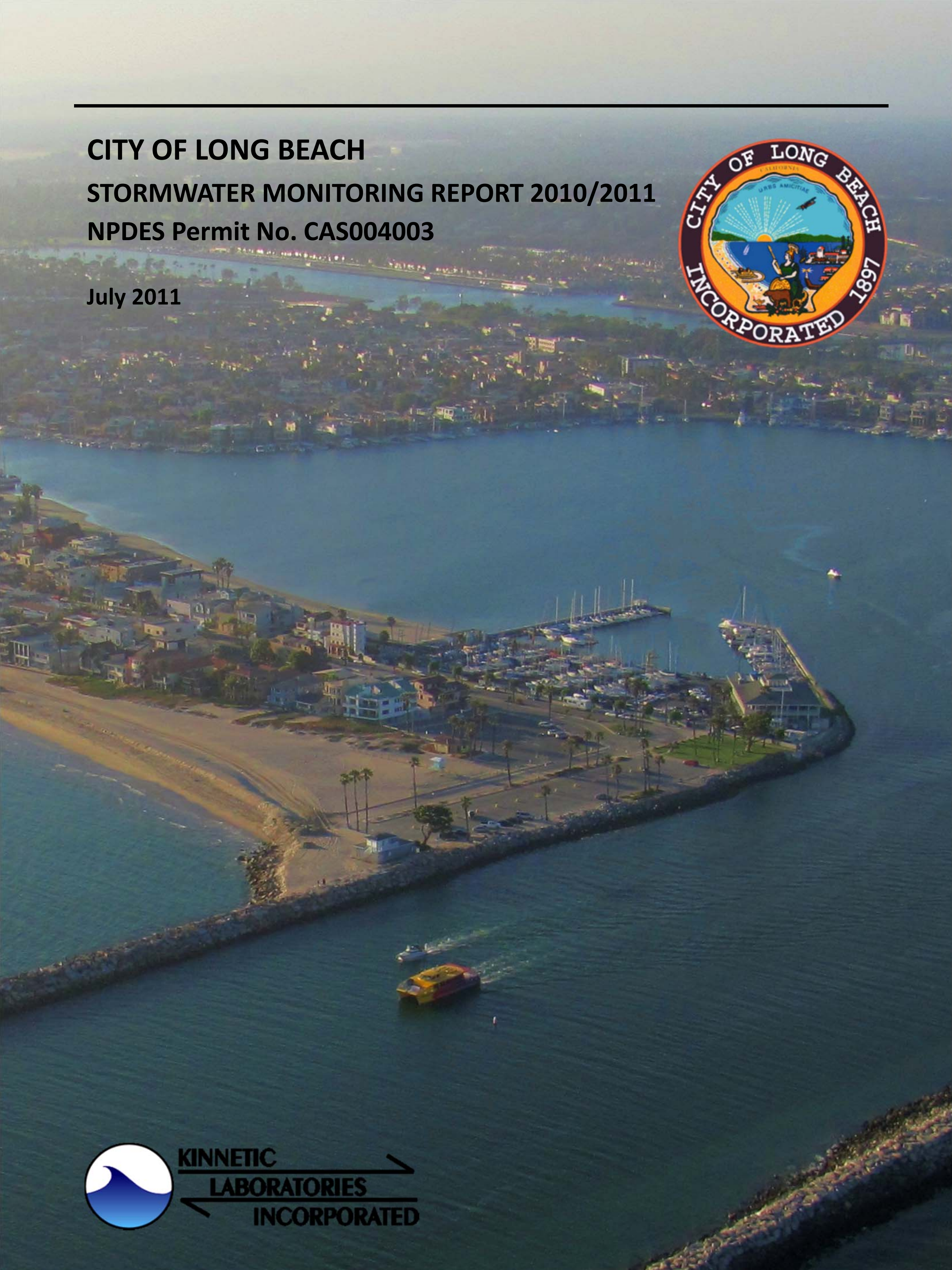
CITY OF LONG BEACH

STORMWATER MONITORING REPORT 2010/2011

NPDES Permit No. CAS004003

July 2011



KINNETIC LABORATORIES INCORPORATED

CITY OF LONG BEACH
DEPARTMENT OF PUBLIC WORKS

STORM WATER MANAGEMENT
CITY OF LONG BEACH

333 W. Ocean Blvd., 9th Floor | Long Beach, CA 90802 | (562) 570-6023 FAX: (562) 570-6501

STORM WATER/ENVIRONMENTAL COMPLIANCE DIVISION

July 14, 2011

The City of Long Beach is pleased to submit the twelfth annual, "Stormwater Monitoring Report, 2010/2011" 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 14th of July, 2011
at Long Beach, California.

[signature] 7-14-11

Anthony Arevalo
Acting Storm Water/Environmental
Compliance Officer

Date

Cc: Michael Conway, Director of Public Works
Mark Christoffels, Deputy Director of Public Works/City Engineer

AA:aa
2011 SWM Cover.doc

THIS PAGE INTENTIONALLY LEFT BLANK

CITY OF LONG BEACH

STORMWATER MONITORING REPORT 2010/2011

NPDES Permit No. CAS004003 (CI 8052)

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

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
Halocline – a locally steepened vertical gradient of salinity
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
NADP - National Atmospheric Deposition Program
NCDC - National Climate Data Center
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
TSI - ToxScan, Inc.
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

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

This report provides a summary of the results of the eleventh year of monitoring conducted under the terms of Order No. 99-060 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 data set as developed over the past 11 years. 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, 2011.

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 Board to continue operating under the 1999 permit until further notice. Current guidance from Regional Board staff indicates that a new permit will be addressed in late 2011. Development of a new permit has been delayed while the Ventura County permit was being negotiated. The completed Ventura County permit was intended to serve as a model for both Los Angeles County and City of Long Beach NPDES permits.

Major elements of 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 are 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. Data from the monitoring program is intended to support decisions necessary to refine 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 include conventional constituents, total and dissolved metals, organophosphate pesticides and herbicides. Partway through the season pyrethroid pesticides were added to the constituent list. Toxicity testing using sea urchin fertilization tests and water flea survival and reproduction is conducted on the composite storm 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 designed to determine 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 identify pollutants of concern and associated toxicity at the mass emission sites during the dry season. Dry weather discharge samples are subjected to the same chemical analysis and toxicity testing used for the stormwater monitoring program.

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 the current monitoring season (2010/2011) and compared with results from the full eleven years of monitoring.

SUMMARY OF RESULTS

The 2010/2011 season had the second highest rainfall encountered since the start of the City's stormwater monitoring effort. Rainfall was still much less than measured during the 2004/2005 season. Over the past eleven years, this is only the third time that we have had above normal precipitation. Normal precipitation for September through April at the Long Beach Airport is 12.51 inches. This season's cumulative rainfall of 18.11 inches is well above both the normal wet season average of 12.27 inches and the average of 10.55 inches since the inception of this program in 1999.

Two dry weather inspections/monitoring events were conducted during the 2010/2011 monitoring year. These surveys are conducted during the summer dry weather period at each of three mass emission stations. Dry weather sampling has not been conducted at the Belmont Pump Station since all dry weather flows were diverted to the sanitary system in 2009. Although the Dominguez Gap Pump Station was always inspected during dry weather surveys, discharges were never observed until last year. This is only the second year that we have sampled dry weather discharges from the Dominguez Pump Station but it is important to note that dry weather flows consist predominantly of water that is drawn from the Los Angeles River and passed through the Dominguez Gap wetlands to provide both treatment and to enhance the constructed wetland habitat.

The first dry weather survey was conducted on September 22-23, 2010 about two weeks prior to the first storm event of the year. The second dry weather survey was conducted on May 10-11, 2011 after more than two weeks of dry weather conditions.

With a single exception, the maximum number of storm events for each station (four) was monitored this season. This could be attributed to the above average rainfall encountered during the 2010/2011 wet weather season. Stormwater sampling was accomplished over the course of nine separate rainfall events, including the October 6, 2010 "first flush" event of the season. Sufficient sample volume was collected during four events each at Belmont Pump, Bouton Creek and Los Cerritos Channel to complete the full required suite of analyses. Because of the lack of discharge during events that met antecedent rainfall criteria, only three events were sampled at the Dominguez Gap Pump Station for the full required suite of analyses. In addition to storm events sampled for the full suite of analyses, three events at Belmont Pump, two events at Bouton Creek, and five events at Los Cerritos Channel were sampled for total suspended solids (TSS) only. TSS events were conducted only when there was not sufficient rainfall and sample volume to conduct the majority of the analyses or after the required four events for the full suite of analyses were completed.

Wet Weather Chemical and Bacterial Results

For the purpose of this report, 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. The 2005 California Ocean Plan (SWRCB, 2006), the Los Angeles Region Basin Plan (CRWQCB, Los Angeles Region, 1994), California Department of Fish and Game (Siepmann and Finlayson, 2002) criteria for chlorpyrifos and diazinon, and both saltwater and freshwater criteria from the California Toxics Rule (USEPA, 2000) were used as benchmarks as requested by Regional Board staff. In addition, National Recommended Water Quality Criteria (USEPA, 2009) were used as benchmarks for compounds such as malathion that are not considered to be priority pollutants. Comparisons of stormwater concentrations with various water quality criteria are intended to provide a framework for evaluating constituents of concern and allow for identification of watersheds that could benefit from additional BMPs or source identification/reduction efforts.

Benchmark reference values have been often exceeded for dissolved forms of copper, lead and zinc throughout the life of the permit (Kinnetic Laboratories, Inc., 2010). For stormwater discharges, the CTR freshwater acute criteria are the most applicable benchmarks for all sites. Copper and zinc continue to exceed benchmark criteria on a frequent basis at all but the Dominguez Gap Pump Station. Dissolved copper exceeded the CTR freshwater criteria in 80% of all stormwater samples this wet season. Stormwater discharged from the Dominguez Gap Pump Station slightly exceeded the CTR freshwater criterion during only one of three monitored events. Concentrations of dissolved zinc exceeded the CTR freshwater acute criterion just once in Bouton Creek and two times in the Los Cerritos Channel. Although dissolved lead was measured above the chronic criterion during 9 of the 15 station-events, the acute criterion used as a benchmark for shorter term stormwater discharges was never exceeded.

Other than bacteria, few other constituents have exceeded benchmark values. MBAS minimally exceeded the Basin Plan criteria of 0.5 mg/L in the Los Cerritos Channel during the first storm event and pH was just above the upper limit (8.5) in samples taken from one event in Bouton Creek.

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 are still detected in a large percentage of the samples. The Belmont Pump Station most commonly has the highest levels of these compounds. This year stormwater samples from the Belmont Pump Station exceeded CTR chronic freshwater criteria once for chlordane and twice for toxaphene. Although the acute criteria considered more relevant to stormwater were never exceeded, the consistency of chlorinated compounds in discharges from this watershed is of concern. The continued detection of low concentrations of chlordane compounds 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. In addition, sediments within the estuary of the Los Cerritos Channel are currently listed

Stormwater discharged from the Dominguez Gap Pump Station to the Los Angeles River continues to contain lower concentration of most major constituents of concern. Total cadmium, dissolved and total copper, and dissolved and total zinc were all found to be significantly lower ($p<0.05$) than measured at the three other mass emission sites. In the case of lead, no significant differences were evident among stations for dissolved lead but stormwater discharges from both the Dominguez Gap Pump Station and Bouton Creek had significantly lower concentrations of total lead than measured at the Belmont Pump Station and the Los Cerritos Channel. Overall, tests confirmed that concentrations of most metals were significantly lower at 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.

Although the Dominguez Gap Pump Station and associated wetlands have shown significant water quality benefits, the potential exists to further improve water quality and have fewer discharges therefore further reducing mass emissions of metals to the Los Angeles River. Water levels in the wetlands during the early part of the season were maintained at 7-8 feet which provided capacity for at least one inch of runoff. As the season progressed, water levels in the wetlands and sumpe were often 10 to 10.5 feet. With the major pumps triggering at 11 feet, relatively small storm events cause discharges to the River. We are continuing to work with the Los Angeles County Department of Public Works in order to reach a common ground as to maintenance practices that will balance both wetland and stormwater benefits and comply with the EIR.

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 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 taken along with general observations of site conditions.

For the past several seasons the Belmont Pump Station dry weather flows have been diverted to the sanitary sewer system either by means of a temporary pump or by the permanent low-flow diverter system completed in December 2009. During the same general time period, the Dominguez Gap infiltration basin has been 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.

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 of the sampling station to the 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 for 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 time periods when extreme low tides allow the tidal water to drain from the channel such that flows are dominated by dry weather discharges. A composite sample is typically collected over a 30-minute period preceding tidal waters reentering the channel to isolate sampling to just the freshwater discharge down the creek. 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 were represented by at least 90% of the flow.

Dry weather flows in Bouton Creek have notably declined in recent years thus requiring relocation of the dry weather sampling station. 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 had been done for the 2009/2010 season, for the 2010/1011 surveys the sampling location was again conducted at a location 1,250 feet upstream from the primary site location at the LADPW Alamitos Yard. The new location is just below the point where Bouton Creek emerges from under the California State University at Long Beach (CSULB) campus. The salinity of the water where the samples were collected was 0.9 and 1.2 ppt for the two events. Outfalls located along the creek from Alamitos Yard to CSULB 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.

This is the second year that dry weather discharges were documented and sampled at the Dominguez Gap Pump Station following reconfiguration of the Dominguez Gap Treatment Wetlands. A permanent sump pump maintains relatively continuous flows through the wetlands. The sump pump was in operation for the both dry weather events this storm year.

The treatment provided by the wetlands and detention of dry weather discharges has resulted in water that has consistently met bacterial water quality standards. The overall water quality met all applicable standards including trace metal concentrations required by the Los Angeles River metals TMDL.

Temporal Trends in Constituents of Concern

Most long-term trends tend to be obscured by factors that are not evident when exclusively looking at changes in concentrations. However, general trends noted in previous years continue to be reflected in the data.

- The dissolved concentrations of different metals exhibit different responses to wet and dry weather conditions. Dissolved concentrations of three metals (cadmium, copper, and nickel) do not vary substantially between wet and dry weather periods. Nevertheless, the highest concentrations of these three metals are typically encountered in association with early season storm events. Concentrations of two other dissolved metals (zinc and lead) tend to increase substantially in response to storm events. Concentrations of these two dissolved metals also tend to be highest during early season events. However, for dissolved zinc and lead, concentrations measured during early season events often are up to 5 times higher than late season events.
- Concentrations of total copper, lead and zinc are consistently higher in association with storm flows. All three are strongly associated with suspended sediment during storm events. Correlation and multiple regression analysis confirmed that total recoverable metals were highly correlated with TSS and that variability in sediment loads could explain much of the variation in metals.
- Malathion, another organophosphate pesticide, continues to be commonly detected in stormwater at levels exceeding chronic national nonpriority pollutant guidelines but has not been implicated as a source of significant toxicity. Highest concentrations continue to occur early in the storm season.
- Fecal indicator bacteria typically exceed Basin Plan water quality criteria during both wet and dry weather monitoring (Appendix C). Interestingly, fecal indicator bacteria measured in association with the four consecutive dry weather monitoring events conducted during the past two years at the Dominguez Gap Pump Station were all below applicable water quality criteria.
- Initial testing of pyrethroid pesticides has provided evidence that these pesticides are commonly detected in stormwater. In addition, based upon a review of aquatic toxicity data for these compounds, concentrations were identified to be sufficient to cause significant toxicity in receiving waters. Although these compounds were present at potential toxic levels, the bioassay test species (the water flea *Ceriodaphnia*) currently used to measure toxicity would not have been expected to provide a significant response. Sediment loads are known to mitigate pyrethroid toxicity in the water column due to the tendency for these compounds to attach to

particles and not be bioavailable. Impacts are more commonly expected in receiving water sediments where pyrethroid pesticides accumulate and persist. Half lives of these compounds in sediments are believed to range from several weeks to months.

Toxicity Results

A general trend of reduced toxicity has been observed at all sites in recent years. Comparisons of the actual toxicity versus expected toxicity calculated from the concentrations of key toxicants provided confirmation that little or no toxicity would be expected in either the stormwater or dry weather samples.

No significant daphnid mortality was seen at any of the three stations in any of the five storms collected. Minor water flea reproductive toxicity (2 TU_c) was detected two of five storms (at the Cerritos Channel station in October 2010 and at the Belmont Pump station in December 2010). Both the frequency (18%) and the magnitude of chronic toxicity were decreased from pre-2009 levels.

Toxicity to sea urchin fertilization was not detected at any of the stations during any of the five storm events. The frequency (0%) and magnitude (2TU_c) of stormwater toxicity to sea urchins during both the 2009/2010 and 2010/2011 monitoring periods were decreased from previous years.

The comparison with stormwater samples from early storms in other southern California watersheds detailed in previous reports suggested that the Chollas Creek (San Diego) and Ballona Creek (Santa Monica) urchin results were overall more similar to Long Beach than were the Los Angeles River and San Gabriel River results, as the Chollas and Ballona samples were obtained from smaller highly urbanized watersheds. More recent data show a pattern of decreasing frequency and magnitude of wet weather toxicity to both water fleas and sea urchins in Long Beach and in other southern California watersheds. The reduction in toxicity to water fleas is clearly attributable to the near elimination of chlorpyrifos and diazinon in stormwater samples since these chemicals were banned for most applications.

RECOMMENDED PROGRAMATIC CHANGES

Only minor adjustments to the NPDES monitoring program are recommended based upon the results of the 2010/2011 monitoring period as well as work conducted over the past eleven years.

- Pyrethroid pesticides are recommended for continued monitoring at all mass emission sites. Monitoring of these compounds was implemented midyear and yielded relatively high levels compared to other programs in Southern California. They also showed some trends in seasonality with higher concentrations in association with the initial sampling period. In addition it is recommended that the City join with CASQA's (California Stormwater Quality Association) efforts to improve pesticide regulation processes and encourage use of IPM (integrated pest management) to minimize use of pesticides.
- Install sensors to monitor run time for the sump pump at Dominguez Pump in order to estimate discharges through the dry season. A request has been submitted to the County to provide open contacts that can be integrated with the stormwater monitoring equipment at this site.
- Continue to work with the County to improve operation of the wetlands and pump station during the wet season. This effort should emphasize compliance with the Project's EIR.

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 of stormwater and urban runoff 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, 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 Alamitos Bay, 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 the Los Cerritos Channel. These areas also include coastal shorelines, including Alamitos Bay Beaches, Belmont Shore Beach, Bluff Park Beach, and Long Beach Shore[1].

A number of TMDLs have been implemented or are under development in four of 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 and PAHs are also a concern in some segments. The TMDLs listed in Table 1 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 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 actively pursued a series of special studies to address the primary objectives of the stormwater program and has continued to make improvements to better address emerging contaminants of concern. Evolution of the program is summarized in Table 2.

[1] Los Angeles Regional Water Quality Control Board, 2006 303(d) list

Table 1. Impaired Water Bodies with Existing or Developing TMDLs.

Water Body	Pollutant	Basin Plan Amendment/ Board Resolution	Approval or Effective Date
Los Angeles River	Metals	2007-14	Effective October 29, 2008
	Trash	2007-12	Effective September 23, 2008
	Bacteria	In Development by RB[1]	
San Gabriel River	Metals and Selenium	2006-14	Effective July 14, 2006
Colorado Lagoon	Organochlorine Pesticides, PCBs, Sediment Toxicity, PAHs, and Metals	R09-005	Regional Board Approval October 1, 2009
Los Angeles and Long Beach Harbors	Organochlorine Pesticides, PCBs, Sediment Toxicity, PAHs, and Metals	In Development by EPA[2]	Consent Decree[3] requires implementation by March 2012
Los Cerritos Channel, freshwater portion	Metals	EPA TMDL 38254	EPA established and approved March 17, 2010
City of Long Beach Coastal Beaches	Bacteria	In Development by EPA[2]	Consent Decree[3] requires implementation by March 2012

1. RB – Los Angeles Regional Water Quality Control Board
2. EPA – U. S. Environmental Protection Agency, Region 9
3. Consent decree between the USEPA, the Santa Monica BayKeeper and Heal the Bay Inc., represented by the Natural Resources Defense Council (NRDC), was signed on March 22, 1999

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 composites 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 compound.
- 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.

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

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.
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 the watershed and the 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..

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 past 11 years.

GEOGRAPHY

The City of Long Beach is located in the center and southern part of the Los Angeles Basin (Figure 2) 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 3) in the region. Signal Hill has a population of approximately 11,500 residents 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 originates in Long Beach, flows near the eastern City boundary, and discharges into the Marine Stadium and then into 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 Channel and Los Cerritos Line E 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.

The four City of Long Beach mass emission monitoring sites address runoff from 32% of entire City (Figure 4). 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

Last year, the population of the City of Long Beach was estimated at 494,709 residents on January 1, 2010 (State of California Department of Finance, 2010[2]) and the total population of the County of Los Angeles, in which it resides, was 10,441,080. At that time, population estimates were still being based upon the 2000 census data with adjustments developed from driver's license applications. This year the State established a new baseline population derived from the 2010 census. The 2010 census indicated that the actual population was only 462,578, substantially lower than previous estimates (Figure 1). Using the new 2010 baseline data set (State of California, Department of Finance, 2011[3]), the City of Long Beach is estimated have 463,894 residents as of January 1, 2011. This corresponds to a 0.3 percent increase in population between 2010 and 2011. The apparent population decrease of over 32,000 residents between 2009 and 2010 should not be considered indicative of a true decline. Instead this reflects on the errors associated with assumptions and methods [Housing Unit Method (HUM)]applied to estimate populations between census periods.. Based upon the 2000 and 2010 census data, population growth has averaged less than 0.3 percent per year for the last 10-11 years.

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 increase to 11,072 by January 2011. Stormwater from the City of Signal Hill discharges both to the Los Angeles River and the Los Cerritos Channel.

---

[2] *State of California, Department of Finance, E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark. Sacramento, California, May 2010.*

[3] *State of California, Department of Finance, January 2011 Tables of City Population Ranked by Size, Numeric and Percent Change. Sacramento, California, May 2011*

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.

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.

During the past year, 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 now considered the seventh most populated city in the California.

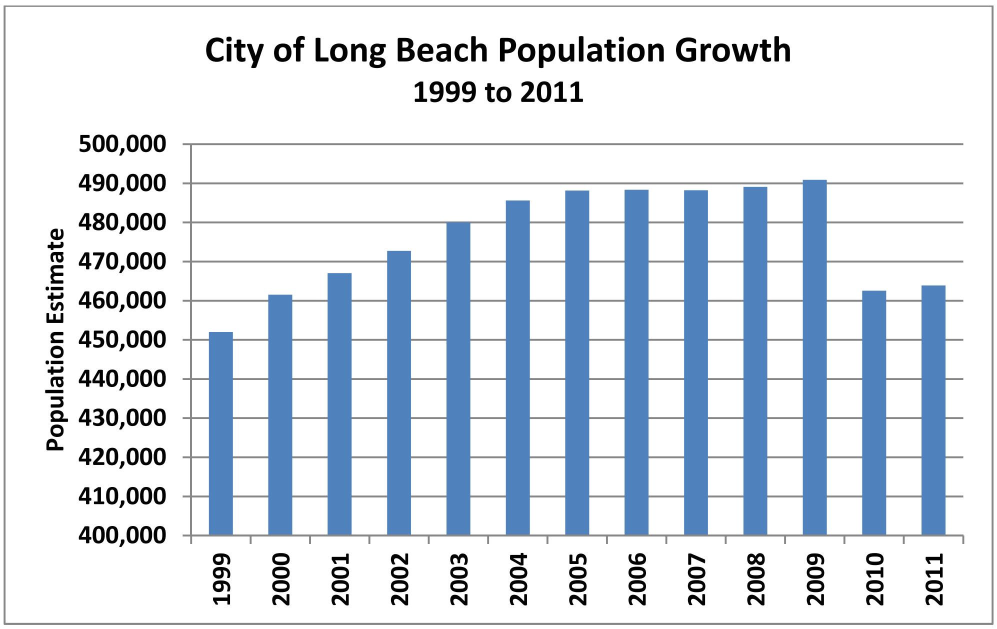


Figure 1. City of Long Beach Population Growth over the Past Twelve Years.

Figure 2. Los Angeles Basin. (Source: 3-D TopoQuads, Copyright 1999, Del Lorme, Yarmouth, ME 04096).

Figure 3. City of Long Beach. (Source: Google Earth Pro, 2006).

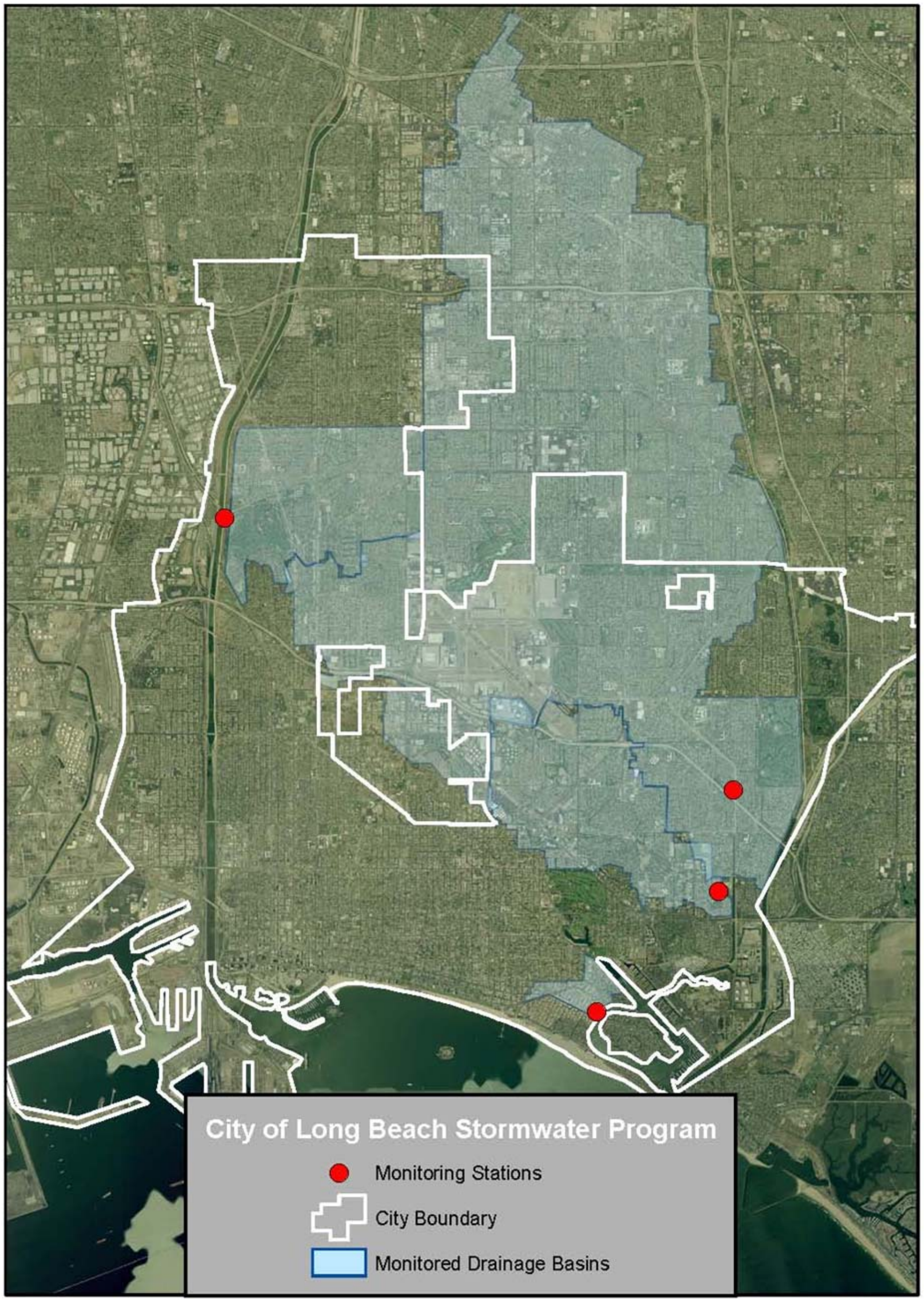


Figure 4. City of Long Beach and Drainage Basins Monitored by the Stormwater Program.

Table 3. Total Area and 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 w/i 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**

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 2010/2011 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.

One special study was conducted during the 2010/2011 monitoring period. Instrumentation was installed at the Los Cerritos Channel monitoring site that enabled both pH and temperature to be recorded at 10-minute time intervals for a large portion of the past monitoring period.

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.

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 in Figure 4. 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

Water enters the forebay of the facility via a nine-foot diameter underground storm 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 due to dry weather flows. Starting in 2007, all summer dry weather flows were diverted to the sanitary system. Initially this was performed by a temporary pumping system but 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 during the winter to handle low flows and to lower the sump level once the main pumps are turned off. Water from these pumps is discharged into Alamitos Bay.

The storm monitoring equipment is interfaced with all five pumps to determine when each pump is activated. 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. Unexpected corrosion of the titanium pressure sensor and stainless steel strainer subsequent to installation of the permanent bypass system has necessitated replacement of both systems. The pressure sensor at this site was replaced with a bubbler for measuring water depth in the sump and the strainer was modified to eliminate metal parts that could be subject to electrolytic corrosion.

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 way upstream from the point of discharge into Los Cerritos Channel, alongside 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 a 35 ft wide, 8.5 ft deep open concrete box channel. The elevation of the channel bed is approximately one inch lower at the side than the center. About a quarter of a mile to the southeast, Bouton Creek flows into Los Cerritos Channel. 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 directional flow (upstream or downstream) as well as the conductivity of the water at three elevations. This allows the sampler to obtain flow-composited samples of the freshwater discharges down the creek, avoiding tidal contributions by using real-time conductivity sensors. The upstream flow of freshwater is quantified and used to correct discharge calculations. An AVB velocity and depth sensor was 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. A third conductivity sensor and the sample intake were mounted on a floating arm that keeps them near the surface.

Location of Dry Weather Sampling Site in Bouton Creek

Refurbishment of most equipment at this site was mostly completed in 2009. A new CR-1000 datalogger/control module, along with an updated sampling program, was installed before the start of the 2009/1010 sampling season. The autosampler remains scheduled for replacement when sufficient funds are available. The AVB sensor was destroyed during the first storm of the season requiring that a replacement unit be purchased and reinstalled before missing any events.

Several years ago a secondary sampling site was selected for purposes of dry weather sampling in the Bouton Creek watershed. 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. In recent years declining dry weather flows combined with increased algal growth in the channel has 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 that was excessive for both bioassay testing and chemical analysis for determination of dry weather loads. The elevated conductivity of water collected at the original site precluded collection and analysis of representative dry weather samples at this site for the two years prior to the October 2009 event.

Los Cerritos Channel

The entire Los Cerritos Channel watershed is estimated at 17,716 acres (Figure 7). This watershed includes 7,972 acres of the City of Long Beach or 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.

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 based upon flow velocity and channel dimensions are used to control the composite sampler, and to calculate total flow at the end of the storm event.

Stormwater Runoff at the Los Cerritos Channel Monitoring Station

This site was the first to receive a new Campbell Scientific 1000 datalogger/control units along with an updated Kinnetic Laboratories, Inc. stormwater monitoring program. The only remaining major upgrade requirement at this site is replacement of the 10-year old autosampler and modem. These final upgrades are planned to occur as soon as budgets permit.

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

Dominguez Gap Pump Station

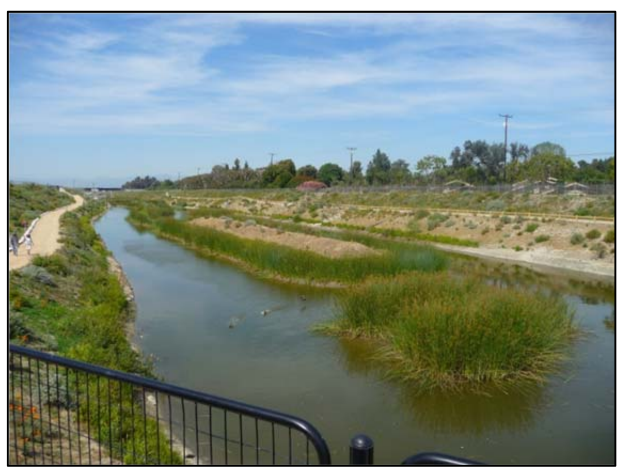
The sampling station located at the Dominguez Gap Pump Station is intended to monitor Basin 14. As part of the Dominguez Gap/DeForest Wetland project the drainage for Basin 14 was modified so that runoff from north of Market Street would be directed the Market Street Pump Station and DeForest Wetlands and runoff from the portion of Basin 14 located south of Market Street continued to drain to the Dominguez Gap Pump Station and Wetlands. The two areas were further separated by elimination of a previous connection between the two infiltration 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 percent commercial, 17% open space and 1% mixed urban. Much of the open space is golf course that borders the infiltration basin. 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 were undergoing major renovations during the summer of 2006 and through most of the 2007/2008 wet season. For the last three years of the monitoring program, wetland vegetation was fully developed.

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 Eastern Basin of the Dominguez Gap system where further infiltration capacity could be provided. From there it comes back 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.

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

The stormwater monitoring equipment at this site is located within the Dominguez Gap 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 the RPM while the pumps are being operated. Flow is calculated based upon pump 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 complement of pumps to be activated.



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

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

The summer pump is currently not instrumented however we are in the process of submitting a request to the County to allow us to install noninvasive equipment to sense when the summer pump is running. A constant flow would be assumed whenever the summer pump is operating.

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 are currently underway in order to assure that this site is regulated consider the importance of both the wetland habitat and to minimize mass emissions of trace metals and other contaminants 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 or a pressure transducer, a datalogger/controller module, cellular or landline telecommunications equipment, a rain gauge, and a peristaltic sampler. 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 a security enclosure. 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.

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 is sufficient volumes to allow for both chemical analysis and toxicity testing. A few analytes 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 the rainfall. 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. 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 our Santa Cruz laboratory. The Storm Control computer can be securely accessed from any location with internet access. The status of each station is monitored through telecommunication links to each site. Station data are downloaded, and the stations are controlled and reprogrammed remotely. 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, or debris.

Once a storm event ended, 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 near Long Beach. 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 samples for oil and grease, total and fecal coliform, and enterococcus are collected. 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.

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

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 sample containers for some of the containers contain preservative.

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 taken along with general observations of site conditions.

For the past several seasons the Belmont Pump Station dry weather flows have been diverted to the sanitary sewer system either by means of a temporary pump or by the permanent low-flow diverter system completed in December 2009. During the same general time period, the Dominguez Gap infiltration 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.

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 the 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 for 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 time periods when extreme low tides allow the tidal water to drain from the channel such 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 down the creek. 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. 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 ever 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. Initially, the permanent sump pump was intended to maintain continuous flows through the wetlands but did not function as expected. Circulation through the system has often been augmented by periodic operation of the larger pumps. This year the sump pump was in operation for both dry weather events

Grab samples are *in situ* water quality and flow measurements are taken after composite sampling is completed at each site. Temperature, conductivity, salinity and pH are measured with a YSI Model 63 portable water quality meter and dissolved oxygen was measured with a YSI Model 58 Dissolved Oxygen Meter.

Flows in channels were measured by the Area/Velocity method. Water depths are consistently too low for use of flow meters. The cross sectional area of the flow was determined by measuring the width of the flowing water and the maximum depth, and calculating the area. The velocity was determined by observing the time it took for a particle embedded in the flow to transit a measured stretch of the stream. Observations were made of the transit time of several particles and the times were averaged. Flow at pump stations are estimated based upon dynamic head and pump curves or, in the case of the Dominguez Gap summer pump, on the basis of estimated flow rates provided by the LACDPW.

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 Standard Reference Materials (SRMs).

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, 2002a), 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 in the laboratory, stormwater discharge and receiving water samples were stored at 4 °C, in the dark until used in toxicity testing. Toxicity testing commenced within 72 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 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.

Water Flea Reproduction and Survival Test

Toxicity tests using the water flea, *Ceriodaphnia dubia*, were conducted in accordance with methods recommended by USEPA (2002b). The test procedure consisted of exposing 10 *C. dubia* neonates (less than 24 hours old and 8 hour range in age) to the samples for six or seven days. One animal was placed in each of 10 individual polystyrene cups containing approximately 20 mL of test solution. The test temperature was 25 ± 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) were made at this time also. Prior to transfer, each cup was inoculated with food (200 µL of a 3:1 mixture of *Selenastrum* culture, density approximately 3.5 x 10^7 cells/mL, and YCT).

The test organisms were obtained from in-house cultures that were established from broodstock obtained from Aquatic BioSystems (Fort Collins, CO). The laboratory water used for cultures, controls, and preparation of sample dilutions was synthetic moderately hard freshwater, prepared with deionized (e-Pure™) water and Perrier Water. Test samples were 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 were prepared, resulting in test concentrations of 100, 50, 25, 12.5, and 6.25 %.

The quality assurance program for this test consisted of three components. First, a control sample (laboratory water) was included in all tests in order to document the health of the test organisms. Second, a reference toxicant test consisting of a concentration series of potassium chloride (KCl) was conducted with each batch of samples to evaluate test sensitivity and precision. Third, the results were compared to established performance criteria for control survival, reproduction, reference toxicant sensitivity, sample storage, and test conditions. Any deviations from the performance criteria were noted in the laboratory records and prompted corrective action, ranging from a repeat of the test to adjustment of laboratory equipment.

Sea Urchin Fertilization Test

All discharge and receiving water samples of stormwater were 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 consisted of a 20-minute exposure of sperm to the samples. Eggs were then added and given 20 minutes for fertilization to occur. The eggs were 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 were supplied by U.C. Davis MPSL – Granite Canyon or by David Gutoff, San Diego CA, The tests were conducted in glass shell vials containing 5 mL of solution at a temperature of 12 ± 1 °C. Four replicates were tested at each sample concentration.

All samples were 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 was adjusted by the addition of hypersaline brine. The brine was prepared by partially freezing seawater. Since the addition of brine dilutes the sample, the highest stormwater concentration that could be tested for the sperm cell test was 50%. The adjusted samples were diluted with seawater to produce test concentrations of 50, 25, 12.5, 6.25, and 3.125%.

Seawater control (1.0 µm filtered natural seawater from ToxScan's Long Marine Laboratory facility) and brine control samples (50% deionized water and 50% brine) were included in each test series for quality control purposes. Water quality parameters (temperature, dissolved oxygen, pH, ammonia, and salinity) were measured on the test samples to ensure that the experimental conditions were within desired ranges and did not create unintended stress on the test organisms. In addition, a reference toxicant test was included with each stormwater test series in order to document intralaboratory variability and test organism sensitivity. Each reference toxicant test consisted of a concentration series of copper sulfate with four replicates tested per concentration. The 25^{th} percentile effective concentration (EC_{25}) was estimated from the data and compared to control limits based upon the cumulative mean and two standard deviations of recent experiments.

Toxicity Identification Evaluations (TIEs)

If either stormwater or dry weather runoff samples exhibited substantial toxicity (> 2 TU_a for *Ceriodaphnia*, > 3 TU_a for sea urchins), Phase I TIEs were to be conducted in order to determine the characteristics of the toxicants present. Although no TIEs were triggered this year, the processes used in previous years are summarized below.

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 had decreased to levels below the original trigger point, further toxicity tests would not performed and the TIE would be abandoned.

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 had decreased to levels below the original trigger point, further toxicity tests would not performed and the TIE would be 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 marine 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 OP pesticides is added to a concentration of 100 mg/L for mysids and 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 data sets.

Chemical Data Analysis

For the past 10 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. Visual trends for all other constituents have not been evident. Although it has been common to use the nonparametric Mann-Kendall Trends (Mann, 1945) test to determine if there is an increasing or decreasing trend and Sen's method for estimation of slope or rate of change (Gilbert, 1987), this approach cannot be used without an initial and thorough assessment of the data set. One key assumption is that there is an underlying, monotonic trend. This requires addressing some of the functional relationships associated with stormwater that could either obscure long term trends or lead to misinterpretation of the trends.

Further screening was conducted 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 TSS. 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.

Initially, it was assumed that data from all sites were combined in the regression analysis. This report examines trends of major constituents at individual monitoring sites. Independent variables of total flow, peak flow and flow duration were incorporated to assist in further understanding functional relationships of stormwater quality with environmental factors.

Application of the Mann-Kendall Trends test and Sen's method for estimation of slope were applied to the residuals from multiple linear regression for total lead, copper and zinc by site. Residuals were aggregated by monitoring years and tested for evidence of significant decreases or increases unrelated to other factors known to influence stormwater quality.

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 and mysid survival data were 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.

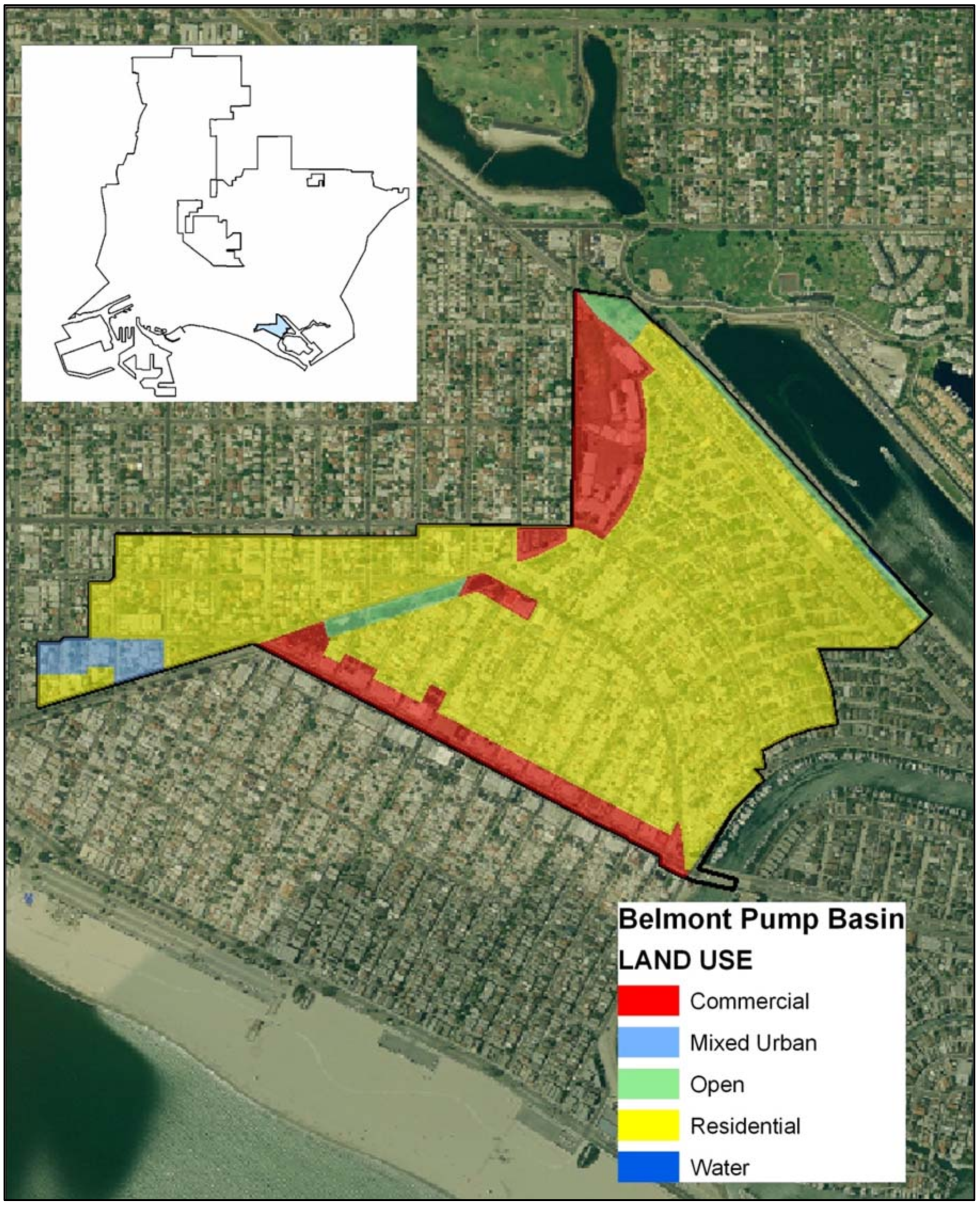


Figure 5. Land Use within the Belmont Pump Station Drainage Basin.

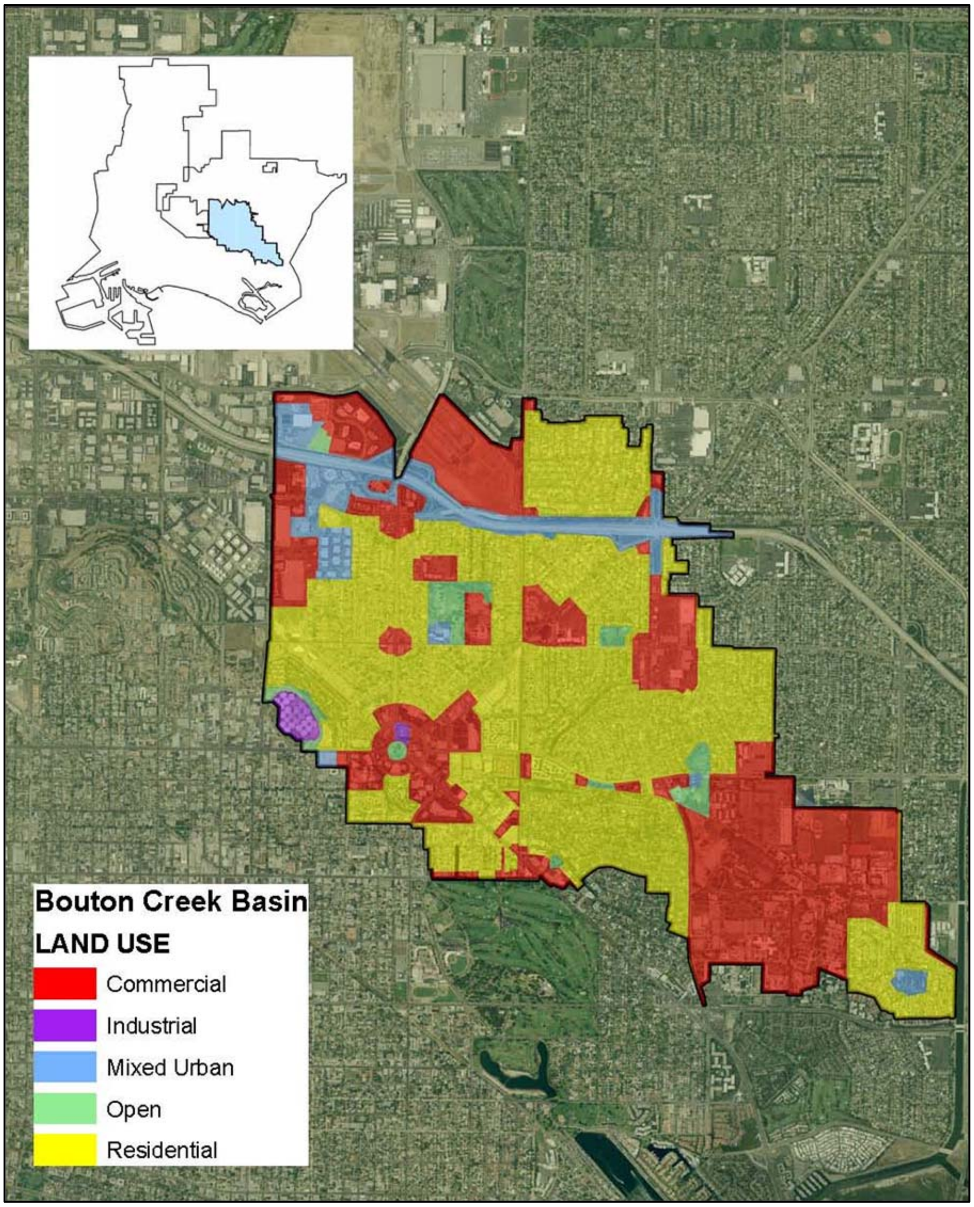


Figure 6. Land Use within the Bouton Creek Drainage Basin

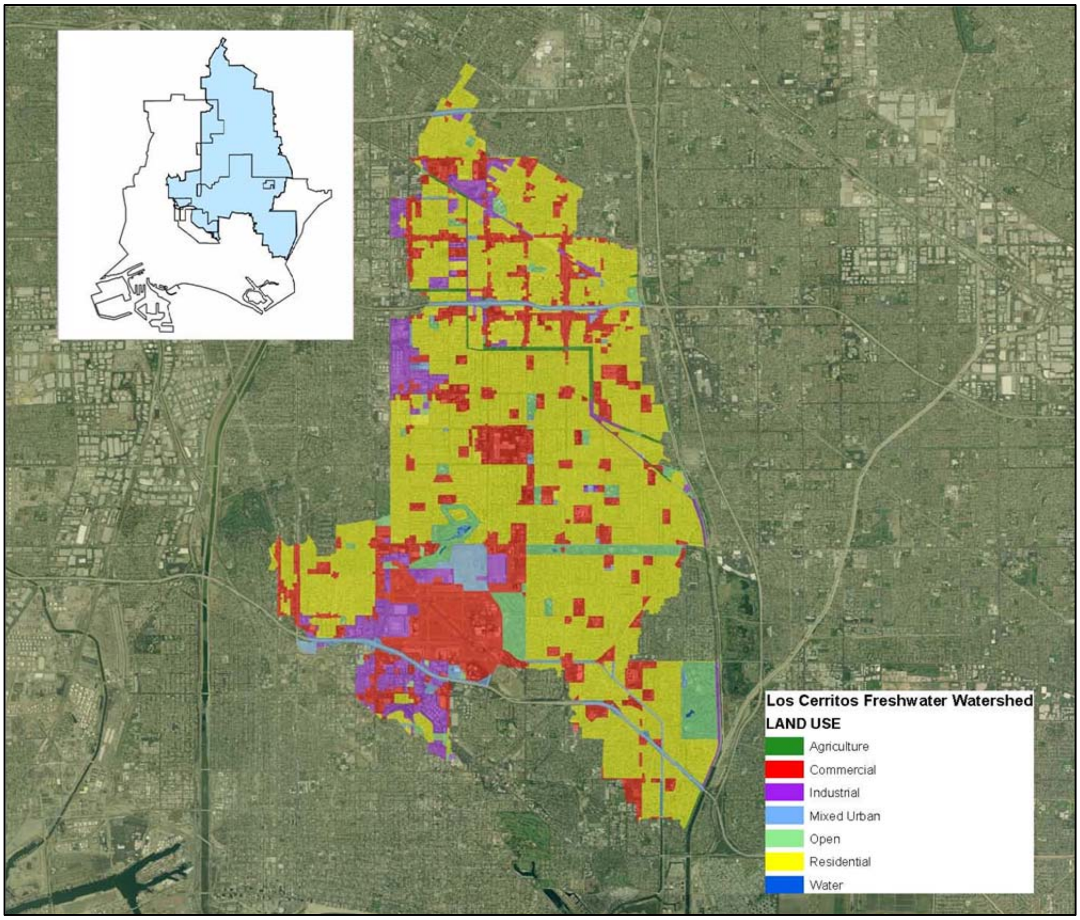


Figure 7. Land Use within the Entire Los Cerritos Channel Drainage Basin.

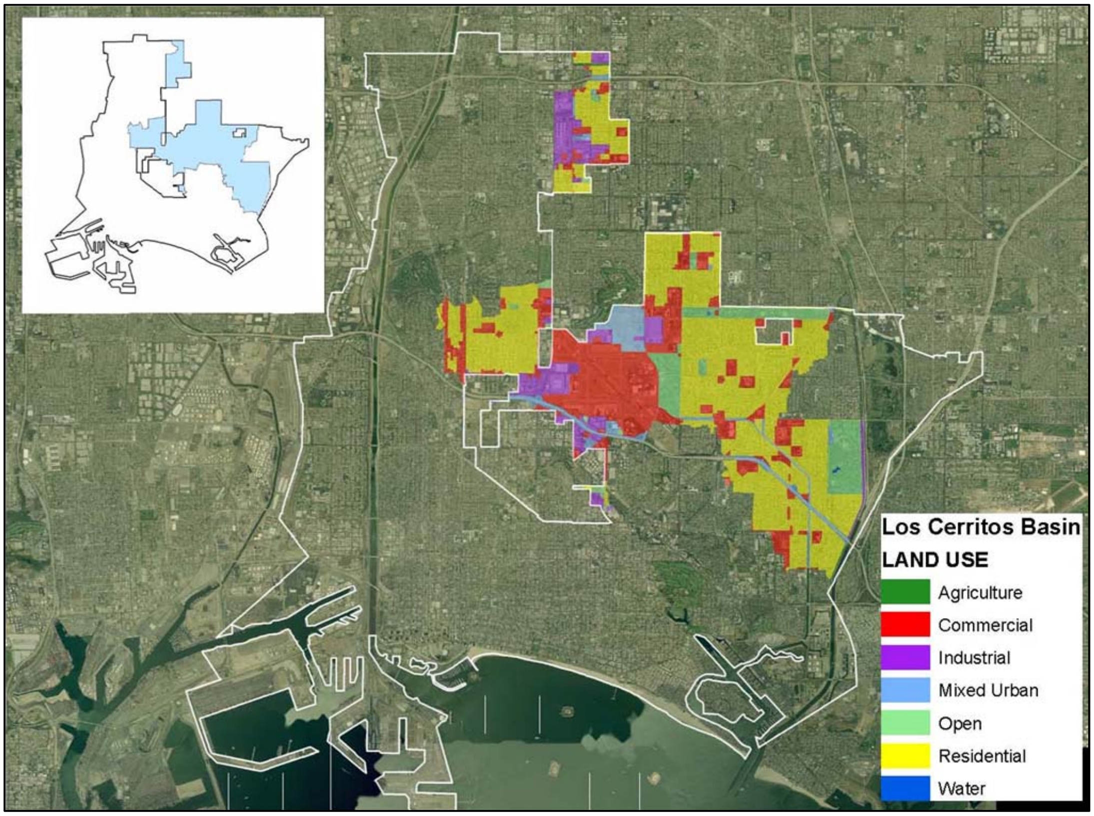


Figure 8. Land Use within the Portion of the Los Cerritos Channel Drainage Basin Located within the City of Long Beach.

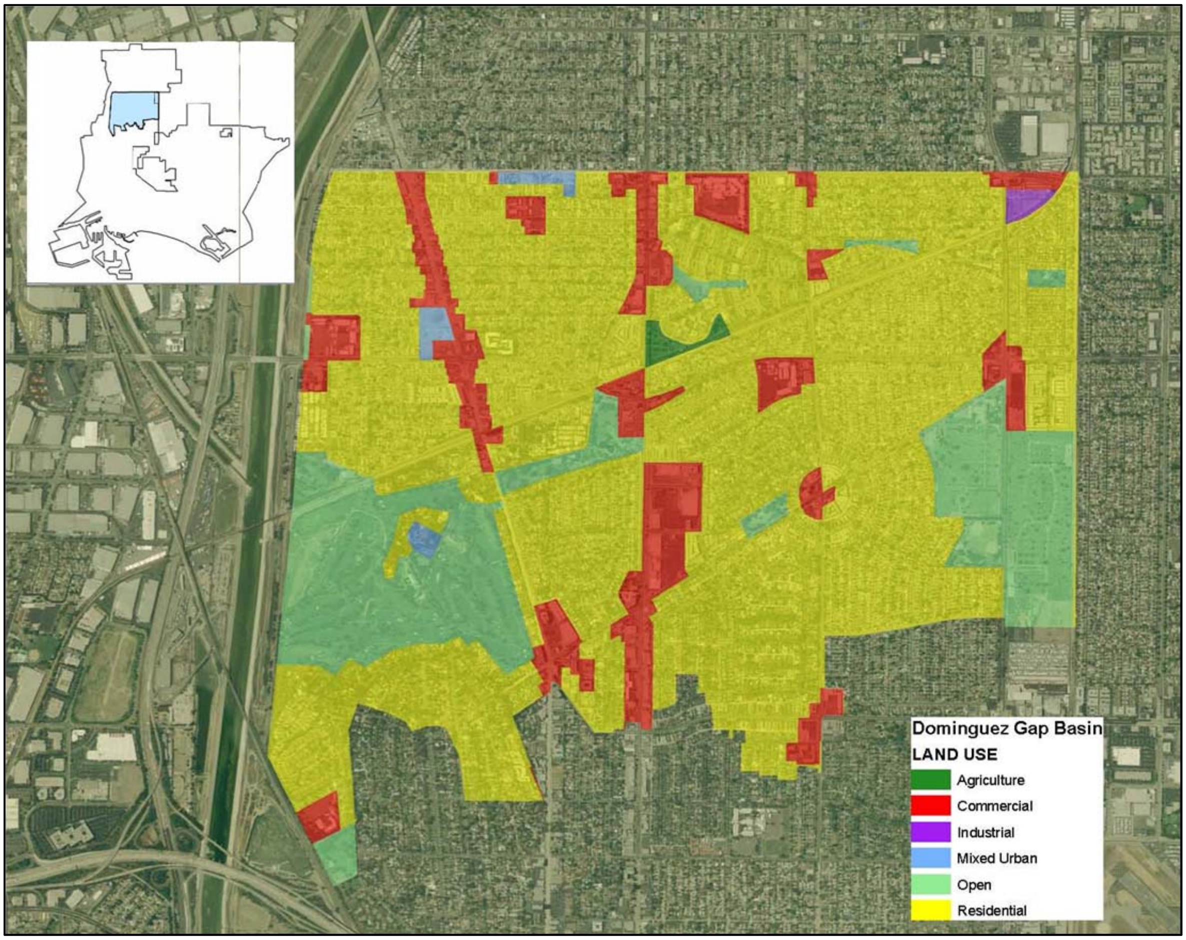


Figure 9. Land Use within the Dominguez Gap Drainage Basin.

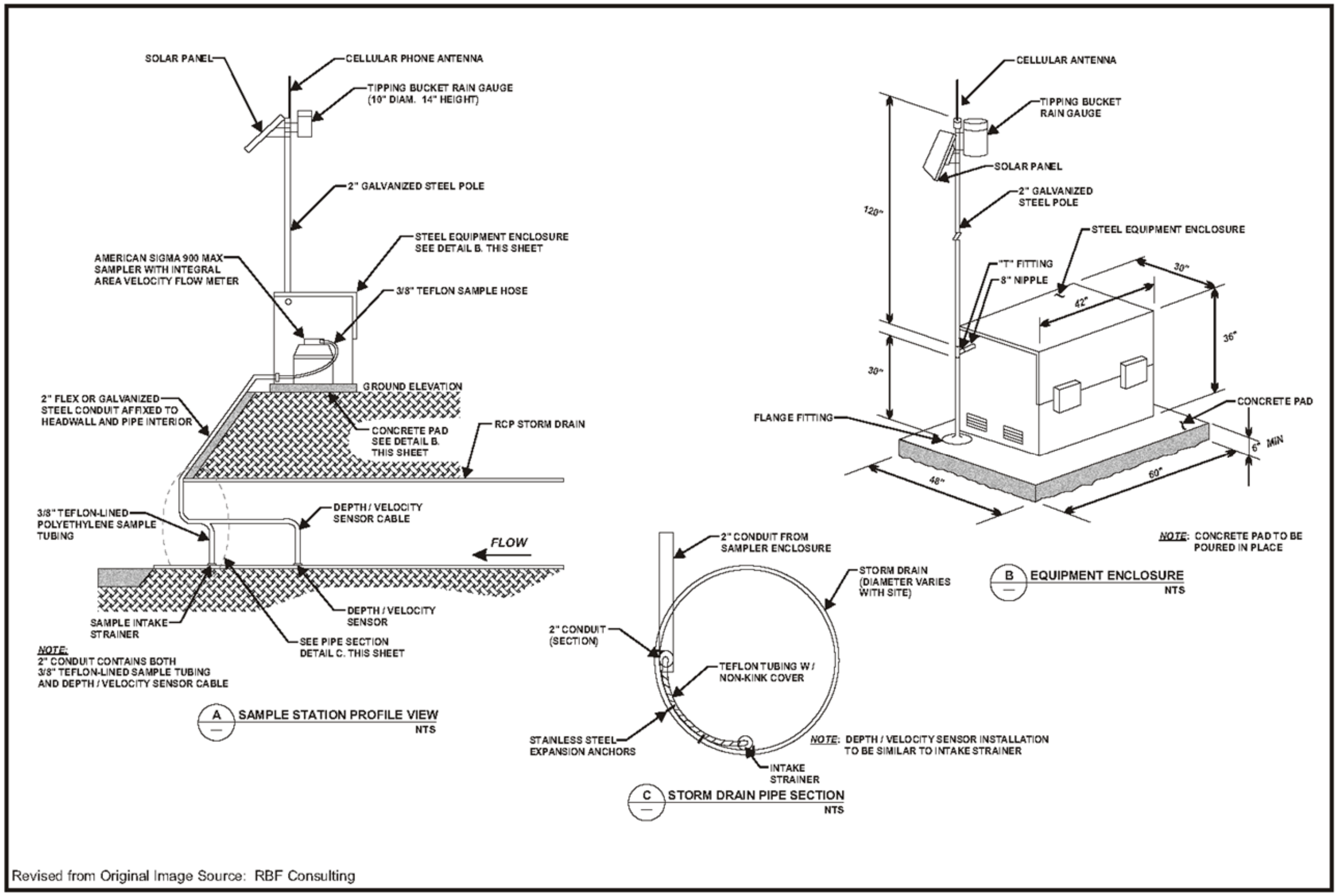


Figure 10. Typical KLASS Stormwater Monitoring Station.

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	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.

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
TRIAZINE PESTICIDES (µg/L)			
Prometryn	625m	7 days	0.01
Atrazine	625m	7 days	0.01
Simazine	625m	7 days	0.01
Cyanazine	625m	7 days	0.01

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

THIS PAGE INTENTIONALLY LEFT BLANK

RAINFALL AND HYDROLOGY

With a single exception, the maximum number of storm events for each station (four) was monitored this season. This could be attributed to the above average rainfall encountered during the 2010/2011 wet weather season. Stormwater sampling was accomplished over the course of nine separate rainfall events, including the October 6, 2010 “first flush” event of the season. Sufficient sample volume was collected during four events each at Belmont Pump, Bouton Creek and Los Cerritos Channel to complete the full required suite of analyses. Because of the lack of discharge during events that met antecedent rainfall criteria, only three events were sampled at the Dominguez Gap Pump Station for the full required suite of analyses. In addition to storm events sampled for the full suite of analyses, three events at Belmont Pump, two events at Bouton Creek, and five events at Los Cerritos Channel were sampled for total suspended solids (TSS) only. TSS events were conducted only when there was not sufficient rainfall and sample volume to conduct the majority of the analyses or after the required four events for the full suite of analyses were completed.

A complete record of precipitation data for the 2010/2011 wet weather season, starting in late September, exists, though some of the precipitation data are augmented with nearby precipitation data. All rain gauges were inspected prior to the first rain and subsequently during maintenance visits, yet there were a few instances when they did not function properly as a result of spiders, birds and other fowling problems. In those cases, rain data were substituted with data from a nearby gauge. Due to roosting birds, the rain gauge at Dominguez Gap was discovered to have been clogged during the first monitored event (December 17-19) and those data were substituted with data from the nearby Wardlow-LAR USACOE Station. The Los Cerritos rain gage failed twice during the season. The first failure was due to vandalism and the gauge was repaired on October 19th. The Los Cerritos gauge failed again due to debris accumulation during the eighth event (February 25-26). In both cases the records for the affected time periods were replaced with Bouton Creek data. Belmont Pump and Bouton Creek gauges operated throughout the season without any significant maintenance issues.

With one exception, a complete record of discharge data also exists for the four monitoring stations. The lone exception is due to an intermittent velocity sensor failure at Bouton Creek between September 28 and October 17, 2010. Because of the intermittent failure, the composite sample collected at Bouton Creek during the October 6 event was unrepresentative and was subsequently discarded. The sensor was replaced on October 17 and no other failures were identified thereafter.

PRECIPITATION DURING THE 2010/2011 WET WEATHER SEASON

Table 6 through Table 9 summarize the daily rainfall for each monitoring station during the 2010/2011 season along with daily rainfall from the previous 2009/2010 season. As these data show, the 2010/2011 season was the second season in a row with above normal rainfall. This is also evident in Figure 11 which shows the seasonal precipitation at Long Beach Airport for the past 12 years. This season’s cumulative rainfall of 18.11 inches is well above both the normal wet season average of 12.27 inches and the average of 10.55 inches since the inception of this program in 1999.

Cumulative rainfall for each station is illustrated in Figure 12. As this figure shows, rainfall totals varied somewhat among the four monitoring stations as a result local orographic differences and the showery nature of some events. Season totals (October 1 through April 30) were 17.69 inches at the Belmont Pump Station, 15.65 inches at Los Cerritos Channel, 15.05 inches at Bouton Creek, and 13.92

inches at the Dominguez Gap Pump Station. Long Beach Airport had rainfall totals (18.11 inches) that were slightly higher than those measured at each of the four monitoring stations.

Monthly Precipitation

Figure 13 shows monthly rainfall for the four monitoring sites and at the Long Beach Airport along with the normal average monthly rainfall at the airport. More than half the season rainfall occurred in December whereas rainfall in a normal year is spread relatively evenly between December and March. Besides December, only October had higher than normal precipitation. November, January, February and March had below normal precipitation and March had near normal precipitation.

Precipitation during 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. Descriptive statistics for all monitored events and for each station, including TSS only events are presented in Table 11. Cumulative rainfall and intensity are summarized graphically for each monitored event at each station in Figure 14 through Figure 38

For the 2010/2011 wet weather season, total rainfall between full testing events varied between 0.48 and 2.58 inches at the Belmont Pump Station, 0.45 and 2.34 inches at Bouton Creek, 0.25 and 2.29 inches at Los Cerritos Channel and 0.52, and 1.16 inches at the Dominguez Gap Pump Station. For TSS-only storm events, total rainfall between monitored events ranged from 0.20 inches to 1.15 inches at the Belmont Pump Station, 0.04 inches to 1.49 inches at Bouton Creek, and 0.17 inches to 1.60 inches at Los Cerritos Channel.

Mean total rainfall between all testing events (Full and TSS only) during the 2010/2011 wet weather season ranged from 0.72 inches at Los Cerritos Channel to 0.99 inches at Bouton Creek. If only full suite storm events are considered, mean rainfall between testing events ranged from 0.93 inches at both Los Cerritos Channel and the Dominguez Gap Pump Station to 1.16 inches at the Belmont Pump Station.

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. Mean maximum rainfall intensities among monitored events (based on five minutes of data) ranged from 0.55 inches/hour at Bouton Creek to 0.77 inches/hour at the Belmont Pump Station. Maximum intensities during the 2010/2011 wet weather season reached as high as 0.96 inches/hour at the Belmont Pump Station and Los Cerritos Channel, 1.32 inches/hour at Bouton Creek, and 0.72 inches/hour at the Dominguez Gap Pump Station.

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 the descriptive statistics in Table 11 show that all monitored events during the 2010/2011 season, with one exception, were preceded by at least five and a half days of dry conditions. The five and a half days of dry conditions, which occurred prior to the February 25 and 26 event, fell short of the targeted seven days. Because of uncertainties on whether or not the remainder of the wet season would provide any more significant rainfall events, it was difficult to pass up the well predicted rainfall levels forecasted for February 25 and 26 event that produced around 0.6 inches of rain. This was especially true for the Dominguez Gap Pump Station that requires significantly more rain than the other stations to produce discharge. At the time of February 25 and 26 event only one storm had occurred that produced discharges along with suitable antecedent conditions at the Dominguez Gap Pump Station. Note that only the February 25 and 26 composite samples from Bouton Creek and the Dominguez Gap Pump Station were analyzed for the full suite of analyses. The one exception noted earlier occurred for a TSS only event (October 30, 2010) at the Los Cerritos Channel that was preceded by 0.16 inches of rain that had occurred 4.6 days earlier. Besides the February 25-26 and October 30 events, all other monitored events were preceded by at least 11 days of dry conditions. The mean period of dry conditions among all monitored events ranged from 13 days at the Dominguez Gap Pump Station to 37 days at the Belmont Pump Station. The mean antecedent rain prior to all monitored events ranged from 0.39 inches at the Dominguez Gap Pump Station to 0.63 inches from the Belmont Pump Station.

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 flow based descriptive statistics for all monitored events during the 2010/2011 season. This information complements the calculated EMCs for each monitored analyte at these sites. Table 12 summarizes flow characteristics among monitored events at each station including the duration of discharge/flow, total discharge volume, and peak discharge/flow.

Figure 14 through Figure 38 graphically depicts flow during each monitored event 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.

Flow duration or the period of discharge varied between stations and events. As is the usual case at these sites, flow duration was typically 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. In contrast, the period of discharge at the pump stations was much less.

The duration of discharge is reported in Table 12 for the 2010/2011 monitoring season. The Belmont and Dominguez Gap pump stations are often overestimated because of the on and off cycling of the pumps. Discharge durations reported in these tables represent the period between the times the first pump came on until all pumps became silent. One should refer to the hydrographs developed for the pump stations for a better estimate of the duration of discharge.

For the 2010/2011 wet weather season, mean total flow or discharge for monitored events ranged from 405 kilo-cubic feet (kcf) at the Belmont Pump Station to 11,482 kcf at Los Cerritos Channel Station. Excluding TSS only events, mean total flow ranged from 493 kcf at the Belmont Pump Station to 14,093 kcf at Los Cerritos Channel.

Percent storm captures (percentage of the total storm event volume effectively represented by the flow-weighted composite sample) met the optimal objective (>90%) in 80% of the station events. Percent captures below 90% were due to a variety of reasons including multiple bottles filling at the same time under heavy rain conditions. Of the five station events with less than 90% capture, three station events achieved between 80% and 90% storm capture, one station event achieved 73% capture, and one station event achieved 68% capture. There were 13 station events (52% of the total) that achieved 100% capture.

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. These segments were sampled for all station events during the 2010/2011 wet weather season. Note that this does not appear to be the case for all Bouton Creek events. The hydrographs for this station are misleading because early and peak flows are often too salty to sample. Therefore, it is important to compare conductivity readings to the hydrographs when assessing when sampling occurred.

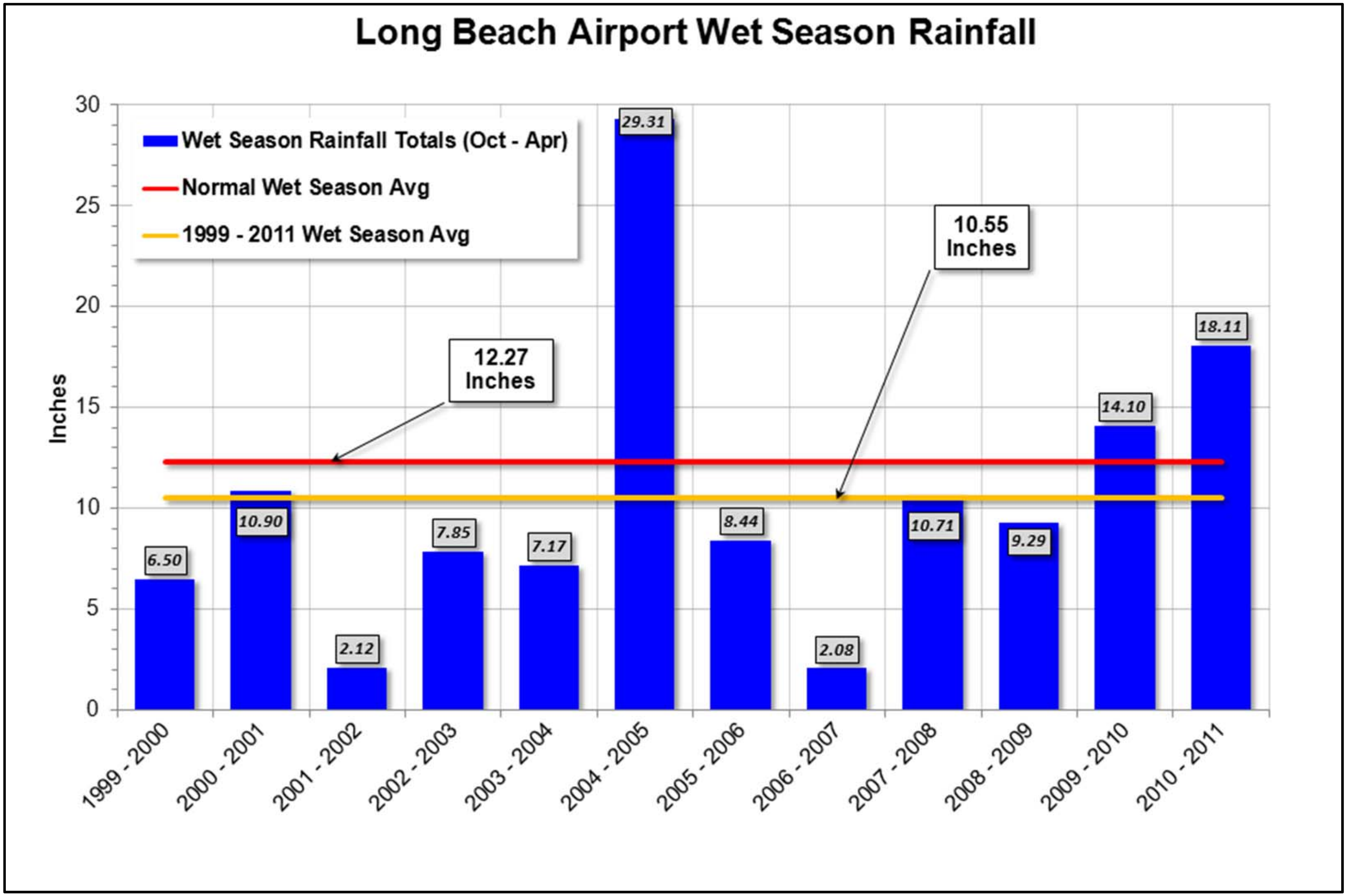


Figure 11. Annual Rainfall (October –May) at Long Beach Daugherty Airport over Past Twelve Years.

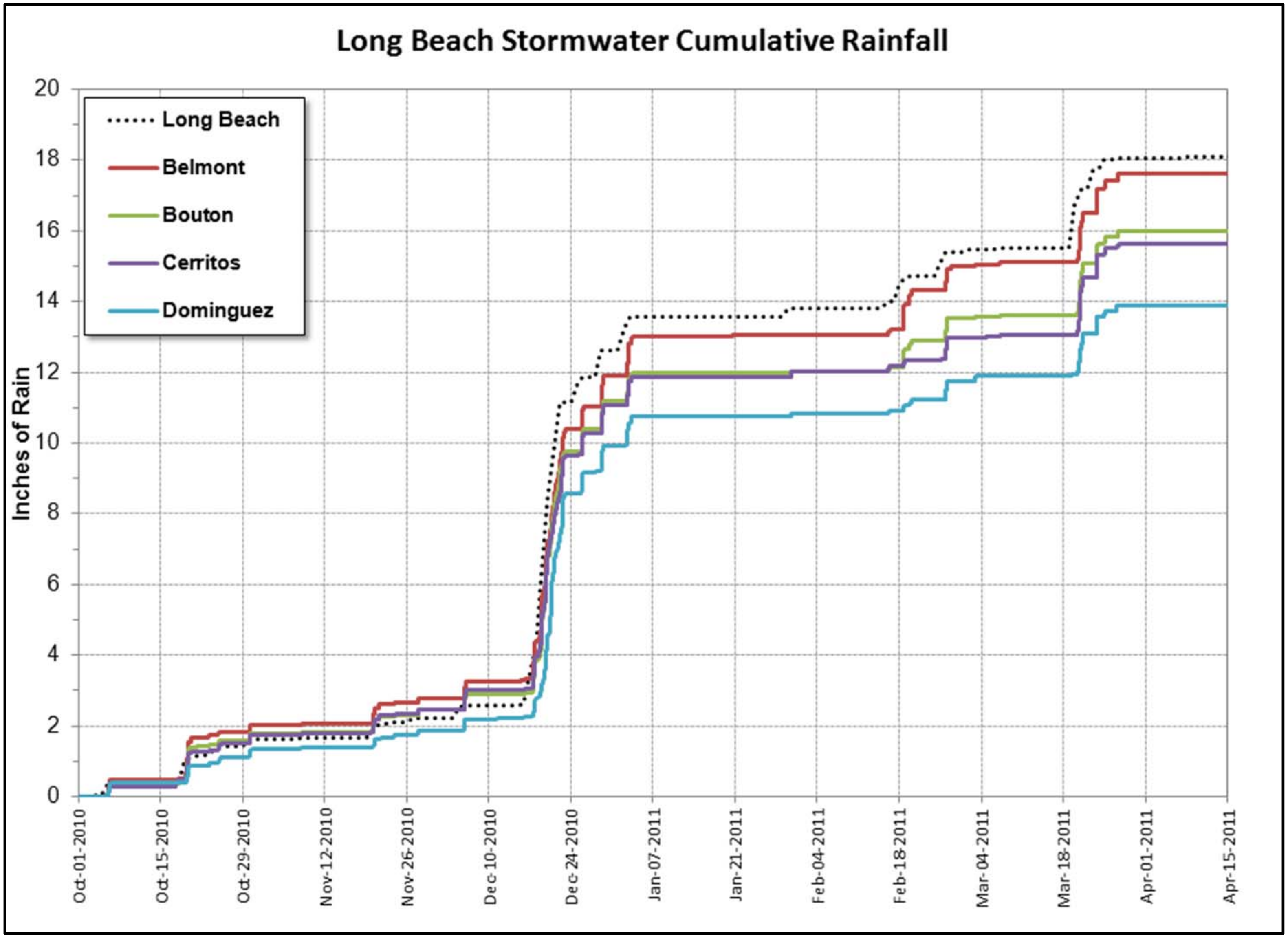
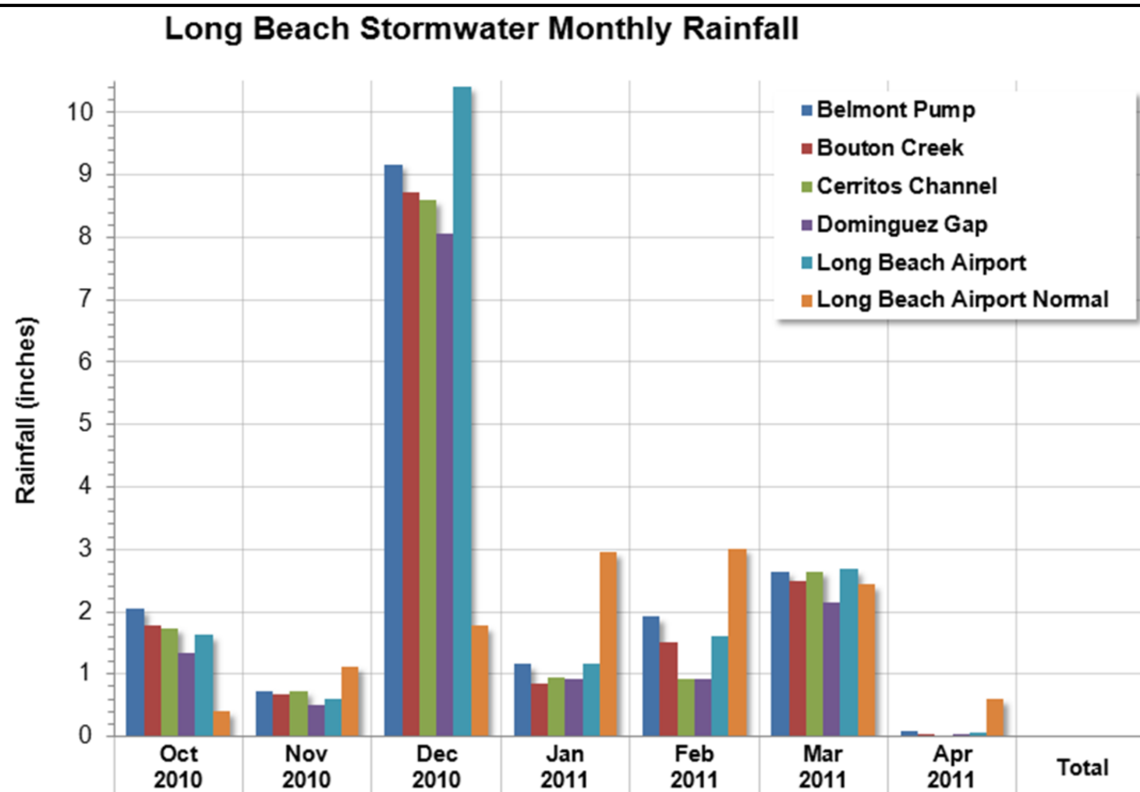


Figure 12. Cumulative Rainfall for the 2010/2011 Wet Weather Season.



	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	Mar 2011	Apr 2011	Total
Belmont Pump	2.04	0.72	9.16	1.15	1.91	2.64	0.07	17.69
Bouton Creek	1.78	0.67	8.72	0.84	1.50	2.49	0.05	16.05
Cerritos Channel	1.74	0.73	8.60	0.97	0.93	2.65	0.03	15.65
Dominguez Gap	1.34	0.51	8.07	0.91	0.92	2.14	0.03	13.92
Long Beach Airport	1.62	0.60	10.41	1.16	1.60	2.67	0.05	18.11
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 2010/2011 Wet Weather Season and Normal Rainfall at Long Beach Daugherty Air Field.

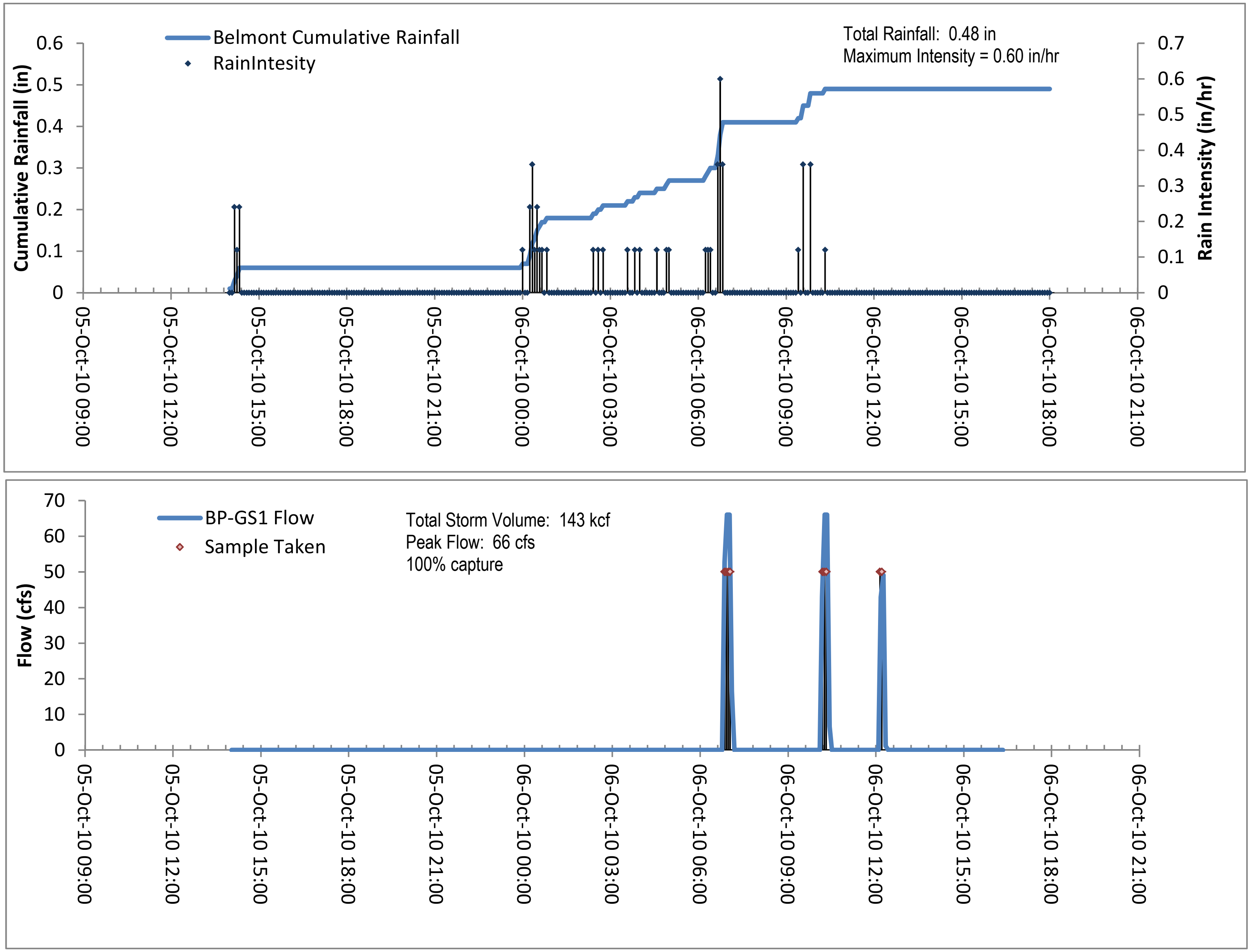


Figure 14. Rain and Discharge from the Belmont Pump Station for Station Event 1 (October 5-6, 2010– Global Event 1).

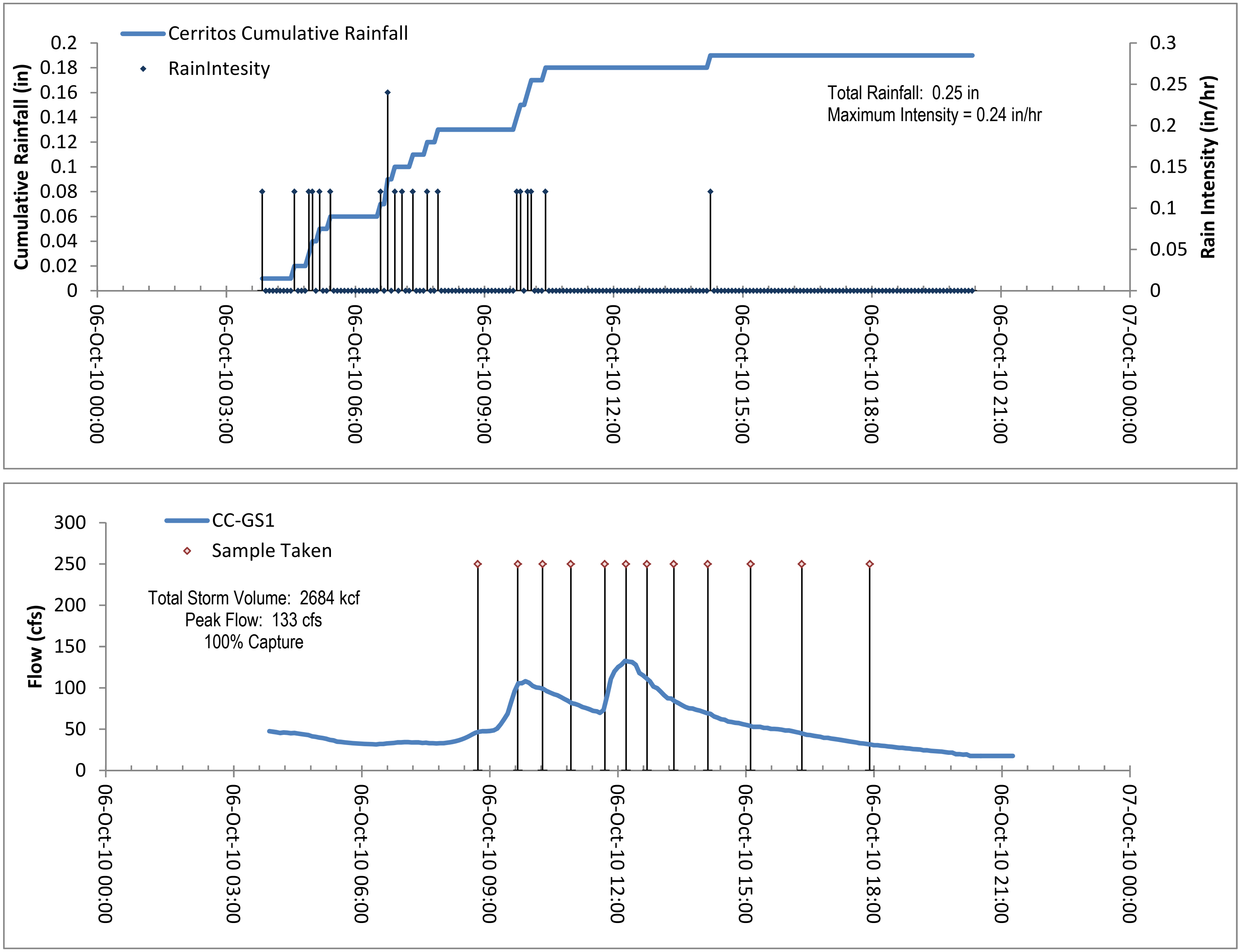


Figure 15. **Rain and Flow from Los Cerritos Channel for Station Event 1 (October 6, 2010 – Global Event 1).**

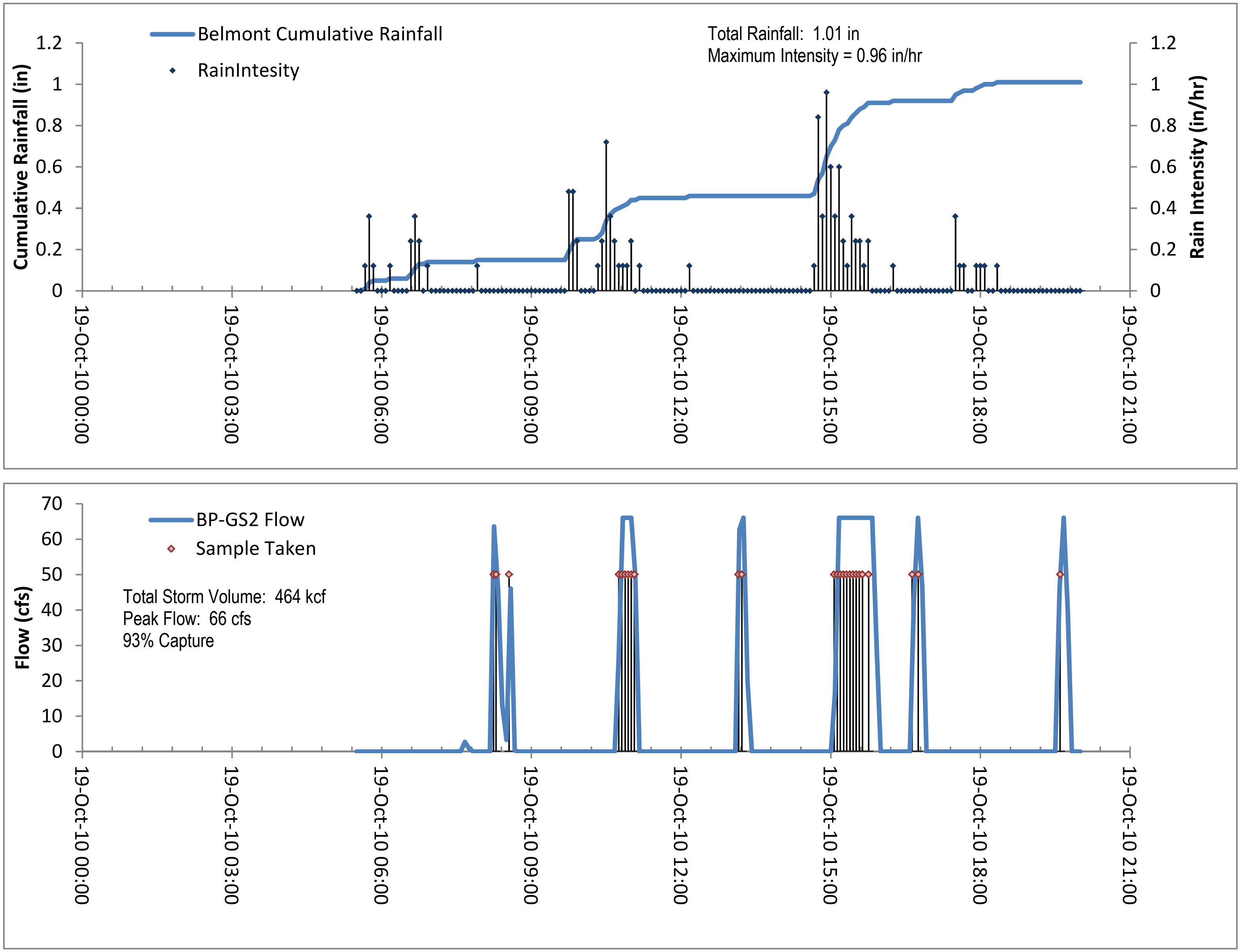


Figure 16. Rain and Discharge from the Belmont Pump Station for Station Event 2 (October 19, 2010 – Global Event 2).

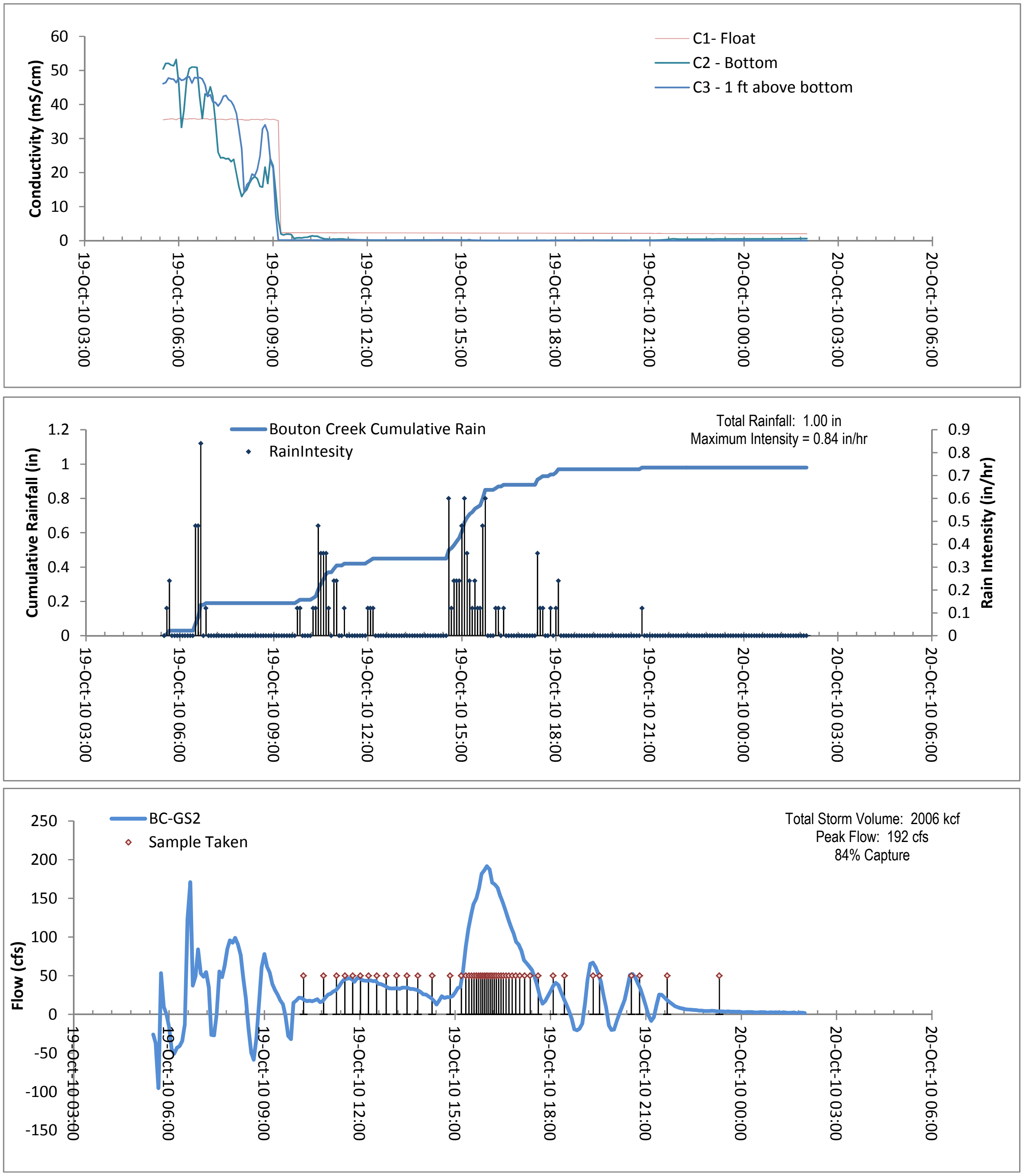


Figure 17. Rain, Flow and Salinity from Bouton Creek for Station Event 1 (October 19-20, 2010 – Global Event 2).

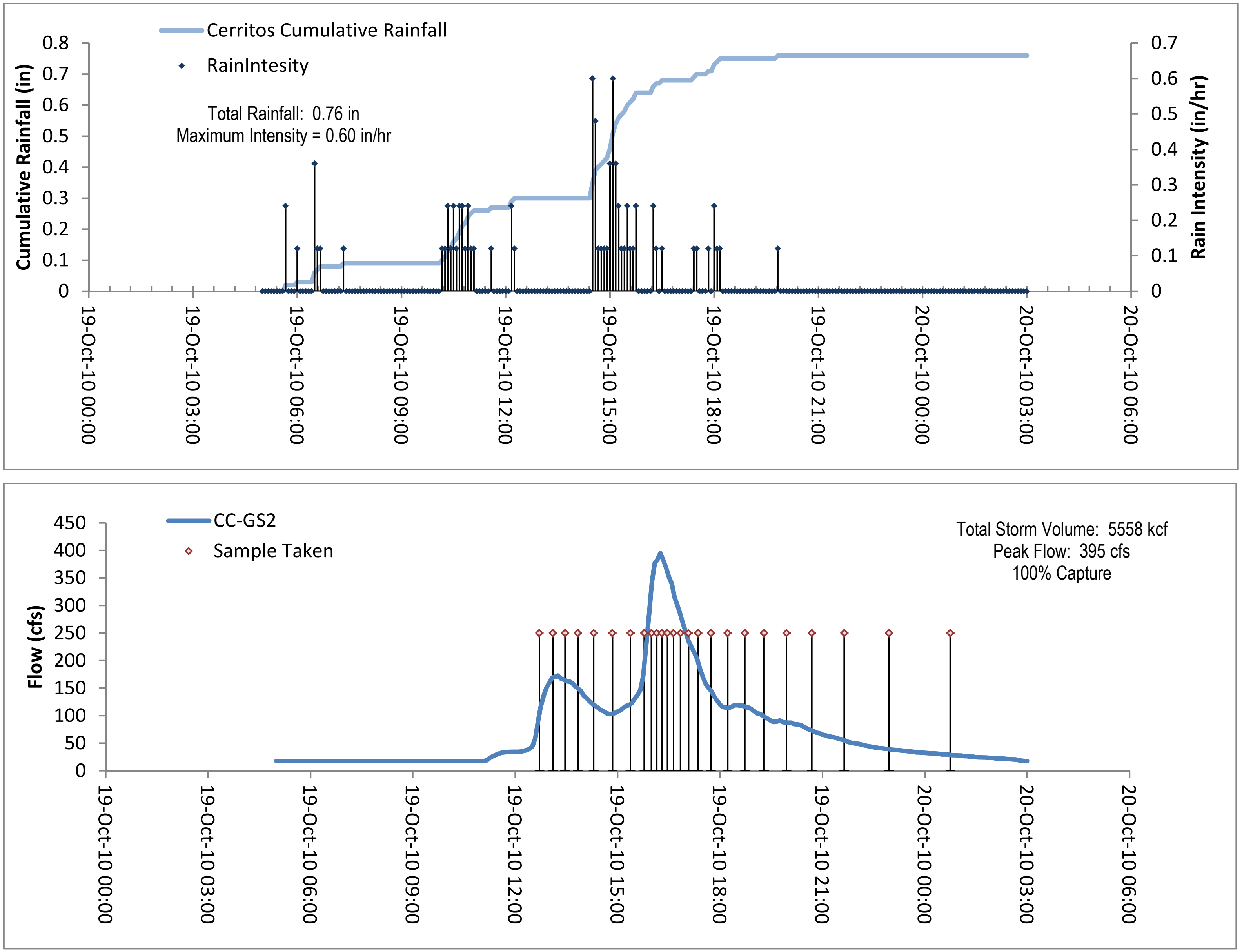


Figure 18. Rain and Flow from Los Cerritos Channel Station for Station Event 2 (October 19-20, 2010 – Global Event 2).

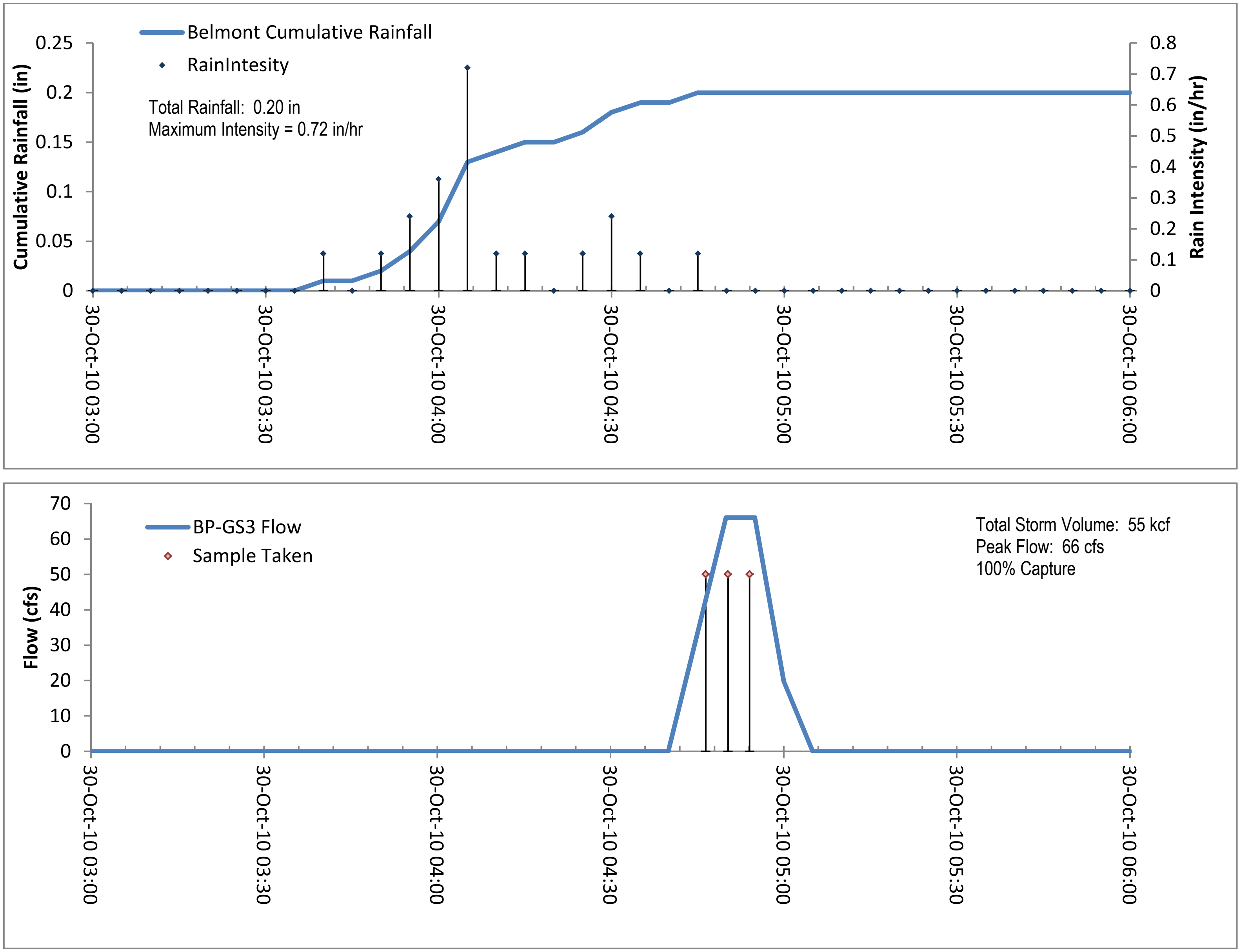


Figure 19. **Rain and Discharge from the Belmont Pump Station for TSS Only Station Event 1 (October 30, 2010 – Global Event 3).**

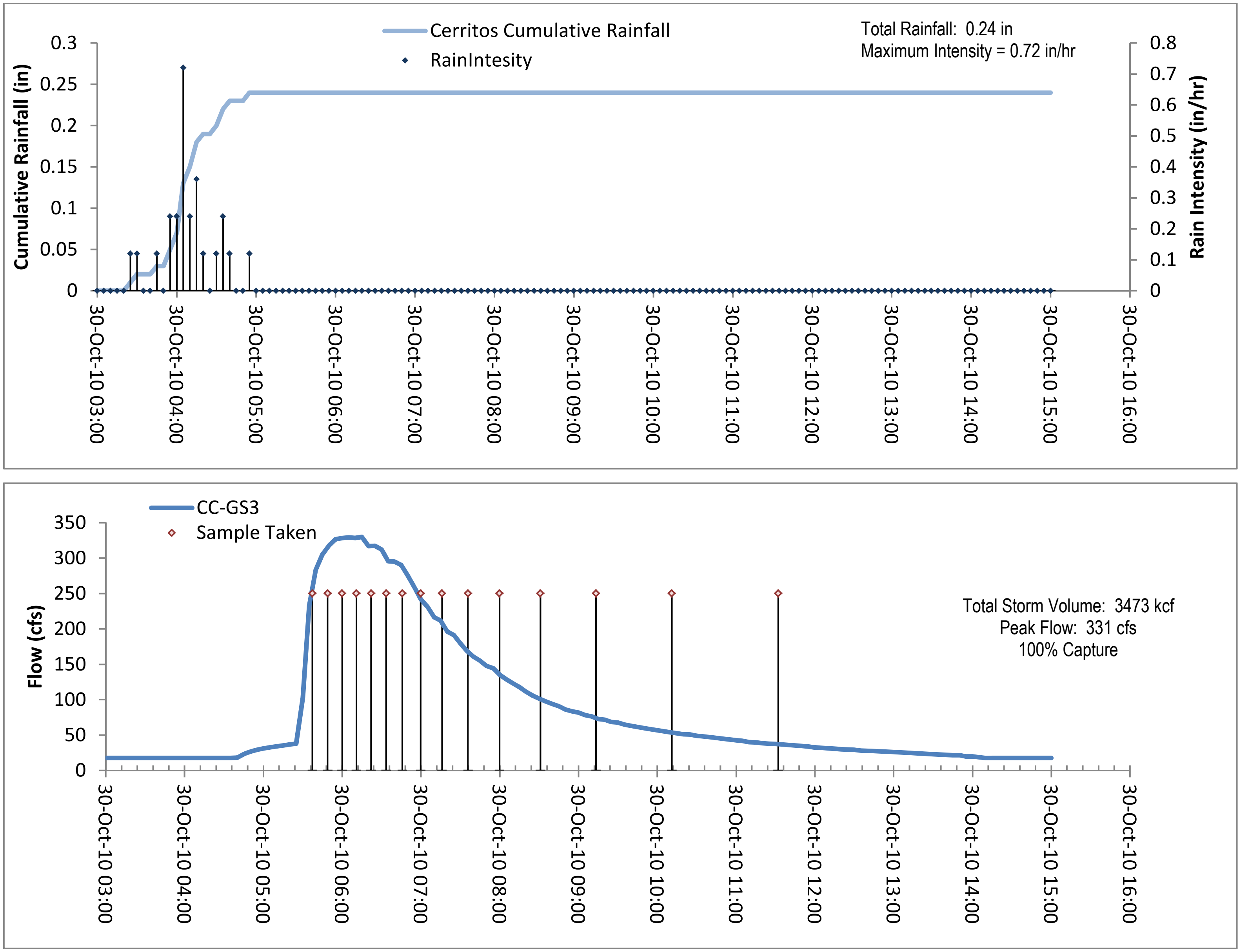


Figure 20. Rain and Flow from Los Cerritos Channel for TSS Only Station Event 1 (October 30, 2010– Global Event 3).

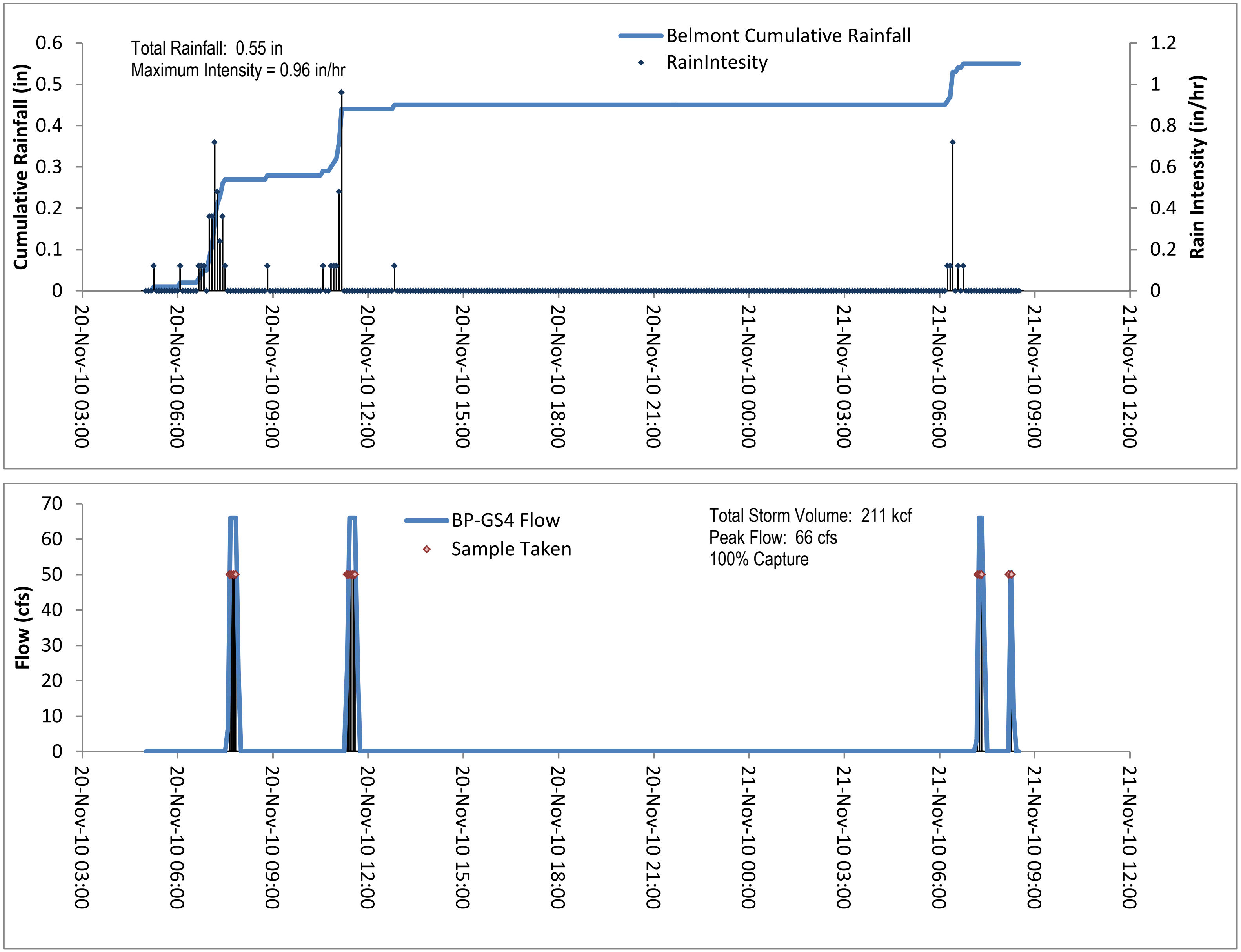
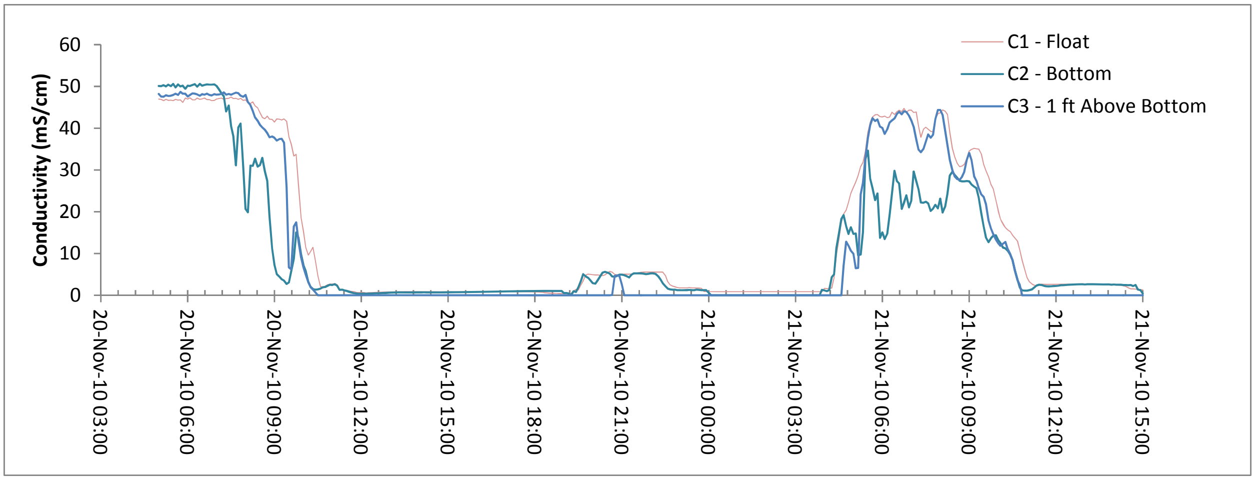
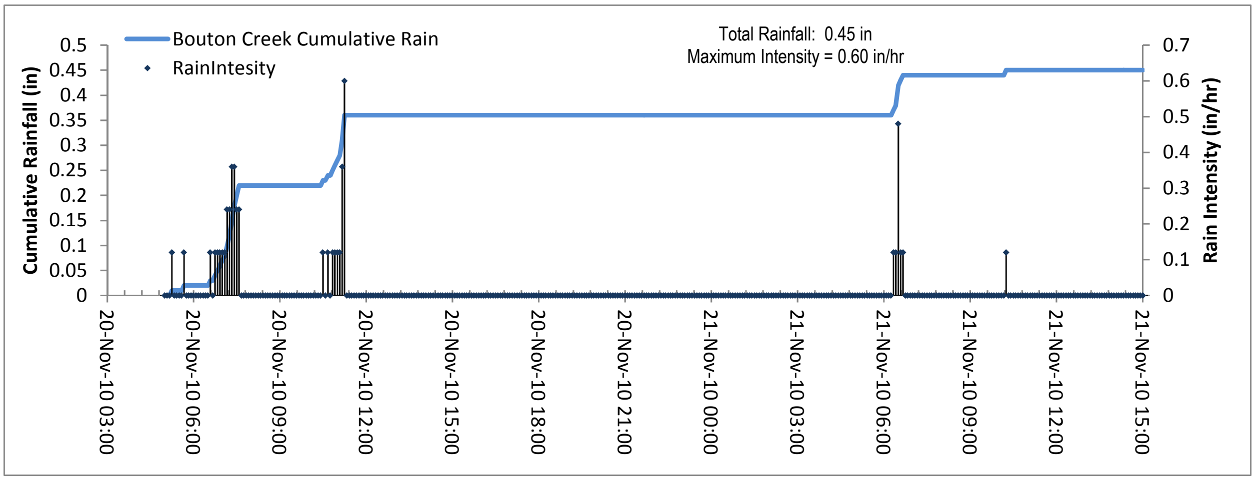


Figure 21. Rain and Discharge from the Belmont Pump Station for Station Event 3 (November 20-21, 2010 – Global Event 4).





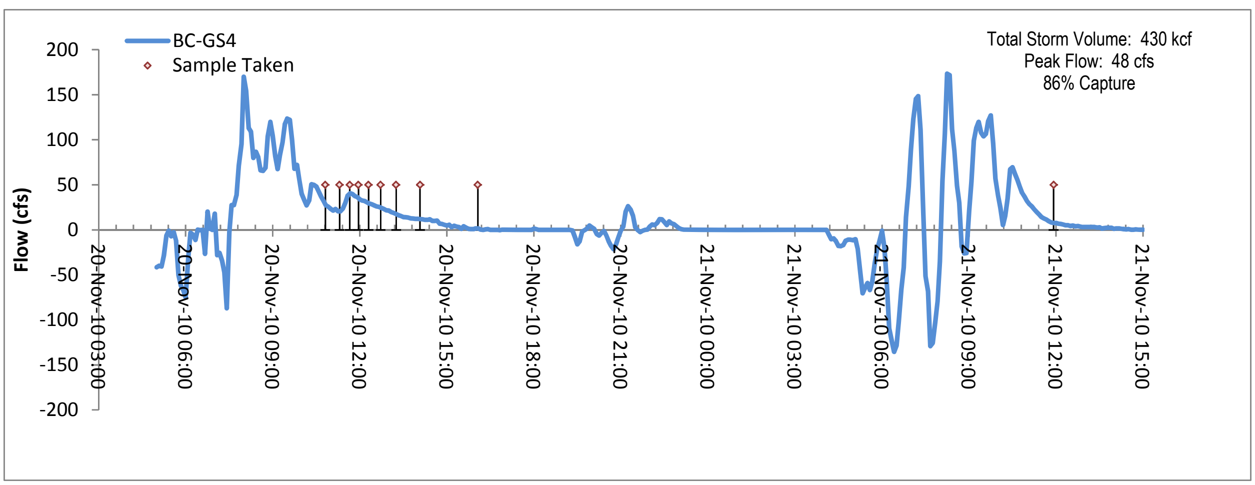


Figure 22. **Rain, Flow and Salinity from Bouton Creek for Station Event 2 (November 20-21, 2010 – Global Event 4)**

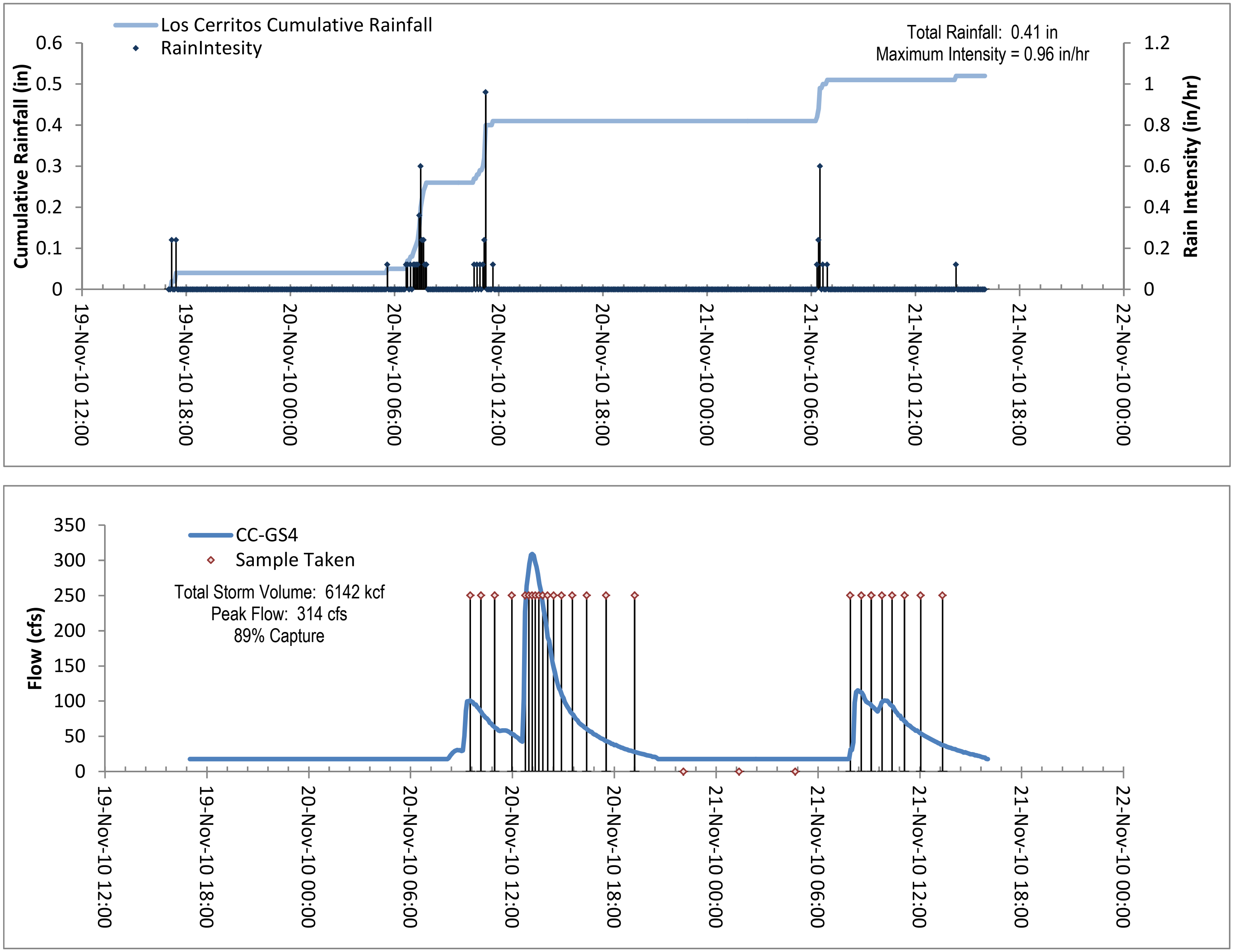


Figure 23. Rain and Flow from Los Cerritos Channel Station for Station Event 3 (November 19-21, 2010 – Global Event 4).

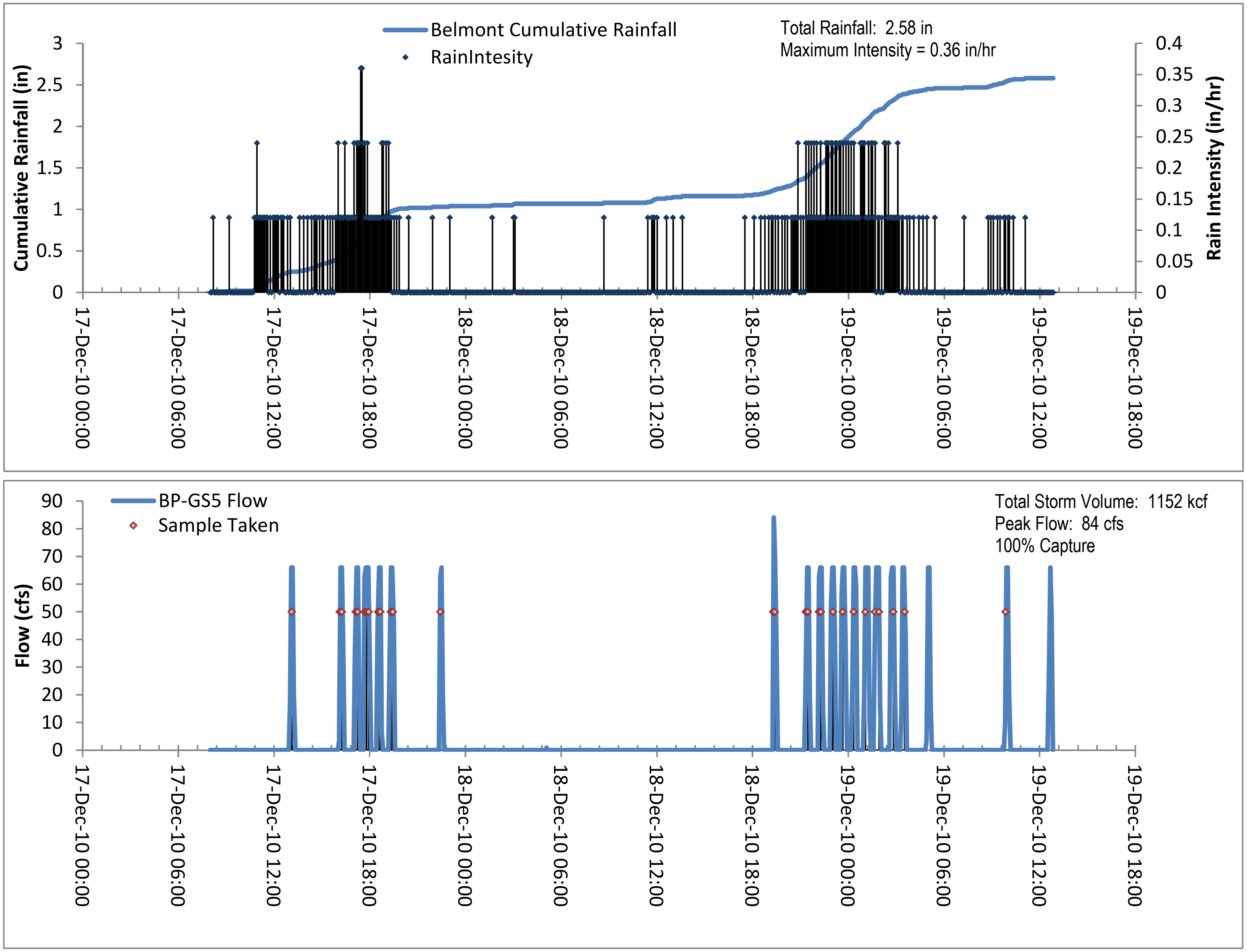


Figure 24. Rain and Discharge from the Belmont Pump Station for Station Event 4 (December 17-19, 2010 – Global Event 5).

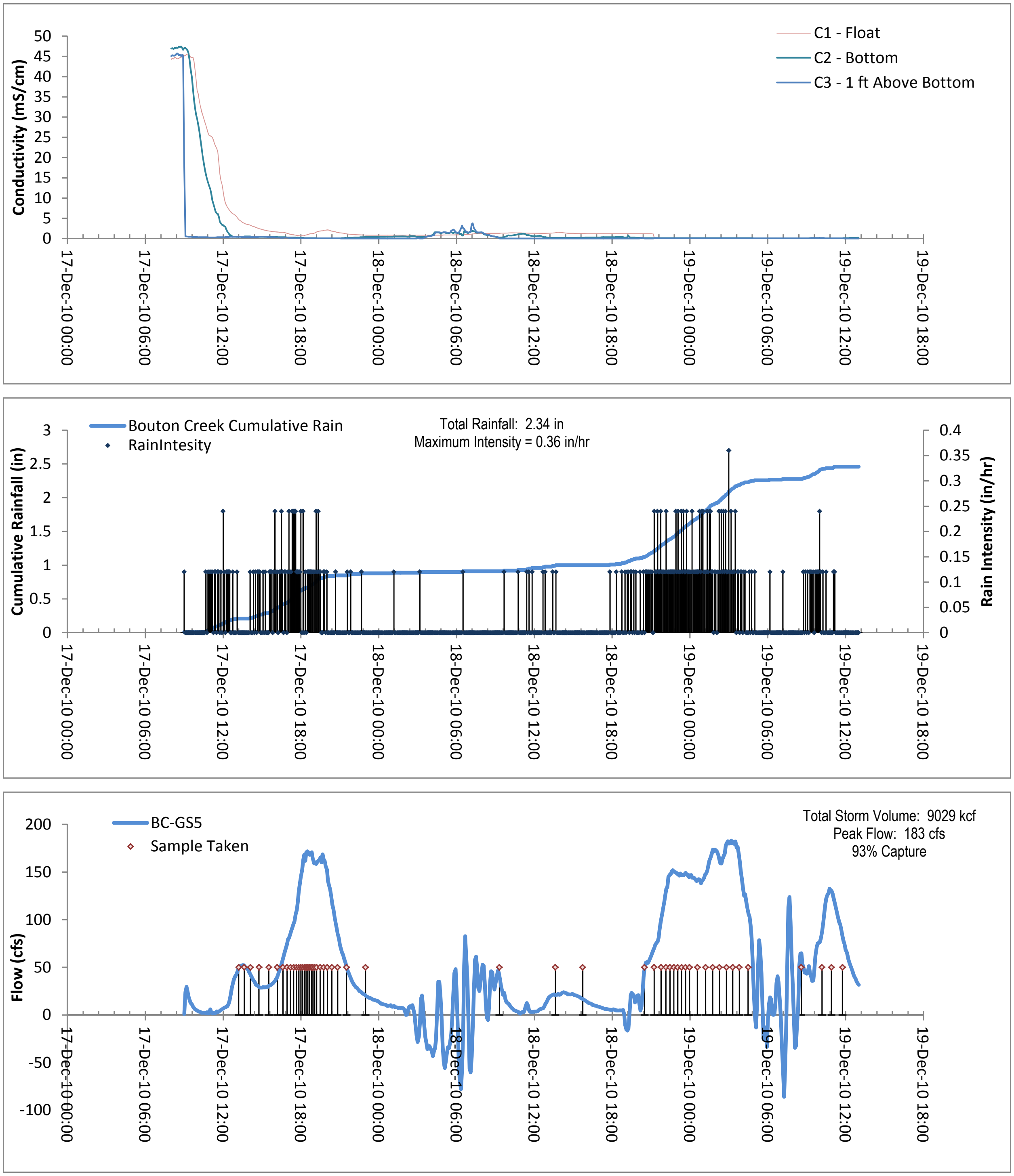


Figure 25. **Rain, Flow and Salinity from Bouton Creek for Station Event 4 (December 17-19, 2010 – Global Event 5).**

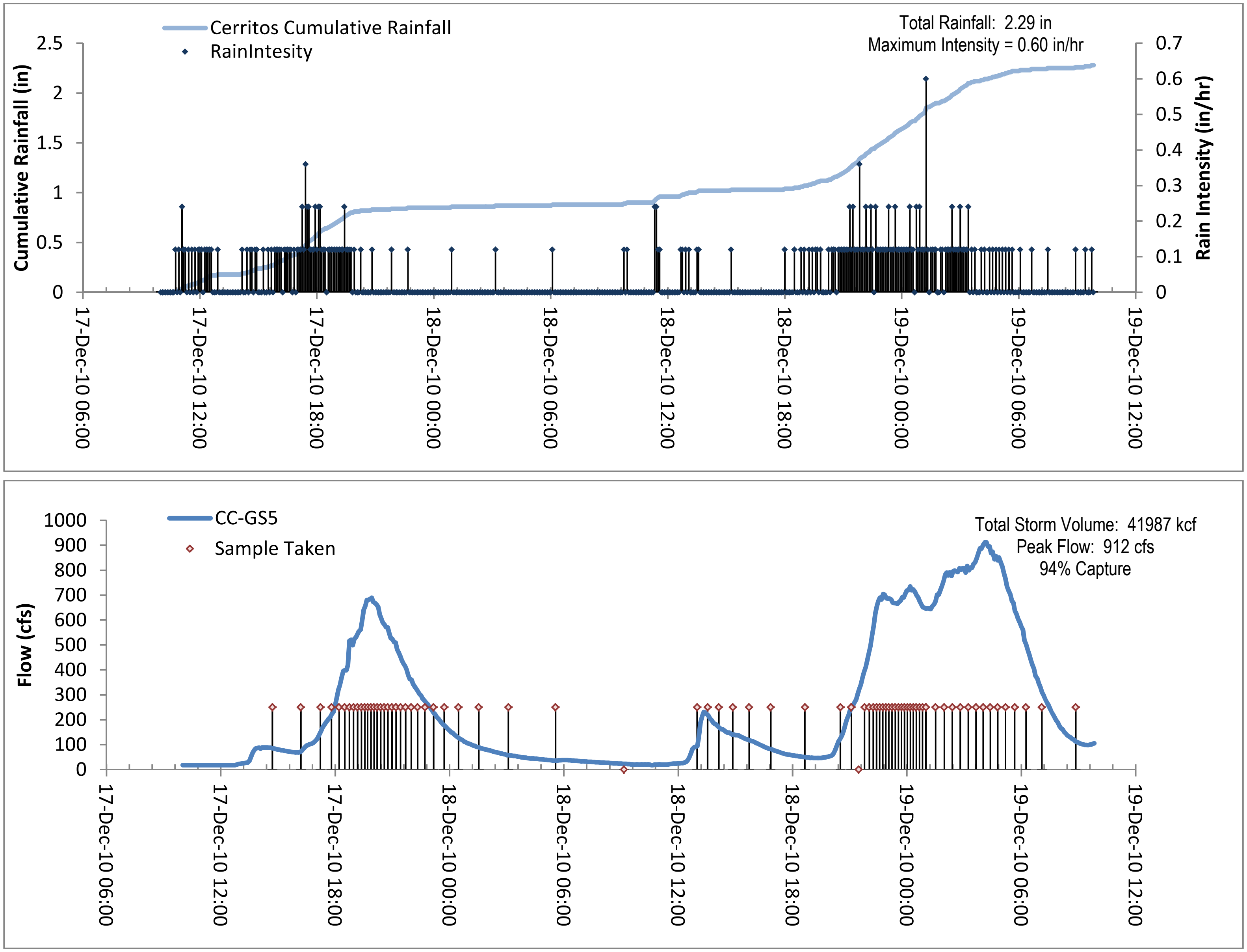


Figure 26. Rain and Flow from Los Cerritos Channel for Station Event 4 (December 17-19, 2010 – Global Event 5).

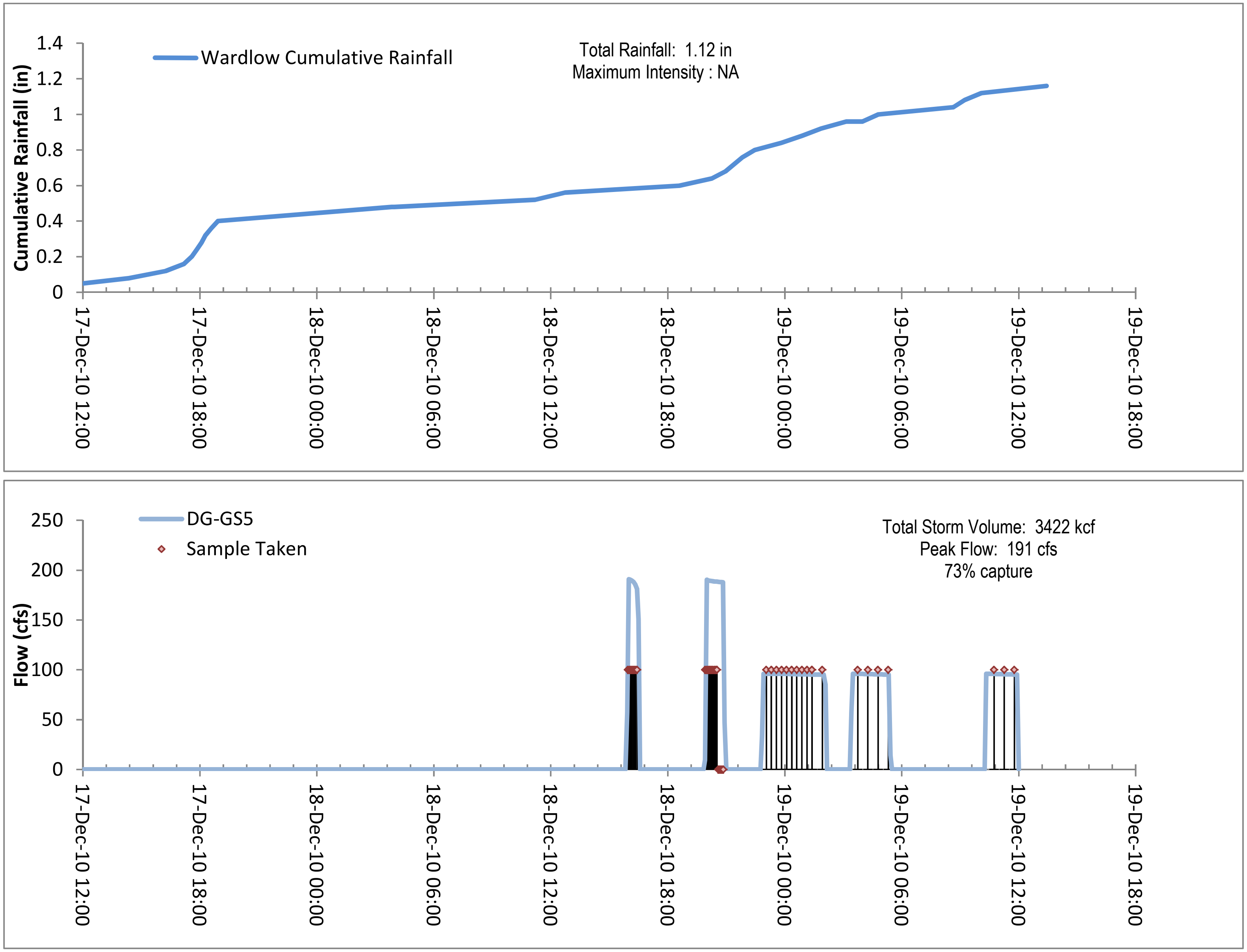


Figure 27. Rain and Discharge from the Dominguez Gap Pump Station for Station Event 1 (December 17-19, 2010 – Global Event 5).

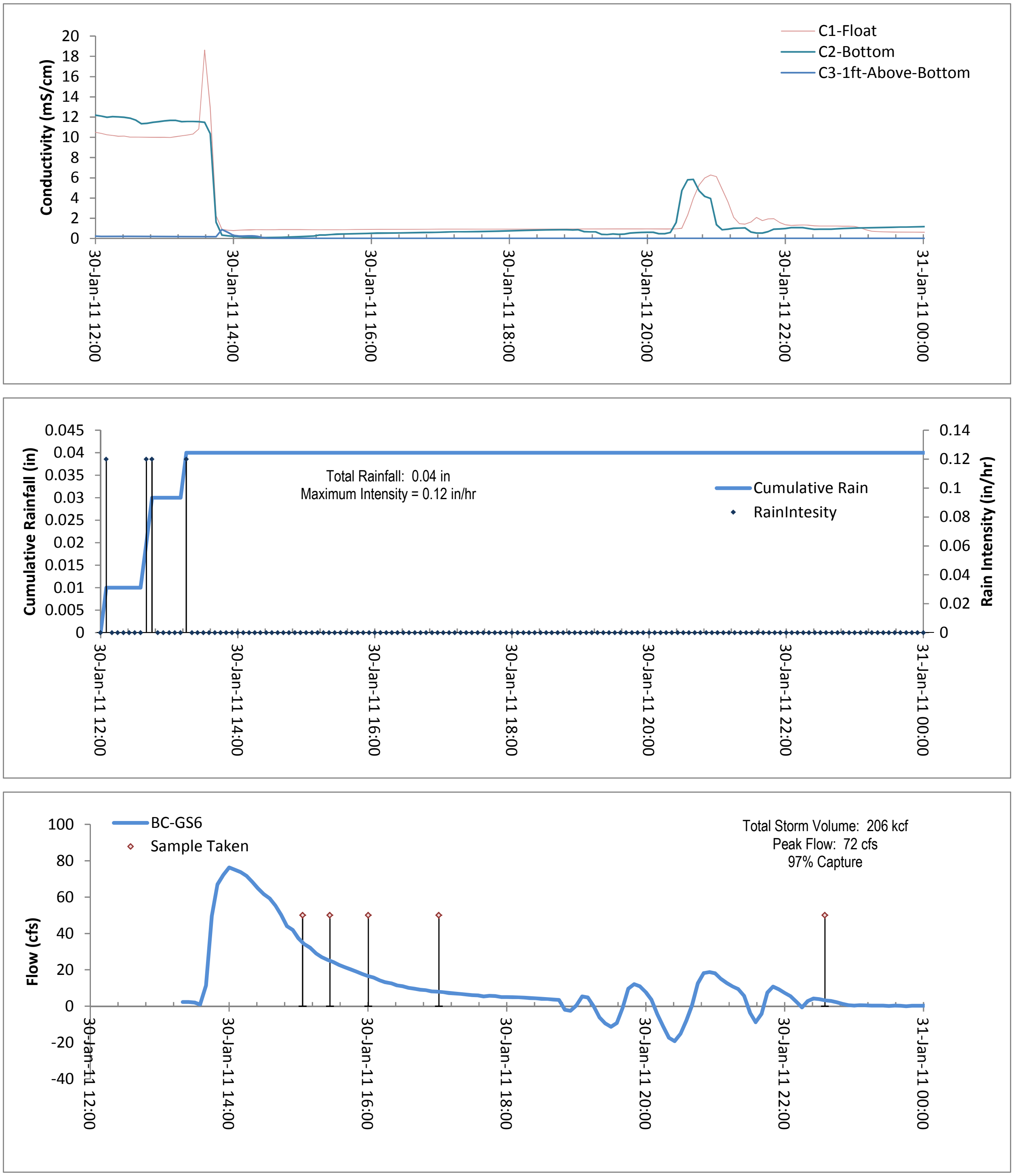


Figure 28. Rain, Flow and Salinity from Bouton Creek for TSS Station Event 1 (January 30, 2011 – Global Event 6).

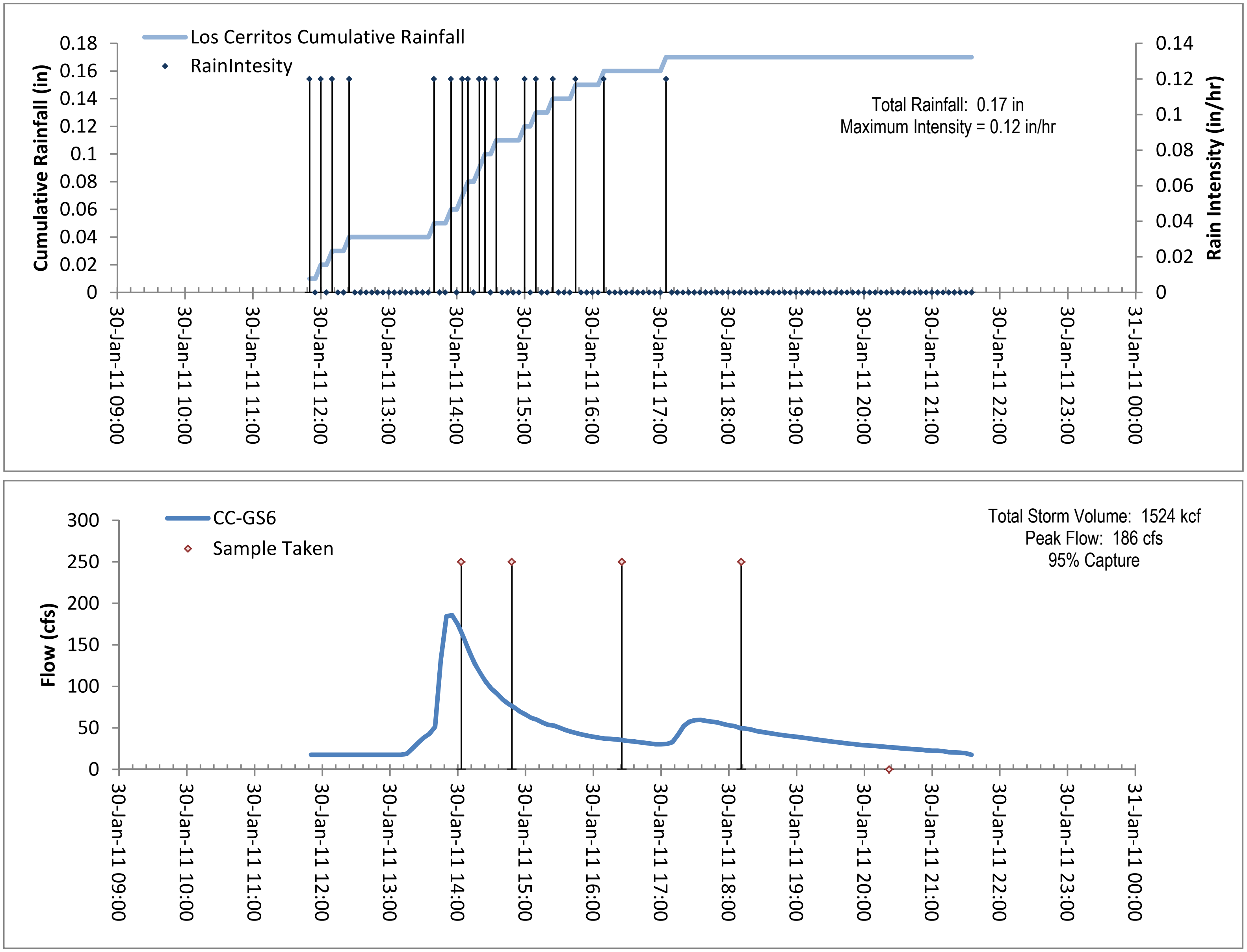


Figure 29. Rain and Flow from Los Cerritos Channel Station for TSS Only Station Event 2 (January 30, 2011 – Global Event 6).

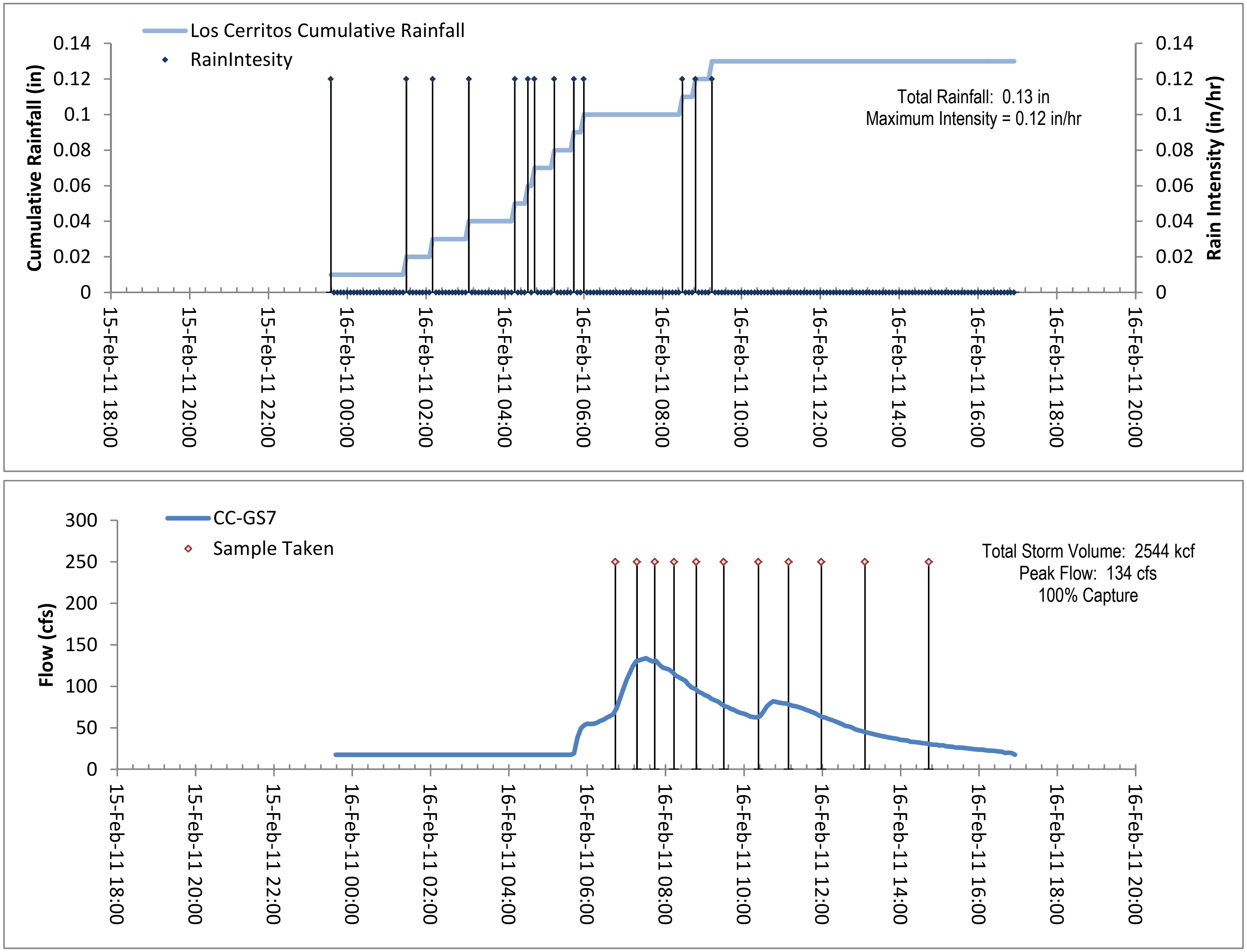


Figure 30. Rain and Flow from Los Cerritos Channel Station for TSS Only Station Event 3 (February 15-16, 2011 – Global Event 7).

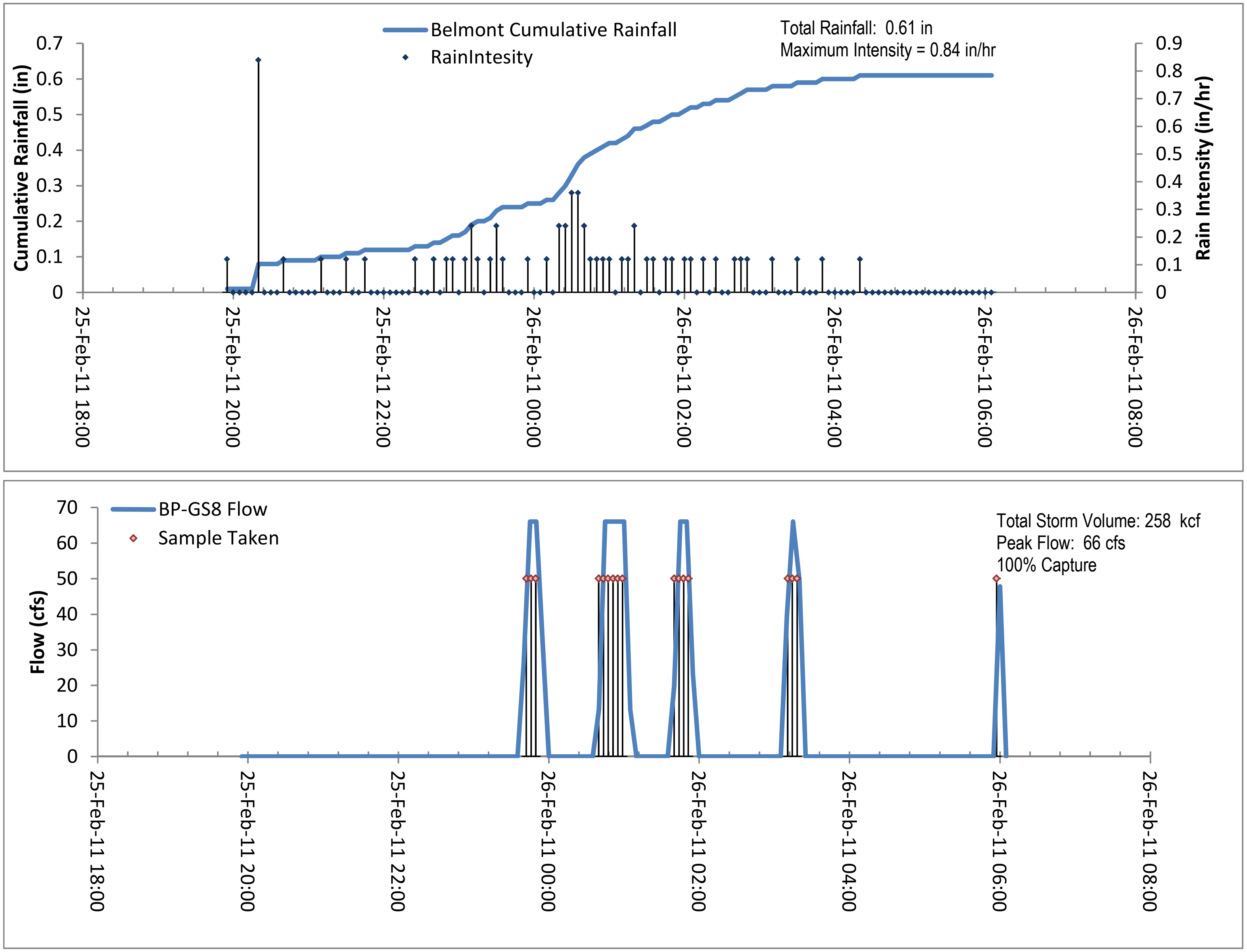


Figure 31. Rain and Discharge from the Belmont Pump Station for TSS Only Station Event 2 (February 25-26, 2010 – Global Event 8).

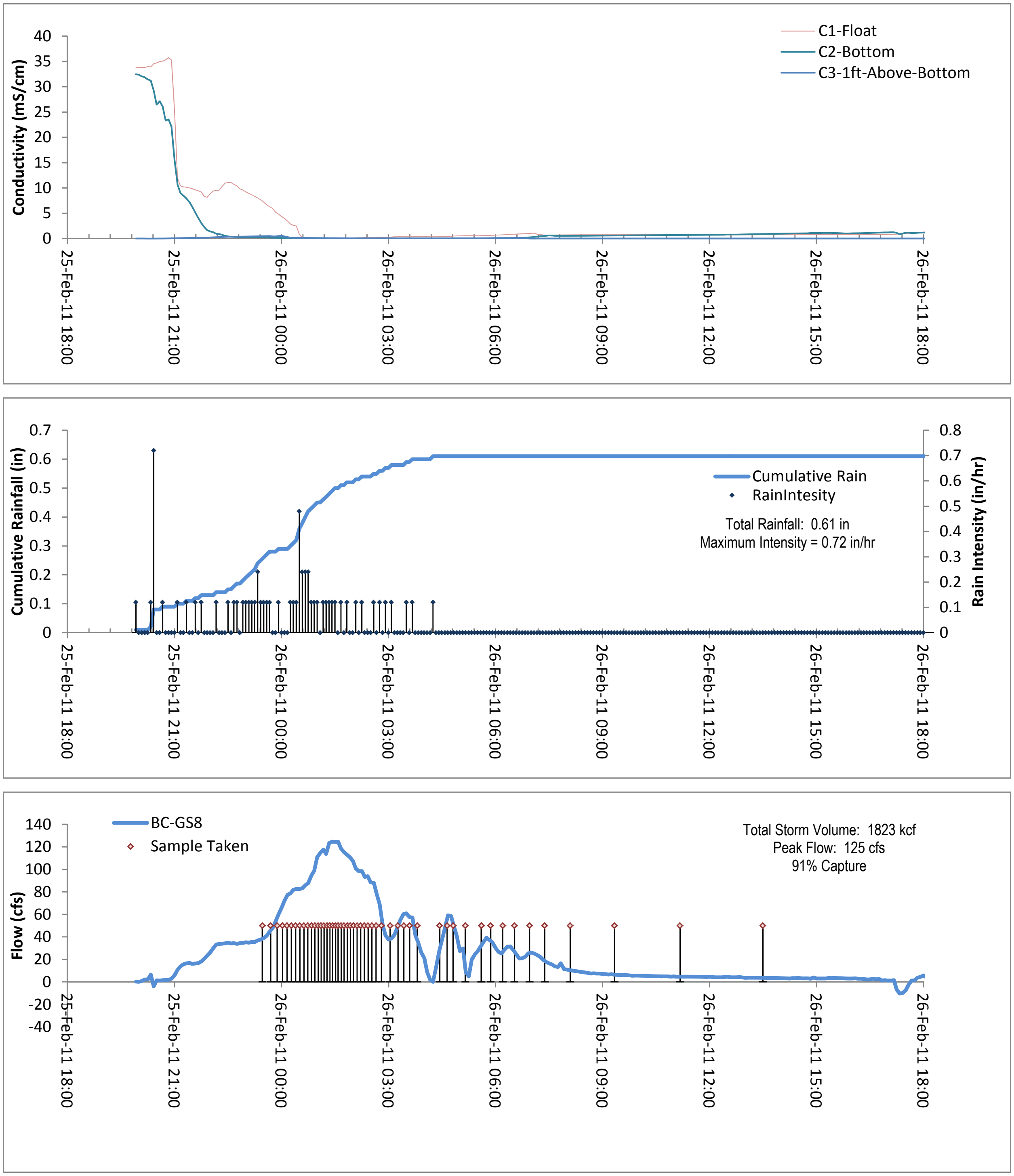


Figure 32. Rain, Flow and Salinity from Bouton Creek for Station Event 4 (February 25-26, 2010 – Global Event 8).

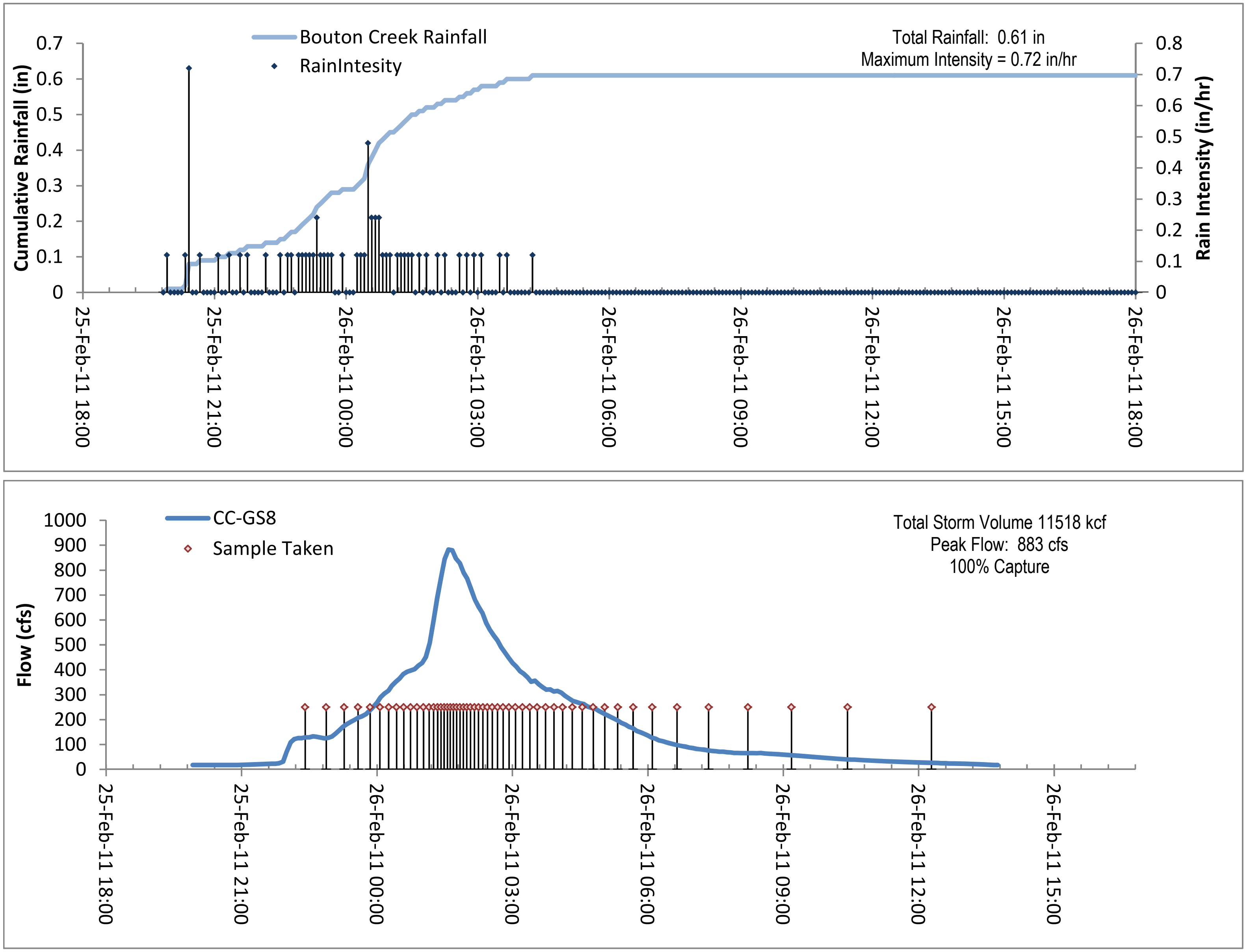


Figure 33. Rain and Flow from Los Cerritos Channel for TSS Only Station Event 4 (February 25-26, 2010 – Global Event 8).

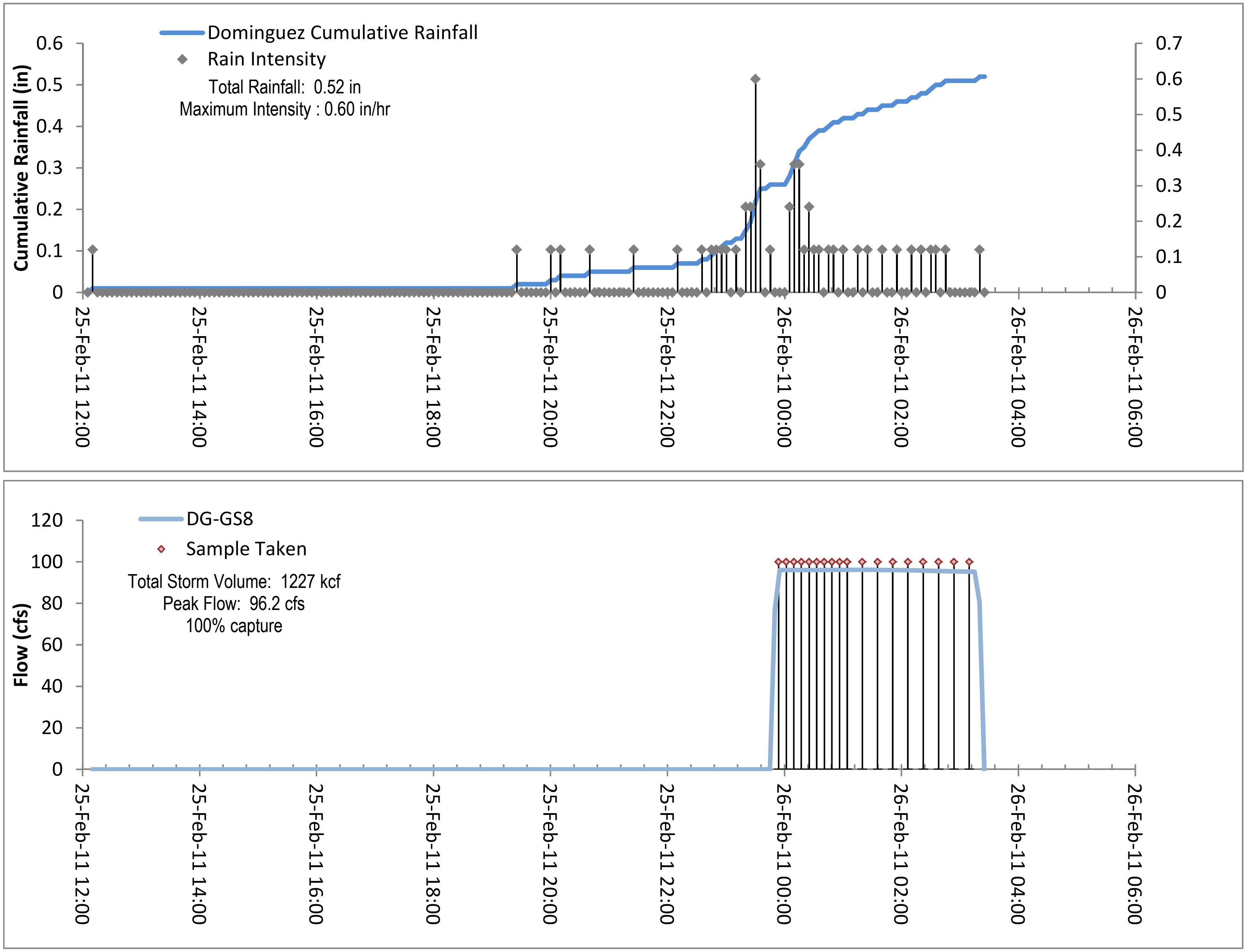


Figure 34. Rain and Discharge from the Dominguez Gap Pump Station for Station Event 2 (February 25-26, 2010 – Global Event 8).

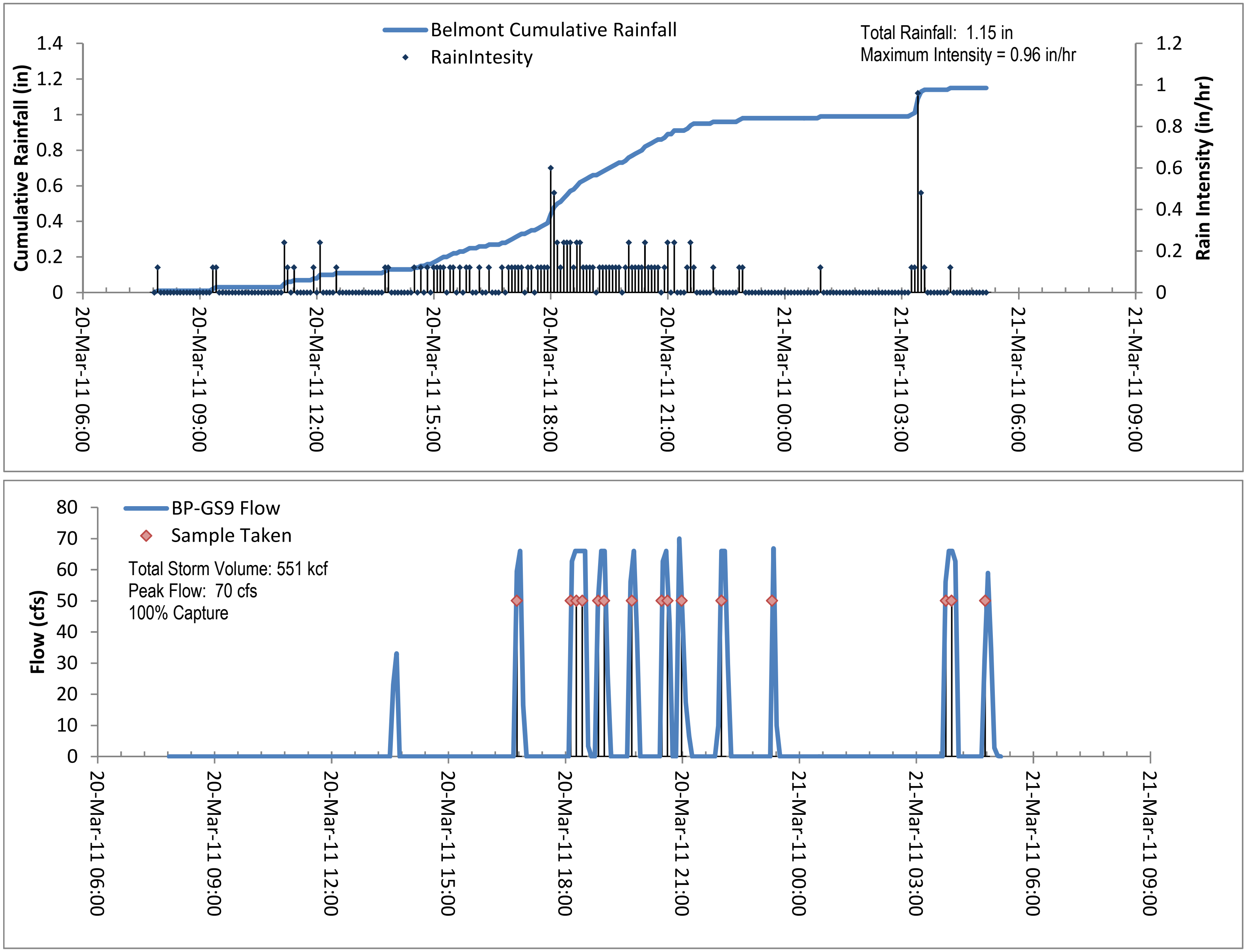


Figure 35. Rain and Flow from the Belmont Pump Station for TSS Only Station Event 3 (March 20-21, 2010 – Global Event 9).

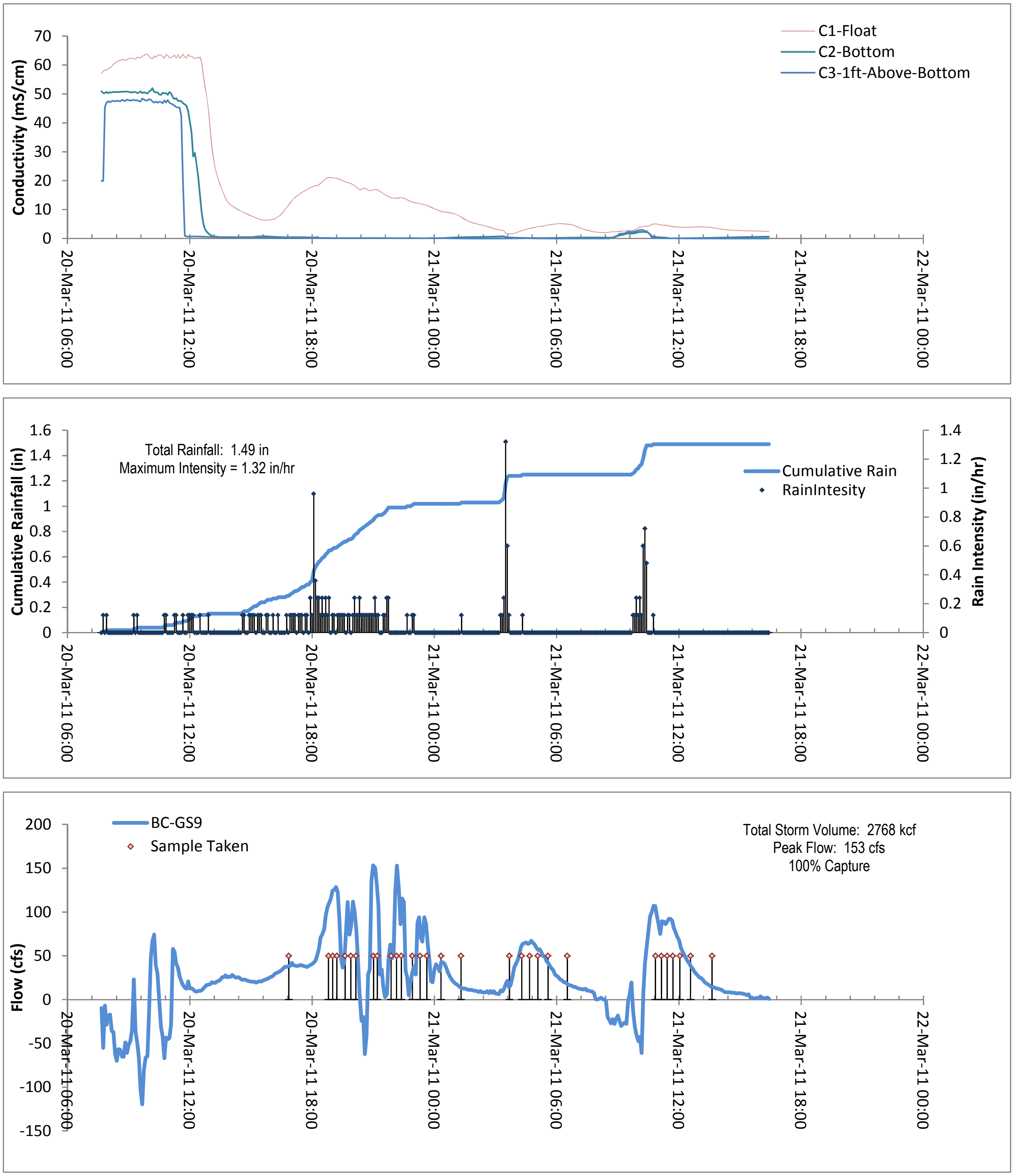


Figure 36. Rain, Flow and Salinity from Bouton Creek for TSS Only Station Event 1 (March 20-21, 2010 – Global Event 9).

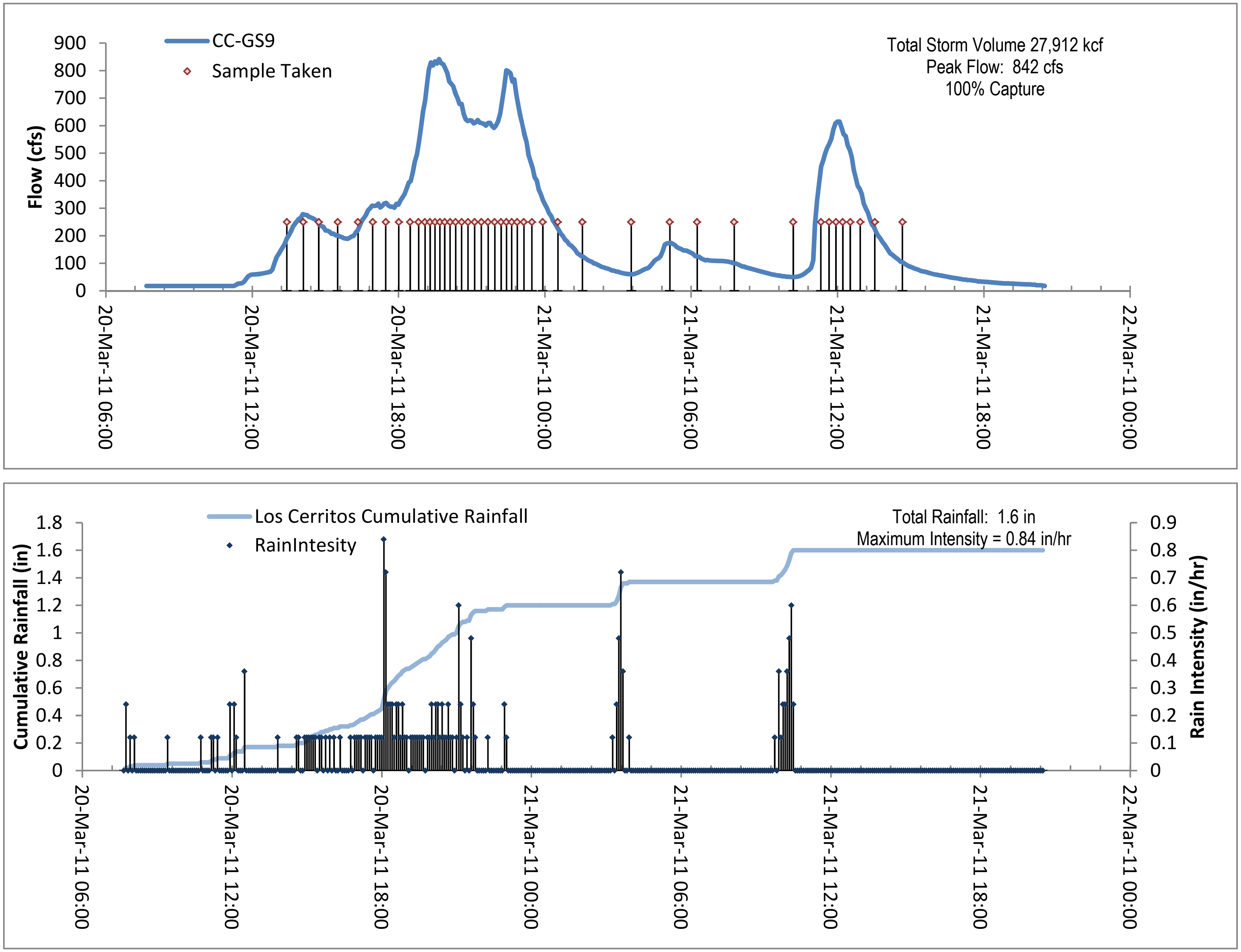


Figure 37. Rain and Flow from Los Cerritos Channel for TSS Only Station Event 5 (March 20-21, 2010 – Global Event 9).

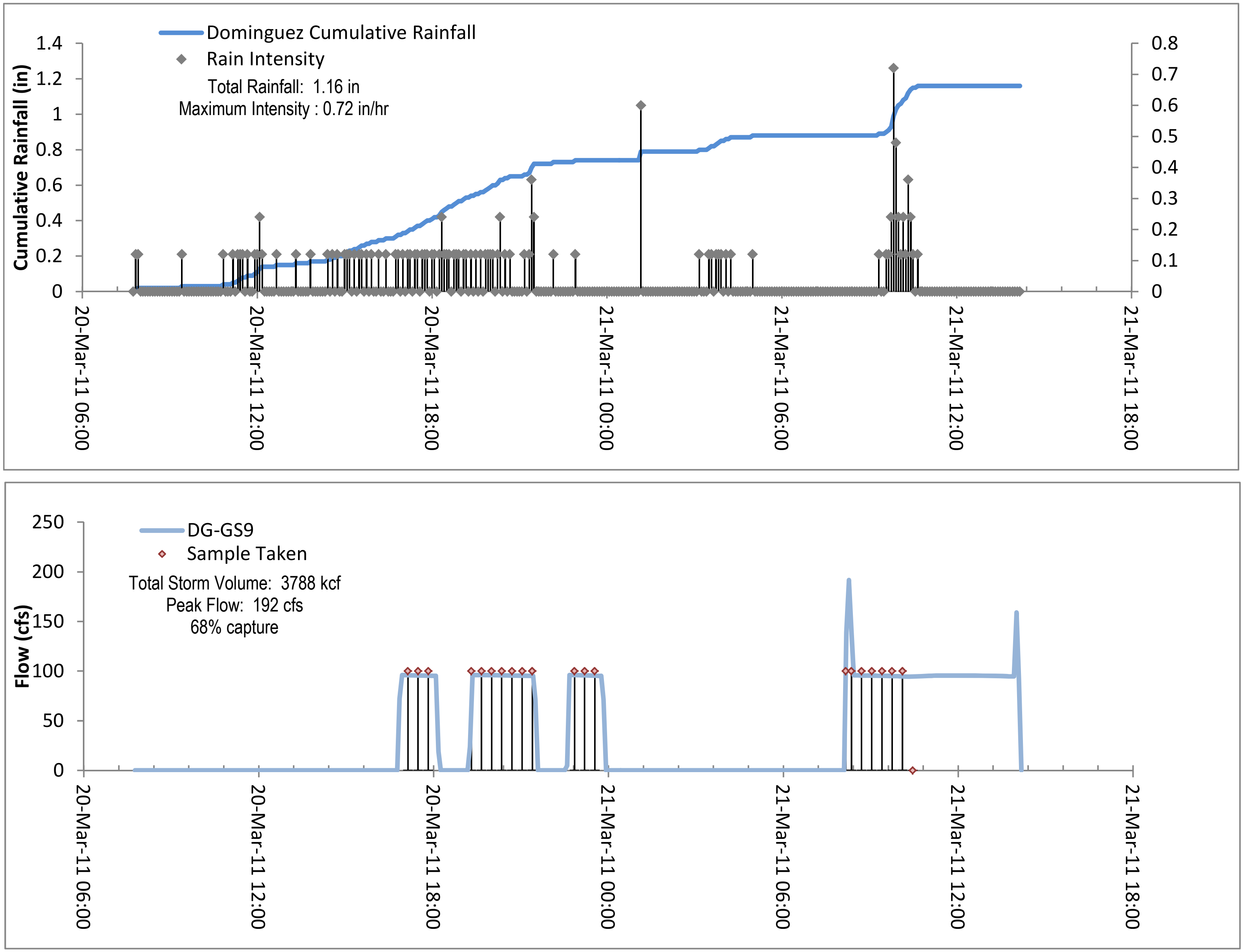


Figure 38. Rain and Discharge from the Dominguez Gap Station for Station Event 3 (March 20-21, 2010 – Global Event 9).

Table 6. Daily Rainfall Data at the Belmont Pump Station during the 2009/2010 and 2010/2011 Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	2009	2010	2009	2010	2009	2010	2010	2011	2010	2011	2010	2011	2010	2011	2009/2010	2010/2011
1	0	0	0	0	0	0	0	0	0	0	0	0	0.11	0		
2	0	0	0	0	0	0	0	0.91	0	0	0	0.06	0	0		
3	0	0	0	0	0	0	0	0.2	0	0	0.04	0	0	0		
4	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0		
5	0	0.05	0	0	0	0.44	0	0	1.42	0	0	0	0.19	0		
6	0	0.43	0	0	0	0.05	0	0	1.22	0	0.26	0	0	0		
7	0	0	0	0	1.12	0.01	0	0	0	0	0.03	0.07	0	0		
8	0	0	0	0.03	0.26	0	0	0	0	0	0	0	0	0		
9	0	0	0	0	0.14	0	0	0	0.4	0	0	0	0	0		
10	0	0	0	0	0.11	0	0	0	0	0	0	0	0	0		
11	0	0	0	0	0.05	0.01	0	0	0	0	0	0	0.09	0		
12	0	0	0	0	0.06	0	0	0	0	0	0	0	0.36	0		
13	0.15	0	0	0	0.05	0	0.1	0	0	0	0	0	0	0		
14	0.26	0	0	0	0.03	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0.03	0.02	0.02	0	0	0.02	0	0	0	0		
16	0	0	0	0	0.03	0.03	0	0	0	0.12	0	0	0	0		
17	0	0	0	0	0.02	1.04	0.26	0	0	0	0	0	0	0		
18	0	0.04	0	0	0.02	0.82	0.76	0	0	0.71	0	0	0	0		
19	0	1.01	0	0	0.01	1.84	1.71	0	0.06	0.29	0	0	0	0		
20	0	0.12	0	0.45	0.02	1.14	1.05	0.02	0.04	0.11	0	0.98	0.02	0		
21	0	0.01	0.01	0.1	0.01	1.01	0.64	0	0	0	0	0.42	0	0		
22	0	0	0	0	0	1.22	0.82	0	0	0	0	0	0.04	0		
23	0	0.08	0.01	0.02	0.01	0.02	0.01	0	0	0	0	0.67	0	0		
24	0	0.07	0	0	0	0	0	0	0.09	0	0	0.02	0	0.07		
25	0	0.02	0	0	0	0.5	0	0	0	0.25	0	0.2	0	0		
26	0	0	0	0	0	0.13	0.17	0	0	0.41	0	0	0	0		
27	0	0	0	0.12	0	0	0	0	0.73	0	0	0.22	0	0		
28	0	0	0	0	0	0	0	0	0.01	0	0	0	0.02	0		
29	0	0	0	0	0	0.88	0	0			0	0	0	0		
30	0	0.2	0	0	0.06	0	0	0.02			0	0	0	0		
31	0	0			0.01	0	0	0			0	0				
Total	0.41	2.04	0.02	0.72	2.04	9.16	5.54	1.15	3.97	1.91	0.33	2.64	0.83	0.07	13.14	17.69

Color shading depicts days water quality monitoring took place

Table 7. Daily Rainfall Data at Bouton Creek during the 2009/2010 and 2010/2011Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	2009	2010	2009	2010	2009	2010	2010	2011	2010	2011	2010	2011	2010	2011	2009/2010	2010/2011
1	0	0	0	0	0	0	0	0	0	0	0	0	0.09	0		
2	0	0	0	0	0	0	0	0.66	0	0	0	0.04	0	0		
3	0	0	0	0	0	0	0	0.14	0	0	0.05	0.01	0	0		
4	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0		
5	0	0.05	0	0	0	0.4	0	0	1.2	0	0	0	0.18	0		
6	0	0.28	0	0	0	0.05	0	0	1.36	0	0.16	0	0	0		
7	0	0	0	0	1.06	0	0	0	0	0	0.01	0.04	0	0		
8	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0		
9	0	0	0	0	0	0	0	0	0.42	0	0	0	0	0		
10	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0		
11	0	0	0	0	0.08	0.01	0	0	0	0	0	0	0.04	0		
12	0	0	0	0	0.5	0	0	0	0	0	0	0	0.46	0		
13	0.07	0	0	0	0.35	0	0.1	0	0	0	0	0	0	0		
14	0.37	0	0	0	0	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0		
16	0	0	0	0	0	0.04	0	0	0	0.13	0	0	0	0		
17	0	0.01	0	0	0	0.88	0.26	0	0	0	0	0	0	0		
18	0	0.04	0	0	0	0.73	0.95	0	0	0.51	0	0	0	0		
19	0	0.98	0	0	0	2	1.78	0	0.05	0.16	0	0	0	0		
20	0	0.03	0	0.36	0	1.33	1.17	0	0.04	0.08	0	1.02	0.02	0		
21	0	0.02	0	0.09	0	0.94	0.65	0	0	0	0	0.47	0	0		
22	0	0	0	0	0.01	0.92	0.88	0	0	0	0	0	0.03	0		
23	0	0.05	0	0.04	0	0.01	0.01	0	0	0	0	0.53	0	0		
24	0	0.08	0	0	0	0	0	0	0.05	0	0	0.04	0	0.05		
25	0	0.05	0	0	0	0.51	0	0	0	0.29	0	0.16	0	0		
26	0	0	0	0	0	0.11	0.15	0	0	0.32	0	0	0	0		
27	0	0	0	0.14	0	0	0	0	0.97	0	0	0.18	0	0		
28	0	0	0	0	0	0	0	0	0.01	0	0	0	0.04	0		
29	0	0	0	0	0	0.79	0	0			0	0	0	0		
30	0	0.18	0	0	0.06	0	0	0.04			0	0	0	0		
31	0	0			0	0	0	0			0	0				
Total	0.44	1.78	0	0.67	2.06	8.72	5.95	0.84	4.11	1.5	0.22	2.49	0.86	0.05	13.64	16.05

Color shading depicts days water quality monitoring took place

Table 8. Daily Rainfall Data at Los Cerritos Channel during the 2009/2010 and 2010/2011 Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	2009	2010	2009	2010	2009	2010	2010	2011	2010	2011	2010	2011	2010	2011	2009/2010	2010/2011
1	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0		
2	0	0	0	0	0	0	0	0.66	0	0	0	0	0	0		
3	0	0	0	0	0	0	0	0.14	0	0	0.05	0	0	0		
4	0	0	0	0	0	0	0	0	0	0	0	0.05	0	0		
5	0	0.03	0	0	0	0.45	0	0	1.18	0	0	0	0.1	0		
6	0	0.25	0	0	0	0.09	0	0	1.49	0	0.22	0	0	0		
7	0	0	0	0	1.2	0	0	0	0	0	0	0.05	0	0		
8	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0.01		
9	0	0	0	0	0	0	0	0	0.56	0	0	0	0	0		
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
11	0	0	0	0	0.11	0	0	0	0.01	0	0	0	0.03	0		
12	0	0	0	0	0.8	0	0	0	0	0	0	0	0.52	0		
13	0.03	0	0	0	0.11	0	0.12	0	0	0	0	0	0	0		
14	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0	0.01	0	0	0	0.01	0	0	0	0		
16	0	0	0	0	0	0.05	0	0	0	0.12	0	0	0	0		
17	0	0.14	0	0	0	0.86	0.28	0	0	0	0	0	0	0		
18	0	0.05	0	0	0	0.78	0.91	0	0	0.12	0	0	0	0		
19	0	0.76	0	0.04	0	1.97	1.65	0	0.06	0.05	0	0	0	0		
20	0	0.03	0	0.37	0	1.01	1.34	0	0.05	0.01	0	1.2	0.03	0		
21	0	0.03	0	0.11	0	0.77	0.84	0	0.04	0	0	0.4	0.02	0		
22	0	0	0	0	0.01	1.19	0.91	0	0.01	0	0	0	0.04	0		
23	0	0.04	0	0.02	0	0.01	0.01	0	0	0	0	0.63	0	0		
24	0	0.07	0	0.01	0	0	0	0	0.06	0	0	0.05	0	0.02		
25	0	0.09	0	0	0	0.51	0	0	0	0.3	0	0.17	0	0		
26	0	0	0	0	0	0.11	0.16	0	0	0.32	0	0	0	0		
27	0	0	0	0.12	0	0	0	0	1.01	0	0	0.1	0.01	0		
28	0	0	0	0.02	0	0	0	0	0.01	0	0	0	0.03	0		
29	0	0	0	0	0	0.79	0	0			0	0	0	0		
30	0	0.25	0	0	0.05	0	0	0.17			0	0	0	0		
31	0	0			0	0	0	0			0	0				
Total	0.28	1.74	0	0.73	2.28	8.6	6.22	0.97	4.48	0.93	0.27	2.65	0.88	0.03	14.41	15.65

Color shading depicts days water quality monitoring took place.

Table 9. Daily Rainfall Data at the Dominguez Gap Pump Station during the 2009/2010 and 2010/2011 Wet Weather Seasons

	October		November		December		January		February		March		April		Seasonal Totals	
Day	2009	2010	2009	2010	2009	2010	2010	2011	2010	2011	2010	2011	2010	2011	2009/2010	2010/2011
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
2	0	0	0	0	0	0	0	0.63	0	0	0	0.12	0	0		
3	0	0	0	0	0	0	0	0.2	0	0	0.03	0.02	0	0		
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
5	0	0	0	0	0	0.35	0	0	1.15	0	0	0	0.14	0		
6	0	0.39	0	0	0	0	0	0	1.43	0	0.26	0	0	0		
7	0	0	0	0	1.03	0	0	0	0	0	0.04	0.03	0	0		
8	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0		
9	0	0	0	0	0	0	0	0	0.35	0	0	0	0	0		
10	0	0	0	0	0.02	0	0	0	0.01	0	0	0	0	0		
11	0	0	0	0	0.07	0.04	0	0	0	0	0	0	0.59	0		
12	0	0	0	0	0.41	0	0	0	0	0	0	0	0.21	0		
13	0.08	0	0	0	0.01	0	0.19	0	0	0	0	0	0	0		
14	0.36	0	0	0	0	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0		
16	0	0	0	0	0	0.04	0	0	0	0.07	0	0	0	0		
17	0	0	0	0	0	0.4	0.25	0	0	0	0	0	0	0		
18	0	0	0	0	0	0.43	0.63	0	0	0.16	0	0	0	0		
19	0	0.44	0	0	0	1.22	1.26	0	0.06	0.09	0	0.01	0	0		
20	0	0.04	0	0.23	0	1.89	0.97	0	0.04	0.05	0	0.74	0.02	0		
21	0	0	0	0.04	0	0.98	0.38	0	0.01	0	0	0.42	0.01	0		
22	0	0	0	0	0	1.34	0.45	0	0	0	0	0	0	0		
23	0	0.07	0	0.08	0	0.04	0.01	0	0	0	0	0.46	0	0		
24	0	0.08	0	0	0	0	0	0	0.04	0	0	0.09	0	0.03		
25	0	0.08	0	0	0	0.51	0	0	0.01	0.26	0	0.1	0	0		
26	0	0	0	0	0	0.08	0.14	0	0	0.28	0	0	0	0		
27	0	0	0	0.12	0	0	0	0	0.48	0	0	0.15	0	0		
28	0	0	0	0	0	0.04	0	0	0	0	0	0	0.03	0		
29	0	0	0	0	0	0.71	0	0			0	0	0	0		
30	0	0.24	0	0	0.06	0	0	0.08			0	0	0	0		
31	0	0			0	0	0	0			0	0				
Total	0.44	1.34	0	0.51	1.6	8.07	4.28	0.91	3.58	0.92	0.33	2.14	1	0.03	11.23	13.92

Color shading depicts days water quality monitoring took place.

Table 10. Rainfall for Monitored Events during the 2010/2011 Wet-Weather Season

Site/Event	Start Date	Start Time	End Date	End 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.	10/5/2010	14:10	10/6/2010	10:20	20:10:00	0.48	0.60	176.2	0.45	Full
LOS CERRITOS CHANNEL	10/6/2010	0:35	10/6/2010	14:20	13:45:00	0.25	0.24	176.6	0.55	Full
Event 2										
BELMONT PUMP ST.	10/19/2010	5:40	10/19/2010	18:25	12:45:00	1.01	0.96	12.8	0.48	Full
BOUTON CREEK	10/19/2010	5:35	10/20/2010	4:25	22:50:00	1.00	0.84	12.8	0.33	Full
LOS CERRITOS CHANNEL	10/19/2010	5:40	10/19/2010	19:55	14:15:00	0.76	0.6	12.6	0.25	Full
Event 3										
BELMONT PUMP ST.	10/30/2010	3:40	10/30/2010	4:50	1:10:00	0.20	0.72	10.4	1.01	TSS
LOS CERRITOS CHANNEL	10/30/2010	3:25	10/30/2010	5:00	1:35:00	0.24	0.72	4.6	0.16	TSS
Event 4										
BELMONT PUMP ST.	11/20/2010	5:15	11/21/2010	6:50	25:35:00	0.55	0.96	21.0	0.20	Full
BOUTON CREEK	11/20/2010	5:15	11/21/2010	10:20	29:05:00	0.45	0.60	21.0	0.18	Full
LOS CERRITOS CHANNEL	11/19/2010	17:10	11/20/2010	11:45	18:35:00	0.41	0.96	20.5	0.24	Full
Event 5										
BELMONT PUMP ST.	12/17/2010	8:10	12/19/2010	11:10	51:00:00	2.58	0.36	11.3	0.49	Full
BOUTON CREEK	12/17/2010	9:00	12/19/2010	11:15	50:15:00	2.34	0.36	11.3	0.45	Full
LOS CERRITOS CHANNEL	12/17/2010	9:10	12/19/2010	9:45	9:47:00	2.29	0.60	11.0	0.54	Full
DOMINGUEZ PUMP ST.	12/17/2010	11:15	12/19/2010	10:04	46:48:10	1.12	N/A	11.4	0.35	Full
Event-6										
BOUTON CREEK	1/30/2011	12:05	1/30/2011	13:20	1:15:00	0.04	0.12	26.9	0.80	TSS
LOS CERRITOS CHANNEL	1/30/2011	11:50	1/30/2011	17:10	5:20:00	0.17	0.12	26.9	0.80	TSS
Event-7										
LOS CERRITOS CHANNEL	2/15/2011	23:35	2/16/2011	9:20	9:45:00	0.13	0.12	16.3	0.17	TSS
Event-8										
BELMONT PUMP ST.	2/25/2011	19:55	2/26/2011	4:25	8:30:00	0.61	0.84	5.5	1.11	TSS
BOUTON CREEK	2/25/2011	19:55	2/26/2011	4:15	8:20:00	0.61	0.72	5.5	0.75	Full
LOS CERRITOS CHANNEL	2/25/2011	19:55	2/26/2011	4:15	8:20:00	0.61	0.72	5.5	0.75	TSS
DOMINGUEZ PUMP ST.	2/25/2011	12:10	2/26/2011	3:25	15:15:00	0.52	0.60	5.3	0.30	Full
Event-9										
BELMONT PUMP ST.	3/20/2011	7:55	3/21/2011	4:15	20:20:00	1.15	0.96	21.5	0.66	TSS
BOUTON CREEK	3/20/2011	7:45	3/21/2011	7:45	24:00:00	1.49	1.32	22.1	0.61	TSS
LOS CERRITOS CHANNEL	3/20/2011	7:45	3/21/2011	10:35	26:50:00	1.6	0.84	22.1	0.61	TSS
DOMINGUEZ PUMP ST.	3/20/2011	7:50	3/21/2011	10:40	26:50:00	1.16	0.72	22.2	0.52	Full

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

CHEM = Full suite of chemical constituents only. No toxicity testing.

NS = No samples collected by autosampler.

Table 11. Descriptive Statistics - Rainfall and Flow Data for All Monitored Events (2010/2011).

Site Parameter	n	Missing Values	Min	Max	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile
BELMONT PUMP ST.									
Duration Flow (days)	7	2	0.01	1.88	0.65	0.63	0.25	0.51	0.84
Total Flow (kcf)	7	2	55	1152	405	373	177	258	508
Duration Rain (days)	7	2	0.05	2.13	0.83	0.67	0.44	0.84	0.96
Total Rain (inches)	7	2	0.20	2.58	0.94	0.79	0.52	0.61	1.08
Max Intensity (in/hr)	7	2	0.36	0.96	0.77	0.23	0.66	0.84	0.96
Antecedent Dry (days)	7	2	5.53	176	37.0	61.7	10.8	12.8	21.2
Antecedent Rain (inches)	7	2	0.20	1.11	0.63	0.33	0.47	0.49	0.84
BOUTON CREEK									
Duration Flow (days)	6	3	6.00	2.01	1.08	0.52	0.79	0.91	1.20
Total Flow (kcf)	6	3	206	9029	2710	3246	778	1915	2578
Duration Rain (days)	6	3	0.05	2.09	0.94	0.71	0.50	0.98	1.16
Total Rain (inches)	6	3	0.04	2.34	0.99	0.83	0.49	0.81	1.37
Max Intensity (in/hr)	6	3	0.12	1.32	0.66	0.41	0.42	0.66	0.81
Antecedent Dry (days)	6	3	5.54	27	16.6	8.0	11.6	16.9	21.9
Antecedent Rain (inches)	6	3	0.18	0.80	0.52	0.24	0.36	0.53	0.72
CERRITOS CREEK									
Duration Flow (days)	9	0	0.35	1.87	0.76	0.51	0.40	0.65	0.70
Total Flow (kcf)	9	0	1524	41987	11482	14074	2684	5558	11518
Duration Rain (days)	9	0	0.07	1.12	0.50	0.31	0.35	0.41	0.59
Total Rain (inches)	9	0	0.13	2.29	0.72	0.75	0.24	0.41	0.76
Max Intensity (in/hr)	9	0	0.12	0.96	0.55	0.31	0.24	0.60	0.72
Antecedent Dry (days)	9	0	4.57	177	32.9	54.4	11.0	16.3	22.1
Antecedent Rain (inches)	9	0	0.16	0.80	0.45	0.25	0.24	0.54	0.61
DOMINGUEZ GAP PUMP ST.									
Duration Flow (days)	3	6	0.15	1.00	0.66	0.45	0.49	0.84	0.92
Total Flow (kcf)	3	6	1227	3778	2809	1382	2325	3422	3600
Duration Rain (days)	3	6	0.64	1.95	1.23	0.67	0.88	1.12	1.53
Total Rain (inches)	3	6	0.52	1.16	0.93	0.36	0.82	1.12	1.14
Max Intensity (in/hr)	2	7	0.60	0.72	0.66	0.08	0.63	0.66	0.69
Antecedent Dry (days)	3	6	5.30	22.2	13.0	8.55	8.34	11.4	16.8
Antecedent Rain (inches)	3	6	0.30	0.52	0.39	0.12	0.33	0.35	0.44

Table 12. Rainfall and Flow Data for all Monitored Events during the 2010/2011 wet season.

Site/Event	Start Date	Start Time	Start Date	Start Time	Duration (hrs:mins)	Total Flow (kcf)	No. of Sample Aliquots Collected	Peak 5-Minute Average Fresh Flow (cfs)	% Storm Capture	Peak Capture	Sampling Code
Event 1											
BELMONT PUMP ST.	10/6/2010	6:50	10/6/2010	12:20	5:30:00	143	9	66	100%	Yes	Full
LOS CERRITOS CHANNEL	10/6/2010	3:20	10/6/2010	20:15	16:55:00	2684	12	133	100%	Yes	Full
Event 2											
BELMONT PUMP ST.	10/19/2010	7:35	10/19/2010	19:50	12:15:00	464	26	66	93%	Yes	Full
BOUTON CREEK	10/19/2010	9:15	10/20/2010	4:15	19:00:00	2006	42	192	84%	Yes	Full
LOS CERRITOS CHANNEL	10/19/2010	11:10	10/20/2010	2:50	15:40:00	5558	25	395	100%	Yes	Full
Event 3											
BELMONT PUMP ST.	10/30/2010	4:45	10/30/2010	5:05	0:20:00	55	3	66	100%	Yes	TSS
LOS CERRITOS CHANNEL	10/30/2010	4:40	10/30/2010	14:10	9:30:00	3473	15	331	100	Yes	TSS
Event 4											
BELMONT PUMP ST.	11/20/2010	7:35	11/21/2010	8:25	24:50:00	211	14	66	100%	Yes	Full
BOUTON CREEK	11/20/2010	10:30	11/21/2010	16:45	30:15:00	430	9	48	86%	Yes	Full
LOS CERRITOS CHANNEL	11/20/2010	8:15	11/21/2010	16:00	31:45:00	6142	25	314	89%	Yes	Full
Event 5											
BELMONT PUMP ST.	12/17/2010	13:00	12/19/2010	10:05	45:05:00	1152	28	84	100%	Yes	Full
BOUTON CREEK	12/17/2010	12:40	12/19/2010	12:59	48:19:00	9029	52	183	93%	Yes	Full
LOS CERRITOS CHANNEL	12/17/2010	12:50	12/19/2010	9:47	44:57:00	41987	74	912	94%	Yes	Full
DOMINGUEZ PUMP ST	12/18/2010	15:55	12/19/2010	12:00	20:05:00	3422	36	191	73%	Yes	Full
Event 6											
BOUTON CREEK	1/30/2011	13:45	1/31/2011	3:20	13:35:00	206	4	72	97%	Yes	TSS
LOS CERRITOS CHANNEL	1/30/2011	13:15	1/30/2011	21:35	8:20:00	1524	4	186	95%	Yes	TSS
Event 7											
LOS CERRITOS CHANNEL	2/16/2011	5:40	2/16/2011	16:55	11:15:00	2544	11	134	100%	Yes	TSS
Event 8											
BELMONT PUMP ST.	2/25/2011	23:40	2/26/2011	6:05	6:25:00	258	17	66	100%	Yes	TSS
BOUTON CREEK	2/25/2011	21:55	2/26/2011	17:10	19:15:00	1823	47	125	91%	Yes	Full
LOS CERRITOS CHANNEL	2/25/2011	21:00	2/26/2011	13:45	16:45:00	11518	53	883	100%	Yes	TSS
DOMINGUEZ PUMP ST	2/25/2011	23:50	2/26/2011	3:25	3:35:00	1227	18	96	100%	Yes	Full
Event 9											
BELMONT PUMP ST.	3/20/2011	13:35	3/21/2011	5:10	15:35:00	551	15	70	100%	Yes	TSS
BOUTON CREEK	3/20/2011	15:35	3/21/2011	16:00	24:25:00	2768	30	153	100%	Yes	TSS
LOS CERRITOS CHANNEL	3/20/2011	11:00	3/20/2011	20:30	9:30:00	27912	45	842	100%	Yes	TSS
DOMINGUEZ PUMP ST	3/20/2011	16:50	3/21/2011	16:50	24:00:00	3778	20	192	68%	Yes	Full

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

CHEM = Sampled for the full suite of chemical constituents only. No toxicity testing.
NS = No samples collected by autosampler.

THIS PAGE INTENTIONALLY LEFT BLANK

CHEMISTRY RESULTS

The following sections separately summarize the results of wet weather and dry weather monitoring efforts.

WET WEATHER CHEMISTRY RESULTS

A total of nine storm events were monitored during the 2010/2011 season (Table 13). Four full storm events were monitored at each of the Belmont Pump, Bouton Creek, and Los Cerritos Channel mass emission stations. Three full storm events were successfully monitored at the Dominguez Gap Pump Station. In addition, two TSS events were monitored at the Bouton Creek mass emission site, three at the Belmont Pump Station and five at the Los Cerritos Channel site

The results of the chemical analysis of these composite and grab stormwater samples are summarized in Table 14 through Table 17. Data from events monitored only for TSS are summarized in Table 18. 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 (**Toxicity Results**).

One unique feature of this past season was the incorporation of pyrethroid pesticides. Analysis of pyrethroid pesticides was incorporated in the middle of the storm season when CRG Marine Laboratories, who had conducted all organic analyses since the early part of the program, suddenly was not accepting samples. CalTest was selected to conduct the organic testing for the remainder of the year. 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 also is the analytical method for pyrethroid pesticides. As the pyrethroid pesticides are rapidly emerging as some of the most important contaminants of concern, we chose 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. At the same time, analysis of the triazine pesticides was eliminated in accordance with recommendations provided in the last three annual reports.

WET WEATHER LOAD CALCULATIONS

Estimates of total pollutant loads associated with stormwater runoff during each storm event are provided in Table 19 through Table 22. Constituents included in these tables are limited to those that had measureable loads during at least one event at one of the four monitoring sites.

Load calculations were made by multiplying the measured concentration times the total stormwater discharge along with the appropriate unit conversion factors. Note that load calculations are now provided in kilograms instead of pounds. The database is in the process of conversion to metric in order to provide standard units for all data. The following calculation is an example of the process used for analytes such as TSS that are measured in mg/L. The specific example is for the first storm event at the Los Cerritos Channel mass emission monitoring station.

(1100 mg/L) x [(2684 kcf)(28317 L/kcf)] x (1 kg/10^6 mg) = 83,603 kilograms

Consistent with sound scientific practice, total pollutant loads are reported to two significant figures since all chemical data are also reported to two significant figures. Thus the TSS load for the first monitored event at the Los Cerritos Channel is reported as 84,000 kilograms or 42 metric tons of sediment.

As one would expect, pollutant loads are largely controlled by the size of the watershed. Over the past eleven years, the Los Cerritos Channel (Table 21) has consistently produced the highest overall loads of solids and total metals simply due to the large size of the watershed and lack of infiltration capacity.

Pollutant loads are consistently lowest at the Belmont Pump Station (Table 19) which has the smallest catchment area. This site was estimated to discharge 700 to 5,000 pounds of solids in association with the five events. The load of total copper discharged from the Belmont Pump Station during these monitored events was estimated at 0.32 and 1.5 pounds.

Historically, loading estimates for solids from the Dominguez Gap Pump Station were substantially lower than all other sites. It is now common for total solid loads to be similar or even exceed those measured at the Belmont Pump Station. Solids loading during the first two storm events at these two sites were comparable (Table 19 and Table 22). During the last two events, solids loading from the Dominguez Gap monitoring site were 7 to 8 times higher than those measured at the Belmont Pump Station.

Historically, estimated loads of total recoverable metals such as copper and lead from the Dominguez Gap Pump Station were also the lowest encountered at all mass emission sites but since the reconfiguration of the Pump Station to accommodate development of the wetlands, metal loads estimated for the Dominguez Gap have increased to levels similar or higher than those measured at the Belmont Pump Stations. As part of that change, the area of the watershed served by this pump station was approximately halved. In both the case of suspended solids and metals, the major increases in loads occurred in association with the latter two storm events when water levels in the forebay were relatively high (9.6 to10.6 feet) before the storms started.

DRY WEATHER CHEMISTRY RESULTS

The NPDES Permit requires that two dry weather inspections and sampling events are to be conducted each year. These surveys are conducted during the summer dry weather period at each of the four mass emission stations. A total of 24 dry weather surveys have been conducted since issuance of the permit in 1999 (Table 24). Events 23 and 24, which were conducted during the 2010/2011 season, are shaded in Table 24. Field measurements are provided in Table 25 for the 2010/2011 season. Chemical analyses performed in the laboratory are summarized in Table 26 through Table 28 for the 2010/2011 season.

Dry weather flow at the Belmont Pump Station continues to be pumped into the sanitary sewer system for treatment. For several seasons this diversion was accomplished by use of a temporary pump, which was in place during the dry weather season. In December, 2009 a permanent low-flow diversion system was installed to divert all low flow, not just dry weather flow, to the sanitary system. Since this site no longer discharges dry weather flow to the receiving waters, no water samples or field measurements were 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 2010/2011 dry weather events. The inspections occurred 2-3 hours after the low-low tide of the day when the salt water had receded and the channel had been flushed by fresher, low flows for a period. During these periods, flow in the creek was not impeded by seawater backing into the creek. In early years the flow was usually freshwater flowing downstream and the volume of fresh flow had been sufficient to flush residual saltwater from the channel.

During the May and July, 2008 and the May, 2009 inspections no samples were collected. Flow was very low during those inspections. Portions of the crown of the channel bottom were exposed, and there was extensive algae growth across the entire bottom. The salinity of the flow never fell below 10.8 ppt before the incoming tidal flows reached the site.

The sampling location was changed for the 2009/2010 and 2010/2011 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 saline there. This is thought to be due to the lack of sea water soaked algae in the channel below the parking lot. 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, 2010 and May 10, 2011

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, 2010 and was completed September 23, 2010. Sampling for the second event began on May 10, 2011 and ended on May 11th. 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 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 subsampled. Grab samples were manually collected for oil and grease and bacteria during the 24-hour sampling on September 22nd and at the end of the 24-hour sampling on May 10th.

Dominguez Gap Monitoring Site

Inspections and sampling for dry weather flow were conducted at the Dominguez Gap Pump Station on September 22-23, 2010, and on May 10-11, 2011. During the both events the sump pump was in continuous operation during the 24-hour sampling effort.

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 LA 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 draw the water level down in the basin.

Table 13. Monitored Storm Events, 2010/2011.

Global Event	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7	Event 8	Event 9
Date	6-Oct-10	19-Oct-10	30-Oct-10	20-Nov-10	18-Dec-10	30-Jan-11	16-Feb-11	26-Feb-11	21-Mar-11
Belmont Pump	S1	S2	TSS1	S3	S4			TSS2	TSS3
Bouton Creek	NS	S1	NS	S2	S3	TSS1		S4	TSS2
Los Cerritos Channel	S1	S2	TSS1	S3	S4	TSS2	TSS3	TSS4	TSS5
Dominguez Gap	NS	NS	NS	NS	S1			S2	S3

Sx=Full Storm Composites – "x" indicates sequential monitored event at each site
TSS=Storm Events monitored for TSS only

Table 14. Belmont Pump Stormwater Chemistry Results, 2010/2011.

Analyte	Oct 5-6, 2010	Oct 19, 2010	Nov 20-21, 2010	Dec 17-19, 2010
Conventionals (mg/L unless otherwise noted)				
pH *(pH units)*	8.02	8.05	7.26	7.55
Alkalinity as CaCO3	89	36	57	39
Biochemical Oxygen Demand	28	13	9.8	4.7
Chemical Oxygen Demand	230	130	140	34
Chloride	97	25	76	22
Conductivity *(uS/cm)*	550	200	390	160
Fluoride	0.52	0.21	0.18	0.079J
Hardness as CaCO3	84	34	47	25
MBAS	0.49	0.14	0.37	0.073
Nitrate (as N)	1.1	0.89	0.51	0.33
Nitrite (as N)	0.16	0.024J	0.1U	0.1U
Oil and Grease	NA	5U	2.9J	2.2J
Total Ammonia (as N)	0.39	0.56	0.34	0.25
Total Dissolved Solids	350	150	220	89
Total Kjeldahl Nitrogen	1.9	3.3	3.2	2.2
Total Organic Carbon	43	17	14	15
Orthophosphate (as P)	0.4	0.26	0.23	0.26
Total Phosphorus	1.6	0.95	0.77	0.73
Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U
Total Suspended Solids	300	210	190	55
Volatile Suspended Solids	100	70	50	21
Turbidity *(NTU)*	120	97	60	29
Dissolved Metals (ug/L)				
Aluminum	31	25	3.7J	15J
Arsenic	2.6	1.5	1.2	1
Cadmium	0.05J	0.028J	0.07J	0.037J
Chromium	7.7	1.5	0.6	0.74
Copper	**14** [3,4]	**10** [3,4]	**8.2** [3,4]	**5.5** [3,4]
Iron	120	64	61	35
Lead	1.1	0.99	0.83	0.7
Nickel	10	3.5	3.4	1.5
Selenium	0.28J	0.15J	1U	1U
Silver	0.2U	0.2U	0.014J	0.2U
Zinc	17	18	25	31
Total Metals (ug/L)				
Aluminum	**5500** [2,5]	**4400** [2]	**3000** [2,5]	**930** [5]
Arsenic	6	3.9	3.1	1.5
Cadmium	1.3	0.91	0.63	0.23
Chromium	**760** [2]	**130** [2]	**56** [2]	6.6
Copper	**140** [1]	**84** [1]	**61** [1]	**21** [1]
Iron	9400	7100	4700	1500
Lead	**71** [1]	**52** [1]	**34** [1]	**11** [1]
Nickel	**110** [1,2]	**34** [1]	17	4.5
Selenium	0.45J	0.35J	1U	1U
Silver	0.29	0.19J	0.2	0.2U
Zinc	**660** [1]	**440** [1]	**310** [1]	**120** [1]

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5= National Non Priority Pollutant Fresh Water CMC, 6=National Non Priority Pollutant Salt Water CMC.

U=not detected at the detection 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. NA-not analyzed

Table 14. Belmont Pump Stormwater Chemistry Results, 2010/2011. (Continued).

Analyte	Oct 5-6, 2010	Oct 19, 2010	Nov 20-21, 2010	Dec 17-19, 2010
Microbiology				
Enterococcus *(CFU/100 ml)*		86000 [1,2]	6000 [1,2]	4200 [1,2]
Fecal Coliform *(MPN/100 ml)*		160000 [1,2]	11000 [1,2]	16000 [1,2]
Total Coliform *(MPN/100 ml)*		160000J [1,2]	30000 [1,2]	160000 [1,2]
Aroclors (ug/L)				
Aroclor 1016	0.0213U	0.0222U	0.12U	0.11U
Aroclor 1221	0.0213U	0.0222U	0.12U	0.11U
Aroclor 1232	0.0213U	0.0222U	0.12U	0.11U
Aroclor 1242	0.0213U	0.0222U	0.12U	0.11U
Aroclor 1248	0.0213U	0.0222U	0.12U	0.11U
Aroclor 1254	0.0213U	0.0222U	0.12U	0.11U
Aroclor 1260	0.0213U	0.0222U	0.12U	0.11U
Total Aroclors	0	0	0	0
Chlorinated Pesticides (ug/L)				
2,4'-DDD	0.00532U	0.00556U	0.006U	0.006U
2,4'-DDE	0.00532U	0.00556U	0.006U	0.006U
2,4'-DDT	0.00532U	0.00556U	0.006U	0.006U
4,4'-DDD	0.00532U	0.00556U	0.006U	0.006U
4,4'-DDE	0.00706	0.00556U	0.006U	0.006U
4,4'-DDT	0.00532U	0.00556U	0.006U	0.006U
Total DDT	0.00706	0	0	0
Aldrin	0.00532U	0.00556U	0.006U	0.006U
Dieldrin	0.00532U	0.00556U	0.006U	0.006U
Endrin	0.00532U	0.00556U	0.006U	0.006U
Endrin aldehyde	0.00532U	0.00556U	0.006U	0.006U
Endrin ketone	0.00532U	0.00556U	0.006U	0.006U
alpha-BHC	0.00532U	0.00556U	0.006U	0.006U
beta-BHC	0.00532U	0.00556U	0.006U	0.006U
delta-BHC	0.00532U	0.00556U	0.006U	0.006U
gamma-BHC (Lindane)	0.00532U	0.00556U	0.006U	0.006U
Endosulfan I	0.00532U	0.00556U	0.006U	0.006U
Endosulfan II	0.00532U	0.00556U	0.006U	0.006U
Endosulfan sulfate	0.00532U	0.00556U	0.006U	0.006U
alpha-Chlordane	0.0147	0.0247	0.006U	0.006U
gamma-Chlordane	0.0159	0.0227	0.039	0.006U
Heptachlor	0.00532U	0.00556U	0.006U	0.006U
Heptachlor epoxide	0.00532U	0.00556U	0.006U	0.006U
Oxychlordane	0.00532U	0.00556U	0.0061U	0.0057U
cis-Nonachlor	0.00456	0.00824	0.0061U	0.0057U
trans-Nonachlor	0.0112	0.0164	0.0061U	0.0057U
Total Chlordane	0.04636	0.07204	0.039	0
Methoxychlor	0.00532U	0.00556U	0.006U	0.006U
Mirex	0.00532U	0.00556U	0.061U	0.057U
Toxaphene	0.0131 [1]	0.0133 [1]	0.6U	0.6U
Trichloronate	0.00213U	0.00222U	0.06U	0.06U

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5= National Non Priority Pollutant Fresh Water CMC, 6=National Non Priority Pollutant Salt Water CMC.

U=not detected at the detection 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, NA-not analyzed.

Table 14. Belmont Pump Stormwater Chemistry Results, 2010/2011. (Continued).

Analyte	Oct 5-6, 2010	Oct 19, 2010	Nov 20-21, 2010	Dec 17-19, 2010
Organophosphates (ug/L)				
Bolstar (Sulprofos)	0.00426U	0.00444U	0.2U	0.2U
Chlorpyrifos	0.00213U	0.00222U	0.0036	0.001J
Demeton	0.00213U	0.00222U	0.5U	0.5U
Diazinon	0.00426U	0.00444U	0.0015U	0.0007J
Dichlorvos	0.00638U	0.00667U	0.2U	0.2U
Dimethoate	0.00638U	0.00667U	0.6U	0.6U
Disulfoton	0.00213U	0.00222U	0.1U	0.1U
Ethoprop	0.00213U	0.00222U	0.2U	0.2U
Fensulfothion	0.00213U	0.00222U	0.6U	0.6U
Fenthion	0.00426U	0.00444U	0.06U	0.06U
Malathion	0.0539	0.119	0.06U	0.06U
Merphos	0.00213U	0.00222U	0.06U	0.06U
Methyl Parathion	0.00213U	0.00222U		
Mevinphos	0.017U	0.0178U	0.1U	0.1U
Phorate	0.0128U	0.0133U	0.06U	0.06U
Tetrachlorvinphos (Stirophos)	0.00426U	0.00444U	0.2U	0.2U
Tokuthion (Prothiofos)	0.00638U	0.00667U	0.06U	0.06U
Trichloronate	0.00213U	0.00222U	0.06U	0.06U
Triazine (ug/L)				
Ametryn	0.0106U	0.0111U		
Atraton	0.0106U	0.0111U		
Atrazine	0.0106U	0.0111U		
Cyanazine	0.0106U	0.0111U		
Prometon	0.0106U	0.0305		
Prometryn	0.0106U	0.0111U		
Propazine	0.0106U	0.0111U		
Secbumeton	0.0106U	0.0111U		
Simazine	0.0106U	0.0111U		
Simetryn	0.0106U	0.0111U		
Terbutryn	0.0106U	0.0111U		
Terbutylazine	0.0106U	0.0111U		
Pyrethroids (ug/L)				
Bifenthrin			0.348	0.112
Cyfluthrin			0.055	0.018
Cypermethrin			0.021	0.0068
Fenpropathrin			0.0015U	0.0015U
L-Cyhalothrin			0.0077	0.003
Permethrin			0.253	0.059
Total Deltamethrin/Tralomethrin			0.047	0.0085
Total Esfenvalerate/Fenvalerate			0.0028	0.0011J

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5= National Non Priority Pollutant Fresh Water CMC, 6=National Non Priority Pollutant Salt Water CMC.

U=not detected at the detection 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.

Table 15. Bouton Creek Stormwater Chemistry Results, 20010/2011.

Analyte	Oct 19-20, 2011	Nov 20-21, 2010	Dec 17-19, 2010	Feb 25-26, 2011
Conventionals (mg/L unless otherwise noted)				
pH *(pH units)*	8.53 [2]	7.63	7.38	8.26
Alkalinity as CaCO3	33	24	17	22
Biochemical Oxygen Demand	15U	7	3.5	4.2
Chemical Oxygen Demand	130	130	36	63
Chloride	42	340	11	24
Conductivity *(uS/cm)*	240	1200	88	130
Fluoride	0.22	0.25	0.07J	0.062J
Hardness as CaCO3	37	110	16	19
MBAS	0.19	0.35	0.065	0.12
Nitrate (as N)	0.97	0.63	0.21	0.2
Nitrite (as N)	0.025J	0.1U	0.1U	0.1U
Oil and Grease	12	2J	1.2J	6.3
Total Ammonia (as N)	0.96	0.59	0.14	0.18
Total Dissolved Solids	170	650	50	78
Total Kjeldahl Nitrogen	3.5	2	0.64	0.78
Total Organic Carbon	18	19	9	6.3
Orthophosphate (as P)	0.21	0.15	0.14	0.08
Total Phosphorus	0.79	0.27	0.25	0.2
Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U
Total Suspended Solids	200	54	31	32
Volatile Suspended Solids	61	16	11	13
Turbidity *(NTU)*	82	51	22	20
Dissolved Metals (ug/L)				
Aluminum	24J	12J	13J	5.7J
Arsenic	1.2	1.1	0.91	0.74
Cadmium	0.092J	0.092J	0.061J	0.036J
Chromium	1.5	5.4	1.3	0.5U
Copper	9.9 [3,4]	12 [3,4]	4.9 [3,4]	3.9 [3]
Iron	69	69	23	5.9J
Lead	1.8 [3]	1.5	0.37	0.41
Nickel	3.3	4.7	1.3	0.2J
Selenium	1U	1U	1U	1U
Silver	0.2U	0.2U	0.2U	0.052J
Zinc	48	34	29 [3]	28
Total Metals (ug/L)				
Aluminum	3500 [2,5]	1400 [2,5]	740	730
Arsenic	2.9	1.8	1.3	0.99
Cadmium	0.75	0.25	0.22	0.15J
Chromium	9.8	15	4.1	1.6
Copper	60 [1]	25 [1]	15 [1]	11
Iron	5100	1900	1100	930
Lead	30 [1]	9.1 [1]	5.4	5.8
Nickel	10	7.6	2.7	1.3
Selenium	0.45J	1U	1U	1U
Silver	0.11J	0.044J	0.2U	0.023J
Zinc	330 [1]	110 [1]	80	77

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5= National Non Priority Pollutant Fresh Water CMC, 6=National Non Priority Pollutant Salt Water CMC.

U=not detected at the detection 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.

Table 15. Bouton Creek Stormwater Chemistry Results, 2010/2011. (Continued).

Analyte	Oct 19-20, 2011	Nov 20-21, 2010	Dec 17-19, 2010	Feb 25-26, 2011
Microbiology				
Enterococcus *(CFU/100 ml)*	49000 [1,2]	9800 1,2	3600 [1,2]	5500 [1,2]
Fecal Coliform *(MPN/100 ml)*	23000 [1,2]	17000 1,2	22000 [1,2]	22000 [1,2]
Total Coliform *(MPN/100 ml)*	80000J [1,2]	110000 1,2	90000 [1,2]	54000 [1,2]
Aroclors (ug/L)				
Aroclor 1016	0.0206U	0.11U	0.12U	0.1U
Aroclor 1221	0.0206U	0.11U	0.12U	0.1U
Aroclor 1232	0.0206U	0.11U	0.12U	0.1U
Aroclor 1242	0.0206U	0.11U	0.12U	0.1U
Aroclor 1248	0.0206U	0.11U	0.12U	0.1U
Aroclor 1254	0.0206U	0.11U	0.12U	0.1U
Aroclor 1260	0.0206U	0.11U	0.12U	0.1U
Total Aroclors	0	0	0	0
Chlorinated Pesticides (ug/L)				
2,4'-DDD	0.00515U	0.006U	0.006U	0.005U
2,4'-DDE	0.00515U	0.006U	0.006U	0.005U
2,4'-DDT	0.00515U	0.006U	0.006U	0.005U
4,4'-DDD	0.00515U	0.006U	0.006U	0.005U
4,4'-DDE	0.00515U	0.006U	0.006U	0.005U
4,4'-DDT	0.00515U	0.006U	0.006U	0.005U
Total DDT	0	0	0	0
Aldrin	0.00515U	0.006U	0.006U	0.005U
Dieldrin	0.00515U	0.006U	0.006U	0.005U
Endrin	0.00515U	0.006U	0.006U	0.005U
Endrin aldehyde	0.00515U	0.006U	0.006U	0.005U
Endrin ketone	0.00515U	0.006U	0.006U	0.005U
alpha-BHC	0.00515U	0.006U	0.006U	0.005U
beta-BHC	0.00515U	0.006U	0.006U	0.005U
delta-BHC	0.00515U	0.006U	0.006U	0.005U
gamma-BHC (Lindane)	0.00515U	0.006U	0.006U	0.005U
Endosulfan I	0.00515U	0.006U	0.006U	0.005U
Endosulfan II	0.00515U	0.006U	0.006U	0.005U
Endosulfan sulfate	0.00515U	0.006U	0.006U	0.005U
alpha-Chlordane	0.00204	0.006U	0.006U	0.005U
gamma-Chlordane	0.00515U	0.006U	0.006U	0.005U
Heptachlor	0.00515U	0.006U	0.006U	0.005U
Heptachlor epoxide	0.00515U	0.006U	0.006U	0.005U
Oxychlordane	0.00515U	0.0056U	0.0059U	0.0058U
cis-Nonachlor	0.00515U	0.0056U	0.0059U	0.0058U
trans-Nonachlor	0.0016	0.0056U	0.0059U	0.012U
Total Chlordane	0.00364	0	0	0
Methoxychlor	0.00515U	0.006U	0.006U	0.005U
Mirex	0.00515U	0.056U	0.059U	0.05U
Toxaphene	0.0515U	0.6U	0.6U	0.5U

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5= National Non Priority Pollutant Fresh Water CMC, 6=National Non Priority Pollutant Salt Water CMC.

U=not detected at the detection 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.

Table 15. Bouton Creek Stormwater Chemistry Results, 2010/2011. (Continued).

Analyte	Oct 19-20, 2011	Nov 20-21, 2010	Dec 17-19, 2010	Feb 25-26, 2011
Organophosphates (ug/L)				
Bolstar (Sulprofos)	0.00412U	0.2U	0.2U	0.2U
Chlorpyrifos	0.00206U	0.0023	0.0005J	0.0007J
Demeton	0.00206U	0.5U	0.5U	0.5U
Diazinon	0.00412U	0.0019	0.0008J	0.012
Dichlorvos	0.00619U	0.2U	0.2U	0.2U
Dimethoate	0.00619U	0.6U	0.6U	0.5U
Disulfoton	0.00206U	0.1U	0.1U	0.1U
Ethoprop	0.00206U	0.2U	0.2U	0.2U
Fensulfothion	0.00206U	0.6U	0.6U	0.5U
Fenthion	0.00412U	0.06U	0.06U	0.05U
Malathion	0.0457	0.06U	0.06U	0.05U
Merphos	0.00206U	0.06U	0.06U	0.05U
Methyl Parathion	0.00206U			
Mevinphos	0.0165U	0.1U	0.1U	0.1U
Phorate	0.0124U	0.06U	0.06U	0.05U
Tetrachlorvinphos (Stirophos)	0.00412U	0.2U	0.2U	0.2U
Tokuthion (Prothiofos)	0.00619U	0.06U	0.06U	0.05U
Trichloronate	0.00206U	0.06U	0.06U	0.05U
Triazine (ug/L)				
Ametryn	0.0103U			
Atraton	0.0103U			
Atrazine	0.0103U			
Cyanazine	0.0103U			
Prometon	0.0337			
Prometryn	0.0103U			
Propazine	0.0103U			
Secbumeton	0.0103U			
Simazine	0.0103U			
Simetryn	0.0103U			
Terbutryn	0.0103U			
Terbutylazine	0.0103U			
Pyrethroids				
Bifenthrin		0.086	0.022	0.02
Cyfluthrin		0.0049	0.0025	0.0035
Cypermethrin		0.0034	0.0046	0.0031
Fenpropathrin		0.0015U	0.0015U	0.0015U
L-Cyhalothrin		0.0015U	0.0005J	0.0004J
Permethrin		0.092	0.033	0.046
Total Deltamethrin/Tralomethrin		0.003U	0.0007J	0.0015J
Total Esfenvalerate/Fenvalerate		0.0015U	0.0003J	0.0004J

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5= National Non Priority Pollutant Fresh Water CMC, 6=National Non Priority Pollutant Salt Water CMC.

U=not detected at the detection 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.

Table 16. Los Cerritos Channel Stormwater Chemistry Results, 2010/2011.

Analyte	Oct 6, 2011	Oct 19-20, 2011	Nov 20-21, 2010	Dec 17-19, 2010
Conventionals (mg/L unless otherwise noted)				
pH *(pH units)*	7.35	7.74	7.1	7.21
Alkalinity as CaCO3	160	48	31	20
Biochemical Oxygen Demand	60	28	14	3.9
Chemical Oxygen Demand	490	160	180	32
Chloride	21	9.2	8.7	3
Conductivity *(uS/cm)*	290	160	130	61
Fluoride	0.56	0.24	0.22	0.058J
Hardness as CaCO3	84	44	30	16
MBAS	**0.57** [2]	0.41	0.4	0.076
Nitrate (as N)	1.6	1.3	0.64	0.21
Nitrite (as N)	0.1	0.049J	0.024J	0.1U
Oil and Grease		2.9J	1.3J	1.4J
Total Ammonia (as N)	0.8	1	0.38	0.16
Total Dissolved Solids	230	160	87	33
Total Kjeldahl Nitrogen	1.3	6.8	4.1	1.1
Total Organic Carbon	64	27	21	7.6
Orthophosphate (as P)	0.32	0.24	0.19	0.12
Total Phosphorus	2.9	1.4	0.77	0.46
Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U
Total Suspended Solids	1100	540	140	52
Volatile Suspended Solids	340	140	38	13
Turbidity *(NTU)*	220	170	63	28
Dissolved Metals (ug/L)				
Aluminum	41	27	10J	22J
Arsenic	2.7	1.9	1.3	0.96
Cadmium	0.048J	0.062J	0.069J	0.049J
Chromium	1.5	1.1	1.5	0.92
Copper	**13** [3,4]	**12** [3,4]	**11** [3,4]	**4.5** [3]
Iron	160	76	46	24
Lead	2	1.6	0.77	0.35
Nickel	8.6	4.4	2.4	0.97
Selenium	0.4J	0.26J	1U	1U
Silver	0.014J	0.2U	0.012J	0.2U
Zinc	30	42	**45** [3]	**28** [3]
Total Metals (ug/L)				
Aluminum	**8500** [2,5]	**8500** [2,5]	**2600** [2,5]	**1200** [2,5]
Arsenic	8.6	6.9	2.6	1.4
Cadmium	2.2	1.9	0.62	0.2
Chromium	21	19	7.4	2.8
Copper	**150** [1]	**100** [1]	**42** [1]	12
Iron	12000	13000	3700	1600
Lead	**63** [1]	**66** [1]	**20** [1]	5.5
Nickel	**29** [1]	**24** [1]	8.4	2.7
Selenium	0.79J	0.82J	1U	1U
Silver	0.54	0.32	0.14J	0.2U
Zinc	**960** [1]	**690** [1]	**270** [1]	**85** [1]

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5= National Non Priority Pollutant Fresh Water CMC, 6=National Non Priority Pollutant Salt Water CMC.

U=not detected at the detection 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.

Table 16. Los Cerritos Channel Stormwater Chemistry Results, 2010/2011. (Continued).

Analyte	Oct 6, 2011	Oct 19-20, 2011	Nov 20-21, 2010	Dec 17-19, 2010
Microbiology				
Enterococcus *(CFU/100 ml)*		72000 [1,2]	6600 [1,2]	6900 [1,2]
Fecal Coliform *(MPN/100 ml)*		30000 [1,2]	3000 [1,2]	16000 [1,2]
Total Coliform *(MPN/100 ml)*		500000J [1,2]	24000 [1,2]	50000 [1,2]
Aroclors (ug/L)				
Aroclor 1016	0.0213U	0.025U	0.11U	0.22U
Aroclor 1221	0.0213U	0.025U	0.11U	0.22U
Aroclor 1232	0.0213U	0.025U	0.11U	0.22U
Aroclor 1242	0.0213U	0.025U	0.11U	0.22U
Aroclor 1248	0.0213U	0.025U	0.11U	0.22U
Aroclor 1254	0.0213U	0.025U	0.11U	0.22U
Aroclor 1260	0.0213U	0.025U	0.11U	0.22U
Total Aroclors	0	0	0	0
Chlorinated Pesticides (ug/L)				
2,4'-DDD	0.00532U	0.00625U	0.006U	0.011U
2,4'-DDE	0.00532U	0.00625U	0.006U	0.011U
2,4'-DDT	0.00532U	0.00625U	0.006U	0.011U
4,4'-DDD	0.00532U	0.00625U	0.006U	0.011U
4,4'-DDE	0.00515	0.00625U	0.006U	0.011U
4,4'-DDT	0.00532U	0.00625U	0.006U	0.011U
Total DDT	0.00515	0	0	0
Aldrin	0.00532U	0.00625U	0.006U	0.011U
Dieldrin	0.00532U	0.00625U	0.006U	0.011U
Endrin	0.00532U	0.00625U	0.006U	0.011U
Endrin aldehyde	0.00532U	0.00625U	0.006U	0.011U
Endrin ketone	0.00532U	0.00625U	0.006U	0.011U
alpha-BHC	0.00532U	0.00625U	0.006U	0.011U
beta-BHC	0.00532U	0.00625U	0.006U	0.011U
delta-BHC	0.00532U	0.00625U	0.006U	0.011U
gamma-BHC (Lindane)	0.00532U	0.00625U	0.006U	0.011U
Endosulfan I	0.00532U	0.00625U	0.006U	0.011U
Endosulfan II	0.00532U	0.00625U	0.006U	0.011U
Endosulfan sulfate	0.00532U	0.00625U	0.006U	0.011U
alpha-Chlordane	0.00621	0.00657	0.006U	0.011U
gamma-Chlordane	0.0046	0.00808	0.006U	0.011U
Heptachlor	0.00532U	0.00625U	0.006U	0.011U
Heptachlor epoxide	0.00532U	0.00625U	0.006U	0.011U
Oxychlordane	0.00532U	0.00625U	0.0057U	0.011U
cis-Nonachlor	0.00295	0.00625U	0.0057U	0.011U
trans-Nonachlor	0.00628	0.00555	0.0057U	0.011U
Total Chlordane	0.02004	0.0202	0	0
Methoxychlor	0.00532U	0.00625U	0.006U	0.011U
Mirex	0.00532U	0.00625U	0.057U	0.11U
Toxaphene	0.0532U	0.0625U	0.6U	1.1U

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5= National Non Priority Pollutant Fresh Water CMC, 6=National Non Priority Pollutant Salt Water CMC.

U=not detected at the detection 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.

Table 16. Los Cerritos Channel Stormwater Chemistry Results, 2010/2011. (Continued).

Analyte	Oct 6, 2011	Oct 19-20, 2011	Nov 20-21, 2010	Dec 17-19, 2010
Organophosphates (ug/L)				
Bolstar (Sulprofos)	0.00426U	0.005U	0.2U	0.2U
Chlorpyrifos	0.00213U	0.0025U	0.011	0.0016J
Demeton	0.00213U	0.0025U	0.5U	0.5U
Diazinon	0.00426U	0.005U	0.0042	0.0016
Dichlorvos	0.00638U	0.0075U	0.2U	0.2U
Dimethoate	0.00638U	0.0075U	0.6U	1.1U
Disulfoton	0.00213U	0.0025U	0.1U	0.2U
Ethoprop	0.00213U	0.0025U	0.2U	0.2U
Fensulfothion	0.00213U	0.0025U	0.6U	1.1U
Fenthion	0.00426U	0.005U	0.06U	0.1U
Malathion	0.211	0.325	0.06U	0.1U
Merphos	0.00213U	0.0025U	0.06U	0.1U
Methyl Parathion	0.00213U	0.0025U		
Mevinphos	0.017U	0.02U	0.1U	0.2U
Phorate	0.0128U	0.015U	0.06U	0.1U
Tetrachlorvinphos (Stirophos)	0.00426U	0.005U	0.2U	0.2U
Tokuthion (Prothiofos)	0.00638U	0.0075U	0.06U	0.1U
Trichloronate	0.00213U	0.0025U	0.06U	0.1U
Triazine (ug/L)				
Ametryn	0.0106U	0.0125U		
Atraton	0.0106U	0.0125U		
Atrazine	0.0106U	0.0125U		
Cyanazine	0.0106U	0.0125U		
Prometon	0.0106U	0.0125U		
Prometryn	0.0106U	0.0125U		
Propazine	0.0106U	0.0125U		
Secbumeton	0.0106U	0.0125U		
Simazine	0.0106U	0.0125U		
Simetryn	0.0106U	0.0125U		
Terbutryn	0.0106U	0.0125U		
Terbutylazine	0.0106U	0.0125U		
Pyrethroids				
Bifenthrin			0.124	0.048
Cyfluthrin			0.028	0.0038
Cypermethrin			0.02	0.0041
Fenpropathrin			0.0015U	0.0015U
L-Cyhalothrin			0.0064	0.0013J
Permethrin			0.227	0.048
Total Deltamethrin/Tralomethrin			0.0083	0.0008J
Total Esfenvalerate/Fenvalerate			0.0016	0.0005J

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5= National Non Priority Pollutant Fresh Water CMC, 6=National Non Priority Pollutant Salt Water CMC.

U=not detected at the detection 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.

Table 17. Dominguez Gap Stormwater Chemistry Results, 2010/2011.

Analyte	Dec 17-19, 2010	Feb 25-26, 2011	Mar 20-21, 2011
Conventionals (mg/L unless otherwise noted)			
pH *(pH units)*	7.17	7.41	7.51
Alkalinity as CaCO3	30	63	46
Biochemical Oxygen Demand	4.3	5.5	7.6
Chemical Oxygen Demand	35	50J+	52J+
Chloride	9.7	38	26
Conductivity *(uS/cm)*	120	380	260
Fluoride	0.077J	0.18	0.15
Hardness as CaCO3	28	89	61
MBAS	0.099	0.11	0.11
Nitrate (as N)	0.26	0.68	0.43
Nitrite (as N)	0.1U	0.1U	0.1U
Oil and Grease	1.8J	5U	5U
Total Ammonia (as N)	0.32	0.33	0.19
Total Dissolved Solids	77	220	150
Total Kjeldahl Nitrogen	1.1	1.3	1.2
Total Organic Carbon	9.0	9.4	13
Orthophosphate (as P)	0.20	0.099	0.12
Total Phosphorus	0.33	0.31	0.3
Total Recoverable Phenolics	0.1U	0.1U	0.1U
Total Suspended Solids	31	52	34
Volatile Suspended Solids	9.6	18	12
Turbidity *(NTU)*	30	32	31
Dissolved Metals (ug/L)			
Aluminum	20J	2.4J	12J
Arsenic	1.1	1.1	1.3
Cadmium	0.032J	0.058J	0.013J
Chromium	0.53	0.5U	0.28J
Copper	4.8[3]	3.1	4.7
Iron	40	8.2J	25
Lead	0.62	0.48	0.68
Nickel	1.5	1.1	1.6
Selenium	1U	1U	1U
Silver	0.2U	0.047J	0.014J
Zinc	24	22	29
Total Metals (ug/L)			
Aluminum	870[5]	1500[2,5]	1000[2,5]
Arsenic	1.5	1.4	1.7
Cadmium	0.11J	0.21	0.11J
Chromium	2	1.3	2.2
Copper	10	12	12
Iron	1100	1800	1300
Lead	5.6	9.1[1]	6.9
Nickel	2.5	3	3
Selenium	1U	1U	1U
Silver	0.2U	0.071J	0.021J
Zinc	55	77	68

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CMC, 4=California Toxic Rule Salt Water CMC, 5= National Non Priority Pollutant Fresh Water CMC, 6=National Non Priority Pollutant Salt Water CMC.

U=not detected at the detection 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.

Table 17. Dominguez Gap Stormwater Chemistry Results, 2010/2011. (Continued).

Analyte	Dec 17-19, 2010	Feb 25-26, 2011	Mar 20-21, 2011
Microbiology			
Enterococcus *(CFU/100 ml)*	5700 [1,2]	6500 [1,2]	6500 [1,2]
Fecal Coliform *(MPN/100 ml)*	30000 [1,2]	9200 [1,2]	5400 [1,2]
Total Coliform *(MPN/100 ml)*	160000 [1,2]	35000 [1,2]	35000 [1,2]
Aroclors (ug/L)			
Aroclor 1016	0.12U	0.12U	0.11U
Aroclor 1221	0.12U	0.12U	0.11U
Aroclor 1232	0.12U	0.12U	0.11U
Aroclor 1242	0.12U	0.12U	0.11U
Aroclor 1248	0.12U	0.12U	0.11U
Aroclor 1254	0.12U	0.12U	0.11U
Aroclor 1260	0.12U	0.12U	0.11U
Total Aroclors	0	0	0
Chlorinated Pesticides (ug/L)			
2,4'-DDD	0.006U	0.006U	0.006U
2,4'-DDE	0.006U	0.006U	0.006U
2,4'-DDT	0.006U	0.006U	0.006U
4,4'-DDD	0.006U	0.006U	0.006U
4,4'-DDE	0.006U	0.006U	0.006U
4,4'-DDT	0.006U	0.006U	0.006U
Total DDT	0	0	0
Aldrin	0.006U	0.006U	0.006U
Dieldrin	0.006U	0.006U	0.006U
Endrin	0.006U	0.006U	0.006U
Endrin aldehyde	0.006U	0.006U	0.006U
Endrin ketone	0.006U	0.006U	0.006U
alpha-BHC	0.006U	0.006U	0.006U
beta-BHC	0.006U	0.006U	0.006U
delta-BHC	0.006U	0.006U	0.006U
gamma-BHC (Lindane)	0.006U	0.006U	0.006U
Endosulfan I	0.006U	0.006U	0.006U
Endosulfan II	0.006U	0.006U	0.006U
Endosulfan sulfate	0.006U	0.006U	0.006U
alpha-Chlordane	0.006U	0.006U	0.006U
gamma-Chlordane	0.006U	0.006U	0.006U
Heptachlor	0.006U	0.006U	0.006U
Heptachlor epoxide	0.006U	0.006U	0.006U
Oxychlordane	0.0059U	0.0058U	0.0057U
cis-Nonachlor	0.0059U	0.0058U	0.0057U
trans-Nonachlor	0.0059U	0.012U	0.011U
Total Chlordane	0	0	0
Methoxychlor	0.006U	0.006U	0.006U
Mirex	0.059U	0.058U	0.057U
Toxaphene	0.6U	0.6U	0.6U

Bolded values with superscripts exceed criteria 1-Ocean Plan, 2-LA Basin Plan, 3-Cal. Fish & Game Freshwater, 4-Cal Fish & Game Saltwater, 5-Cal. Toxics Rule Freshwater, 6-Cal. Toxics Rule Saltwater, 7-National Non-Priority Freshwater, 8-National Non-Priority Pollutant Saltwater. U=not detected at the detection 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.

Table 17. Dominguez Gap Stormwater Chemistry Results, 2010/2011. (Continued).

Analyte	Dec 17-19, 2010	Feb 25-26, 2011	Mar 20-21, 2011
Organophosphates (ug/L)			
Bolstar (Sulprofos)	0.2U	0.2U	0.2U
Chlorpyrifos	0.0011J	0.0009J	0.0008J
Demeton	0.5U	0.5U	0.5U
Diazinon	0.0021	0.0012J	0.02U
Dichlorvos	0.2U	0.2U	0.2U
Dimethoate	0.6U	0.6U	0.6U
Disulfoton	0.1U	0.1U	0.1U
Ethoprop	0.2U	0.2U	0.2U
Fensulfothion	0.6U	0.6U	0.6U
Fenthion	0.06U	0.06U	0.06U
Malathion	0.06U	0.06U	0.06U
Merphos	0.06U	0.06U	0.06U
Methyl Parathion			
Mevinphos	0.1U	0.1U	0.1U
Phorate	0.06U	0.06U	0.06U
Tetrachlorvinphos (Stirophos)	0.2U	0.2U	0.2U
Tokuthion (Prothiofos)	0.06U	0.06U	0.06U
Trichloronate	0.06U	0.06U	0.06U
Triazine (ug/L)			
Ametryn			
Atraton			
Atrazine			
Cyanazine			
Prometon			
Prometryn			
Propazine			
Secbumeton			
Simazine			
Simetryn			
Terbutryn			
Terbutylazine			
Pyrethroids			
Bifenthrin	0.014	0.016	0.0099
Cyfluthrin	0.0024	0.003	0.0033
Cypermethrin	0.0047	0.0056	0.003
Fenpropathrin	0.0015U	0.0015U	0.0015U
L-Cyhalothrin	0.0009J	0.0014J	0.0003J
Permethrin	0.031	0.03	0.029
Total Deltamethrin/Tralomethrin	0.0007J	0.0014J	0.003U
Total Esfenvalerate/Fenvalerate	0.0003J	0.0003J	0.0015U

Bolded values with superscripts exceed criteria 1-Ocean Plan, 2-LA Basin Plan, 3-Cal. Fish & Game Freshwater, 4-Cal Fish & Game Saltwater, 5-Cal. Toxics Rule Freshwater, 6-Cal. Toxics Rule Saltwater, 7-National Non-Priority Freshwater, 8-National Non-Priority Pollutant Saltwater. U=not detected at the detection 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.

Table 18. Summary of Data from Additional Events Monitored for TSS (mg/L), 2010/2011.

Site/Event Date	Oct 30, 2011	Jan 30, 2011	Feb 15-16, 2011	Feb 25-26, 2011	Mar 20-21, 2011
Belmont Pump	244			77	70
Bouton Creek		29			56
Los Cerritos Channel	200	108	99	66	46

Table 19. Total Load in Kilograms at the Belmont Pump Station for 2010/2011 Storm Events

Analyte Group	Oct 5-6, 2010	Oct 19, 2010	Nov 20-21, 2010	Dec 17-19, 2010
Conventionals				
Alkalinity as CaCO3	360	470	340	1300
Hardness as CaCO3	340	450	280	820
Biochemical Oxygen Demand	110	170	59	150
Chemical Oxygen Demand	930	1700	840	1100
Total Organic Carbon	170	220	84	490
Chloride	390	330	450	720
Fluoride	2.1	2.8	1.1	2.6
MBAS	2	1.8	2.2	2.4
Oil and Grease	NS	0	17	72
Total Ammonia (as N)	1.6	7.4	2	8.2
Total Kjeldahl Nitrogen	7.7	43	19	72
Nitrate (as N)	4.5	12	3	11
Nitrite (as N)	0.65	0.32	0	0
Orthophosphate (as P)	1.6	3.4	1.4	8.5
Total Phosphorus	6.5	12	4.6	24
Total Recoverable Phenolics	0	0	0	0
Total Dissolved Solids	1400	2000	1300	2900
Total Suspended Solids	1200	2800	1100	1800
Volatile Suspended Solids	400	920	300	690
Dissolved Metals				
Aluminum	0.13	0.33	0.022	0.49
Arsenic	0.011	0.02	0.0072	0.033
Cadmium	0.0002	0.00037	0.00042	0.0012
Chromium	0.031	0.02	0.0036	0.024
Copper	0.057	0.13	0.049	0.18
Iron	0.49	0.84	0.36	1.1
Lead	0.0045	0.013	0.005	0.023
Nickel	0.04	0.046	0.02	0.049
Selenium	0.0011	0.002	0	0
Silver	0	0	0.000084	0
Zinc	0.069	0.24	0.15	1
Total Metals				
Aluminum	22	58	18	30
Arsenic	0.024	0.051	0.019	0.049
Cadmium	0.0053	0.012	0.0038	0.0075
Chromium	3.1	1.7	0.33	0.22
Copper	0.57	1.1	0.36	0.69
Iron	38	93	28	49
Lead	0.29	0.68	0.2	0.36
Nickel	0.45	0.45	0.1	0.15
Selenium	0.0018	0.0046	0	0
Silver	0.0012	0.0025	0.0012	0
Zinc	2.7	5.8	1.9	3.9

Table 19. Total Load in Kilograms at Belmont Pump Station for 2010/2011 Storm Events. (continued)

Analyte Group	Oct 5-6, 2010	Oct 19, 2010	Nov 20-21, 2010	Dec 17-19, 2010
Aroclors				
Aroclor 1016 - 1260	0	0	0	0
Chlorinated Pesticides				
4,4'-DDE	0.000029	0	0	0
alpha-Chlordane	0.00006	0.00032	0	0
gamma-Chlordane	0.000064	0.0003	0.00023	0
Oxychlordane	0	0	0	0
Total Chlordane	0.000153	0.00062	0.00023	0
Toxaphene	0.000053	0.00017	0	0
cis-Nonachlor	0.000018	0.00011	0	0
trans-Nonachlor	0.000045	0.00022	0	0
Organophosphates				
Chlorpyrifos	0	0	0.000022	0.000033
Diazinon	0	0	0	0.000023
Malathion	0.00022	0.0016	0	0
Triazines				
Prometon	0	0.0004	NS	NS
Pyrethroids				
Bifenthrin	NS	NS	0.0021	0.0037
Cyfluthrin	NS	NS	0.00033	0.00059
Cypermethrin	NS	NS	0.00013	0.00022
L-Cyhalothrin	NS	NS	0.000046	0.000098
Permethrin	NS	NS	0.0015	0.0019
Total Deltamethrin/Tralomethrin	NS	NS	0.00028	0.00028
Total Esfenvalerate/Fenvalerate	NS	NS	0.000017	0.000036

ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.

Table 20. Total Load in Kilograms at the Bouton Creek Stations for 2010/2011 Storm Events.

Analyte Group	Oct 19-20, 2010	Nov 20-21, 2010	Dec 17-19, 2010	Feb 25-26, 2011
Conventionals				
Alkalinity as CaCO3	1900	290	4300	1100
Hardness as CaCO3	2100	1300	4100	980
Biochemical Oxygen Demand	0	85	890	220
Chemical Oxygen Demand	7400	1600	9200	3300
Total Organic Carbon	1000	230	2300	330
Chloride	2400	4100	2800	1200
Fluoride	12	3	18	3.2
MBAS	11	4.3	17	6.2
Oil and Grease	680	24	310	330
Total Ammonia (as N)	55	7.2	36	9.3
Total Kjeldahl Nitrogen	200	24	160	40
Nitrate (as N)	55	7.7	54	10
Nitrite (as N)	1.4	0	0	0
Orthophosphate (as P)	12	1.8	36	4.1
Total Phosphorus	45	3.3	64	10
Total Dissolved Solids	9700	7900	13000	4000
Total Suspended Solids	11000	660	7900	1700
Volatile Suspended Solids	3500	190	2800	670
Dissolved Metals				
Aluminum	1.4	0.15	3.3	0.29
Arsenic	0.068	0.013	0.23	0.038
Cadmium	0.0052	0.0011	0.016	0.0019
Chromium	0.085	0.066	0.33	0
Copper	0.56	0.15	1.3	0.2
Iron	3.9	0.84	5.9	0.3
Lead	0.1	0.018	0.095	0.021
Nickel	0.19	0.057	0.33	0.01
Silver	0	0	0	0.0027
Zinc	2.7	0.41	7.4	1.4
Total Metals				
Aluminum	200	17	190	38
Arsenic	0.16	0.022	0.33	0.051
Cadmium	0.043	0.003	0.056	0.0077
Chromium	0.56	0.18	1	0.083
Copper	3.4	0.3	3.8	0.57
Iron	290	23	280	48
Lead	1.7	0.11	1.4	0.3
Nickel	0.57	0.093	0.69	0.067
Selenium	0.026	0	0	0
Silver	0.0062	0.00054	0	0.0012
Zinc	19	1.3	20	4

Table 20. Total Load in Kilograms at Bouton Creek Station for 2010/2011 Storm Events. (continued)

Analyte Group	Oct 19-20, 2010	Nov 20-21, 2010	Dec 17-19, 2010	Feb 25-26, 2011
Aroclors				
Aroclor 1016 - 1260	0	0	0	0
Chlorinated Pesticides				
alpha-Chlordane	0.00012	0	0	0
Total Chlordane	0.00012	0	0	0
trans-Nonachlor	0.000091	0	0	0
Organophosphates				
Chlorpyrifos	0	0.000028	0.00013	0.000036
Diazinon	0	0.000023	0.0002	0.00062
Malathion	0.0026	0	0	0
Triazines				
Prometon	0.0019	NS	NS	NS
Pyrethroids				
Bifenthrin	NS	0.001	0.0056	0.001
Cyfluthrin	NS	0.00006	0.00064	0.00018
Cypermethrin	NS	0.000041	0.0012	0.00016
L-Cyhalothrin	NS	0	0.00013	0.000021
Permethrin	NS	0.0011	0.0084	0.0024
Total Deltamethrin/Tralomethrin	NS	0	0.00018	0.000077
Total Esfenvalerate/Fenvalerate	NS	0	0.000077	0.000021

ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.

Table 21. Total Load in Kilograms at the Los Cerritos Channel Station for 2010/2011 Events.

Analyte Group	Oct 6, 2011	Oct 19-20, 2011	Nov 20-21, 2010	Dec 17-19, 2010
Conventionals				
Alkalinity as CaCO3	12000	7600	5400	24000
Hardness as CaCO3	6400	6900	5200	19000
Biochemical Oxygen Demand	4600	4400	2400	4600
Chemical Oxygen Demand	37000	25000	31000	38000
Total Organic Carbon	4900	4200	3700	9000
Chloride	1600	1400	1500	3600
Fluoride	43	38	38	69
MBAS	43	65	70	90
Oil and Grease	NS	460	230	1700
Total Ammonia (as N)	61	160	66	190
Total Kjeldahl Nitrogen	99	1100	710	1300
Nitrate (as N)	120	200	110	250
Nitrite (as N)	7.6	7.7	4.2	0
Orthophosphate (as P)	24	38	33	140
Total Phosphorus	220	220	130	550
Total Dissolved Solids	17000	25000	15000	39000
Total Suspended Solids	84000	85000	24000	62000
Volatile Suspended Solids	26000	22000	6600	15000
Dissolved Metals				
Aluminum	3.1	4.2	1.7	26
Arsenic	0.21	0.3	0.23	1.1
Cadmium	0.0036	0.0098	0.012	0.058
Chromium	0.11	0.17	0.26	1.1
Copper	0.99	1.9	1.9	5.4
Iron	12	12	8	29
Lead	0.15	0.25	0.13	0.42
Nickel	0.65	0.69	0.42	1.2
Selenium	0.03	0.041	0	0
Silver	0.0011	0	0.0021	0
Zinc	2.3	6.6	7.8	33
Total Metals				
Aluminum	650	1300	450	1400
Arsenic	0.65	1.1	0.45	1.7
Cadmium	0.17	0.3	0.11	0.24
Chromium	1.6	3	1.3	3.3
Copper	11	16	7.3	14
Iron	910	2000	640	1900
Lead	4.8	10	3.5	6.5
Nickel	2.2	3.8	1.5	3.2
Selenium	0.06	0.13	0	0
Silver	0.041	0.05	0.024	0
Zinc	73	110	47	100

Table 21. Total Load in Kilograms at the Los Cerritos Channel Station for 2010/2011 Events. (continued)

Analyte Group	Oct 6, 2011	Oct 19-20, 2011	Nov 20-21, 2010	Dec 17-19, 2010
Aroclors				
Aroclor 1016 - 1260	0	0	0	0
Chlorinated Pesticides				
4,4'-DDE	0.00039	0	0	0
alpha-Chlordane	0.00047	0.001	0	0
gamma-Chlordane	0.00035	0.0013	0	0
Total Chlordane	0.00121	0.0023	0	0
cis-Nonachlor	0.00022	0	0	0
trans-Nonachlor	0.00048	0.00087	0	0
Organophosphates				
Chlorpyrifos	0	0	0.0019	0.0019
Diazinon	0	0	0.00073	0.0019
Malathion	0.016	0.051	0	0
Triazines				
All Compounds	0	0	0	0
Pyrethroids				
Bifenthrin	NS	NS	0.022	0.057
Cyfluthrin	NS	NS	0.0049	0.0045
Cypermethrin	NS	NS	0.0035	0.0049
L-Cyhalothrin	NS	NS	0.0011	0.0015
Permethrin	NS	NS	0.039	0.057
Total Deltamethrin/Tralomethrin	NS	NS	0.0014	0.00095
Total Esfenvalerate/Fenvalerate	NS	NS	0.00028	0.00059

ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.

Table 22. Total Load in Kilograms at the Dominguez Gap Station for 2010/2011 Events.

Analyte Group	Dec 17-19, 2010	Feb 25-26, 2011	Mar 20-21, 2011
Conventionals			
Alkalinity as CaCO3	2900	2200	4900
Hardness as CaCO3	2700	3100	6500
Biochemical Oxygen Demand	420	190	810
Chemical Oxygen Demand	3400	1700	5600
Total Organic Carbon	870	330	1400
Chloride	940	1300	2800
Fluoride	7.5	6.3	16
MBAS	9.6	3.8	12
Oil and Grease	170	0	0
Total Ammonia (as N)	31	11	20
Total Kjeldahl Nitrogen	110	45	130
Nitrate (as N)	25	24	46
Orthophosphate (as P)	19	3.4	13
Total Phosphorus	32	11	32
Total Dissolved Solids	7500	7600	16000
Total Suspended Solids	3000	1800	3600
Volatile Suspended Solids	930	630	1300
Dissolved Metals			
Aluminum	1.9	0.083	1.3
Arsenic	0.11	0.038	0.14
Cadmium	0.0031	0.002	0.0014
Chromium	0.051	0	0.03
Copper	0.47	0.11	0.50
Iron	3.9	0.28	2.7
Lead	0.06	0.017	0.073
Nickel	0.15	0.038	0.17
Selenium	0	0	0
Silver	0	0.0016	0.0015
Zinc	2.3	0.76	3.1
Total Metals			
Aluminum	84	52	110
Arsenic	0.15	0.049	0.18
Cadmium	0.011	0.0073	0.012
Chromium	0.19	0.045	0.24
Copper	0.97	0.42	1.3
Iron	110	63	140
Lead	0.54	0.32	0.74
Nickel	0.24	0.1	0.32
Selenium	0	0	0
Silver	0	0.0025	0.0022
Zinc	5.3	2.7	7.3

Table 22. Total Load in Kilograms at the Dominguez Gap Stations for 2010/2011 Events. (continued)

Analyte Group	Dec 17-19, 2010	Feb 25-26, 2011	March 20-21, 2011
Aroclors			
Aroclor 1016 - 1260	0	0	0
Chlorinated Pesticides			
All Compounds	0	0	0
Organophosphates			
Chlorpyrifos	0.00011	0.000031	0
Diazinon	0.0002	0.000042	0
Triazines			
All Compounds	NS	NS	NS
Pyrethroids			
Bifenthrin	0.0014	0.00056	0.0011
Cyfluthrin	0.00023	0.0001	0.00035
Cypermethrin	0.00046	0.00019	0.00032
L-Cyhalothrin	0.000087	0.000049	0.000032
Permethrin	0.003	0.001	0.0031
Total Deltamethrin/Tralomethrin	0.000068	0.000049	0
Total Esfenvalerate/Fenvalerate	0.000029	0.00001	0

ND indicates that an analysis was performed but the analyte was not detected.
NS indicates that the analysis was not performed.

Table 23. Total Load in Kilograms for TSS-only events for 2010/2011 Storm Events

	Oct 30, 2011	Jan 30, 2011	Feb 15-16, 2011	Feb 25-26, 2011	Mar 20-21, 2011
Belmont Pump	380			560	1100
Bouton Creek		170			4400
Los Cerritos Channel	20000	4700	4700	22000	36000

Table 24. Monitored Dry Weather Events, 1999-2011.

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 - 9/11/03	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 - 7/2/2008	20 – 5/7/2009	21-10/12/2009	22-5/11/2010	23-9/23/10	24-5/10/11
Bouton Creek		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•[3]	•[3]	•[3]	•[5]	•[5]	•[5]	•[5]
Belmont Pump[5]		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•								
Los Cerritos Channel				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Dominguez Gap		•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[2]	•	•[1]	•[1]	•	•	•	•

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 was being diverted to the sanitary system 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.

Shading indicates 2010/2011 Dry Weather Surveys included in this report.

Table 25. Field Measurements for Dry Weather Surveys.

	Bouton Creek		Los Cerritos Channel		Dominguez Gap Pump	
Date	**22-Sept-10**	**10-May-11**	**23-Sept-10**	**11-May-11**	**23-Sept-10**	**11-May-11**
Time	**1444**	**1126**	**0720**	**0810**	**0905**	**1033**
Temperature (^{0}C)	19.8	20.0	14.8	18.2	21.0	20.2
pH	8.45	8.89	8.15	8.77	7.35	7.56
Specific Conductivity (mS/cm)	1.729	2.360	0.316	0.739	1.007	1.153
Flow (cfs)	1.36[1]	0.53[1]	0.41[1]	0.44[1]	3?[2]	3?[3]
Dissolved Oxygen (mg/L)	8.4	14.5	8.3	14.7	0. 8	3.3

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. 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 8.0 feet at the time of this visit.
3 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 9.7 feet at the time of this visit.

Table 26. Summary of Bouton Creek Dry Weather Chemistry Results, 2010/2011.

Analyte	Sep 22, 2010	May 10, 2011
Conventionals (mg/L unless otherwise noted)		
pH (pH Units)	8.45	**8.89** [2]
Alkalinity as CaCO3	170	140
Biochemical Oxygen Demand	2	9.2
Chemical Oxygen Demand	120	110
Chloride	790	480
Conductivity (uS/cm)	3000	2100
Fluoride	0.8	0.9
Hardness as CaCO3	290	250
MBAS	0.077J	0.11
Nitrate (as N)	0.059J	0.07J
Nitrite (as N)	0.2U	0.2U
Oil and Grease	1.4J	5U
Total Ammonia (as N)	0.26	0.08J
Total Dissolved Solids	1700	1200
Total Kjeldahl Nitrogen	1.3	2.1
Total Organic Carbon	23	6.3
Orthophosphate (as P)	0.033	0.01U
Total Phosphorus	0.074	0.16
Total Recoverable Phenolics	100U	100U
Total Suspended Solids	5.8	15
Volatile Suspended Solids	2.8	6.7
Turbidity (NTU)	5.3	7.3
Dissolved Metals (ug/L)		
Aluminum	120	7.7J
Arsenic	2.3	2.2
Cadmium	0.21	0.26
Chromium	0.24J	0.36J
Copper	5.8	**12** [4]
Iron	21	21
Lead	0.91	0.82
Nickel	1.4	2.1
Selenium	0.25J	0.36J
Silver	0.2U	0.2U
Zinc	21	26
Total Metals (ug/L)		
Aluminum	**140** [5]	**140** [5]
Arsenic	2.2	2.5
Cadmium	0.18J	0.23
Chromium	0.63	0.89
Copper	6.7	**15** [1]
Iron	180	220
Lead	0.96	1.7
Nickel	1.5	2.3
Selenium	0.22J	0.34J
Silver	0.2U	0.2U
Zinc	21	33

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CCC, 4=California Toxic Rule Salt Water CCC, 5= National Non Priority Pollutant Fresh Water CCC, 6=National Non Priority Pollutant Salt Water CCC.

U=not detected at the detection 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.

Table 26. Summary of Bouton Creek Dry Weather Chemistry Results, 2010/2011. (continued)

Analyte	Sep 22, 2010	May 10, 2011
Microbiology		
Enterococcus (CFU/100 ml)	1200 [1,2]	650 [1,2]
Fecal Coliform (MPN/100 ml)	8000 [1,2]	2200 [1,2]
Total Coliform (MPN/100 ml)	13000 [1,2]	130000 [1,2]
Aroclors (ug/L)		
Aroclor 1016	0.0205U	0.12U
Aroclor 1221	0.0205U	0.12U
Aroclor 1232	0.0205U	0.12U
Aroclor 1242	0.0205U	0.12U
Aroclor 1248	0.0205U	0.12U
Aroclor 1254	0.0205U	0.12U
Aroclor 1260	0.0205U	0.12U
Total Aroclors	0	0
Chlorinated Pesticides (ug/L)		
2,4'-DDD	0.00513U	0.0058U
2,4'-DDE	0.00513U	0.0058U
2,4'-DDT	0.00513U	0.012U
4,4'-DDD	0.00513U	0.006U
4,4'-DDE	0.00513U	0.006U
4,4'-DDT	0.00513U	0.006U
Total DDT	0	0
Aldrin	0.00513U	0.006U
Dieldrin	0.00513U	0.006U
Endrin	0.00513U	0.006UJ-
Endrin aldehyde	0.00513U	0.006U
Endrin ketone	0.00513U	0.006UJ-
alpha-BHC	0.00513U	0.006U
beta-BHC	0.00513U	0.006U
delta-BHC	0.00513U	0.006U
gamma-BHC (Lindane)	0.00513U	0.006U
Endosulfan I	0.00513U	0.006U
Endosulfan II	0.00513U	0.006U
Endosulfan sulfate	0.00513U	0.006UJ-
Heptachlor	0.00513U	0.006U
Heptachlor epoxide	0.00513U	0.006U
alpha-Chlordane	0.00513U	0.007
gamma-Chlordane	0.00513U	0.017
Oxychlordane	0.00513U	0.0058U
cis-Nonachlor	0.00513U	0.0058U
trans-Nonachlor	0.00513U	0.012U
Total Chlordane	0	0.024 [3,4]
Methoxychlor	0.00513U	0.006U
Mirex	0.00513U	0.058U
Toxaphene	0.0513U	0.6U

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CCC, 4=California Toxic Rule Salt Water CCC, 5= National Non Priority Pollutant Fresh Water CCC, 6=National Non Priority Pollutant Salt Water CCC.

U=not detected at the detection 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.

Table 26. Summary of Bouton Creek Dry Weather Chemistry Results, 2010/2011. (continued)

Analyte	Sep 22, 2010	May 10, 2011
Organophosphates (ug/L)		
Bolstar (Sulprofos)	0.0041U	0.2U
Chlorpyrifos	0.00205U	0.0002U
Demeton	0.00205U	0.5U
Diazinon	0.0041U	0.0015U
Dichlorvos	0.00615U	0.2U
Dimethoate	0.00615U	0.6U
Disulfoton	0.00205U	0.1U
Ethoprop	0.00205U	0.2U
Fensulfothion	0.00205U	0.6U
Fenthion	0.0041U	0.06U
Malathion	0.00615U	0.06U
Merphos	0.00205U	0.06U
Methyl Parathion	0.00205U	
Mevinphos	0.0164U	0.1U
Phorate	0.0123U	0.06U
Tetrachlorvinphos (Stirophos)	0.0041U	0.2U
Tokuthion (Prothiofos)	0.00615U	0.06U
Trichloronate	0.00205U	0.06U
Triazine (ug/L)		
Ametryn	0.0103U	
Atraton	0.0103U	
Atrazine	0.0103U	
Cyanazine	0.0103U	
Prometon	0.00576	
Prometryn	0.0103U	
Propazine	0.0103U	
Secbumeton	0.0103U	
Simazine	0.0103U	
Simetryn	0.0103U	
Terbutryn	0.0103U	
Terbutylazine	0.0103U	
Pyrethroids (ug/L)		
Bifenthrin		0.0022
Cyfluthrin		0.0004J
Cypermethrin		0.0007J
Fenpropathrin		0.0015U
L-Cyhalothrin		0.0015U
Permethrin		0.015U
Total Deltamethrin/Tralomethrin		0.003U
Total Esfenvalerate/Fenvalerate		0.0015U

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CCC, 4=California Toxic Rule Salt Water CCC, 5= National Non Priority Pollutant Fresh Water CCC, 6=National Non Priority Pollutant Salt Water CCC.

U=not detected at the detection 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.

Table 27. Summary of Los Cerritos Channel Dry Weather Chemistry Results, 2010/2011.

Analyte	Sep 23, 2010	May 11, 2011
Conventionals (mg/L unless otherwise noted)		
pH (pH Units)	8.15	8.77 [2]
Alkalinity as CaCO3	110	120
Biochemical Oxygen Demand	6.7	33
Chemical Oxygen Demand	71	180
Chloride	90	120
Conductivity (uS/cm)	720	0.739
Fluoride	0.52	0.21
Hardness as CaCO3	140	170
MBAS	0.1	0.35
Nitrate (as N)	0.1U	5.3
Nitrite (as N)	0.1U	0.1U
Oil and Grease	5U	5U
Total Ammonia (as N)	0.32	0.11
Total Dissolved Solids	460	510
Total Kjeldahl Nitrogen	1.8	3
Total Organic Carbon	29	19
Orthophosphate (as P)	0.016	0.01U
Total Phosphorus	0.083	0.13
Total Recoverable Phenolics	100U	100U
Total Suspended Solids	6.6	6.4
Volatile Suspended Solids	4.2	5.5
Turbidity (NTU)	7.8	6.6
Dissolved Metals (ug/L)		
Aluminum	31	10J
Arsenic	4.2	3.5
Cadmium	0.17J	0.35
Chromium	0.37J	1
Copper	6.6 [4]	21 [3,4]
Iron	20	68
Lead	0.84	2
Nickel	1.9	5.2
Selenium	0.27J	0.69J
Silver	0.2U	0.2U
Zinc	6.3	21
Total Metals (ug/L)		
Aluminum	35	45
Arsenic	4.6	3.9
Cadmium	0.19J	0.46
Chromium	0.46J	1.5
Copper	8.4	25 [1]
Iron	85	150
Lead	0.99	3.9
Nickel	2.1	5.6
Selenium	0.3J	0.41J
Silver	0.014J	0.2U
Zinc	9.5	29

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CCC, 4=California Toxic Rule Salt Water CCC, 5= National Non Priority Pollutant Fresh Water CCC, 6=National Non Priority Pollutant Salt Water CCC.

U=not detected at the detection 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.

Table 27. Summary of Los Cerritos Channel Dry Weather Chemistry Results, 2010/2011. (continued)

Analyte	Sep 23, 2010	May 11, 2011
Microbiology		
Enterococcus (CFU/100 ml)	60	10
Fecal Coliform (MPN/100 ml)	80	**1300** [1,2]
Total Coliform (MPN/100 ml)	300	**79000** [1,2]
Aroclors (ug/L)		
Aroclor 1016	0.0202U	0.1U
Aroclor 1221	0.0202U	0.1U
Aroclor 1232	0.0202U	0.1U
Aroclor 1242	0.0202U	0.1U
Aroclor 1248	0.0202U	0.1U
Aroclor 1254	0.0202U	0.1U
Aroclor 1260	0.0202U	0.1U
Total Aroclors	0	0
Chlorinated Pesticides (ug/L)		
2,4'-DDD	0.00505U	0.005U
2,4'-DDE	0.00505U	0.005U
2,4'-DDT	0.00505U	0.01U
4,4'-DDD	0.00505U	0.005U
4,4'-DDE	0.00505U	0.005U
4,4'-DDT	0.00505U	0.005U
Total DDT	0	0
Aldrin	0.00505U	0.005U
Dieldrin	0.00505U	0.005U
Endrin	0.00505U	0.005UJ-
Endrin aldehyde	0.00505U	0.005U
Endrin ketone	0.00505U	0.005UJ-
alpha-BHC	0.00505U	0.005U
beta-BHC	0.00505U	0.005U
delta-BHC	0.00505U	0.005U
gamma-BHC (Lindane)	0.00505U	0.005U
Endosulfan I	0.00505U	0.005U
Endosulfan II	0.00505U	0.005U
Endosulfan sulfate	0.00505U	0.005UJ-
Heptachlor	0.00505U	0.005U
Heptachlor epoxide	0.00505U	0.005U
alpha-Chlordane	0.00505U	0.005U
gamma-Chlordane	0.00505U	0.005U
Oxychlordane	0.00505U	0.005U
cis-Nonachlor	0.00505U	0.005U
trans-Nonachlor	0.00505U	0.01U
Total Chlordane	0	0
Methoxychlor	0.00505U	0.005U
Mirex	0.00505U	0.05U
Toxaphene	0.0505U	0.5U

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CCC, 4=California Toxic Rule Salt Water CCC, 5= National Non Priority Pollutant Fresh Water CCC, 6=National Non Priority Pollutant Salt Water CCC.

U=not detected at the detection 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.

Table 27. Summary of Los Cerritos Channel Dry Weather Chemistry Results, 2010/2011. (continued)

Analyte	Sep 23, 2010	May 11, 2011
Organophosphates (ug/L)		
Bolstar (Sulprofos)	0.004U	0.2U
Chlorpyrifos	0.002U	0.002U
Demeton	0.002U	0.5U
Diazinon	0.004U	0.0015U
Dichlorvos	0.006U	0.2U
Dimethoate	0.006U	0.5U
Disulfoton	0.002U	0.1U
Ethoprop	0.002U	0.2U
Fensulfothion	0.002U	0.5U
Fenthion	0.004U	0.05U
Malathion	0.006U	0.05U
Merphos	0.002U	0.05U
Methyl Parathion	0.002U	
Mevinphos	0.0162U	0.1U
Phorate	0.0121U	0.05U
Tetrachlorvinphos (Stirophos)	0.004U	0.2U
Tokuthion (Prothiofos)	0.006U	0.05U
Trichloronate	0.002U	0.05U
Triazine (ug/L)		
Ametryn	0.010U	
Atraton	0.010U	
Atrazine	0.036	
Cyanazine	0.010U	
Prometon	0.010U	
Prometryn	0.010U	
Propazine	0.010U	
Secbumeton	0.010U	
Simazine	0.0095	
Simetryn	0.010U	
Terbutryn	0.010U	
Terbutylazine	0.010U	
Pyrethroids (ug/L)		
Bifenthrin		0.005
Cyfluthrin		0.0015U
Cypermethrin		0.0015U
Fenpropathrin		0.0015U
L-Cyhalothrin		0.0015U
Permethrin		0.011J
Total Deltamethrin/Tralomethrin		0.003U
Total Esfenvalerate/Fenvalerate		0.0015U

Bolded values with superscripts exceed criteria 1=Ocean Plan, 2=LA Basin Plan, 3=California Toxic Rule Fresh Water CCC, 4=California Toxic Rule Salt Water CCC, 5= National Non Priority Pollutant Fresh Water CCC, 6=National Non Priority Pollutant Salt Water CCC.

U=not detected at the detection 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.

Table 28. Summary of Dominguez Gap Dry Weather Chemistry Results, 2010/2011.

Analyte	Sep 23, 2010	May 11, 2011
Conventionals (mg/L unless otherwise noted)		
pH (pH Units)	7.35	7.56
Alkalinity as CaCO3	170	200
Biochemical Oxygen Demand	5.9	4.3
Chemical Oxygen Demand	55	35J+
Chloride	130	110
Conductivity (uS/cm)	1000	1100
Fluoride	0.82	0.62
Hardness as CaCO3	230	340
MBAS	0.067J	0.021J
Nitrate (as N)	0.1U	1.6
Nitrite (as N)	0.1U	0.1U
Oil and Grease	5U	5U
Total Ammonia (as N)	0.18	0.15
Total Dissolved Solids	620	680
Total Kjeldahl Nitrogen	1.6	1.4
Total Organic Carbon	24	5.3
Orthophosphate (as P)	0.15	0.17
Total Phosphorus	0.29	0.28
Total Recoverable Phenolics	100U	100U
Total Suspended Solids	15	14
Volatile Suspended Solids	8.4	3.4
Turbidity (NTU)	12	14
Dissolved Metals (ug/L)		
Aluminum	54	7.7J
Arsenic	3.1	3.1
Cadmium	0.15J	0.2
Chromium	0.5U	0.25J
Copper	0.54	2.2
Iron	20	21
Lead	0.65	0.71
Nickel	3.1	3.3
Selenium	0.82J	1.5
Silver	0.2U	0.2U
Zinc	6.3	11
Total Metals (ug/L)		
Aluminum	270[5]	610[5]
Arsenic	3.1	3.2
Cadmium	0.15J	0.23
Chromium	0.65	0.99
Copper	1.7	3.9
Iron	390	620
Lead	2.2	3.1
Nickel	3.5	3.8
Selenium	0.42J	1.6
Silver	0.2U	0.2U
Zinc	8.8	16

Bolded values with superscripts exceed criteria 1-Ocean Plan, 2-LA Basin Plan, 3-Cal. Fish & Game Freshwater, 4-Cal Fish & Game Saltwater, 5-Cal. Toxics Rule Freshwater, 6-Cal. Toxics Rule Saltwater, 7-National Non-Priority Freshwater, 8-National Non-Priority Pollutant Saltwater. U=not detected at the detection 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.

Table 28. Summary of Dominguez Gap Dry Weather Chemistry Results, 2010/2011. (continued)

Analyte	Sep 23, 2010	May 11, 2011
Microbiology		
Enterococcus (CFU/100 ml)	10U	31
Fecal Coliform (MPN/100 ml)	20	140
Total Coliform (MPN/100 ml)	1700	1300
Aroclors (ug/L)		
Aroclor 1016	0.022U	0.12U
Aroclor 1221	0.022U	0.12U
Aroclor 1232	0.022U	0.12U
Aroclor 1242	0.022U	0.12U
Aroclor 1248	0.022U	0.12U
Aroclor 1254	0.022U	0.12U
Aroclor 1260	0.022U	0.12U
Total Aroclors	0	0
Chlorinated Pesticides (ug/L)		
2,4'-DDD	0.005U	0.006U
2,4'-DDE	0.005U	0.006U
2,4'-DDT	0.005U	0.012U
4,4'-DDD	0.005U	0.006U
4,4'-DDE	0.005U	0.006U
4,4'-DDT	0.005U	0.006U
Total DDT	0	0
Aldrin	0.005U	0.006U
Dieldrin	0.005U	0.006U
Endrin	0.005U	0.006UJ-
Endrin aldehyde	0.005U	0.006U
Endrin ketone	0.005U	0.006UJ-
alpha-BHC	0.005U	0.006U
beta-BHC	0.005U	0.006U
delta-BHC	0.005U	0.006U
gamma-BHC (Lindane)	0.005U	0.006U
Endosulfan I	0.005U	0.006U
Endosulfan II	0.005U	0.006U
Endosulfan sulfate	0.005U	0.006UJ-
Heptachlor	0.005U	0.006U
Heptachlor epoxide	0.005U	0.006U
alpha-Chlordane	0.005U	0.006U
gamma-Chlordane	0.005U	0.006U
Oxychlordane	0.005U	0.006U
cis-Nonachlor	0.005U	0.006U
trans-Nonachlor	0.005U	0.012U
Total Chlordane	0	0
Methoxychlor	0.005U	0.006U
Mirex	0.005U	0.06U
Toxaphene	0.055U	0.6U

Bolded values with superscripts exceed criteria 1-Ocean Plan, 2-LA Basin Plan, 3-Cal. Fish & Game Freshwater, 4-Cal Fish & Game Saltwater, 5-Cal. Toxics Rule Freshwater, 6-Cal. Toxics Rule Saltwater, 7-National Non-Priority Freshwater, 8-National Non-Priority Pollutant Saltwater. U=not detected at the detection 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.

Table 28. Summary of Dominguez Gap Dry Weather Chemistry Results, 2010/2011. (continued)

Analyte	Sep 23, 2010	May 11, 2011
Organophosphates (ug/L)		
Bolstar (Sulprofos)	0.004U	0.2U
Chlorpyrifos	0.002U	0.002U
Demeton	0.002U	0.5U
Diazinon	0.004U	0.0015U
Dichlorvos	0.0066U	0.2U
Dimethoate	0.0066U	0.6U
Disulfoton	0.002U	0.1U
Ethoprop	0.002U	0.2U
Fensulfothion	0.002U	0.6U
Fenthion	0.004U	0.06U
Malathion	0.0066U	0.06U
Merphos	0.002U	0.06U
Methyl Parathion	0.002U	
Mevinphos	0.017U	0.1U
Phorate	0.013U	0.06U
Tetrachlorvinphos (Stirophos)	0.004U	0.2U
Tokuthion (Prothiofos)	0.0066U	0.06U
Trichloronate	0.002U	0.06U
Triazine (ug/L)		
Ametryn	0.011U	
Atraton	0.011U	
Atrazine	0.011U	
Cyanazine	0.011U	
Prometon	0.011U	
Prometryn	0.011U	
Propazine	0.011U	
Secbumeton	0.011U	
Simazine	0.011U	
Simetryn	0.011U	
Terbutryn	0.011U	
Terbutylazine	0.011U	
Pyrethroids (ug/L)		
Bifenthrin		0.0015U
Cyfluthrin		0.0015U
Cypermethrin		0.0015U
Fenpropathrin		0.0015U
L-Cyhalothrin		0.0015U
Permethrin		0.015U
Total Deltamethrin/Tralomethrin		0.003U
Total Esfenvalerate/Fenvalerate		0.0015U

Bolded values with superscripts exceed criteria 1-Ocean Plan, 2-LA Basin Plan, 3-Cal. Fish & Game Freshwater, 4-Cal Fish & Game Saltwater, 5-Cal. Toxics Rule Freshwater, 6-Cal. Toxics Rule Saltwater, 7-National Non-Priority Freshwater, 8-National Non-Priority Pollutant Saltwater. U=not detected at the detection 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.

TOXICITY RESULTS

Toxicity testing is required to be conducted at all sites except the Dominguez Gap Pump Station. Toxicity tests were conducted on subsamples of the composites collected for chemical analysis. Wet weather samples were collected from five storm events. Composite samples were collected during each of the storm events and tested with two species, the water flea (freshwater crustacean) and the sea urchin (marine echinoderm). All three stations were sampled during two of four storm events, two stations were sampled during two events and one station was sampled as part of the fifth and final stormwater monitoring effort.

Dry weather sampling 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 is 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.

Wet weather samples were collected from five storm events: October 6 2010, October 19-20 2010, November 21 2010, December 19 2010 and February 26 2011. Samples could not be collected from Bouton Creek from the first storm event due to the damage that occurred to the equipment. During the November 21, 2010 event, water volumes from Bouton Creek were only sufficient for chemical testing so bioassays were not conducted in association with this event. For storms yielding sufficient sample volumes, composite samples were tested with two species, the water flea (freshwater crustacean), and the sea urchin (marine echinoderm). Results of tests from all three stations are presented in Table 29 through Table 31 and Figure 39 through Figure 41. Complete toxicity test reports with CETIS summaries are included in Appendix B (CD only).

Ceriodaphnia Bioassays

Similar to the previous two years, *Ceriodaphnia* bioassay tests conducted on stormwater runoff collected during 2010/2011 showed no impacts on mortality and occasional small, yet measurable impacts on reproduction. All survival NOECs were 100% sample and all LC_{50}s were >100%. During the October 10 2010 storm there was measurably decreased water flea reproduction at the Los Cerritos Channel mass emission monitoring site, with the NOEC at 50% sample. Likewise, during the December 19 2010 storm there was measurably decreased daphnid reproduction at the Belmont Pump Station, with the NOEC at a concentration of 50% sample. The NOECs at all other stations in all other storms were 100% and the EC_{50}s were >100%. Over the entire storm season, less than 1 acute toxicity unit (TU_a) was measured in all tests conducted at each of the three stations, and no TIEs were triggered. Chronic toxicity units (TU_c) ranged from 1 to 2.

All daphnid bioassays met all test acceptability criteria (TAC) and all concurrent reference toxicant test results were within laboratory control chart limits.

Strongylocentrotus Bioassays

There was no measurable toxicity (no decreased fertilization) at any of the three stations during any of the five storms. NOECs were 50% sample and EC50s were >50% sample (Table 29 through Table 32). Acute toxicity in all sea urchin stormwater tests was below detection limits (2 TU_a), and no TIEs were triggered. Similarly, chronic toxicity was also below detection limits (2 TU_cs) in all samples. With this test, 50% concentrations are the highest that can be tested due to the need to use brine to bring the salinity up to appropriate levels.

All sea urchin bioassays met all test acceptability criteria (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 32 and Figure 42. Toxicity tests were conducted on samples from dry weather sampling events on September 22-23, 2010 and May 10-11, 2011. As with the wet weather monitoring, dry weather discharges from the Dominguez Gap Pump Station are not required to be tested for toxicity. This has not been an issue since dry weather discharges were not observed at the Dominguez Gap Pump Station from the start of the program eleven years ago until the recent completion of the wetlands project. The reconfiguration of this site now results in discharges during dry weather periods but the source of the water is the Los Angeles River which is diverted to provide infiltration and maintain the recently constructed Dominguez Gap wetlands system.

Since completion of the wetland project, water has sporadically been discharged to the Los Angeles River. The 2005 Environmental Impact Report (CH2MHill, 2005) indicated that diversions from the Los Angeles River were expected to average about 1.75 cfs on a year round basis, with up to 5 cfs in the summer months. Due to problems with the summer pump, discharges to the River during dry weather have often been controlled by periodic manual control of the larger, natural gas pumps. More recently, water levels in the basin have been maintained at a relatively constant level of 9-10 feet.

Los Cerritos Channel and Bouton Creek

The September 2010 dry weather samples from both Bouton Creek and Los Cerritos Channel showed minor toxicity to *Ceriodaphnia*. The NOECs for reproduction were 50% sample concentration (2 TU_c). The EC_{50} for the Bouton Creek sample was 90.4% sample (1.1 TUa) while that for the Los Cerritos Channel sample was greater than the undiluted sample (<1 TU_a). There was no detectable decrease in water flea survival in either sample, with the NOECs at 100% (1 TU_c) and the LC_{50s} at greater than 100% of the sample (<1 TU_a).

The May 2011 dry weather composite samples from both Bouton Creek and Los Cerritos Channel showed no measurable toxicity to water fleas. NOECs for survival and reproduction were 100% (1 TU_c) and both the LC_{50} and EC_{50} were greater than 100% (<1 TU_a).

The September 2010 dry weather samples from both the Los Cerritos Channel and Bouton Creek mass emission monitoring sites showed no measurable toxicity to sea urchin fertilization, with NOECs measuring 50% sample (2 TU_c) and EC_{50}s measuring >50% sample (<2 TU_a). The May 2011 sample from Bouton Creek likewise showed no measurable urchin toxicity, but the May sample from Los Cerritos Channel demonstrated minor toxicity, with a NOEC of 25% sample (4 TUc) and an EC50 of >50% sample (<2 TUa) No TIEs were triggered by these dry weather samples.

Toxicity Identification Evaluations (TIEs)

The trigger for TIE initiation in this program is 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**.** No bioassays performed during this monitoring period showed toxicity high enough to meet these criteria, and no TIEs were performed.

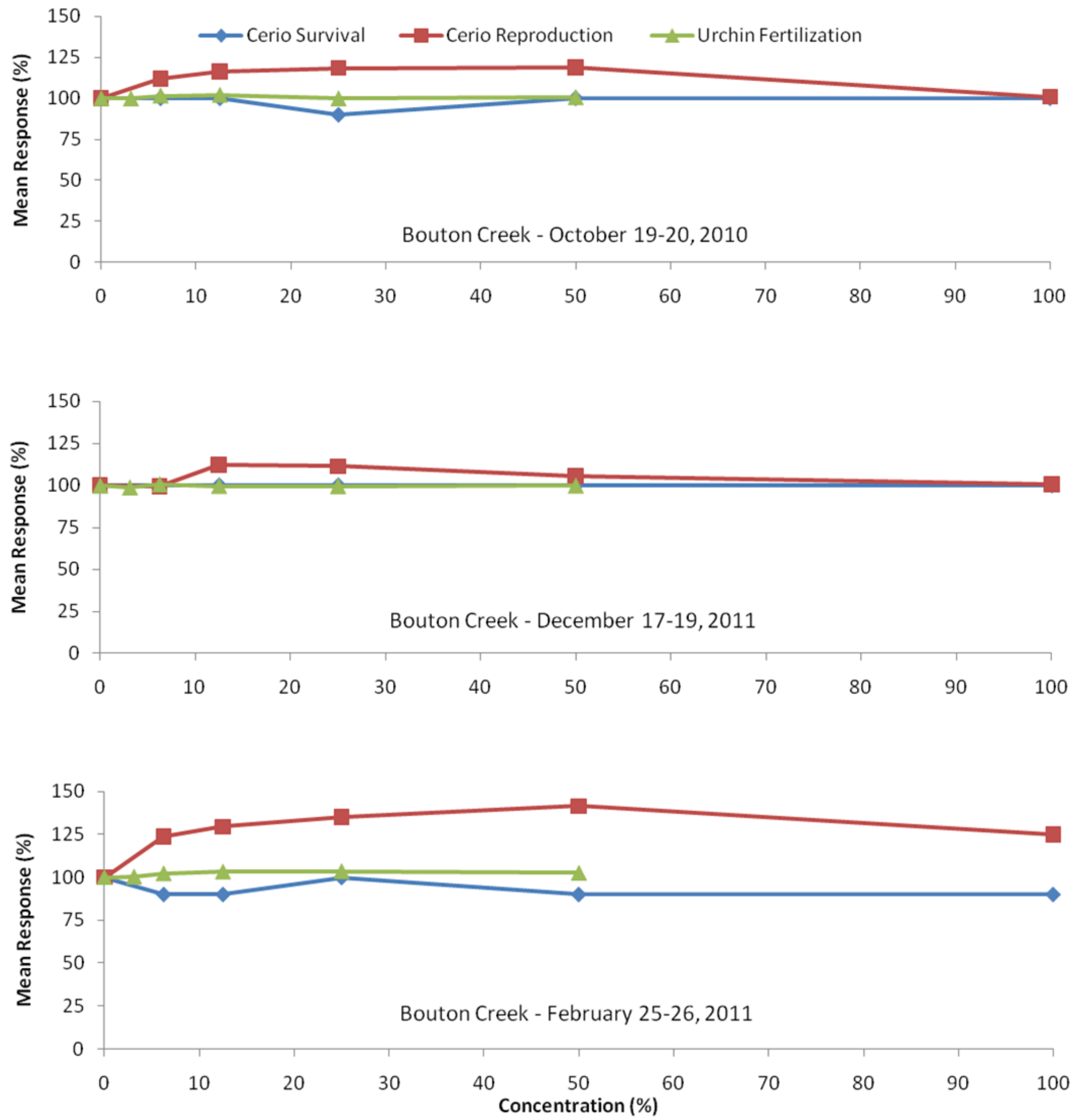


Figure 39. Toxicity Dose Response Plots for Stormwater Samples Collected at Belmont Pump during the 2010/2011 Season.

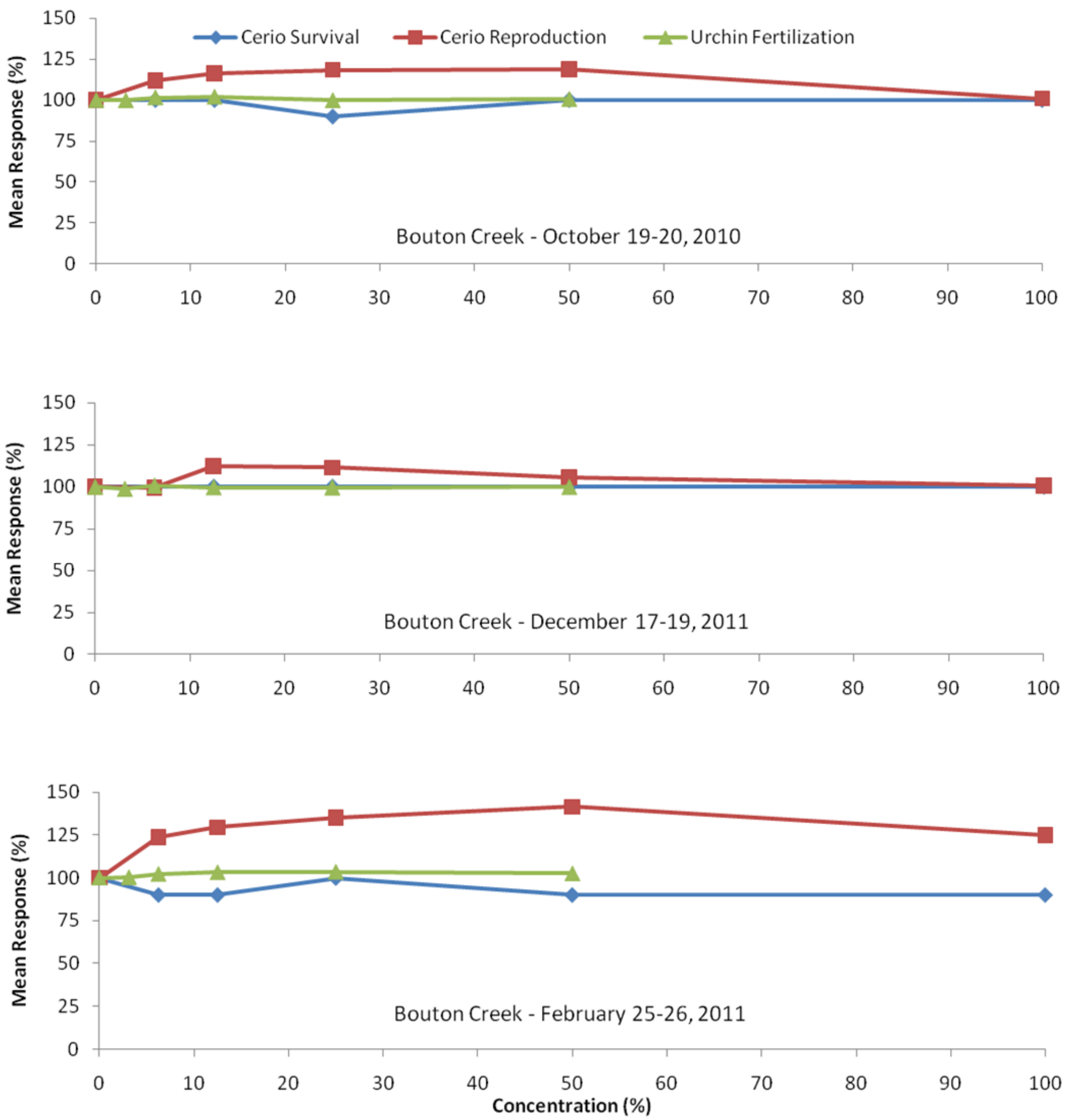


Figure 40. Toxicity Dose Response Plots for Stormwater Samples Collected at Bouton Creek during the 2010/2011 Season.

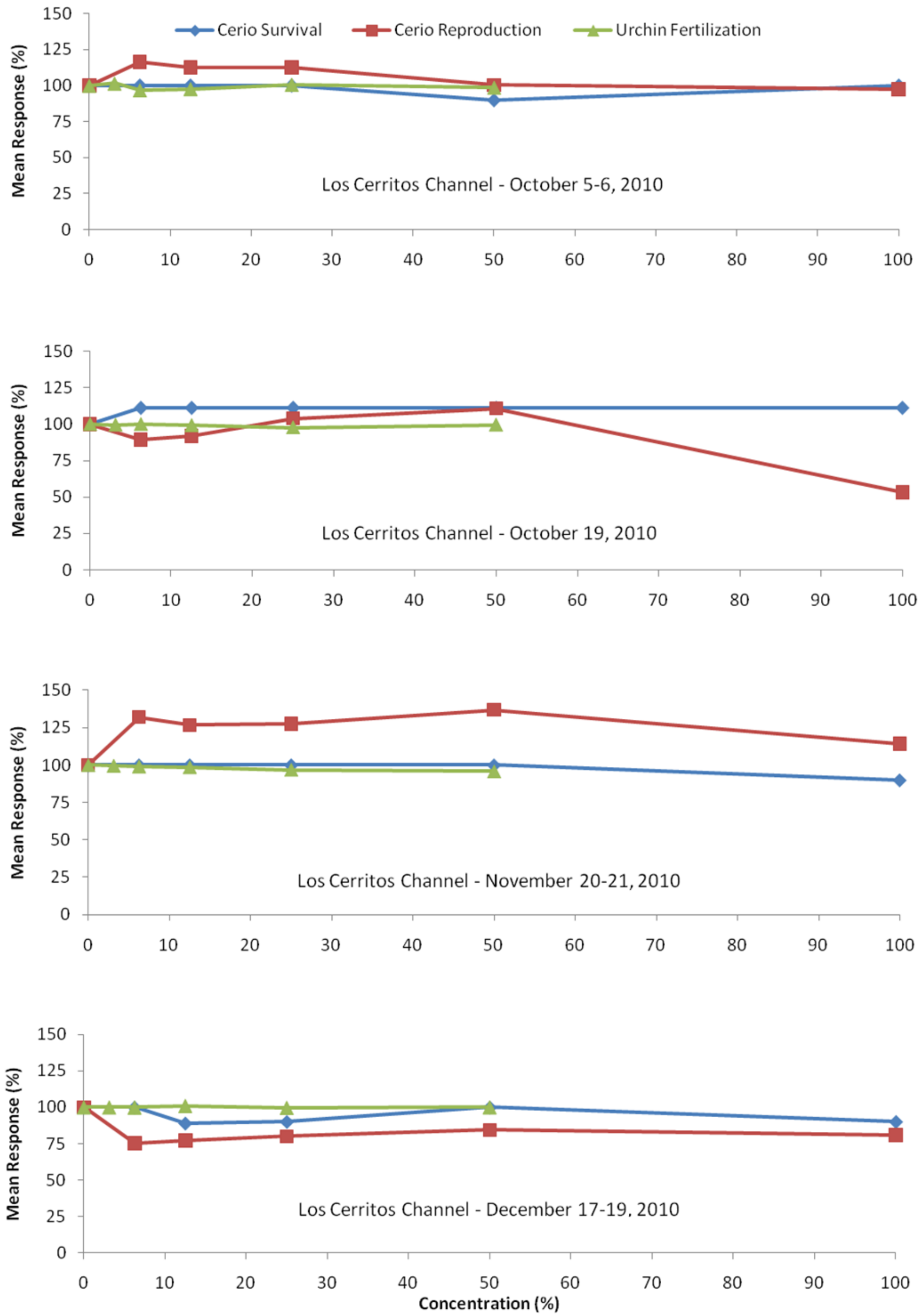


Figure 41. Toxicity Dose Response Plots for Stormwater Samples Collected at Los Cerritos Channel during the 2010/2011 Season.

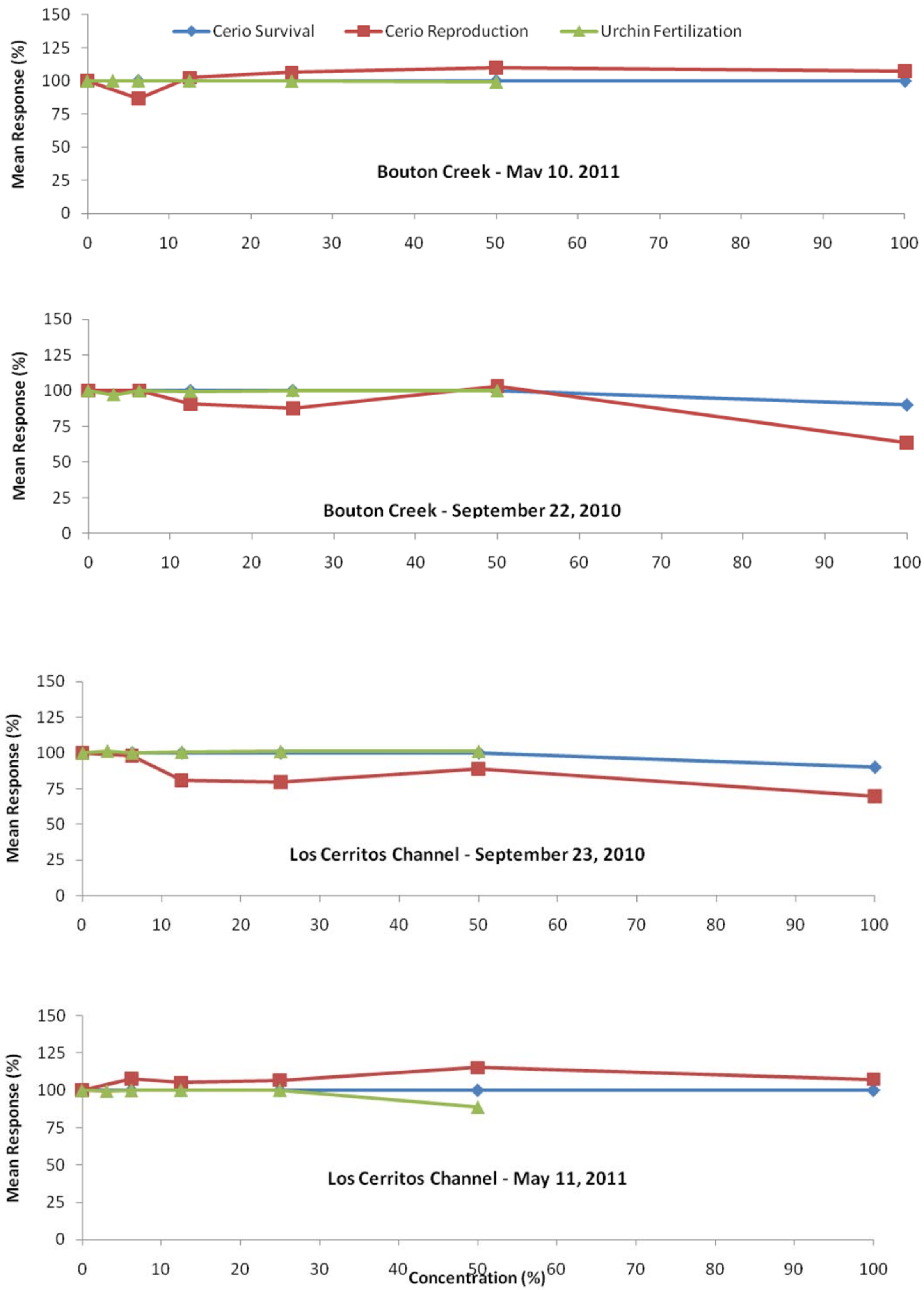


Figure 42. Toxicity Dose Response Plots for Dry Weather Samples Collected at Bouton Creek and Los Cerritos Channel during the 2010/2011 Season.

Table 29. Toxicity of Wet Weather Samples Collected from the City of Long Beach Belmont Pump Station during the 2010/2011 Monitoring Season.

Test results indicating toxicity are shown in bold type.

Date	Test	Test Response (% sample)			TU_a[d]	TU_c[e]
		NOEC[a]	LOEC[b]	Median Response[c]		
10/6/10	Water Flea Survival	100	>100	>100	<1	1
10/6/10	Water Flea Reproduction	100	100	>100	<1	1
10/6/10	Sea Urchin Fertilization	50	>50	>50	<2	2
10/20/10	Water Flea Survival	100	>100	>100	<1	1
10/20/10	Water Flea Reproduction	100	>100	>100	<1	1
10/20/10	Sea Urchin Fertilization	50	>50	>50	<2	2
11/21/10	Water Flea Survival	100	>100	>100	<1	1
11/21/10	Water Flea Reproduction	100	>100	>100	<1	1
11/21/10	Sea Urchin Fertilization	50	>50	>50	<2	2
12/19/10	Water Flea Survival	100	>100	>100	<1	1
12/19/10	**Water Flea Reproduction**	**50**	**100**	**>100**	**<1**	**2**
12/19/10	Sea Urchin Fertilization	50	>50	>50	<2	2

[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 30. Toxicity of Wet Weather Samples Collected from the City of Long Beach Bouton Creek Station during the 2010/2011 Monitoring Season.

Test results indicating toxicity are shown in bold type.

Date	Test	Test Response (% sample)			TU_a[d]	TU_c[e]
		NOEC[a]	LOEC[b]	Median Response[c]		
10/20/10	Water Flea Survival	100	>100	>100	<1	1
10/20/10	Water Flea Reproduction	100	>100	>100	<1	1
10/20/10	Sea Urchin Fertilization	50	>50	>50	<2	2
12/19/10	Water Flea Survival	100	>100	>100	<1	1
12/19/10	Water Flea Reproduction	100	>100	>100	<1	1
12/19/10	Sea Urchin Fertilization	50	>50	>50	<2	2
2/26/11	Water Flea Survival	100	>100	>100	<1	1
2/26/11	Water Flea Reproduction	100	>100	>100	<1	1
2/26/11	Sea Urchin Fertilization	50	>50	>50	<2	2

[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 31. Toxicity of Wet Weather Samples Collected from the City of Long Beach Los Cerritos Channel Station during the 2010/2011 Monitoring Season.

Test results indicating toxicity are shown in bold type.

Date	Test	Test Response (% sample)			TU_a[d]	TU_c[e]
		NOEC[a]	LOEC[b]	Median Response[c]		
10/6/10	Water Flea Survival	100	>100	>100	<1	1
10/6/10	Water Flea Reproduction	100	>100	>100	<1	1
10/6/10	Sea Urchin Fertilization	50	>50	>50	<2	2
10/20/10	Water Flea Survival	100	>100	>100	<1	1
10/20/10	**Water Flea Reproduction**	**50**	**100**	**>100**	**<1**	**2**
10/20/10	Sea Urchin Fertilization	50	>50	>50	<2	2
11/21/10	Water Flea Survival	100	>100	>100	<1	1
11/21/10	Water Flea Reproduction	100	>100	>100	<1	1
11/21/10	Sea Urchin Fertilization	50	>50	>50	<2	2
12/19/10	Water Flea Survival	100	>100	>100	<1	1
12/19/10	Water Flea Reproduction	100	>100	>100	<1	1
12/19/10	Sea Urchin Fertilization	50	>50	>50	<2	2

[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 32. Toxicity of Dry Weather Samples from the City of Long Beach Mass Emission Monitoring Sites during the 2010/2011 Monitoring Season.

Test results indicating toxicity are shown in bold type.

Station	Date	Test	Test Response (% sample)			TU_a[d]	TU_c[e]
			NOEC[a]	LOEC[b]	Median Response[c]		
Bouton Creek	9/22/10	Water Flea Survival	100	>100	>100	<1	1
Bouton Creek	**9/22/10**	**Water Flea Reproduction**	**50**	**100**	**90.4**	**1.1**	**2**
Bouton Creek	9/22/10	Sea Urchin Fertilization	50	>50	>50	<2	2
Los Cerritos	9/23/10	Water Flea Survival	100	>100	>100	<1	1
Los Cerritos	**9/23/10**	**Water Flea Reproduction**	**50**	**100**	**>100**	**<1**	**2**
Los Cerritos	9/23/10	Sea Urchin Fertilization	50	>50	>50	<2	2
Bouton Creek	5/10/11	Water Flea Survival	100	>100	>100	<1	1
Bouton Creek	5/10/11	Water Flea Reproduction	100	>100	>100	<1	1
Bouton Creek	5/10/11	Sea Urchin Fertilization	50	>50	>50	<2	2
Los Cerritos	5/11/11	Water Flea Survival	100	>100	>100	<1	1
Los Cerritos	5/11/11	Water Flea Reproduction	100	>100	>100	<1	1
Los Cerritos	**5/11/11**	**Sea Urchin Fertilization**	**25**	**50**	**>50**	**<2**	**4**

[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.

THIS PAGE INTENTIONALLY LEFT BLANK

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 stormwater and dry weather discharges are compared with various receiving water quality criteria. Temporal trends over the past ten years are examined for principal contaminants of concern. The functional relationships between environmental factors, solids and principal contaminants of concern are explored in order to better understand long-term trends. 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, 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 33).

Wet Season Water Quality

Water quality criteria used as benchmarks in freshwater environments are summarized in Table 34. Criteria applicable to saline conditions are summarized separately in Table 35. 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 17) also identify various benchmarks that are exceeded for each 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 34 are based upon a default hardness of 50 mg/L. Evaluation of any possible exceedance of hardness-dependent criterion is based upon the actual hardness EMC for that site and event therefore the criterion will change. Hardness measured during wet weather events is often much 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 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 the coastal waters of Long Beach are considered enclosed bays and estuaries. Water quality criteria provided in the 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). USEPA (2009) National Recommended Water Quality Criteria provide an additional reference for many of the nonpriority pollutants included in the monitoring program.

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).

As noted in previous years, the pH of stormwater runoff is typically slightly acidic. This is mostly due to dissolved carbon dioxide that the rain “scrubs” from the atmosphere. Other gases such as sulfur dioxide (SO_2) and nitrogen oxides (NO_x) can cause further acidification of the rainfall. The National Atmospheric Deposition Program (NADP, 2010) indicated that pH associated with rainfall during 2009 was typically 5.4-5.5 in the general vicinity of Los Angeles County area. This is slightly higher than the pH of 5.1 reported in the NADP, 2007 annual report. Over the past 30 years, the pH of rainfall has shown evidence of increasing throughout the United States although these increases have been most notable on the east coast. Rainfall in the northeastern portion of the United States is typically much more acidic due largely to use of coal-fired electrical generation plants. In 2009, the average pH values measured in precipitation from the northeastern United States was approximately 4.6 to 4.7, 0.8 units lower than the Los Angeles basin.

The water quality criteria for pH included in the Los Angeles Basin Plan (CRWQCB, Los Angeles, 1994) indicate that surface waters should be maintained in the range of 6.5 to 8.5. During the 2010/11 wet season, the pH of stormwater discharges met Basin Plan criteria (Table 36 through

Table 37) except during one storm at Bouton Creek on October 19-20. Although pH measurements in stormwater have typically met Basin Plan criteria at all sites, this has not always been the case. In earlier years of the program about 25% of the stormwater samples had measured pH values that were below the lower Basin Plan limits of 6.5. Due to the acid nature of rainfall, it is unusual to have stormwater with measured pH values greater than the upper Basin Plan limit of 8.5. Overall, pH measurements have exceeded the upper standard of 8.5 in about 2 to 5 percent of the storm events. Runoff with pH concentrations in excess of 8.5 are attributed to the low buffering capacity (alkalinity) in most stormwater runoff. This has only happened during a few small volume storm events and has not been unique to any one monitoring site.

Although care is taken to get accurate pH measurements, it is well-known that water with low ionic strength can make it difficult to get a stable measurement. Nevertheless, it is possible that some historical measurements were impacted by this problem. Sensors and measurement techniques for addressing water with low ionic strength have improved over the past decade.

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 typically exceed Basin Plan water quality criteria but also have shown a tremendous degree of variability of 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. A graphical comparison of bacterial concentrations measured at each site during all storm events (Figure 43) suggests that variability is high and differences among sites are minimal. Overall Enterococcus and fecal coliform average about 104 mpn/100 ml. Total coliform concentrations at each site average roughly an order of magnitude higher or 105 mpn/100 ml.

Over the past 11 years, five total recoverable metals including aluminum, copper, iron, lead and zinc have frequently exceeded benchmark reference values. One of these five metals, iron, is only listed as a chronic criterion on the National Non Priority Pollutant list for freshwater. Criteria for total recoverable aluminum exist for drinking water (Basin Plan criteria) and aquatic life as a nonpriority pollutant (Table 34). Both total recoverable aluminum and iron are abundant in soils and often used to normalize other metals data to better evaluate enrichment from anthropogenic activities. Elevated levels of both iron and aluminum are normal during storm events (Table 34) with increased loads of sediment and are not typically considered to be a major concern.

Concentrations of total recoverable copper, lead, and zinc measured in runoff from the mass emission sites exceeded Ocean Plan criteria 63% of the time. Nickel was the only other total recoverable metals found to exceed Ocean Plan criteria during the 16 station events monitored during the 2010/2011 wet season. A single exceedance occurred in association with runoff collected from the Belmont Pump Station. Historically, exceedances of the Ocean Plan total recoverable nickel criterion have been most frequently associated with the Belmont Pump Station. Total recoverable concentrations of three metals (copper, lead and zinc) have frequently exceeded Ocean Plan criteria over the past ten years of the stormwater monitoring program. Total recoverable concentrations of these metals have met the criteria only when TSS concentrations were also low.

In 1993 (USEPA, 1993) EPA recognized that, in most cases, measurement of metals in the dissolved form provided the most accurate assessment of potential stress to aquatic ecosystems. As a result water quality criteria promulgated by EPA as the "California Toxics Rule" (CTR; USEPA, 2000) were based upon the dissolved fraction for both freshwater and saltwater. In the case of freshwater, criteria for six of the eight metals included in the monitoring are functions of hardness. Low concentrations of hardness lead to low water quality criteria. With increasing hardness, toxicity decreases and the water quality criteria for these six metals increase. The saltwater criteria included in the CTR are applicable in bays and estuaries of California.

Dissolved copper exceeded the CTR acute freshwater criteria in 75% of the stormwater samples this wet season. The only other metal exceeding these criteria was zinc (18%). Discharges from the Dominguez Gap were again found to have the best water quality associated with any of the sites. Copper and lead acute freshwater criteria were only exceeded during one of the four events monitoring at this site.

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. Chlorinated pesticides are hydrophobic, lipophilic and very stable. Due to the hydrophobic nature of these compounds, chlorinated pesticides strongly associate with suspended solids which settle and accumulate in bottom sediments. Organochlorine pesticides most often detected in stormwater runoff have been DDT compounds, primarily 4,4'-DDE, and chlordane compounds. This year the frequency of measurable quantities of all organochlorine pesticides decreased with only 4,4' DDE being detected once during the first event of the season at both the Belmont Pump Station and Los Cerritos Channel. As is often the case, this compound was present at very low levels (less than 2 times the reporting limits).

Technical chlordane, another organochlorine compound, is a complex mixture of approximately 140 compounds but NOAA considers seven compounds as representative of the major components of technical chlordane. These include alpha-chlordane, gamma-chlordane, cis-nonachlor, trans-nonachlor, heptachlor, heptachlor epoxide and oxychlordane. During the 2008/2009 storm season, chlordane was detected in 70% of the stormwater composites including all three monitored events at the Belmont Pump Station. Despite being completely banned for over 20 years, chlordane was detected at 0.336 µg/L during the first monitored event of the2008/2009 monitoring season at the Belmont Pump Station.

This was the highest concentration measured at any monitoring station since the program was initiated 12 years ago. Last year (2009/2010) the highest concentration of chlordane compounds (0.308 ug/l) once again was measured in runoff from the Belmont Pump Station. This year, chlordane remained most common in runoff from the Belmont Pump Station and this site continued to produce the highest concentrations but maximum values were now approximately 10% of those measured in 2008/2009.

Chlordane was detected in 17 of the 19 stormwater samples (~90%) taken this season but only exceeded the 0.1 µg/L Basin Plan criterion once each at the Belmont Pump Station, the Los Cerritos Channel site and once at the Dominguez Gap Pump station. Due to the larger size of the Los Cerritos Channel watershed, total loads of chlordane from the Los Cerritos Channel are often higher than those from the Belmont Pump Station despite similar or slightly lower concentrations (Table 19 and Table 21).

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. Diazinon was detected in eight of the 16 stormwater samples from the 2010/2011 season but, in all cases, concentrations remained well below the available criterion (0.08 µg/L; Siepmann and Finlayson, 2002). During the previous three years, chlorpyrifos had not been detected in any samples. Although this compound was detected in single samples from each of three sites, concentrations remained below the suggested criterion of 0.012 µg/L. As will be discussed further below, the near elimination of these pesticides in stormwater discharges has resulted in substantial decreases in toxicity to *Ceriodaphnia*.

Malathion, another organophosphate pesticide used as a residential pesticide, continues to be common in stormwater samples. Malathion is far less toxic to daphnids with reported LC_{50}s ranging from 1.14 to 3.18 µg/L (TDC, 2003). With both diazinon and chlorpyrifos being taken off the shelves, detection of malathion in stormwater sampling became more common. Since the 2006/2007 season, malathion has been detected in 65 to 100 percent of the samples. This season, just 31 percent of the samples had detectable quantities of malathion. None exceeded the California Department of Fish and Game suggested chronic criterion of 0.43 µg/L. Malathion concentrations continue to be highest during early season events with concentrations decreasing substantially later in the season. None of the reported concentrations were high enough to be expected to exert a toxic response in the *Ceriodaphnia* (waterflea) tests.

The triazine pesticides continue to be uncommon in stormwater runoff. In previous years, the only triazine pesticides detected in stormwater or dry weather discharges have been prometon, simazine and cyanazine. All three typically occur at levels of less than 10 times the project reporting limits. This year prometon was the only compound detected in early season events. Midseason, the triazine pesticides were dropped from the analytical list and replaced by pyrethroid pesticides.

Pyrethroid pesticides have largely replaced diazinon and chlorpyrifos for pest control in the urban environment. 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. Although pyrethroids were not added to the analytical suite until mid-season, concentrations tended to decline with the progression of the storm season. Many of the pyrethroids were measured at concentrations that would be expected to cause toxicity to *Hyallela* or *Americamysis* but generally low enough that *Ceriodaphnia* would not be expected to show impacts (Table 38). In addition, Yang et al. (2006) have shown that suspended solids can inhibit toxicity since pyrethroids would tend to partition with the solids and not be bioavailable. Since these compounds are highly hydrophobic, they are best known for the toxicity that they excerpt on the benthos. These compounds are more known for toxicity in sediments. Although they 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.*

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 including the elimination of dry weather flow at the Belmont Pump Station. The location for monitoring dry weather discharges in Bouton Creek site was relocated 1,250 feet upstream due to low flows making sampling impossible for the past two years. Flows at this site have not been sufficient to clear the saltwater from the channel to the degree that samples could be taken to characterize the dry weather flow.

The is the second 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.

It is notable that, since reconfiguration of the wetland system, very few of the constituents measured in dry weather discharges at the Dominguez Gap Pump Station, including bacteria, were found to exceed any of the available water quality benchmarks in all four surveys. With the exception of simazine which was detected in the first dry weather survey of the previous season, all organic constituents (aroclors, chlorinated pesticides, organophosphate pesticides and triazine pesticides) were below detection limits. Pyrethroid pesticides, which were monitored for the first time this year, were all below very low project detection limits. Concentrations of metals subject to the Los Angeles River TMDL have met the TMDL targets and are generally lower than measurements made within the Los Angeles River by the Los Angeles County Stormwater Program.

Low concentrations of suspended solids are the primary characteristic of dry weather discharges. Discharges sampled during all dry weather surveys had TSS concentrations ranging from 5.8 to 15 mg/L. In general, these low concentrations of suspended particulates result in total recoverable metal concentrations that meet all water quality criteria (Table 37). Trace metals associated with dry weather discharge have predominantly been in the dissolved form largely due to lower concentrations of suspended solids. Copper is the only metal typically found to exceed Ocean Plan water quality criteria that are based upon total metals. This year a single exceedance of the chronic freshwater criterion occurred in the Los Cerritos Channel but the CTR chronic saltwater criterion was exceeded in both dry surveys at Bouton Creek and in the Los Cerritos Channel.

Another important characteristic of dry weather discharges is the hardness of these discharges. Hardness as $CaCO_3$ is consistently elevated in dry weather flows from the mass emission sites. Hardness concentrations measured in dry weather samples this season ranged from 140 to 340 mg/L. The lowest hardness values occurred in water from the Los Cerritos Channel site while water sampled from the Dominguez Gap Pump station had the highest hardness values. Hardness tends to mitigate the effects of the dissolved metals (Table 26 through Table 28) resulting in very few water quality exceedances for most metals. Dissolved copper remains an occasional exception to this general rule.

The pH of dry weather flows exceeded the upper Basin Plan criterion of 8.5 during one survey at both the Los Cerritos Channel and Bouton Creek. Occurrences of elevated pH in dry weather discharges within shallow open concrete channels appear to be both common and part of a natural process associated with photosynthetic activity (Kinnetic Laboratories, Inc. 2005 – Appendix B). Evidence suggests that pH increases during the day. Algae, that are very abundant in the channels, during the summer, consume carbon dioxide (CO_2) while undergoing photosynthesis. High photosynthetic activity is typically evident in the form of the high concentrations of dissolved oxygen in the water as well as visual evidence of bubbles being generated as the water becomes oversaturated from oxygen. The removal of CO_2 from the water causes bicarbonate and carbonate ions to react with hydrogen ions (H^+) to form more CO_2. The loss of H^+ from the water causes the pH to increase during daylight hours. During the night, respiration of the algae and bacteria in the channel cause CO_2 to be released and oxygen to be consumed. This causes a pH drop during the night. This diurnal cycling of pH is a common occurrence in open waterways with shallow, sluggish flow. The process is further influenced by the alkalinity or buffering capacity of the water such that high alkalinity water should be expected experience less extreme diurnal changes in pH. A detailed examination of pH fluctuations in the Los Cerritos Channel is incorporated in Appendix D of this report.

As in all previous years, copper remains the primary constituent of concern in dry weather discharges although it has been uncommon for dissolved copper to exceed the CTR freshwater criterion at most stations due to the elevated hardness of dry weather discharges. Dissolved copper in dry weather discharges from the Los Cerritos Channel exceeded the CTR freshwater only during the May 2011 survey. All dry weather measurements of dissolved copper in both Bouton Creek and the Los Cerritos Channel exceeded CTR saltwater criterion of 3.1 µg/L (Table 26, Table 27).

The recent TMDL for metals in the freshwater portion of the Los Cerritos Channel (EPA 2010) set a dry weather target of 19.1 µg/L for total copper. This was exceeded during the May, 2011 survey when total copper was reported as 25 µg/L.

The 30-day average ammonia-N criterion was not exceeded during both of the dry weather surveys conducted this year at all three sites. For the Dominguez Gap Pump Station, calculation of the criterion was based upon use of instantaneous temperature and pH measurement taken at the site during daylight hours. For Bouton Creek, a 30-day average temperature derived from an in-situ thermistor was used along with a single point measure of pH. Calculations of the ammonia-N criteria at the Los Cerritos Channels used data from a pH/temperature datalogger installed at the site (see Appendix D).

Triazine pesticides were analyzed during the first dry weather event and pyrethroid pesticides were incorporated during the second survey. Very few triazine pesticides (Simazine, Atrazine and Prometon) continue to be detected in association with dry weather surveys. Each of these compounds was detected at only one site and each was very near the reporting limit of 0.01 µg/L. The infrequent presence of these compounds in stormwater runoff and consistently low concentrations when they are detected led to replacing this group of organic compounds with the pyrethroid pesticides.

Most pyrethroids were not detected in dry flows. None were detected at the Dominguez Gap Pump Station. Bifenthrin was the only pesticide in this group that was detected above the reporting limits. Three other compounds were identified present at levels between the Method Detection Limit (MDL) and the reporting limit.

TEMPORAL TRENDS OF STORMWATER POLLUTANTS

Temporal trends in concentrations of selected trace metals, three organophosphate pesticides, TSS and bacteria have been tracked since the first dry weather surveys conducted in 2000. Time series plots of these contaminants are provided in Appendix C. Separate time series are presented for dry and wet weather. The metals and organic compounds included in this assessment are those that are 1) often detected in both stormwater and dry weather discharges and/or 2) are suspected to be primary sources of toxicity. Time series include total and dissolved concentrations of five trace metals; cadmium, copper, nickel, lead and zinc. Due to the typically large differences between total and dissolved lead concentrations, separate graphics are included to detail changes in dissolved lead over time.

With the exception of diazinon and chlorpyrifos, visual review of the data has not shown obvious increases or decreases in concentration over time. Since residential use of diazinon and chlorpyrifos was phased out, these pesticides have rarely been detected. Prior to this year, chlorpyrifos had not been detected in runoff since November 2001. Very low concentrations were detected in both Bouton Creek (0.0023 µg/L) and the Los Cerritos Channel (0.011 µg/L) during one event. In both cases, concentrations were below CDF&G aquatic life acute criterion of 0.02 µg/L. Diazinon continues to be detected but the frequency and magnitude of these detections has dramatically declined. The highest concentration of diazinon measured this past year was 0.012 µg/L from one event at Bouton Creek. In all cases, concentrations remain well below the CDF&G aquatic life criterion of 0.08 µg/L.

Most long-term trends tend to be obscured by factors that are not evident when exclusively looking at changes in concentrations. However, some general trends noted in previous years continue to be reflected in the data.

- Dissolved metals tend to have very different responses to wet and dry weather conditions. Dissolved concentrations of three metals (cadmium, copper, and nickel) do not vary substantially between wet and dry weather periods although dissolved copper is often highest in early season storm events. Concentrations of two other dissolved metals (zinc and lead) tend to increase in response to storm events.
- Concentrations of total copper, lead and zinc are consistently higher in association with storm flows. All three are strongly associated with suspended sediment during storm events.
- Malathion, another organophosphate pesticide, continues to be commonly detected in stormwater at levels exceeding national nonpriority pollutant guidelines but has not been implicated as a source of significant toxicity. Highest concentrations occur early in the storm season.
- Fecal indicator bacteria typically exceed Basin Plan water quality criteria during both wet and dry weather monitoring (Appendix C). Interestingly, fecal indicator bacteria measured in association with the first four dry weather monitoring events conducted at the Dominguez Gap Pump Station were all below applicable water quality criteria. In addition, both total and fecal coliform analyzed in water collected from the Los Cerritos Channel were also below the water quality criteria during the one dry weather survey this year and two dry weather surveys last year. Concentrations of *Enterococcus* in the Los Cerritos Channel met standards during both dry weather surveys.

Over the first six to seven years of the monitoring effort stormwater discharges at the Dominguez Gap Pump Station were uncommon and, when they occurred, concentrations of TSS and metals were among the lowest encountered at the four mass emission sites. Some of the highest concentrations of TSS occurred during storm events monitored during the 2007/2008 and 2008/2009 seasons exceeding those of the 2004/2005 season when the seasonal rainfall was nearly 30 inches. Although the 2009/2010 season was the first year where rainfall exceeded long-term averages, TSS in discharges from the Dominguez Gap Pump Station showed some sign of dropping despite one event where the TSS was the third highest recorded at this site. Even with the much higher rainfall experienced this year, TSS concentrations in discharges from the Dominguez Gap Pump Station ranged from 31 to 52 mg/L which is below the long-term mean. Similar trends remain evident for total recoverable trace metals such as lead, copper and zinc that are strongly associated with suspended solids.

The apparent changes in quantity and quality of stormwater discharges at the Dominguez Gap Pump Station are believed to be associated with both soil disturbances that occurred during the construction phase and changes in the operation of the Pump Station to help establish and maintain the wetlands. As expected, full development of the wetland vegetation appears to have resulted in decreases in concentrations of TSS and trace metals.

Although the Dominguez Gap Pump Station and associated wetlands have shown significant Improvement the potential exists to further improve water quality and have fewer discharges. Water levels in the wetlands during the early part of the season were maintained at 7-8 feet which provided capacity for at least an inch of runoff. As the season progressed, water levels were often in excess of 10 feet such that relatively small storm events could cause discharges to the River. We are continuing to work with the Los Angeles County Department of Public Works in order to reach a common ground as to maintenance practices that will balance both wetland and stormwater benefits in accordance with the EIR.

RELATIONSHIPS OF POLLUTANTS WITH TSS AND ENVIRONMENTAL FACTORS

Correlation analysis (Table 39) conducted on pooled data from all mass emission monitoring sites provided insight as to the degree of linear correlation of major environmental predictor variables, TSS and metals. Correlation analysis was based upon the non-parametric Spearman Rho which uses ranked data instead of actual values. Several environmental variables including maximum rainfall intensity, total seasonal rainfall at the start of an event, antecedent rainfall (inches), and duration of rainfall were excluded from the correlation matrix since initial processing indicated that they did not typically provide sufficient explanation for variation in most pollutants.

Overall, total rainfall tended to have a dilution effect with respect to concentrations of TSS and both total and dissolved metals. Dissolved copper exhibited the largest inverse relationship with total rainfall. Although correlations were significant, the coefficients of determination for total rainfall and contaminants suggested that total rainfall was a minor factor for most pollutants. The number of days since the last rain event (AnteDay– antecedent rain days) was positively correlated with TSS and all total and dissolved metals except for dissolved cadmium and total lead.

Concentrations of TSS were strongly correlated with total recoverable concentrations of all four metals. This was most evident for total lead that had a Spearman Rho correlation coefficient of 0.818 and a coefficient of determination of 0.669.

Total recoverable concentrations of all four total metals tended to exhibit high linear correlations with each other. Similarly, dissolved concentrations of each of the four metals tended to be correlated with each other. This was most evident with dissolved copper and zinc. Concentrations of these two dissolved metals had a Pearson correlation coefficient of 0.856.

Multiple linear regressions were conducted with each dissolved and total trace metal to provide additional information to model and understand factors controlling these constituents (Table 38). Variations in both total lead and total cadmium were primarily attributable to concentrations of TSS. Based upon the adjusted squared multiple R, variation in concentrations of total metals can be largely explained 64.6 to 76.9 percent. In each case, TSS is the primary factor followed by the number of dry weather days preceding an event (ANTEDAY), total seasonal rainfall (SEASONRAIN), and the duration of the event (DURATION). Total runoff (TOTFLOW) and total rainfall (TOTRAIN) primarily had an inverse effect on the concentrations of dissolved metals. Overall small storm events preceded by a long period of dry weather tend to yield the highest concentrations of dissolved metals. These results are very similar to an analysis of stormwater discharges in Sacramento (Ruby and LWA, 2005) which has similar weather pattern to that of Southern California.

SPATIAL DIFFERENCES IN CONCENTRATIONS OF TRACE METALS AND TSS

Box plots were used to visually compare the distribution of EMCs measured at each mass emission site for fecal indicator bacteria and TSS (Figure 43) total and dissolved cadmium and copper (Figure 44) and total and dissolved zinc and lead (Figure 45). Visual comparisons suggest that there were significant differences among monitoring sites for some of these analytes. The nonparametric Kruskal-Wallis Test was used to determine if distributions at each site are from the same population. If the Kruskal-Wallis test indicated that significant (p=0.05) differences existed among sites, then the Steel-Dwass-Critchlow-Fligner multiple pairwise comparisons test was used to determine which site or groups of sites differ from the others.

A summary of these tests is provided in Table 41. A number of dissolved and total metals were found to be significantly lower in discharges from the Dominguez Gap Pump Station. These included total cadmium, dissolved and total copper, and dissolved and total zinc. In the case of lead, no significant differences were evident among stations for dissolved lead but runoff from both the Dominguez Gap Pump Station and Bouton Creek had significantly lower concentrations of total lead in stormwater discharges. Overall, tests confirmed that concentrations of most metals were significantly lower at 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.

TOXICITY

The following sections address toxicity as expressed during both dry and wet weather periods, examine long-term (between years) and short-term (within seasons) trends, provide a comparison with toxicity in other Southern California areas, and examine sources of toxicity.

Stormwater Toxicity

Four wet weather samples from the Belmont Pump and Los Cerritos Channel stations and three samples from the Bouton Creek station were analyzed for toxicity during the monitoring period. Five storms were collected over a period of five months. The first storm of the season occurred in October 2010 and the fifth storm was sampled in February of 2011. All three stations were sampled during the second and fourth storms. Only Belmont Pump and Cerritos Channel were sampled during the first and third storms and only Bouton Creek was sampled during the fifth storm. All eleven of those samples were tested with water fleas and sea urchins (22 total bioassays).

None of the samples tested exhibited measurable toxicity to water flea survival. Survival NOECs were 100% sample (1 TU_c) and LC_{50}s were >100% sample (<1 TU_a). Urchin tests exhibited no measurable toxicity in four of five storms, with NOECs of 50% sample (2 TU_c) and EC_{50}s of >50% sample (<2 TU_a).

The October 20 2010 sample from the Los Cerritos Channel and the December 19, 2010 sample from Belmont Pump Station were the only stormwater samples that produced measurable toxicity to water flea reproduction. The NOECs for those samples were 50% (2 TU_c) and the EC_{50}s were >100% (<1 TU_a). The remaining nine samples showed reproductive NOECs of 100% sample (1 TU_c) and EC_{50}s of >100% sample (<1 TU_a). Acute toxicity was not sufficient to trigger a TIE.

Statistical analysis of the sea urchin data from the Los Cerritos Channel station during the November 21, 2010 storm indicated significantly decreased fertilization in the highest (50%) sample concentration. Close examination of those data revealed a high level of fertilization (94%) in that sample concentration and that the PMSD for the test was very low (3.84%) due to very low variability among replicates. Our professional opinion is that the statistically significant result was a Type 1 Error (False Positive) and that the true NOEC was 50%.

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 dry weather flows at that station first started being bypassed to the sanitary sewer.

Neither the September 2010 nor the May 2011 dry weather samples from Bouton Creek and the Los Cerritos Channel produced measurable lethal toxicity (NOECs = 100%) to water fleas. The September 2010 dry weather samples from both stations produced slightly decreased reproduction (NOECs = 50%, 2 TU_c) in water fleas. The May 2011 samples showed no reproductive effects, with NOECs of 100% sample (1 TU_c). None of the four dry weather samples showed measurable toxicity to sea urchin fertilization. NOECs were 50% sample (2 TU_c) and EC_{50}s were >50% (<2 TU_a). Acute toxicity was not sufficient to trigger a TIE.

Historical Toxicity Trend

Figure 47 and Figure 49 summarize chronic toxicity of stormwater to sea urchin fertilization and water flea reproduction, respectively, throughout the eleven years of the City's monitoring program. Figure 46 and Figure 48 provide similar summaries of dry weather chronic toxicity for urchins and water fleas, respectively.

Sea urchins have shown more instances of moderate to high (>8 TU_c) wet weather toxicity than have water fleas (Figure 47 and Figure 49). 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 2008/2009. No such episodes occurred during either the current (2010/2011) or the immediately previous (2009/2010) monitoring programs.

Figure 49 shows a virtual absence of wet weather water flea toxicity after the 2001/2002 storm season at all three stations, except for sporadic episodes of minor to moderate reproductive effects in 2004/2005 and 2006/2007. 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 and 2010/2011 monitoring programs continue to suggest that water flea toxicity is almost undetectable in wet weather samples.

Dry weather samples were negligibly toxic to both species (Figure 46 and Figure 48) 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. Water from the Los Cerritos Channel exhibited elevated toxicity in spring and fall samples of the 2007/2008 program and in the spring of 2008/2009. Minor inhibition of fertilization was observed in the dry weather discharges from Bouton Creek taken in the fall of 2009/2010 and during dry weather sampling during the fall of 2010/2011 at both the Bouton Creek site and in the 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. Toxicity to sea urchins has varied widely over the storm seasons at each of the three stations. Figure 47 shows that stormwater samples exhibiting urchin toxicity of 16 TU_c or more have been encountered throughout the storm season. There has been little toxicity to either species over the past two storm seasons.

Thus the initial suggestions that seasonal flushing significantly affects stormwater toxicity is not supported by more recent water flea and sea urchin data test data. Earlier observations may have been attributable to the solubility of the primary toxicants and tendency for higher concentrations earlier in the season.

Comparison of Relative Toxicity of Stormwater in Southern California

Table 42 compares the frequency and magnitude of toxicity to sea urchin fertilization from the Long Beach stations in 2010/2011 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 Cholla Creeks). Current data continue the recent trend towards decreasing frequency and magnitude of Long Beach stormwater toxicity to sea urchins.

A similar decreasing trend is evident in the frequency of toxicity to water fleas (Table 43). 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 seen in the 2007/2008 and 2009/2009 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.

We might expect results from 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 42) 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 Rivers and Ballona Creek during the period of 2007 to 2009 indicate similar trends with decreasing frequency and magnitude of toxicity as reported for Long Beach samples from the same time period. Sea urchins were not tested at Chollas Creek during those years.

Table 43 summarizes Long Beach water flea toxicity data from the past 11 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 show generally decreased frequency and magnitude of reproductive toxicity over time.

Toxicity Characterization

During the current monitoring period, acute toxicity in both wet and dry weather sample was insufficient to trigger TIEs, and no direct evidence of possible toxicants was obtained. In contrast, however, toxicants were not generally detected at levels that would have been expected to cause acute toxicity.

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 (Figure 50). 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 (Figure 51). Similarly, these two metals were 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 EC_{50} or LC_{50}. It is of interest that measured concentrations of all relevant toxicants predicted acute toxicity of <1 TU_a to either species in all eleven storm samples examined, which agrees well with the observed bioassay results. Thus, chemical concentrations predicted a lack of observable toxicity, which matched observed test results.

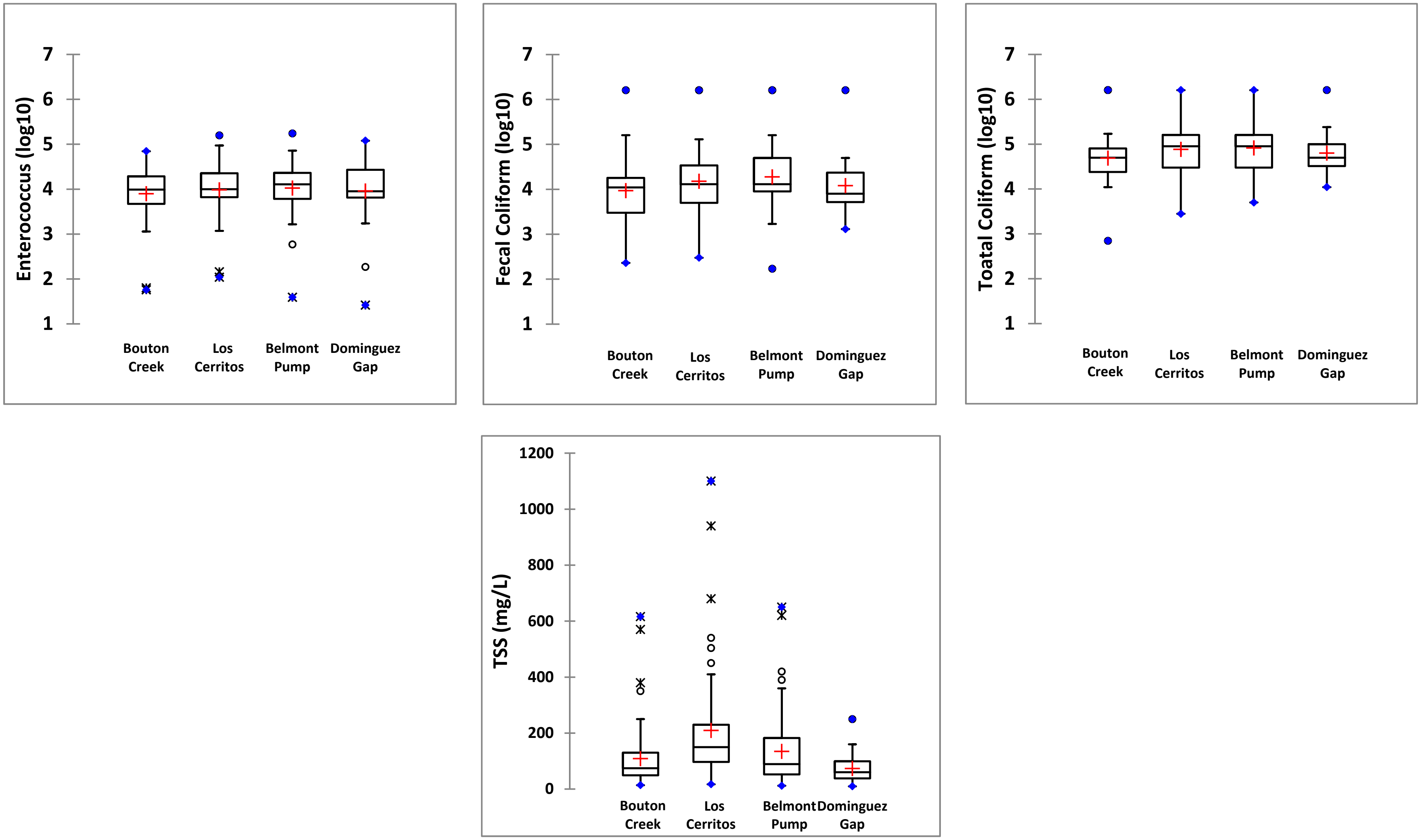


Figure 43. Box Plots of Fecal Indicator Bacteria and TSS Concentrations from All Events at each Mass Emission Site.

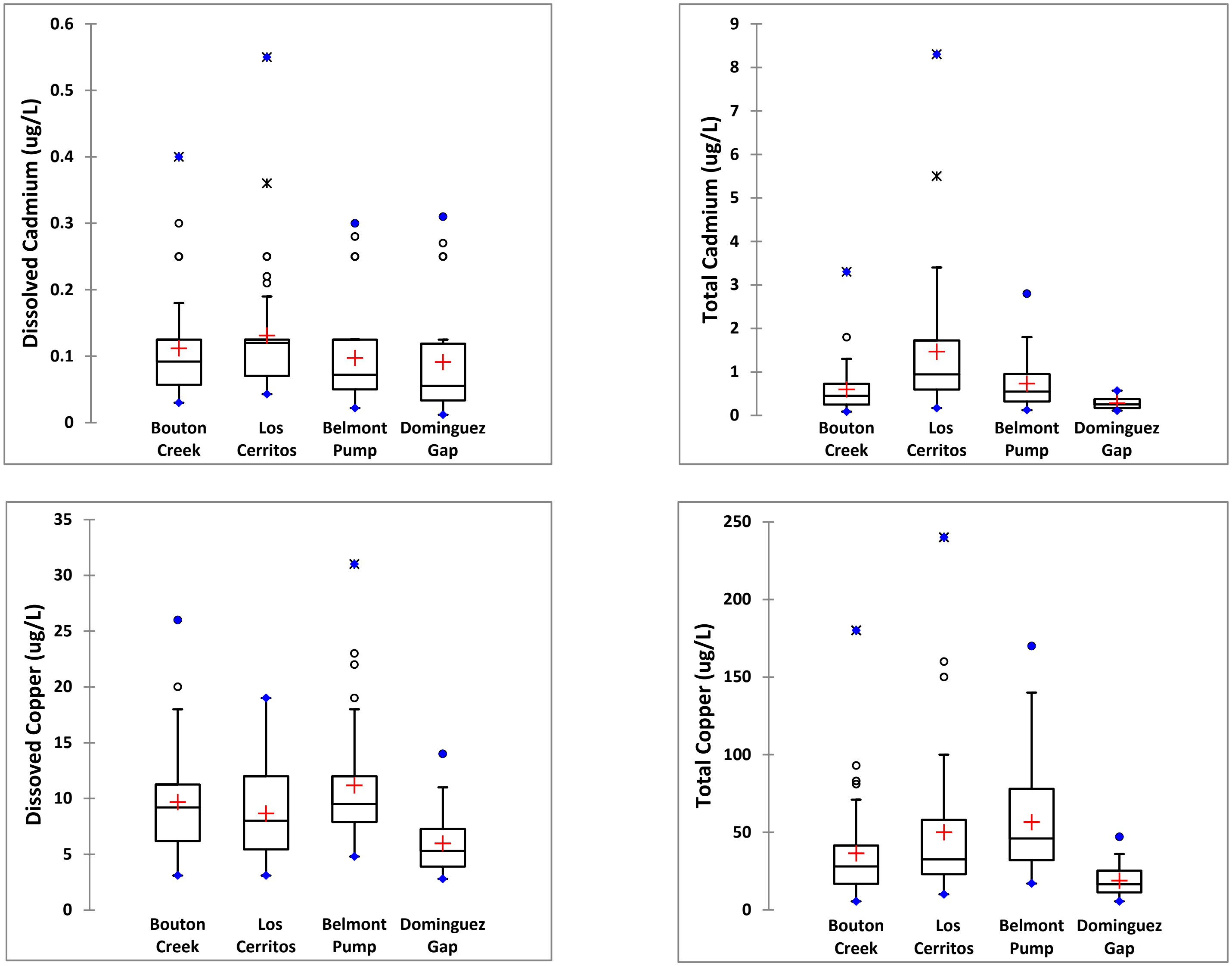


Figure 44. Box Plots of Dissolved and Total Cadmium and Copper from All Events at each Mass Emission Site.

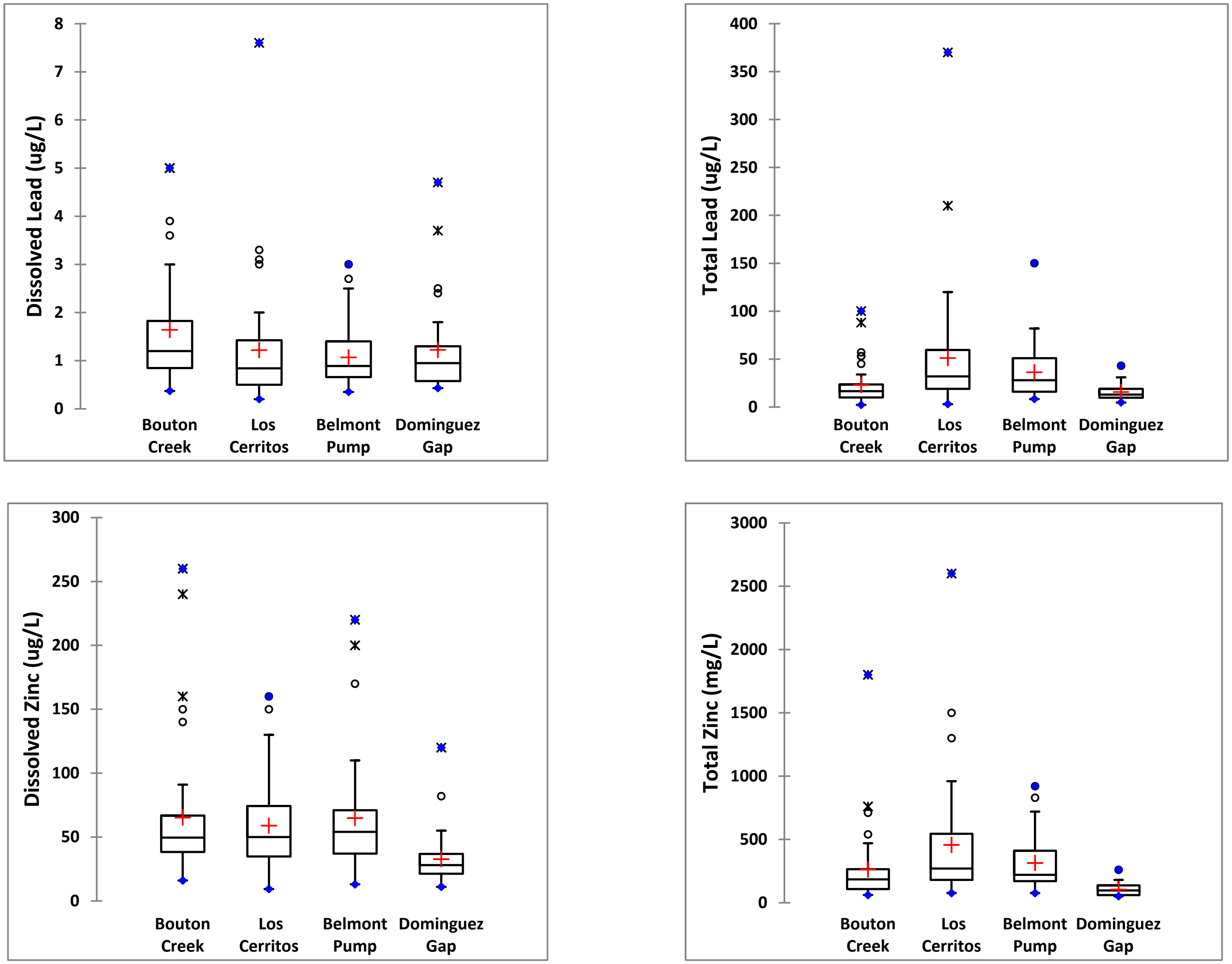
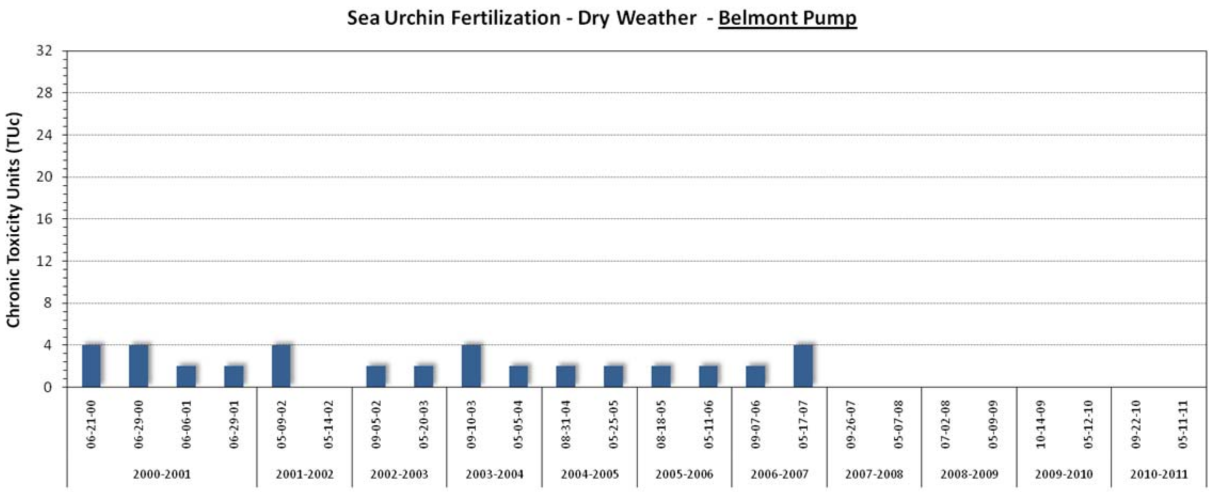
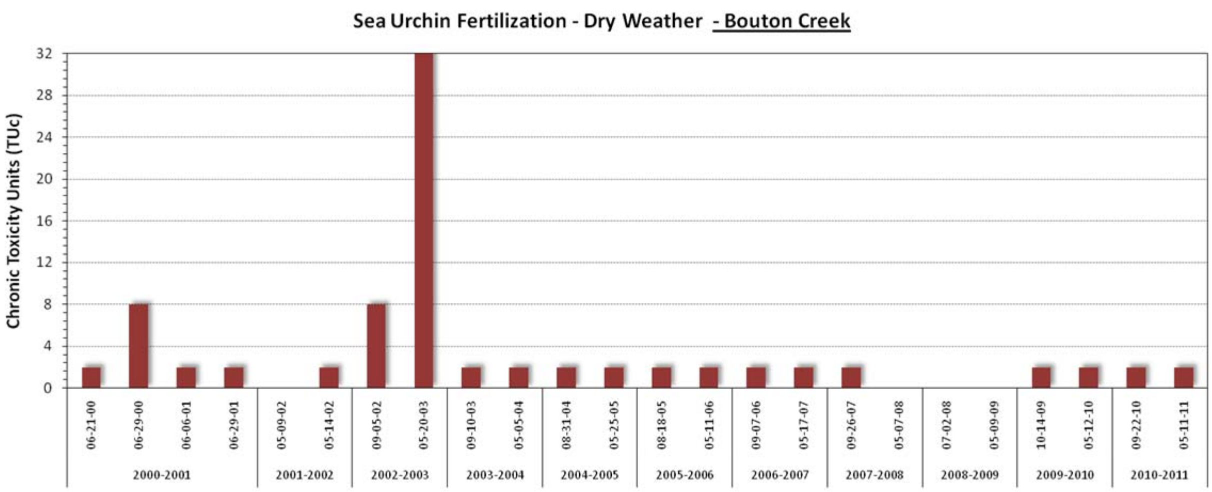


Figure 45. Box Plots of Dissolved and Total Zinc and Lead from All Events at each Mass Emission Site.





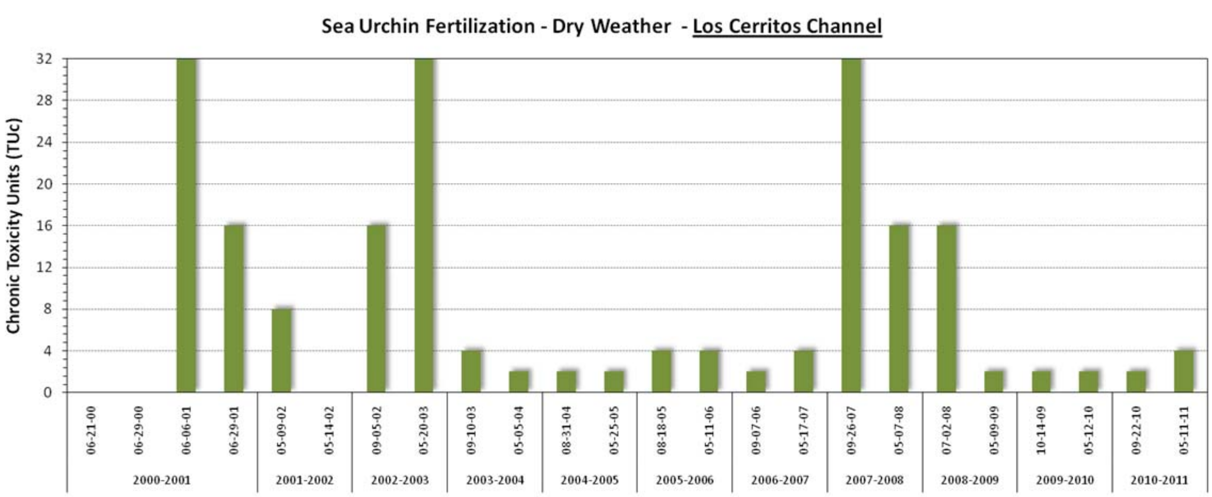


Figure 46. Chronic Toxicity of Dry Weather Discharge to Sea Urchins – 2000/2001 through 2010/2011.

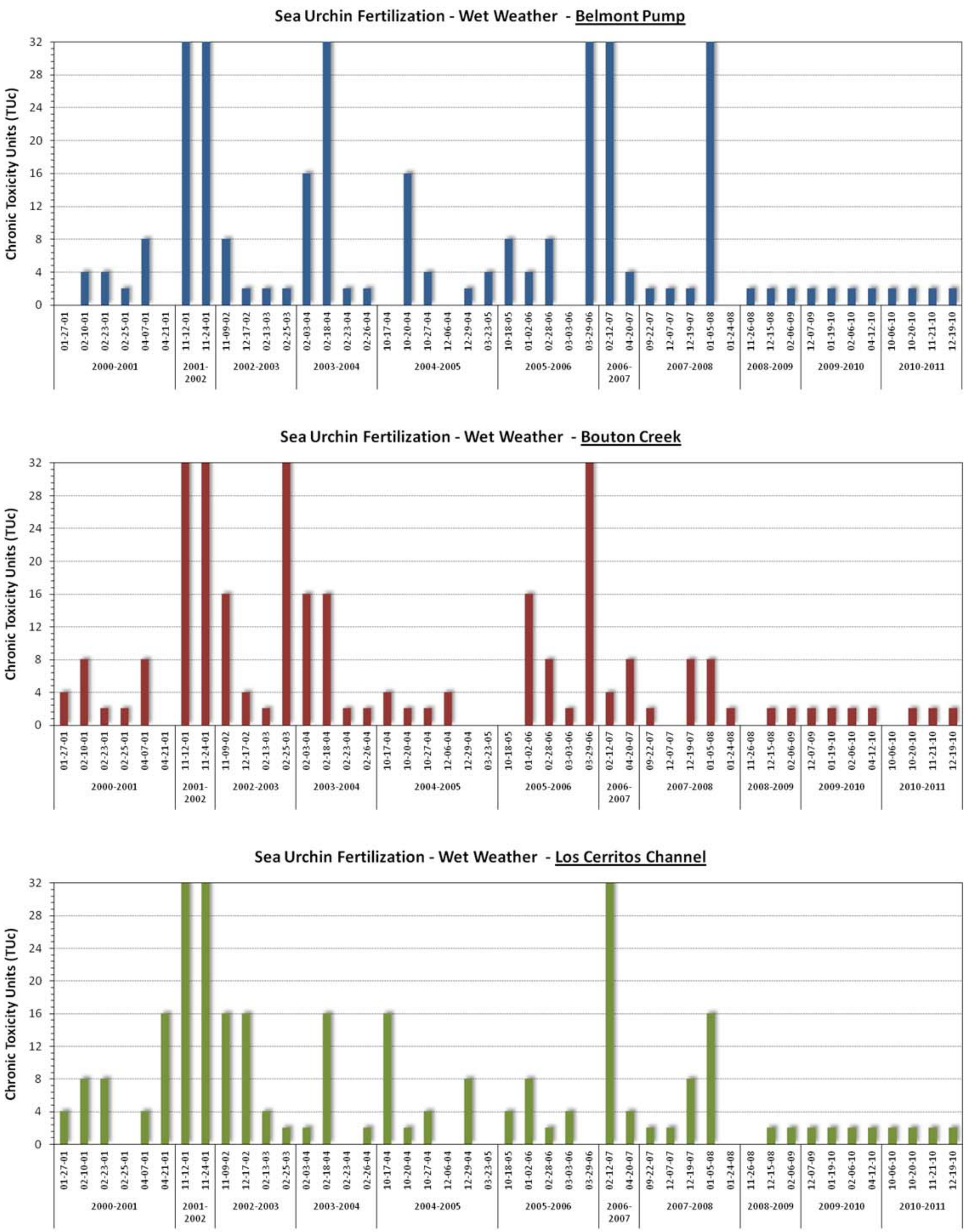


Figure 47. Chronic Toxicity of Stormwater to Sea Urchins – 2000/2001 through 2010/2011.

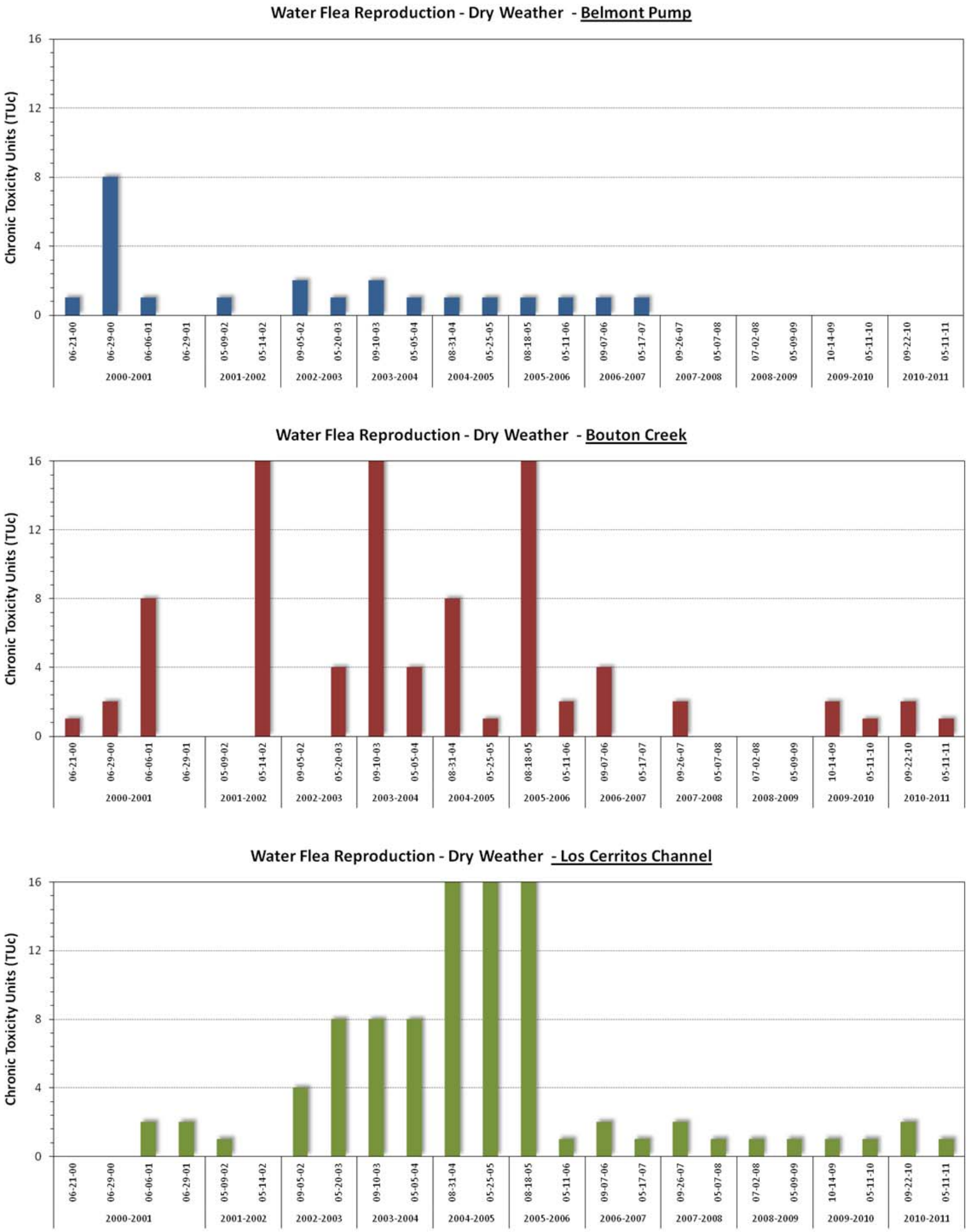


Figure 48. Chronic Toxicity of Dry Weather Discharge to Water Fleas – 2000/2001 through 2010/2011.

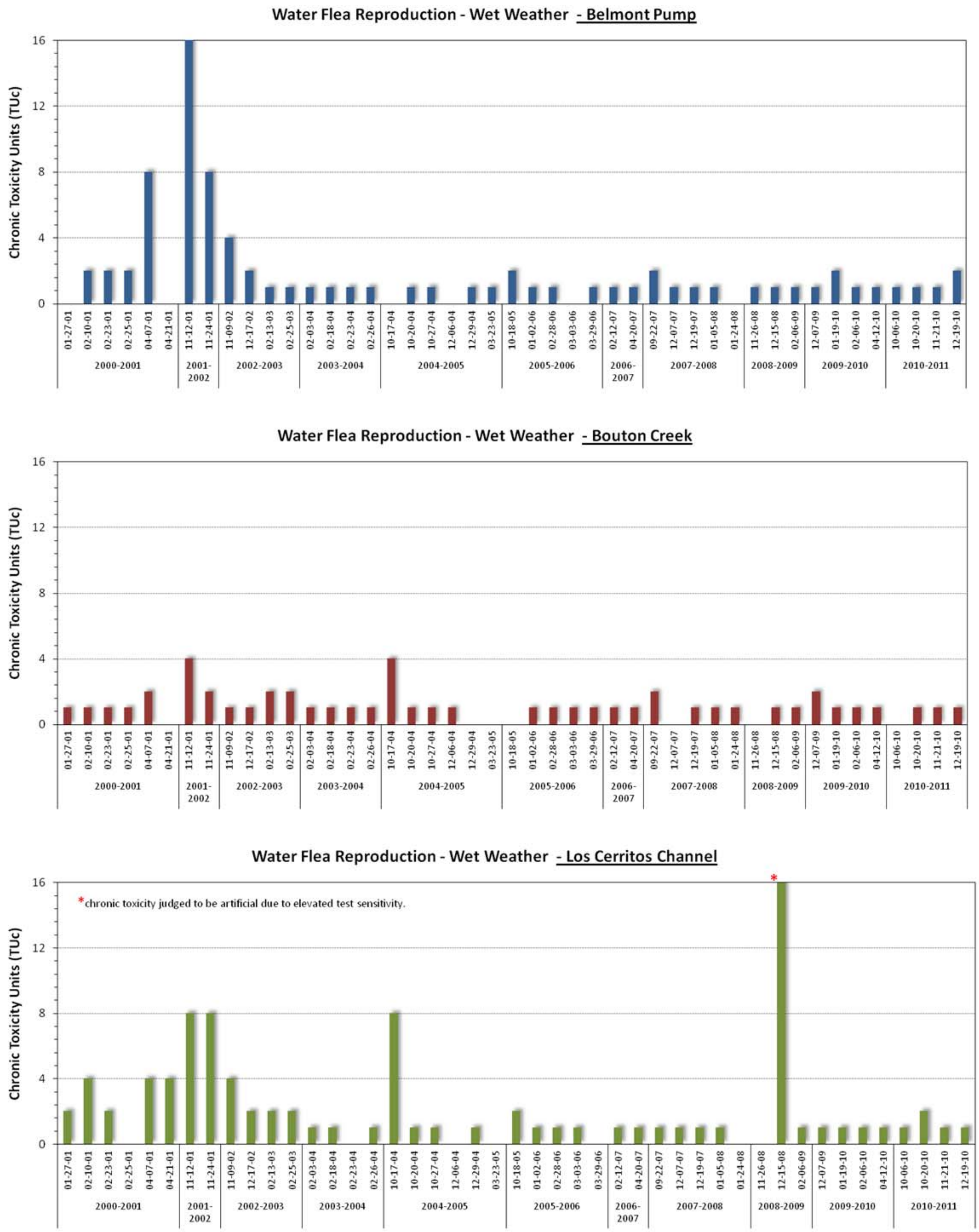


Figure 49. Chronic Toxicity of Stormwater to Water Fleas – 2000/2001 through 2010/2011.

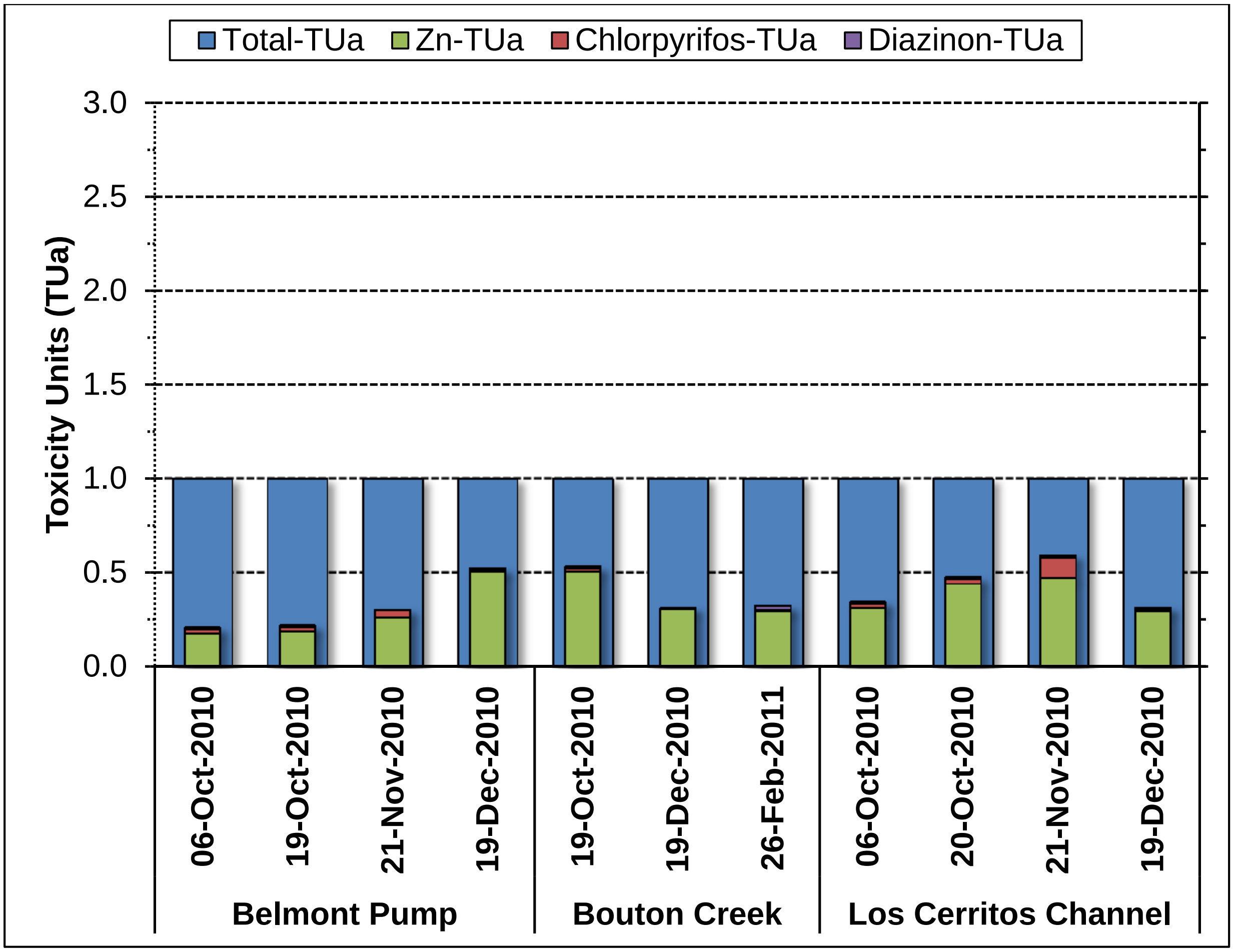


Figure 50. Measured Acute Toxicity to *Ceriodaphnia dubia* versus Predicted Toxicity due to Zinc, Chlorpyrifos and Diazinon, 2010/2011.

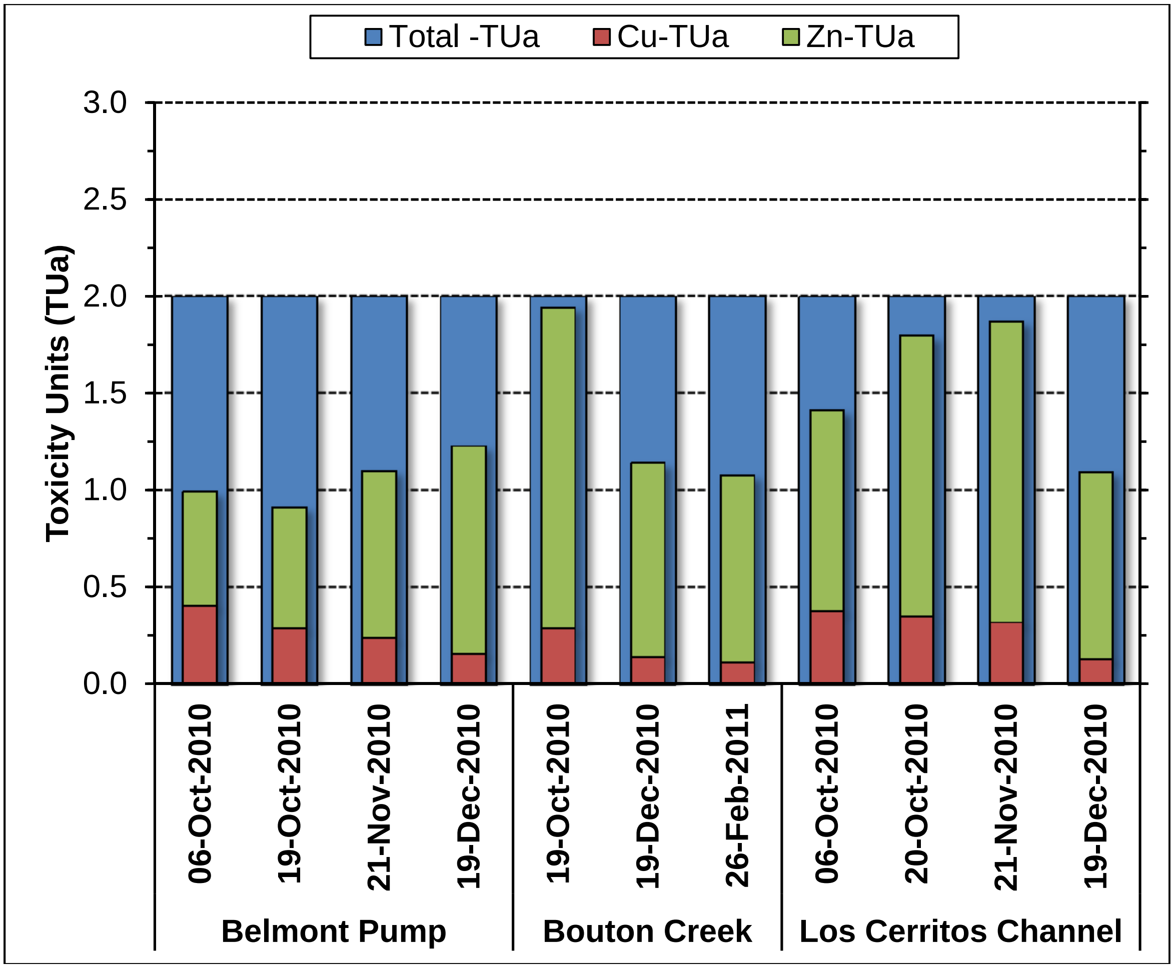


Figure 51. **Measured Acute Toxicity to *Strongylocentrotus purpuratus* versus Predicted Toxicity due to Zinc and Copper, 2010/2011**

Table 33. 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 34. 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		National Non Priority Pollutant	
	2001-2011	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute
Analyte Group	ML	Max. Level	CCC [2]	CMC [2]	CCC	CMC	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					87	750
Iron	25						1000	
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 34. 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		National Non Priority Pollutant	
	2001-2011	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	0.041	0.011
Demeton	0.002						0.1	
Diazinon	0.004				0.05	0.08	0.17	0.82
Malathion	0.006				0.1	0.43	0.1	
Triazines (µg/L)								
Atrazine	0.01	3						
Simazine	0.01	2						

Table 35. Saltwater Benchmarks and Guidelines Used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites.

Analyte Group	Long Beach 2001-2011 ML	California Ocean Plan Instantaneous Single Sample	California Ocean Plan Daily Maximum	California Ocean Plan 30-day Average	California Toxics Rule Chronic CCC	California Toxics Rule Acute CMC	California Fish and Game Chronic CCC	California Fish and Game Acute CMC	National Non Priority Pollutant Chronic CCC	National Non Priority Pollutant 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 35. 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		National Non Priority Pollutant	
		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		

Notes to Table 34 and 35:

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 dependent. 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.

National Recommended Water Quality Criteria

- All values CCCs

Table 36. Comparison of Storm Chemistry with Benchmarks and Guidelines: Counts of Exceedances per Site

Analyte Group	Reference	Criteria	Belmont Pump	Bouton Creek	Los Cerritos Channel	Dominguez Gap
		N grab samples >>	*3*	*4*	*3*	*3*
		N composite samples >>	*4*	*4*	*4*	*3*
Microbiology						
Enterococcus	LA Basin and Ocean Plan	AB411	3	4	3	3
Fecal Coliform	LA Basin and Ocean Plan	AB411	3	4	3	3
Total Coliform	LA Basin and Ocean Plan	AB411	3	4	3	3
Conventionals						
MBAS	LA Basin	LA Basin	0	0	1	0
pH	LA Basin	LA Basin	0	1	0	0
Dissolved Metals						
Copper	CTR Fresh	Acute (CMC)	4	3	4	1
Copper	CTR Salt	Acute (CMC)	4	3	3	0
Copper	CTR Fresh	Chronic (CCC)	4	4	4	1
Copper	CTR Salt	Chronic (CCC)	4	4	4	2
Lead	CTR Fresh	Chronic (CCC)	2	3	3	1
Nickel	CTR Salt	Chronic (CCC)	1	0	1	0
Zinc	CTR Fresh	Acute (CMC)	0	1	2	0
Zinc	CTR Fresh	Chronic (CCC)	0	1	2	0
Total Metals						
Aluminum	LA Basin	LA Basin	3	2	4	1
Aluminum	NRWQ_NPP Fresh	Acute (CMC)	4	2	4	3
Aluminum	NRWQ_NPP Fresh	Chronic (CCC)	4	4	4	3
Chromium	LA Basin	LA Basin	3	0	0	0
Copper	Ocean Plan	Daily Max	4	3	3	0
Iron	NRWQ_NPP Fresh	Chronic (CCC)	4	3	4	3
Lead	Ocean Plan	Daily Max	4	2	3	1
Nickel	LA Basin	LA Basin	1	0	0	0
Nickel	Ocean Plan	Daily Max	2	0	2	0
Zinc	Ocean Plan	Daily Max	4	2	4	0

Table 36. Comparison of Storm Chemistry with Benchmarks and Guidelines: Counts of Exceedances per Site (continued)

Analyte Group	Reference	Criteria	Belmont Pump	Bouton Creek	Los Cerritos Channel	Dominguez Gap
Chlorinated Pesticides						
Toxaphene	Ocean Plan	30-day	2	0	0	0
Toxaphene	CTR Fresh	Chronic (CCC)	2	0	0	0
Toxaphene	CTR Salt	Chronic (CCC)	2	0	0	0
Total Chlordane	CTR Fresh	Chronic (CCC)	1	0	0	0
Organophosphates						
Chlorpyrifos	NRWQ_NPP Salt	Chronic (CCC)	0	0	1	0
Malathion	NRWQ_NPP Fresh	Chronic (CCC)	1	0	2	0
Malathion	NRWQ_NPP Salt	Chronic (CCC)	1	0	2	0

Table 37. Comparison of Dry Weather Chemistry with Benchmarks and Guidelines: Counts of Exceedances per Site

Analyte Group	Reference	Criteria	Bouton Creek	Los Cerritos Channel	Dominguez Gap
		N grab samples >>	*2*	*2*	*2*
		N composite samples >>	*2*	*2*	*2*
Microbiology					
Enterococcus	Ocean and LA Basin Plans	AB411	2	0	0
Fecal Coliform	Ocean and LA Basin Plans	AB411	2	1	0
Total Coliform	Ocean and LA Basin Plans	AB411	2	1	0
Conventionals					
pH	LA Basin		1	1	0
Dissolved Metals					
Copper	CTR Fresh	Chronic (CCC)	0	1	0
Copper	CTR Salt	Chronic (CCC)	2	2	0
Copper	CTR Salt	Acute (CMC)	2	2	0
Total Metals					
Aluminum	NRWQ_NPP	Chronic (CCC)	2	0	2
Copper	Ocean Plan	(Daily Max)	1	1	0
Chlorinated Pesticides					
Total Chlordane	CTR Fresh	Chronic (CCC)	1	0	0
Total Chlordane	CTR Salt	Chronic (CCC)	1	0	0

Table 38. Comparison of Measured Concentration of Pyrethroid Pesticides with Toxicity.

	Min	*Avg*	*Max*	*Ceriodaphnia dubia (48-hr LC_{50}s in ug/L)*	*Daphnia magma (48-hr LC_{50}s in ug/L)*	*Hyallela azteca (48-hr LC_{50}s in ug/L)*	*Americamysis bahia (96-hr LC_{50}s in ug/L)*
Lambda- Cyhalothrin	0.0003	0.0019	0.0077		0.36	0.0023	
Permethrin	0.0059	0.0558	0.253	0.55	0.075	**0.021**[1]	0.02
Cyfluthrin	0.0002	0.0078	0.055	0.14	0.17		0.0024
Bifenthrin	0.0004	0.0483	0.348	0.07	0.32	**0.009**[1]	0.004
Cypermethrin	0.0007	0.0051	0.021		0.13	0.005	0.005
Deltamethrin	0.0004	0.0054	0.047		0.37		0.0017
Esfenvalerate	0.0002	0.0011	0.0028	**0.3**[1]	0.24	0.05	0.038

LC_{50} data summarized from Werner and Oram 2008

1. Value corresponds to the 96-hr LC_{50} rather than the 48-hr LC_{50}. All test data for mysids are also based upon the 96-hr LC_{50}.

Table 39. Spearman Rho Correlation Coefficients and Coefficients of Determination (R^2) for Selected Metals and Important Environmental Predictor Variables.

Correlation matrix (Spearman):

r	TOT RAIN	ANTE DAY	TSS	DISS CD	TOT CD	DISS CU	TOT CU	DISS PB	TOT PB	DISS ZN	TOT ZN
TOT RAIN	**1**										
ANTE DAY	**-0.187**	**1**									
TSS	-0.113	**0.239**	**1**								
DISS CD	-0.100	-0.091	-0.034	**1**							
TOT CD	**-0.237**	**0.179**	**0.770**	**0.295**	**1**						
DISS CU	**-0.429**	**0.348**	**0.257**	**0.254**	**0.388**	**1**					
TOT CU	**-0.372**	**0.298**	**0.766**	0.020	**0.802**	**0.613**	**1**				
DISS PB	**-0.262**	**0.250**	**0.208**	**0.392**	**0.379**	**0.547**	**0.369**	**1**			
TOT PB	**-0.187**	0.085	**0.818**	0.146	**0.876**	**0.269**	**0.813**	**0.319**	**1**		
DISS ZN	**-0.317**	**0.252**	**0.184**	**0.442**	**0.457**	**0.736**	**0.472**	**0.574**	**0.277**	**1**	
TOT ZN	**-0.356**	**0.245**	**0.781**	0.144	**0.893**	**0.512**	**0.915**	**0.330**	**0.837**	**0.492**	**1**

*Values in **bold** are different from 0 with a significance level alpha=0.05*

Red Bar Equals a Negative Correlation, Blue Bar Equals a Positive Correlation (Larger the Bar, Higher the Correlation).

Coefficients of determination (Spearman):

R^2	TOT RAIN	ANTE DAY	TSS	DISS CD	TOT CD	DISS CU	TOT CU	DISS PB	TOT PB	DISS ZN	TOT ZN
TOT RAIN	**1**										
ANTE DAY	0.001	**1**									
TSS	**0.035**	**0.057**	**1**								
DISS CD	0.010	0.008	0.001	**1**							
TOT CD	**0.056**	**0.032**	**0.593**	**0.087**	**1**						
DISS CU	**0.184**	**0.121**	**0.066**	**0.065**	**0.151**	**1**					
TOT CU	**0.139**	**0.089**	**0.587**	0.000	**0.643**	**0.376**	**1**				
DISS PB	**0.069**	**0.062**	**0.043**	**0.154**	**0.144**	**0.299**	**0.136**	**1**			
TOT PB	**0.035**	0.007	**0.669**	0.021	**0.767**	**0.072**	**0.660**	**0.102**	**1**		
DISS ZN	**0.101**	**0.063**	**0.034**	**0.196**	**0.209**	**0.542**	**0.223**	**0.329**	**0.077**	**1**	
TOT ZN	**0.127**	**0.060**	**0.610**	0.021	**0.797**	**0.262**	**0.837**	**0.109**	**0.701**	**0.242**	**1**

*Values in **bold** are different from 0 with a significance level alpha=0.05*

Larger the Blue Bar, Higher the Coefficient of Determination or the Proportion of Variance Explained.

Table 40. Results of Stepwise Multiple Linear Regression Analysis of TSS Total Cadmium, Copper, Lead and Zinc (all sites).

Multiple Linear Regression Results: Stepwise Backward Procedure

		Dependent Y's*							
Explanatory X's**	**Model Statistics**	**Dissolved Cadmium**	**Total Cadmium**	**Dissolved Copper**	**Total Copper**	**Dissolved Lead**	**Total Lead**	**Dissolved Zinc**	**Total Zinc**
(overall importance from high to low)	R^2	0.101	0.646	0.338	0.769	0.321	0.683	0.206	0.676
	F	5.218	127.747	17.585	90.980	16.335	74.385	12.002	96.075
	Pr > F	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
TSS	F		233.881		200.220	12.356	204.225		174.715
	Pr > F		< 0.0001		< 0.0001	0.001	< 0.0001		< 0.0001
ANTEDAY	F	6.040		13.719	36.850	6.769		9.132	14.485
	Pr > F	0.015		0.000	< 0.0001	0.010		0.003	0.000
SEASONRAIN	F			11.468	8.005	9.556	3.214	6.256	
	Pr > F			0.001	0.005	0.002	0.075	0.014	
DURATION	F		4.414		5.664		10.142		8.678
	Pr > F		0.037		0.019		0.002		0.004
TOTFLOW	F			5.302	10.746	12.741			
	Pr > F			0.023	0.001	0.000			
TOTRAIN	F	5.624		11.607				9.460	
	Pr > F	0.019		0.001				0.003	
MAXINT	F						6.252		
	Pr > F						0.014		
ANTERAIN	F	5.159							
	Pr > F	0.025							

*Raw Non-Transformed Metals Data

** The "PEAKFLOW" (Peak Flow in cfs) was excluded from the model due to high colinearity with "TOTFLOW" (Total Flow in cfs).

Multicolinearity statistics: (Explanatory Variables)

Statistic	**TSS**	**Total Flow (kcf)**	**Peak Flow (cfs)**	**Seasonal Rain to date (inches)**	**Duration (days)**	**Total Rain (inches)**	**Maximum Intensity (inches/hr)**	**Antecedent Dry Weather (days)**	**Antecedent Rain (inches)**
R^2	0.290	**0.764**	**0.763**	0.142	0.311	0.501	0.329	0.249	0.055
Tolerance[1]	0.710	0.236	0.237	0.858	0.689	0.499	0.671	0.751	0.945
VIF[2]	1.409	4.242	4.217	1.165	1.452	2.005	1.489	1.331	1.059

[1]Tolerance = $1-R^2$ and [2]VIF = 1/Tolerance

Guidance: A tolerance of less than 0.20 or 0.10 and/or a VIF of 5 or 10 and above indicates a multicollinearity problem

Table 41. Kruskal-Wallis Test with the Steel-Dwass-Critchlow-Fligner Multiple Pairwise Comparisons.

Sample	Count	Sum of ranks	Mean of ranks	Groups*				
							K (Observed value)	**10.204**
DISCD | Dominguez Gap	30	1766.000	58.867	A			K (Critical value)	7.815
DISCD | Belmont Pump	41	2881.500	70.280	A	B		DF	3
DISCD | Bouton Creek	40	3201.000	80.025	A	B		p-value (Two-tailed)	0.0169
DISCD | Los Cerritos	40	3627.500	90.688		B		alpha	0.05

Sample	Count	Sum of ranks	Mean of ranks	Groups				
							K (Observed value)	**46.603**
TOTCD | Dominguez Gap	30	1090.000	36.333	A			K (Critical value)	7.815
TOTCD | Bouton Creek	40	2744.500	68.613		B		DF	3
TOTCD | Belmont Pump	41	3365.500	82.085		B		p-value (Two-tailed)	< 0.0001
TOTCD | Los Cerritos	40	4276.000	106.900			C	alpha	0.05

Sample	Count	Sum of ranks	Mean of ranks	Groups				
							K (Observed value)	**28.344**
DISCU | Dominguez Gap	30	1240.500	41.350	A			K (Critical value)	7.815
DISCU | Los Cerritos	40	2997.000	74.925		B		DF	3
DISCU | Bouton Creek	40	3304.500	82.613		B		p-value (Two-tailed)	< 0.0001
DISCU | Belmont Pump	41	3934.000	95.951		B		alpha	0.05

Sample	Count	Sum of ranks	Mean of ranks	Groups				
							K (Observed value)	**37.944**
TOTCU | Dominguez Gap	30	1125.500	37.517	A			K (Critical value)	7.815
TOTCU | Bouton Creek	40	2813.500	70.338		B		DF	3
TOTCU | Los Cerritos	40	3464.500	86.613		B	C	p-value (Two-tailed)	< 0.0001
TOTCU | Belmont Pump	41	4072.500	99.329			C	alpha	0.05

Sample	Count	Sum of ranks	Mean of ranks	Groups		
					K (Observed value)	**7.797**
DISPB | Los Cerritos	40	2700.500	67.513	A	K (Critical value)	7.815
DISPB | Belmont Pump	41	2919.000	71.195	A	DF	3
DISPB | Dominguez Gap	30	2164.500	72.150	A	p-value (Two-tailed)	0.0504
DISPB | Bouton Creek	40	3692.000	92.300	A	alpha	0.05

Sample	Count	Sum of ranks	Mean of ranks	Groups			
						K (Observed value)	**28.267**
TOTPB | Dominguez Gap	30	1468.500	48.950	A		K (Critical value)	7.815
TOTPB | Bouton Creek	40	2471.000	61.775	A		DF	3
TOTPB | Belmont Pump	41	3718.500	90.695		B	p-value (Two-tailed)	< 0.0001
TOTPB | Los Cerritos	40	3818.000	95.450		B	alpha	0.05

* Letters Denote Significantly Different Station Groups

Table 41. Multiple pairwise comparisons Steel-Dwass-Critchlow-Fligner Two-tailed test: Kruskal-Wallis test. (continued).

Sample	Count	Sum of ranks	Mean of ranks	Groups			
						K (Observed value)	24.943
DISZN | Dominguez Gap	30	1212.500	40.417	A		K (Critical value)	7.815
DISZN | Los Cerritos	40	3325.500	83.138		B	DF	3
DISZN | Bouton Creek	40	3377.000	84.425		B	p-value (Two-tailed)	< 0.0001
DISZN | Belmont Pump	41	3561.000	86.854		B	alpha	0.05

Sample	Count	Sum of ranks	Mean of ranks	Groups				
							K (Observed value)	48.239
TOTZN | Dominguez Ga	30	920.500	30.683	A			K (Critical value)	7.815
TOTZN | Bouton Creek	40	2861.500	71.538		B		DF	3
TOTZN | Belmont Pump	41	3674.500	89.622		B	C	p-value (Two-tailed)	< 0.0001
TOTZN | Los Cerritos	39	3868.500	99.192			C	alpha	0.05

Sample	Count	Sum of ranks	Mean of ranks	Groups			
						K (Observed value)	37.196
TSS | Dominguez Gap	34	2648.500	77.897	A		K (Critical value)	7.815
TSS | Bouton Creek	64	6111.500	95.492	A		DF	3
TSS | Belmont Pump	64	7235.000	113.047	A		p-value (Two-tailed)	< 0.0001
TSS | Los Cerritos	65	9883.000	152.046		B	alpha	0.05

* Letters Denote Significantly Different Station Groups

Table 42. 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	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	2008-2009	2	50	2-3
	1997-1999	4	100	4-8
San Gabriel River	2008-2009	2	50	2-3
	1997-1999	4	50	≤2-4
Ballona Creek	2008-2009	2	100	2-3
	1996-1997	13	85	≤4-32
Chollas Creek	1999-2000	5	100	8-32

Table 43. Comparison of Daphnid Toxicity Characteristics of Stormwater from Long Beach and Various Southern California Watersheds.

Location	Date	Number of Samples	%Toxic	TU_c
Long Beach	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	2007-2008	2	50	1-1.1
San Gabriel River	2007-2008	2	0	1
Ballona Creek	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}.

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, 146 wet weather monitoring events have been conducted at the four Long Beach mass emission stations for the full set of analytes, along with 86 dry weather inspections/monitoring events. In addition 74 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. Over the past three or more years, stormwater discharges have not exhibited toxicity to the current test species, the water flea (*Ceriodaphnia*) and sea urchin (*Strongylocentrotus*) gametes. Removal of two key organophosphate pesticides, chlorpyrifos and diazinon, from the market is clearly responsible for elimination of toxicity previously observed with water fleas. Reduction in toxicity measured with the sea urchin fertilization tests correlate with concentrations of dissolved copper and zinc. The predicted toxicity of these two dissolved metals has typically been less than the sensitivity of the test.

Most long-term trends continue to be obscured by factors that are not evident when exclusively looking at changes in concentrations over time. Seasonal trends have been evident since the start to program. Higher concentrations of metals and other contaminants are encountered during early season events. 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.

The concentrations of most dissolved and total metals in stormwater discharged through the Dominguez Gap Pump Station were demonstrated to be significantly lower than measured at the other three mass emission sites. This site has long been recognized as an effective site for treating stormwater. Nevertheless, major improvements could be made in reducing mass emissions from stormwater and providing even better treatment. We are continuing to work with the Los Angeles County Department of Public Works in order to achieve a more effective balance between maintaining the constructed wetlands and providing stormwater treatment.

THIS PAGE INTENTIONALLY LEFT BLANK

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 Stormwater 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.

Enminger, M. and K. Kelley. 2011. Monitoring Urban Pesticide Runoff in California 2008-2009. California Environmental Protection Agency, California Department of Pesticide Regulation, Environmental Monitoring Branch, Surface Water Protection, Report 249, March 2011.

Gilbert, R.O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. van Nostrand Rienhold Company, Inc., New York.

Kinnetic Laboratories, Inc. 2005. City of Long Beach Stormwater Monitoring Report 2004-2005. NPDES Permit No. CAS0040003 (CI 8052), July, 2005.

Kinnetic Laboratories, Inc. 2008. City of Long Beach Stormwater Monitoring Report 2007-2008 NPDES Permit No. CAS0040003 (CI 8052), July, 2008.

Kinnetic Laboratories, Inc. 2009. City of Long Beach Stormwater Monitoring Report 2008-2009 NPDES Permit No. CAS0040003 (CI 8052), July, 2009.

Kinnetic Laboratories, Inc. 2011. City of Long Beach Stormwater Monitoring Report 2009-2010 NPDES Permit No. CAS0040003 (CI 8052), July, 2010

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

Mann, H.B. (1945), Nonparametric tests against trend, Econometrica, 13, 245-259.

Marshack, J. 2011. A Compilation of Water Quality Goals, 16th Edition. April 2011, SWRCB.

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).

National Atmospheric Deposition Program. 2007. 30 Years of the NADP: 2007 Summary of the National Atmospheric Deposition Program. Illinois State Water Survey, Champaign, IL.

National Atmospheric Deposition Program. 2010. 2009 Annual Summary. National Atmospheric Deposition Program, Illinois State Water Survey, Champaign, IL, September 2010.

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

Ruby, A. and LWA. 2005. Sacramento Urban Runoff Discharge Characterization. Report for the Sacramento Stormwater Quality Partnership.

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.

Southern California Coastal Water Research Project. 1999. Characterization of stormwater toxicity from Chollas Creek, San Diego. Southern California Coastal Water Research. Westminster, CA.

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

State of California, Department of Finance, E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark. Sacramento, California, May 2010.

State of California, Department of Finance, 2011a. January 2011 Tables of City Population Ranked by Size, Numeric and Percent Change. Sacramento, California, May 2011

State of California, Department of Finance, 2011b. E-5 Population and Housing Estimates for Cities, Counties, and the State, 2010-2011, with 2010 Benchmark. Sacramento, California, May 2011.

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

TDC Environmental. 2003. Insecticide Market Trends and Potential Water Quality Implications. Prepared for the San Francisco Estuary Project. April.

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]. 1993. Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria. Memorandum from Martha Prothro, Acting Assistant Administrator for Water.

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]. 2002a. USEPA Functional Guidelines for Inorganic Data Review. EPA 540-R-01-008.

USEPA [U.S. Environmental Protection Agency]. 2002b. 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]. 2009. National Recommended Water Quality Criteria.

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

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

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