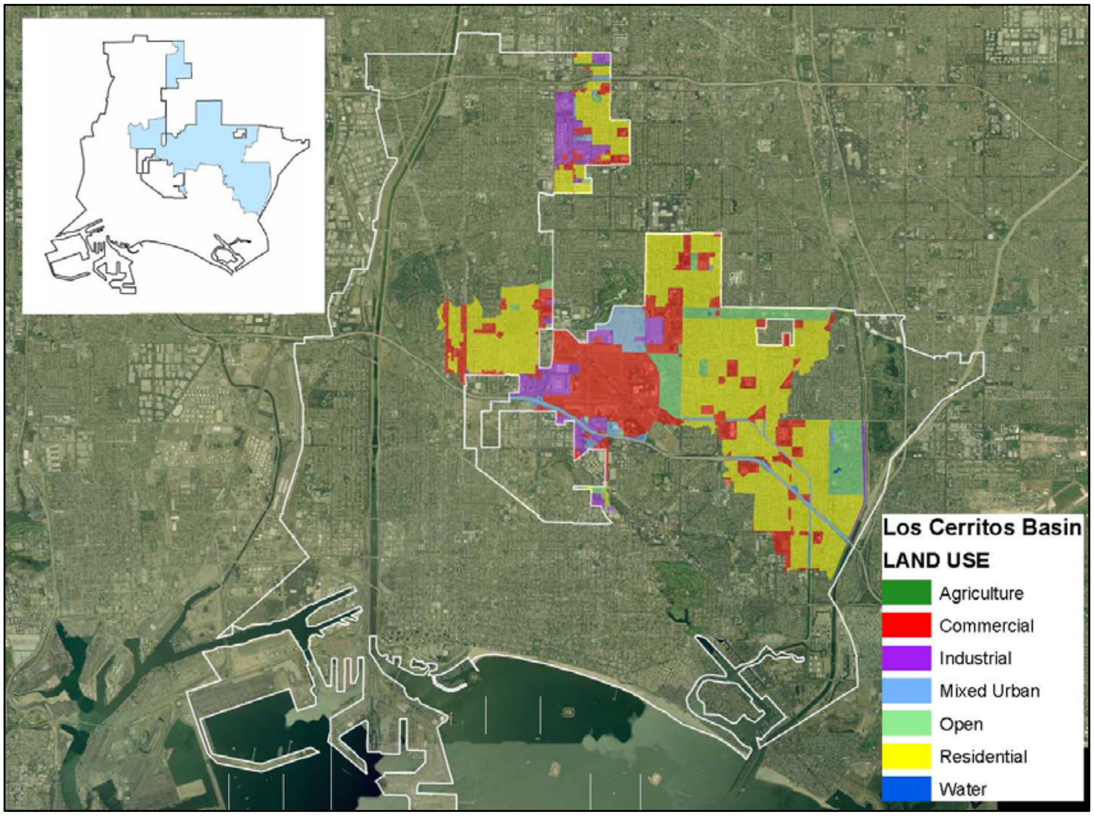


Figure 8. Land Use within the Portion of the Los Cerritos Channel Drainage Basin Located within the City of Long Beach.

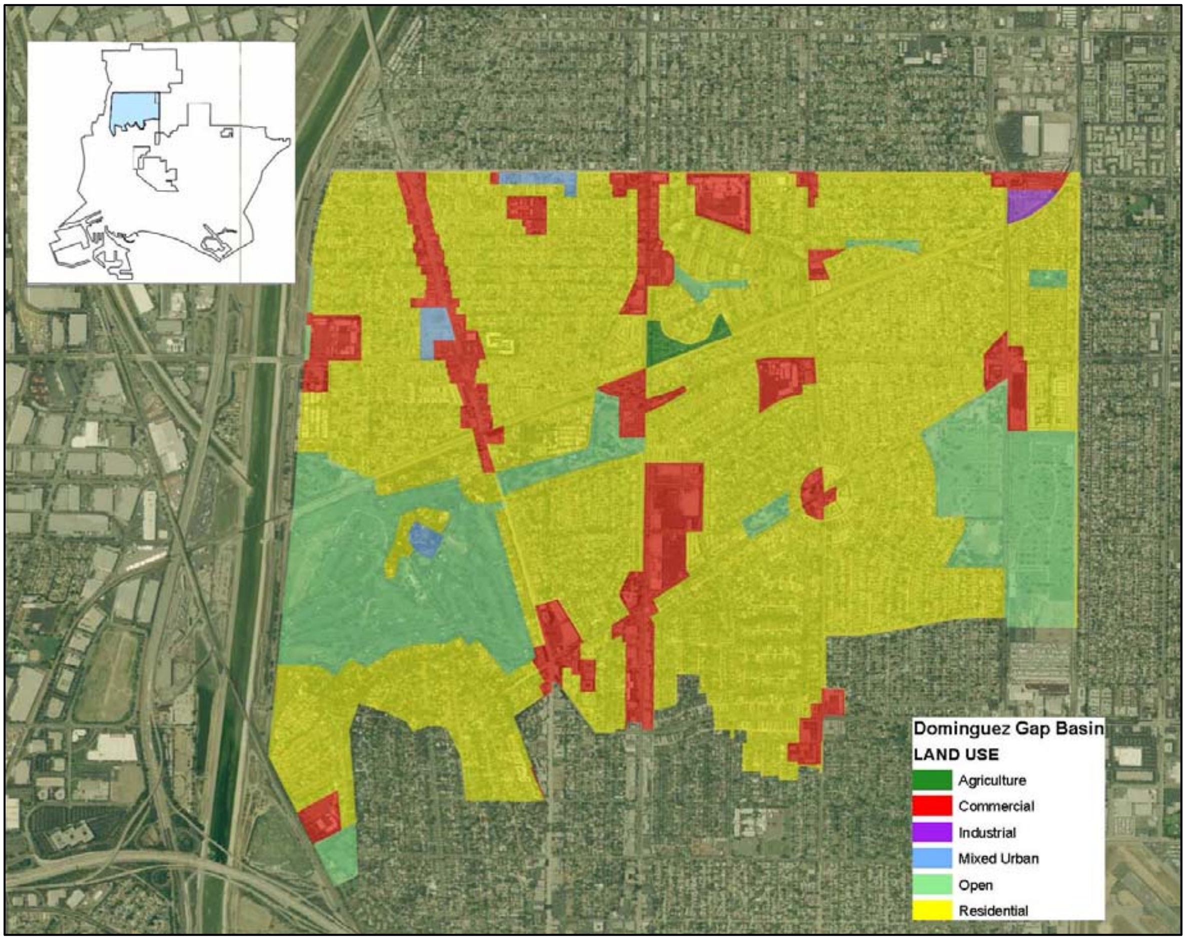


Figure 9. Land Use within the Dominguez Gap Drainage Basin.

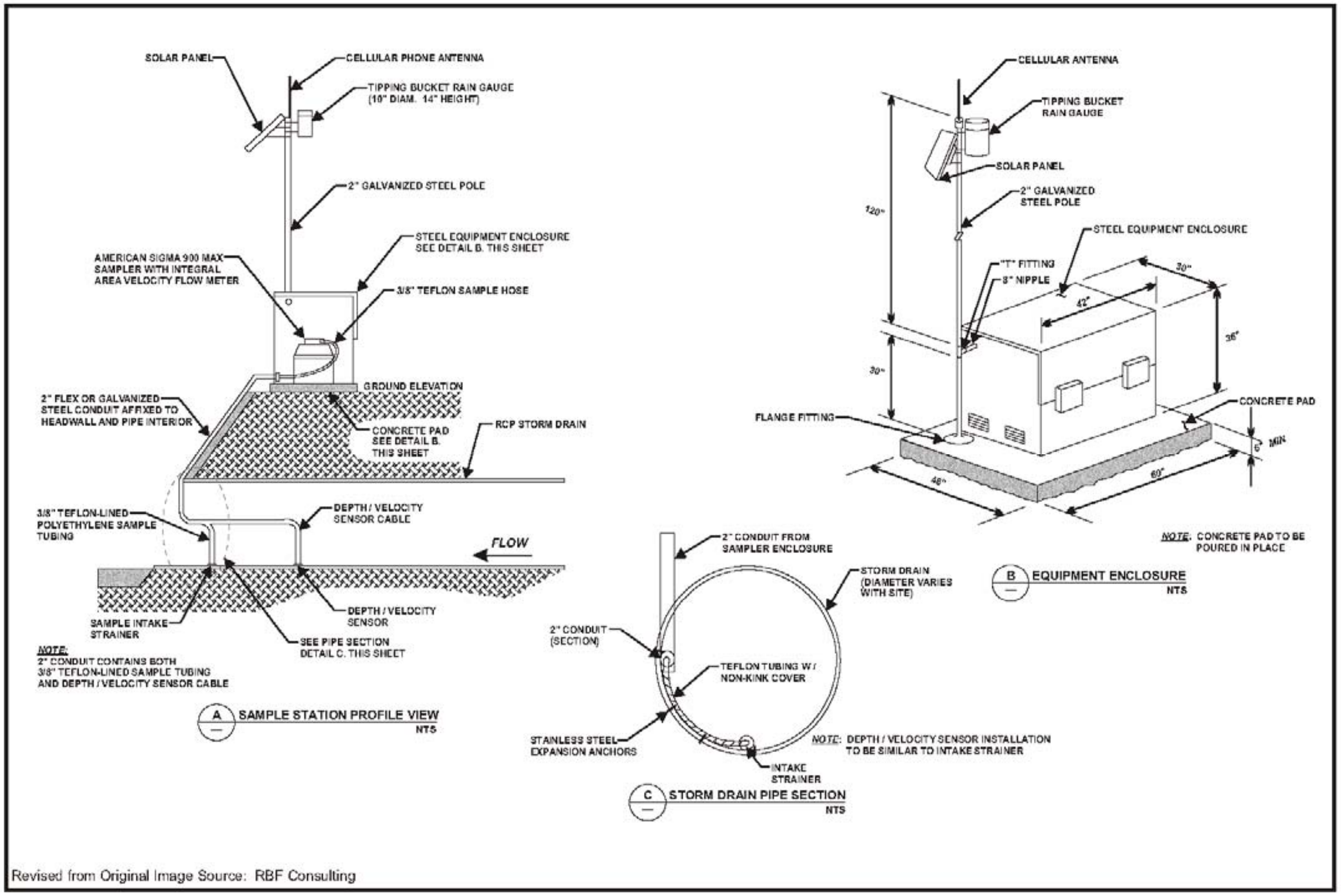


Figure 10. Typical KLASS Stormwater Monitoring Station.

Table 4. Location Coordinates of Monitoring Stations for the City of Long Beach Stormwater Monitoring Program.

Station Name	State Plane Coordinates: Zone 5 Northing (ft)	State Plane Coordinates: Zone 5 Easting (ft)	North American Datum (NAD) 83 Latitude	North American Datum (NAD) 83 Longitude
Belmont Pump	1734835	6522091	33° 45' 36.6"N	118° 07' 48.7"W
Bouton Creek-wet[1]	1741961	6529305	33° 46' 44.3"N	118° 06' 23.4"W
Bouton Creek-dry[1]	1742580	6527993	33° 46' 50.4"N	118° 06' 35.9"W
Los Cerritos Channel	1747936	6530153	33° 47' 43.3"N	118° 06' 13.4"W
Dominguez Gap Pump	1764025	6500043	33° 50' 22.1"N	118° 12' 10.5"W

1. A separate upstream sampling location was established for Bouton Creek during dry weather due to decreases in dry weather flow that had proven insufficient to flush saltwater from the channel before the flood tide once again inundated the site with marine water.

Table 5. Analytical Methods, Holding Times, and Reporting Limits.

Analyte and Reporting Unit	EPA Method Number	Holding Time	Target Reporting Limit or ML
CONVENTIONAL PARAMETERS			
Oil and Grease (mg/L)	1664	28 days	5.0
Total Phenols (mg/L)	420.1	28 days	0.1
pH (units)	150.1	ASAP	0 – 14
Orthophosphate-P (mg/L)	365.2	48 hours	0.01
Total Phosphorus (mg/L)	365.2	28 days	0.05
Turbidity (NTU)	180.1	48 hours	1.0
Total Suspended Solids (mg/L)	160.2	7 days	1.0
Total Dissolved Solids (mg/L)	160.1	7 days	1.0
Volatile Suspended Solids (mg/L)	160.4	7 days	1.0
Total Organic Carbon (mg/L)	415.1	28 days	1.0
Biochemical Oxygen Demand (mg/L)	405.1	48 hours	4.0
Chemical Oxygen Demand (mg/L)	410.1	28 days	4.0
Total Ammonia-Nitrogen (mg/L)	350.1	28 days	0.1
Total Kjeldahl Nitrogen (mg/L)	351.1	28 days	0.1
Nitrite Nitrogen (mg/L)	300.0	48 hours	0.1
Nitrate Nitrogen (mg/L)	300.0	48 hours	0.1
Alkalinity, as CaCO3 (mg/L)	310.1	48 hours	5.0
Specific Conductance (umhos/cm)	120.1	48 hours	1.0
Total Hardness (mg/L)	130.2	180 days	1.0
MBAS (mg/L)	425.1	48 hours	0.025
Chloride (mg/L)	300.0	48 hours	1.0
Fluoride (mg/L)	300.0	48 hours	0.1
BACTERIA (MPN/100ml)			
Total Coliform	SM 9221B[2]	6 hours	<20
Fecal Coliform	SM 9221E	6 hours	<20
Enterococcus	1600	6 hours	<10
TOTAL AND DISSOLVED METALS (µg/L)[1]			
Aluminum	200.8	180 days	100
Arsenic	200.8	180 days	0.5
Cadmium	200.8	180 days	0.25
Chromium	200.8	180 days	0.5
Copper	200.8	180 days	0.5
Iron	200.8	180 days	25
Lead	200.8	180 days	0.2
Nickel	200.8	180 days	0.5
Selenium	200.8	180 days	1.0
Silver	200.8	180 days	0.2
Zinc	200.8	180 days	1.0

1. Samples to be analyzed for dissolved metals are to be filtered within 48 hours.
2. SM refers " Standard Methods for the Examination of Water and Waste Water. (19th edition)" (APHA 1995)

Table 5. Analytical Methods, Holding Times, and Reporting Limits. (continued)

Analyte and Reporting Unit	EPA Method Number	Holding Time	Target Reporting Limit
CHLORINATED PESTICIDES (µg/L)			
Aldrin	625m/608	7 days	0.005
alpha-BHC	625m/608	7 days	0.005
beta-BHC	625m/608	7 days	0.005
delta-BHC	625m/608	7 days	0.005
gamma-BHC (lindane)	625m/608	7 days	0.005
alpha-Chlordane	625m/608	7 days	0.005
gamma-Chlordane	625m/608	7 days	0.005
4,4'-DDD	625m/608	7 days	0.005
4,4'-DDE	625m/608	7 days	0.005
4,4'-DDT	625m/608	7 days	0.005
Dieldrin	625m/608	7 days	0.005
Endosulfan I	625m/608	7 days	0.005
Endosulfan II	625m/608	7 days	0.005
Endosulfan sulfate	625m/608	7 days	0.005
Endrin	625m/608	7 days	0.005
Endrin Aldehyde	625m/608	7 days	0.005
Heptachlor	625m/608	7 days	0.005
Heptachlor Epoxide	625m/608	7 days	0.005
Toxaphene	625m/608	7 days	0.005
PCBs (µg/L)			
Aroclor-1016	625m/608	7 days	0.02
Aroclor-1221	625m/608	7 days	0.02
Aroclor-1232	625m/608	7 days	0.02
Aroclor-1242	625m/608	7 days	0.02
Aroclor-1248	625m/608	7 days	0.02
Aroclor-1254	625m/608	7 days	0.02
Aroclor-1260	625m/608	7 days	0.02
Total PCBs	625m/608	7 days	0.02
ORGANOPHOSPHATE PESTICIDES (µg/L)			
Diazinon	625m/SW846 3510C	7 days	0.004
Chlorpyrifos (Dursban)	625m/SW846 3510C	7 days	0.002
Malathion	625m/614	7 days	0.006-0.050

Table 5. Analytical Methods, Holding Times, and Reporting Limits. (continued)

Analyte and Reporting Unit	EPA Method Number	Holding Time	Target Reporting Limit
PYRETHROID PESTICIDES (ng/L)			
Allethrin	SW846 3510C	7 Days/40 Days	1.5
Bifenthrin	SW846 3510C	7 Days/40 Days	1.5
Cyfluthrin	SW846 3510C	7 Days/40 Days	1.5
Cypermethrin	SW846 3510C	7 Days/40 Days	1.5
Deltamethrin:Tralomethrin	SW846 3510C	7 Days/40 Days	3
Esfenvalerate:Fenvalerate	SW846 3510C	7 Days/40 Days	1.5
Fenpropathrin	SW846 3510C	7 Days/40 Days	1.5
Lambda-Cyhalothrin	SW846 3510C	7 Days/40 Days	1.5
Permethrin	SW846 3510C	7 Days/40 Days	15
Tau-Fluvalinate	SW846 3510C	7 Days/40 Days	1.5
Tetramethrin	SW846 3510C	7 Days/40 Days	1.5
FIPRONIL (ng/L)			
Fipronil	SW846 8270 Mod	7 Days/40 Days	1.5
Fipronil Desulfinyl	SW846 8270 Mod	7 Days/40 Days	1.5
Fipronil Sulfide	SW846 8270 Mod	7 Days/40 Days	1.5
Fipronil Sulfone	SW846 8270 Mod	7 Days/40 Days	1.5

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RAINFALL AND HYDROLOGY

Another year with below normal precipitation made for another difficult wet weather monitoring season. The first significant storm of the season occurred on November 20 and 21, 2013 and was predicted to drop less than a quarter of an inch and thus did not meet mobilization requirements. This storm instead produced about a quarter to half inch of rain. The first targeted event occurred on December 19, 2013. However, this event ended up producing less than 0.2 inches of rain and only a small quantity of total flow. The flow generated produced only enough sample volume for a partial suite of analyses at Bouton Creek and Los Cerritos Channel. Subsequent to this event, it remained dry until February 2, 2014. This event also produced less than 0.2 inches of rain and resulted in the collecting of only enough sample for a partial suite of analyses at all monitoring stations but the Dominguez Gap Pump Station. The next targeted event began on February 27, 2014. Though this event stretched out over a four day period and produced up to two and a half inches of rain, sampling was terminated during a 12 hour break in the rain after and discharge at the four monitoring stations ceased. Discharge sampled was produced by the initial half inch or so of rain that fell for this event, and total discharge was sufficient enough to produce enough sample volume at all four monitoring stations to run the full suite of analyses. After the February 27 through March 2, 2014 rain, it remained dry until April 1, 2014. The April 1 and 2 event was small and only produced about a quarter inch or less of rain. However, the rain that did fall was sufficient enough to generate enough sample volume at the Bouton Creek and Los Cerritos Channel monitoring stations to run the full suite of chemical analyses but not enough to run any toxicity tests.

A nearly complete record of precipitation and discharge data exist for the 2013/2014 wet weather season, starting October 1. Gaps do exist in the precipitation data for Bouton Creek and the Dominguez Gap Pump Station due to rain gauge malfunctions. Gaps in the Bouton Creek precipitation data were supplemented with precipitation data from the Los Cerritos Channel monitoring station and gaps in the Dominguez Gap Pump Station precipitation data were supplemented with data from a county rain gauge adjacent to the LA River at Wardlow Avenue (314- LA Rvr).

PRECIPITATION DURING THE 2013/2014 WET WEATHER SEASON

Tables 6 through 9 summarize daily rainfall for each monitoring station during the 2013/2014 wet weather monitoring season along with daily rainfall from the previous 2012/2013 season (Oct – Apr). As these data show, both of these wet weather seasons had about a third to half of normal precipitation, even less than the 2011/2012 season, which had slightly more than half of normal precipitation. Therefore the 2013/2014 season represents the third year of monitoring during drought conditions.

Figure 11 shows the seasonal precipitation at Long Beach Airport for the past 14 years. This season's cumulative rainfall of 4.43 inches at the airport is 36% of the normal wet season average of 12.27 inches and 46% of the 9.63 inch average since the inception of this program in 1999. This was the third driest wet weather season since the inception of this program.

Cumulative rainfall for each station is illustrated in Figure 12. Season totals (October 1 through April 30) were 4.27 inches at the Belmont Pump Station, 4.45 inches at Los Cerritos Channel, 4.43 inches at Bouton Creek, and 3.88 inches at the Dominguez Gap Pump Station. The rainfall total at Long Beach Airport (4.43 inches) was similar to the totals measured or estimated for each of the four monitoring stations.

Monthly Precipitation

Figure 13 shows monthly rainfall at the four monitoring sites and at the Long Beach Airport along with the normal average monthly rainfall at the airport. This season did not follow a typical wet weather pattern. All months had below normal precipitation at the airport. In fact, there was only one bucket tip recorded at the Long Beach Airport during the month of January, which is typically the second wettest month of the year. High pressure over the Pacific Southwest shifted the jet stream north and kept most weather systems well to the north.

Precipitation During 2013/2014 Monitored Events

Precipitation during each storm event has been characterized by total rainfall, duration of rainfall, maximum intensity, days since last rainfall, and the magnitude of the event immediately preceding the monitored storm event (antecedent rainfall). Precipitation characteristics for each monitored event are summarized in Table 10. Cumulative descriptive statistics between all monitored events, including partial events, for each monitoring station are presented in Table 11. Cumulative rainfall and intensity are summarized graphically for each monitored event at each station in Figure 14 through Figure 24.

Total rainfall during the only full testing event during the 2013/2014 wet weather season (February 27) was 0.44 inches at the Belmont Pump Station, 0.64 at Los Cerritos Channel, and 0.5 inches at the Dominguez Gap Pump Station (supplemented by the Wardlow Avenue rain gauge). Rainfall at Bouton Creek for this event was supplemented with Los Cerritos Channel rainfall. Among all four monitored events, mean total rainfall measured during each event ranged from 0.21 to 0.32 inches of rain.

An important variable that directly affects water quality is maximum rainfall intensity during a rainfall event. Higher maximum rainfall intensities, especially over a sustained period, usually create higher flows that carry more particulates. Maximum rainfall intensities (based on five minutes of data) for the February 27 full monitoring event ranged from 0.36 inches per hour at the Belmont Pump station to 0.48 inches per hour at Los Cerritos Channel. Maximum intensity data are not available for the Dominguez Gap Pump Station for any event of the season, and the Bouton Creek rainfall intensity data for the February 27 event were supplemented with Los Cerritos Channel data. Except for the Dominguez Gap Pump Station, maximum mean rainfall intensity among all monitored events ranged from 0.30 inches per hour at the Belmont Pump Station to 0.39 inches per hour at Los Cerritos Channel.

Another important variable that directly affects water quality is antecedent rainfall. It can be expected that the longer the period of dry weather between rainfall events and the less amount of rainfall from the previous event, the greater the accumulation of pollutants on impervious surfaces. With this in mind, the Regional Water Quality Control Board stipulated a targeted period of dry conditions prior to monitoring events of at least seven days. Daily dry conditions for the purpose of monitoring are defined as a 24-hour period with less than 0.1 inches of rain. Dry periods prior to monitored events and the magnitude of the previous event are best illustrated by reviewing daily rainfall data in Table 6 through Table 9. These data and data summarized in Table 10 show that all monitored events during the 2013/2014 wet weather season met antecedent criteria. The preceding period of dry weather for the February 27 full event was about 20 days. Precipitation that fell just prior to this dry period ranged from 0.11 to 0.27 inches. The preceding period of dry weather for all monitored events averaged 22 to 28 days and antecedent rain averaged from 0.17 to 0.27 inches.

STORMWATER RUNOFF DURING MONITORED EVENTS

In order to properly estimate Event Mean Concentrations (EMCs) and constituent loadings, monitoring was designed to quantify rainfall events in their entirety and the majority of runoff created by those events.

Table 11 provides descriptive statistics for total flow volume and total flow duration. Table 12 summarizes flow characteristics for the four monitored events at each station including the duration of discharge/flow, total discharge volume, and peak discharge/flow. This information complements the calculated EMCs for each monitored analyte at these sites. Figure 14 through Figure 24 graphically depict flow during the each monitored events at each station in response to rainfall. These figures also show how the aliquoting of each composite sample was conducted and when grab samples were collected. Since Bouton Creek is tidally influenced, hydrographs for Bouton Creek are accompanied with plots of conductivity readings.

Flow duration or the period of discharge varies between stations. As is the usual case at these sites, flow duration for the February 27 full monitoring event was greatest at Bouton Creek due to tidal effects and at Los Cerritos Channel due to the large drainage area. During incoming tides at Bouton Creek, low flows are backed up and held back by the tide. As the tide recedes, stormwater is once again detected at the station using the conductivity sensors and sampling continues. The period of discharge at the Belmont and Dominguez Gap pump stations were similar or not much less. However, these are overestimations of the true period of discharge because of the on and off cycling of the pumps. Discharge durations reported in for the pump stations represent the period between the times the first pump came on until all pumps became silent. Consult Figures 16, 19, and 21 to get a better sense of the duration of discharge for the pump stations. Flow durations during the three partial events were atypical because of the low rainfall and showery nature of the rain.

As usual, total flow or discharge for the February 27 full monitoring event was the greatest at Los Cerritos Channel (14,049 kcf) and much less at the Bouton Creek (1,273 kcf), the Belmont Pump Station (177 kcf), and the Dominguez Gap Pump Station (300 kcf). Mean total flow among all monitored events ranges from 127 kcf at the Belmont Pump Station to 5,302 kcf at Los Cerritos Channel.

Percent storm captures (percentage of the total storm event volume effectively represented by the flow-weighted composite sample) did not meet the optimal objective (>90%) for the February 27 full monitoring event at Los Cerritos Channel. Reduced storm capture comes from a variety of reasons, but the reduced storm capture at Los Cerritos Channel for this event (57%) was due to delays in changing the first full composite bottle. Percent storm captures for all partial monitored events for all stations met the optimal objective.

It can be expected that throughout a rain event, peak concentrations of pollutants occur at the start of an event and during peak flow/discharge. Therefore, it is important to be sampling during these segments of an event. With the exception of Los Cerritos Channel during the February 27 full monitoring event, these segments were sampled at all stations during all four events.

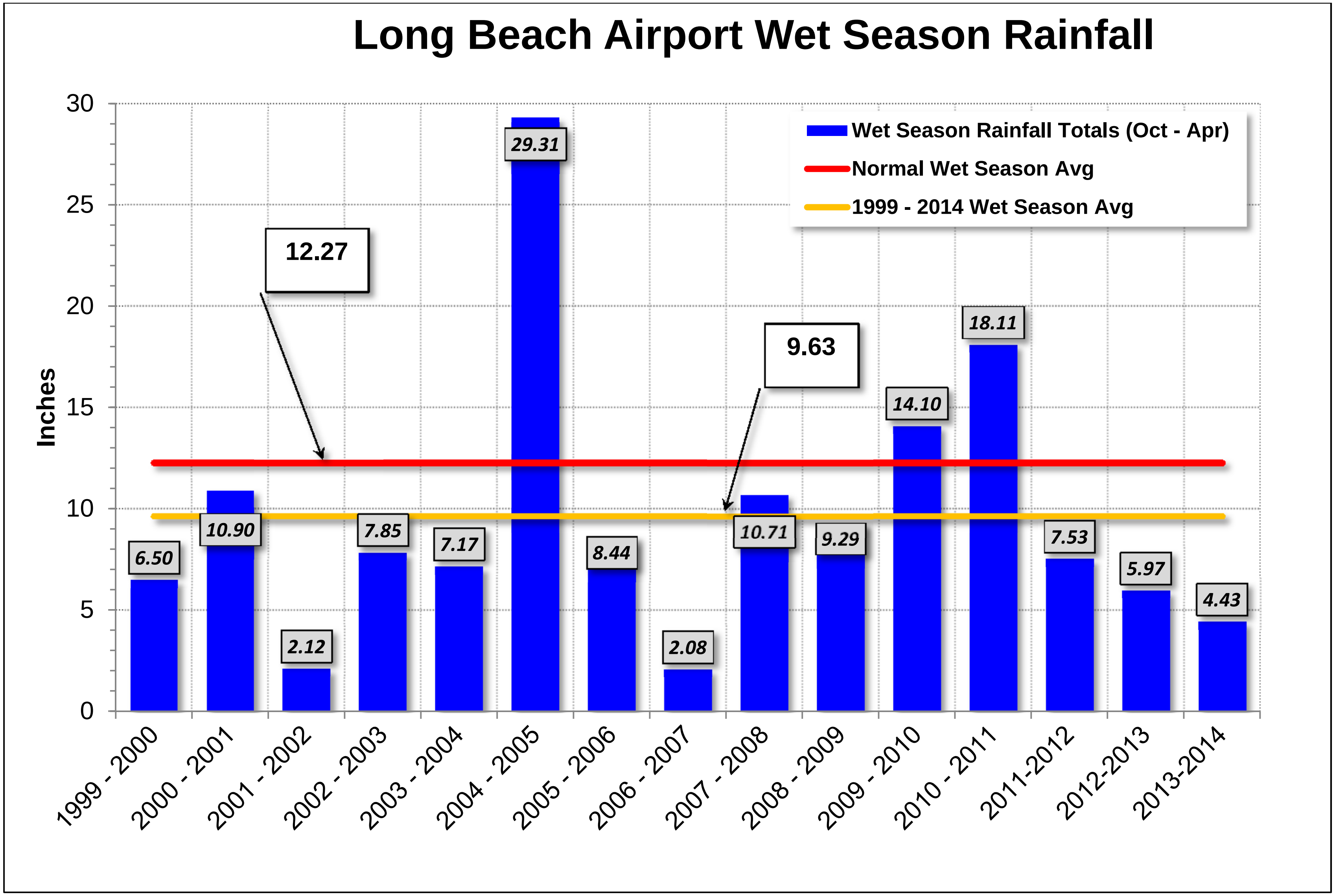


Figure 11. **Annual Rainfall (October –May) at Long Beach Daugherty Airport over Past Fourteen Years.**

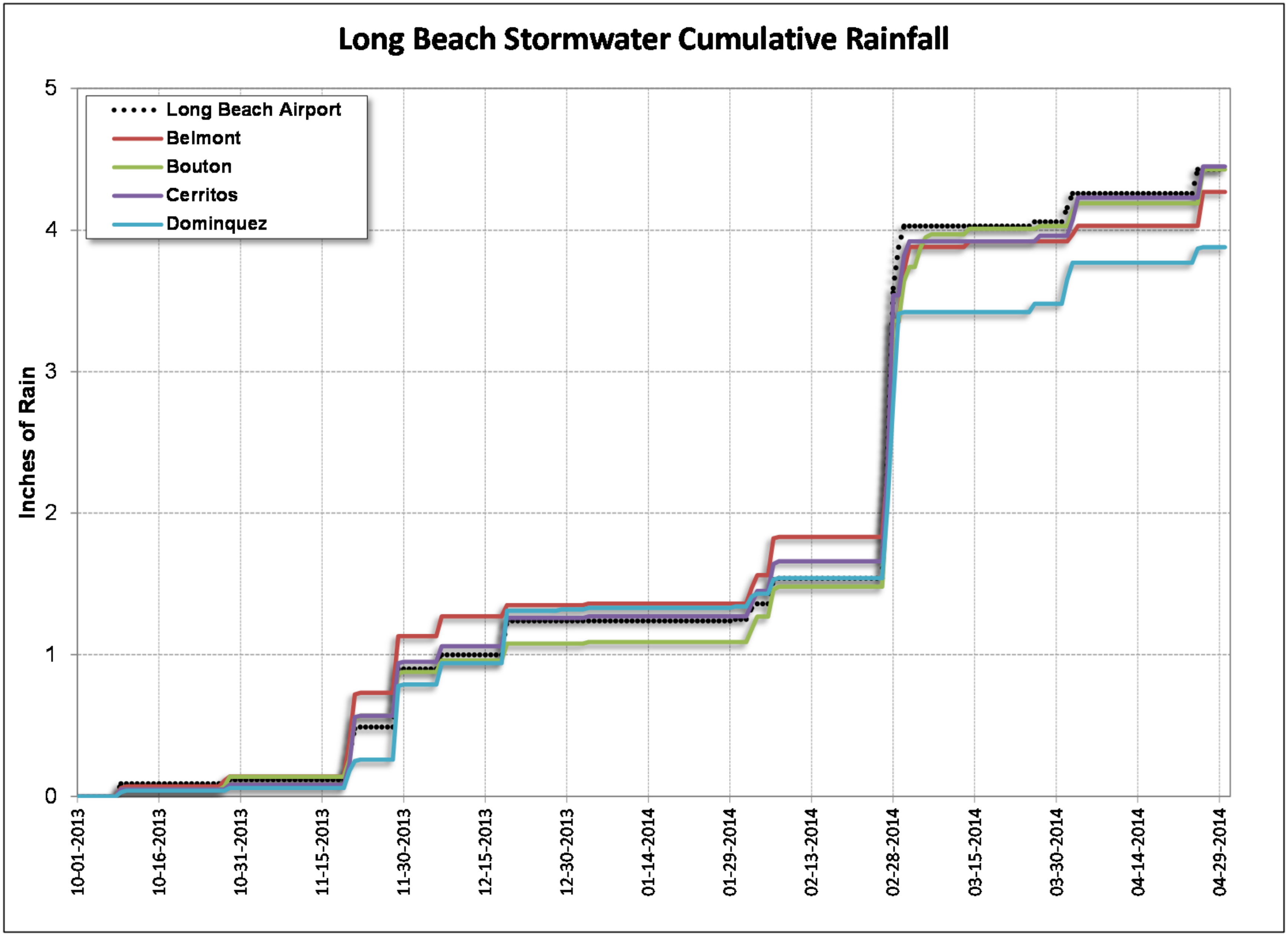
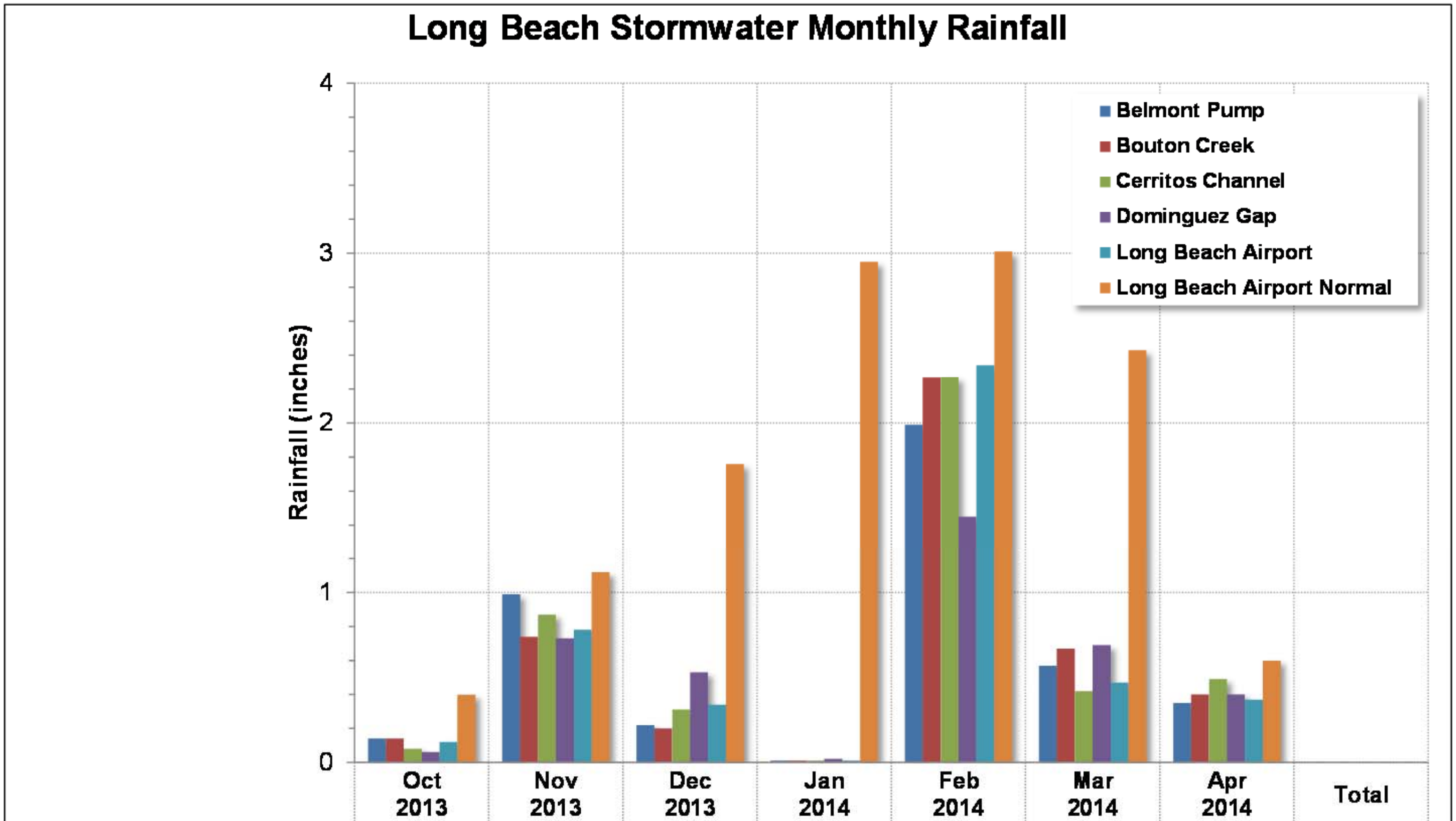


Figure 12. **Cumulative Rainfall for the 2013/2014 Wet Weather Season.**



	Oct 2013	Nov 2013	Dec 2013	Jan 2014	Feb 2014	Mar 2014	Apr 2014	Total
Belmont Pump	0.14	0.99	0.22	0.01	1.99	0.57	0.35	4.27
Bouton Creek	0.14	0.74	0.20	0.01	2.27	0.67	0.40	4.43
Cerritos Channel	0.08	0.87	0.31	0.01	2.27	0.42	0.49	4.45
Dominguez Gap	0.06	0.73	0.53	0.02	1.45	0.69	0.40	3.88
Long Beach Airport	0.12	0.78	0.34	0.01	2.34	0.47	0.37	4.43
Long Beach Airport Normal	0.40	1.12	1.76	2.95	3.01	2.43	0.60	12.27

Figure 13. **Monthly Rainfall Totals for each Monitoring Site during the 2013/2014 Wet Weather Season and Normal Rainfall at Long Beach Daugherty Air Field.**

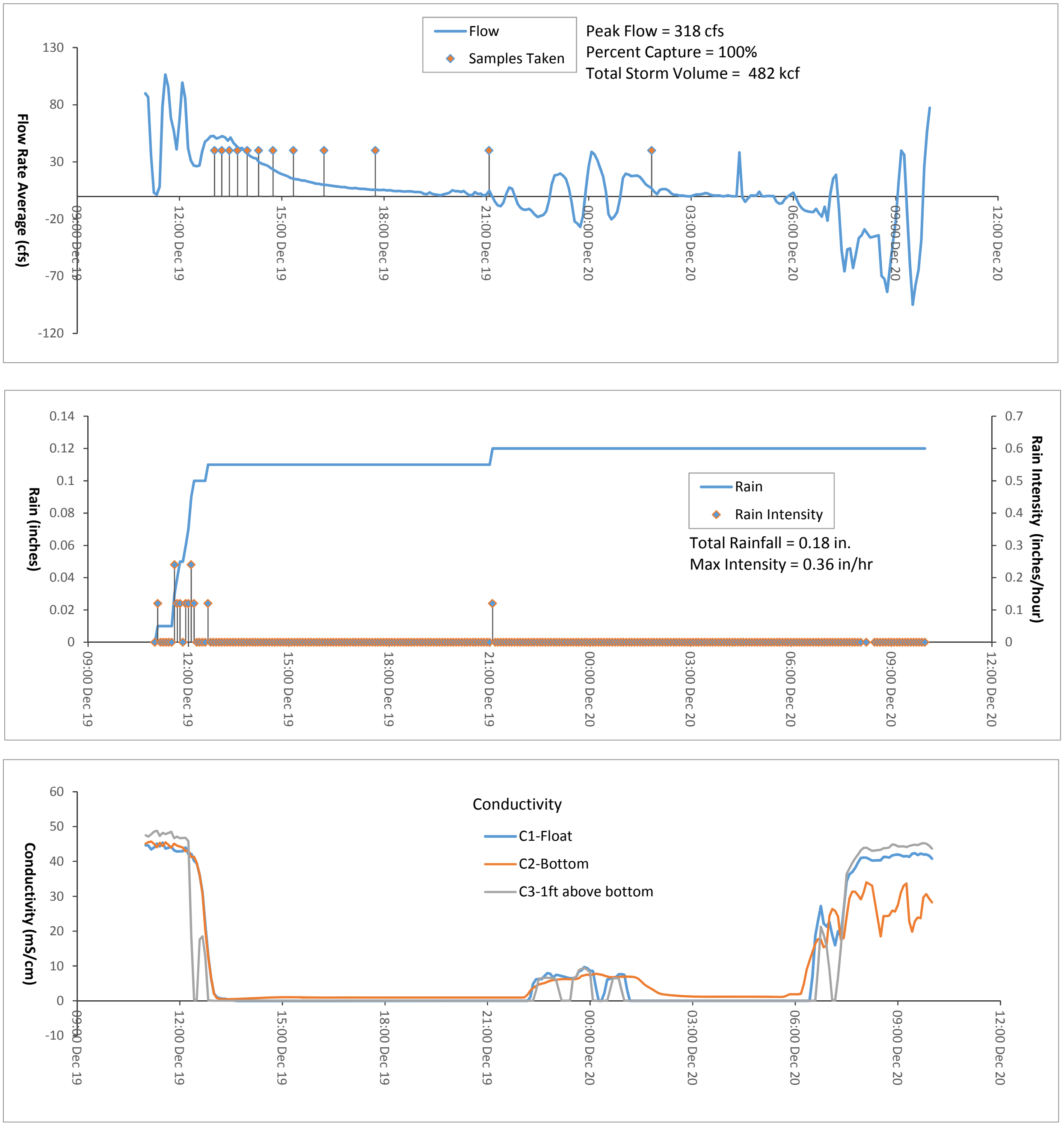


Figure 14. Rain, Flow and Salinity from the Bouton Creek Station for Station Event 1 (December 19 and 20, 2013).

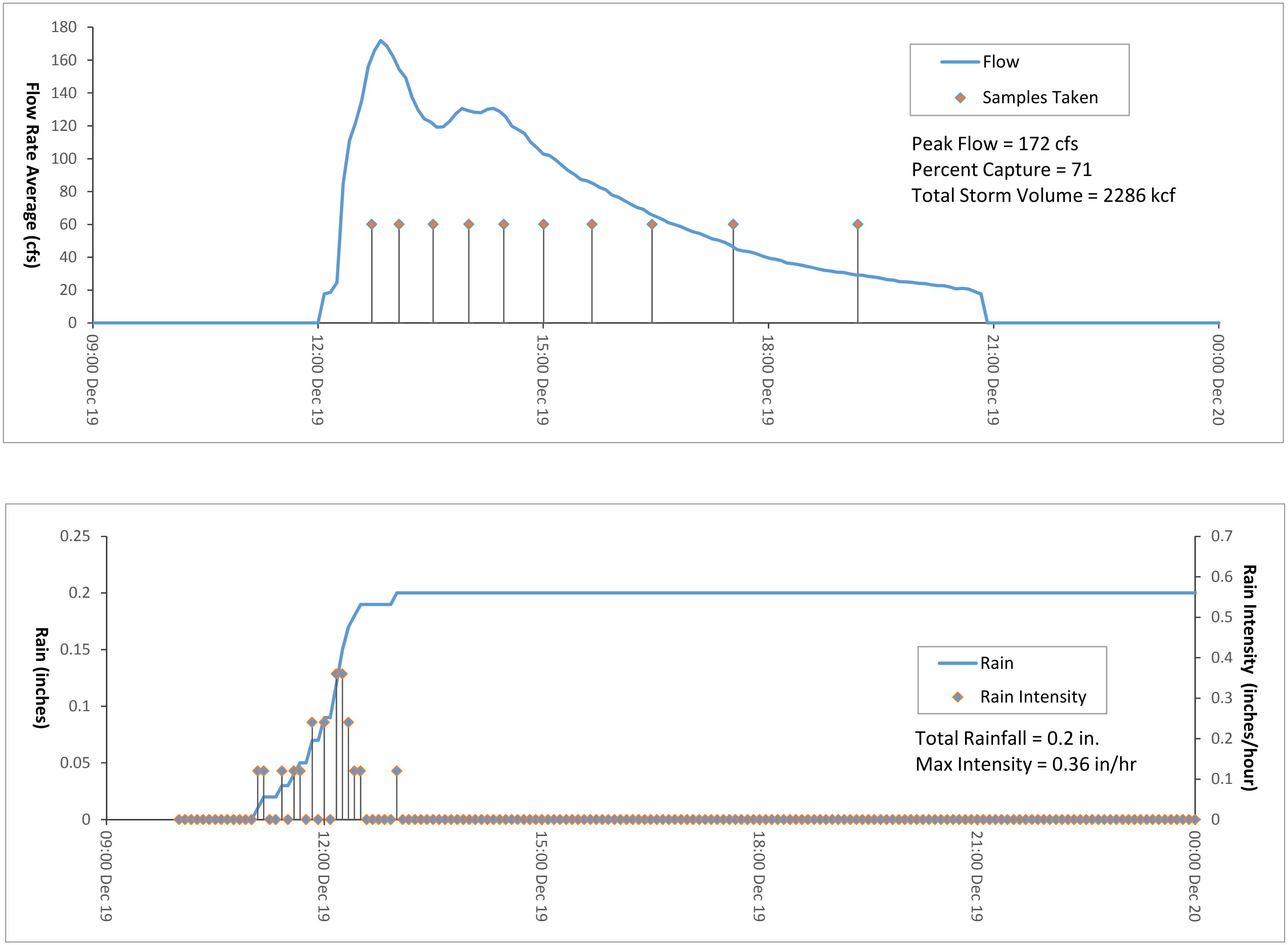


Figure 15. **Rain and Flow from the Los Cerritos Channel Station for Station Event 1 (December 19, 2013).**

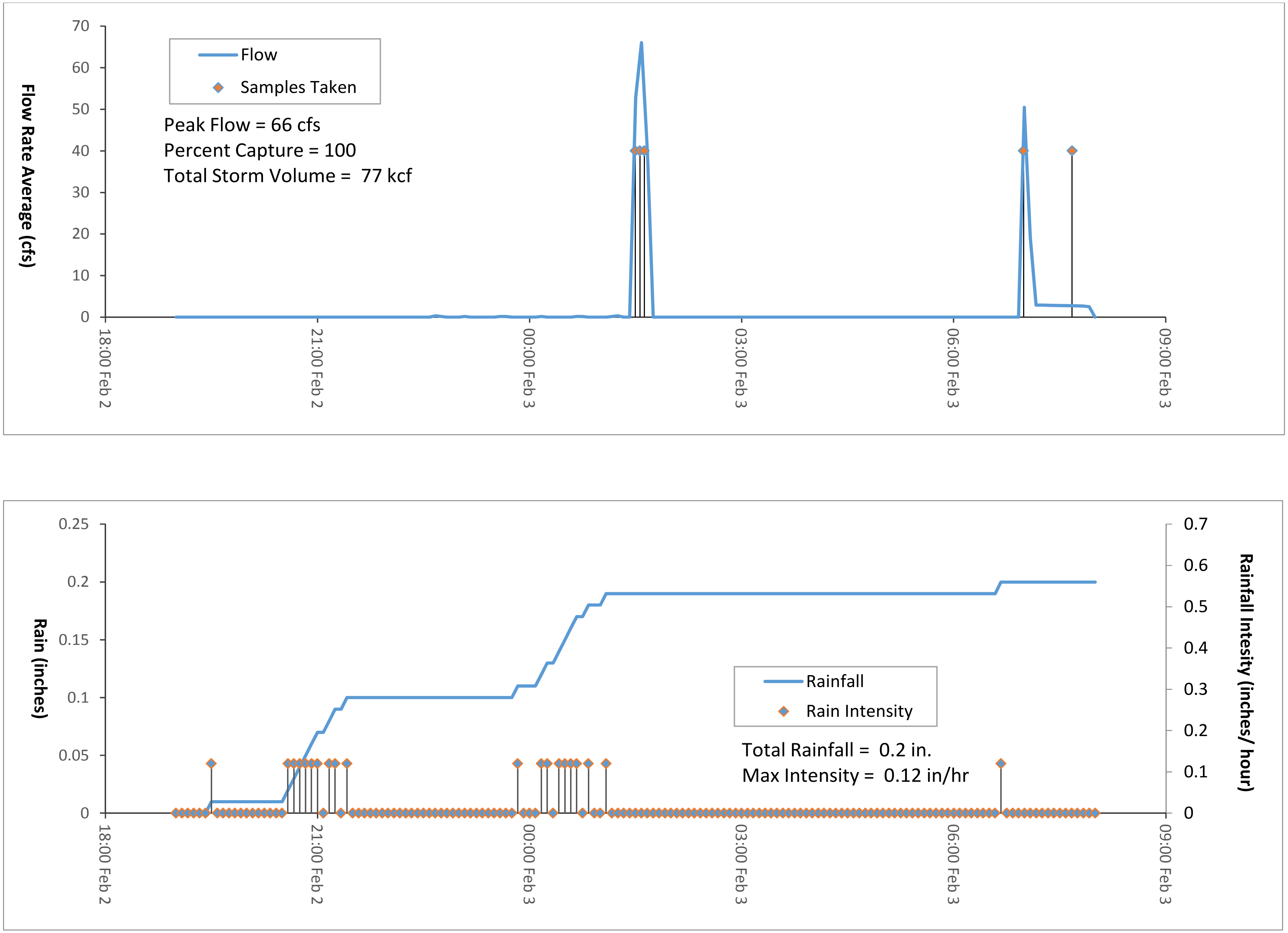


Figure 16. Rain and Flow from the Belmont Pump Station for Station Event 2 (February 2 and 3, 2014).

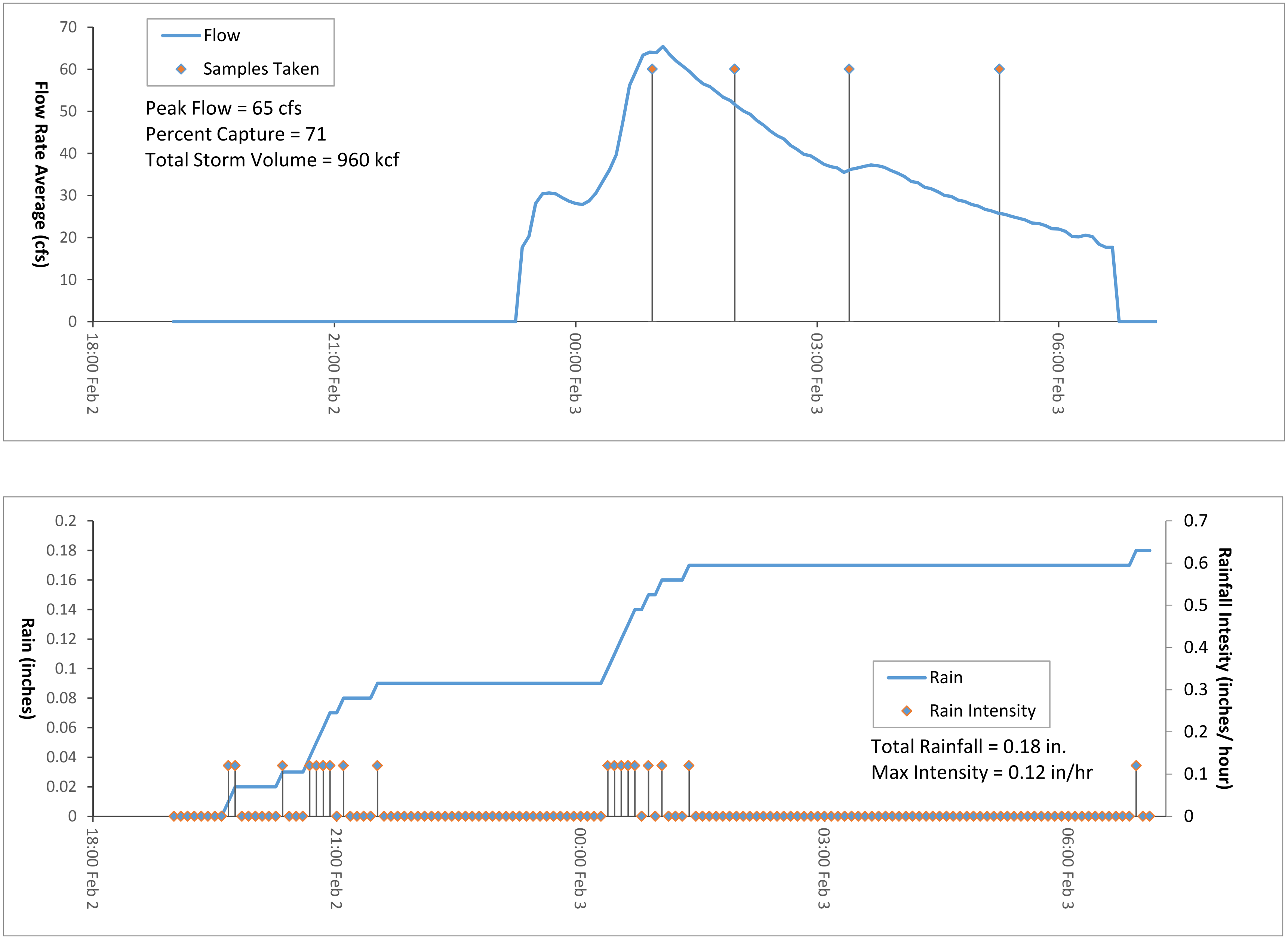


Figure 17. Rain and Flow from the Los Cerritos Channel Station for Station Event 2 (February 2 and 3, 2014).

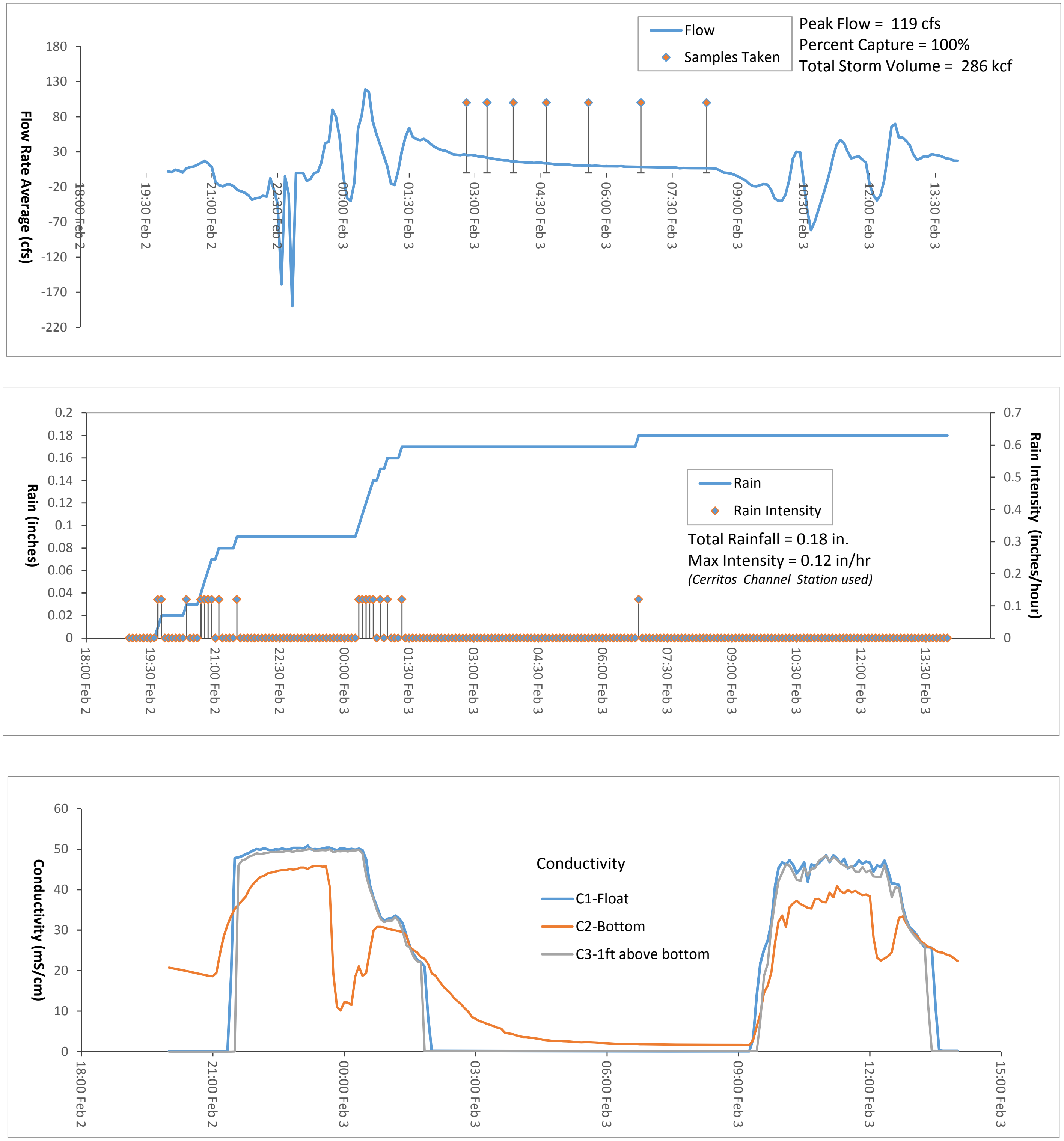


Figure 18. Rain, Flow and Conductivity from the Bouton Creek Station for Station Event 2 (February 2, 2014).

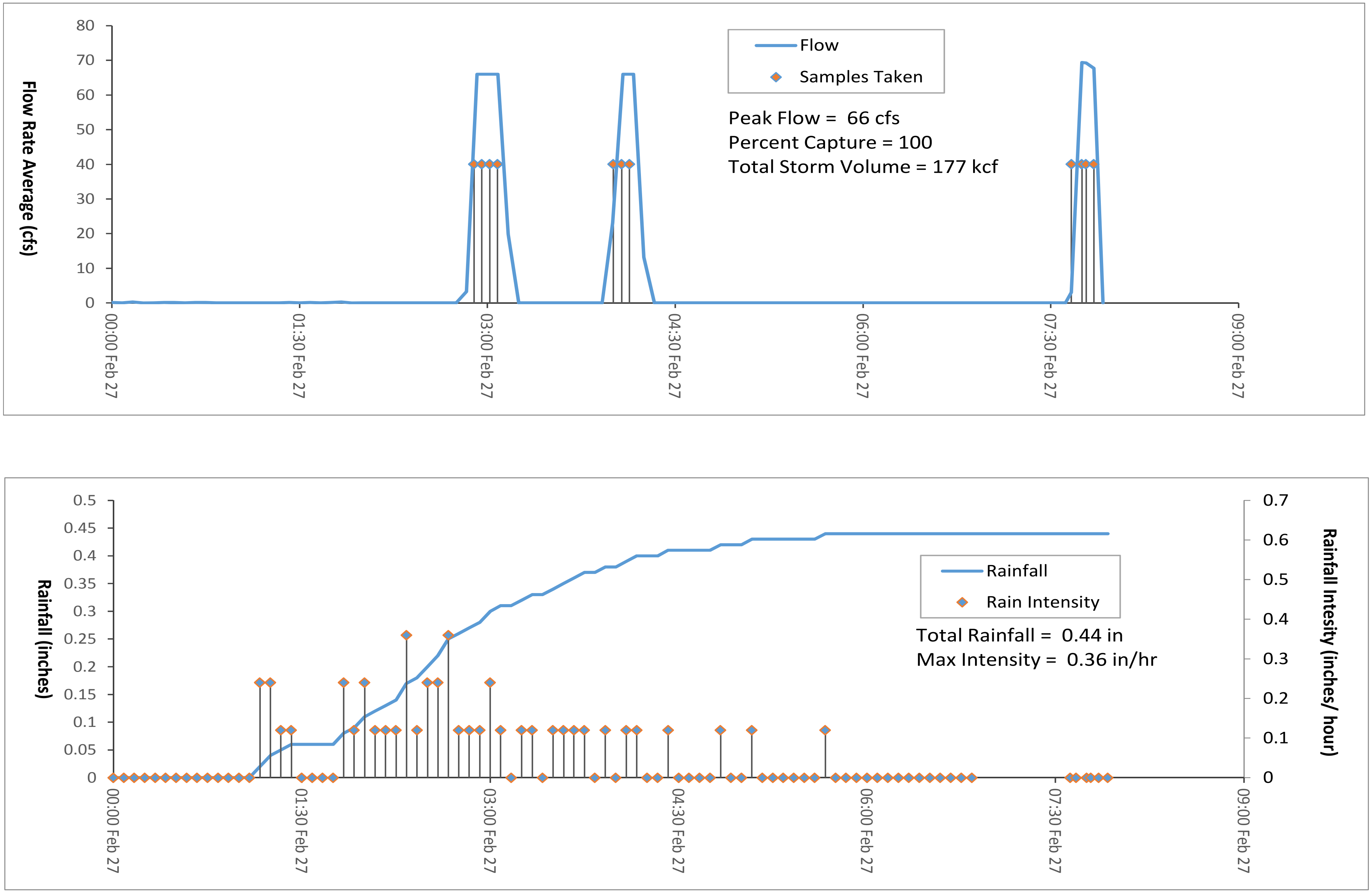
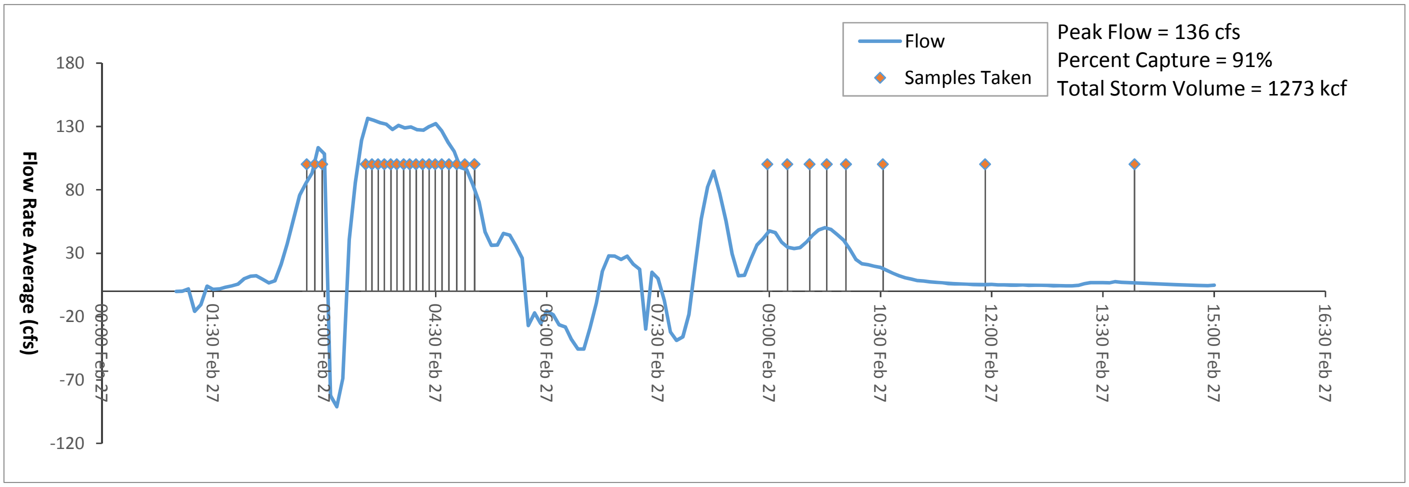
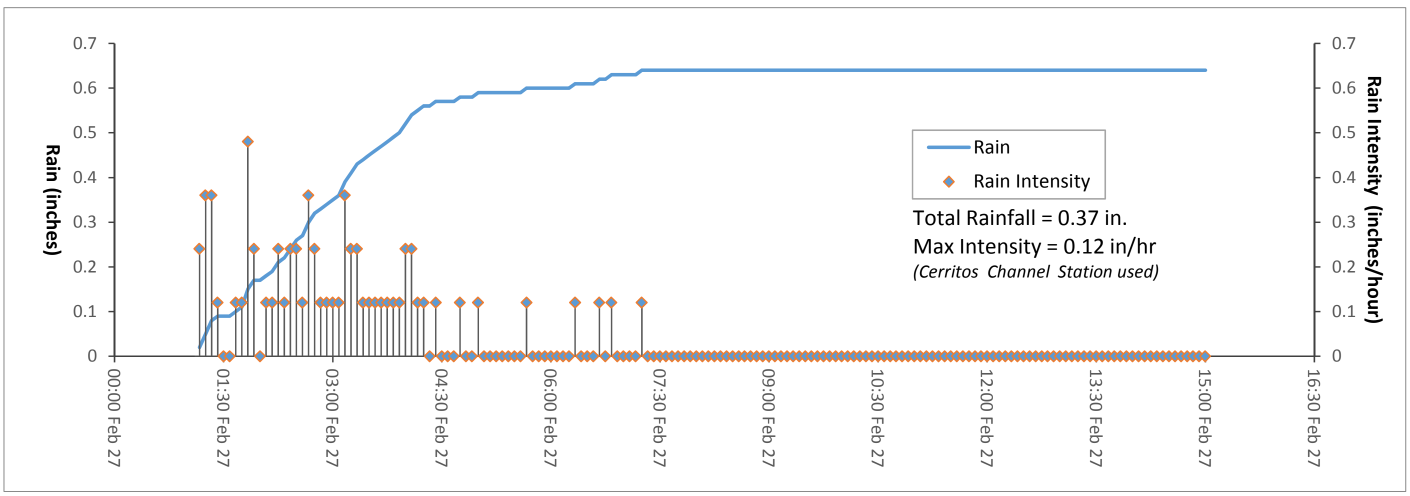


Figure 19. Rain and Flow from the Belmont Pump Station for Station Event 3 (February 27, 2014).





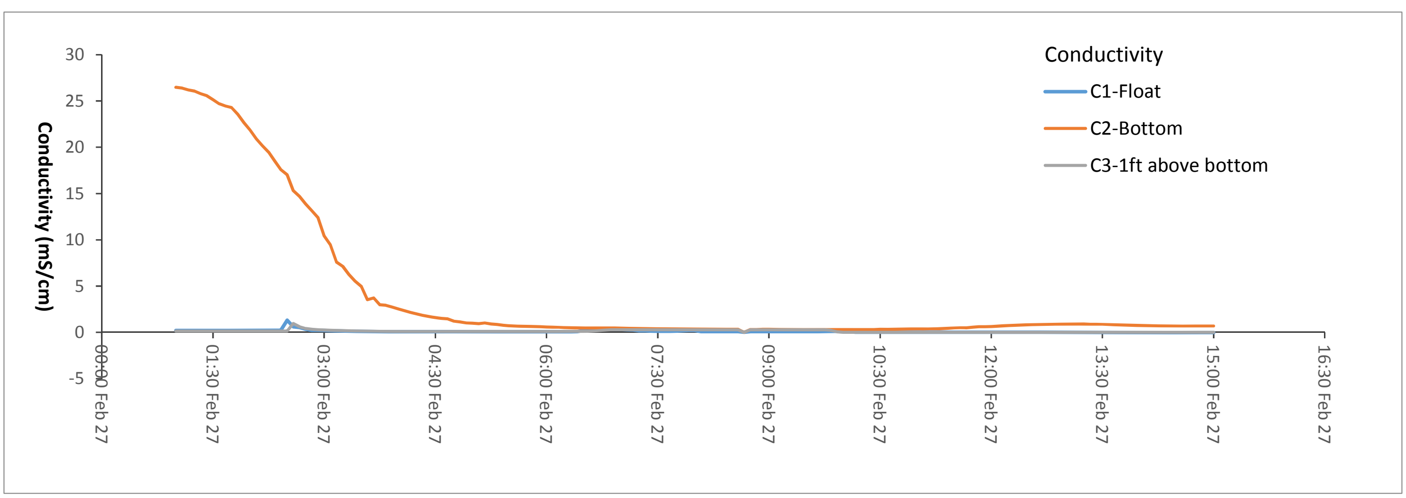


Figure 20. Rain, Flow and Conductivity from the Bouton Creek Station for Station Event 3 (February 27, 2014).

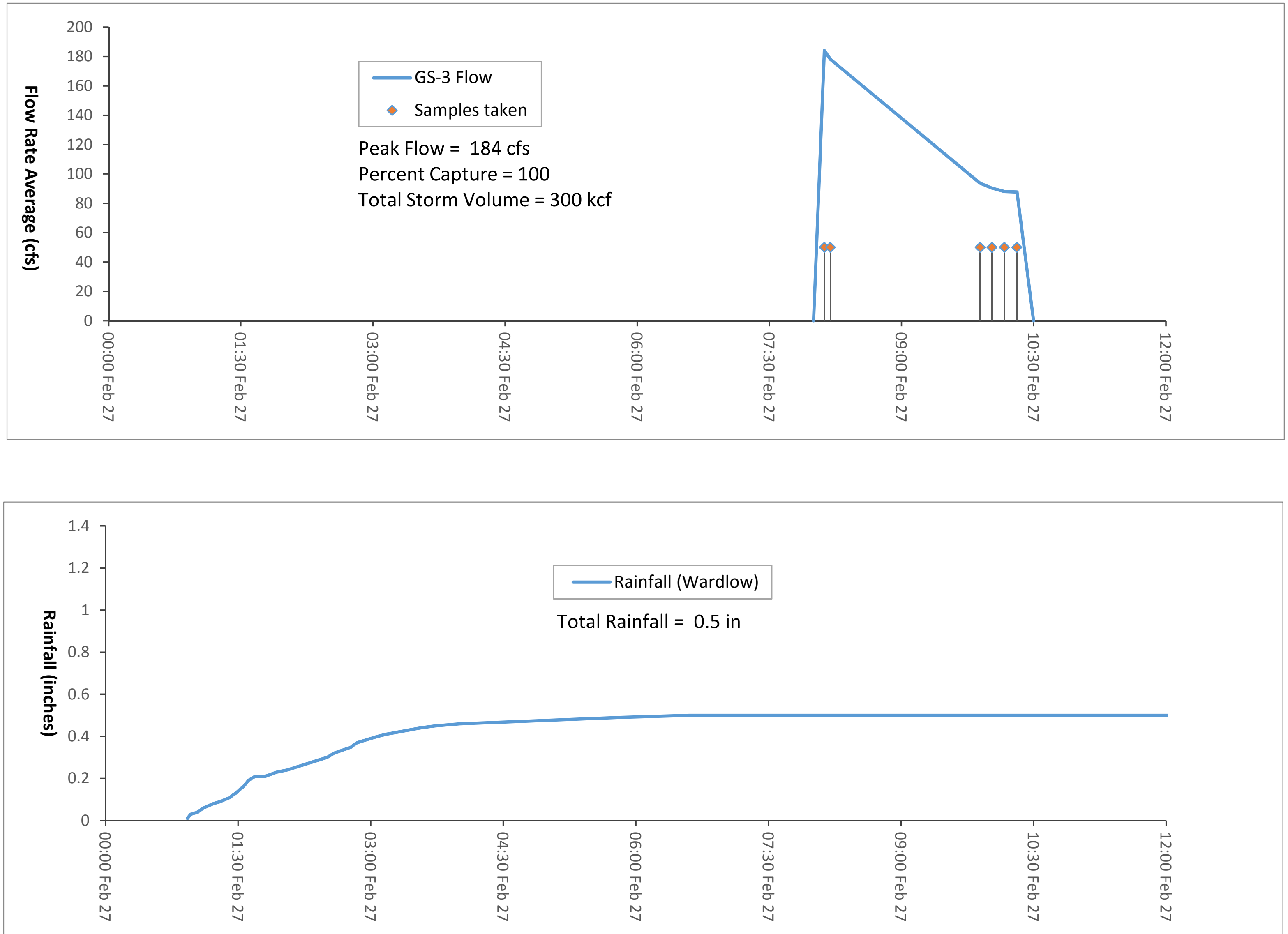
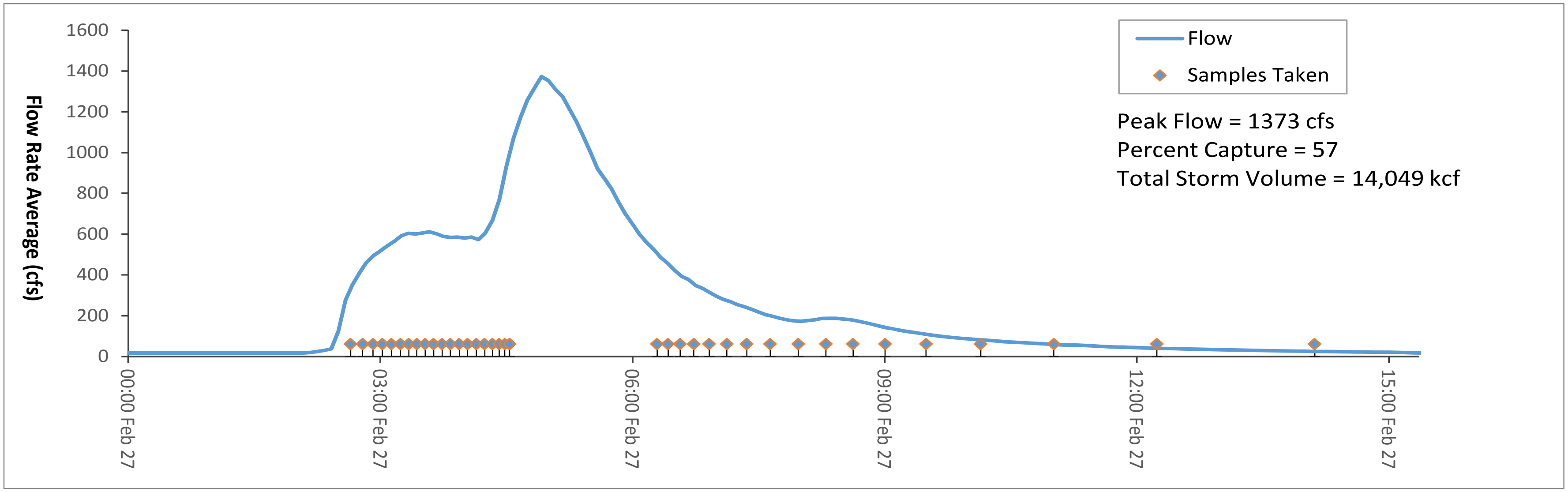


Figure 21. **Rain and Flow from the Dominguez Gap Pump Station for Station Event 3 (February 27, 2014).**



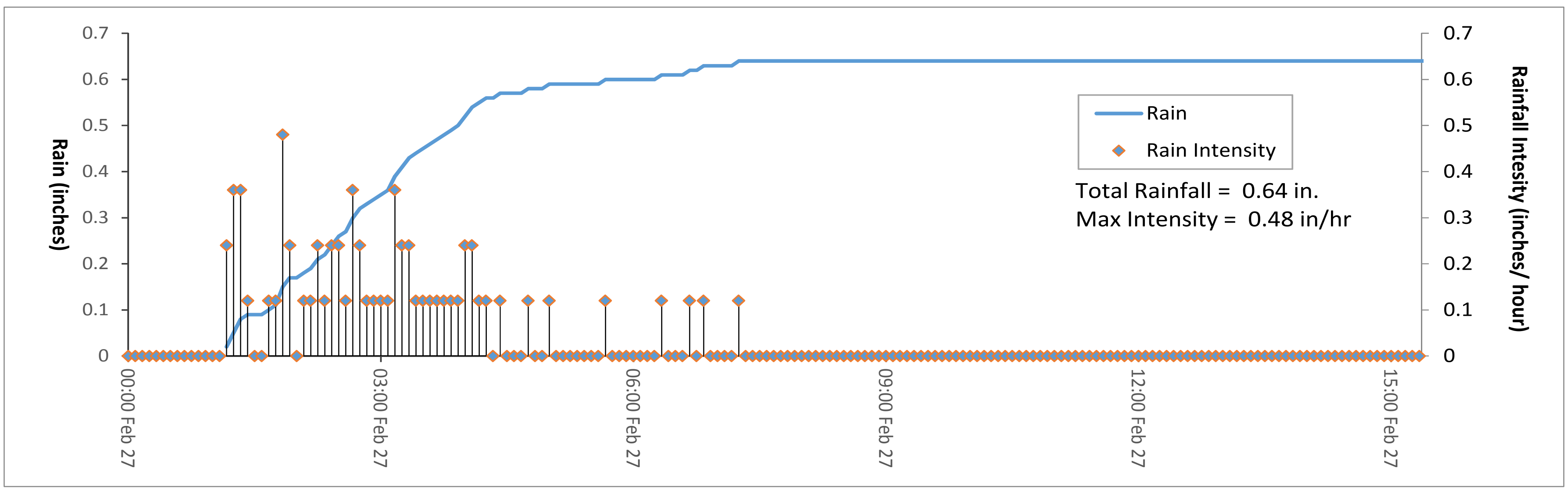
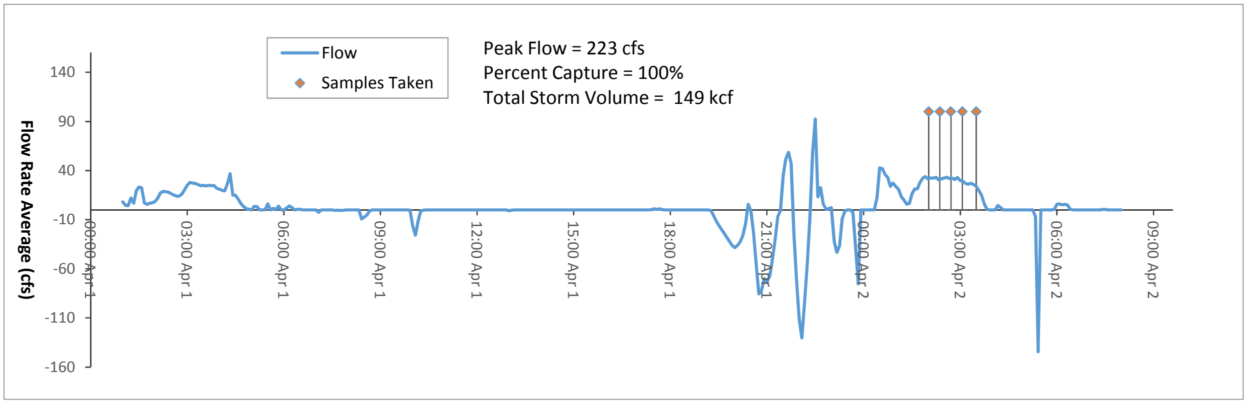
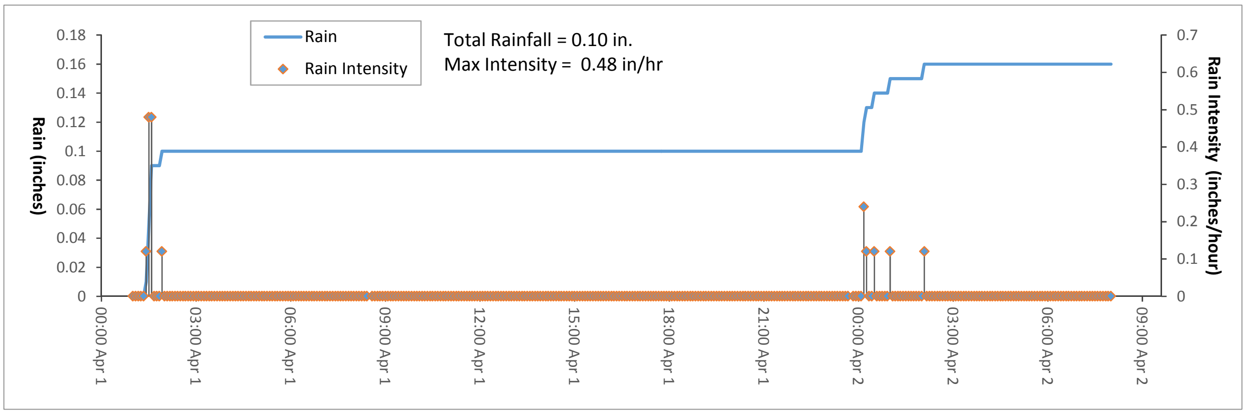


Figure 22. Rain and Flow from the Los Cerritos Channel Station for Station Event 3 (February 27, 2014).





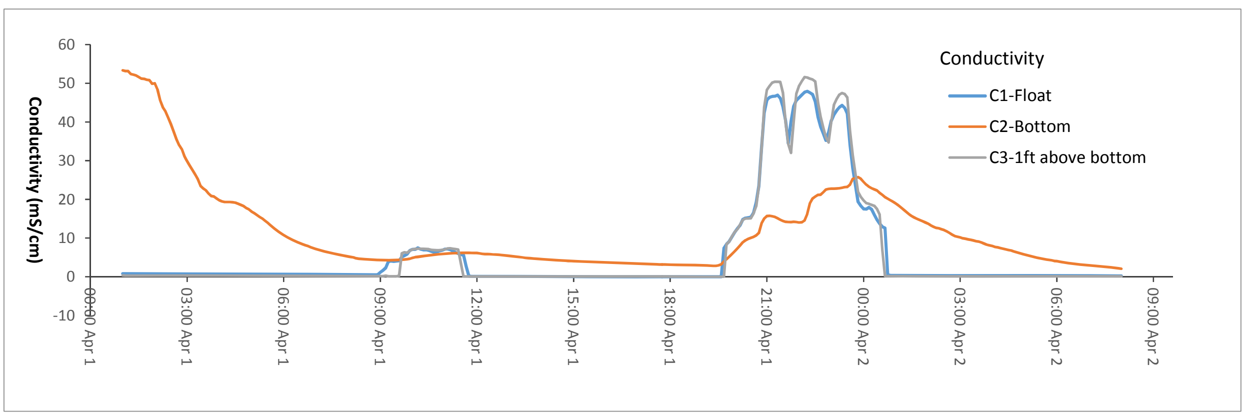


Figure 23. Rain, Flow and Conductivity from the Bouton Creek Station for Station Event 4 (April 1 and 2, 2014).

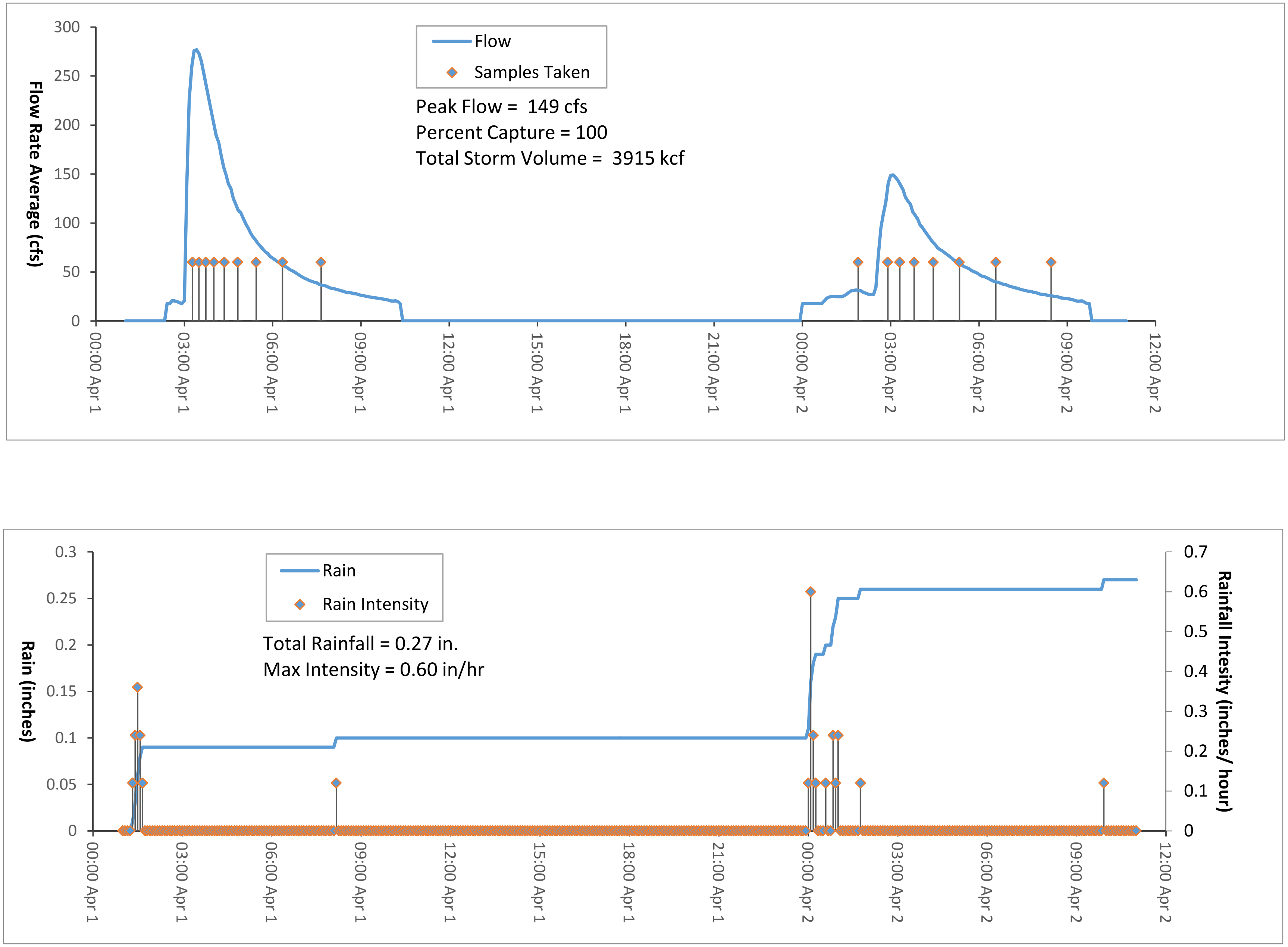


Figure 24. **Rain and Flow from the Los Cerritos Channel Station for Station Event 4 (April 1 and 2, 2014).**

Table 6. Daily Rainfall Data at the Belmont Pump Station during the 2012/2013 and 2013/2014 Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2012-13**	**2013-14**
1	0	0	0	0	0.01	0	0	0	0	0	0	0.36	0	0.05		
2	0	0	0	0	0.08	0	0	0	0	0.11	0	0.17	0	0.06		
3	0	0	0	0	0.31	0	0	0.01	0	0.09	0	0	0	0		
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
5	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0		
6	0	0	0	0	0	0	0.04	0	0	0.26	0	0	0	0		
7	0	0	0	0	0	0.14	0	0	0	0.01	0	0	0	0		
8	0	0	0.06	0	0	0	0	0	0.1	0	0.59	0	0	0		
9	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0		
10	0	0.01	0	0	0	0	0.01	0	0	0	0	0	0	0		
11	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0		
12	0	0	0	0	0.07	0	0	0	0	0	0	0	0	0		
13	0	0	0	0	0.15	0	0	0	0	0	0	0.04	0	0		
14	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0		
15	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0		
16	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0		
17	0	0	0.08	0	0	0	0	0	0	0	0	0	0	0		
18	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0		
19	0	0	0	0	0	0.08	0	0	0.08	0	0	0	0	0		
20	0	0	0	0.24	0	0	0	0	0	0	0	0	0	0		
21	0.04	0	0	0.34	0	0	0	0	0	0	0	0	0	0		
22	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0		
23	0.08	0	0	0	0	0	0.01	0	0	0	0	0	0	0		
24	0	0	0.01	0	0.45	0	0.66	0	0	0	0	0	0	0		
25	0	0	0	0	0	0	0.16	0	0	0	0	0	0	0.24		
26	0	0	0	0	0.07	0	0.12	0	0	0	0	0	0	0		
27	0	0	0	0	0	0	0.05	0	0	0.48	0	0	0	0		
28	0	0.04	0	0	0	0	0	0	0	1.04	0	0	0	0		
29	0	0.03	0.26	0.4	0.19	0	0	0			0	0	0	0		
30	0	0	0.43	0	0	0	0	0			0	0	0	0		
31	0	0			0	0	0	0			0	0				
Total	**0.25**	**0.14**	**0.89**	**0.99**	**1.46**	**0.22**	**1.05**	**0.01**	**0.18**	**1.99**	**0.59**	**0.57**	**0**	**0.35**	**4.42**	**4.27**

Darker shading depicts days water quality monitoring took place.

Table 7. Daily Rainfall Data at Bouton Creek during the 2012/2013 and 2013/2014 Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2012-13**	**2013-14**
1	0	0	0	0	0.02	0	0	0	0	0	0	0.28	0	0.1		
2	0	0	0	0	0.12	0	0	0	0	0.09	0	0.1	0	0.06		
3	0	0	0	0	0.42	0	0	0.01	0	0.09	0	0	0	0		
4	0	0	0	0	0	0	0	0	0	0	0	0.13	0	0		
5	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0		
6	0	0	0	0	0	0	0.05	0	0	0.19	0	0.02	0	0		
7	0	0	0	0	0	0.08	0	0	0	0.02	0.01	0	0	0		
8	0	0	0.05	0	0	0	0	0	0.22	0	0.44	0	0	0		
9	0	0.05	0	0	0	0	0	0	0	0	0	0	0	0		
10	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0		
11	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0		
12	0	0	0	0	0.08	0	0	0	0	0	0	0	0	0		
13	0	0	0	0	0.17	0	0	0	0	0	0	0.04	0	0		
14	0	0	0	0	0.05	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0		
16	0	0	0.05	0	0	0	0	0	0	0	0	0	0	0		
17	0	0	0.06	0	0	0	0	0	0	0	0	0	0	0		
18	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0		
19	0	0	0	0	0	0.12	0	0	0.24	0	0	0	0	0		
20	0	0	0	0.12	0	0	0	0	0	0	0	0	0	0		
21	0	0	0	0.29	0	0	0	0	0	0	0	0	0	0		
22	0	0	0	0.02	0	0	0	0	0	0	0	0	0	0		
23	0.01	0	0	0	0	0	0.01	0	0	0	0	0	0	0		
24	0	0	0.01	0	0.58	0	0.57	0	0	0	0	0	0	0		
25	0	0	0	0	0	0	0.11	0	0	0	0	0	0	0.24		
26	0	0	0	0	0.16	0	0.06	0	0	0	0	0.02	0	0		
27	0	0	0	0	0	0	0.08	0	0	0.67	0	0	0	0		
28	0	0.02	0	0	0	0	0	0	0	1.21	0	0	0	0		
29	0	0.07	0.23	0.3	0.16	0	0	0			0	0	0	0		
30	0	0	0.29	0.01	0.02	0	0	0			0	0	0	0		
31	0	0			0	0	0	0			0	0				
Total	**0.05**	**0.14**	**0.69**	**0.74**	**1.89**	**0.2**	**0.89**	**0.01**	**0.46**	**2.27**	**0.45**	**0.67**	**0**	**0.4**	**4.43**	**3.43**

Darker shading depicts days water quality monitoring took place

Table 8. Daily Rainfall Data at Los Cerritos Channel during the 2012/2013 and 2013/2014 Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2012-13**	**2013-14**
1	0	0	0	0	0.04	0	0	0	0	0	0	0.28	0	0.11		
2	0	0	0	0	0.19	0	0	0	0	0.09	0	0.1	0	0.16		
3	0	0	0	0	0.4	0	0	0.01	0	0.09	0	0	0	0		
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
6	0	0	0	0	0	0	0.05	0	0	0.19	0	0	0	0		
7	0	0	0	0	0	0.11	0	0	0	0.02	0	0	0	0		
8	0	0	0.07	0	0	0	0	0	0.3	0	0.63	0	0	0		
9	0	0.05	0	0	0	0	0	0	0	0	0	0	0	0		
10	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0		
11	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0		
12	0	0	0	0	0.07	0	0	0	0	0	0	0	0	0		
13	0	0	0	0	0.22	0	0	0	0	0	0	0	0	0		
14	0	0	0	0	0.05	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0.01	0	0	0	0	0	0	0	0.01	0		
16	0	0	0.08	0	0	0	0	0	0	0	0	0	0	0		
17	0	0	0.06	0	0.01	0	0	0	0	0	0	0	0	0		
18	0	0	0	0	0.11	0	0	0	0	0	0	0	0	0		
19	0	0	0	0	0	0.2	0	0	0.31	0	0	0	0	0		
20	0	0	0	0.15	0	0	0	0	0	0	0	0	0	0		
21	0	0	0	0.33	0	0	0	0	0	0	0	0	0	0		
22	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0		
23	0.01	0	0	0	0	0	0.01	0	0	0	0	0	0	0		
24	0	0	0.01	0	1.18	0	0.68	0	0	0	0	0	0	0		
25	0	0	0	0	0	0	0.14	0	0	0	0	0	0	0.22		
26	0	0	0	0	0.14	0	0.02	0	0	0	0	0.04	0	0		
27	0	0	0	0	0	0	0.05	0	0	0.67	0	0	0	0		
28	0	0	0	0	0	0	0	0	0	1.21	0	0	0	0		
29	0	0.03	0.28	0.37	0.16	0	0	0			0	0	0	0		
30	0	0	0.28	0.01	0.08	0	0	0			0	0	0	0		
31	0	0			0.01	0	0	0			0	0				
Total	**0.03**	**0.08**	**0.78**	**0.87**	**2.67**	**0.31**	**0.96**	**0.01**	**0.61**	**2.27**	**0.63**	**0.42**	**0.01**	**0.49**	**5.69**	**4.45**

Darker shading depicts days water quality monitoring took place.

Table 9. Daily Rainfall Data at the Dominguez Gap Pump Station during the 2012/2013 and 2013/2014 Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2012-13**	**2013-14**
1	0	0	0	0	0	0	0	0	0	0	0	0.62	0	0.17		
2	0	0	0	0	0.11	0	0	0	0	0.07	0	0.01	0	0.12		
3	0	0	0	0	0.19	0	0	0.01	0	0.02	0	0	0	0		
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
5	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0		
6	0	0	0	0	0	0	0.11	0	0	0.1	0	0	0	0		
7	0	0	0	0	0	0.15	0	0	0	0.01	0.15	0	0	0		
8	0	0	0	0	0	0	0	0	0.06	0	0.48	0	0	0		
9	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0		
10	0	0.01	0	0	0	0	0.01	0	0	0	0	0	0	0		
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
12	0	0	0	0	0.04	0	0	0	0	0	0	0	0	0		
13	0	0	0	0	0.09	0	0	0	0	0	0	0	0	0		
14	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
16	0	0	0.01	0	0.01	0	0	0	0	0	0	0	0	0		
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
18	0	0	0	0	0.11	0	0	0	0	0	0	0	0	0		
19	0	0	0	0	0	0.37	0	0	0.11	0	0	0	0	0		
20	0	0	0	0.12	0	0	0	0	0	0	0	0	0	0		
21	0	0	0	0.07	0	0	0	0	0	0	0	0	0	0		
22	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0		
23	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0		
24	0	0	0.01	0	0.75	0	0.69	0	0	0	0	0	0	0		
25	0	0.02	0	0	0	0	0.15	0	0	0	0	0	0	0.1		
26	0	0	0	0	0.13	0	0.14	0	0	0	0	0.06	0	0.01		
27	0	0	0	0	0	0	0.04	0	0	0.52	0	0	0	0		
28	0	0	0	0	0	0	0	0	0	0.73	0	0	0	0		
29	0	0	0.12	0.52	0.19	0.01	0	0			0	0	0	0		
30	0	0	0.39	0.01	0	0	0	0.01			0	0	0	0		
31	0	0			0	0	0	0			0	0				
Total	**0**	**0.06**	**0.53**	**0.73**	**1.69**	**0.53**	**1.15**	**0.02**	**0.17**	**1.45**	**0.63**	**0.69**	**0**	**0.4**	**4.17**	**3.88**

Darker shading depicts days water quality monitoring took place.

Table 10. Rainfall for Monitored Events during the 2013/2014 Wet-Weather Season.

Site/Event	Start Rain Date	Start Rain Time	End Rain Date	End Rain Time	Duration Rain (hours:minutes)	Total Rain (inches)	Max Intensity (Inches/hr)	Antecedent Rain (days)	Antecedent Rain (inches)	Sampling Code
Event 1										
BELMONT PUMP ST.	12/19/2013	11:26	12/19/2013	12:14	0:48	0.08	0.36	11.9	0.14	NS
BOUTON CREEK	12/19/2013	11:04	12/19/2013	12:55	1:51:00	0.18	0.36	19.8	0.30	Partial
LOS CERRITOS	12/19/2013	11:04	12/19/2013	12:55	1:51:00	0.18	0.36	12.0	0.57	Partial
DOMINGUEZ PUMP ST	12/19/2013	11:00	12/19/2013	11:58	0:58:00	0.13	0.24	20.0	0.52	NS
Event 2										
BELMONT PUMP ST.	2/2/2014	19:30	2/3/2014	6:38	11:08	0.2	0.12	45.3	0.08	Partial
BOUTON CREEK	2/2/2014	19:37	2/3/2014	6:48	11:11	0.18	0.12	44.9	0.24	Partial
LOS CERRITOS	2/2/2014	19:37	2/3/2014	6:48	11:11	0.18	0.12	45.3	0.20	Partial
DOMINGUEZ PUMP ST	2/2/2014	13:48	2/3/2014	0:37	10:48	0.09	NA	45.1	0.13	NS
Event 3										
BELMONT PUMP ST.	2/27/2014	1:08	2/27/2014	5:40	4:32:00	0.44	0.36	19.9	0.37	Full
BOUTON CREEK	2/27/2014	1:09	2/27/2014	7:15	6:06:00	0.64	0.48	19.4	0.16	Full
LOS CERRITOS	2/27/2014	1:09	2/27/2014	7:15	6:06:00	0.64	0.48	19.8	0.21	Full
DOMINGUEZ PUMP ST	2/27/2014	0:55	2/27/2014	13:48	12:52:23	0.50	NA	20.0	0.11	Full
Event 4										
BELMONT PUMP ST.	4/1/2014	1:20	4/2/2014	1:30	10:55	0.11	0.36	29.6	0.5	NS
BOUTON CREEK	4/1/2014	1:22	4/2/2014	2:01	11:55	0.16	0.48	29.6	0.82	Full
LOS CERRITOS	4/1/2014	1:18	4/2/2014	9:53	8:35	0.27	0.60	29.6	0.34	Full
DOMINGUEZ PUMP ST	4/1/2014	1:40	4/2/2014	1:50	0:10	0.28	NA	29.6	0.63	ND

Sampling Codes

Full = Sampled for full suite of chemical constituents and toxicity tests
Partial = Sampled for a reduced set of chemical constituents plus toxicity tests
TSS = Sampled for TSS only
ND = No Discharge
NS = No samples collected by autosampler

Table 11. Descriptive Statistics – Rainfall and Flow Data for All Monitored Events (2013/2014).

Site Parameter	n	Missing Values	Min	Max	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile
BELMONT PUMP									
Duration Flow (days)	2	2	0.39	0.40	0.39	0.00	0.39	0.39	0.39
Total Flow (kcf)	2	2	77.30	177.00	127.15	70.50	102.23	127.15	152.08
Duration Rain (days)	4	0	0.03	0.46	0.29	0.21	0.15	0.32	0.46
Total Rain (inches)	4	0	0.08	0.44	0.21	0.16	0.10	0.16	0.26
Max Intensity (in/hr)	4	0	0.12	0.36	0.30	0.12	0.30	0.36	0.36
Antecedent Dry (days)	4	0	0.37	45.30	21.80	19.74	9.05	20.76	33.51
Antecedent Rain (inches)	4	0	0.08	0.50	0.27	0.20	0.13	0.26	0.40
BOUTON CREEK									
Duration Flow (days)	4	0	0.26	1.21	0.68	0.41	0.44	0.62	0.86
Total Flow (kcf)	4	0	223.00	1273.00	566.00	484.06	270.25	384.00	679.75
Duration Rain (days)	4	0	0.08	0.50	0.32	0.20	0.21	0.36	0.47
Total Rain (inches)	4	0	0.16	0.64	0.29	0.23	0.18	0.18	0.30
Max Intensity (in/hr)	4	0	0.12	0.48	0.36	0.17	0.30	0.42	0.48
Antecedent Dry (days)	4	0	19.35	44.94	28.40	11.99	19.65	24.66	33.42
Antecedent Rain (inches)	4	0	0.16	0.82	0.38	0.30	0.22	0.27	0.43
LOS CERRITOS CHANNEL									
Duration Flow (days)	4	0	0.30	0.86	0.55	0.25	0.37	0.52	0.70
Total Flow (kcf)	4	0	960	14049.00	5302.50	5954.91	1954.50	3100.50	6448.50
Duration Rain (days)	4	0	0.08	1.36	0.54	0.57	0.21	0.36	0.69
Total Rain (inches)	4	0	0.18	0.64	0.32	0.22	0.18	0.23	0.36
Max Intensity (in/hr)	4	0	0.12	0.60	0.39	0.20	0.30	0.42	0.51
Antecedent Dry (days)	4	0	11.96	45.28	26.66	14.35	17.86	24.71	33.51
Antecedent Rain (inches)	4	0	0.20	0.57	0.33	0.17	0.21	0.28	0.40
DOMINGUEZ GAP									
Duration Flow (days)	1	3	0.52	0.52	0.52	NA	0.52	0.52	0.52
Total Flow (kcf)	1	3	300.25	300.25	300.25	NA	300.25	300.25	300.25
Duration Rain (days)	4	0	0.04	1.01	0.51	0.40	0.35	0.49	0.65
Total Rain (inches)	4	0	0.09	0.50	0.25	0.19	0.12	0.21	0.34
Max Intensity (in/hr)	0	4	0.00	0.00	NA	NA	NA	NA	NA
Antecedent Dry (days)	4	0	19.98	45.08	28.66	11.84	19.99	24.79	33.46
Antecedent Rain (inches)	4	0	0.11	0.63	0.45	0.23	0.42	0.52	0.55

Table 12. Rainfall and Flow Data for all Monitored Events during the 2013/2014 wet season.

	Start Flow		End Flow or Sampling								
Site/Event	Date	Time	Date	Time	Flow or Discharge Duration (hrs:mins)	Total Flow (kilo- cubic feet)	No. of Sample Aliquots Collected	PeakFlow (cfs)	% Storm Capture	Peak Capture	Sampling Code
Event 1											
BELMONT PUMP ST.	--	--	--	--	--	--	--	--	--	--	ND
BOUTON CREEK	12/19/2013	12:50	12/20/2013	6:35	17:45	482	12	318	100%	Yes	Partial
LOS CERRITOS	12/19/2013	12:15	12/20/2013	9:55	20:45	2286	10	172	100%	Yes	Partial
DOMINGUEZ PUMP ST	--	--	--	--	--	--	--	--	--	--	ND
Event 2											
BELMONT PUMP ST.	2/2/2014	22:30	2/3/2014	7:55	9:25	77	5	66	100%	Yes	Partial
BOUTON CREEK	2/3/2014	2:25	2/3/2014	8:35	6:10	286	7	119	100%	Yes	Partial
LOS CERRITOS	2/2/2014	23:25	2/3/2014	6:35	7:10	960	4	65	100%	Yes	Partial
DOMINGUEZ PUMP ST	--	--	--	--	--	--	--	--	--	--	ND
Event 3											
BELMONT PUMP ST.	2/26/2014	22:30	2/27/2014	8:00	9:30	177	11	66	100%	Yes	Full
BOUTON CREEK	2/27/2014	2:40	2/27/2014	14:50	12:10	1273	29	137	91%	Yes	Full
LOS CERRITOS	2/27/2014	2:10	2/27/2014	15:20	13:10	14049	38	1373	57%	No	Full
DOMINGUEZ PUMP ST	2/27/2014	8:00	2/27/2014	20:30	12:30	300	6	184	100%	Yes	Full
Event 4											
BELMONT PUMP ST.	--	--	--	--	--	--	--	--	--	--	NS
BOUTON CREEK	4/1/2014	2:35	4/2/2014	7:40	5:05	223	5	92	100%	Yes	No Tox
LOS CERRITOS	4/2/2014	0:05	4/2/2014	9:40	9:35	3915	17	149	100%	Yes	No Tox
DOMINGUEZ PUMP ST	--	--	--	--	--	--	--	--	--	--	ND

Sampling Codes

Full = Sampled for full suite of chemical constituents and toxicity tests
Partial = Sampled for a reduced set of chemical constituents plus toxicity tests
TSS = Sampled for TSS only
NS = No samples collected by autosampler.
ND = No Discharge

CHEMISTRY RESULTS

The following sections separately summarize the results of wet weather and dry weather monitoring efforts (Table 13). Wet weather results are provided in terms of the Event Mean Concentration (EMCs) for analytes that were collected either as flow-weighted composites or grab samples (Table 14 through Table 16). Loads are presented as the EMC of each analyte multiplied by the total flow for the event with appropriate factors to convert to kilograms.

Estimates of total pollutant loads associated with stormwater runoff during each storm event are provided in Table 17 through Table 19. Constituents included in these tables are limited to those that had measureable loads.

As of the 2010/2011 season, all load calculations are provided in kilograms. Reports prior to the 2010/2011 annual report had presented loads in terms of pounds. The database is in the process of converting to metric units in order to provide standard units for all data. The calculation as follows:

$$\text{TMDL Load kg/day} = \text{Daily Storm Volume (liters)} \times \text{numeric target (ug/L)} \times 10^{-9}$$

Consistent with sound scientific practice, total pollutant loads are reported to two significant digitssince all chemical data are also reported to two significant digits. Thus the TSS load for the first monitored event at the Los Cerritos Channel is reported as 107,000 kilograms or 53 metric tons of sediment.

WET WEATHER EMC AND LOADS

Four storm events were monitored during the 2013/2014 season as summarized in Table 13. Event 3 on February 27-29, 2014 provided four composite samples for full chemical and toxicity testing. The other events provided enough sample volumes for only partial chemical analyses but not for toxicity testing.

The results of the chemical analysis of these composite and grab stormwater samples are summarized in Table 14 through Table 16. Any values exceeding benchmarks are highlighted and footnoted to indicate which of the benchmarks are exceeded. Toxicity results for the composite samples from these monitored events are presented separately in the following section.

Pyrethroid pesticides were incorporated into the program during the middle of the 2010/2011. storm season. Initial samples were analyzed by CRG Marine Laboratories. CalTest Laboratories has performed all subsequent testing for pyrethroid pesticides. In order to achieve detection limits necessary for the two key organophosphate compounds, diazinon and chlorpyrifos, the laboratory needed to run the tests using NCI-GCMS which is also the analytical method for pyrethroid pesticides. As the pyrethoid pesticides were rapidly emerging as some of the most important contaminants of concern, it was chosen to incorporate this analytical method to provide an initial evaluation of the presence and concentrations of these compounds in stormwater runoff from the City of Long Beach. Pyrethroid pesticides were again analyzed in the stormwater samples from this year. Beginning with this present storm season, fipronil and major degradate compounds of fipronil were incorporated into the program. Fipronil is a pyrethroid replacement insecticide and is of increasing concern to state and federal agencies.

As one would expect, pollutant loads are largely controlled by the size of the watershed. Over the past 14 years, the Los Cerritos Channel (Table 19) has consistently produced the highest overall loads of solids and total metals simply due to the large size of the watershed and limited infiltration capacity.

Pollutant loads are consistently lowest at the Belmont Pump Station (Table 17) which has the smallest catchment area.

DRY WEATHER CHEMISTRY RESULTS

The NPDES Permit requires that two dry weather inspections and sampling events be conducted each year. These surveys are scheduled during the summer dry weather period at three of the four mass emission stations. A total of 30 dry weather surveys have been conducted since initial issuance of the permit (Table 20). Events 29 and 30, which were conducted during the 2013/2014 season, are shaded in Table 20. Field measurements are provided in Table 21 for the 2013/2014 season. Chemical analyses performed in the laboratory are summarized in Table 22 for the 2013/2014 season.

Since 2009, dry weather flows from the Belmont Pump Station have been pumped into the sanitary sewer system for treatment. Since this site no longer discharges dry weather flow to the receiving waters, no water samples or field measurements are taken. The site was still visited during each of the dry weather events to verify that the bypass was operational.

Bouton Creek Monitoring Site

Bouton Creek was inspected during both of the 2013/2014 dry weather events. The inspections occurred 2-3 hours after the lowest low tide of the day when the salt water had receded and the channel had been mostly flushed by fresher, low flow discharges. During these periods, flow in the creek was not impeded at the secondary monitoring site upstream by seawater backing into the creek. In early years, flow was usually freshwater and the volume of fresh flow had been sufficient to flush all residual saltwater from the channel at the primary monitoring site. Total and dissolved nickel measured values were rejected (R) for the first dry weather sampling event at Bouton Creek where the dissolved value of3.5 ug/L was higher than the measured total value of 1.3 ug/L.

The dry weather sampling location was changed for the 2009/2010 through the 2013/2014 inspections. Previously the dry weather samples were collected at the LADPW Alamitos Maintenance Yard at the same location as the wet weather samples are collected. Starting in October of 2009 the dry weather samples were collected just east of where Bouton Creek emerges from under the California State University Long Beach parking lot. The low flows were found to be much less influenced by residual salts that remain after higher tidal incursions into the channel. None of The outfalls located between the Alamitos Yard and the Cal State parking lot had discharges at the time of the inspection/sampling. The 20 liter grab samples were collected on September 22, 2013 and May 7, 2014.

Los Cerritos Channel Monitoring Site

Time-weighted samples are taken at 30-minute intervals covering a period of 24 hours during each dry weather event. Sampling was initiated for the first event on September 22, 2013 and was completed by September 23, 2013. Sampling for the second event began on May 6, 2014 and ended on May 7, 2014. All 48 samples were collected during both events.

Samples were taken from the middle of the channel using the automated sampler installed on the bank of the channel. Dry weather flows consisted of a shallow, narrow stream located near the middle of the channel. To reach the water, the sampling hose used for sampling stormwater was extended an additional 33 feet using protocol cleaned and blanked intake hose to reach the low flow channel. The composite bottles were changed every 12 hours and chilled to 4°C with ice during both the 24-hour sampling effort and during transportation. Following completion of the sampling, the bottles of water were combined into a single composite sample, mixed and then sub-sampled. Grab samples were manually collected for oil and grease and bacteria during the 24-hour sampling on September 22, 2013 and at the end of the 24-hour sampling on May 7, 2014.

Dominguez Gap Monitoring Site

Inspections for dry weather flow were conducted at the Dominguez Gap Pump Station on September 22, 2013 and on May 7, 2013. During the May 2014 event, sampling was initiated on May 6th and completed on May 7th.

Accurate discharge rates cannot be assessed at this site due to the configuration of the pump and the use of a valve to restrict the rate of discharge. The LADPW Engineering Department has indicated that the design level of the wet basin is 7 feet, and at this level the objective was to maintain a discharge of 3 cfs. Various Public Works personnel encountered at the pump station have indicated that they have been instructed to maintain water levels of either 8 or 9 feet. During dry weather periods, the water level in the basin is dependent upon a combination of manual adjustment of the gate valve that allows water to flow into it from the Los Angeles River and the capacity of the pump to discharge it back to the river. Public Works personnel make adjustments of the gate setting to maintain a level or, alternatively, use the larger pumps to periodically draw down the water level in the basin.

Table 13. Monitored Storm Events, 2013/2014.

Global Event	Event 1	Event 2	Event 3	Event 4
Date	December 19-20, 2013	February 3, 2014	February 27, 2014	April 4, 2014
Belmont Pump	ND	Partial, No Toxicity	Full	NS
Bouton Creek	Partial, No Toxicity	Partial, No Toxicity	Full	Full, No Toxicity
Los Cerritos Channel	Partial, No Toxicity	Partial, No Toxicity	Full	Full, No Toxicity
Dominguez Gap	ND	ND	Full	ND

Partial = Partial chemistry analysis due to low storm volumes and included metals and key conventional analytes.
Full = Full chemistry and toxicity
ND = No discharge
NS = No sample

Table 14. Belmont Pump and Domingez Gap Stormwater Chemistry Results, 2013/2014.

	Belmont Pump		Dominguez Gap
Analyte	2/3/2014	2/27/2014	2/27/2014
Conventionals (mg/L unless noted)			
pH (pH Units)	7.84	7.59	8.42
Alkalinity as CaCO3		52	130
Biochemical Oxygen Demand		14	10
Chemical Oxygen Demand		140	62
Chloride		60	130
Conductivity (uS/cm)		370	960
Fluoride		0.45	0.55
Hardness as CaCO3	160	50	210
MBAS		0.054	0.024J
Nitrate (as N)		1.4	1.3
Nitrite (as N)		0.035J	0.065J
Oil and Grease		5U	5U
Total Ammonia (as N)		0.55	0.32
Total Dissolved Solids		220	560
Total Kjeldahl Nitrogen		3.9	2.3
Total Organic Carbon		28	11
Orthophosphate (as P)		0.38	0.099
Total Phosphorus (as P)		0.82	0.37
Total Recoverable Phenolics		0.1U	0.1U
Total Suspended Solids	77	150	40
Volatile Suspended Solids		47	10
Turbidity (NTU)		63J	32J
Dissolved Metals (ug/L)			
Aluminum	22.6J	26J+	25U
Arsenic	2.79	1.5	2
Cadmium	1U	0.036J	0.15J
Chromium	0.788J	0.59	0.12J
Copper	14.9 [3,4]	14 [3,4]	5.7 [3,4]
Iron		68	25
Lead	0.472J	0.71	0.75
Nickel	5.05	3.9	4.4
Selenium	0.298J	1U	1U
Silver	1U	0.2U	0.2U
Zinc	52.7	63	22
Total Metals (ug/L)			
Aluminum	1020 [1]	3900J [1]	1500J [1]
Arsenic	3.16	3.9	3.1
Cadmium	0.196J	0.46	0.26
Chromium	3.24	8.2	2.1
Copper	44.4 [2]	72 [2]	11
Iron		4700	1600
Lead	12.4 [2]	30 [2]	6.1
Nickel	6.98	10	5.6
Selenium	0.312J	1U	1U
Silver	1U	0.094J	0.026J
Zinc	133 [2]	280 [2]	47

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5=UC Davis CMC

U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative

Table 14. Belmont Pump and Domingez Gap Stormwater Chemistry Results, 2013/2014 (cont.).

	Belmont Pump		Dominguez Gap
Analyte	2/3/2014	2/27/2014	2/27/2014
Microbiology (MPN/100 ml)			
Enterococcus		1100 [1,2]	17000 [1,2]
Fecal Coliform		3600J [1,2]	17000J [1,2]
Total Coliform		22000 [1,2]	35000 [1,2]
Aroclors (ug/L)			
Aroclor 1016		0.1U	0.1U
Aroclor 1221		0.1U	0.1U
Aroclor 1232		0.1U	0.1U
Aroclor 1242		0.1U	0.1U
Aroclor 1248		0.1U	0.1U
Analyte			
Aroclor 1254		0.1U	0.1U
Aroclor 1260		0.1U	0.1U
Total Aroclors		0	0
Chlorinated Pesticides (ug/L)			
2,4'-DDD		0.005U	0.005U
2,4'-DDE		0.005U	0.005U
2,4'-DDT		0.01U	0.01U
4,4'-DDD		0.005U	0.005U
4,4'-DDE		0.005U	0.005U
4,4'-DDT		0.005U	0.005U
Total DDT		0	0
Aldrin		0.005U	0.005U
Dieldrin		0.005U	0.005U
Endrin		0.005U	0.005U
Endrin aldehyde		0.005U	0.005U
Endrin ketone		0.005U	0.005U
alpha-BHC		0.005U	0.005U
beta-BHC		0.005U	0.005U
delta-BHC		0.005U	0.005U
gamma-BHC (Lindane)		0.005U	0.005U
Endosulfan I		0.005U	0.005U
Endosulfan II		0.005U	0.005U
Endosulfan sulfate		0.005U	0.005U
Heptachlor		0.005U	0.005U
Heptachlor epoxide		0.005U	0.005U
alpha-Chlordane		0.005U	0.005U
gamma-Chlordane		0.005U	0.005U
Oxychlordane		0.005U	0.005U
cis-Nonachlor		0.005U	0.005U
trans-Nonachlor		0.01U	0.01U
Total Chlordane		0	0
Methoxychlor		0.005U	0.005U
Toxaphene		0.5U	0.5U

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5=UC Davis CMC

U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative

Table 14. Belmont Pump and Domingez Gap Stormwater Chemistry Results, 2013/2014 (cont.).

	Belmont Pump		Dominguez Gap
Analyte	2/3/2014	2/27/2014	2/27/2014
Organophosphates (ug/L)			
Azinphos methyl		0.05U	0.05U
Chlorpyrifos		0.0009J	0.002U
Demeton		0.5U	0.5U
Diazinon		0.0015U	0.0015U
Disulfoton		0.1U	0.1U
Ethion		0.02U	0.02U
Malathion		0.05U	0.05U
Parathion ethyl		0.05U	0.05U
Parathion methyl		0.1U	0.1U
Thiobencarb		0.2U	0.2U
Pyrethroids (ng/L)			
Allethrin		1.5U	1.5U
Bifenthrin		**49**[5]	1J
Cyfluthrin		**37J-**[5]	**0.7J-**[5]
Cypermethrin		**10**[5]	1.5U
Fenpropathrin		1.5U	1.5U
Lambda-Cyhalothrin		1.2J	1.5U
Permethrin		**94**[5]	15U
Deltamethrin:Tralomethrin		32	3
Esfenvalerate:Fenvalerate		0.3J	3U
Tau-Fluvalinate		1.5U	1.5U
Tetramethrin		1.5U	1.5U
Fipronil (ng/L)			
Fipronil		**30J-**[6]	5.9J-
Fipronil Sulfide		1J-	1J-
Fipronil Sulfone		16J-	4J-
Fipronil Desulfinyl		14 J-	5.6 J-

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5=UC Davis CMC, 6=Lowest EPA Aquatic Life Benchmark

U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative

Table 15. Bouton Creek Stormwater Chemistry Results, 2013/2014.

	Bouton Creek			
Analyte	12/19-20/2013	2/3/2014	2/27/2014	4/1-2/2014
Conventionals (mg/L unless noted)				
pH (pH Units)		7.44	7.53	
Alkalinity as CaCO3			27	31
Biochemical Oxygen Demand			12	24
Chemical Oxygen Demand			90	150
Chloride			38	91
Conductivity (uS/cm)			220	440
Fluoride			0.35	0.37
Hardness as CaCO3	94	150	32	57
MBAS			0.046	0.3
Nitrate (as N)			0.87	0.65
Nitrite (as N)			0.029J	0.1U
Oil and Grease			5U	6.1U
Total Ammonia (as N)			0.5	0.7
Total Dissolved Solids			140	260
Total Kjeldahl Nitrogen			2.3	3.9
Total Organic Carbon			20	34
Orthophosphate (as P)			0.22	0.11
Total Phosphorus (as P)			0.51	0.57
Total Recoverable Phenolics			0.1U	0.1U
Total Suspended Solids	71	31	86	110
Volatile Suspended Solids			31	48
Turbidity (NTU)			37J	74
Dissolved Metals (ug/L)				
Aluminum	54.4J	54.6	26J+	25U
Arsenic	2.35J	1.81	0.81	1.1
Cadmium	5U	1U	0.036J	0.2U
Chromium	6.98	11.5	6.2	10
Copper	23.3 [3,4]	20 [3,4]	8.8 [3,4]	11 [3,4]
Iron			80	94
Lead	2.09J	1.56	0.9	1.2
Nickel	4.84J	10.9	5.2	7.1
Selenium	5U	1U	1U	1U
Silver	5U	1U	0.2U	0.2U
Zinc	94.4 [4]	50.7	55 [3]	48
Total Metals (ug/L)				
Aluminum	1310 [1]	385	1700J [1]	2100 [1]
Arsenic	5U	2.62	2	2.2
Cadmium	5U	1U	0.23	0.33
Chromium	8.61	19.4	14	31
Copper	48.7 [2]	30.6 [2]	30 [2]	40 [2]
Iron			2000	2700
Lead	12.4 [2]	4.74	11 [2]	16J [2]
Nickel	7.35	13.2	8.4	13
Selenium	5U	0.222J	1U	1U
Silver	5U	0.651J	0.041J	0.044J
Zinc	203 [2]	97.7 [2]	170 [2]	230J [2]

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5=UC Davis CMC

U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative

Table 15. Bouton Creek Stormwater Chemistry Results, 2013/2014 (continued).

	Bouton Creek			
Analyte	12/19-20/2013	2/3/2014	2/27/2014	4/1-2/2014
Microbiology (MPN/100 ml)				
Enterococcus			**2600** [1,2]	**12000** [1,2]
Fecal Coliform			**11000J** [1,2]	**1600000** [1,2]
Total Coliform			**9400** [1,2]	**1600000** [1,2]
Aroclors (ug/L)				
Aroclor 1016			0.1U	0.15U
Aroclor 1221			0.1U	0.15U
Aroclor 1232			0.1U	0.15U
Aroclor 1242			0.1U	0.15U
Aroclor 1248			0.1U	0.15U
Analyte				
Aroclor 1254			0.1U	0.15U
Aroclor 1260			0.1U	0.15U
Total Aroclors			0	0
Chlorinated Pesticides (ug/L)				
2,4'-DDD			0.005U	0.0075U
2,4'-DDE			0.005U	0.0075U
2,4'-DDT			0.01U	0.015UJ
4,4'-DDD			0.005U	0.007U
4,4'-DDE			0.005U	0.007U
4,4'-DDT			0.005U	0.007U
Total DDT			0	0
Aldrin			0.005U	0.007U
Dieldrin			0.005U	0.007U
Endrin			0.005U	0.007U
Endrin aldehyde			0.005U	0.007U
Endrin ketone			0.005U	0.007U
alpha-BHC			0.005U	0.007U
beta-BHC			0.005U	0.007U
delta-BHC			0.005U	0.007U
gamma-BHC (Lindane)			0.005U	0.007U
Endosulfan I			0.005U	0.007U
Endosulfan II			0.005U	0.007U
Endosulfan sulfate			0.005U	0.007U
Heptachlor			0.005U	0.007U
Heptachlor epoxide			0.005U	0.007U
alpha-Chlordane			0.005U	0.007U
gamma-Chlordane			0.005U	0.007U
Oxychlordane			0.005U	0.0075U
cis-Nonachlor			0.005U	0.0075U
trans-Nonachlor			0.01U	0.015U
Total Chlordane			0	0
Methoxychlor			0.005U	0.007U
Toxaphene			0.5U	0.7U

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5=UC Davis CMC

U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative

Table 15. Bouton Creek Stormwater Chemistry Results, 2013/2014 (continued).

	Bouton Creek			
Analyte	12/19-20/2013	2/3/2014	2/27/2014	4/1-2/2014
Organophosphates (ug/L)				
Azinphos methyl			0.05U	0.07U
Chlorpyrifos			0.002U	0.002U
Demeton			0.5U	0.5U
Diazinon			0.0015U	0.0015U
Disulfoton			0.1U	0.1U
Ethion			0.02U	0.03U
Malathion			0.05U	0.07U
Parathion ethyl			0.05U	0.07U
Parathion methyl			0.1U	0.1U
Thiobencarb			0.2U	0.2U
Pyrethroids (ng/L)				
Allethrin			1.5U	1.5U
Bifenthrin			**33** [5]	**13** [5]
Cyfluthrin			**11J-** [5]	**25** [5]
Cypermethrin			**2.2** [5]	**20** [5]
Fenpropathrin			1.5U	1.5U
Lambda-Cyhalothrin			0.5J	1J
Permethrin			**22** [5]	**27** [5]
Deltamethrin:Tralomethrin			5.6	3.8
Esfenvalerate:Fenvalerate			3U	1.3J
Tau-Fluvalinate			1.5U	1.5U
Tetramethrin			1.5U	1.5U
Fipronil (ng/L)				
Fipronil			4.9J-	4
Fipronil Sulfide			1.5U	1.5U
Fipronil Sulfone			3.2 J-	3
Fipronil Desulfinyl			2.5 J-	3.2

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5=UC Davis CMC

U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative

Table 16. Los Cerritos Channel Stormwater Chemistry Results, 2013/2014.

	Los Cerritos Channel			
Analyte	12/19-20/2013	2/3/2014	2/27/2014	4/1-2/2014
Conventionals (mg/L unless noted)				
pH (pH Units)		7.76	7.26	7.42
Alkalinity as CaCO3			23	31
Biochemical Oxygen Demand			11	24
Chemical Oxygen Demand			110	170
Chloride			5.8	14
Conductivity (uS/cm)			92	150
Fluoride			0.24	0.34
Hardness as CaCO3	38	68	22	39
MBAS			0.056	0.29
Nitrate (as N)			0.88	0.89
Nitrite (as N)			0.026J	0.025J
Oil and Grease			1J	5.1U
Total Ammonia (as N)			0.5	0.58
Total Dissolved Solids	127		65	120
Total Kjeldahl Nitrogen			2.3	4
Total Organic Carbon			16	33
Orthophosphate (as P)			0.2	0.21
Total Phosphorus (as P)			0.59	0.7
Total Recoverable Phenolics			0.1U	0.1U
Total Suspended Solids	158	68	110	210
Volatile Suspended Solids			33	78
Turbidity (NTU)			36J	56
Dissolved Metals (ug/L)				
Aluminum	49.6J	45.6J	25U	25U
Arsenic	5U	1.98	0.88	1
Cadmium	5U	1U	0.085J	0.088J
Chromium	5U	1.73	0.83	0.9
Copper	**17.4** [3,4]	**28.5** [3,4]	**9.9** [3,4]	**15** [3,4]
Iron			32	53
Lead	2.06J	1.79	0.56	0.91
Nickel	3.52J	7.49	2.4	3.6
Selenium	5U	0.343J	1U	1U
Silver	5U	1U	0.2U	0.018J
Zinc	**93.7** [3,4]	**122** [3,4]	**66** [3]	**82** [3]
Total Metals (ug/L)				
Aluminum	**1890** [1]	**1080** [1]	**4000J** [1]	**2600** [1]
Arsenic	2.41J	2.74	2.8	2.7
Cadmium	0.707J	0.511J	0.57	0.7
Chromium	7.04	4.97	7.6	7.2
Copper	**50.6** [2]	**53.8** [2]	**35** [2]	**49** [2]
Iron			3000	3400
Lead	**20.1** [2]	**12.6** [2]	**20** [2]	**27J** [2]
Nickel	10.2	11	8.4	12
Selenium	0.905J	0.52J	1U	1U
Silver	5U	0.141J	0.072J	0.085J
Zinc	**324** [2]	**346** [2]	**260** [2]	**390J** [2]

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5=UC Davis CMC

U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative

Table 16. Los Cerritos Channel Stormwater Chemistry Results, 2013/2014 (continued).

	Los Cerritos Channel			
Analyte	12/19-20/2013	2/3/2014	2/27/2014	4/1-2/2014
Microbiology (MPN/100 ml)				
Enterococcus			4900 [1,2]	840 [1,2]
Fecal Coliform			35000J [1,2]	390000 [1,2]
Total Coliform			35000 [1,2]	440000 [1,2]
Aroclors (ug/L)				
Aroclor 1016			0.11U	0.1U
Aroclor 1221			0.11U	0.1U
Aroclor 1232			0.11U	0.1U
Aroclor 1242			0.11U	0.1U
Aroclor 1248			0.11U	0.1U
Analyte				
Aroclor 1254			0.11U	0.1U
Aroclor 1260			0.11U	0.1U
Total Aroclors			0	0
Chlorinated Pesticides (ug/L)				
2,4'-DDD			0.0056U	0.005U
2,4'-DDE			0.0056U	0.005U
2,4'-DDT			0.011U	0.01UJ
4,4'-DDD			0.006U	0.005U
4,4'-DDE			0.006U	0.005U
4,4'-DDT			0.006U	0.005U
Total DDT			0	0
Aldrin			0.006U	0.005U
Dieldrin			0.006U	0.005U
Endrin			0.006U	0.005U
Endrin aldehyde			0.006U	0.005U
Endrin ketone			0.006U	0.005U
alpha-BHC			0.006U	0.005U
beta-BHC			0.006U	0.005U
delta-BHC			0.006U	0.005U
gamma-BHC (Lindane)			0.006U	0.005U
Endosulfan I			0.006U	0.005U
Endosulfan II			0.006U	0.005U
Endosulfan sulfate			0.006U	0.005U
Heptachlor			0.006U	0.005U
Heptachlor epoxide			0.006U	0.005U
alpha-Chlordane			0.006U	0.005U
gamma-Chlordane			0.006U	0.005U
Oxychlordane			0.0056U	0.005U
cis-Nonachlor			0.0056U	0.005U
trans-Nonachlor			0.011U	0.01U
Total Chlordane			0	0
Methoxychlor			0.006U	0.005U
Toxaphene			0.6U	0.5U

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5=UC Davis CMC
U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative

Table 16. Los Cerritos Channel Stormwater Chemistry Results, 2013/2014 (continued).

	Los Cerritos Channel			
Analyte	12/19-20/2013	2/3/2014	2/27/2014	4/1-2/2014
Organophosphates (ug/L)				
Azinphos methyl			0.06U	0.05U
Chlorpyrifos			0.0006J	0.002U
Demeton			0.5U	0.5U
Diazinon			0.0015U	0.0015U
Disulfoton			0.1U	0.1U
Ethion			0.02U	0.02U
Malathion			0.06U	0.05U
Parathion ethyl			0.06U	0.05U
Parathion methyl			0.1U	0.1U
Thiobencarb			0.2U	0.2U
Pyrethroids (ng/L)				
Allethrin			1.5U	1.5U
Bifenthrin			**17** [5]	**11** [5]
Cyfluthrin			**28J-** [5]	**19** [5]
Cypermethrin			**10** [5]	**5.3** [5]
Fenpropathrin			1.5U	1.5U
Lambda-Cyhalothrin			1.5U	1.1J
Permethrin			**28** [5]	**25** [5]
Deltamethrin:Tralomethrin			6.3	6.8
Esfenvalerate:Fenvalerate			3U	0.3J
Tau-Fluvalinate			1.5U	1.5U
Tetramethrin			1.5U	1.5U
Fipronil (ng/L)				
Fipronil			6.2J-	4.2
Fipronil Sulfide			1.5U	1.5U
Fipronil Sulfone			1.5U	2.4
Fipronil Desulfinyl			3.6J-	3.2

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5=UC Davis CMC

U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative

Table 17. Total Load in Kilograms at the Belmont Pump Station and Dominguez Gap for the 2013/2014 Storm Events.

	Belmont Pump		Dominguez Gap
Analyte	2/3/2014	2/27/2014	2/27/2014
Conventionals			
Alkalinity as CaCO3		260	1100
Hardness as CaCO3	350	250	1800
Biochemical Oxygen Demand		70	85
Chemical Oxygen Demand		700	530
Total Organic Carbon		140	94
Chloride		300	1100
Fluoride		2.3	4.7
MBAS		0.27	0.2
Oil and Grease		0	0
Total Ammonia (as N)		2.8	2.7
Total Kjeldahl Nitrogen		20	20
Nitrate (as N)		7	11
Nitrite (as N)		0.18	0.55
Orthophosphate (as P)		1.9	0.84
Total Phosphorus (as P)		4.1	3.1
Total Dissolved Solids		1100	4800
Total Suspended Solids	170	750	340
Volatile Suspended Solids		240	85
Organophosphates			
Chlorpyrifos		0.0000045	0
Pyrethroids			
Bifenthrin		0.00025	0.0000085
Cyfluthrin		0.00019	0.000006
Cypermethrin		0.00005	0
Lambda-Cyhalothrin		0.000006	0
Permethrin		0.00047	0
Deltamethrin:Tralomethrin		0.00016	0.000026
Esfenvalerate:Fenvalerate		0.0000015	0
Fipronil			
Fipronil		0.00015	0.00005
Fipronil Desulfinyl		0.00007	0.000048
Fipronil Sulfide		0.000005	0.0000085
Fipronil Sulfone		0.00008	0.000034

Zero is used for non-detects in calculating total load. Those cases with non-detects across the board have been skipped for brevity, including all Aroclors and Chlorinated Pesticides.

Table 17. Total Load in Kilograms at Belmont Pump and Dominguez Gap for the 2013/2014 Storm Events (cont.).

	Belmont Pump		Dominguez Gap
Analyte	2/3/2014	2/27/2014	2/3/2014
Dissolved Metals			
Aluminum	0.049	0.13	0.056
Arsenic	0.0061	0.0075	0.017
Cadmium	0	0.00018	0.0013
Chromium	0.00172	0.003	0.001
Copper	0.0326	0.07	0.048
Iron		0.34	0.21
Lead	0.001	0.0036	0.0064
Nickel	0.011	0.02	0.037
Selenium	0.00065	0	0
Silver	0	0	0
Zinc	0.12	0.32	0.19
Total Metals			
Aluminum	2.2	20	13
Arsenic	0.0069	0.02	0.026
Cadmium	0.00043	0.0023	0.0022
Chromium	0.0071	0.041	0.018
Copper	0.097	0.36	0.094
Iron		24	14
Lead	0.027	0.15	0.052
Nickel	0.015	0.05	0.048
Selenium	0.00068	0	0
Silver	0	0.00047	0.00022
Zinc	0.29	1.4	0.4

Zero is used for non-detects in calculating total load. Those cases with non-detects across the board have been skipped for brevity, including all Aroclors and Chlorinated Pesticides.

Table 18. Total Load in Kilograms at Bouton Creek for the 2013/2014 Storm Events.

	Bouton Creek			
Analyte	12/19-20/2013	12/19-20/2013	12/19-20/2013	12/19-20/2013
Conventionals				
Alkalinity as CaCO3			970	200
Hardness as CaCO3	1300	1200	1200	360
Biochemical Oxygen Demand			430	150
Chemical Oxygen Demand			3200	950
Total Organic Carbon			720	210
Chloride			1400	570
Fluoride			13	2.3
MBAS			1.7	1.9
Oil and Grease			0	0
Total Ammonia (as N)			18	4.4
Total Kjeldahl Nitrogen			83	25
Nitrate (as N)			31	4.1
Nitrite (as N)			1	0
Orthophosphate (as P)			7.9	0.69
Total Phosphorus (as P)			18	3.6
Total Dissolved Solids			5000	1600
Total Suspended Solids	970	250	3100	690
Volatile Suspended Solids			1100	300
Organophosphates				
Chlorpyrifos			0	0
Pyrethroids				
Bifenthrin			0.0012	0.000082
Cyfluthrin			0.0004	0.00016
Cypermethrin			0.000079	0.00013
Lambda-Cyhalothrin			0.000018	0.0000063
Permethrin			0.00079	0.00017
Deltamethrin:Tralomethrin			0.0002	0.000024
Esfenvalerate:Fenvalerate			0	0.0000082
Fipronil				
Fipronil			0.00018	0.000025
Fipronil Desulfinyl			0.00009	0.00002
Fipronil Sulfide			0	0
Fipronil Sulfone			0.00012	0.000019

Zero is used for non-detects in calculating total load. Those cases with non-detects across the board have been skipped for brevity, including all Aroclors and Chlorinated Pesticides.

Table 18. Total Load in Kilograms at Bouton Creek for the 2013/2014 Storm Events (cont.).

	Bouton Creek			
Analyte	12/19-20/2013	12/19-20/2013	12/19-20/2013	12/19-20/2013
Dissolved Metals				
Aluminum	0.74	0.44	0.94	0.13
Arsenic	0.032	0.015	0.029	0.0069
Cadmium	0	0	0.0013	0
Chromium	0.095	0.093	0.22	0.063
Copper	0.32	0.16	0.32	0.069
Iron			2.9	0.59
Lead	0.029	0.013	0.032	0.0076
Nickel	0.066	0.088	0.19	0.045
Selenium	0	0	0	0
Silver	0	0	0	0
Zinc	1.3	0.41	2	0.3
Total Metals				
Aluminum	18	3.1	61	13
Arsenic	0	0.021	0.072	0.014
Cadmium	0	0	0.0083	0.0021
Chromium	0.12	0.16	0.5	0.2
Copper	0.66	0.25	1.1	0.25
Iron			72	17
Lead	0.17	0.038	0.4	0.1
Nickel	0.1	0.11	0.3	0.082
Selenium	0	0.0018	0	0
Silver	0	0.0053	0.0015	0.00028
Zinc	2.8	0.79	6.1	1.5

Zero is used for non-detects in calculating total load. Those cases with non-detects across the board have been skipped for brevity, including all Aroclors and Chlorinated Pesticides.

Table 19. Total Load in Kilograms at Los Cerritos Channel for the 2013/2014 Storm Events.

	Los Cerritos Channel			
Analyte	12/19-20/2013	12/19-20/2013	12/19-20/2013	12/19-20/2013
Conventionals				
Alkalinity as CaCO3			9100	3400
Hardness as CaCO3	2500	1800	8800	4300
Biochemical Oxygen Demand			4400	2700
Chemical Oxygen Demand			44000	19000
Total Organic Carbon			6400	3700
Chloride			2300	1600
Fluoride			95	38
MBAS			22	32
Oil and Grease			400	0
Total Ammonia (as N)			200	64
Total Kjeldahl Nitrogen			910	440
Nitrate (as N)			350	99
Nitrite (as N)			10	2.8
Orthophosphate (as P)			80	23
Total Phosphorus (as P)			230	78
Total Dissolved Solids	8200		26000	13000
Total Suspended Solids	10000	1800	44000	23000
Volatile Suspended Solids			13000	8600
Organophosphates				
Chlorpyrifos			0.00024	0
Pyrethroids				
Bifenthrin			0.0068	0.0012
Cyfluthrin			0.011	0.0021
Cypermethrin			0.004	0.00059
Lambda-Cyhalothrin			0	0.00012
Permethrin			0.011	0.0028
Deltamethrin:Tralomethrin			0.0025	0.00075
Esfenvalerate:Fenvalerate			0	0.000033
Fipronil				
Fipronil			0.0025	0.00047
Fipronil Desulfinyl			0.0014	0.00035
Fipronil Sulfide			0	0
Fipronil Sulfone			0	0.00027

Zero is used for non-detects in calculating total load. Those cases with non-detects across the board have been skipped for brevity, including all Aroclors and Chlorinated Pesticides.

Table 19. Total Load in Kilograms at Los Cerritos Channel for the 2013/2014 Storm Events (cont.).

	Los Cerritos Channel			
Analyte	12/19-20/2013	12/19-20/2013	12/19-20/2013	12/19-20/2013
Dissolved Metals				
Aluminum	3.2	1.2	8.8	2.7
Arsenic	0	0.054	0.35	0.11
Cadmium	0	0	0.034	0.0098
Chromium	0	0.047	0.33	0.1
Copper	1.1	0.77	3.9	1.7
Iron			13	5.9
Lead	0.13	0.049	0.22	0.1
Nickel	0.23	0.2	0.95	0.4
Selenium	0	0.0093	0	0
Silver	0	0	0	0.002
Zinc	6.1	3.3	26	9.1
Total Metals				
Aluminum	120	29	1600	290
Arsenic	0.16	0.074	1.1	0.3
Cadmium	0.046	0.014	0.23	0.078
Chromium	0.46	0.14	3	0.8
Copper	3.3	1.5	14	5.4
Iron			1200	380
Lead	1.3	0.34	8	3
Nickel	0.66	0.3	3.3	1.3
Selenium	0.059	0.014	0	0
Silver	0	0.0038	0.029	0.0094
Zinc	21	9.4	100	43

Zero is used for non-detects in calculating total load. Those cases with non-detects across the board have been skipped for brevity, including all Aroclors and Chlorinated Pesticides.

Table 20. Monitored Dry Weather Events, 1999-2014.

Station	1 - 10/4/00	2 - 6/21/00	3 - 6/29/00	4 – 6/5/01	5 – 8/16/01	6 – 5/9,14/02	7 – 9/5/02	8 – 5/20/03	9 – 9/II/03	10 – 5/4/04	11 – 8/4/04	12 – 5/4/05	13 – 8/18/05	14 – 5/11/06	15 – 9/7/06	16 – 5/17/07	17 – 9/27/07	18 – 5/7/08	19 – 7/2/08	20 – 5/7/09	21 – 10/12/09	22 – 5/11/10	23 – 9/23/10	24 – 5/10/11	25 – 9/14/11	26 – 5/1/12	27 – 9/13/12	28 – 5/1/13	29 – 9/22/13	30 – 5/7/14
Bouton Creek		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●[3]	●[3]	●[3]	●[5]	●[5]	●[5]	●[5]	●[5]	●[5]	●[5]	●[5]	●[5]	●[5]
Belmont Pump[4]		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●														
Los Cerritos Channel				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Dominguez Gap		●[1]	●[1]	●[1]	●[1]	●[1]	●[1]	●[1]	●[1]	●[1]	●[1]	●[1]	●[1]	●[1]	●[1]	●[1]	●[2]	●	●[1]	●[1]	●	●	●	●	●[6]	●	●	●[7]	●[8]	●

1. The intake to the sump was observed to be dry. Therefore, no samples were collected.
2. The pump station was inoperative during renovation of the pumps and the wet basin behind the pump house. No samples were collected.
3. There was very low flow along both sides of the channel during each event. In each case flow was insufficient to flush the salt water out of the channel. Salinity never dropped below 17 ppt during Event 19 and 10.8 during Event 20 before the channel was flooded by the incoming tide. No samples were collected.
4. The Belmont Pump Station dry weather flow has been continually diverted to the sanitary sewer system since prior to the 17th dry weather survey.
5. Due to the continued presence of brackish water in Bouton Creek during low flow, the sampling location for dry weather was relocated upstream to where Bouton Creek emergences from under the parking lot of California State University Long Beach.
6. The sump pump was not in operation, therefore; no discharge was taking place. No samples were collected.
7. The sample was collected as a grab sample. When the pump station was visited on April 29th to program the sampler for a 24-hour timed sample the sump pump was nut running. The status board in the pump station office showed the pump to be faulted and it had been locked out. The lock-out tag showed that the pump had been shut down on April 4th. The water level in the sump was 7.3 feet. When the station was again visited on May 1st the pump had been repaired and returned to service. The water level in the sump was 9.8 feet. A grab sample was collected and field measurements were made.
8. There was no flow. The pump was off for maintenance. No samples were collected.

Shading indicates 2013/2014 Dry Weather Surveys included in this report.

Table 21. Field Measurements for Dry Weather Surveys.

	Bouton Creek		Los Cerritos Channel		Dominguez Gap Pump	
Date	**22-Sept-13**	**6-May-14**	**22-Sept-13**	**6-May-14**	**22-Sept-13**	**6-May-14**
Time	**0635**	**1108**	**0716**	**0825**	**NA[3]**	**1330**
Temperature (^{0}C)	20.71	25.97	16.3	15.60	NA	21.69
pH	7.78	9.43	8.16	8.70	NA	7.74
Specific Conductivity (mS/cm)	1.30	1.05	1.37	0.99	NA	1.02
Flow (cfs)	0.23[1]	0.29[2]	0.33[1]	2.62[1]	0	[4]
Dissolved Oxygen (mg/L)	6.76	11.78	7.57	11.92	NA	3.00

NA = not available

1. Flow was calculated from measurements of the depth and width of the water stream, as well as the velocity of a floating object in the water.
2. This is an estimated flow based on similar depth and widths that were recorded on 12 Sept 2012. Due to the heavy growth of algae and the steady-state and gusty upstream winds the water was moving back and forth. It was not possible to follow a moving particle in the water long enough to determine flow.
3. There was no flow. The pump was off for maintenance.
4. The exact flow is not known. The Los Angeles County Department of Public Works estimates flow at 3 cfs when the stage is at 7.0 feet. The stage was at 7.59 feet on 7 May 2014 at the time of the visit.

Table 22. Summary of Dry Weather Chemistry Results at All Stations, 2013/2014.

	Bouton Creek		Los Cerritos Channel		Dominguez Gap
Analyte	9/22/2013	5/6/2014	9/22/2013	5/6/2014	5/6/2014
Conventionals (mg/L unless noted)					
pH (pH Units)	7.3	9.55	8.56	9.88	8.04
Alkalinity as CaCO3	140	290	130	240	290
Biochemical Oxygen Demand	12	5.8	12	34	7.1
Chemical Oxygen Demand	35	43	120	110	48
Chloride	210	170	300	120	140
Conductivity (uS/cm)	1200	990	1500	880	1000
Fluoride	1	0.9	0.85	0.98	0.68
Hardness as CaCO3	160	130	190	120	230
MBAS	0.1U	0.1U	0.1	0.1U	0.1U
Nitrate (as N)	0.34	0.044J	0.48	0.1U	0.1U
Nitrite (as N)	0.1U	0.1U	0.027J	0.1U	0.1U
Oil and Grease	5U	4.9U	5U	5U	5.2U
Total Ammonia (as N)	0.16J+	0.1J+	0.44	0.66	0.28J+
Total Dissolved Solids	700	570	950	590	620
Total Kjeldahl Nitrogen	0.95	1	8.8	2.8	1.7
Total Organic Carbon	10	12	46	39	17
Orthophosphate (as P)	0.17	0.12	0.01U	0.01U	0.2
Total Phosphorus (as P)	0.22	0.28	0.2	0.22	0.38
Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U	0.1U
Total Suspended Solids	3	7.6	17	11	8.3
Volatile Suspended Solids	1.9J+	3.1	13	8.8	4.9
Turbidity (NTU)	6.1	10	17	12	14
Dissolved Metals (ug/L)					
Aluminum	29	32	11J	25U	25U
Arsenic	2.2	1.9	4.3	3.7	4.2
Cadmium	0.81	0.034J	0.095J	0.18J	0.033J
Chromium	0.21J	0.27J	0.31J	0.31J	0.18J
Copper	18 [3,4]	10 [4]	7.2 [4]	15 [3,4]	2.4
Iron	25	38J	22	16J	71J
Lead	1.2	0.67	0.63	0.59	0.66
Nickel	R	1.1	2.7	2.7	4.3
Selenium	1U	1U	1U	1U	1U
Silver	0.2U	0.2U	0.2U	0.013J	0.2U
Zinc	15	9.2	7.9	7.3	10
Total Metals (ug/L)					
Aluminum	140	200	53	25U	340
Arsenic	2.5	2.2	5.2	4.6	4.9
Cadmium	3.3	0.09J	0.13J	0.24	0.058J
Chromium	0.51J+	0.65J+	0.5U	0.5U	0.68J+
Copper	23 [2]	17 [2]	11	19 [2]	3.7
Iron	150	260	91	46J+	590
Lead	4.7	2.2	0.92	1.1	2.7
Nickel	R	1.4	3.2	3.3	4.8
Selenium	1U	1U	1U	1U	1U
Silver	0.2U	0.017J	0.2U	0.048J	0.2U
Zinc	18	25	13	11	15

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CCC, 4=California Toxic Rule Salt Water CCC, 5=UC Davis CCC

U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative, R=rejected data

Table 22. Summary of Dry Weather Chemistry Results at All Stations, 2013/2014 (continued).

	Bouton Creek		Los Cerritos Channel		Dominguez Gap
Analyte	9/22/2013	5/6/2014	9/22/2013	5/6/2014	5/6/2014
Microbiology (MPN/100 ml)					
Enterococcus	770 [1,2]	320 [1,2]	1300 [1,2]	1700 [1,2]	20
Fecal Coliform	54000J [1,2]	9000 [1,2]	1700J [1,2]	1700 [1,2]	40
Total Coliform	54000 [1,2]	16000 [1,2]	3300	3500	170
Aroclors (ug/L)					
Aroclor 1016	0.1U	0.1U	0.1U	0.1U	0.1U
Aroclor 1221	0.1U	0.1U	0.1U	0.1U	0.1U
Aroclor 1232	0.1U	0.1U	0.1U	0.1U	0.1U
Aroclor 1242	0.1U	0.1U	0.1U	0.1U	0.1U
Aroclor 1248	0.1U	0.1U	0.1U	0.1U	0.1U
Analyte					
Aroclor 1254	0.1U	0.1U	0.1U	0.1U	0.1U
Aroclor 1260	0.1U	0.1U	0.1U	0.1U	0.1U
Total Aroclors	0	0	0	0	0
Chlorinated Pesticides (ug/L)					
2,4'-DDD	0.005U	0.005U	0.005U	0.005U	0.005U
2,4'-DDE	0.005U	0.005U	0.005U	0.005U	0.005U
2,4'-DDT	0.005U	0.01UJ	0.005U	0.01UJ	0.01UJ
4,4'-DDD	0.005U	0.005UJ	0.005U	0.005UJ	0.005UJ
4,4'-DDE	0.005U	0.005U	0.005U	0.005U	0.005U
4,4'-DDT	0.005U	0.005UJ	0.005U	0.005UJ	0.005UJ
Total DDT	0	0	0	0	0
Aldrin	0.005U	0.005U	0.005U	0.005U	0.005U
Dieldrin	0.005U	0.005U	0.005U	0.005U	0.005U
Endrin	0.005U	0.005U	0.005U	0.005U	0.005U
Endrin aldehyde	0.005U	0.005UJ	0.005U	0.005UJ	0.005UJ
Endrin ketone	0.005U	0.005U	0.005U	0.005U	0.005U
alpha-BHC	0.005U	0.005UJ	0.005U	0.005UJ	0.005UJ
beta-BHC	0.005U	0.005U	0.005U	0.005U	0.005U
delta-BHC	0.005U	0.005UJ	0.005U	0.005UJ	0.005UJ
gamma-BHC (Lindane)	0.005U	0.005UJ	0.005U	0.005UJ	0.005UJ
Endosulfan I	0.005U	0.005U	0.005U	0.005U	0.005U
Endosulfan II	0.005U	0.005U	0.005U	0.005U	0.005U
Endosulfan sulfate	0.005U	0.005UJ	0.005U	0.005UJ	0.005UJ
Heptachlor	0.005U	0.005U	0.005U	0.005U	0.005U
Heptachlor epoxide	0.005U	0.005U	0.005U	0.005U	0.005U
alpha-Chlordane	0.005U	0.005U	0.005U	0.005U	0.005U
gamma-Chlordane	0.005U	0.005U	0.005U	0.005U	0.005U
Oxychlordane	0.005U	0.005U	0.005U	0.005U	0.005U
cis-Nonachlor	0.005U	0.005U	0.005U	0.005U	0.005U
trans-Nonachlor	0.01U	0.01U	0.01U	0.01U	0.01U
Total Chlordane	0	0	0	0	0
Methoxychlor	0.005U	0.005U	0.005U	0.005U	0.005U
Toxaphene	0.5U	0.5U	0.5U	0.5U	0.5U

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CCC, 4=California Toxic Rule Salt Water CCC, 5=UC Davis CCC

U=not detected at the reporting limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate, UJ=possible false negative, R=rejected data

Table 22. Summary of Dry Weather Chemistry Results at All Stations, 2013/2014 (continued).

	Bouton Creek		Los Cerritos Channel		Dominguez Gap
Analyte	9/22/2013	5/6/2014	9/22/2013	5/6/2014	5/6/2014
Organophosphates (ug/L)					
Azinphos methyl	0.05U	0.05UJ	0.05U	0.05UJ	0.05UJ
Chlorpyrifos	0.002U	0.002U	0.002U	0.002U	0.002U
Demeton	0.5U	0.5U	0.5U	0.5U	0.5U
Diazinon	0.0015U	0.0015U	0.0015U	0.0015U	0.056J
Disulfoton	0.1U	0.1U	0.1U	0.1U	0.1U
Ethion	0.02U	0.02U	0.02U	0.02U	0.02U
Malathion	0.05U	0.05U	0.05U	0.05U	0.05U
Parathion ethyl	0.05U	0.05U	0.05U	0.05U	0.05U
Parathion methyl	0.1U	0.1U	0.1U	0.1U	0.1U
Thiobencarb	0.2U	0.2U	0.2U	0.2U	0.2U
Pyrethroids (ng/L)					
Allethrin	1.5U	1.5U	1.5U	1.5U	0.1J
Bifenthrin	0.6J	**7.9** [5]	**1.6** [5]	**2.8** [5]	1.5U
Cyfluthrin	1.5U	**0.7J** [5]	1.5U	**0.5J** [5]	1.5U
Cypermethrin	1.5U	1.5U	1.5U	1.5U	1.5U
Fenpropathrin	1.5U	1.5U	1.5U	1.5U	1.5U
Lambda-Cyhalothrin	1.5U	1.5U	1.5U	1.5U	1.5U
Permethrin	20U	15U	20U	15U	15U
Deltamethrin:Tralomethrin	3U	3U	3U	3U	3U
Esfenvalerate:Fenvalerate	3U	3U	3U	3U	3U
Tau-Fluvalinate	1.5U	1.5U	1.5U	1.5U	1.5U
Tetramethrin	1.5U	1.5UJ	1.5U	1.5UJ	1.5UJ
Fipronil (ng/L)					
Fipronil	2U	0.7J	1.5J	2.4	1.3J
Fipronil Sulfide	2U	1.5U	2U	1.5U	0.8J
Fipronil Sulfone	1.3J	0.8J	1.1J	1.5U	2
Fipronil Desulfinyl	1.3J	1.1J	7.6	5.7	4

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=Ocean Plan Daily Max or Inst. Max, 3=California Toxic Rule Fresh Water CCC, 4=California Toxic Rule Salt Water CCC, 5=UC Davis CCC

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TOXICITY RESULTS

Toxicity testing is required to be conducted at all sites except the Dominguez Gap Pump Station. Toxicity tests were conducted on composite sample subsamples. Enough sample volume for toxicity testing was collected during only one storm event for the 2013/2014 season (February 27, 2014). Testing conducted with two species, the water flea (freshwater crustacean) and the sea urchin (marine echinoderm). All three stations were sampled during the one storm event.

Dry weather sampling for toxicity testing was conducted during two events in accordance with NPDES requirements. Both Bouton Creek and the Los Cerritos Channel had sufficient flow to be sampled in both dry weather periods. With installation of a permanent dry weather diversion system at the Belmont Pump Station this site no longer discharges to receiving waters and is not included in the two dry weather surveys.

WET WEATHER DISCHARGE

Wet weather toxicity testing for the one event was conducted in association with full analytical chemical testing at the Belmont Pump Station, Bouton Creek and Los Cerritos Channel mass emission sites. Concurrent chemical testing is critical for interpretation of any toxicity. Toxicity testing was eliminated at the Dominguez Gap Pump Station in 2002 due to infrequent discharges and lack of toxicity whenever discharges occurred.

Results of tests from all three stations are presented in Table 23 through Table 25 and are shown graphically on Figure 25 for each dilution. Complete toxicity test reports with CETIS summaries are included in Appendix B (CD only).

Ceriodaphnia Bioassays

There was no measurable toxicity at any of the three stations during the storm event for the water flea (*Ceriodaphnia*) bioassay tests. Stormwater runoff collected for the one 2013/2014 storm showed no impacts on mortality or reproduction with all NOECs equaling 100% and all LC_{50}s being >100%. Less than one acute toxicity unit (TU_a) was measured in all tests conducted at each of the three stations, and no TIEs were triggered.

All daphnid bioassays met the test acceptability criteria (TAC) and all reference toxicant test results were within laboratory control chart limits with one exception. The reproduction percent minimum difference (PMSD) in the water flea reference toxicant test was below the acceptable range. No effect was seen in the sample therefore the low PMSD does not affect the results. Minor temperature fluctuations were noted during testing, however, the deviations were corrected quickly with no adverse effect on the samples.

Strongylocentrotus Bioassays

Sea urchin (*Strongylocentrotus*) fertilization tests showed statistically significant toxicity in all three toxicity tests run for the wet weather samples with all three sites requiring a TIE to be performed.

Stormwater from all three stations showed a significant decrease in fertilization; Belmont Pump Station (NOEC = <6.25%, EC_{50} 5.42%), Bouton Creek (NOEC = 6.25%, EC_{50} = 14.8%) and Los Cerritos Channel (NOEC = 6.25%, EC_{50} = 5.55%).

With this test, the highest concentration that can be tested is 60.6%-63.8% of the original sample. This is due to the need to use brine to bring the salinity up to appropriate levels. The lowest measureable chronic toxicity is therefore limited to approximately 1.7-1.6 TU_c.

All sea urchin bioassays met all TAC and all concurrent reference toxicant test results were within laboratory control chart limits.

DRY WEATHER DISCHARGES

Toxicity results from the dry weather samples are presented in Table 26 and Figure 26. Toxicity tests were conducted from dry weather samples collected on September 23, 2013 and May 6-7, 2014. As with the wet weather monitoring, dry weather discharges from the Dominguez Gap Pump Station are not required to be tested for toxicity.

No toxicity was found in the water flea tests at either the Los Cerritos Channel or the Bouton Creek mass emission monitoring sites for the either the September dry weather event or the May dry weather event. The NOECs for both survival and reproduction in the *Ceriodaphnia* bioassays were 100% sample concentration and the EC_{50s} were >100%. The acute toxicity units (TU_a) were measured at ≤1.0 in all tests conducted, and no TIEs were triggered.

The sea urchin fertilization tests showed no measurable toxicity at either site for the first dry weather event in September 2013. NOECs ranged from 63.7% to 63.8% of the original sample, which was the highest concentration tested due to the upper range that can be achieved using brines to adjust salinity. Therefore, the lowest measureable chronic toxicity is limited to approximately 1.6 TU_c. All acute toxicity units were <1.0. No TIE was triggered at either station for this event.

Sea urchin (*Strongylocentrotus*) fertilization tests for the May dry weather event showed statistically significant toxicity in both stations requiring a TIE to be performed on each of the samples. Bouton Creek had a NOEC of 12.5% and an EC_{50} of 36.1% with a TU_c of 8.0, Los Cerritos Channel had a NOEC of 25% and an EC_{50} of >60.6% with a TU_c of 4.0. The highest concentration that could be tested was 60.6% of the original sample making lowest measureable TU_c of 1.7.

All daphnid bioassays met all TAC and all reference toxicant test results were within laboratory control chart limits. Minor temperature fluctuations were noted in the storm samples. However, the deviation was corrected quickly with no adverse effect on the samples.

All sea urchin bioassays met all TAC and all concurrent reference toxicant test results were within laboratory control chart limits.

Toxicity Identification Evaluations (TIEs)

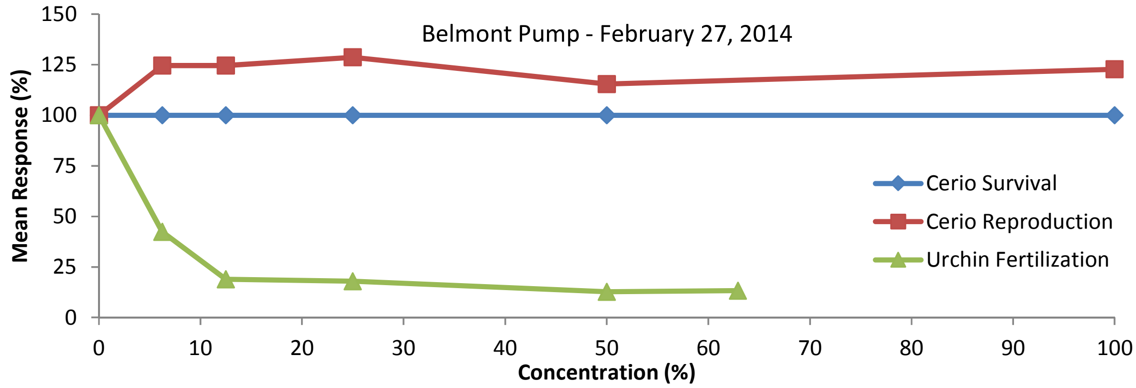
The trigger for TIE initiation in this program is the occurrence of an LC_{50} of ≤50% (equivalent to ≥2 TU_a) for water flea survival or an EC_{50} of ≤33% (≥3 TU_a) for the sea urchin fertilization test**.** All three stations for the wet weather sampling on February 27, 2014 required a TIE to be conducted for the sea urchin fertilization test as well as both stations for the May dry weather sampling event. The results for the February 27, 2014 TIE are summarized in Table 27 through Table 29 and results for the May dry weather TIE are summarized in Table 30.

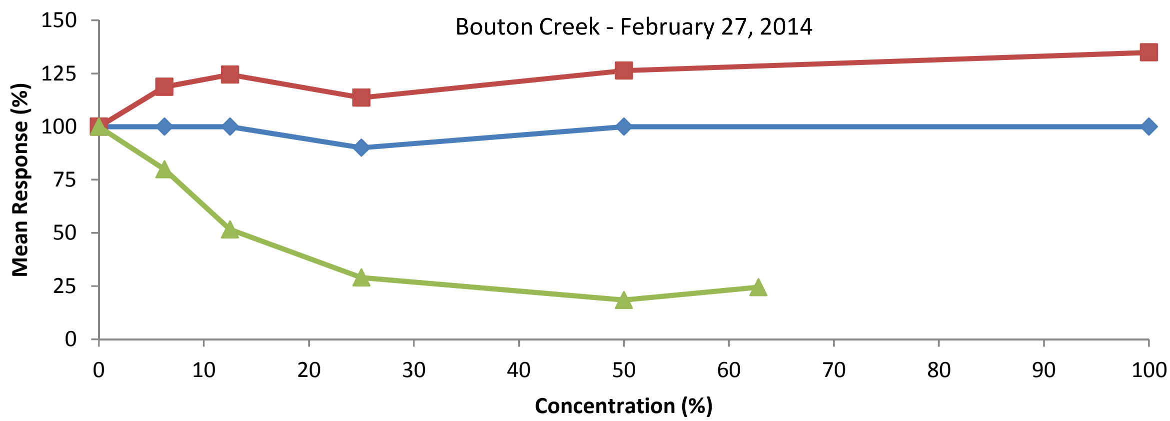
The February storm event caused significant toxicity in all three sea urchin fertilization tests which resulted in a TU_c of ≥16 for all three sites. Although the TIEs were initiated eight days after sample collection, the toxicity had already dissipated from the samples. The percent effect between the brine control and the untreated baseline was insufficient to discern improvements based on the TIE treatments performed. It is unclear what caused the loss of toxicity in the stormwater samples. Loss of toxicity could be caused by a volatile toxicant or simply due to the changing nature of stormwater which will alter over time moving to a point of equilibrium. It is important to note that the samples were stored in cold storage in a tightly sealed container with no head space which minimizes the loss of volatile toxicants.

The May dry weather sampling event also triggered TIEs for both stations, though only Bouton Creek fully met the criteria for a TIE. Los Cerritos Channel had an EC_{50} of >60.6% and a TU_a of <1.7 and a TU_c of 4.0. The decision was made to start the phase 1 TIE with and without filtration on the Los Cerritos Channel sample. After filtration all toxicity had been removed from the sample and so the remaining treatments were abandoned. Particulate toxicity may be due to a number of containments ranging from metals to organics to algae.

The Bouton Creek dry weather sample had an EC_{50} of 36.1% and a TU_a of 2.8 and a TU_c of 8.0. Filtration did not remove the toxicity from this sample and so a full TIE was performed. The only treatment to get the mean fertilization in the sample similar to that of the control was the addition of EDTA. In the samples treated with EDTA, the mean percent fertilization increased from 7.8% in the baseline to 88.4% and 91.6% in the treated samples. EDTA chelates cationic metals indicating that metals may have been the cause of the toxicity seen in these samples.

A lab error caused replicates 31-80 in the February wet weather TIE sample (including the lab, brine and method controls) to not receive the sperm addition during the test initiation procedure. Therefore, these replicates were excluded from the data analysis. All method controls and sample treatments were randomized together resulting in the loss of no more than 3 replicates in each treatment. The number of replicates remaining was sufficient to provide data regarding the effectiveness of all controls and sample treatments. The standard deviation was less than 5% between the mean fertilization rates for all treatments and the controls indicating that the resulting calculated means are representative of the given treatments. Therefore, the results for the TIE are considered reliable.





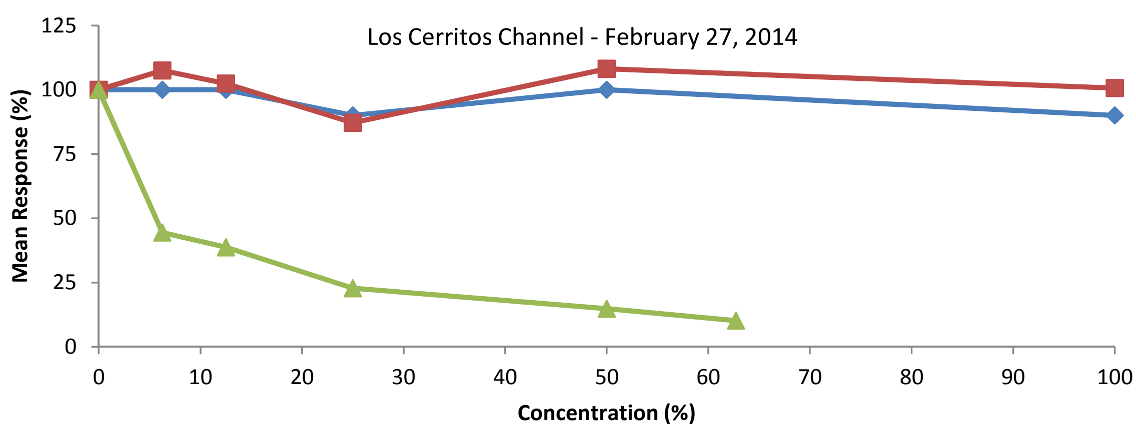


Figure 25. Toxicity Dose Response Plots for Stormwater Samples Collected during the February 27, 2014 Storm Event.

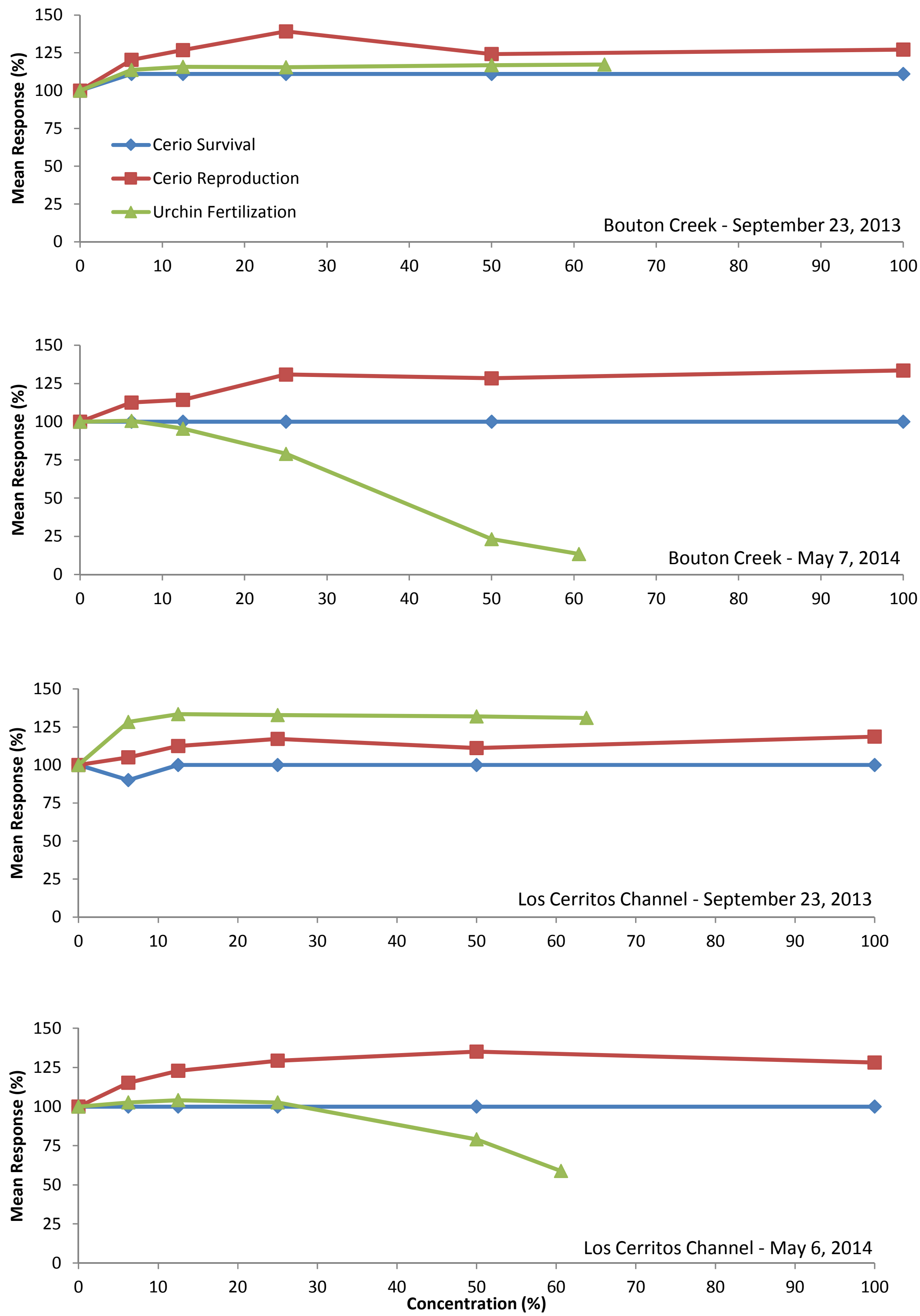


Figure 26. **Toxicity Dose Response Plots for Dry Weather Samples Collected at the Bouton Creek and Los Cerritos Channel Sites during the 2013/2014 Season.**

Table 23. Toxicity of Wet Weather Samples Collected from the City of Long Beach Belmont Pump Station during the 2013/2014 Monitoring Season.

Date	Test	Test Response (% sample)			TU_a[d]	TU_c[e]
		NOEC[a]	LOEC[b]	Median Response[c]		
2/27/14	Water Flea Survival	100	>100	>100	<1.0	1.0
2/27/14	Water Flea Reproduction	100	>100	>100	<1.0	1.0
2/27/14	**Sea Urchin Fertilization**	**<6.25**	**6.25**	**5.42**	**18.5**	**>16**

Test results indicating toxicity are shown in **bold** type.

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.
[b] Lowest Observed Effect concentration: the lowest concentration producing a test response that was significantly different from the control.
[c] Concentration causing 50% mortality to water fleas (LC_{50}), 50% inhibition in water flea reproduction (IC_{50}), or 50% reduction in sea urchin fertilization (EC_{50}).
[d] Acute toxicity units = 100/LC_{50} or EC_{50}.
[e] Chronic toxicity units = 100/NOEC.

Table 24. Toxicity of Wet Weather Samples Collected from the City of Long Beach Bouton Creek Station during the 2013/2014 Monitoring Season.

Date	Test	Test Response (% sample)			TU_a[d]	TU_c[e]
		NOEC[a]	LOEC[b]	Median Response[c]		
2/27/14	Water Flea Survival	100	>100	>100	<1.0	1.0
2/27/14	Water Flea Reproduction	100	>100	>100	<1.0	1.0
2/27/14	**Sea Urchin Fertilization**	**6.25**	**12.5**	**14.8**	**6.8**	**16**

Test results indicating toxicity are shown in **bold** type.

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.
[b] Lowest Observed Effect concentration: the lowest concentration producing a test response that was significantly different from the control.
[c] Concentration causing 50% mortality to water fleas (LC_{50}), 50% inhibition in water flea reproduction (IC_{50}), or 50% reduction in sea urchin fertilization (EC_{50}).
[d] Acute toxicity units = 100/LC_{50} or EC_{50}.
[e] Chronic toxicity units = 100/NOEC.

Table 25. Toxicity of Wet Weather Samples Collected from the City of Long Beach Los Cerritos Channel Station during the 2013/2014 Monitoring Season.

Date	Test	Test Response (% sample)			TU_a[d]	TU_c[e]
		NOEC[a]	LOEC[b]	Median Response[c]		
2/27/14	Water Flea Survival	100	>100	>100	<1.0	1.0
2/27/14	Water Flea Reproduction	100	>100	>100	<1.0	1.0
2/27/14	**Sea Urchin Fertilization**	**<6.25**	**6.25**	**5.55**	**18.0**	**>16**

Test results indicating toxicity are shown in **bold** type.

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.
[b] Lowest Observed Effect concentration: the lowest concentration producing a test response that was significantly different from the control.
[c] Concentration causing 50% mortality to water fleas (LC_{50}), 50% inhibition in water flea reproduction (IC_{50}), or 50% reduction in sea urchin fertilization (EC_{50}).
[d] Acute toxicity units = 100/LC_{50} or EC_{50}.
[e] Chronic toxicity units = 100/NOEC.

Table 26. Toxicity of Dry Weather Samples from the City of Long Beach Mass Emission Monitoring Sites during the 2013/2014 Monitoring Season.

Station	Date	Test	Test Response (% sample)			TU_a[d]	TU_c[e]
			NOEC[a]	LOEC[b]	Median Response[c]		
Bouton Creek	9/23/13	Water Flea Survival	100	>100	>100	<1.0	1.0
Bouton Creek	9/23/13	Water Flea Reproduction	100	>100	>100	<1.0	1.0
Bouton Creek	9/23/13	Sea Urchin Fertilization	63.7	>63.7	>63.7	<1.0	<1.6
Los Cerritos	9/23/13	Water Flea Survival	100	>100	>100	<1.0	1.0
Los Cerritos	9/23/13	Water Flea Reproduction	100	>100	>100	<1.0	1.0
Los Cerritos	9/23/13	Sea Urchin Fertilization	63.8	>63.8	>63.8	<1.0	1.0
Bouton Creek	5/7/14	Water Flea Survival	100	>100	>100	<1.0	1.0
Bouton Creek	5/7/14	Water Flea Reproduction	100	>100	>100	<1.0	1.0
Bouton Creek	**5/7/14**	**Sea Urchin Fertilization**	**12.5**	**25**	**36.1**	**2.8**	**8.0**
Los Cerritos	5/6/14	Water Flea Survival	100	>100	>100	<1.0	1.0
Los Cerritos	5/6/14	Water Flea Reproduction	100	>100	>100	<1.0	1.0
Los Cerritos	**5/6/14**	**Sea Urchin Fertilization**	**25**	**50**	**>60.6**	**<1.7**	**4.0**

Test results indicating toxicity are shown in **bold** type.

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.
[b] Lowest Observed Effect concentration: the lowest concentration producing a test response that was significantly different from the control.
[c] Concentration causing 50% mortality to water fleas (LC_{50}), 50% inhibition in water flea reproduction (IC_{50}), or 50% reduction in sea urchin fertilization (EC_{50}).
[d] Acute toxicity units = 100/LC_{50} or EC_{50}.
[e] Chronic toxicity units = 100/NOEC.

Table 27. Summary of Belmont Pump Station TIE using Sea Urchin Fertilization Test (February 27, 2014).

TIE Treatment	Mean Fertilization (%)	Standard Deviation
Lab Control	98.5	1.0
Baseline Sample (56.5% Sample)	88.7	2.9
25 mg/L EDTA	98.0	1.0
50 mg/L EDTA	97.0	1.0
25 mg/L STS	88.5	3.7
50 mg/L STS	93.5	2.1
0.45 µm Filtration	93.0	1.4
C8 Column	92.8	2.8

Table 28. Summary of Bouton Creek Station TIE using the Sea Urchin Fertilization Test (February 27, 2014).

TIE Treatment	Mean Fertilization (%)	Standard Deviation
Lab Control	98.5	1.0
Baseline Sample (55.9% Sample)	91.0	1.7
25 mg/L EDTA	97.3	1.3
50 mg/L EDTA	95.8	2.9
25 mg/L STS	94.0	2.8
50 mg/L STS	92.3	4.5
0.45 µm Filtration	95.0	1.0
C8 Column	94.0	3.0

Table 29. Summary of Los Cerritos Channel Station TIE results using the Sea Urchin fertilization (February 27, 2014).

TIE Treatment	Mean Fertilization (%)	Standard Deviation
Lab Control	98.5	1.0
Baseline Sample (55.9% Sample)	91.7	4.2
25 mg/L EDTA	96.6	1.1
50 mg/L EDTA	95.0	2.4
25 mg/L STS	96.5	0.7
50 mg/L STS	92.0	2.2
0.45 µm Filtration	94.8	2.9
C8 Column	95.8	2.8

Table 30. Summary of Bouton Creek Station Dry Weather TIE using the Sea Urchin Fertilization Test (May 7, 2014).

TIE Treatment	Mean Fertilization (%)	Standard Deviation
Lab Control	88.6	3.6
Baseline Sample (55.9% Sample)	7.8	4.9
25 mg/L EDTA	88.4	2.9
50 mg/L EDTA	91.6	3.3
25 mg/L STS	14.6	4.0
50 mg/L STS	24.0	4.0
Centrifugation	15.2	3.3
0.45 µm Filtration	10.4	3.2
C8 Column	72.6	4.5

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DISCUSSION

The following sections discuss the quality of stormwater and dry weather discharges from the mass emission monitoring sites. Concentrations of contaminants measured in both wet and dry weather discharges are compared with various receiving water quality criteria. Temporal trends over the past 14 years are examined for principal contaminants of concern. Data from the two monitoring sites with existing TMDLs are examined in greater detail in order to assess progress towards meeting established Waste Load Allocations or other California Toxics Rule Water Quality Criteria. The toxicity of both stormwater and dry weather discharges is evaluated for the current year and general trends are examined over the duration of this permit.

COMPARISON TO WATER QUALITY CRITERIA

Numeric standards are not available for stormwater discharges. For the purpose of this report, receiving water quality criteria or objectives were used to provide reference points for assessing the relative importance of various stormwater contaminants, though specific receiving water studies are necessary to quantify the presence and magnitude of any actual water quality impacts. Ultimately, specific beneficial uses of the receiving water body should be considered when selecting the appropriate benchmarks. Existing, potential and intermittent beneficial uses are provided for the receiving waters associated with each discharge point (Table 31).

Water quality criteria used as benchmarks in freshwater environments are summarized in Table 32. Criteria applicable to saline conditions are summarized separately in Table 33. These reference water quality criteria are useful for screening Event Mean Concentrations (EMCs) generated for most of the major constituents measured as part of this program. The results summary tables (Table 14 through Table 16) identifies various benchmarks that are exceeded for the storm event. Most importantly, these benchmarks are only intended to serve as a tool to assist with the interpretation of the stormwater quality data. Exceedances of these receiving water quality benchmarks do not necessarily indicate impairment. Other factors such as dilution, duration and transformation in the receiving waters must also be considered. Nevertheless, they can be extremely useful in screening for analytes that might have greater potential to impact receiving waters and/or warrant more consideration in development of BMPs and implementation of source control strategies.

For comparative purposes, an EMC was considered to be an exceedance if the value was higher than any of the reference or benchmark values. In using these benchmarks, it is important that the source of the specific criterion is considered. For instance, metals concentrations derived from California Toxics Rule (CTR) freshwater criteria for protection of aquatic life are based upon dissolved concentrations and are often a function of hardness. Values listed in Table 32 are based upon a default hardness of 50 mg/L since stormwater typically has lower hardness. This differs from the default hardness value of 100 mg/L used for tabulated values in the CTR. Evaluation of any possible exceedance of hardness-dependent criterion is based upon the actual hardness EMC for that site and event and therefore the criterion will change. Hardness measured during wet weather events is typically far less than 50 mg/L, while hardness associated with dry weather events will be substantially higher. For metals with criteria dependent upon hardness, CTR criteria tend to be much higher for dry weather discharges since elevated hardness encountered during the dry season tends to mitigate potential toxicity of these metals. Saltwater objectives listed for metals under the CTR are also based upon dissolved concentrations while those listed under the California Ocean Plan are based upon total recoverable measurements. Although Ocean Plan numbers are used for comparative purposes, the marine and estuarine receiving waters in the vicinity of Long Beach would only be subject to the CTR saltwater values since both Alamitos Bay and San Pedro Bay are considered enclosed bays and estuaries. Water quality criteria provided in the Los Angeles Basin Plan are primarily based upon Title 22 drinking water standards. For two of the key organophosphate pesticides, the only available water quality criteria are those proposed by the California Department of Fish and Game (Siepmann and Finlayson, 2002). UC Davis (Faria et al. 2010; Fojut et al. 2012) has recently provided a series of reports that suggest new acute and chronic water quality criteria for a series of pesticides that include various pyrethroids and organophosphate pesticides.

Both acute and chronic water quality criteria are used in this evaluation. Due to the limited period of discharge, the acute criteria are considered most applicable to stormwater. Dry weather discharges are most appropriately compared against chronic criteria (CCCs or daily maxima).

Wet Season Water Quality

The water quality objective for pH included in the Los Angeles Basin Plan (CRWQCB, Los Angeles, 1994) indicates that surface waters should be maintained in the range of 6.5 to 8.5. During storm events at all sites, measured pH values were within this range. Prior to last years event, there were two stormwater samples from the Belmont Pump Station that had pH values in excess of 8.5.

The total coliform, fecal coliform and enterococcus single sample criteria are commonly exceeded at all sites during wet weather sampling events. Grab samples taken for bacteria during storm events most often exceed Basin Plan water quality objectives but also have shown a tremendous degree of variability over time. This can be attributed to both extreme variability that can occur over the course of a storm event and even extreme short term variability that is common when taking field duplicates. Although the variation is substantial, overall concentrations of fecal indicator bacteria (FIB) in stormwater average about 10^4 mpn/100 ml for both *Enterococcus* and fecal coliform.

Over the past 14 years, four total recoverable metals including aluminum, copper, lead and zinc have frequently exceeded benchmark reference values. Criteria for total recoverable aluminum exist for drinking water (Basin Plan criteria) and aquatic life as a nonpriority pollutant (Table 32). Elevated levels of aluminum are normal during storm events due to naturally high levels in soils and the increased loads of sediment.

Concentrations of total recoverable copper, lead, and zinc measured in runoff from the mass emission sites exceeded Ocean Plan criteria in nearly 100% of the storm events. Total recoverable concentrations of three metals (copper, lead and zinc) have frequently exceeded Ocean Plan criteria over the past fourteen years of the stormwater monitoring program. Only dissolved copper exceeded water quality criteria from the two pump stations, but the open channel station showed exceedances for both dissolved copper and dissolved zinc.

Chlorinated pesticides continue to be uncommon in stormwater runoff from the mass emission sites. When detected, concentrations of detected compounds have typically been low (less than 10 times the reporting limit). Although largely banned or restricted throughout the industrialized nations, these legacy pesticides persist in the environment. Low concentrations of gamma-chlordane detected last year from the Belmont Pump watershed and from the Los Cerritos Channel watershed were not repeated this year.

The banning of residential, nonprofessional use of diazinon and chlorpyrifos resulted in these contaminants no longer being measureable in most stormwater samples from City of Long Beach Stormwater monitoring program. Lower detection limits were implemented in the middle of the 2010/2011 monitoring season. The detection limit for chlorpyrifos dropped from 0.05 µg/L to 0.002 µg/L and the detection limit for diazinon dropped from 0.01 µg/L to 0.0015 µg/L. Use of the lower detection limits has resulted in chlorpyrifos being detected in runoff from both the Belmont Pump Station and the Los Cerritos Channel. However, these compounds were below the detection limit this year.

Pyrethroid pesticides have largely replaced diazinon and chorpyrifos for pest control in the urban environment. This year was the fourth year where pyrethroid pesticides were analyzed for all events. Again this year, the highest concentrations of pyrethroid pesticides were encountered in stormwater from the Belmont Pump Station. Bifenthrin, cyfluthrin, cypermethrin and permethrin are of primary concern and results show that measured levels are above UC Davis CMC values for all stations other than the Dominguez Pump station. Although permethrin is consistently measured at the highest concentrations, this compound is the least toxic of the four pyrethroid pesticides. These pesticides are known to be highly toxic with several compounds causing a toxic response to *Hyalella* at levels as low as 0.002 µg/L (2 ng/L) which is near the detection limit for many of these compounds. Pyrethroids were not added to the analytical suite until mid-season during 2010/2011. Many of the pyrethroids were measured at concentrations that would be expected to cause toxicity to *Hyalella* or *Americamysis* but generally low enough that *Ceriodaphnia* would not be expected to show impacts. It is also unlikely that pyrethroid toxicity would be measureable using the standard suite of WET tests being proposed for use in newer stormwater monitoring programs in Los Angeles and Ventura County.

Although pyrethroid pesticides are a recognized concern, the short and long-term impacts of these compounds are not well understood. These compounds are extremely difficult to measure since they are highly hydrophobic and tend to adhere to surfaces. In stormwater, pyrethroids tend to partition to suspended solids reducing bioavailability (Yang et al., 2006). Since these compounds are highly hydrophobic, they are best known for the toxicity that they exert on the benthos. The environmental toxicity of these compounds was first established using amphipod tests conducted on sediment. Tests were later modified to use amphipods for water testing. Although these compounds typically have a half-life in water that ranges from days to months, it is expected that they may persist much longer in the sediments. Recently, Lao et al. (2010) identified the presence of pyrethroid pesticides in sediment sampled in the Ballona Creek Estuary. Levels measured in the sediments were considered sufficient to have caused observed toxicity to *Eohaustorius*, which is an amphipod common in marine and estuarine environments.

Analysis for the pesticide fipronil was initiated this year for the City of Long Beach since it is an emerging pesticide of concern. Fipronil is a leading replacement for pyrethroid pesticides in urban areas (TDC Environmental, 2007). Fipronil has multiple degradates, some of which are more environmentally stable than fipronil itself, and some which have equal or greater aquatic toxicity than the parent compound (Ruby, 2013). Fipronil is subject to degradation by two main processes. It is converted to fipronil sulfone and fipronil-desulfinyl under oxidative conditions and may retain equal or greater toxicity to fish and aquatic invertebrates and higher persistence than fipronil itself (Stratman et al., 2013). Photolysis will also degrade fipronil to fipronil- desulfinyl. Fipronil reacts with water to break down into smaller chemicals at a speed that increases as the water becomes less acidic (Jackson et al., 2009). When fipronil in water is exposed to sunlight it breaks down rapidly with a half-life of 4-12 hours. Fipronil and its breakdown products can build up in water under normal conditions.

Fipronil varies greatly in its toxicity and potential to bioaccumulate in aquatic arthropods. Depending on the species, toxicity can vary by several orders of magnitude (see: Stratman et al. 2013, Table 1). Fipronil LC_{50} for the water flea *Ceriodaphnia dubia* was 17,700 ng/L but for the mysid *Mysidopsis bahia* it was only 140 ng/L. The LC_{50} for the midge *Chironomis crassicaudatus* was found to be 420 ng/L but for the crayfish *Procambarus clarkia* it was as high as 179,000 ng/L.

The EPA Aquatic Life Benchmark website lists a chronic toxicity values of 11 ng/L for fipronil, 37 ng/L for fipronil-sulfone, 110 ng/L for fipronil-sulfide, and 590 ng/l for fipronil-desulfinyl (USEPA, 2014). Only during the storm event on February 23 at Belmont Pump did fipronil exceed the EPA benchmark value with a 30 ng/L concentration being reported (see table 4). None of the other sites, storm events, or degradation products were beyond the benchmark values set by the EPA and all were well below the *Ceriodaphania* LC_{50} of 17,700 ng/L.

Dry Season Water Quality

With the exception of organophosphate pesticides, water quality of dry weather discharges has not changed substantially since the start of the program in early 2000. Dry season water quality has not tended to vary greatly between sites or sampling dates. The most significant changes continue to be decreases in the volume of dry weather discharges and the elimination of dry weather flow at the Belmont Pump Station.

Exceedance of pH criteria remains one of the most common occurrences during dry weather. These exceedances typically occur only in drainages with open concrete channels. These excursions are not observed in waters that enter the storm drains or receiving waters directly from pipes. The pH of water collected from the Los Cerritos Channel site during the second dry weather survey exceeded the upper range limit of 8.5 established in the Basin. Extensive testing conducted in the Los Cerritos Channel during the 2010/2011 season demonstrated natural cycling of pH in any shallow, low flow channel with the presence of algae. Controlling these fluctuations would require enclosing the channel or eliminating flow during the dry seasons. Enclosure of the channels would impact bacterial concentrations by eliminating the sanitizing effects of sunlight that helps to control bacteria concentrations.

This is the fifth year of dry weather monitoring at the Dominguez Gap Pump Station. Although dry weather discharges now occur at the Dominguez Gap Pump Station, the water originates from the Los Angeles River. Continuous discharges were observed during the first survey of 2012/2013 season but the second survey for that season was conducted during a pump-draw down using the large natural gas pumps. Use of the large pumps to control water levels during dry weather conditions is suspected to contribute to minor increases in sediment and total metals but increases, if true, do not appear sufficient to cause water quality exceedances.

Exceedances of dissolved metals criteria during dry weather are largely limited to copper in waters from Bouton Creek and the Los Cerritos Channel. In addition, exceedances of dissolved copper criteria are often exceedances of the CTR saltwater criteria. The CTR freshwater CCC criterion for copper was only exceeded during the first dry weather monitoring event at the Los Cerritos Channel monitoring location.

The quality of dry weather discharges from the Dominguez Gap Pump Station has tended to be excellent ever since vegetation within wetland treatment system stabilized.

Low levels of four pyrethroid compounds caused exceedances of draft criteria during dry weather sampling. However, most were detected at concentrations between the Method Detection Limit and the Reporting Limit. Since the criteria proposed by the Fojut et al. (2012) are below established reporting limits, these detections were considered to be exceedances. Bifenthrin was the only pyrethroid pesticide detected above reporting limits during the dry weather surveys. With the exception of these pyrethroid pesticides, all organic constituents (Aroclors, chlorinated pesticides, and organophosphate pesticides) were undetected in dry weather samples.

No fipronil or degradate concentrations during dry weather sampling were above the EPA benchmarks.

SPATIAL DIFFERENCES IN CONCENTRATIONS OF FIBS, TSS AND TRACE METALS

Box plots were used to visually compare the distribution of fecal indicator bacteria, total suspended solids, and both total recoverable and dissolved forms of key trace metals (Figures 27 through 29). The water quality associated with discharges from the Dominguez Gap Pump Station has remained consistently better than all other mass emission sites.

Concentrations of TSS, total cadmium, total zinc and total lead each tend to be more elevated in water from the Los Cerritos Channel watershed. Total copper tends to be more elevated in water from the Belmont

Pump Station. Spatial differences in dissolved metal concentrations are less evident although Bouton Creek tended to have slightly higher levels of dissolved lead.

Box plots (Figure 30) and bar charts (Figure 31) were also used to compare the relative distribution of pyrethroid pesticides among stations. Both graphics include the results of all stormwater monitoring surveys from 2010 through 2014. Concentrations of the six pyrethroids common in urban runoff tended to be most elevated in stormwater samples from the Belmont Pump Station subwatershed and, to a lesser degree, the Los Cerritos Channel subwatershed. Stormwater runoff from both Bouton Creek and Dominguez Gap tend to have concentrations that are consistently less than other two sites.

TMDLs

Currently, TMDLs are applicable to both the Los Cerritos Channel (LCC) watershed and the Dominguez Gap Pump Station. The Los Cerritos Watershed has active TMDLs for trace metals during both wet and dry weather. Los Angeles River TMDLs applicable to the Dominguez Gap Pump Station include metals during both wet and dry weather conditions and nitrogen compounds. The following sections examine trends and the current conditions with respect to these TMDLs.

Los Cerritos Channel (LCC) Metals TMDL

The LCC Metals TMDL (USEPA, 2010) has established dry weather WLAs for copper and wet weather WLAs for copper, lead and zinc. The copper dry-weather loading capacity (TMDL) for Los Cerritos Channel was established based upon the following calculation: TMDL Load kg/day = Daily Storm Volume (liters) x numeric target (ug/L) x 10^{-9}. The TMDL objectives are expressed as total recoverable metals.

Dry weather flows have dramatically declined in recent years (Figure 32), presumably due to better water conservation efforts. The average flow measured at the Los Cerritos Channel monitoring site has been consistently under 0.5 cfs since 2009. At the same time, concentrations of total copper have significantly declined. The combination of these factors resulted in dry weather copper loads in the Los Cerritos Channel declining to levels that are less than 20% of the WLA (Figure 32).

Wet weather load capacities were established for total copper, total lead and total zinc in the Los Cerritos Channel. The load capacities were calculated based upon storm volumes and the following concentrations:

Total copper = 9.8 ug/L

Total lead = 55.8 ug/L

Total zinc = 95.6 ug/L

Table 34 provides a summary of the TMDL load limitations for copper, lead and zinc along with storm volumes, calculated loads, and exceedance factors for storm events from 2011 through 2014. Measured loads of total copper exceed the TMDL limits by a factor of 1.9 to 8.0. Similarly, measured loads of zinc exceed the TMDL limitation by factors ranging from 1.4 to 5.9. Load limits established for total lead were based upon assuring that historical conditions were not exceeded. Lead loads have not exceeded a factor of 0.8 (or 80%) of the limit established in the TMDL. This suggests that the historical decline in lead concentrations is continuing. A comparison of concentrations of total copper, lead and zinc prior to the TMDL and after the TMDL (Figure 33) shows little evidence of changes for metals over this short time but the concentrations of total lead do show less variability in recent time. In contrast, the box plots for total copper and zinc show substantial variability in post TMDL measurements.

Figure 34 provides a more detailed examination of trends over time. Graphics on the left side of the page separate conditions before and after implementation of the TMDL while those on the right side of the page simply illustrate long-term trends. Flows associated with monitored events are relatively consistent although there is some suggestion that flows associated with monitored events have slightly increased over time. Concentrations of total copper have been relatively stable but both total lead and total zinc concentrations show evidence of decreases in concentration over the past 14 years. Wet weather loads show similar but more muted trends as a result of increase in storm volumes. Apparent decreases in total zinc loads after implementation of the TMDL are of interest but are likely an artifact of the limited post-TMDL data set.

Necessary decreases in concentrations of total copper are best illustrated by examination of the distributional characteristics of total copper concentrations (Figure 35). All measurements of total copper have exceeded the limit established in the TMDL. In order to simply meet TMDL requirements 50% of the time, total copper concentrations will need to be reduced by more than 70%.

Los Angeles River Metals and Nitrogen TMDL

The Los Angeles River Metals TMDL (SWRCB 2011) established concentration-based targets at 23 µg/L for total recoverable copper and 12 µg/L for total recoverable lead at the downstream Wardlow monitoring site during dry weather. A summary of all dry weather monitoring data from the Dominguez Gap Pump Station for these metals (Figure 36) shows consistently low concentrations of copper, lead and zinc in both the total recoverable and dissolved forms. Concentrations of these metals in Dominguez Gap Pump Stations dry weather discharges have also remained lower than measurements made within the Los Angeles River by the Coordinated Monitoring Program. This indicates that the wetland system is has very effective in removing these metals.

The Los Angeles River Metals TMDL establishes wet weather water quality targets based on the acute CTR criteria and the 50th percentile hardness values for stormwater collected at the County's Wardlow water quality monitoring site on the Los Angeles River. These targets are for total recoverable metals:

Cadmium: 3.1 ug/l

Copper: 17 ug/l

Lead: 62 ug/l

Zinc: 159 ug/l

In a total of 38 monitored storm events, concentrations of total cadmium have never exceeded 0.55 mg/L and the median concentration has been 0.26 mg/L. Long term trends for discharges of total copper, lead and zinc are illustrated in Figure 37. This figure examines trends in flow, concentrations of the target metals, and loads of trace metal discharges. Figures on the left side of the graphic illustrate trends both before and after implementation of the TMDL while figures on the right view trends without regard to the implementation date. Stormwater discharges have tended to decrease over time. However this watershed was reconfigured when the treatment wetland system was created. It now has a smaller drainage area. Concentrations of total copper, total lead and total zinc were all increasing prior to both completion of the wetland treatment system and implementation of the TMDL. General trends suggest that loads of all three metals decreasing in recent years but further data will be necessary to confirm this trend. Concentrations of total copper still occasionally exceed the current water quality target established for the Los Angeles River at Wardlow (17 ug/L) but measured concentrations in the past three years have never exceeded 21 ug/L. Concentrations of total lead present in wet weather discharges from the Dominguez Gap Pump Station are less than 25% of the established objective. Concentrations of total zinc are also declining and, in recent years, have remained less than 2/3 of the water quality target in Los Angeles River Reach 1.

The Los Angeles River Nitrogen TMDL established WLAs for both ammonia-N and nitrate-N that apply to minor discharges that discharge both below the Los Angeles-Glendale WRP and within Reach 1 of the Los

Angeles River. Ammonia-N WLAs were established for a 1-hour average (8.7 mg/L) and a 30-day average (2.4 mg/L). WLAs for both nitrate-N and nitrate+nitrite-N were both set at 8.0 mg/L for a 30-day average. Concentrations of ammonia-N have consistently been less than 0.7 mg/L during both dry and wet weather monitoring (Figure 38). Median concentrations of ammonia are 0.18 mg/L during dry weather and 0.38 mg/L during wet weather discharges. Concentrations of nitrate-N in dry weather discharges have never exceeded 1.9 mg/L and all wet weather discharges have had concentrations of less than 1.4 mg/L. Thus all discharges from the Dominguez Gap Pump Station continue to achieve the WLAs established for nitrogen compounds. Furthermore, total nitrogen (TKN plus nitrate/nitrite-N) concentrations typically range between 2.0 and 3.0 mg/L with the highest measured concentration being reported at 5.02 mg/L during a wet weather discharge.

TOXICITY

Toxicity results for the 2013/2014 monitoring year were presented above. The following sections discuss these results for both dry and wet weather periods, examine long-term trends (between years), provide a comparison with toxicity in other Southern California areas, and examine sources of toxicity.

Stormwater Toxicity

Single wet weather samples from the Belmont Pump, Bouton Creek and Los Cerritos Channel stations were analyzed for toxicity using water fleas and sea urchins during the monitoring period. All of these samples were collected during the February 27, 2014 storm event.

None of the samples tested exhibited measurable toxicity to water flea survival or reproduction. NOECs for all stations were 100% sample (1 TU_c) and LC_{50}s/IC_{50}s were >100% sample (<1 TU_a).

Urchin tests exhibited toxicity that was significantly higher than the controls in all three stations with all three meeting the criteria for performing a TIE. Results of the TIE were inconclusive due to the toxicity disappearing from the samples prior to the start of the TIE.

Dry Weather Toxicity

Dry weather toxicity tests are limited to the Bouton Creek and Los Cerritos Channel sites. Testing of discharges from the Belmont Pump station has not been conducted since 2009 when a low flow diversion system was first installed to direct dry weather flows to the sanitary sewer.

There was no toxicity found in either the water flea or the urchin tests at any station for the first dry weather event in September 2013. The May 2014 dry weather samples from Bouton Creek and the Los Cerritos Channel showed no toxicity in the water flea tests but both sites caused a significant decrease in the sea urchin fertilization. Both stations triggered a TIE. However, only Bouton Creek completed a full TIE as all toxicity was removed from the Los Cerritos Channel sample after filtration making it unnecessary to continue with the remaining treatments. Results for the Bouton Creek sample indicate that metals were the likely source of toxicity as the EDTA treatment removed all of the toxicity from the sample.

Historical Toxicity Trend

Figure 39 and Figure 41 summarize chronic toxicity of Stormwater to sea urchin fertilization and water flea reproduction, respectively, throughout the fourteen years of the City's monitoring program. Figure 40 and Figure 42 provide similar summaries of dry weather chronic toxicity for urchins and water fleas, respectively.

Sea urchins (Figure 39) have shown more instances of moderate to high (>8 TUc) wet weather toxicity than have water fleas (Figure 41). Episodes of high urchin toxicity have occurred with approximately equal frequency at all three stations, beginning with the 2000/2001 monitoring program and continuing through 2007/2008 and again in the 2011/2012 and continuing through this current 2013/2014 season. No such episodes occurred during the 2008/2009 through 2010/2011 monitoring programs.

Figure 42 shows a virtual absence of wet weather water flea toxicity after the 2001/2002 storm season at all three stations, except minor to moderate reproductive effects in 2004/2005. In the 2008/2009 program, instances of elevated reproductive toxicity were attributed to statistical artifacts due to very low within-test variability. Data from the 2009/2010 through the 2013/2014 monitoring programs continues to show that water flea toxicity is almost undetectable in wet weather samples.

Dry weather samples were negligibly toxic to both species (Figure 40 and Figure 42) in water collected from Belmont Pump in all study years. With the exception of the 2002/2003 program, sea urchins have shown little dry weather toxicity at the Bouton Creek site. Some of the *Ceriodaphnia* toxicity observed in Bouton Creek dry weather samples between 2003 and 2005 can probably be attributed to elevated sample salinity since dry weather flows have been declining and contribute to tidal exchanges having greater influence on the samples. The relocation of the Bouton Creek site to a site >1000 feet further upstream was designed to decrease the influence of marine waters on dry weather discharges. Since that time, very little water flea toxicity in the dry weather samples has been observed. Water from the Los Cerritos Channel exhibited elevated sea urchin toxicity in fall and spring samples of the 2007/2008 program and in the summer of 2008 (2008/2009). Water flea toxicity has dropped off to little or no toxicity since the 2005/2006 sampling season at Los Cerritos Channel.

Temporal Toxicity Patterns

There was some suggestion in the toxicity data from early monitoring periods that seasonal flushing may have been a factor affecting the variability in stormwater toxicity. Early years of the program suggested that *Ceriodaphnia* toxicity was usually somewhat elevated in early versus late storms, but this pattern has not been evident in recent years especially in regards to the drought. Toxicity to sea urchins has varied widely over the storm seasons at each of the three stations. Figure 39 shows that stormwater samples exhibiting urchin toxicity of 16 TU_c or more have been encountered throughout the storm season. Since the 2004/2005 storm season, water flea toxicity has dropped to near undetectable levels while the sea urchin toxicity has been more sporadic with toxicity increasing slightly in the 2011/2012 season and continuing through this current 2013/2014 storm season.

Comparison of Relative Toxicity of Stormwater in Southern California

Table 35 compares the frequency and magnitude of toxicity to sea urchin fertilization from the Long Beach stations in 2013/2014 with that of stormwater samples from Long Beach in previous years and with toxicity in other southern California watersheds (Los Angeles and San Gabriel Rivers, Ballona and Chollas Creeks). Current data disrupts the recent trend towards decreasing frequency and magnitude of Long Beach stormwater toxicity to sea urchins with a 100% of the stormwater samples being toxic.

We might expect results from the Chollas Creek and Ballona Creek to be similar to Long Beach results, as these samples were obtained from smaller highly urbanized watersheds, relative to the samples from the Los Angeles and San Gabriel Rivers. The Chollas/Ballona Creek sea urchin data (Table 35) show frequency of toxicity ranging from 85-100%, suggesting comparability for Long Beach samples from the first two monitoring periods. Sea urchin toxicity data from similar studies in the Los Angeles River, San Gabriel River and Ballona Creek indicated an absence of toxicity during the period of 2009 through 2013. Data from the 2013/2014 season are not available for comparison at this time. Samples taken from the Long Beach monitoring sites during the 2009 to 2011 time period indicated similar trends of decreasing frequency and magnitude of toxicity. However, sea urchin fertilization rates have decreased significantly over the 2011/2012 through 2013/2014 seasons with toxicity ranging from 75% to 100%.

Table 36 summarizes Long Beach water flea toxicity data from the past 14 years as well as similar data from monitoring conducted in the Los Angeles and San Gabriel Rivers, Ballona Creek and Chollas Creek. All Southern California sites have shown a general decrease in both the frequency and magnitude of reproductive toxicity over time. This has been clearly associated with elimination of diazinon and chlorpyrifos as pesticides for use in residential applications.

A decreasing trend is evident in the frequency of toxicity to water fleas (Table 36) with no toxicity seen since the 2011/2012 season. In 2010/2011, toxicity associated with the water flea tests was only slightly elevated from the low level seen in the 2009-2010 season, opposing the trend towards higher frequency of toxicity seen in the 2007/2008 and 2008/2009 monitoring years. The magnitude of toxic response was low continuing the trend toward reduction in magnitude seen in the previous six monitoring periods. The spike in magnitude seen in December of 2008 was judged to be artificial, due to unusually high test sensitivity during that test episode.

Toxicity Characterization

During the current monitoring period, one storm event was monitored resulting in all stations triggering a TIE for sea urchins. The acute TU was 18.5 with an EC_{50} of 5.42% at the Belmont Pump Station. Bouton Creek had an acute TU of 6.8 with an EC_{50} of 14.8%, and the Los Cerritos Channel had an acute TU of 18.0 with an EC_{50} of 5.55%. The results of the TIE were inconclusive as all toxicity had dissipated from the sample when the TIE was initiated.

One method used to evaluate the importance of key toxicants is the comparison of the measured and predicted toxic units of the samples. Expected water flea toxicity is calculated based upon LC_{50}s for zinc, chlorpyrifos and diazinon (Table 37 and Figure 43). Earlier testing implicated these analytes as the primary toxicants contributing to mortality and reproduction. Expected toxicity for sea urchins is calculated based upon EC_{50} data for zinc and copper (Table 37 and Figure 44). Similarly, these two metals are often implicated as the primary toxicants affecting sea urchin fertilization.

The predicted acute toxicity of the sample is calculated from the measured concentrations of the chemical constituents and their corresponding LC_{50}. Similar analyses of the characteristics of toxicity in the early years of this program demonstrated good correlations with the chemical data. However, more recent years fail to show such a correlation with measured concentrations of all relevant toxicants failing to explain the occurrence of toxicity. This lack of correlation was only observed in the sea urchin fertilization tests. The concentrations of dissolved zinc during the first-flush monitoring event in the 2011/2012 indicated that toxicity should have been encountered. Conversely, the storm events monitored during 2012/2013 and the 2013/2014 seasons showed high toxicity in sea urchins with relatively low metals. Thus, chemical concentrations no longer appear to match observed toxic responses or lack thereof.

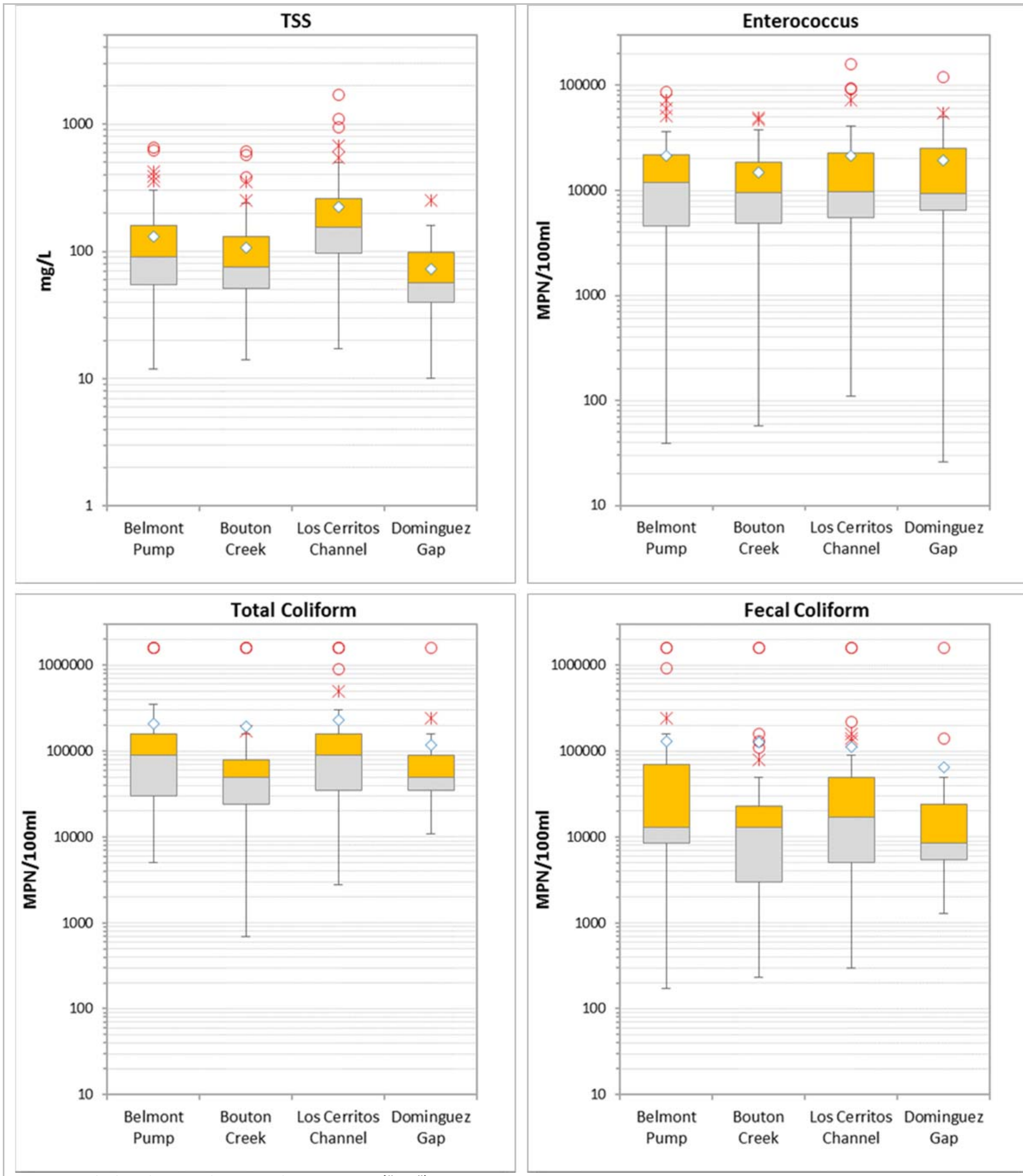
Test of Significant Toxicity (TST)

The Test of Significant Toxicity (TST) is a statistical approach to analyze whole effluent tests (WET) and ambient toxicity data that is being developed by the U.S. Environmental Protection Agency. The State Water Resources Board has proposed a draft policy to implement Statewide use of the TST approach. The new policy is intended to provide a consistent approach to monitoring toxicity in discharges to inland surface waters, enclosed bays, and estuaries. The potential impacts of incorporating the TST approach into stormwater programs have not been fully evaluated.

The TST is designed to be used as a two concentration data analysis of the sample contrasting receiving water, also referred to as the critical concentration, with a control concentration. Once WET tests are completed, results are analyzed with the TST calculator to assess if the sample was toxic. The TST approach is intended to determine if a sample at the critical concentration and the control within a WET test differ by an acceptable amount. This method yields a simple yes/no as to whether or not a sample is considered toxic.

There were no cases of toxicity in the water flea tests for the entire 2013/2014 season. For the 2012/2013 Long Beach season, data from all water flea reproduction tests (stormwater and dry weather tests) were subjected to both analytical approaches. All stormwater samples for water flea reproduction passed using both the NOEC and TST approach. However, use of the TST approach would have triggered three additional TIE tests including Bouton Creek on the September 2012 and both Bouton Creek and the Los Cerritos Channel site in May 2013 (Table 38).

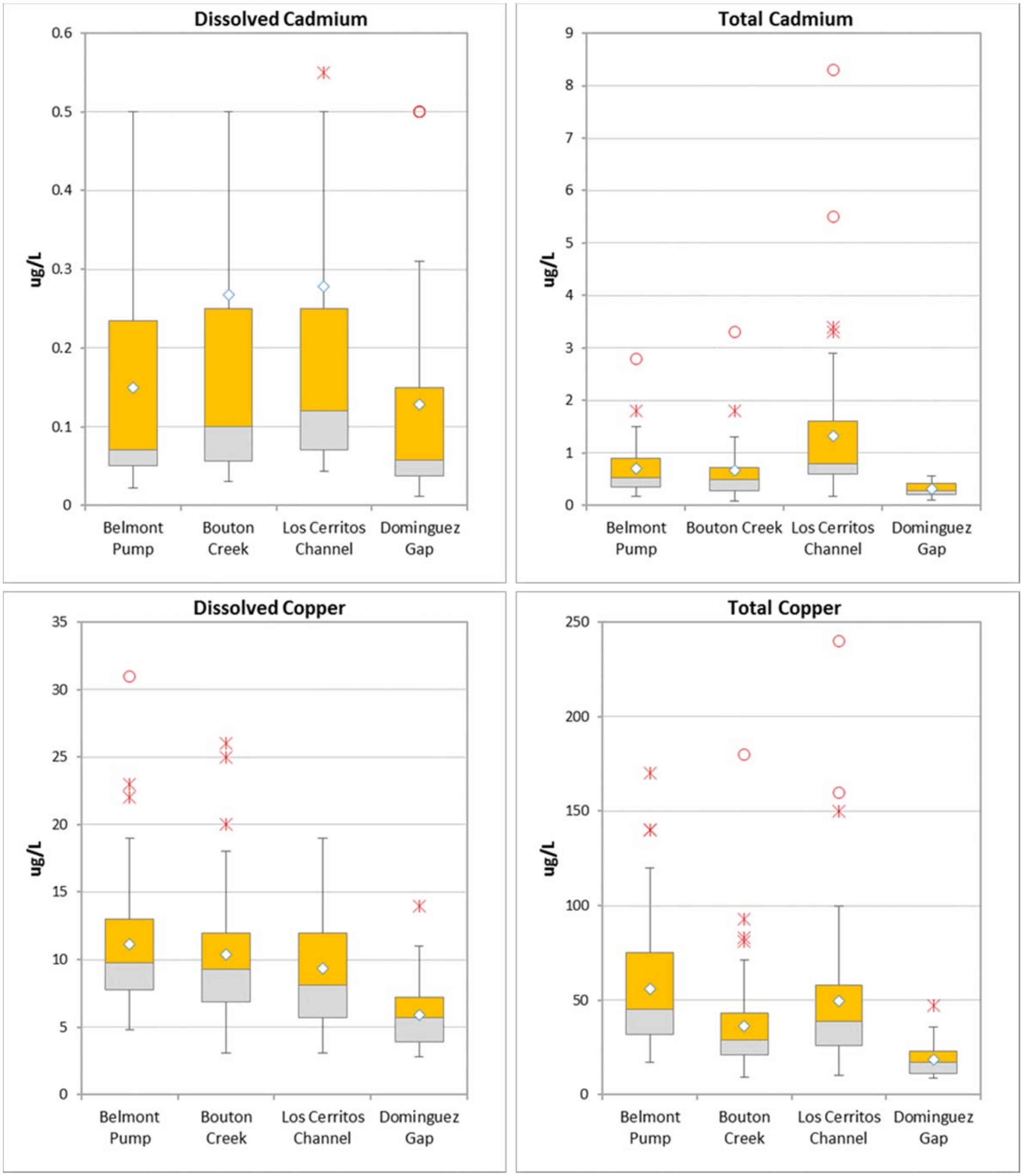
Further comparisons were conducted for water flea reproduction tests conducted in waters from the Los Cerritos Channel for the 2010/2011 and the 2011/2012 seasons using the same strategy. All samples from the Los Cerritos site were considered nontoxic using both the NOEC and TST methods for the 2011/2012 season. Analysis of data from the 2010/2011 season indicated that TIE testing would have likely been necessary for three additional samples. The TST approach would require further testing of samples from the September 23, 2010 dry weather event and both the October 20, 2010 and December 19, 2010 stormwater events. Both the September 23, 2010 and the October 20, 2010 event showed mild toxicity when using the NOEC approach. The December 19, 2010 showed no toxicity when analyzing the data using the NOEC method with the NOEC at 100% and 1 TU_c. This failed TST is likely due to a failed replicate and once the replicate is removed the sample passes. There were no cases where a TIE was indicated when using the NOEC method and not in the TST approach.



Quartiles based on Cumulative Distribution Function ("CDF")

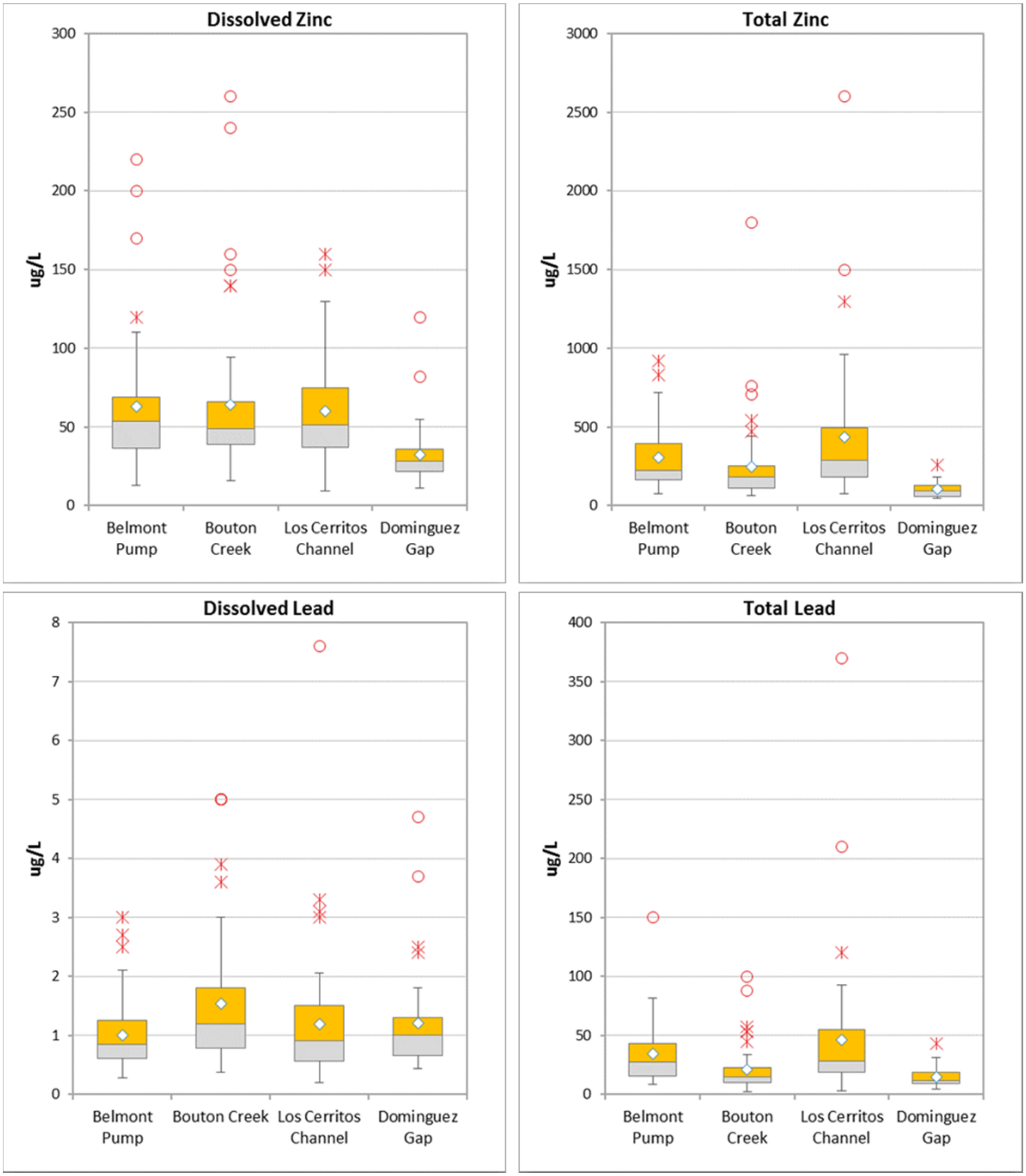
Outliers are based on 1.5 (*) and 3 (O) IQR (inner quartile range) from the median.
Diamond symbol = average
Division between shaded boxes = median
Whiskers = non-outlier minimum and maximum

Figure 27. Box Plots of TSS and Fecal Indicator Bacteria from All Wet Weather Events at each Mass Emission Site for All Years.



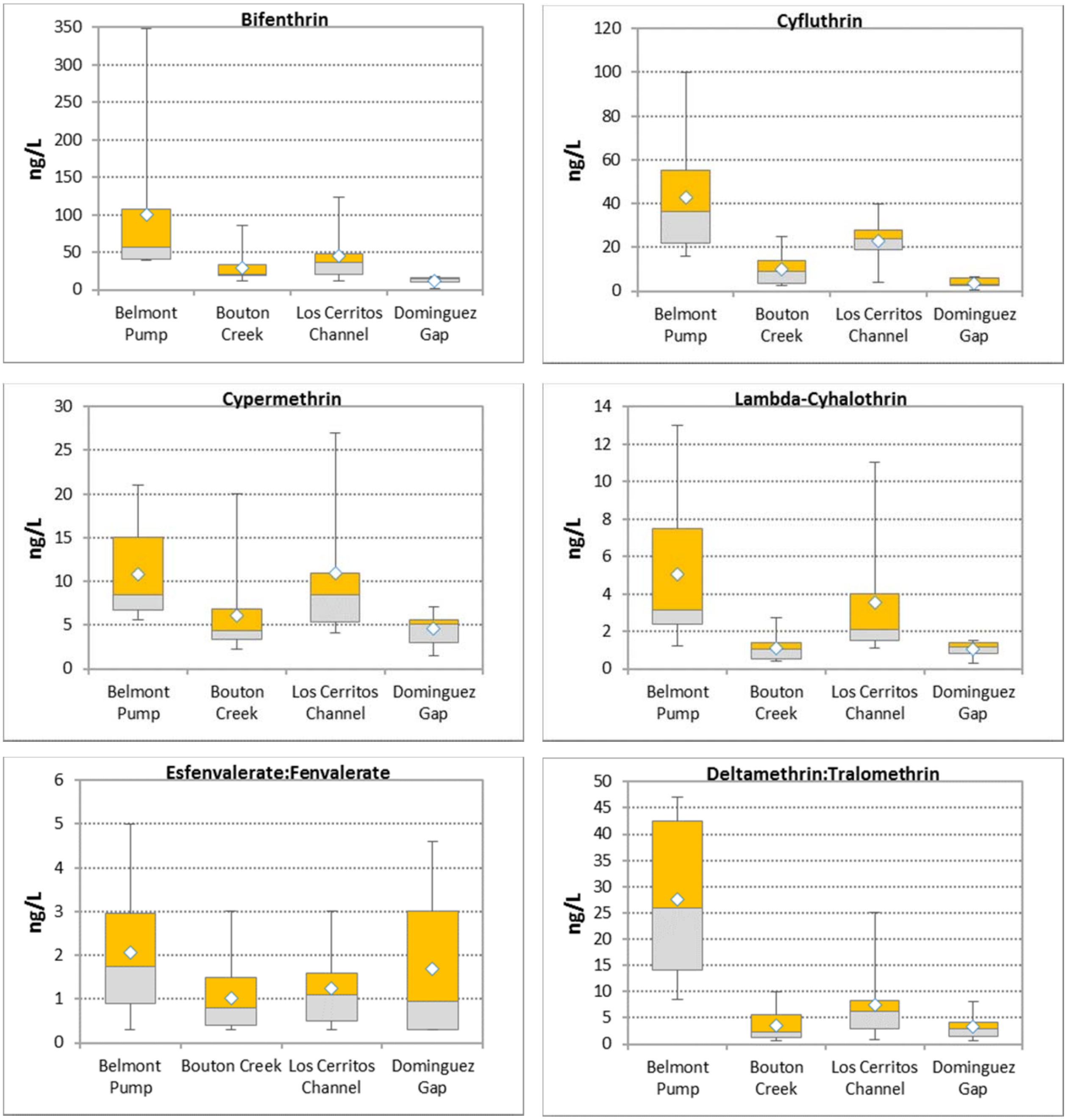
Quartiles based on Cumulative Distribution Function ("CDF")
Outliers are based on 1.5 (✳) and 3 (O) IQR (inner quartile range) from the median.
Diamond symbol = average
Division between shaded boxes = median
Whiskers = non-outlier minimum and maximum

Figure 28. Box Plots of Dissolved and Total Cadmium and Copper from All Wet Weather Events at each Mass Emission Site for All Years.



Quartiles based on Cumulative Distribution Function ("CDF")
Outliers are based on 1.5 (✳) and 3 (O) IQR (inner quartile range) from the median.
Diamond symbol = average
Division between shaded boxes = median
Whiskers = non-outlier minimum and maximum

Figure 29. Box Plots of Dissolved and Total Zinc and Lead from All Events at each Mass Emission Site.



Quartiles based on Cumulative Distribution Function ("CDF")
Outliers are based on 1.5 (*) and 3 (O) IQR (inner quartile range) from the median.
Diamond symbol = average
Division between shaded boxes = median
Whiskers = non-outlier minimum and maximum

Figure 30. Box Plots of Pyrethroid Pesticides from All Events at each Mass Emission Site.

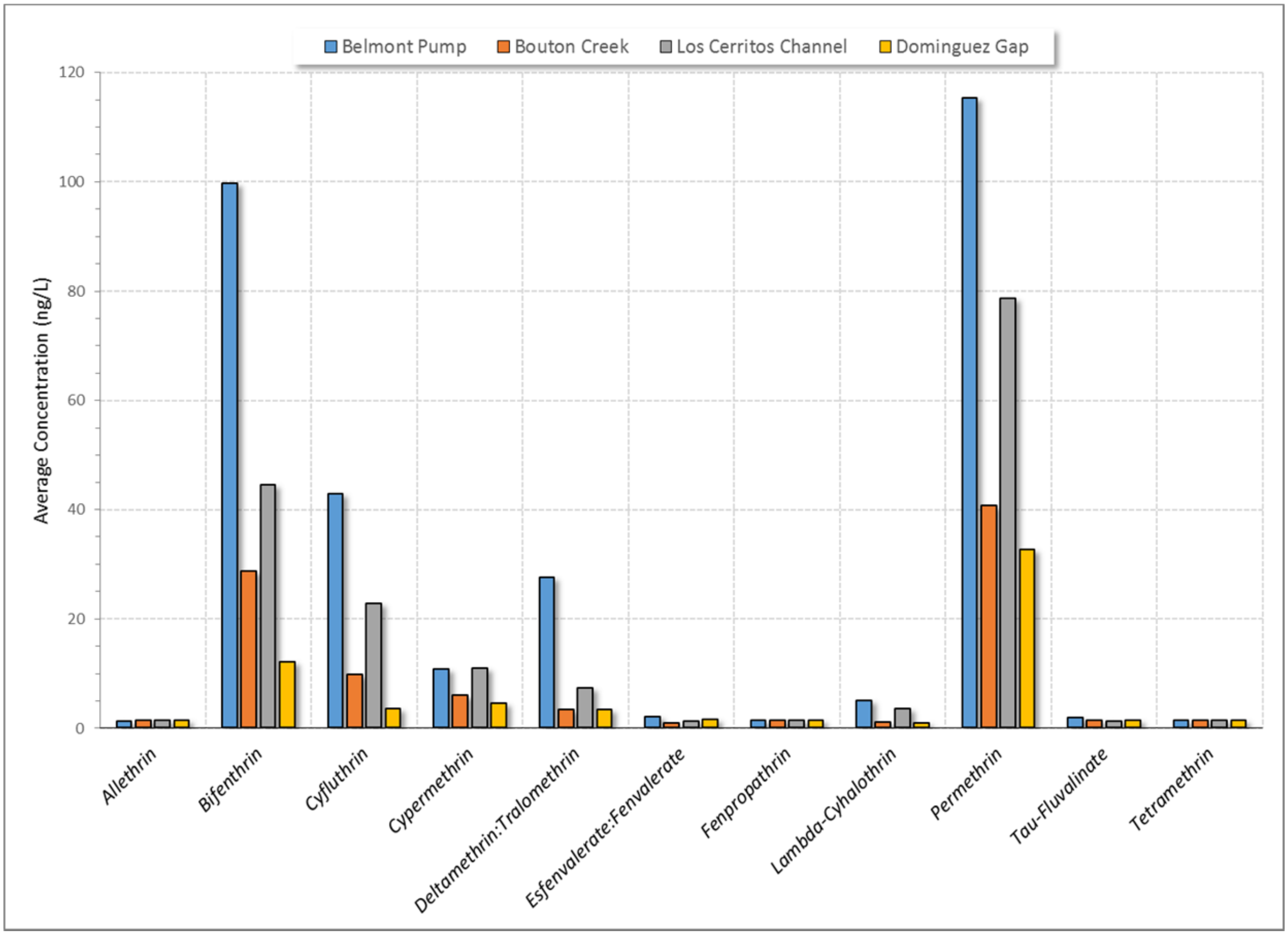


Figure 31. Average Concentration of Pyrethroid Pesticides Measured in Stormwater from the Four Mass Emission Monitoring Sites (2010-2014)

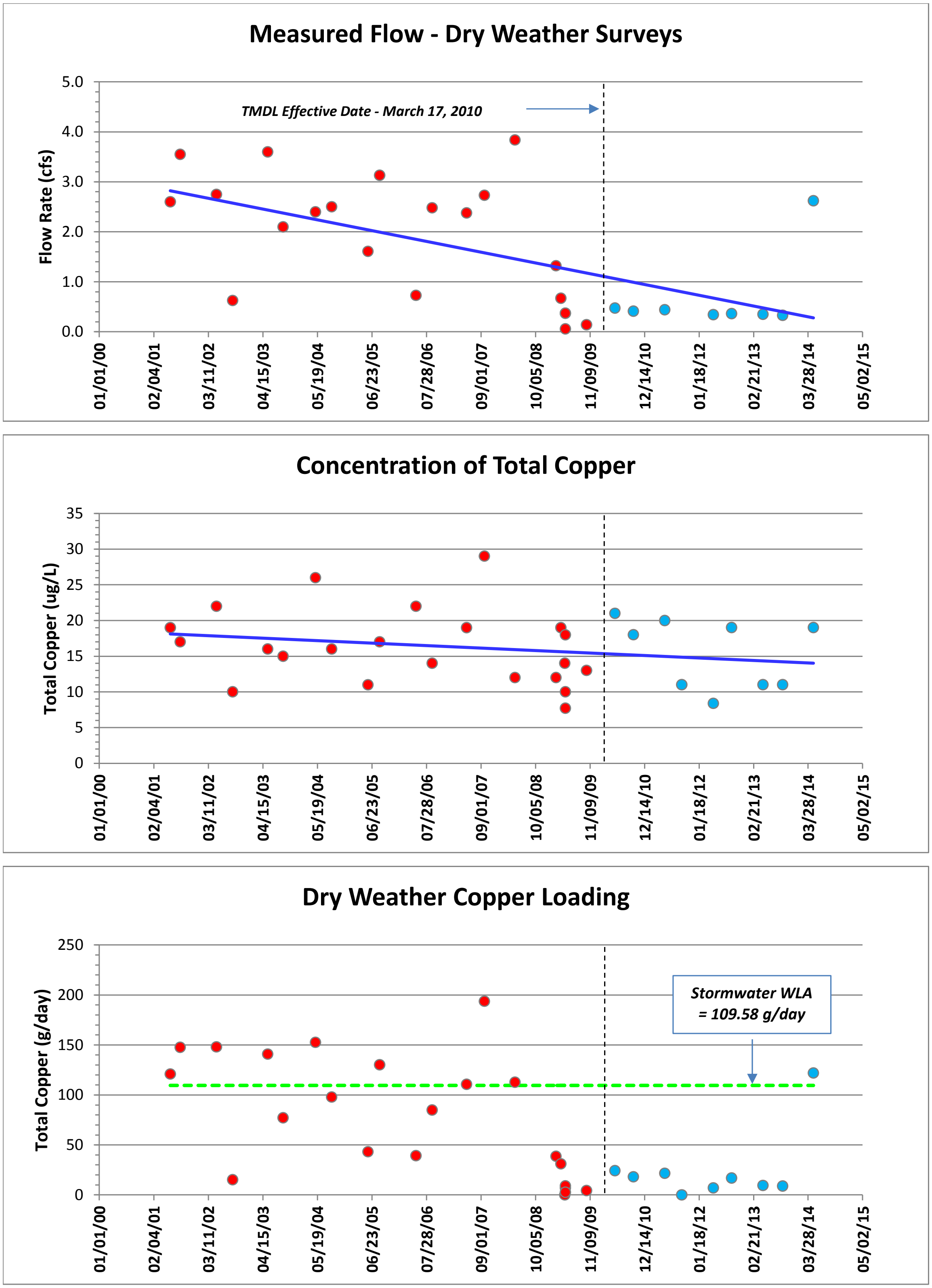


Figure 32. **Dry Weather Flow, Total Copper Concentrations and Total Copper Loading at the Los Cerritos Channel Monitoring Site.**

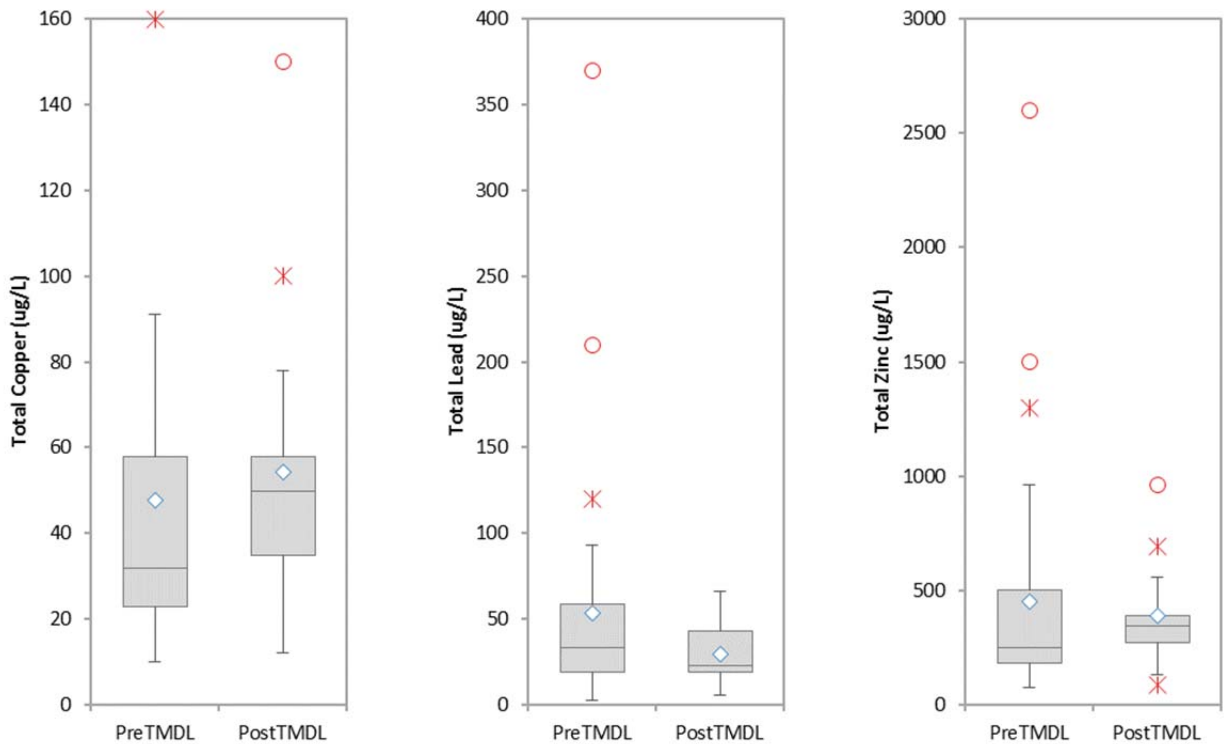
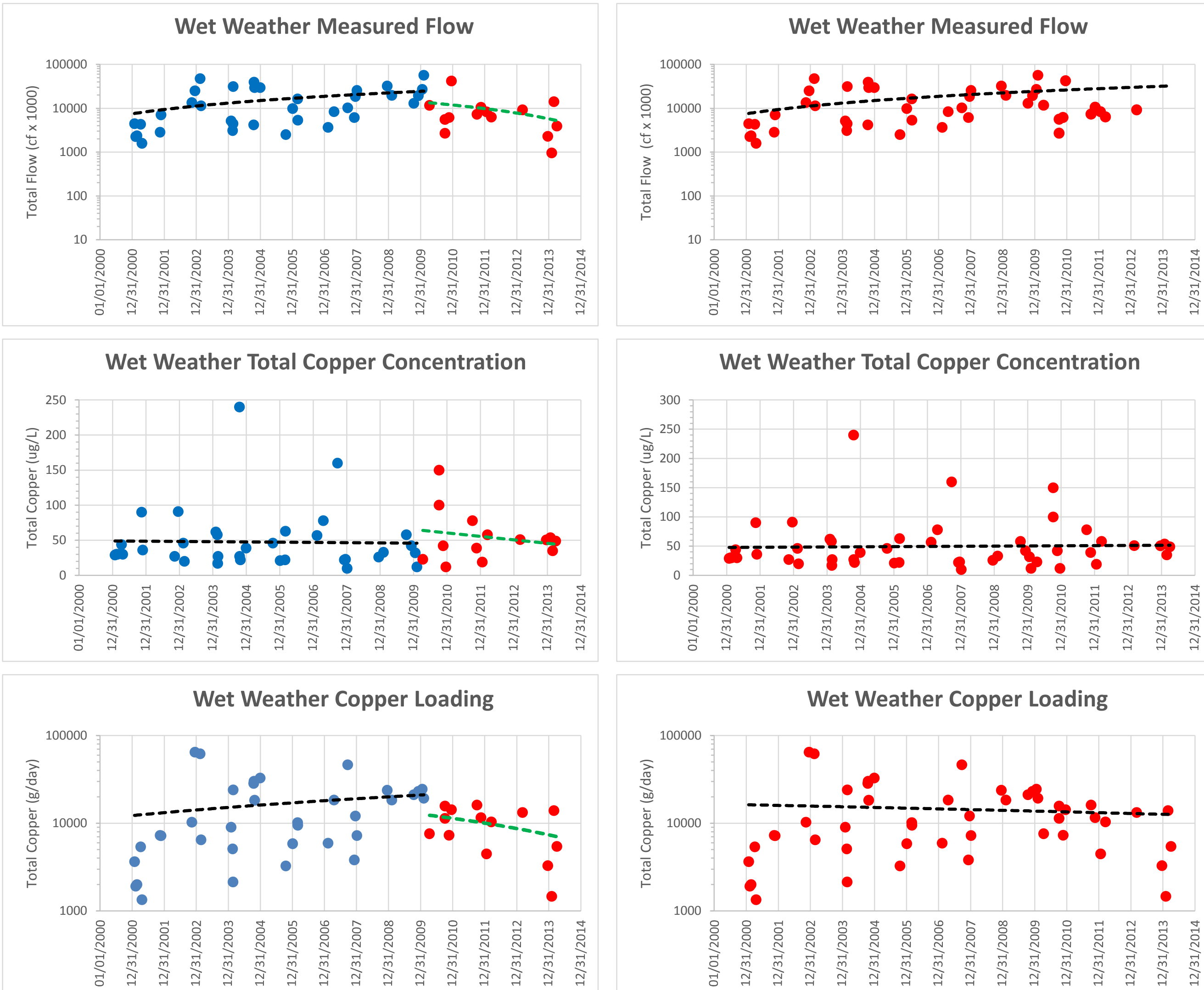
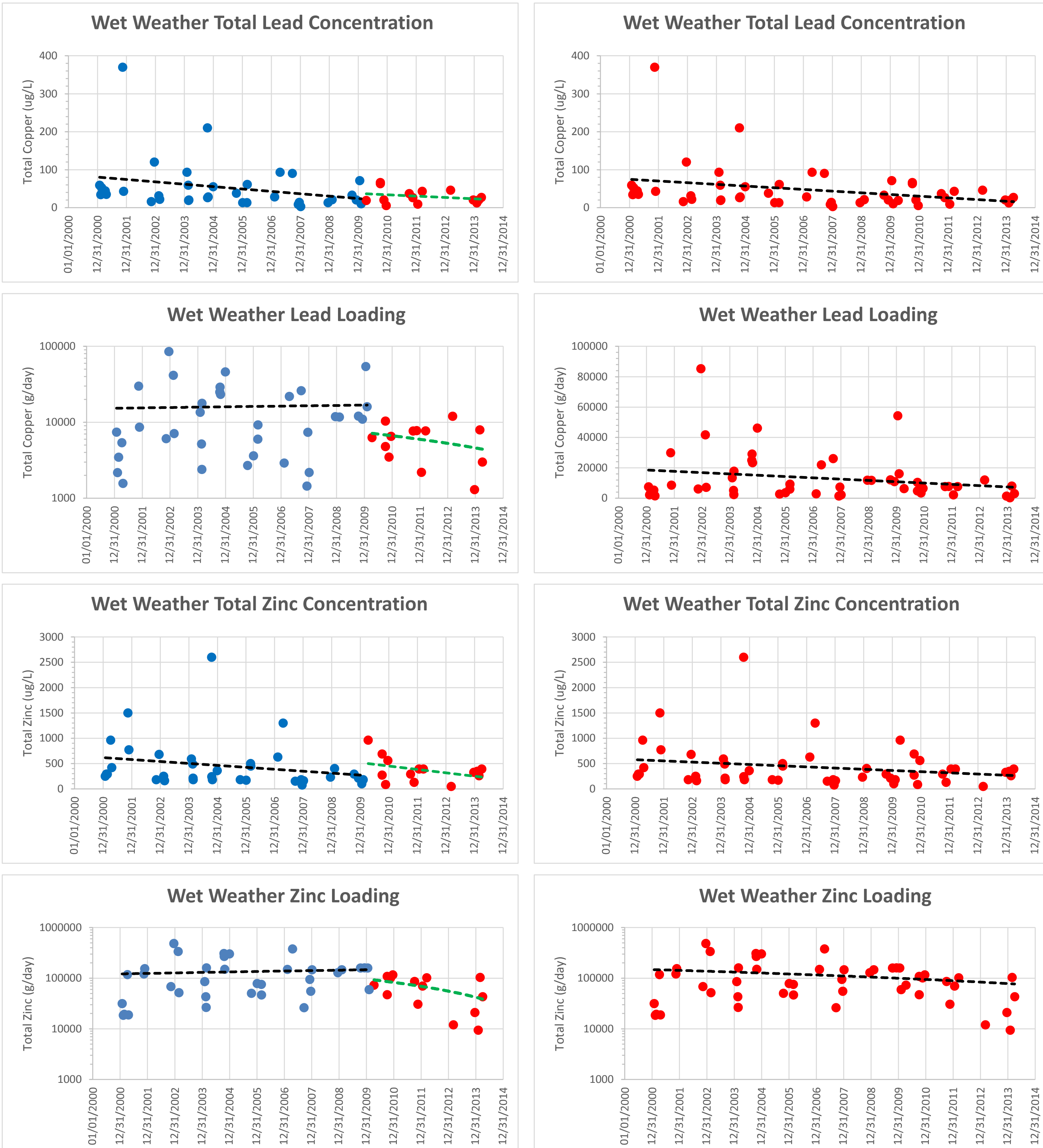


Figure 33. Box Plots showing the Distribution of Total Copper, Lead and Zinc before and after TMDL Implementation at the Los Cerritos Channel Monitoring Site (PreTMDL=35 samples, PostTMDL=13 samples).



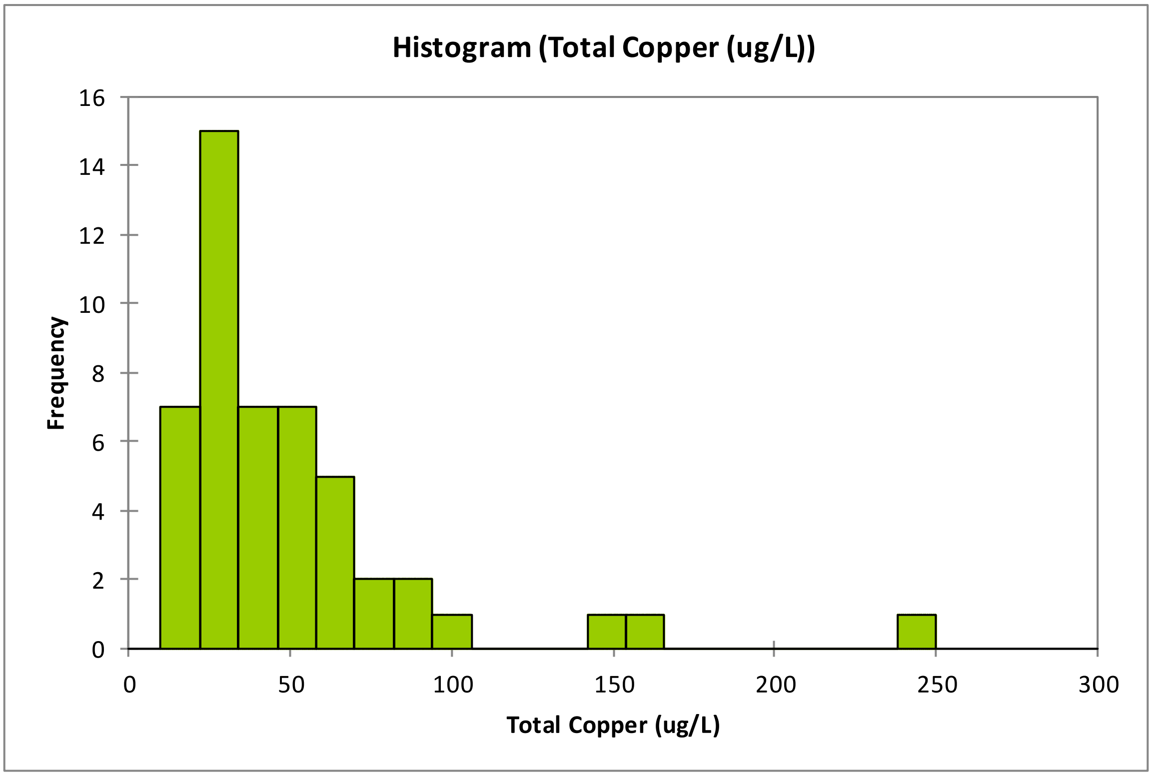
Note: Figures on the left illustrate samples taken before and after the effective date of the TMDL (3/17/2010). Figures on the right illustrate trends without consideration of the effective date of the TMDL.

Figure 34. Stormwater Flow, Concentration and Loads for Total Copper, Lead, and Zinc at the Los Cerritos Channel Station.



Note: Figures on the left illustrate samples taken before and after the effective date of the TMDL (3/17/2010). Figures on the right illustrate trends without consideration of the effective date of the TMDL.

Figure 34. Stormwater Flow, Concentration and Loads for Total Copper, Zinc and Lead at the Los Cerritos Channel Station. (continued)



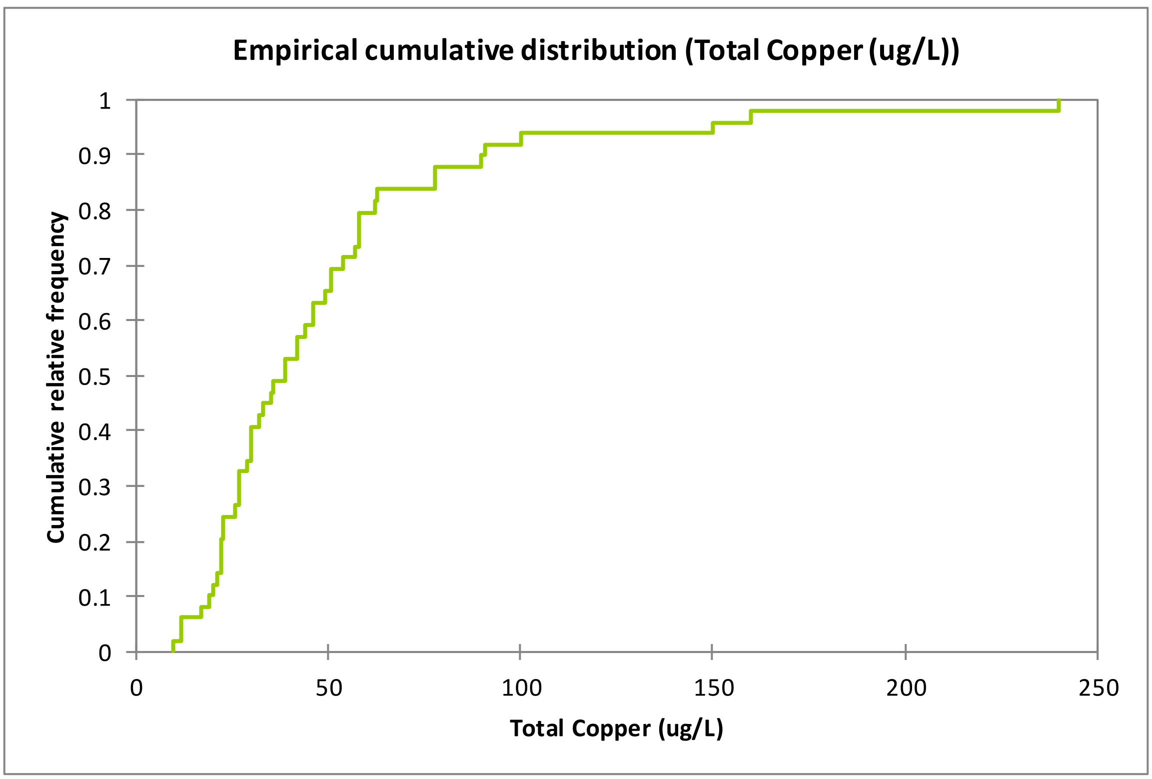
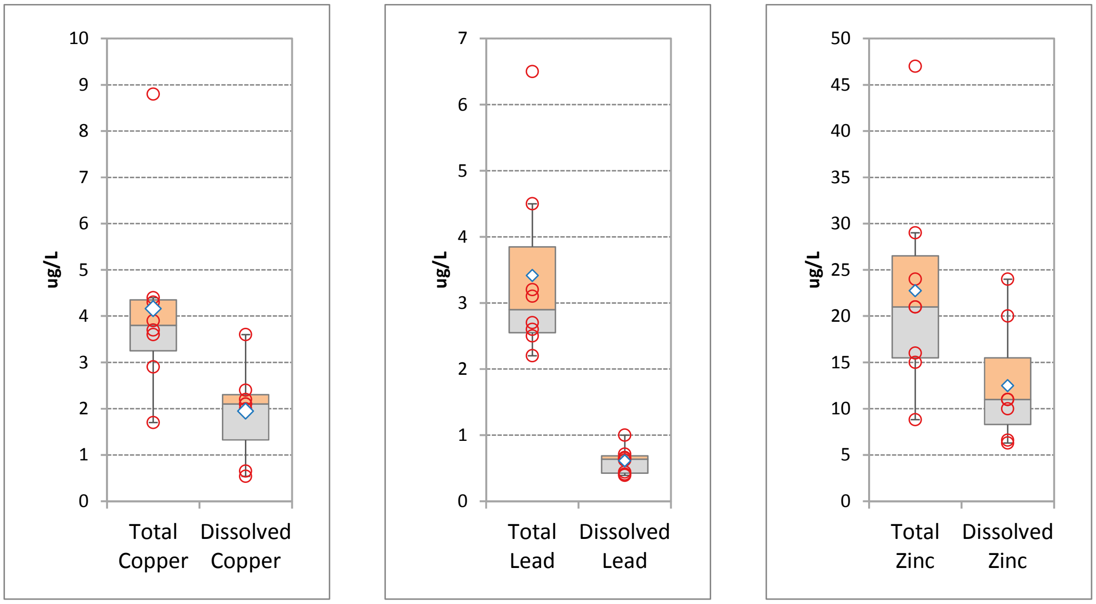


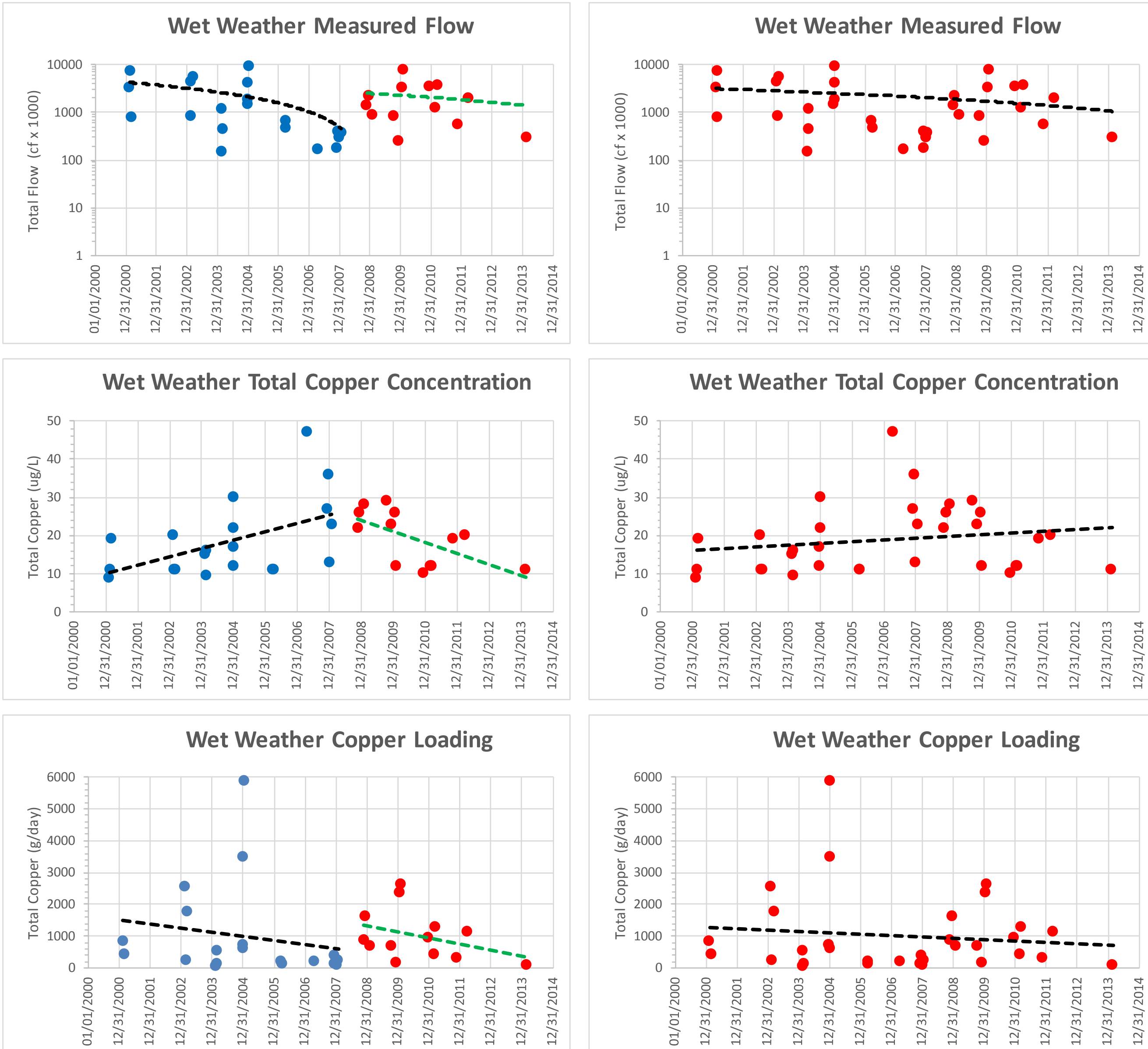
Figure 35. Histogram and Cumulative Distribution of Total Copper Concentrations in Stormwater Runoff collected at the Los Cerritos Channel Monitoring Site for All Years.



Circles are raw data values, diamonds are mean values

	TOTAL METALS		
	Copper	*Lead*	*Zinc*
LA River @ Wardlow TMDL objective	23	12	
No. of Events	8	8	8
Mean	4.2	3.4	22.7
Standard Deviation	2.1	1.4	11.6
Minimum	1.7	2.2	8.8
Median	3.8	2.9	21.0
Maximum	8.8	6.5	47.0
	DISSOLVED METALS		
	Copper	*Lead*	*Zinc*
CTR Objective (median hardness=282 mg/L, 10^{th} percentile hardness=219 mg/L)	22	7.6	230
No. of Events	8	8	8
Mean	1.9	0.6	12.5
Standard Deviation	1.0	0.2	6.3
Minimum	0.5	0.4	6.3
Median	2.1	0.6	11.0
Maximum	3.6	1.0	24.0

Figure 36. Total Recoverable and Dissolved Copper, Lead and Zinc in Dry Weather Discharges from the Dominguez Gap Pump Station.



Note: Figures on the left illustrate samples taken before and after the effective date of the TMDL (10/29/2008). Figures on the right illustrate trends without consideration of the effective date of the TMDL.

Figure 37. Stormwater Flow, Concentration and Loads for Total Copper, Lead, and Zinc at the Dominguez Gap Pump Station.

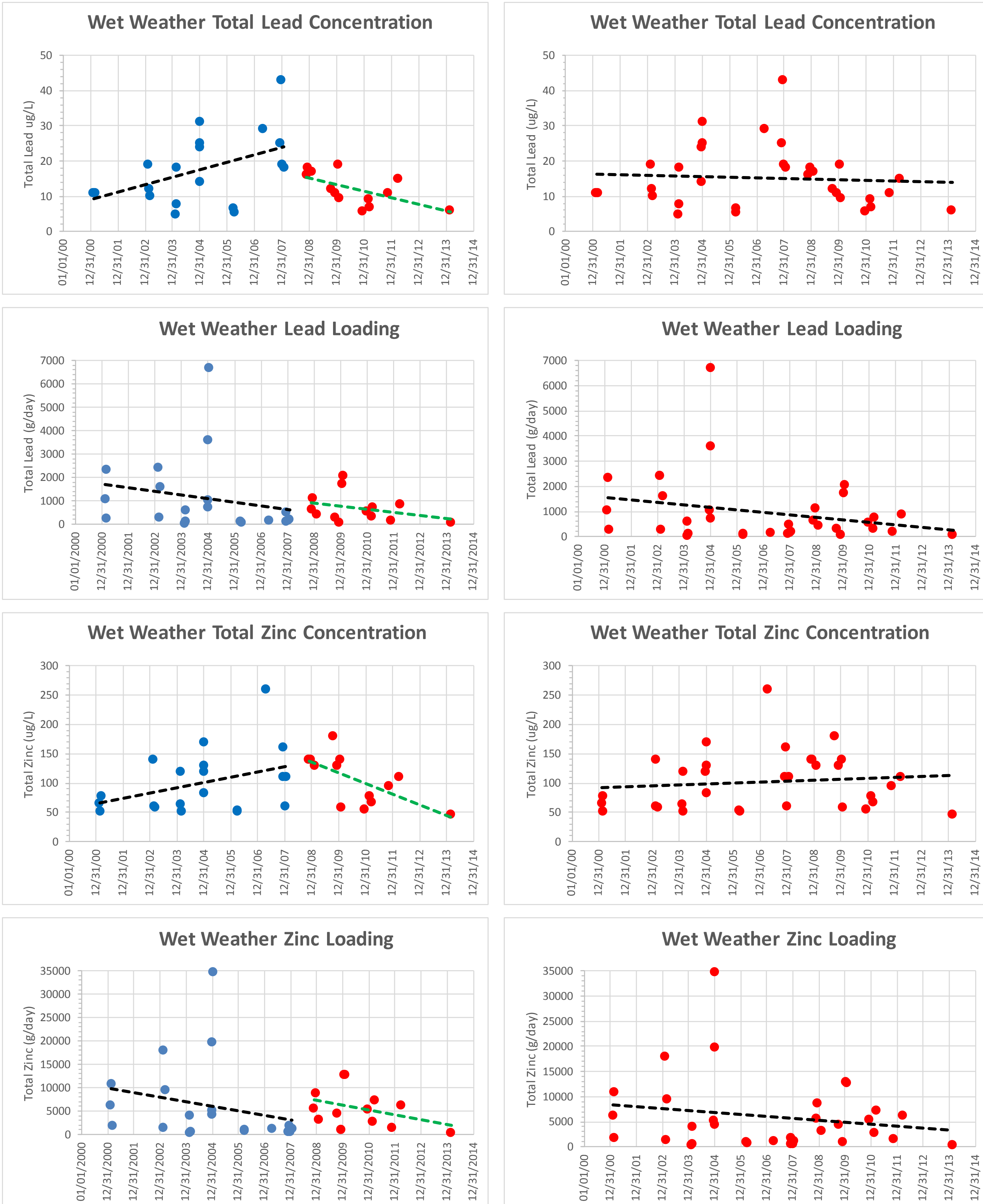
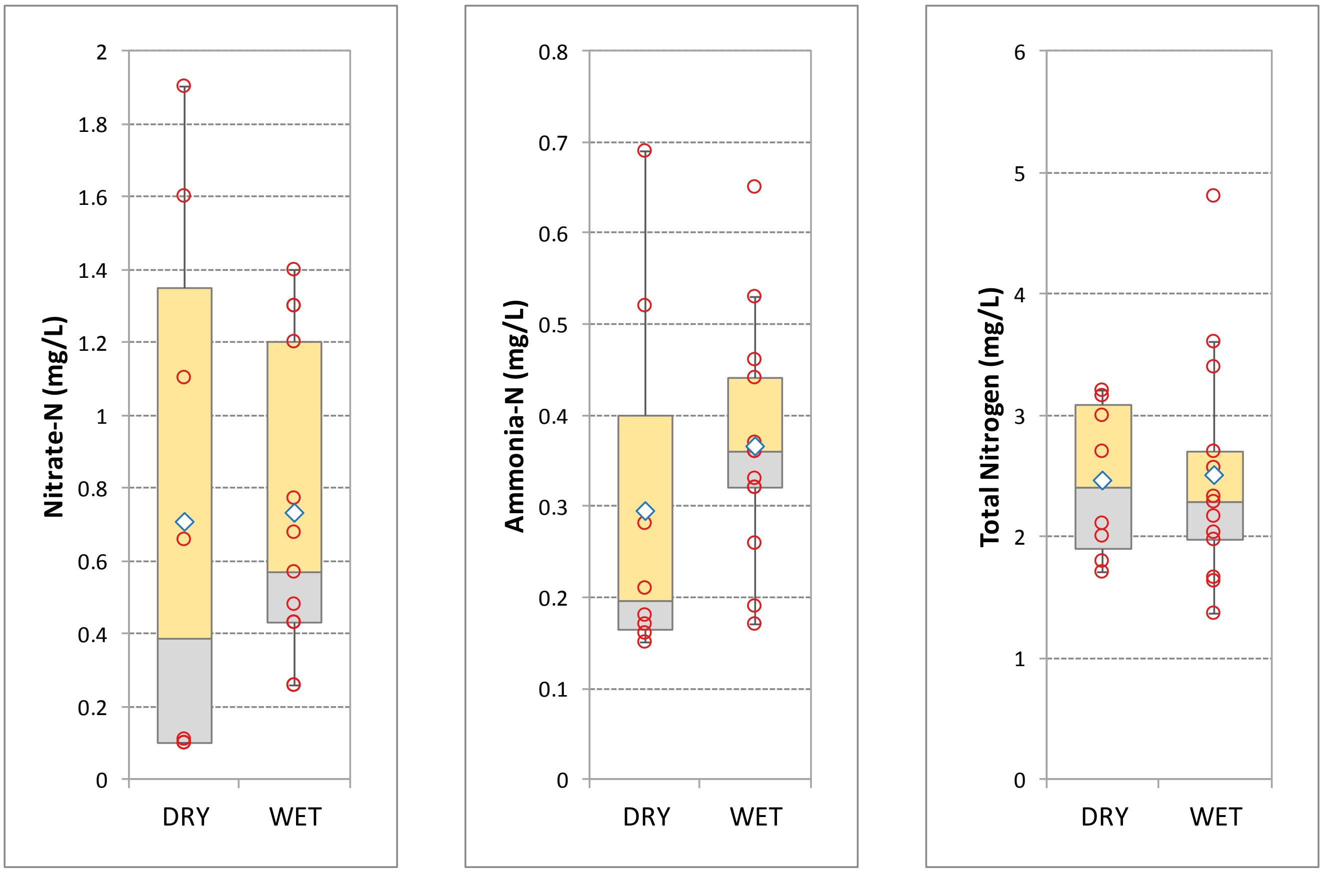


Figure 37. **Stormwater Flow, Concentration and Loads for Total Copper, Zinc and Lead at the Dominguez Gap Pump Station. (continued)**



Circles are raw data values, diamond equals the mean. Total nitrogen is the sum of TKN and nitrate-N.

Figure 38. Distribution of Nitrate-N, Ammonia-N, and Total Nitrogen Measured in both Dry and Wet Weather Discharges from the Dominguez Pump Station, 2008-2014.

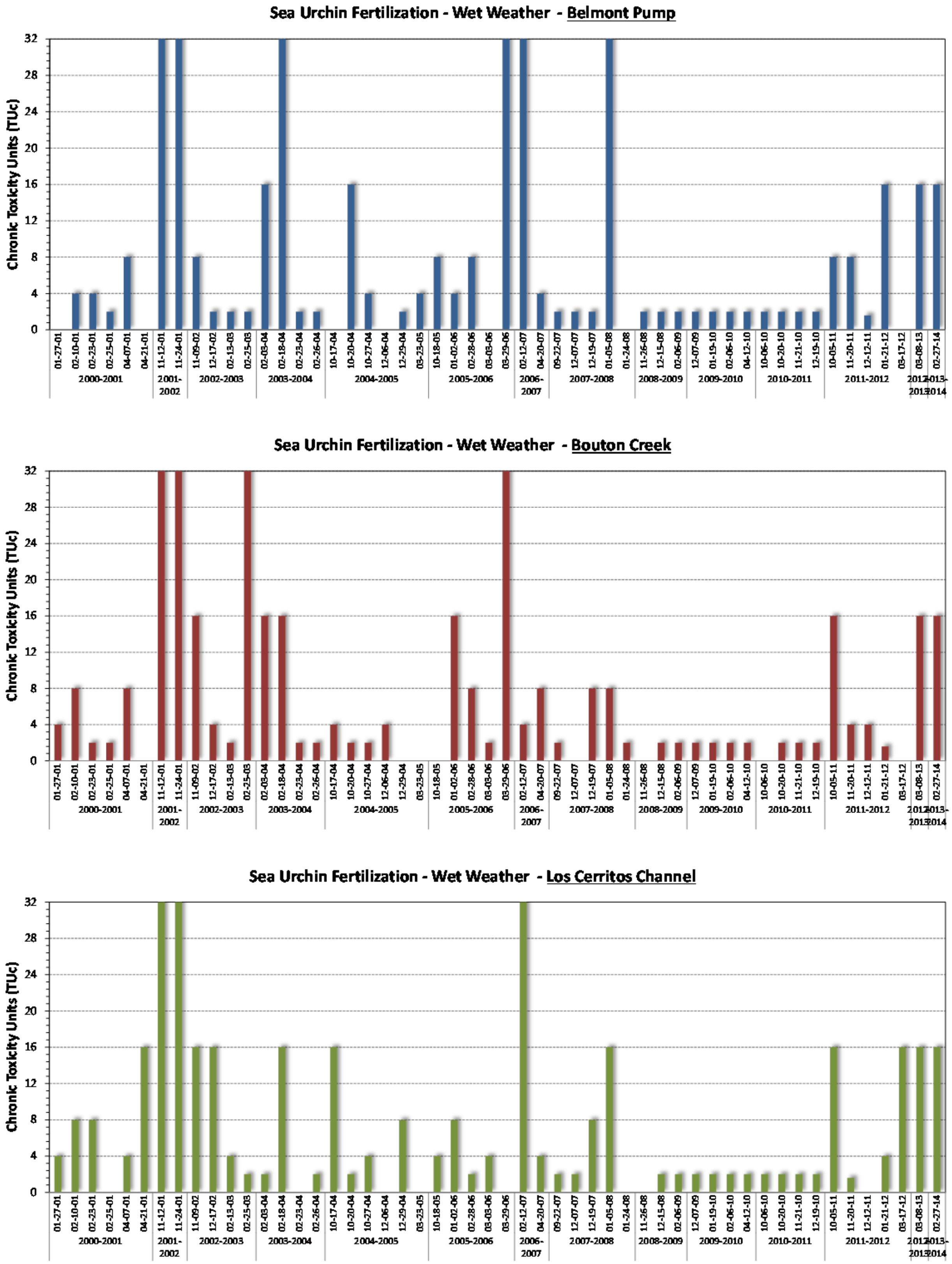


Figure 39. Chronic Toxicity of Stormwater Discharge to Sea Urchin Fertilization, 2000 to 2014.

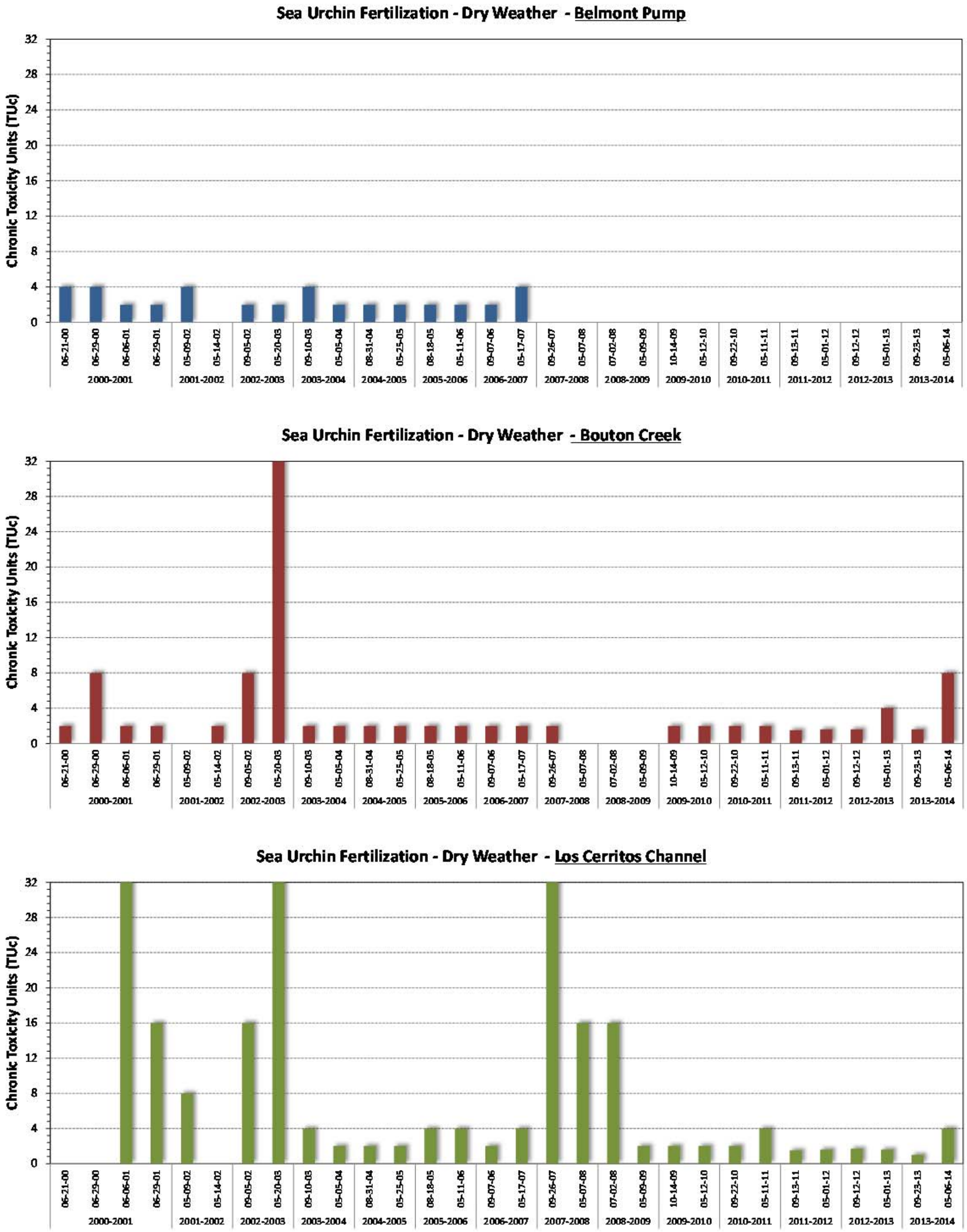


Figure 40. **Chronic Toxicity of Dry Weather Discharge to Sea Urchin Fertilization, 2000 to 2014.**

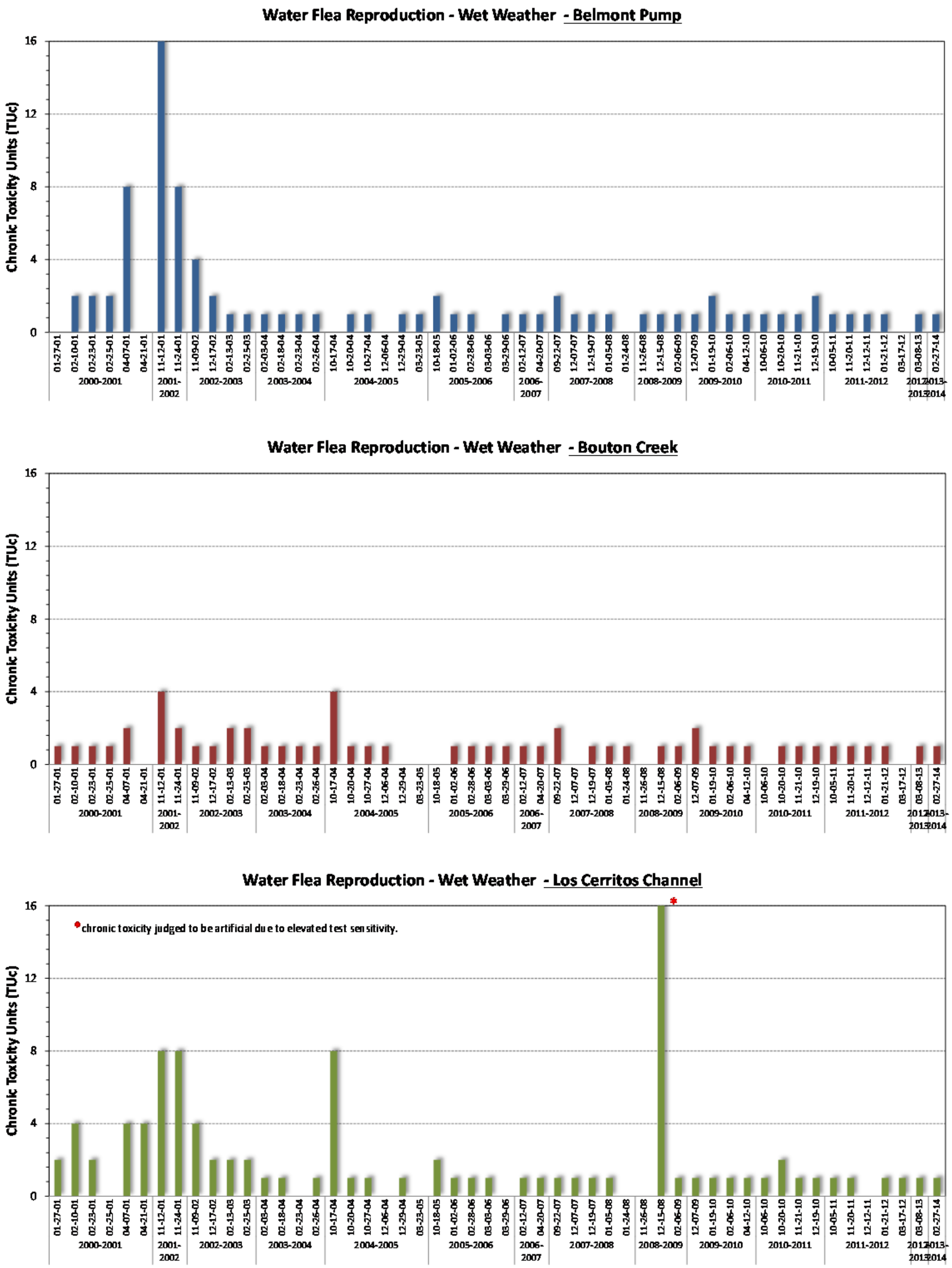


Figure 41. Chronic Toxicity of Stormwater Discharge to Water Flea Reproduction, 2000 to 2014.

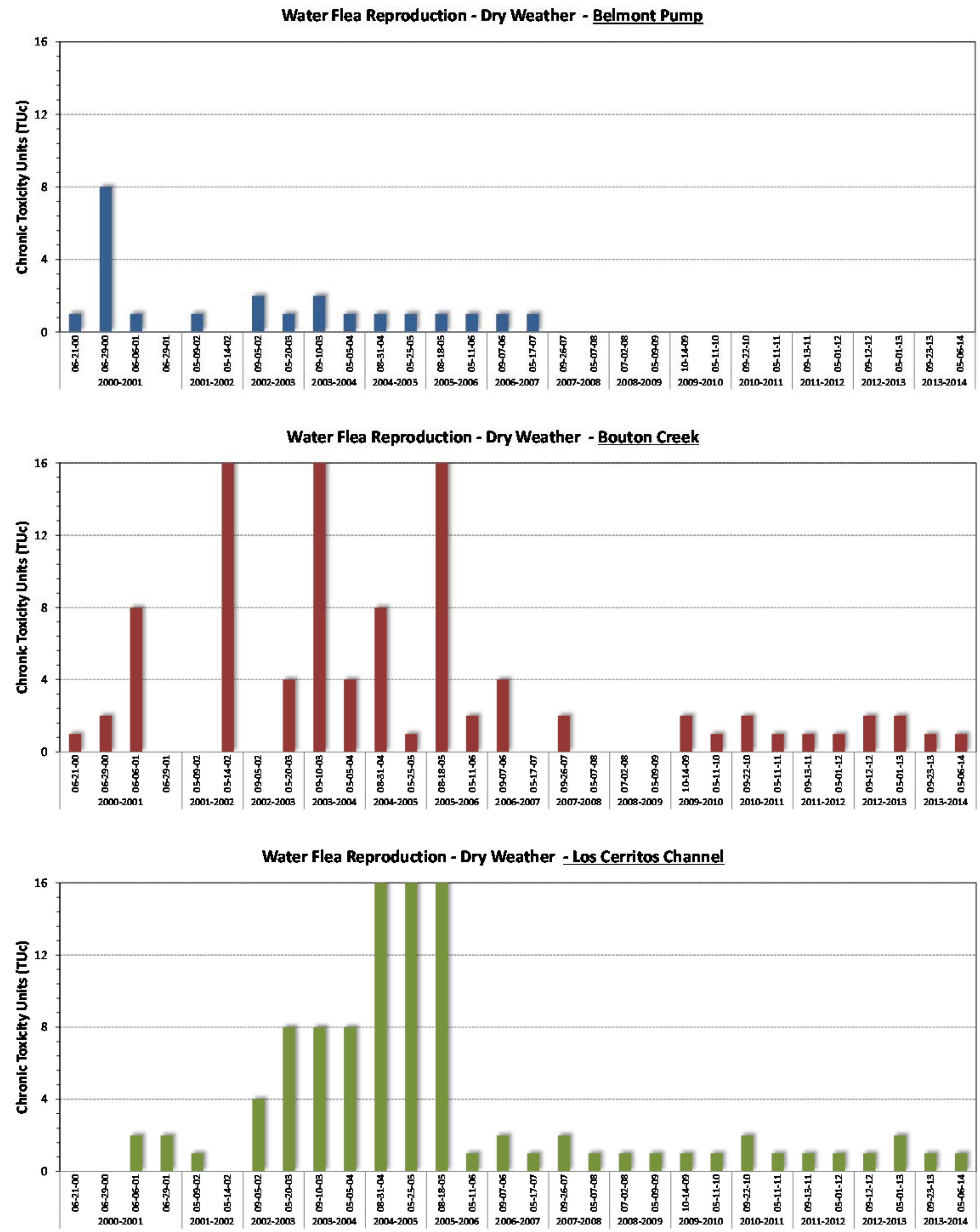


Figure 42. Chronic Toxicity of Dry Weather Discharge to Water Flea Reproduction, 2000 to 2014.

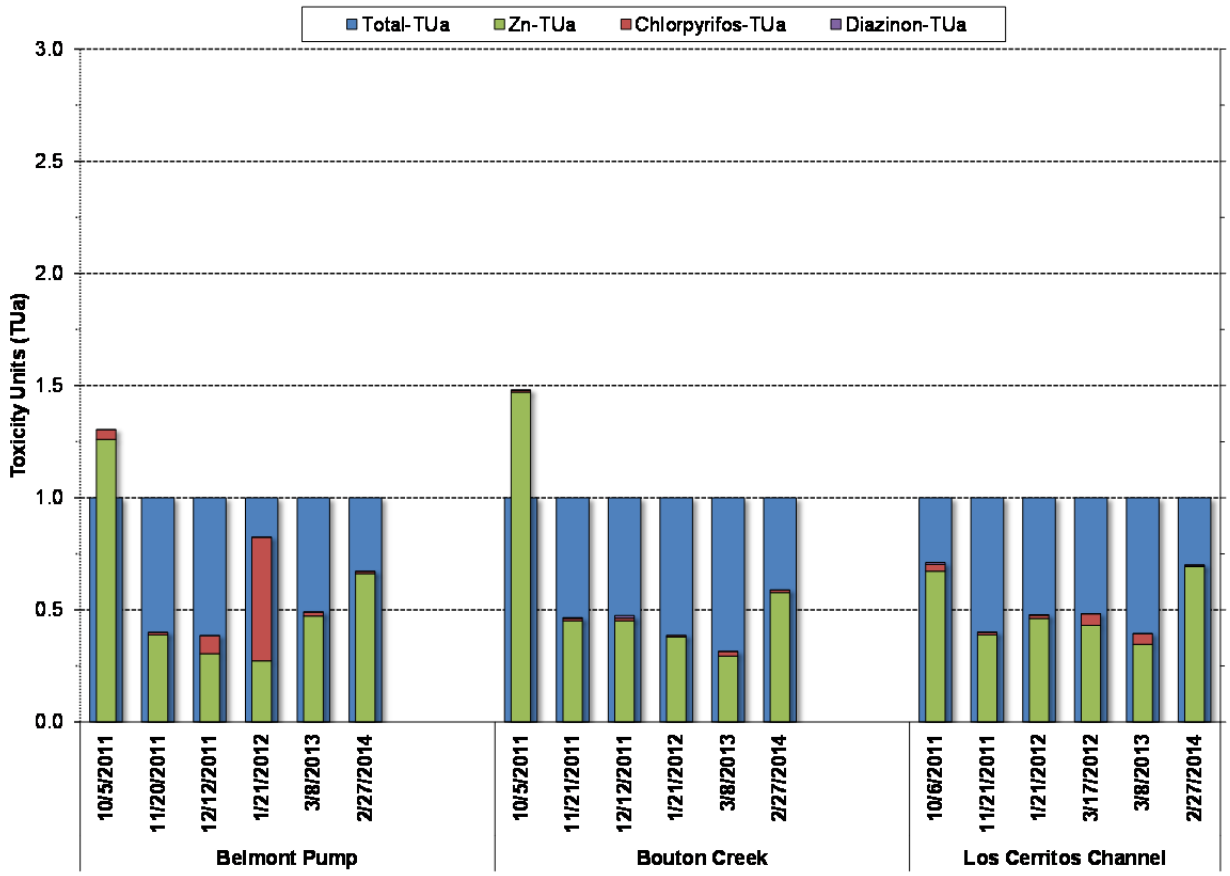


Figure 43. **Measured Acute Toxicity to *Ceriodaphnia dubia* versus Predicted Toxicity due to Zinc, Chlorpyrifos and Diazinon, 2011 to 2014.**

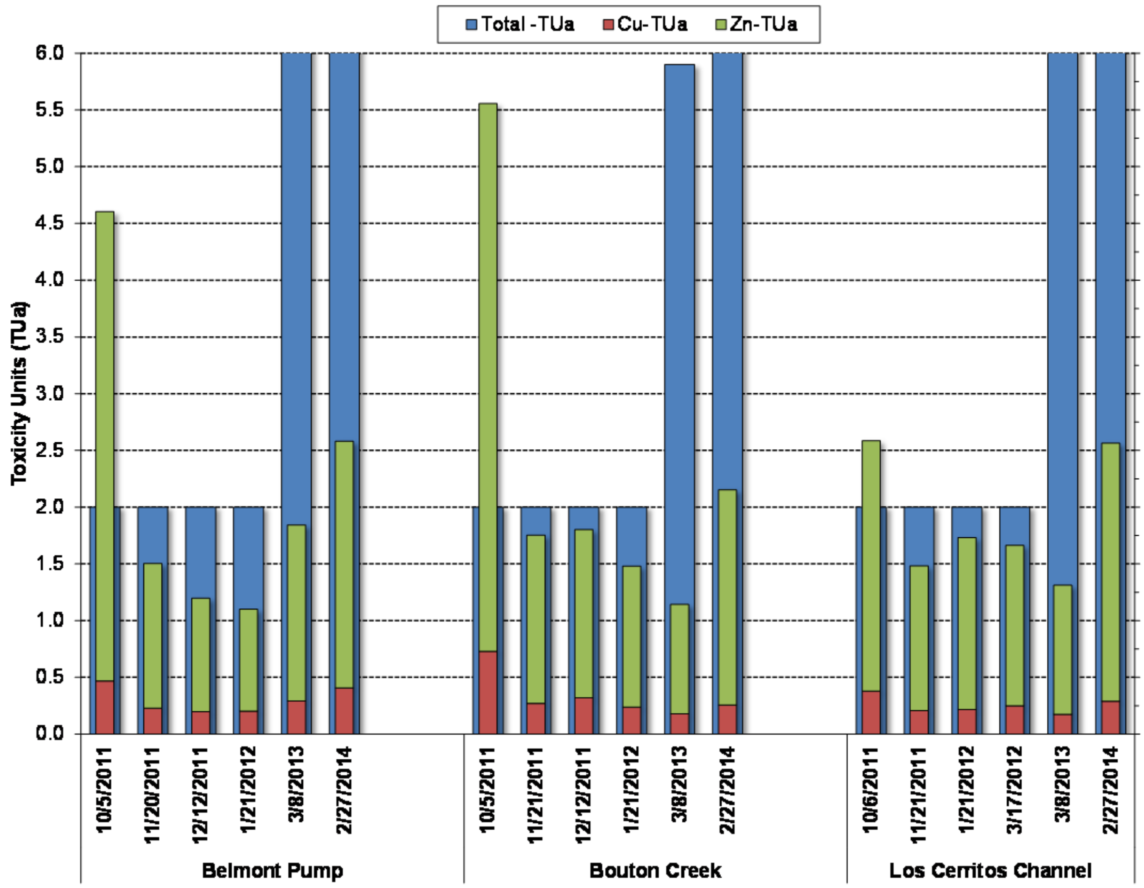


Figure 44. **Measured Acute Toxicity to *Strongylocentrotus purpuratus* versus Predicted Toxicity due to Zinc and Copper, 2011 to 2014.**

Table 31. Summary of Beneficial Uses for Receiving Water Bodies Associated with each Monitoring Location[1].

DISCHARGE LOCATION	HYDRO. UNIT	COMM	EST	GWR	IND	MAR	MUN	NAV	RARE	REC1	REC2	SHELL	WARM	WET	WILD
Bouton Creek	405.15						P			P	I		I		E
Los Cerritos Channel	405.15						P			P	I		I		E
Dominguez Gap Pump Sta.	405. 15			E	P		P			E	E		E		P
Belmont Pump Sta./Alamitos Bay	405.12	E	E		E	E		E	E	E	E	E		E	E

1. Source: California Regional Water Quality Control Board, Los Angeles Region. 1994. Water Quality Control Plan, Los Angeles Region, Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties. P=Potential, E=Existing, and I=Intermittent

Commercial and Sport Fishing (COMM): Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Estuarine Habitat (EST): Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Ground Water Recharge (GWR): Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Industrial Service Supply (IND): Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

Marine Habitat (MAR): Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation, such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Municipal and Domestic Supply (MUN): Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water.

Navigation (NAV): Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Rare, Threatened, or Endangered Species (RARE): Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Water Contact Recreation (REC-1): Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-contact Water Recreation (REC-2): Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sun bathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Shellfish Harvesting (SHELL): Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

Warm Freshwater Habitat (WARM): Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Wetland Habitat (WET): Uses if water that support wetland ecosystems including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

Wildlife Habitat (WILD): Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., Mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Table 32. Available Freshwater Benchmarks and Guidelines Used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites.

	Long Beach	LA Basin Plan	California Toxics Rule		California Fish and Game	
	2001-2011	Acute	Chronic	Acute	Chronic	Acute
Analyte Group	ML	Max. Level	CCC [2]	CMC [2]	CCC	CMC
Bacteria (MPN/100 ml)						
Enterococcus	10	104				
Fecal Coliform	20	400				
Total Coliform	20	10000				
Ratio of Fecal to Total Coliform		FC/TC≥0.1 & TC>1000				
Conventionals (mg/L unless noted)						
pH (pH Units)	0.1	[6.5 - 8.5]				
MBAS	0.025	0.5				
Nitrate (as N)	0.1	10				
Nitrite (as N)	0.1	1				
Total Ammonia (as N)	0.1	- [1]				
Dissolved Metals (µg/L)						
Arsenic	0.5		150	340		
Cadmium	0.2		1.3	2.0		
Copper	0.5		5.0	7.0		
Lead	0.2		1.2	30		
Nickel	0.5		29	260		
Silver	0.2			1.0		
Zinc	1		66	65		
Total Metals (µg/L)						
Aluminum	25	1000				
Iron	25					
Nickel	0.5	100				
Selenium	1	50	5	20		

1. The one-hour average ammonia-N criterion applicable to storm events is pH dependent. The 30-day ammonia-N criterion applicable to dry weather is both temperature and pH dependent.
2. CTR freshwater dissolved metals are hardness dependent. The values listed here are computed for a hardness of 50 mg/L.
   CTR freshwater dissolved cadmium and lead coefficients for conversion of total recoverable to dissolved criteria are also hardness dependent.

Table 32. Freshwater Benchmarks and Guidelines Used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites (continued)

	Long Beach	LA Basin Plan	California Toxics Rule		California Fish and Game		UC Davis	
	2001-2012	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute
Analyte Group	ML	Max. Level	CCC *	CMC *	CCC	CMC	CCC	CMC
Aroclors (µg/L)								
Aroclor 1016	0.02	0.5						
Aroclor 1221	0.02	0.5						
Aroclor 1232	0.02	0.5						
Aroclor 1242	0.02	0.5						
Aroclor 1248	0.02	0.5						
Aroclor 1254	0.02	0.5						
Aroclor 1260	0.02	0.5						
Chlorinated Pesticides (µg/L)								
4,4'-DDT	0.005		0.001	1.1				
Aldrin	0.005			3				
Dieldrin	0.005		0.056	0.24				
Endrin	0.005	2	0.036	0.086				
gamma-BHC (Lindane)	0.005			0.95				
Endosulfan I	0.005		0.056	0.22				
Endosulfan II	0.005		0.056	0.22				
Heptachlor	0.005	0.01	0.0038					
Heptachlor epoxide	0.005	0.01	0.0038					
Total Chlordane	0.005	0.1	0.0043	2.4				
Methoxychlor	0.005	40						
Mirex	0.005						0.001	
Toxaphene	0.05	2	0.0002					
Organophosphates (µg/L)								
Chlorpyrifos	0.002				0.014	0.02	0.0056	0.011
Diazinon	0.004				0.1	0.16	0.17	0.82
Malathion	0.006				0.1	0.43	0.028	0.17
Pyrethroids (ng/L)								
Bifenthrin	1.5	3					0.6	4
Cyfluthrin	1.5	2					0.05	0.3
Cypermethrin	1.5						0.2	1
L-Cyhalothrin	1.5						0.5	1
Permethrin	15						2	10
Total Deltamethrin/Tralomethrin	3							
Total Esfenvalerate/Fenvalerate	1.5							

Table 33. Saltwater Benchmarks and Guidelines Used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites.

	Long Beach	California Ocean Plan			California Toxics Rule		California Fish and Game		UC Davis	
Analyte Group	2001-2011 ML	Instantaneous Single Sample	Daily Maximum	30-day Average	Chronic CCC	Acute CMC	Chronic CCC	Acute CMC	Chronic CCC	Acute CMC
Bacteria (MPN/100 ml)										
Enterococcus	10	104								
Fecal Coliform	20	400								
Total Coliform	20	10000								
Ratio of Fecal to Total Coliform		FC/TC≥0.1 & TC>1000								
Conventionals (mg/L unless noted)										
pH (pH Units)	0.1		[6.0 - 9.0]							
Total Ammonia (as N)	0.1		2.4							
Dissolved Metals (µg/L)										
Arsenic	0.5				36	69				
Cadmium	0.2				9.3	42				
Copper	0.5				3.1	4.8				
Lead	0.2				8.1	210				
Nickel	0.5				8.2	74				
Selenium	1				71	290				
Silver	0.2				-	1.9				
Zinc	1				81	90				
Total Metals (µg/L)										
Arsenic	0.5	80	32							
Cadmium	0.2	10	4							
Copper	0.5	30	12							
Lead	0.2	20	8							
Nickel	0.5	50	20							
Selenium	1	150	60							
Silver	0.2	7	2.8							
Zinc	1	200	80							
Aroclors (µg/L)										
Total Aroclors				0.000019						

Table 33. Saltwater Benchmarks and Guidelines Used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites (continued.)

Analyte Group	Long Beach 2001-2011 ML	California Ocean Plan			California Toxics Rule		California Fish and Game		UC Davis	
		Instantaneous Single Sample	Daily Maximum	30-day Average	Chronic CCC	Acute CMC	Chronic CCC	Acute CMC	Chronic CCC	Acute CMC
Chlorinated Pesticides (µg/L)										
4,4'-DDT	0.005				0.001	0.13				
Aldrin	0.005			0.000022		1.3				
Dieldrin	0.005			0.00004		0.71				
Endrin	0.005		0.004			0.037				
gamma-BHC (Lindane)	0.005					0.16				
Endosulfan I	0.005		0.018			0.034				
Endosulfan II	0.005		0.018			0.034				
Heptachlor	0.005			0.00005		0.053				
Heptachlor epoxide	0.005			0.00002		0.053				
Total Chlordane	0.005				0.004	0.09				
Methoxychlor	0.005									
Mirex	0.005									0.001
Toxaphene	0.05			0.00021		0.21				
Organophosphates (µg/L)										
Chlorpyrifos	0.002						0.009	0.02	0.0056	0.011
Malathion	0.006						0.1	0.34	0.028	0.17
Pyrethroids (ng/L)										
Bifenthrin	1.5								0.6	4
Cyfluthrin	1.5								0.05	0.3
Cypermethrin	1.5								0.2	1
L-Cyhalothrin	1.5								0.5	1
Permethrin	15								2	10
Total Deltamethrin/Tralomethrin	3									
Total Esfenvalerate/Fenvalerate	1.5									

Notes to Table 32 and 33:

General

- Minimum Level (ML) is the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.
- Criteria continuous concentration (CCC) equals the highest concentration of pollutant to which aquatic life can be exposed for an extended period of time without deleterious effects.
- Criteria maximum concentration (CMC) equals the highest concentration of pollutant to which aquatic life can be exposed for a short period of time with deleterious effects.

California Toxics Rule

- CTR freshwater dissolved metals are hardness dependant. The values listed here are computed for a hardness of 50 mg/L.
- CTR freshwater dissolved cadmium and lead conversion coefficients for total to dissolved are also hardness dependent.
- CTR freshwater and saltwater dissolved metal criteria are "CCC" except for silver which are "CMC".
- CTR freshwater and saltwater organics are "CCC" except for aldrin and gamma-BHC which are "CMC".

Ocean Plan and LA Basin Plan

- Bacteria are instantaneous or single sample criteria.
- LA Basin Plan contains Title 22 Drinking Water standards
- Ammonia listed is Acute 1-hour average objective for waters not designated COLD and/or MIGR and is pH dependent. The value listed is for a pH of 7.5. Chronic criteria are applied to Dry Weather results and are pH and temperature dependent

California Fish and Game

- All values are "CMC" criteria. CMCs are considered acute criteria.

UC Davis - Werner and Oram, 2008.

Table 34. TMDL Load Limitations and Measured Loads at the Los Cerritos Monitoring Site during Storm Events.

		TMDL Load Limits (ug/L)								
		Total Copper	Total Lead	Total Zinc						
		9.8	55.8	95.6						
		TMDL Load Limits (kilograms/day)			Total Measured Loads (kilograms/day)			Exceedance Factors (Measured Load / TMDL Load Limit)		
Season	Total Flow (L)	Total Copper	Total Lead	Total Zinc	Total Copper	Total Lead	Total Zinc	Total Copper	Total Lead	Total Zinc
2011-2012	2.07E+08	2	11.6	19.8	16.2	7.7	116	8.0	0.7	5.9
	2.99E+08	2.9	16.7	28.6	11.6	7.8	86	4.0	0.5	3.0
	2.36E+08	2.3	13.2	22.6	4.5	2.2	31	1.9	0.2	1.4
	1.80E+08	1.8	10.1	17.2	10.4	7.7	70	5.9	0.8	4.1
2012-2013	2.60E+08	2.6	14.5	24.9	13.3	12	102	5.2	0.8	4.1
2013-2014	6.47E+07	0.63	3.6	6.2	3.3	1.3	21	5.2	0.4	3.4
	2.72E+07	0.27	1.5	2.6	1.5	0.34	9.4	5.6	0.2	3.6
	3.98E+08	3.9	22.2	38.0	14	8	100	3.6	0.4	2.6
	1.11E+08	1.1	6.2	10.6	5.4	3	43	5.0	0.5	4.1

TMDL Load Limits calculation: TMDL (kg/day) = daily storm volume (liters) X numeric target (µg/L) / 1,000,000,000
GREEN indicates exceedance factors of less than 1
RED indicates exceedance factors greater than 1

Table 35. Comparison of Sea Urchin Fertilization Toxicity Characteristics of Stormwater from Long Beach and Various Southern California Watersheds.

Location	Date	Number of Samples	%Toxic	TU_c
Long Beach	2013-2014	3	100	16 - >16
	2012-2013	3	100	>16
	2011-2012	12	75	8 - >16
	2010-2011	11	0	<2
	2009-2010	12	0	<2
	2008-2009	7	29	2 - 8
	2007-2008	12	42	2 - 32
	2006-2007	6	100	4 - >32
	2005-2006	12	83	2 - >32
	2004-2005	12	58	2 - 16
	2003-2004	11	45	<2 - 32
	2002-2003	13	46	≤2 - 32
	2000-2002	22	86	≤2 - 32
Los Angeles River	2012-2013	2	0	<1
	2011-2012	2	0	<1
	2010-2011	2	0	<1
	2009-2010	2	0	<1
	2008-2009	2	50	2 - 3
	1997-1999	4	100	4-8
San Gabriel River	2012-2013	2	0	<1
	2011-2012	2	0	<1
	2010-2011	1	0	<1
	2009-2010	2	0	<1
	2008-2009	2	50	2-3
	1997-1999	4	50	≤2 - 4
Ballona Creek	2012-2013	2	0	<1
	2011-2012	2	0	<1
	2010-2011	2	0	<1
	2009-2010	2	0	<1
	2008-2009	2	50	2 - 3
	1996-1997	13	85	≤4 - 32
Chollas Creek	1999-2000	5	100	8 - 32

Table 36. Comparison of Daphnid Toxicity Characteristics of Stormwater from Long Beach and Various Southern California Watersheds.

Location	Date	Number of Samples	%Toxic[1]	TU_c
Long Beach	2013-2014	3	0	1
	2012-2013	3	0	1
	2011-2012	12	0	1
	2010-2011	11	18	1 - 2
	2009-2010	12	8	1 - 2
	2008-2009	7	57	1 - >16
	2007-2008	12	33	1 - 2
	2006-2007	6	0	1
	2005-2006	2	17	1 - 2
	2004-2005	12	25	1 - 8
	2003-2004	11	9	1 - 2
	2002-2003	13	31	1 - 4
	2000-2002	22	77	1 - >16
Los Angeles River	2012-2013	2	0	<1
	2011-2012	2	0	<1
	2010-2011	2	0	<1
	2009-2010	2	0	<1
	2008-2009	2	0	<1
	2007-2008	2	50	1 - 1.1
San Gabriel River	2012-2013	2	50	<1 – 1.17
	2011-2012	2	0	<1
	2010-2011	1	0	<1
	2009-2010	2	0	<1
	2008-2009	2	0	<1
	2007-2008	2	0	1
Ballona Creek	2012-2013	2	0	<1
	2011-2012	2	0	<1
	2010-2011	2	0	<1
	2009-2010	2	0	<1
	2008-2009	2	0	<1
	2007-2008	2	0	1
Chollas Creek	2007-2008	2	0	1
	2006-2007	3	0	1
	2005-2006	3	33	1 - 2
	2004-2005	3	33	1 - 4
	2003-2004	3	0	1
	2002-2003	2	50	1 - 2
	2001-2002	3	100	4 - 8
	2000-2001	40	35[1]	Not reported
	1999-2000	5	100	8 - 32
	1999	3	0	1
	1999	3	67	1 - 2
	1994-1998	11	100	2 - 8

1. Percent toxic based only on daphnid survival LC_{50}.

Table 37. **LC/EC50 values used to calculate expected TU_a based upon concentrations of dissolved copper, dissolved zinc, diazinon, and chlorpyrifos in stormwater samples.**

	Dissolved Copper (ug/L)	Dissolved Zinc (ug/L)	Diazinon (ug/L)	Chlorpyrifos (ug/L)
Sea Urchin Fertilization	**34.3**	**29**		
Water Flea Survival		**95.2**	**0.49**	**0.10**

Table 38. **Comparison of the use of Toxicity Units and the TST procedure for triggering Phase 1 TIE tests for water flea reproduction.**

Station	Date	NOEC[a]	Median Response[b]	TU_a[c]	TU_c[d]	TST[e]
Los Cerritos	9/23/10	50	>100	<1.0	2.0	Fail
Los Cerritos	10/6/10	100	>100	<1.0	1.0	Pass
Los Cerritos	10/20/10	50	>100	<1.0	2.0	Fail
Los Cerritos	11/21/10	100	>100	<1.0	1.0	Pass
Los Cerritos	12/19/10	100	>100	<1.0	1.0	Fail
Los Cerritos	5/11/11	100	>100	<1.0	1.0	Pass
Los Cerritos	9/14/11	100	>100	<1.0	1.0	Pass
Los Cerritos	10/6/11	100	>100	<1.0	1.0	Pass
Los Cerritos	11/20/11	100	>100	<1.0	1.0	Pass
Los Cerritos	1/21/12	100	>100	<1.0	1.0	Pass
Los Cerritos	3/17/12	100	>100	<1.0	1.0	Pass
Los Cerritos	5/2/12	100	>100	<1.0	1.0	Pass
Bouton Creek	9/12/12	50	86.6	1.2	2.0	Fail
Los Cerritos	9/13/12	100	>100	<1.0	1.0	Pass
Belmont Pump	3/8/13	100	>100	<1.0	1.0	Pass
Bouton Creek	3/8/13	100	>100	<1.0	1.0	Pass
Los Cerritos	3/8/13	100	>100	<1.0	1.0	Pass
Bouton Creek	5/1/13	50	>100	<1.0	2.0	Fail
Los Cerritos	5/1/13	50	86.5	1.2	2.0	Fail
Bouton Creek	9/23/13	100	>100	<1.0	1.0	Pass
Los Cerritos	9/23/13	100	>100	<1.0	1.0	Pass
Belmont Pump	2/27/14	100	>100	<1.0	1.0	Pass
Bouton Creek	2/27/14	100	>100	<1.0	1.0	Pass
Los Cerritos	2/27/14	100	>100	<1.0	1.0	Pass
Bouton Creek	5/7/14	100	>100	<1.0	1.0	Pass
Los Cerritos	5/6/14	100	>100	<1.0	1.0	Pass

Test results indicating where a TIE would have been performed using the TST method but was not indicated with the NOEC approach are highlighted in red.

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.

[b] Concentration causing 50% inhibition in water flea reproduction (IC_{50}).

[c] Acute toxicity units = 100/IC_{50}.

[d] Chronic toxicity units = 100/NOEC.

[e] Test of Significant Toxicity.

CONCLUSIONS

The City of Long Beach's water quality monitoring program for stormwater and dry weather discharges through the City's municipal separate storm sewer system (MS4) began in the 1999/2000 wet weather season under terms of Order No. 99-060 National Pollutant Discharge Elimination Systems Municipal Permit No. CAS004003 (CI 8052). Since that time, 164 wet weather monitoring events have been conducted at the four Long Beach mass emission stations for the full set of analytes, along with 90 dry weather inspections/monitoring events. In addition, 89 wet weather events have been monitored to develop Event Mean Concentrations (EMCs) for total suspended solids only.

The Long Beach stormwater monitoring program has emphasized an approach of paired chemical analysis and toxicity testing of discharges of municipal stormwater. The purpose of this approach was to first identify the constituents in the City of Long Beaches stormwater discharges that exhibited potential water quality impacts. This requires that the chemical analyses and toxicity tests be conducted on the same composite water samples. This approach has successfully led to identification of impacts of organophosphate pesticides as problems early in the program. Removal of diazinon and chlorpyrifos has led to a significant reduction in toxicity of stormwater discharges using current test species, particularly, the water flea (*Ceriodaphnia*). Bioassay tests using sea urchin (*Strongylocentrotus*) gametes have also shown signs in the past of decreasing toxicity which has been partially attributed to the gradual reduction in several trace metal contaminants. More recently,however, there has been increased incidence of toxicity based upon the sea urchin fertilization test that cannot be explained by levels of dissolved metals measured in the stormwater discharges. In addition, toxicity measured in stormwater samples within 36 to 72 hours of a storm event continue to show evidence of a decline in toxicity over a brief amount of time. While this has had impacts on the ability to perform TIEs, enough toxicity typically remains to complete the Phase I TIE process. All past TIEs conducted with the sea urchin fertilization test have implicated metals as the dominant source of toxicity.

Increases in the incidence of toxic responses measured by the sea urchin test correspond with utilization of a new bioassay laboratory. The laboratory is capable of running slightly higher concentrations of stormwater using more concentrated brines but this alone was not sufficient to explain the differences. Although it is possible a number of emerging contaminants of concern may contribute to the initial toxicity, TIEs conducted throughout the past 14 years have consistently implicated metals based upon the impacts of both EDTA and STS treatments. Recent data from tests conducted on stormwater runoff from both the Los Angeles River and Ballona Creek have not shown the level of toxicity measured at the three Long Beach sites. It is unlikely that unidentified emerging contaminants of concern would impact tests conducted at multiple sites in Long Beach and not have similar impacts in other watersheds within Los Angeles County. Although laboratory QAQC data indicates that these tests are providing reliable data, there have been no intercalibration studies conducted through the Stormwater Monitoring Coalition (SMC) to provide a detailed comparison of laboratory methods and performance on standardized stormwater samples. We strongly recommend that the SMC moves forward with efforts to implement a comprehensive intercalibration study among all laboratories conducting bioassay tests on stormwater samples. Interlaboratory testing should incorporate each bioassay test method required for monitoring of MS4 discharges and should, at a minimum; include actual stormwater samples collected from a highly urbanized watershed.

The City of Long Beach MS4 monitoring program has continued to track long-term trends in both contaminant concentrations and loads and the addition of the 2013/2014 data has not significantly changed previous conclusions. Even after monitoring for 14 years, it is evident that long-term trends are often difficult to differentiate due to the complex factors that tend to impact measured concentrations of each analyte. Unlike the abrupt decline in diazinon and chlorpyrifos that occurred soon after removing these pesticides from the market, trends associated with most key contaminants have been relatively gradual and difficult to discern from the variability caused by a multitude of other factors. In some cases, it has taken a full decade to observe clear visual trends based upon long-term graphics. Both the source of each particular contaminant and differences in the physical/chemical characteristics of each contaminant tend to influence the concentration of each contaminant in stormwater runoff.

Multiple regression analysis has proven to be most helpful for developing an understanding of the factors that have the largest impact on contaminant concentrations. Understanding these factors is useful in determining which BMPs might be most effective in reducing pollutant loads. Multiple regression analysis was conducted on the full data set two years ago. Multiple regression analysis indicated that TSS, the number of dry days preceding a storm event, the total amount of seasonal rainfall, total runoff and duration of runoff influence concentrations of total metals in runoff. Concentrations of many dissolved metals are most impacted by the number of dry days preceding the storm event. In addition, larger storms are negatively correlated with concentrations of many contaminants due to a dilution of the available contaminants. As a result, long term trends are difficult to discern from the high variability introduced by the unique characteristics of each storm event and more obvious seasonal trends.

Concentrations of both total and dissolved lead have been decreasing slowly at all sites since the start of the stormwater program in 2000. Although changes are not as distinct, total and dissolved zinc show some signs of decreasing particularly in the Los Cerritos Channel. Concentrations of total and dissolved copper measured during wet weather events at the Los Cerritos Channel site have been relatively stable or slightly increased over the past 14 years. In contrast, copper associated with dry weather flows at the Los Cerritos Channel site have shown evidence of decreasing trends over the past 14 years. More importantly, the load of copper measured at the Los Cerritos Channel site has significantly declined in large part due to substantial decline in dry weather flow.

Two of the mass emission sites, the Los Cerritos Channel and Dominguez Gap Pump Stations, are subject to TMDL. Both wet and dry weather limitations are established for the Los Cerritos Channel. The Dominguez Gap Pump Station discharges into the lower segment of Los Angeles River thus wet season and dry season discharges were compared against TMDL objectives established at the Wardlow monitoring site.

TMDL limits established for the Los Cerritos Channel were achieved during the dry season but significant improvements will be required to meet all wet weather limits. Dry weather flows in the Los Cerritos Channel have dramatically declined over the past few years. The lower flows enabled the dry weather waste load allocations to be easily met for copper. Wet weather flows are subject to targets for copper, lead and zinc. Lead remained well below TMDL limits but both copper and zinc exceeded TMDL limits during each of the four storm events. Copper loads for the 2013/2014 season (Table 31) exceeded the TMDL limit by a factor of 3.0 to 5.6 while zinc loads exceeded the limit were by a factor of 2.6 to 3.6.

The Los Angeles River is subject to both metals TMDL and nitrogen TMDL. All dry weather discharges from the Dominguez Gap Pump Station continue be less than concentration-based WLAs established for the Los Angeles River at the County's Wardlow monitoring site. Concentration-based WLAs for wet weather are currently being achieved for cadmium, lead and zinc. Water quality objectives for total copper are showing evidence of a gradual decline but still exceed TMDL limits in 50% of the storm events (Figure 36). All stormwater discharges from the Dominguez Gap Pump Station were found to meet the ammonia-N, nitrate-N, and nitrate/nitrite-N limits established for Reach 1 of the Los Angeles River.

REFERENCES CITED

APHA [American Public Health Association]. 1995. Standard Methods for the Examination of Water and Waste Water. (19th edition) Eaton, A.D., L.S. Clesceri, and A.E. Greenberg (Eds.). American Public Health Association, Washington, D.C.

CH2MHill. 2005. Joint Dominguez Gap and DeForest Treatment Wetlands Project Draft Environmental Impact Report. Prepared for County of Los Angeles, Department of Public Works.

CRWQCB, Los Angeles [California Regional Water Quality Control Board, Los Angeles Region]. 1994. Water Quality Control Plan, Los Angeles Region, Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties.

CRWQCB, Los Angeles [California Regional Water Quality Control Board, Los Angeles Region]. 1999. Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges within the City of Long Beach. Order No. 99-060 National Pollutant Discharge Elimination Systems Municipal Permit No. CAS004003 (CI 8052), June 30, 1999.

CRWQCB, Los Angeles [California Regional Water Quality Control Board, Los Angeles Region]. 2006. Region 4, 303(d) List.

City of Long Beach, 2006. City of Long Beach GIS Database. Dept. of Technology, Long Beach.

Faria, I.R., A.J. Palumbo, T.L. Fojut and R.S. Tjeerdema , 2010. Water Quality Criteria Report for Malathion Phase III: Application of Pesticide Water Quality Criteria Methodology, Report Prepared for the Central Valley Regional Water Quality Control Board. March 2010.

Fojut, T. L. A.J. Palumbo, and R. S. Tjeerdema, 2012. Aquatic Life Water Quality Criteria Derived via the UC Davis Method: II. Pyrethroid Insecticides. R.S. Tjeerdema (ed.), Aquatic Life Water Quality Criteria for Selected Pesticides, Reviews of Environmental Contamination and Toxicology 216.

Jackson, D.; Cornell, C. B.; Luukinen, B.; Buhl, K.; Stone, D., 2009. Fipronil Technical Fact Sheet; National Pesticide Information Center, Oregon State University Extension Services. http://npic.orst.edu/factsheets/fiptech.html.

Kinnetic Laboratories, Inc. 2013. City of Long Beach Stormwater Monitoring Report 2012-2013 NPDES Permit No. CAS0040003 (CI 8052), July, 2013.

Lao, W, D. Tsukada, D.J. Greenstein, S. M. Bay and K. A. Maruya 2010. Analysis, occurrence, and Toxic Potential of Pyrethroids and Fipronil in Sediments from an Urban Estuary. Environmental Toxicology and Chemistry, Vol. 29, No. 4, pp. 843–851, 2010.

Miles, S.R. and C.B. Goudey. 1998. Ecological Subregions of California, Section and Subsection Descriptions. http://www.fs.fed.us/r5/projects/ecoregions/ (Access Date June 5, 2010).

NCDC/NOAA. 2004. Climatography of the United States, No. 81. http://lwf.ncdc.noaa.gov/oa/climate/normals/usnormalsprods.html#CLIM81.

Ruby, A., 2013.. Review of Pyrethroid, Fipronil, and Toxicity Monitoring Data from California Urban Watersheds. Review prepared for the California Stormwater Quality Association (CASQA) by Armand Ruby Consulting. July 10, 2013.

Siepmann, S. and B. Finlayson. 2002. Water Quality Criteria for Diazinon and Chlorpyrifos. California Department of Fish and Game Office of Spill Prevention and Response, Administrative Report 00-3, 2000.

SCAG [Southern California Association of Governments]. 2005. Southern California Land Use GIS database.

State of California, Department of Finance, *E-1 Population Estimates for Cities, Counties and the State with Annual Percent Change — January 1, 2013 and 2014.* Sacramento, California, May 2014.

Stratman, Karen N., P. Chris Wilson , William A. Overholt , James P. Cuda & Michael D. Netherland, 2013. Toxicity of Fipronil to the Midge, Cricotopus lebetis Sublette, Journal of Toxicology and Environmental Health, Part A: Current Issues, 76:12, 716-722, DOI: 10.1080/15287394.2013.802266

SWRCB (State Water Resources Control Board) 2006. Water Quality Control Plan, Ocean Waters of California, California Ocean Plan 2005.

SWRCB (State Water Resources Control Board) 2011. Amendment to the Water Quality Control Plan for the Los Angeles Basin Region (Basin Plan) to revise the Total Maximum Daily Load for Metals in the Los Angeles River and Tributaries. Resolution No. 2011-21.

TDC Environmental, 2007. Urban Use of the Insecticide Fipronil--Water Quality Implications, Memorandum to the Urban Pesticide Committee from Kelly D. Moran, June 18, 2007.

USEPA [U.S. Environmental Protection Agency]. 1983. Methods for the chemical analyses of water and wastes. EPA-600/4-79/020. Revised March 1983.

USEPA [U.S. Environmental Protection Agency]. 1991. Methods for Aquatic Toxicity Identification Evaluations. Phase I, Toxicity Characterization Procedures. (2nd Ed.). EPA/600/6-91/003. Office of Research and Development.

USEPA [U.S. Environmental Protection Agency]. 1995. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to west coast marine and estuarine organisms. Edited by G. A. Chapman, D. L. Denton and J. M. Lazorchak. First ed. Cincinnati, OH: Office of Research and Development

USEPA [U.S. Environmental Protection Agency]. 1996. Guidance on the Documentation and Evaluation of Trace Metals Data Collected for Clean Water Act Compliance Monitoring (Draft) EPA 821-B-96-004.

USEPA [U.S. Environmental Protection Agency]. 2000. Federal Register, Part III. "California Toxics Rule: Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule."

USEPA [U.S. Environmental Protection Agency]. 2001. USEPA Functional Guidelines for Low Level Concentration Organic Data Review. EPA540-R-00-006.

USEPA [U.S. Environmental Protection Agency]. 2002. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms EPA-821-R-02-013, October 2002.

USEPA [U.S. Environmental Protection Agency]. 2004. USEPA Contract Laboratory Program, Functional Guidelines for Inorganic Data Review. EPA 540-R-04-004 October 2004.

USEPA [U.S. Environmental Protection Agency]. 2010. Los Cerritos Channel Total Maximum Daily Load for Metals.

USEPA [U.S. Environmental Protection Agency]. 2014. Office of Pesticide Programs' Aquatic Life Benchmarks Website. U.S. Environmental Protection Agency. http://www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm

Werner I, and Oram J., 2008. Pyrethroid insecticides conceptual model. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

Yang, Weichun, F. Spurlock, W. Lui, J. Gan. 2006. Inhibition of Aquatic Toxicity of Pyrethroid Insecticides by Suspended Sediment. Environmental Toxicology and Chemistry, Vol. 25, No. 7, pp. 1913–1919, 2006