City of Long Beach
Storm Water Monitoring Report 2004-2005

NPDES Permit No. CAS004003 (CI 8052)

Submitted By
City
Of
Long
Beach

July 2005

Prepared By
Kinnetic Laboratories, Inc.

CITY OF LONG BEACH
DEPARTMENT OF PUBLIC WORKS
333 West Ocean Boulevard • Long Beach, CA 90802 • (562) 570-6383 • FAX (562) 570-6012

July 14, 2005

Jonathan Bishop, Executive Officer
California Environmental Protection Agency
Los Angeles Regional Water Quality Control Board
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Subject: Annual Storm Water Report 2004-2005

Dear Mr. Bishop:

The City of Long Beach is pleased to submit its sixth annual "Stormwater Monitoring Report 2004 – 2005" in compliance with Order No. 99-060, for the Municipal National Pollutant Discharge Elimination System (NPDES) Permit No. CAS0040003 (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 Regional Board.

Should you have any questions in regard to this report, please contact Tom Leary, Stormwater Program Officer, at (562) 570-6023.

Sincerely,

Mark Christoffels
City Engineer

MAC:TL:km

Attachments

CITY OF LONG BEACH
STORM WATER MONITORING REPORT 2004-2005

NPDES PERMIT NO. CAS004003 (CI 8052)

JULY *2005*

PREPARED BY

KINNETIC LABORATORIES, INC.

SUBMITTED BY

CITY
OF
LONG
BEACH

CITY OF LONG BEACH
STORMWATER MONITORING REPORT 2004/2005

NPDES Permit No. CAS004003 (CI 8052)

TABLE OF CONTENTS

TABLE OF CONTENTS **i**
LIST OF FIGURES **iii**
LIST OF TABLES **vi**
ACRONYMNS AND ABBREVIATIONS LIST **viii**
1.0 EXECUTIVE SUMMARY **1**
1.1 Background and Purpose 1
1.2 Summary of 2004-2005 Results 2
2.0 INTRODUCTION **9**
2.1 Annual Program Adjustments 9
3.0 STUDY AREA DESCRIPTION **13**
3.1 Regional Setting 13
3.1.1 Geography 13
3.1.2 Major Watersheds 13
3.1.3 Annual Rainfall and Climate 14
3.1.4 Population and Land Use Characteristics 14
4.0 MONITORING PROGRAM **19**
4.1 Monitoring Program Objectives 19
4.2 Monitoring Site Descriptions 19
4.2.1 Basin 14: Dominguez Gap Monitoring Site 19
4.2.2 Basin 20: Bouton Creek Monitoring Site 20
4.2.3 Basin 23: Belmont Pump Station Monitoring Site 20
4.2.4 Portions of Basins 18, 19, 27 and 29: Los Cerritos Channel Monitoring Site 21
4.3 Monitoring Station Design and Configuration 21
4.4 Field Monitoring Procedures 22
4.4.1 Wet Weather Monitoring 22
4.4.2 Dry Weather Monitoring 25
4.5 Laboratory Analyses 25
4.5.1 Analytical Suite and Methods 25
4.5.2 Toxicity Testing Procedures 26
5.0 RAINFALL AND HYDROLOGY **37**
5.1 Precipitation during the 2004/2005 Wet Weather Season 37
5.1.1 Monthly Precipitation 38
5.1.2 Precipitation during Monitored Events 38
5.2 Stormwater Runoff during Monitored Events 39
6.0 CHEMISTRY RESULTS **71**
6.1 Wet Weather Chemistry Results 71
6.2 Wet Weather Load Calculations 71
6.3 Dry Weather Chemistry Results 72
6.3.1 Basin 14: Dominguez Gap Monitoring Site 72

6.3.2 Basin 20: Bouton Creek Monitoring Site 72
6.3.3 Basin 23: Belmont Pump Station Monitoring Site 72
6.3.4 Portions of Basins 18, 19, 27 and 29: Los Cerritos Channel Monitoring Site 73
7.0 TOXICITY RESULTS 97
7.1 Wet Weather Discharge 97
7.1.1 Belmont Pump 97
7.1.2. Bouton Creek 97
7.1.3. Los Cerritos Channel 98
7.2 Toxicity Identification Evaluations (TIEs) of Stormwater 98
7.2.1 Los Cerritos Channel Station 98
7.3 Dry Weather Discharge 99
7.3.1 Belmont Pump Station 99
7.3.2 Bouton Creek 99
7.3.3 Los Cerritos Channel 99
7.4 Dry Weather Toxicity Identification Evaluations 100
8.0 ALAMITOS BAY PILOT RECEIVING WATER STUDY RESULTS 113
8.1 Vertical and Horizontal Extent of the Stormwater Plume 113
8.2 Chemical Characterization 113
8.3 Toxicological Characterization 114
9.0 DISCUSSION 123
9.1 Comparison to Water Quality Criteria 123
9.1.1 Wet Season Water Quality 123
9.1.2 Dry Season Water Quality 125
9.2 Temporal Trends of Stormwater Contaminants 125
9.3 Loading Rate Assessment 127
9.4 Stormwater Toxicity 127
9.4.1 Dry Weather Toxicity 128
9.4.2 Temporal Toxicity Patterns 130
9.4.3 Comparative Sensitivity of Test Species 130
9.4.4 Relative Toxicity of Stormwater 131
9.4.5 Toxicity Characterization 131
10.0 CONCLUSIONS 181
11.0 REFERENCES CITED 183

APPENDICES
Appendix A - Quality Assurance/Quality Control Assessment
Appendix B – Los Cerritos Channel Dry Weather Upstream Investigation

Report on CD

LIST OF FIGURES

Figure No. *Page*

3.1 Los Angeles Basin. 15
3.2 City of Long Beach. 15
3.3 City of Long Beach, Major Drainage Basins. 16
4.1 Land Use of Drainage Basin #14 which Drains to the Dominguez Gap Mass Emission Site. 29
4.2 Land Use of Drainage Basin #20 which Drains to the Bouton Creek Mass Emission Site. 30
4.3 Land Use of Drainage Basin #23 which Drains to the Belmont Pump Station Mass Emission Site. 31
4.4 Land Use of Drainage Basins which Drain to the Los Cerritos Channel Monitoring Site. 32
4.5 Typical KLASS Stormwater Monitoring Station. 33
5.1 Cumulative Rainfall for the 2004/2005 Wet Weather Season. 40
5.2 Monthly Rainfall Totals for the 2004/2005 Wet Weather Season and Normal Rainfall at Long Beach Daugherty Air Field. 41
5.3 Belmont Pump Station – Event 1 (October 19 and 20, 2004). 42
5.4 Bouton Creek – Event 1 (October 17, 2004). 43
5.5 Los Cerritos Channel – Event 1 (October 17, 2004). 44
5.6 Dominguez Gap Pump Station – Event 1 (December 28, 2004). 45
5.7 Belmont Pump Station – Event 2 (October 26 and 27, 2004). 46
5.8 Bouton Creek – Event 2 (October 19 and 20, 2004). 47
5.9 Los Cerritos Channel – Event 2 (October 19 and 20, 2004). 48
5.10 Dominguez Gap Pump Station – Event 2 (January 2 and 3, 2005). 49
5.11 Belmont Pump Station – Event 3 (December 28 and 29, 2004). 50
5.12 Bouton Creek – Event 3 (October 26 and 27, 2004). 51
5.13 Los Cerritos Channel – Event 3 (October 26 and 27, 2004). 52
5.14 Dominguez Gap Pump Station – Event 3 January 7 and 8, 2005). 53
5.15 Belmont Pump Station – Event 4 (March 22, 2005). 54
5.16 Bouton Creek – Event 4 (December 5, 2004). 55
5.17 Los Cerritos Channel – Event 4 (December 28 and 29, 2004). 56
5.18 Dominguez Gap Pump Station – Event 4 (January 8-10, 2005). 57
7.1 Toxicity Dose Response Plots for Storm Water Samples Collected from Belmont Pump. 101
7.2 Toxicity Dose Response Plots for Storm Water Samples Collected from Bouton Creek. 102
7.3 Toxicity Dose Response Plots for Storm Water Samples Collected from Los Cerritos Channel. 103
7.4 Summary of Phase I TIE Analyses on Stormwater Samples from the Los Cerritos Channel Station October 17, 2004.. 104
7.5 Toxicity Dose Response Plots for the August Dry Weather Samples Collected from Belmont Pump, Bouton Creek and Los Cerritos Channel. 105
7.6 Toxicity Dose Response Plots for the May Dry Weather Samples Collected from Belmont Pump, Bouton Creek and Los Cerritos Channel. 106
7.7 Summary of Phase I TIE Analyses on Dry Weather Samples from the Los Cerritos Channel Station August 31, 2004. 107

Figure No. *Page*

7.8 Summary of Phase I TIE Analyses on Dry Weather Samples from the Los Cerritos Channel Station May 25, 2005. 107
8.1 Map of Surface Salinity in Alamitos Bay with Locations of Eleven Water Quality Profiling Sites, 10/20/2004. 115
8.2(a-d) CTD Casts Taken During Alamitos Bay Receiving Water Study. 116
8.2(e-h) CTD Casts Taken During Alamitos Bay Receiving Water Study. 117
8.2(i-k) CTD Casts Taken During Alamitos Bay Receiving Water Study. 118
8.3 Map of Surface Salinity in Alamitos Bay with Water Quality Sampling Locations, 10/20/2004. 119
8.4 Toxicity Dose Response Plots for Sea Urchin Fertilization Tests using Stormwater Plume Samples collected from Alamitos Bay. 120
9.1 Belmont Pump Station Chemistry Results: a) Cadmium; b) Copper; c) Nickel. 134
9.2 Belmont Pump Station Chemistry Results: a) Lead (total and dissolved); b) Lead (dissolved); c) Zinc. 135
9.3 Belmont Pump Station Chemistry Results: a) Chlorpyrifos; b) Diazinon; c) TSS. 136
9.4 Bouton Creek Chemistry Results: a) Cadmium; b) Copper; c) Nickel. 137
9.5 Bouton Creek Chemistry Results: a) Lead (total and dissolved); b) Lead (dissolved only); c) Zinc. 138
9.6 Bouton Creek Chemistry Results: a) Chlorpyrifos; b) Diazinon; c) TSS. 139
9.7 Los Cerritos Channel Chemistry Results: a) Cadmium; b) Copper; c) Nickel. 140
9.8 Los Cerritos Channel Chemistry Results: a) Lead (total and dissolved); b) Lead (dissolved only); c) Zinc. 141
9.9 Los Cerritos Channel Chemistry Results: a) Chlorpyrifos; b) Diazinon; c) TSS. 142
9.10 Dominquez Gap Chemistry Results: a) Cadmium; b) Copper; c) Nickel. 143
9.11 Dominquez Gap Chemistry Results: a) Lead (total and dissolved); b) Lead (dissolved only); c) Zinc. 144
9.12 Dominquez Gap Chemistry Results: a) Chlorpyrifos; b) Diazinon; c) TSS. 145
9.13 Belmont Pump Station Bacteria Concentrations for 2000 through 2005. 146
9.14 Bouton Creek Bacteria Concentrations for 2000 through 2005. 147
9.15 Los Cerritos Channel Bacteria Concentrations for 2000 through 2005. 148
9.16 Dominguez Gap Bacteria Concentrations for 2000 through 2005. 149
9.17 Total and Dissolved Copper Loading Rates Calculated for all Monitored Storm Events, 2001-2005. 150
9.18 Total and Dissolved Lead Loading Rates Calculated for all Monitored Storm Events, 2001-2005. 151
9.19 Total and Dissolved Zinc Loading Rates Calculated for all Monitored Storm Events, 2001-2005. 152
9.20 Diazinon Loading Rates Calculated for all Monitored Storm Events, 2001-2005. 153
9.21 Summary of Wet and Dry Weather Toxicity Results for all Long Beach Samples. 154
9.22a Comparison of Measured (Total) Toxic Units for the Sea Urchin Fertilization Test and Toxic Units Predicted from the Dissolved Concentrations of Copper and Zinc in the Test Samples. 155
9.22b Comparison of Measured (Total) Toxic Units for the Sea Urchin Fertilization Test and Toxic Units Predicted from the Dissolved Concentrations of Copper and Zinc in the Test Samples. 156

Figure No. ***Page***

9.22c Comparison of Measured (Total) Toxic Units for the Sea Urchin Fertilization Test and Toxic Units Predicted from the Dissolved Concentrations of Copper and Zinc in the Test Samples. 157
9.23a Comparison of Measured (Total) Toxic Units for the Water Flea Survival Test and Toxic Units Predicted from the Concentrations of Chlorpyrifos, Diazinon, and Dissolved Zinc in the Test Samples. 158
9.23b Comparison of Measured (Total) Toxic Units for the Water Flea Survival Test and Toxic Units Predicted from the Concentrations of Chlorpyrifos, Diazinon, and Dissolved Zinc in the Test Samples. 159

LIST OF TABLES

Table No. ***Page***

3.1 Total Areas and Land Use for City of Long Beach Watersheds. 17
4.1 Location Coordinates of Monitoring Stations for the City of Long Beach Stormwater Monitoring Program. 34
4.2 Analytical Methods, Holding Times, and Reporting Limits. 35
5.1 Daily Rainfall Data at Belmont Pump Station During the 2003/2004 and 2004/2005 Wet Weather Seasons. 58
5.2 Daily Rainfall Data at Bouton Creek during the 2003/2004 and 2004/2005 Wet Weather Seasons. 59
5.3 Daily Rainfall Data at Los Cerritos Channel During the 2003/2004 and 2004/2005 Wet Weather Seasons. 60
5.4 Daily Rainfall Data at the Dominguez Gap Pump Station During the 2003/2004 and 2004/2005 Wet Weather Seasons. 61
5.5 Rainfall for Monitored Events during the 2004/2005 Wet Weather Season. 62
5.6 Descriptive Statistics - Rainfall and Flow Data for Full Suite Events (2004/2005). 65
5.7 Flow for Monitored Events During the 2004/2005 Wet Weather Season. 66
6.1 Monitored Storm Events, 2004/2005. 73
6.2 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Bouton Creek Station 74
6.3 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Belmont Pump Station 76
6.4 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Los Cerritos Channel 78
6.5 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Dominguez Pump Station 80
6.6 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, TSS Events 82
6.7 Load Calculations (pounds) for Each Storm Event at Bouton Creek. 83
6.8 Load Calculations (pounds) for Each Storm Event at the Belmont Pump Station. 85
6.9 Load Calculations (pounds) for Each Storm Event at the Los Cerritos Channel Station. 87
6.10 Load Calculations (pounds) for Each Storm Event at the Dominguez Gap Pump Station. 89
6.11 Load Calculations (pounds) for TSS Storm Events at Each Station. 91
6.12 Monitored Dry Weather Events, 1999-2005 92
6.13 Field Measurements for Bouton Creek, Belmont Pump, and Los Cerritos Channel, Dry Weather Season (2004/2005). 92
6.14 Summary of Chemical Analyses of Dry Weather Monitoring, 2004/2005 93

7.1 Toxicity of Wet Weather Samples Collected from the City of Long Beach Belmont Pump Station During the 2004/2005 Monitoring Season. 108

Table No. ***Page***

7.2 Toxicity of Wet Weather Samples Collected from the City of Long Beach Bouton Creek Station During the 2004/2005 Monitoring Season. 109
7.3 Toxicity of Wet Weather Samples Collected from the City of Long Beach Los Cerritos Channel Station During the 2004/2005 Monitoring Season. 110
7.4 Summary of TIE Activities. 111
7.5 Toxicity of Dry Weather Samples from the City of Long Beach. 112
8.1 Summary of Receiving Water Quality in Stormwater Plume Samples from Alamitos Bay. 121
8.2 Toxicity of Receiving Water Samples Collected from Alamitos Bay during the 2004/2005 Storm Season. 121
9.1 Summary of Beneficial Uses for Receiving Water Bodies Associated with each Monitoring Location. 160
9.2 Summary of Available Benchmarks and Guidelines used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites. 161
9.3 Comparison of Stormwater Quality Measurements from Bouton Creek with Guidelines and Standards..164
9.4 Comparison of Stormwater Water Quality Measurements from Belmont Pump Station with Guidelines and Standards. 166
9.5 Comparison of Stormwater Water Quality Measurements from Los Cerritos Channel with Guidelines and Standards. 168
9.6 Comparison of Stormwater Water Quality Measurements from Dominguez Pump Station with Guidelines and Standards. 170
9.7 Comparison of Dry Weather Water Quality Measurements from Bouton Creek with Guidelines and Standards...172
9.8 Comparison of Dry Weather Water Quality Measurements from Belmont Pump Stations with Guidelines and Standards...174
9.9 Comparison of Dry Weather Water Quality Measurements from Los Cerritos Channel with Guidelines and Standards. 176
9.10 Summary of Toxicity Characteristics of Stormwater from Various Southern California Watersheds. 178
9.11 Summary of TIE Results for Each Sample. 179
9.12 Spearman Rank Correlation coefficients (rs) were calculated using selected toxicity data gathered from samples taken during five wet weather seasons 180

ACRONYMNS AND ABBREVIATIONS LIST

BMP - Best Management Practice
BOD- Biochemical Oxygen Demand
CCC – Criterion Continuous Concentration
CD - Compact Disk
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
DO - Dissolved Oxygen
EC_{50} - Concentration causing effects to 50% of the test population
EDTA - ethylene diamine triacetic acid
ELISA – Enzyme linked immunosorbant assay
EMC - Event mean concentration
GIS - Geographic Information System
IC25 - Concentration causing 25% inhibition in growth or reproduction
IC50 - Concentration causing 50% inhibition in growth or reproduction
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
LPC - Limiting Permissible 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
NTS - Not to Scale
NTU - nephelometric turbidity units
NURP - Nationwide Urban Runoff Program
PCB - Polychlorinated biphenyls
PDF - Portable Document Format
ppb - Parts per Billion
ppt - Parts per Thousand
Q - Flow
QA/QC - Quality Assurance/Quality Control
RMP - Regional Monitoring Program
RL - Reporting Limit (considered the same as DL)
RPD - Relative Percent Difference

SAP - Sampling and Analysis Plan
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
TU_c – Chronic Toxicity Unit
USEPA - U.S. Environmental Protection Agency
WQO - Water Quality Objective
WQS - Water Quality Standard

1.0 EXECUTIVE SUMMARY

CITY OF LONG BEACH
STORMWATER MONITORING REPORT 2004/2005

NPDES Permit No. CAS004003 (CI 8052)

1.0 EXECUTIVE SUMMARY

This report provides a summary of the results of the sixth 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. The following section provides a summary of the background for the program including annual adjustments for each year of the program and a summary of key findings from this report.

1.1 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.

The initial monitoring program called for monitoring mass emissions and toxicity at three representative mass emission sites during the first wet season and four sites for subsequent wet seasons. Four wet weather storm events were to be monitored annually. Monitoring during the first two years also included a receiving water site (Alamitos Bay) be monitored with each wet weather storm event.

Dry weather inspections and the collection and analysis of dry weather discharges were required at each of these monitoring sites over two different 24-hour periods during each dry season. Water samples collected at the monitoring sites during each time period were to be analyzed for all parameters specified in the permit and tested for toxicity.

Monitoring sites specified in the permit are as follows:

- Basin 14: Dominguez Gap Pump Station Monitoring Site
- Basin 20: Bouton Creek Monitoring Site
- Basin 23: Belmont Pump Station Monitoring Site
- Portions of Basins 18, 19, 27 and 29: Los Cerritos Channel Monitoring Site (Starting in Second Year)
- Alamitos Bay Receiving Water Monitoring Site (First two years only)

During the first 1999/2000 wet weather season, start-up delays associated with permitting for placement of stormwater monitoring equipment in the Los Angeles County Flood Control District facilities prevented the wet weather monitoring from being carried out. Instead, a special research study on Parking Lot Runoff was carried out with the permission of the Regional Water Quality Control Board staff. In addition, the required dry weather monitoring was carried out for this first year. The first monitoring report (Kinnetic Laboratories, Inc., 2000) covered the first season dry-weather monitoring events performed in June of 2000 as well as one additional receiving water sampling in April 2000.

Subsequent reports (Kinnetic Laboratories, Inc., 2001, 2002, 2003 and 2004) have included both wet and dry season monitoring programs and presented cumulative data results.

During the first five years of the program, adjustments were made on an annual basis to better focus on specific issues. Each year, the Regional Board and the City of Long Beach have worked together to improve the program based upon results of previous years of work. Among the key changes have been:

- Implementation of a receiving water quality element to examine the extent and impacts of the stormwater plume in Alamitos Bay.
- Suspension of toxicity testing at the Dominguez Gap site.
- Suspension of analyses of PAHs as well as a number of other constituents not commonly detected or that are detected consistently at levels well below receiving water quality criteria.
- Adding TSS monitoring for all events.
- Adjustment of the trigger point for TIEs in order to enable greater sensitivity in the identification of toxicants.

There were no significant changes to the program for the sixth year of monitoring under the 1999 MS4 NPDES permit. In a letter from the Los Angeles Regional Board Executive Officer dated October 17, 2004, the City of Long Beach was directed to continue the current monitoring program until the Regional Board revises and reissues the City of Long Beach's MS4 permit.

Last year's annual monitoring report (Kinnetic Laboratories, Inc. 2004) provided the first comprehensive review of all monitoring data from the first full five years of the NPDES permit. The complete database was used to provide a detailed evaluation of the water quality characteristics of dry and wet weather discharges from each mass emission site. This evaluation included examination of 1) relationships between total recoverable trace metals and suspended sediments, 2) concentrations of dissolved metals and hardness in relationship to freshwater CTR criteria, 3) discharges of suspended solids and total recoverable metals as a function of flow, and 4) pollutant loading rates associated with each watershed.

1.2 Summary of 2004-2005 Results

The 2004/2005 wet weather season was one of the wettest in recorded history in Southern California with over 29 inches of rain (240% of normal), ending several years of drought conditions. Also important were the large magnitude of the individual storm events and the high intensity of the rainfall experienced during these events.

Wet weather sampling of storm events began in October 2004. The first major storm of the year occurred on October 17th, 2004. This event was predicted to be a marginal event. Forecasts indicated that the storm might yield as much as 0.25 inches which would meet the criteria for a storm event. Instead rainfall during that event was four to five times greater than forecast and had high intensity. First flush samples were obtained at both Bouton Creek and the Los Cerritos Channel but an equipment malfunction prevented sampling at the Belmont Pump Station. However during this wet weather season, a total of four storm events were monitored at all four City of Long Beach mass emission stations. In addition, a combined total of 27 additional wet weather samples were obtained from the four stations for analysis of TSS. Events sampled exclusively for TSS were required to meet the same quality criteria as events where all constituents were analyzed.

The third year of a receiving water study was conducted to monitor the horizontal and vertical extent of the stormwater plume in Alamitos Bay and to characterize key contaminants and toxicity within the plume. This study was conducted on October 19th 2004, following the second event of the season. The plume was delineated and water samples were taken from four different locations in the plume. Sampling locations represented a range of salinities within the plume that ranged from 8.1 to 21ppt. Water samples were tested for toxicity and a subset of water quality parameters which included selected trace metals and organophosphate pesticides.

Two dry weather inspections/monitoring events were conducted. The first was conducted on August 31, 2004 prior to the winter rains. High pH (>9.0) in the composite sample from the Los Cerritos Channel site during this survey triggered an upstream investigation. Immediate investigations were conducted on August 31st but no source could be rapidly identified. A thorough upstream survey was implemented on September 3, 2004 to allow further investigation of possible sources in the watershed. The second dry weather survey was conducted on May 25, 2004 once winter rains had subsided. Dry weather monitoring was conducted for the three mass emission sites that exhibited dry weather flows. These included Bouton Creek, the Belmont Pump Station, and the Los Cerritos Channel.

The results of the City of Long Beach's 2004/2005 stormwater monitoring program are summarized as follows:

Wet Weather Chemical and Bacterial Results

Numerical standards do not exist for stormwater discharges. However, water quality criteria or objectives may 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 California Ocean Plan (SWRCB 2002), 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. Not all of these criteria are appropriate for Long Beach discharges or for comparison with stormwater runoff water quality. In order for these comparisons to be useful, it is important that a regional strategy be developed that provides consistent and appropriate benchmarks.

- Concentrations of bacteria (total coliform, fecal coliform, and enterococcus) in the Long Beach stormwater discharges routinely exceed public health criteria provided by the Basin Plan and the Ocean Plan. This year, as in most, 100 percent of the stormwater samples exceeded the Basin Plan criteria. Grab samples for bacteria could not be taken on two occasions (October 17, 2004 and December 6, 2004) due to issues with sampling logistics. Other studies have shown that such exceedances are not limited to urban stormwater sources but are also measured in stormwater discharges from undeveloped surrounding land.

- Total recoverable metal concentrations were compared against the Ocean Plan's aquatic life criteria and the Basin Plan drinking water quality objectives. Concentrations of total recoverable copper, lead and zinc exceeded Ocean Plan criteria in 100 percent of the samples from the Belmont Pump Station and the Los Cerritos Channel. Stormwater runoff from Bouton Creek exceeded the Ocean Plan lead criterion during all four events. Ocean Plan copper and zinc criteria were exceeded during three of the four events at this site. Concentrations of total recoverable copper, lead and zinc in runoff from the Dominguez Gap Pump Station exceeded Ocean Plan criteria for lead and zinc 100 percent of the time. The Ocean Plan criterion for copper was exceeded during three of the four events monitored at this location.

- The aluminum drinking water quality criteria of 1000 ug/L was exceeded in 50% of the samples from the Belmont Pump Station, 75% of the samples from Bouton Creek, and all stormwater samples from Los Cerritos Channel and the Dominguez Gap Pump Station.

- Dissolved metal concentrations were compared against both saltwater and freshwater Criteria Continuous Concentrations (CCC) values from the California Toxics Rule (CTR). As noted in previous years, dissolved copper, lead and zinc commonly exceed these reference values. In the case of dissolved copper, 94% of the samples exceeded the freshwater CTR criteria and 88% exceeded the saltwater CTR criteria. Dissolved lead exceeded the freshwater CTR criteria in 50% of the samples and never exceeded the saltwater CTR criteria. Dissolved zinc exceeded freshwater CTR criteria in 38% of the samples and exceeded saltwater CTR criteria in 13 percent of the cases.

- Typically, very few organic compounds have been found to exceed available reference criteria in runoff from the four mass emission sites. Only one chlorinated pesticides, 4-4' DDT, was detected in stormwater at levels above receiving water quality criteria during a single event at the Belmont Pump Station. In the previous season, DDT was detected in two samples from the Belmont Pump Station and one from Los Cerritos Creek. In both the current (2004/2005) and previous monitoring year (2003/2004) measured concentrations of DDT were always less than 3 times the reporting limits.

- Among the four mass emission sites, the Los Cerritos Channel consistently exhibited the highest overall loads of solids and total metals due to the large size of the watershed monitored at this location.

- Due to the large size differences among watersheds, loads were normalized to a unit of 1000 acres in order to provide a more meaningful comparison for key stormwater contaminants. Overall total metals loading rates from the Los Cerritos Channel tend to be among highest measured at the four mass emission sites. Increased total metals loading rates are particularly evident in association with larger rainfall events. This pattern suggests that possible mobilization of an upstream source of particulate metals in the watershed or resuspension of instream sources.

<u>Dry Weather Chemical and Bacterial Results</u>

- Over the life of the NPDES permit, dry weather runoff has consistently been characterized by lower concentrations of suspended particulates and total recoverable metal concentrations. Trace metals are predominantly in the dissolved form. Hardness is also consistently high which tends to mitigate the effects of the dissolved metals. None of the dissolved metals exceeded freshwater CTR criteria this year or in the previous year. Very few have exceeded these criteria since implementation of the monitoring program.

- Although concentrations of bacteria in dry weather runoff still often exceed Basin Plan public health criteria, recent dry weather investigations have tended to have consistently lower levels than measured at the same sites during storm events. Total and fecal coliform concentrations measured in Bouton Creek during dry weather surveys continue to be unique. Concentrations of total and fecal coliform are below Basin Plan single sample criteria approximately 50% of the time at this site.

- As in all previous years, no dry weather discharges were observed from the Dominguez Gap Pump Station.

- Occasional elevations of pH during dry weather surveys in open concrete channels of the Los Cerritos Channel are consistent with normal diurnal variations associated with periods with high photosynthetic activity. Evidence suggests that pH increases during the day. Algae in the channels consume carbon dioxide (CO_2) while undergoing photosynthesis. 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 the night, respiration of the algae and bacteria in the channel cause CO_2 to be released and oxygen to be consumed. This allows the pH drop during the night. The diurnal cycling of pH is a common occurrence in open waterways.

Alamitos Bay Receiving Water Program

- The three surveys conducted in receiving waters have shown no evidence of wide-spread toxicity in stormwater plumes within Alamitos Bay. The first survey was conducted during the 2002/2003 monitoring year. This survey was conducted in association with a brief, intense storm that yielded 1.21 to 1.26 inches of rain in less than five hours. The plume extended from the surface down to depths of 3 to 6 feet throughout Alamitos Bay, with salinities varying from 1 to 28ppt but no toxicity was noted. The 2003/2004 survey was conducted during an event that yielded 0.67 to 0.77 inches of rain. Evidence of the plume was largely limited to the mouth of Los Cerritos Channel as it entered Marine Stadium. Although a toxicity gradient was identified, toxicity was still very low in comparison to other studies. The highest toxicity was observed in a sample containing approximately 68% stormwater. This sample had an EC_{50} of 44.7% (TU_a=2.2) and a NOEC of 25%.

  This year's plume study was conducted after a very large storm event that resulted in 1.55 inches to 1.83 inches over a period of roughly ten hours. The monitored event followed just 72 hours after the first storm event of the season which yielded between 0.81 to 1.36 inches of rainfall in the study area. Plume samples were taken at salinities ranging from 8.3 to 21ppt. All plume samples were found to contain low concentrations of trace metals and exhibited very little evidence of toxicity. This is consistent with a lack of toxicity at each of the mass emission monitoring sites during this event.

  The three plume tracking studies conducted in Alamitos Bay have all contrasted sharply with studies in Santa Monica Bay and San Diego Bay that have shown substantial toxicity in samples containing as little as 10 to 25% stormwater. Stormwater plume samples from the 2004/2005 plume contained 38 to 76% stormwater. The lower levels of toxicity of the stormwater plume in Alamitos Bay are consistent with lower concentrations of dissolved zinc relative to both the Ballona Creek and San Diego Bay studies.

Temporal Trends in Constituents of Concern

Each year, long term trends have been examined for selected trace metals and organic compounds, TSS, and bacteria. Patterns identified in previous reports continue to persist as more data are obtained through the ongoing sampling efforts. Major observations include:

- Dissolved concentrations of cadmium, copper, nickel and lead appear to be comparable during both wet and dry weather periods. Unlike these four metals, dissolved zinc concentrations are often higher during storm events.

- Concentrations of total copper, lead and zinc are distinctly higher in association with storm flows. Seasonal differences in total cadmium and nickel are less evident but the highest concentrations still tend to occur during winter storm events.

- Over the past three years, the highest concentrations of two organophosphate compounds, chlorpyrifos and diazinon, have occurred during wet weather runoff but no seasonal trends were noted for either compound. The highest concentrations of both these contaminants were reported during the 2001/2002 wet weather season.

- Stormwater discharges from the Dominguez Gap Pump Station are consistently of a higher quality than the other mass emission sites. In addition, stormwater discharges are less frequent at Dominguez Gap because of the storage capacity and infiltration that occurs in the basin associated with this pump station. Exceptions to this occur in situations when unusually high volume storm events occur repeatedly over a relatively short time interval

Toxicity Results

- Toxicity to one or both test organisms was detected at all three of the stations sampled this year during each of the wet weather storm events. Water flea (*Ceriodaphnia*) toxicity was seen only during the first storm at the Cerritos and Bouton stations, and only during the last storm at the Belmont station. Sea urchin toxicity was seen during the first and fourth storms at Bouton and during the first, third and fifth storms at Cerritos. Belmont showed urchin toxicity during the second, third and sixth storms. The frequency and magnitude of stormwater toxicity from the Long Beach stations during this monitoring period were similar to those reported for the previous monitoring period, and generally reduced from the three previous Long Beach stormwater programs. Frequency and magnitude of stormwater toxicity were also reduced compared with stormwater samples from other southern California watersheds. The Chollas Creek (San Diego) and Ballona Creek (Santa Monica) were most similar to the Long Beach study, as these samples were obtained from smaller highly urbanized watersheds relative to the Los Angeles River and San Gabriel River.

- Toxicity to water fleas was measured in the fall dry weather samples from Bouton Creek and Cerritos Channel and the spring dry weather sample from Cerritos Channel. The magnitude of dry weather toxicity to water fleas at Cerritos was comparable to that measured in the first wet weather sample, but much greater than that seen in later storm samples. These results do not support a hypothesis suggesting significant differences in the composition of stormwater and dry weather discharge from the City of Long Beach.

- Perhaps indicative of the generally reduced magnitude of toxicity seen during this testing program, only three TIEs (one wet weather and two dry weather) were triggered in 2004/2005. All three TIEs were performed with water fleas and all yielded useful information. The results of this year were somewhat different from the 2003/2004 monitoring period, but were similar to TIE results from previous years.

- In contrast to last year, both of the dry-season TIEs indicated that organophosphate pesticides were important toxic constituents with possible additional toxicity contributions from pyrethroid pesticides. Metals were not implicated in dry weather toxicity.

- The single wet weather water flea TIE provided results that were similar to last year, with a non-polar organic compound suggested as the most likely toxicant. Organophosphates were not implicated, since PBO treatment was ineffective in toxicity reduction. PBO, however, slightly enhanced toxicity at its highest treatment concentration, suggesting pyrethroids as a minor toxicant. Metals were not implicated.

- The toxicity data also implicated dissolved metals, including copper, lead nickel and zinc, as causes of stormwater toxicity. These conclusions are generally supported by TIE results, by correlations of toxicity with chemical constituents, and by calculations of predicted toxicity based upon measured zinc and copper concentrations in the stormwater.

2.0 INTRODUCTION

2.0 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))(CRWQCB, Los Angeles 1999). 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.

Since issuance of the 1999 NPDES permit, the population served by City of Long Beach has increased by nearly 9 percent. When the permit was first issued, the population was estimated at 452,000. Current estimates place the City's population at 491,564[1] people in an area of approximately 50 square miles. This makes the City of Long Beach the fifth most populated city in the California. 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 Los Cerritos Channel. These areas also include coastal shorelines, including Alamitos Bay Beaches, Belmont Shore Beach, Bluff Park Beach, and Long Beach Shore[2].

2.1 Annual Program Adjustments

The NPDES permit requires the City of Long Beach to prepare, maintain, and update if necessary a monitoring plan. The specified 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.

The Regional Board first modified the permit by letter on October 24, 2001 based upon review of the second year report and concurrent modifications being negotiated on the Los Angeles County stormwater permit. Permit modifications consisted of three primary elements. The first modification was an adjustment to the list of constituents and the required reporting limits 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). The second change addressed the requirements for triggering TIEs and a reduction in toxicity testing requirements for the mysid, *Americamysis*. TIE triggers were changed to enhance opportunities for defining toxicity that might be related to first flush or other early season events. Testing of mysids was reduced to conducting these tests only during the first

[1] Population estimate. State of California Department of Finance Demographic Research Unit, 1/1/2005
[2] Los Angeles Regional Water Quality Control Board, 2002 303(d) list

event of the season. The final change was a requirement to compare stormwater quality data to water quality criteria applicable to specific beneficial uses in each receiving water body.

After reviewing the third year report, the Regional Board issued another letter on November 13, 2002 that provided further adjustments to the monitoring program. Major changes included:

- continuation of monitoring at the Dominguez Pump Station site but suspension of toxicity testing at this site,
- elimination of monitoring requirements for semi-volatile organic compounds during the 2002/2003 season while investigating alternative sampling and analytical approaches to obtain lower detection limits in subsequent years,
- elimination of the Alamitos Bay Receiving Water Site,
- implementation of a pilot receiving water program, and
- implementation of upstream investigations if extreme pH values are encountered during Dry Weather monitoring at any of the Mass Emission Stations.

Major program adjustments implemented in the fifth year of the current permit were detailed in the September 12, 2003 letter from the Executive Officer. Adjustments were based upon meetings with Regional Board staff, the City of Long Beach, Kinnetic Laboratories, Inc., and SCCWRP. The following summarizes the most significant changes.

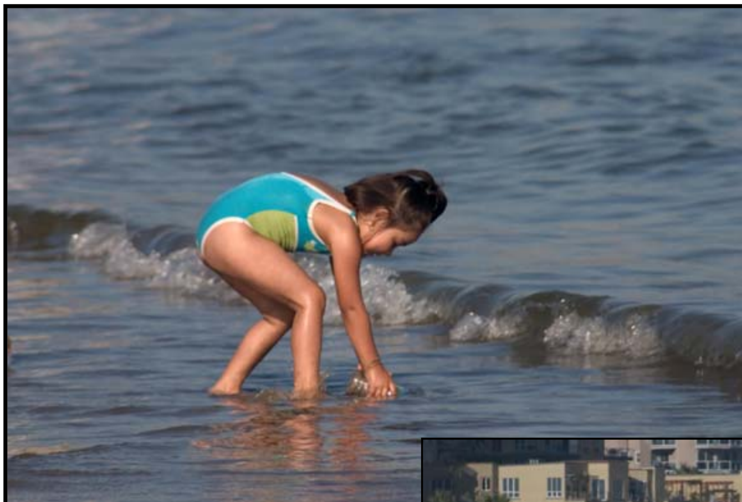
- Suspend analyses of parameters that have been infrequently detected and/or typically detected at low levels not considered to be ecologically important. Specific analytes included antimony, beryllium, hexavalent chromium, mercury, thallium, total recoverable petroleum hydrocarbons (TRPH), MTBE, cyanide, glyphosate, 2,4,D and 2,4,5-TP (Silvex).
- Continue with the plume study. Target first storm of the season that exceeds 0.25-0.30 inches of rainfall in the study area.
- Suspend mysid toxicity tests previously conducted in conjunction with the first storm of the season.
- Raise the trigger point for implementation of TIEs from 2 Toxicity Units (TUs) to 3 TUs.
- Change the monitoring strategy to emphasize sampling runoff during early season storm events
- Suspend PAHs and semivolatile organic compounds from analysis during the 2004/2005 (final year) of the permit since the current detection limits are not low enough to provide any meaningful data. The model monitoring program being developed by the Southern California Stormwater Monitoring Coalition (SMC) is expected to develop consistent monitoring designs, sampling and analysis, and quality assurance protocols.
- Monitor Total Suspended Solids (TSS) and stormwater discharges for all storm events at all four monitoring stations.

The City of Long Beach has continued to operate under the 1999 MS4 NPDES permit. A letter providing comments on the 2003/2004 report and recommendations for the 2004/2005 season was received by the City on October 14, 2004. The letter directed the City to continue to implement the current monitoring program as modified in the fourth year of the 1999 permit until the Regional Board revises and reissues the City of Long Beach's MS4 Permit. This letter also contained several minor recommendations and adjustments. Major points identified in this letter included:

- Recommendations to allow for at least a minimum of 7 days between monitored events
- Include daily records of rainfall for both the current and previous seasons in subsequent reports
- Submit the previously developed Draft Work Plan for "Identification of Major Watershed Sources of Persistent, Bioaccumulative and Toxic Chemicals in Watersheds with Impacted Water Bodies" to the Southern California Stormwater Monitoring Coalition (SMC) to seek input and participation before proceeding with the study.

Copies of the Draft Work Plan were provided to the SMC for review and a presentation was given at the SMC Meeting on March 2, 2005. Comments and suggestions were solicited at that time. No responses have been received from the SMC as of early July.

This report provides a summary and analysis of data collected during the sixth year of permit.



3.0 STUDY AREA DESCRIPTION

3.0 STUDY AREA DESCRIPTION

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.

3.1 Regional Setting

3.1.1 Geography

The City of Long Beach is located in the center and southern part of the Los Angeles Basin (Figure 3.1) and is part of the highly urbanized Los Angeles region. In addition to residential and other uses, the City also encompasses heavy industrial and commercial areas and includes a major port facility, one of the largest in the United States. The City's waterfront is protected from the open Pacific Ocean by the extensive rock dikes 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, with Signal Hill being the most prominent topographic feature (Figure 3.2).

3.1.2 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 City of Long Beach, including the City of Signal Hill, is divided into 30 watersheds as shown in Figure 3.3. Data presently in the City of Long Beach GIS database on total areas and specific land use categories for each basin are given in Table 3.1 (City of Long Beach 2001). Specific watersheds selected by the City of Long Beach for this present stormwater monitoring program are described in more detail in the section 4.0.

3.1.3 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 5.2 for average rainfall by month and seasonal total rainfall as measured at the Long Beach Airport). The long-term average rainfall for October through April at the Long Beach Airport is 12.27 inches per year.

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 stream on the Plain and it drains the San Fernando Valley and much of the San Gabriel Mountains. Most of the streams are dry during the summer and there are no lakes or ponds, other than temporary ponding behind dunes (Miles & Goudy, 1998). The climate is mild, with a 30-year average temperature of 23.4 °C (74.1°F) at the Long Beach Daugherty Airport (NCDC, 2000).

3.1.4 Population and Land Use Characteristics

The population of the City of Long Beach totaled 491,564 residents in January 2005 (California Department of Finance Demographic Research Unit, 2005). The total population of the County of Los Angeles, in which it resides, was 10,226,506. The independent city of Signal Hill, located on a promontory, is surrounded by the City of Long Beach. Signal Hill's population was recently estimated to be 10,951. Signal Hill contributes runoff to drainage basins 6, 7, 8, 9 and 18.

The City of Long Beach has a total area of 26,616 acres. Of that total 16,926 acres (64%) are classified as residential, 4,784 acres (18%) as commercial, 2,269 acres (8.5%) as industrial, 1,846 (7%) as institutional, and 786 acres (3%) as open space (City of Long Beach, 1999). The drainage basins sampled for the stormwater monitoring study follow this general pattern of land use.

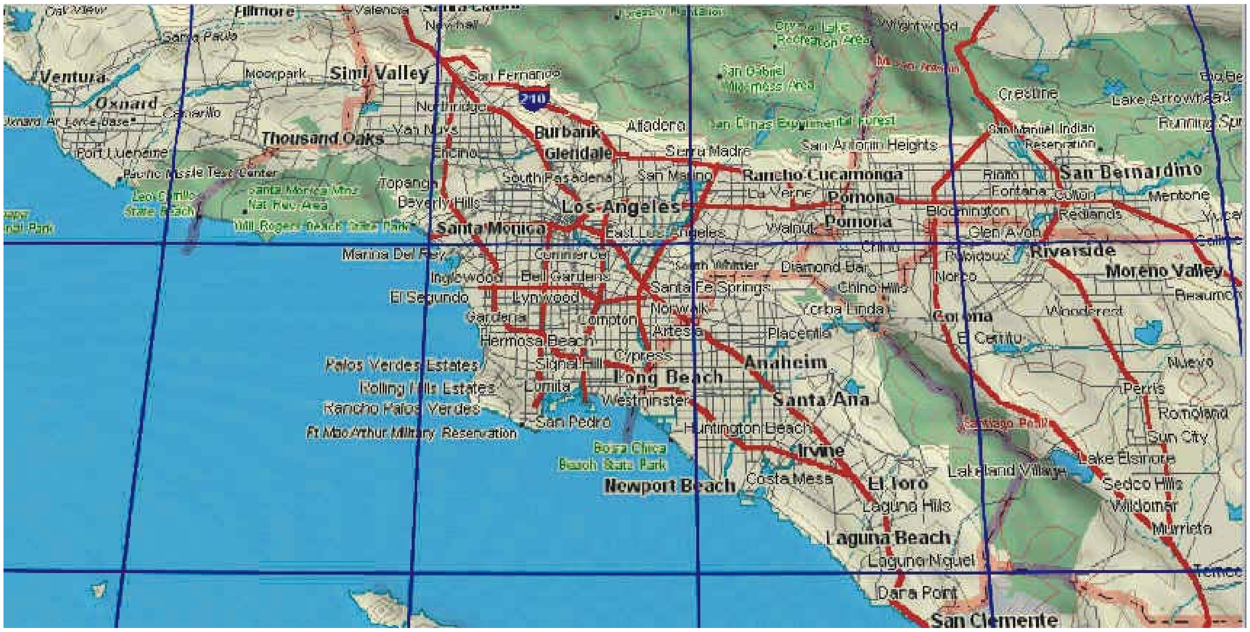


Figure 3.1 **Los Angeles Basin. (Source: 3-D TopoQuads Copyright 1999 DelLorme, Yarmouth, ME 04096).**

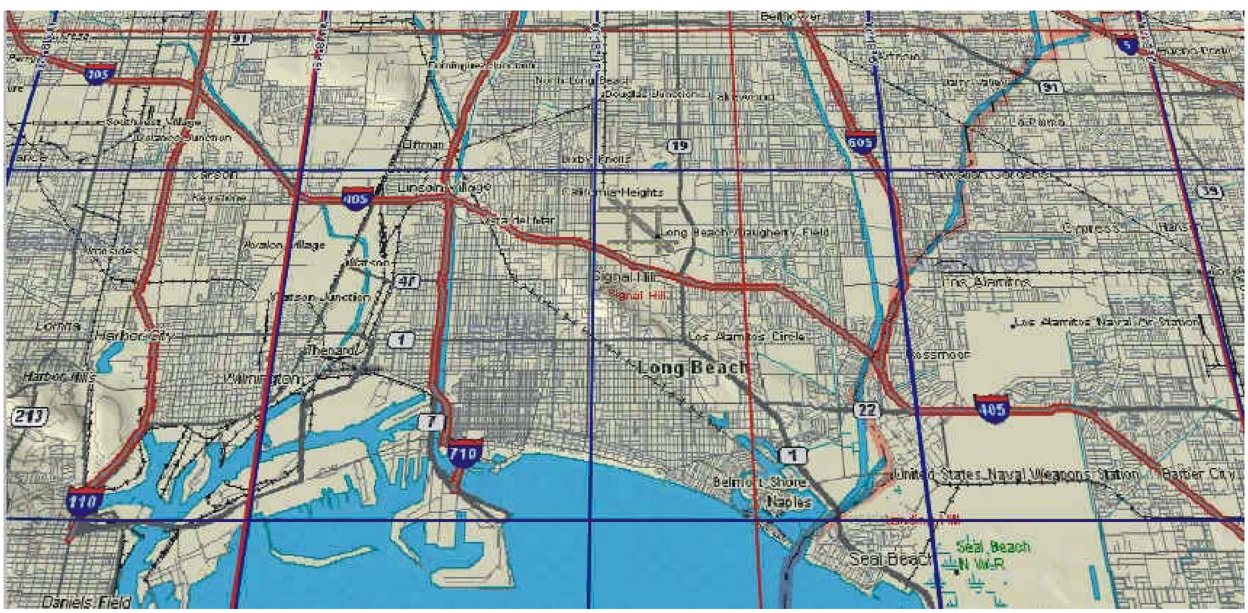


Figure 3.2 **City of Long Beach. (Source: 3-D TopoQuads Copyright 1999 DelLorme, Yarmouth, ME 04096).**

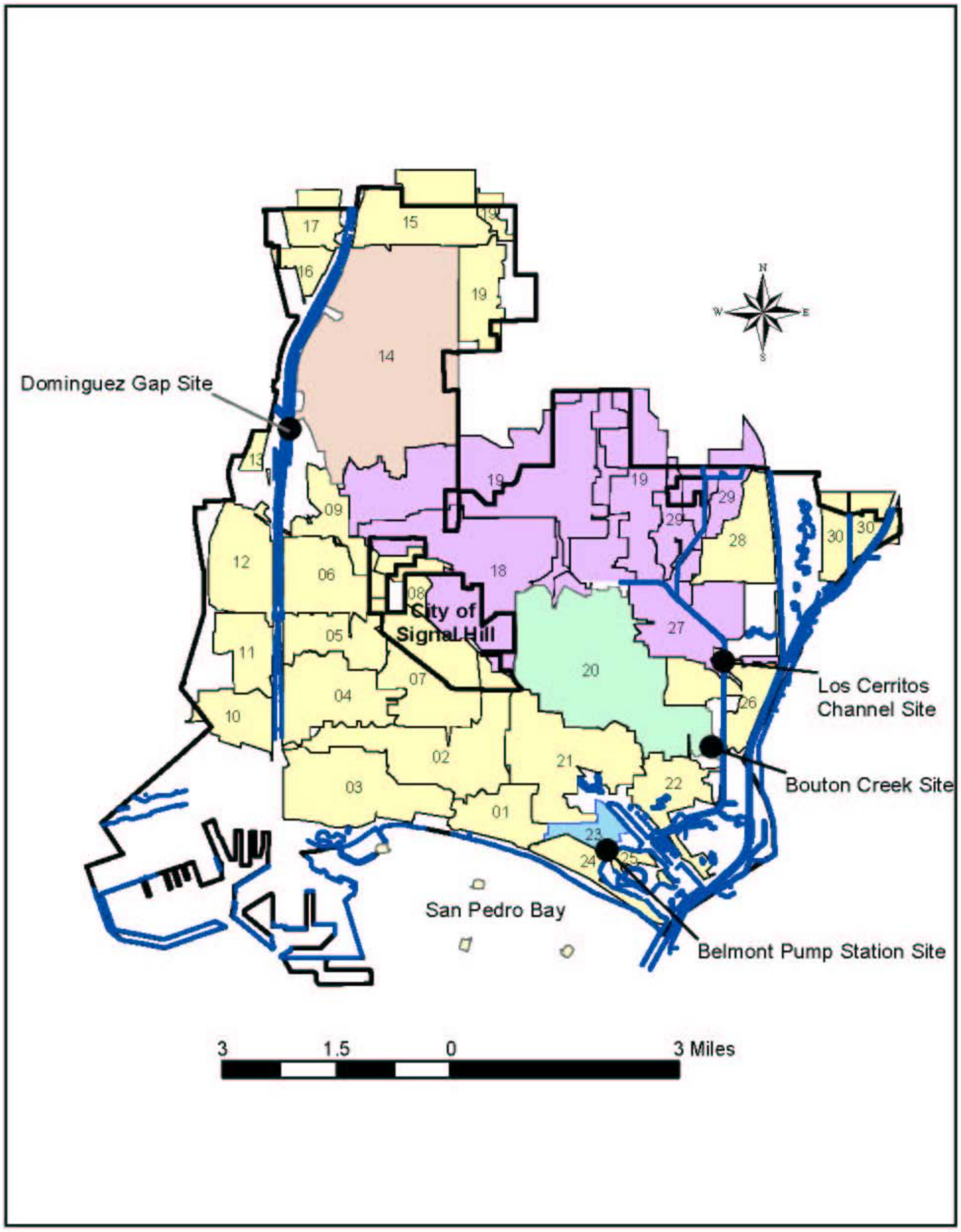


Figure 3.3 City of Long Beach Major Drainage Basins (Source: City of Long Beach, Department of Technology Services, last update 1994) and City of Long Beach Stormwater Monitoring Sites.

Table 3.1 Total Areas and Land Use for City of Long Beach Watersheds.

Drainage Basin	Drainage Pattern	Sub-basins	Total Acres	Residential Acres	Commercial Acres	Industrial Acres	Institutional Acres	Open Space Acres
1	N to S	4	456	393	44	0	7	12
2	E to W	1	1,276	905	287	22	59	3
3	E to W	3	1,083	367	642	7	58	9
4	E to W	2	810	426	176	140	56	12
5	E to W	1	546	434	97	0	13	2
6	S & SE	1	695	475	125	0	73	17
7	to center	1	1,029	858	89	11	53	18
8	E to W	1	248	163	27	58	0	0
9	SW & NW	1	399	295	91	0	12	1
10	S & E	3	416	16	49	351	0	0
11	S & E	1	424	338	64	3	18	1
12	S & E	1	719	556	98	9	41	15
13	S & E	1	84	0	7	77	0	0
14	S & W	2	3,374	2,445	392	148	273	116
15	S & W	1	958	569	167	197	25	0
16	N to S	1	194	113	61	8	5	7
17	S & E	1	317	244	68	0	5	0
18	E	1	1,814	804	262	729	19	0
19	E	20	3,898	2,475	610	439	228	146
20	S & E	1	2,259	1,215	412	70	492	70
21	S & E	3	1,172	773	125	0	55	219
22	variable	9	520	38	428	0	54	0
23	S	1	213	110	85	0	14	4
24	SE & NW	1	281	188	30	0	0	63
25	W & E	2	90	70	9	0	4	7
26	S & W	3	355	304	22	0	29	0
27	E & S	9	1,083	825	109	0	143	6
28	S & E	1	630	386	179	0	65	0
29	S	8	727	633	10	0	26	58
30	SW(6) & SE(1)	7	546	508	19	0	19	0
	Total Acres		26,616	16,926	4,784	2,269	1,846	786

4.0 MONITORING PROGRAM

4.0 MONITORING PROGRAM

4.1 Monitoring Program Objectives

The stated long-term objectives of the stormwater monitoring program are as follows:

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 investigations; and
6. Evaluate BMP effectiveness.

Monitoring efforts during the first term of the permit have emphasized characterizing the chemical and toxicological characteristics of discharges from the city's MS4 during both storm events and dry weather periods to develop the data needed address the first five objectives listed above. In addition, a start on BMP investigations through the special Parking Lot Study was implemented during the first full year of monitoring. Specific objectives of this year's work included the following:

1. Obtain monitoring data from four (4) storm events for each mass emission station during the 2004/2005 storm season.
2. Conduct a field study to document the extent of stormwater plumes in Alamitos Bay and measure associated toxicity and water chemistry at four different dilutions.
3. Carry out dry weather inspections and obtain samples of dry weather flow at each of the four mass emission stations. Perform this dry weather work twice during the dry season that extends from May through October.
4. Perform chemical analyses for the specified suite of analytes at the appropriate detection limits for all stormwater samples collected.
5. 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.
6. Report the above results and evaluate the monitoring data with respect to receiving water quality criteria.

4.2 Monitoring Site Descriptions

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 3.3. The latitude and longitude of each site are shown in Table 4.1. Brief descriptions of each drainage basin and land use are provided in the following sections.

4.2.1 Basin 14: Dominguez Gap Monitoring Site

The sampling station located at the Dominguez Gap Pump Station is intended to monitor Basin 14 that covers 3,374 acres. Land use in this basin is 72% residential, 12% commercial, 8% institutional, 4% industrial, and 4% open space (Figure 4.1). 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 Artesia Boulevard, Roosevelt Road, the railroad, and the Los Angeles River respectively (City of Long Beach, 2001).

Normally in the summer, the retention basin located adjacent to the pump station would be dry according to the Flood Maintenance Division of the Los Angeles Public Works. However, current practice is to have the pumps locked off for the summer with water diverted into the retention basin from the Los Angeles River to recharge the groundwater aquifer and to study the feasibility of a wetland habitat in the area. During winter storms, the retention basin fills from stormwater discharge, which then infiltrates into the groundwater. During intense rains, when the retention basin fills to a specified level, the pump station pumps the water over the levee and discharges it into the Los Angeles River.

The stormwater monitoring equipment was located within the Dominguez Gap Pump Station. The automatic sampler utilized a peristaltic pump to collect water from the pump station's sump. The configuration of monitoring equipment was updated this year to improve measurement of flow particularly during periods when the basin was being manually pumped down. All five pumps have been individually instrumented to detect when each pump is activated. Flow is calculated based upon pump curves and water elevations in the sump as measured with a pressure transducer 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. In the past, equipment constraints prevented instrumentation of the final pump that comes on line during high flows. Although this was not an issue with automatic operations, this becomes an issue when the basin is manually pumped down since all pumps are operated at such times.

4.2.2 Basin 20: Bouton Creek Monitoring Site

This site collects water from Basin 20 covering 2,259 acres. Basin 20 is 54% residential, 22% institutional, 18% commercial, 3% industrial, and 3% open space (Figure 4.2). 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, along side of the Alamitos Maintenance Yard of the Los Angeles County Public Works Department.

At the 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 saltwater influence at tide levels above three feet. The automatic sampling equipment was therefore configured and programmed to measure discharge flow and to obtain flow-composited samples of the freshwater discharge down the creek, avoiding the tidal contributions by using real-time conductivity sensors. A velocity 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 2 feet above the bottom. A third conductivity sensor and the sample intake were mounted on a floating arm that kept them near the surface.

4.2.3 Basin 23: Belmont Pump Station Monitoring Site

This site collects water from Basin 23 that covers 213 acres. Land use in the basin is 52% residential, 40% commercial, 0% industrial, 6% institutional, and 2% open space (Figure 4.3). 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.

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 single sump pump typically comes on and discharges about two feet of water from the sump area every evening at around 2300 hours. Four main pumps are available to remove water during storm events. Water from these pumps is discharged into Alamitos Bay.

The stormwater monitoring equipment was initially located outside the pump station but on the grounds of the pump station inside a steel utility box. The equipment was moved inside pump station in 2003 to shorten hose lengths and improve reproducibility of sample volumes. The sensors and sampling hose were installed inside the pump station sump adjacent to the large discharge pumps. The automatic sampler utilized a peristaltic pump to sample from the sump. The sampler was activated at the same set point (sump elevation) that activated the discharge pumps, thus obtaining water samples during the discharge to Alamitos Bay. Sump elevation was determined with a pressure transducer. Flow rates were determined from the individual pump curves of each pump, and total volume discharged obtained by integrating this data over the period of time each pump discharged.

This year additional instrumentation was installed to enable monitoring of flows from the small summer pump. The summer pump normally deals only with low flows that occur during dry weather periods. This pump has become more important during storm events since it has been used before and at the end of events to clear the storm drain systems of residual water for flood protection purposes. In the prior year, these manual pump downs resulted in a moderate bias when performed in conjunction with smaller events. This year an additional pressure sensor was installed to monitor summer pump activity and incorporate discharges caused by this pump into the total discharge calculations.

New Summer Pump Sensor installed at the Belmont Pump Station

4.2.4 Portions of Basins 18, 19, 27 and 29: Los Cerritos Channel Monitoring Site

The Los Cerritos Channel Monitoring Site receives runoff from all or portions of four different basins. Small portions of the watershed are located outside of the City of Long Beach. This includes roughly 577 acres of the City of Lakewood and 581 acres of the City of Signal Hill.

The total area of watershed above the sampling site is approximately 7,685 acres. Land use within the watershed consists of 65% residential, 12% commercial, 12% institutional and 5% open space (Figure 4.4).

The stormwater monitoring station was installed in a steel utility box located on the west side of the channel south of Stearns Street. Flow sensors and sampling tubing were installed on the bottom of the large concrete lined channel. This sampling site is above tidewater on Los Cerritos 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.

4.3 Monitoring Station Design and Configuration

Each of the four land use stations monitored in Long Beach were equipped with Kinnetic Laboratories Automatic Sampling System (KLASS). Figure 4.5 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 receiving water site was not equipped with a KLASS.

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. The system installed at Bouton Creek also incorporated several conductivity cells for distinguishing tidal flow from fresh water runoff. Pump station sites also incorporate a variety of sensors to monitor individual pump activity.

The equipment was installed with intakes and sensors securely mounted, tubing and wires in conduits, and all above ground instruments protected within a security enclosure. Section 4.2 described how the equipment was placed at each station.

All materials used in the collection of stormwater samples and in contact with the samples met strict criteria in order to prevent any form of contamination of the sample. These materials must 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. Sample hoses were Teflon®.

All bottles and hoses were cleaned according to EPA-approved protocols consistent with approved methodology for analysis of stormwater samples (USEPA, 1983). These bottles and hoses were 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.

4.4 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.

4.4.1 Wet Weather Monitoring

Stormwater runoff was collected using two primary methods. Composite sampling was conducted to collect water for both chemical analysis and toxicity testing. A few analytes such as bacteria must be sampled using grab sampling methods and thus reflect conditions only at the time of sampling. For the past three years, wet weather monitoring has also included a second study designed to investigate the spatial extent of the stormwater plume in the receiving waters of Alamitos Bay. The following sections provide details of methods used for composite sampling, grab sampling and for the receiving water study in Alamitos Bay.

4.4.1.1 Composite Sample Collection

A priority objective of the storm monitoring was 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. This study required volumes of 20 to 30 liters of sample from each of the four land use sites to meet these analytical needs.

All aspects of the sampling events were continuously tracked from an office command and control center (Storm Control) located at our Santa Cruz laboratory. The status of each station was monitored through telecommunication links to each site. Station data were downloaded, and the stations were controlled and reprogrammed remotely. Weather information, including Doppler displays of rainfall for each area being monitored were also available on screen at the Storm Control center. In addition, Storm Control was in contact by cellular phone with the field crews.

When a storm was likely, all stations were made ready to sample. This preparation included entering the correct volume of runoff required for each sample aliquot ("Volume to Sample"), setting the automatic sampler and the data logger to sampling mode, pre-icing the composite sample bottle, and performing a general equipment inspection. A brief physical inspection of the equipment was 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 were shut down either on site or remotely by Storm Control. The station was left ready for the next storm event in case there was insufficient time for a maintenance visit between storms. Data were retrieved remotely via telecommunications from the data logger on a daily basis throughout the wet weather season.

All water samples were kept chilled (4ºC) and were transferred to the analytical laboratories within holding times. Prior to sample shipping, sub-sampling from the composite container into sample containers was accomplished using protocol cleaned Teflon and silicone sub-sampling hoses and a peristaltic pump. Using a large magnetic stirrer, all composite water was first mixed together thoroughly and then continuously mixed while the sub-sampling took place. All sub-sampling took place at a staging area near Long Beach. Documentation accompanying samples to the laboratories included Chain of Custody forms, and Analysis Request forms (complete with detection limits).

4.4.1.2 Grab Sampling

During each storm event, grab samples for oil and grease, total and fecal coliform, and enterococcus were collected. The timing of grab sampling efforts was 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 was always a major consideration.

Except at the pump stations, all grab samples were taken near 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 were taken from the sump. A specially constructed sampling pole was required to obtain samples at most sites. Poles used were fitted with special bottle holders to secure the sampling containers. Care was taken not to overfill the sample containers for some of the containers contained preservative.

4.4.1.3 Alamitos Bay Receiving Water Study

This element of the stormwater monitoring program was initiated during the 2001/2002 annual program review with Regional Board staff. A pilot receiving water program was first conducted during the 2002/2003 season. This program was retained as a component of the 2003/2004 and 2004/2005 monitoring efforts. The primary objectives of the receiving water program were to:

- Define the general vertical and horizontal extent of stormwater in Alamitos Bay, Marine Stadium and Los Cerritos Channel.
- Evaluate toxicity and associated water quality characteristics of the stormwater plume.

Alamitos Bay, located approximately 10 miles southeast of Long Beach Harbor, is a 1 by ¾ mile, multi-use harbor. The opening of the harbor is at the southeast corner. The center of the harbor is occupied by Naples Island, which effectively gives it the structure of a ring. The bay receives fresh water from a variety of sources, the largest being Cerritos Creek, which drains the Long Beach Area and regions further inland. The upper end of Marine Stadium also can receive significant stormwater discharge volumes from Colorado Lagoon.

This program was intended to be conducted once during the early portion of the wet-weather season. The study area included all of Alamitos Bay, Marine Stadium and the Los Cerritos Channel up to the first upstream bridge. Field sampling was to be initiated within 12 to 24 hours following the end of rainfall.

The first task of this field program was to roughly define the horizontal and vertical extent of the stormwater plume. This required rapid characterization of the plume by use of a towed YSI Multiparameter Sonde deployed from a boom off the side of KLI's research vessel, the *D.W. Hood*. For establishing the horizontal extent of the plume, the sonde was towed at a depth of approximately 0.5 feet. Data from the Sonde was recorded on a portable computer. Sonde parameters included time, salinity, temperature, turbidity, pH and dissolved oxygen. A Garmin differential global positioning system (DGPS) unit was linked to a separate portable computer to record location and time and provide a real-time display of position. The Sonde and DGPS unit were synchronized to the nearest second to ensure concurrent locational data for all water quality data.

Occasional depth profiles were conducted in the plume to determine the depth of freshwater influence. Profiles were made to a depth of 10 feet with near surface data being recorded at six-inch depth intervals. After defining the halocline, recording depth intervals were increased to 1-foot. After establishing the general distribution of stormwater in receiving waters, sites were selected for collection of water samples based upon salinity. Four sites were selected to be representative of four different stormwater dilutions. To the extent practical, sites were intended to be selected from locations within the defined study area where receiving water salinities ranged from approximately 15 to 30 ppt.

The following table summarizes the target ranges of conditions to be sampled in the field. The target ranges were to provide a general framework and strategy for selection of sampling locations. This was intended to provide stormwater concentrations ranging from 12 to 56 percent. As anticipated, the actual ranges varied due to specific field conditions during the survey such as the general extent of the stormwater plume and characteristics of the vertical profiles of the plume.

Receiving Water Station Designation	Salinity (ppt)	Est. % Stormwater
RW-1	15	56
RW-2	20	41
RW-3	25	26
RW-4	30	12

Each receiving water sample was subjected to the sea urchin fertilization test. This is the only test that has been found to suggest potential for toxicity in the marine/estuarine receiving waters of Alamitos Bay. These samples were also analyzed for a subset of the analytes required for the stormwater monitoring program. Analytes were selected based upon previous results of toxicity testing and Toxicity Identification Evaluations (TIEs) conducted on the stormwater samples as well as general potential for toxicity. Chemical analyses of receiving water samples included total and dissolved trace metals (Cd, Cu, Ni, Pb and Zn), TSS, ammonia-N, pH, conductivity, salinity and organophosphate pesticides.

The data files from the YSI Sonde that contained time and water quality measurements, and from the Garmin DGPS that contained time and position data were merged by the time field. This combined data was entered into ArcInfo and contours based upon the point measured values of salinity were generated. The contours were plotted on a map of Alamitos Bay to show the salinity throughout the bay a few hours after the end of the rainfall.

4.4.2 Dry Weather Monitoring

The NPDES Permit calls for two dry weather inspections and sampling events to be carried out during the summer dry weather period at each of the four mass emission stations as well as samples to be taken at the Alamitos Bay receiving water site.

Inspections at each site included whether water was present and whether this water was flowing or just ponded. When flowing water was present at one of these mass emission sites, then water quality measurements, flow estimates, and water samples were taken along with observations of site conditions. Flowing water was present and all measurements were taken at Bouton Creek, the Belmont Pump Station, and at Los Cerritos Channel. As in previous years, no dry weather discharge was observed at the Dominguez Gap Pump Station. Temperature and conductivity were measured with an Orion Model 140 meter, pH with an Orion Model 250 meter, and oxygen was measured the Orion Model 840.

Water samples were collected at the Belmont Pump Station and the Los Cerritos Channel Station by use of an automatic peristaltic pump sampler that collected aliquots every half hour for a 24-hour period. For the Bouton Creek Station where tidal influences are present, a similar sample was collected over a 2-4 hour period of low tide in order to isolate sampling of just the fresh water discharge down the creek. Additional grab samples were taken just after the time-composited samples for TPH and bacteria. All samples were chilled to 4 ºC and transported to the appropriate laboratory for analysis.

4.5 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.

4.5.1 Analytical Suite and Methods

Conventional, bacteriological, and chemical constituents selected for inclusion in this stormwater quality program are presented in Table 4.2. Analytical method numbers, holding times, and reporting limits are also indicated for each analysis.

4.5.1.1 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 2002), and Guidance on the Documentation and Evaluation of Trace Metals Data Collected for the Clean Water Act Compliance Monitoring (USEPA 1995a).

4.5.2 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 (Appendix Table A.11). 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). ToxScan, Inc. conducted all toxicity tests.

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.

4.5.2.1 Water Flea Reproduction and Survival Test

Toxicity tests using the water flea, *Ceriodaphnia dubia*, were conducted in accordance with methods recommended by USEPA (1994a). The test procedure consisted of exposing 10 *C. dubia* neonates (less than 24 hours old) to the samples for six 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 was 16 hours light: 8 hours dark. 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 (100 µL of a 3:1 mixture of *Selenastrum* culture, density approximately 3.5 x 10^8 cells/mL, and *Ceriodaphnia* chow).

The test organisms were obtained from in-house cultures that were established from broodstock obtained from USEPA (Duluth, MN). The laboratory water used for cultures, controls, and preparation of sample dilutions was synthetic moderately hard freshwater, prepared with deionized water and reagent chemicals.

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, and 6 %.

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.

4.5.2.2 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 1995b). 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 – Granite Canyon. The tests were conducted in glass shell vials containing 10 mL of solution at a temperature of 15 ± 1 °C. Five replicates were tested at each sample concentration.

All samples were adjusted to a salinity of 33.5 ppt for the fertilization test. Previous experience has determined that many 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 freezing and partially thawing 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, 6, and 3%.

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. Each reference toxicant test consisted of a concentration series of copper sulfate with four replicates tested per concentration. The median effective concentration (EC50) was estimated from the data and compared to control limits based upon the cumulative mean and two standard deviations of recent experiments.

4.5.2.3 Toxicity Identification Evaluations (TIEs)

Phase I TIEs were conducted on selected runoff samples from stations that exhibited substantial toxicity, in order to determine the characteristics of the toxicants present. Substantial toxicity was defined as ≥ 3 TUs for urchins and ≥ 2 TUs for water fleas. This provides at least 1 TU of toxicity for partitioning of toxic effects. Each sample was subjected to 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 were then tested to determine the change in toxicity using the sea urchin fertilization test.

Four or five treatments were applied to each sample. These treatments were: 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 was applied independently on a salinity-adjusted sample. A control sample (lab dilution water) was included with each type of treatment to verify that the manipulation itself was not causing toxicity. If the TIE was not conducted concurrently with the initial testing of a sample, then a reduced set of concentrations of untreated sample was tested at the time of the TIE to determine the baseline toxicity and control for changes in toxicity due to sample storage.

Ethylene diamine tetraacetic acid (EDTA), a chelator of metals, was added to a concentration of 60 mg/L to the marine test samples. EDTA additions to the *Ceriodaphnia* samples were 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 was added to a concentration of 50 mg/L to separate portions of each marine sample. STS additions to the *Ceriodaphnia* samples were at 500, 250 and 125 mg/L. The EDTA and STS treatments were given at least one hour to interact with the sample prior to the start of toxicity testing. Pipernyl butoxide (PBO), which inhibits activation of OP pesticides was added at three concentrations (125, 250 and 500 mg/L) for *Ceriodaphnia.* Since PBO is also a synergist for pyrethoid pesticides, interpretation of PBO results must be approached with caution.

Samples were centrifuged for 30 min at 3000 X g to remove particle-borne contaminants and tested for toxicity. A portion of the centrifuged sample was also passed through a 360 mg Sep-Pak™ C18 solid phase extraction column in order to remove nonpolar organic compounds. C18 columns have also been found to remove some metals from aqueous solutions.

4.5.2.4 Statistical 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 data were tested against the control using Fisher's Exact test. Water flea reproduction and sea urchin fertilization 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 LC50 (concentration producing a 50% reduction in survival) for water flea survival, the EC50 (concentration effective on 50% of eggs) for sea urchin fertilization, or the IC50 (concentration inhibitory to 50% of individuals) for water flea reproduction. The LC50 or EC50 was calculated using either probit analysis or the trimmed Spearman-Karber method. The IC25 and IC50 were calculated using linear interpolation analysis. All procedures for calculation of median effects followed USEPA guidelines.

The toxicity results were also expressed as chronic Toxic Units (TU_c). This statistic was calculated as: 100/NOEC. Another expression of toxicity was acute Toxic Units (TU_a), which was calculated as 100/median effect value (LC50, EC50 or IC50). 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. Comparisons of chemical or physical parameters with toxicity results were made using the non-parametric Spearman rank order correlation.

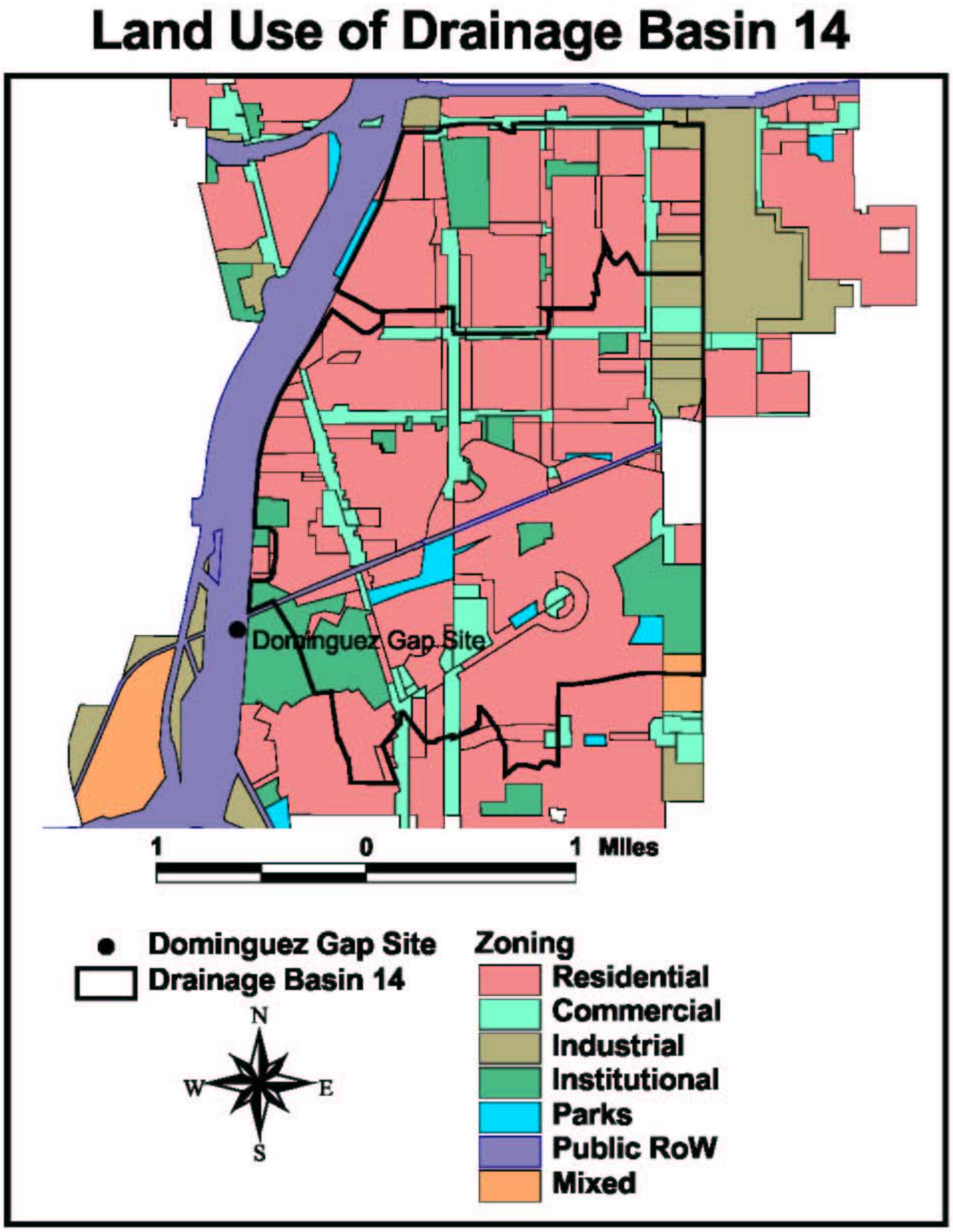


Figure 4.1 Land Use of Drainage Basin #14 which Drains to the Dominguez Gap Mass Emission Site (Source: City of Long Beach Department of Technology Services, last update 12/20/00).

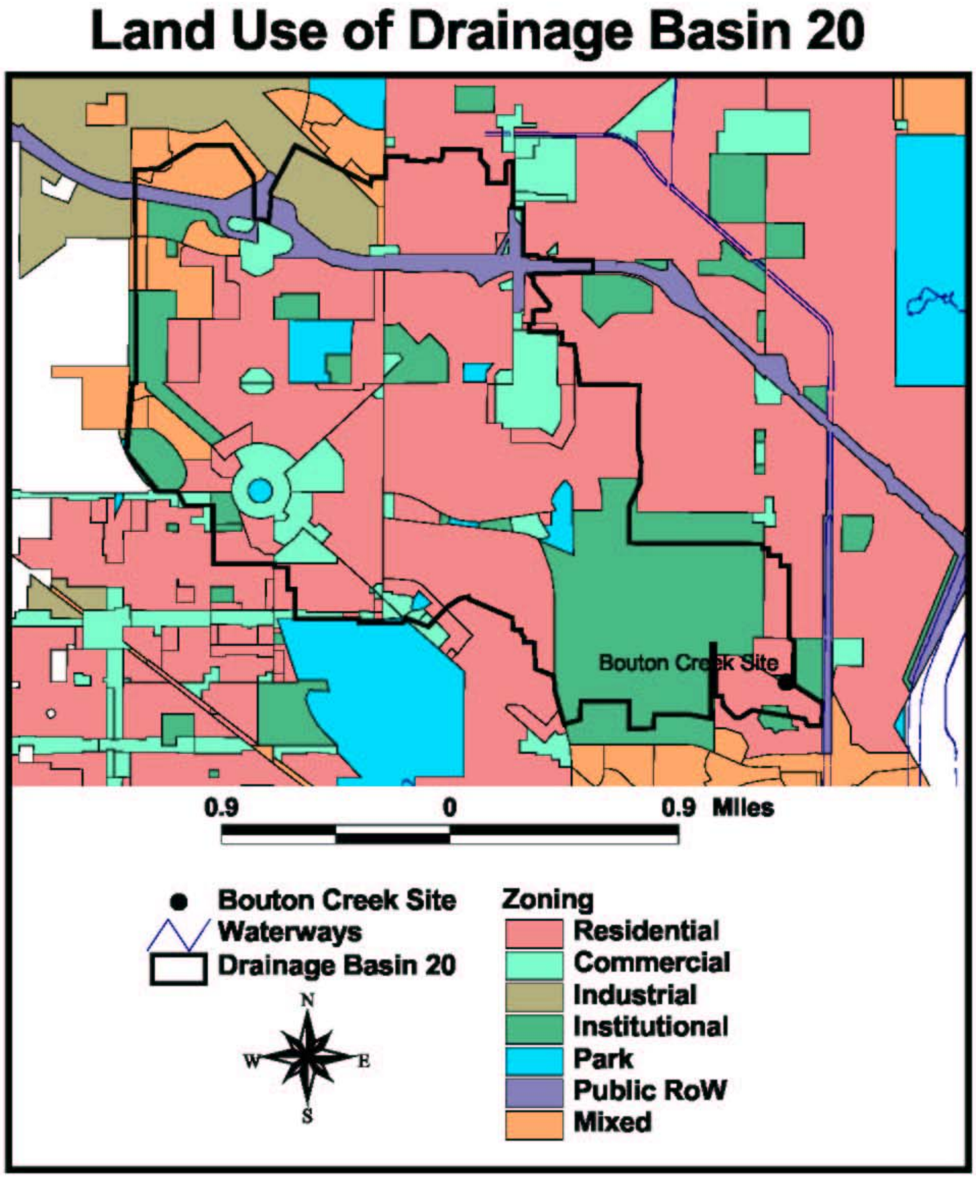


Figure 4.2 Land Use of Drainage Basin #20 which drains to the Bouton Creek Mass Emission Site (Source: City of Long Beach, Department of Technology Services, last updated 12/20/00).

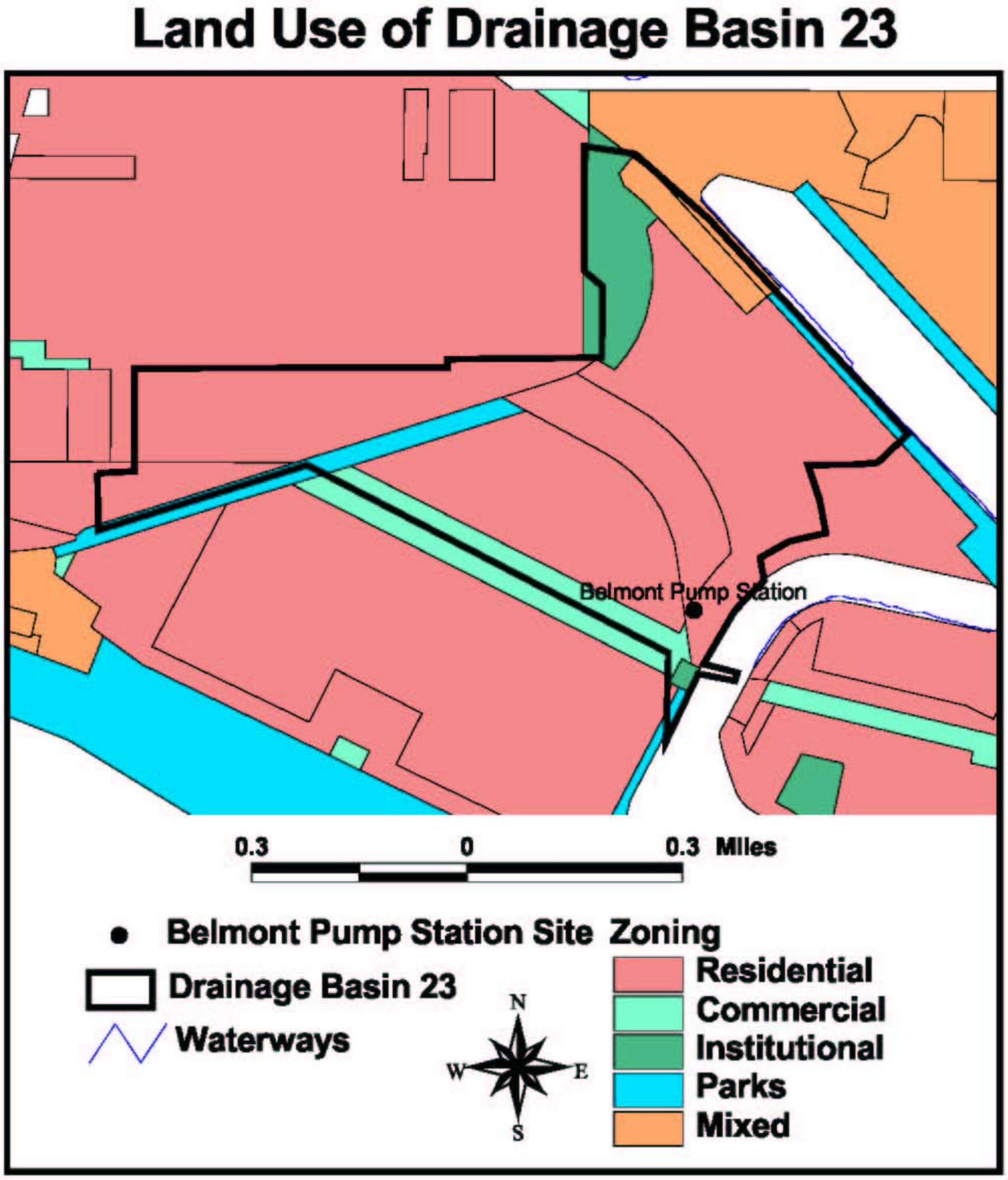


Figure 4.3 Land Use of Drainage Basin #23 which Drains to the Belmont Pump Station Mass Emission Site (Source: City of Long Beach, Department of Technology Services, last updated 12/20/00)

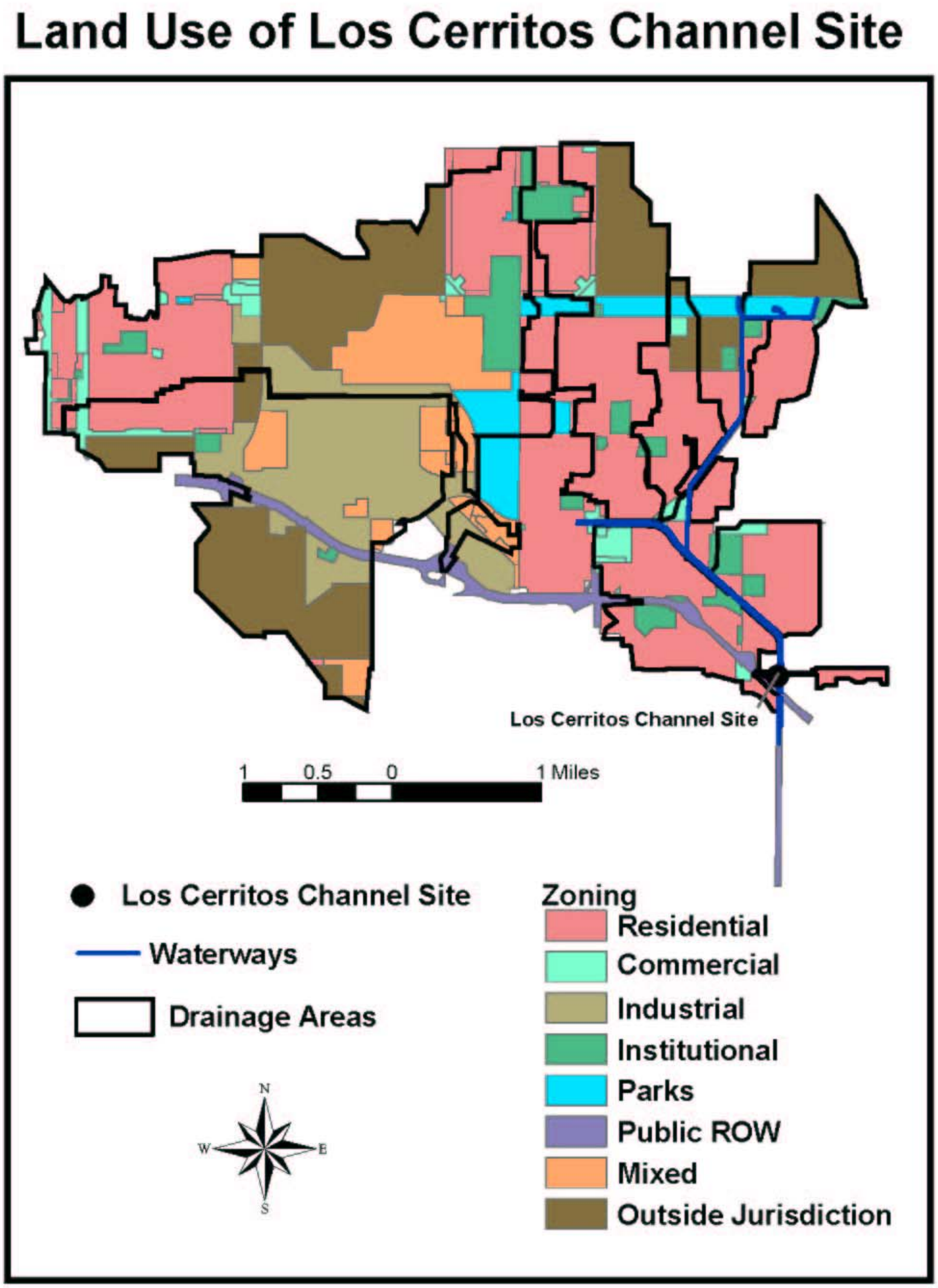


Figure 4.4 **Land Use of Drainage Basins which Drain to the Los Cerritos Channel Monitoring Site. (Source: City of Long Beach, Department of Technology Services, last update 12/20/00).**

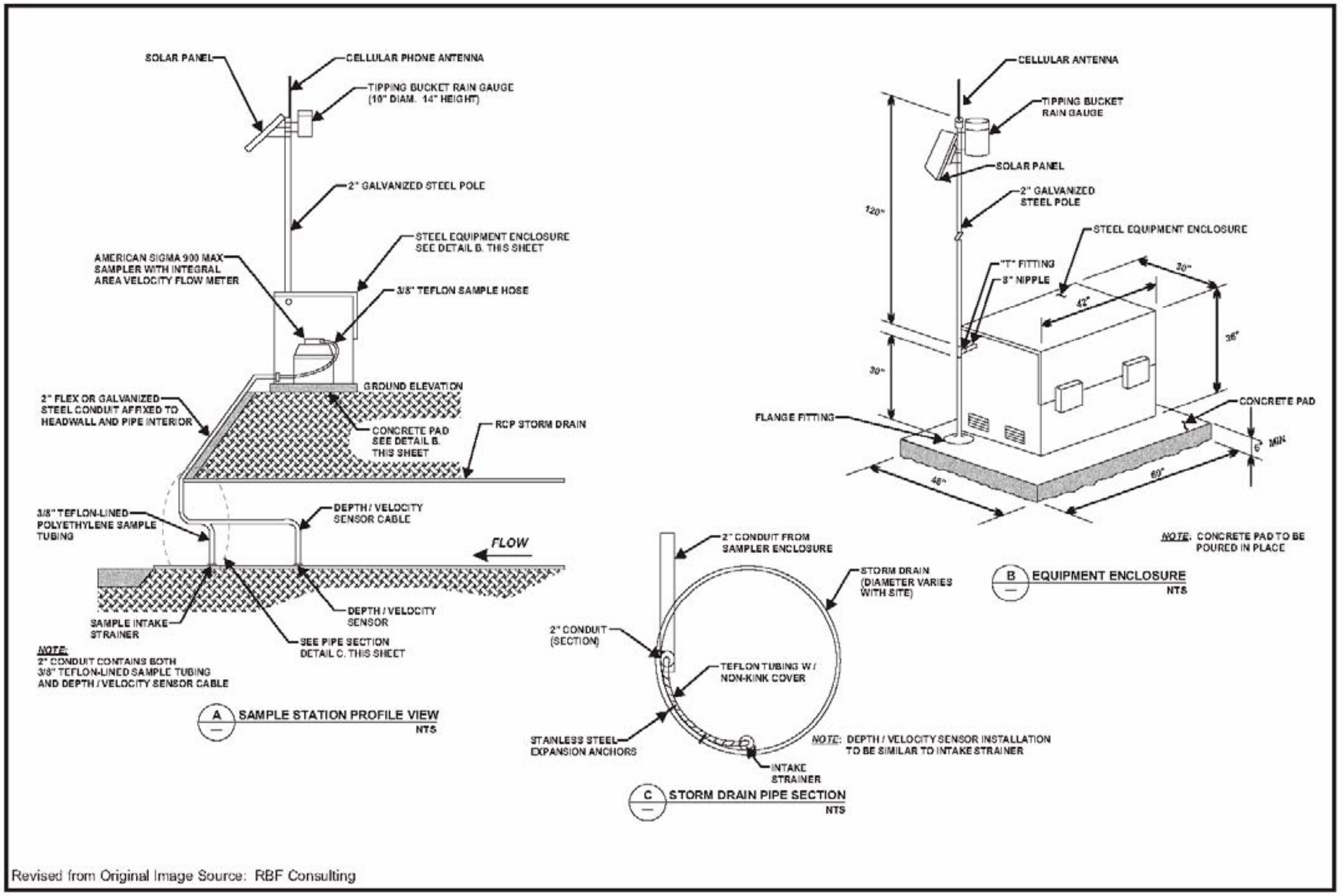


Figure 4.5 Typical KLASS Stormwater Monitoring Station.

Table 4.1 Location Coordinates of Monitoring Stations for the City of Long Beach Stormwater Monitoring Program.

Station Name	State Plane Coordinates: Zone 5		North American Datum (NAD) 83	
	Northing (ft)	Easting (ft)	Latitude	Longitude
Belmont Pump	1734834.9	6522091.2	33° 45' 36.6"N	118° 07' 48.7"W
Bouton Creek	1741960.5	6529305.2	33° 46' 44.3"N	118° 06' 23.4"W
Los Cerritos Channel	1747935.9	6530153.2	33° 47' 43.3"N	118° 06'13.4"W
Dominguez Gap Pump	1764025.0	6500042.5	33° 50' 22.1"N	118° 12' 10.5"W

Table 4.2 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)	365.3	48 hours	0.01
Total Phosphorus (mg/L)	365.3	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)	350.2	28 days	0.1
Total Kjeldahl Nitrogen (mg/L)	351.3	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	0.02
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 9221B	6 hours	<20
Enterococcus	SM 9230C	6 hours	<20
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	236.1	180 days	25
Lead	200.8	180 days	0.5
Nickel	200.8	180 days	1.0
Selenium	200.8	180 days	1.0
Silver	200.8	180 days	0.25
Zinc	200.8	180 days	1.0

1. Samples to be analyzed for dissolved metals are to be filtered within 48 hours.

Table 4.2 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	8081A	7 days	0.005
alpha-BHC	8081A	7 days	0.01
beta-BHC	8081A	7 days	0.005
delta-BHC	8081A	7 days	0.005
gamma-BHC (lindane)	8081A	7 days	0.02
alpha-Chlordane	8081A	7 days	0.1
gamma-Chlordane	8081A	7 days	0.1
4,4'-DDD	8081A	7 days	0.05
4,4'-DDE	8081A	7 days	0.05
4,4'-DDT	8081A	7 days	0.01
Dieldrin	8081A	7 days	0.01
Endosulfan I	8081A	7 days	0.02
Endosulfan II	8081A	7 days	0.01
Endosulfan sulfate	8081A	7 days	0.05
Endrin	8081A	7 days	0.01
Endrin Aldehyde	8081A	7 days	0.01
Heptachlor	8081A	7 days	0.01
Heptachlor Epoxide	8081A	7 days	0.01
Toxaphene	8081A	7 days	0.5
PCBs (µg/L)			
Aroclor-1016	8081A	7 days	0.5
Aroclor-1221	8081A	7 days	0.5
Aroclor-1232	8081A	7 days	0.5
Aroclor-1242	8081A	7 days	0.5
Aroclor-1248	8081A	7 days	0.5
Aroclor-1254	8081A	7 days	0.5
Aroclor-1260	8081A	7 days	0.5
Total PCBs	8081A	7 days	0.5
ORGANOPHOSPHATE PESTICIDES (µg/L)			
Diazinon	8141A	7 days	0.01
Chlorpyrifos (Dursban)	8141A	7 days	0.05
Malathion	8141A	7 days	1.0
Prometryn	8141A	7 days	1.0
Atrazine	8141A	7 days	1.0
Simazine	8141A	7 days	1.0
Cyanazine	8141A	7 days	1.0

5.0 RAINFALL AND HYDROLOGY

5.0 RAINFALL AND HYDROLOGY

All Long Beach monitoring stations were fully operational at the end of September 2004 prior to the start of the 2004/2005 wet weather season. Except for occasional short-term malfunctions, precipitation and discharge were continuously monitored throughout the season.

An attempt was made to collect samples for a complete suite of water quality analytes during the first significant rains of the season. The first storm fully monitored occurred on October 16 and 17, 2004 and represented the “first flush” of the season. This initial event was forecasted as a marginal event that was anticipated to yield 0.20 to 0.25 inches of rainfall. Actual rainfall was three to four times the forecast. The exceptionally heavy early season rain resulted in only partial sampling of the “first flush” event (initial 16% to 20% of the runoff) at the Bouton and Los Cerritos Channel stations. The sampler malfunctioned at the Belmont Pump Station, while no discharge occurred at the Dominguez Gap Pump Station. Subsequent to the “first flush” event, the following two events (October 19-21 and October 26-27, 2004) were successfully sampled for the full suite of analytes at all sites except the Dominguez Gap Pump Station where no discharge occurred. Due to the lack of discharge, only Bouton Creek obtained sufficient volume for the full suite of analytes during the monitored event following these two events (December 4, 2004). This fulfilled the 2004/2005 monitoring requirements at Bouton Creek. An unforecasted event that was not monitored occurred on November 21, 2004. The third fully monitored event at the Belmont Pump Station and the last fully monitored event at the Los Cerritos Channel site occurred on December 28, 2004. This was also the “first flush” event at the Dominguez Gap Pump Station. The remaining fully monitored events at the Dominguez Gap Pump Station began on January 2, January 7, and January 8, 2005. Uncharacteristic of previous seasons, discharge from the Dominguez Gap Pump Station occurred over six separate events or wet weather periods. Due to an oversight, the last fully monitored event at the Belmont Pump Station did not occur until March 22 and 23, 2005. All other events monitored (up to 10 events at each station) were for the collection of total suspended solids (TSS) samples only.

5.1 Precipitation during the 2004/2005 Wet Weather Season

The 2004/2005 wet weather season was one of the wettest in recorded history in Southern California ending several years of drought conditions. Normal precipitation for October through April at the Long Beach Airport is 12.27 inches. Only 1.99 inches was recorded during this same period four years ago. During the 2002/2003 season, 8.62 inches of rain was recorded at the Long Beach Airport, while 7.41 inches of rain was recorded at the airport last season. This season, a total of 29.39 inches of rainfall was recorded at the airport during the same period (Figure 5.1) shattering the 1997/1998 rainfall record for the same period of 27.50 inches. The 2004/2005 wet weather season was an astonishing 240% of normal. Also important were the large magnitude of the individual storm events and the high intensity of the rainfall experienced during these events.

A direct comparison of daily rainfall measured at each site during the 2003/2004 and 2004/2005 wet weather seasons (Tables 5.1 through 5.4) clearly illustrates the large differences in rainfall over the past two years. Large differences are evident in terms of both the number of days of precipitation, the daily precipitation totals, and monthly precipitation totals.

Rainfall was relatively uniform at each of the monitoring stations with seasonal totals ranging from 24.57 inches at the Los Cerritos Channel monitoring station to 25.59 inches at the Dominguez Gap Pump Station (Figure 5.1).

5.1.1 Monthly Precipitation

Substantial precipitation was recorded for most months during the 2004/2005 wet weather season (Figure 5.2). This is in stark contrast to the 2003/2004 season when the bulk of the season's precipitation (4.66 inches at Long Beach Airport) occurred during the month of February (Tables 5.1 through 5.4).

Most months during the 2004/2005 wet weather season in Long Beach experienced above normal rainfall. Only November and March had below normal rainfall. Above normal precipitation was especially evident in October, January and February. These months typically see 6.63 inches of rain at the Long Beach Airport. For the 2004/2005 season, these months saw 22.45 inches of rain, which is 340% of normal.

5.1.2 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 5.5. Cumulative descriptive statistics between fully monitored events (as opposed to TSS events only) for each monitoring station are presented in Table 5.6. Cumulative rainfall and intensity are summarized graphically for each fully monitored event at each station in Figures 5.3 through 5.18.

For the 2004/2005 wet weather season, rainfall during fully monitored events varied between 0.51 and 1.71 inches at the Belmont Pump Station, 0.40 and 1.67 inches at Bouton Creek, 0.81 and 1.91 inches at Los Cerritos Channel, and 1.31 and 2.83 inches at the Dominguez Gap Pump Station. The mean rainfall total for all fully monitored events ranged from 1.24 inches at Bouton Creek to 1.96 inches at the Dominguez Gap Pump Station. This is more than twice the mean rainfall totals that occurred during 2003/2004 monitored events. Flow from as much as 4.51 inches of rain, which occurred at the Belmont Pump Station from February 17 to February 21, 2005, was sampled for TSS.

Maximum rainfall intensities (based on five minutes of data) were impressive during the 2004/2005 storm season. The mean maximum rainfall intensities among fully monitored events ranged from 1.17 inches per hour at the Belmont Pump Station to 1.44 inches per hour at the Dominguez Gap Pump Station. Like mean total rainfall, mean maximum rainfall intensities during fully monitored events were more than twice as high as occurred during the 2003/2004 monitored events. Rainfall intensities were as high as 5.16 inches per hour at Bouton Creek and the Belmont Pump Station during the February 17 through 21, 2005 TSS event. For fully monitored events, the highest maximum rainfall intensity was 2.16 inches per hour at both the Belmont and Dominguez Gap pump stations during the event that occurred on December 28 and 29, 2004.

With some exceptions, all storm events sampled for the full suite of analytes were spaced by at least three days of no rainfall. The start of sampling during the second fully monitored event occurred after only a day and a half of dry weather. It was thought essential to sample the second event at this time because of its early season importance. Although less than a day separated the third and fourth fully monitored events at the Dominguez Gap Pump Station, it was prudent to monitor the fourth event at this time because of the rare occurrence of discharge experienced at this station in previous years. For the three seasons prior to the 2004/2005 wet weather season, runoff automatically discharged from the Dominguez Gap Pump Station on only seven occasions.

Overall, the mean period of dry conditions prior to fully monitored events ranged from 6.1 days at the Dominguez Gap Pump Station to 64.0 days at the Los Cerritos Channel site. If the extended dry period prior to the first rain at Los Cerritos Channel is ignored, then the mean period of dry conditions prior to a fully monitored event is reduced to 9.0 days at this site. Besides the "first flush" event, the 20 days preceding the fifth event on December 28 and 29, 2004 was the driest period prior to a fully monitored event.

5.2 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 5.7 summarizes flow characteristics among monitored events at each station including the duration of discharge/flow, total discharge volume, and peak discharge/flow. Table 5.6 provides descriptive statistics for all four fully monitored events during the 2004/2005 season. This information complements the calculated EMCs for each monitored analyte at these sites. Figures 5.3 through 5.18 graphically depict flow during each fully 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. Flow duration was typically greatest at Bouton Creek due to tidal effects and 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 detected at the station using the conductivity sensors and sampling continues. In contrast, the period of discharge at the Dominguez Gap Pump Station was the smallest since most of the runoff from this drainage must fill a reservoir prior to discharge.

The duration of discharge reported in Tables 5.6 and 5.7 for the Belmont and Dominguez Gap pump stations are often overestimated because of the on and off cycling of the pumps. The discharge durations reported in these tables represent the period between when the first pump came on to the time all pumps became silent. One should refer to the hydrographs developed for the pump stations for a better estimate of the duration of discharge.

As a direct result of the larger storms monitored during the 2004/2005 wet weather season, the mean total flow or discharge among fully monitored events was higher than in previous seasons. For the 2004/2005 wet weather season, mean total flow or discharge for fully monitored events ranged from 778,000 cf at the Belmont Pump Station to 25,693,000 cf at Los Cerritos Channel. For TSS only events, the per event total flow or discharge was as high as 3,642,000 cf at the Belmont Pump Station, 12,262,000 cf at Bouton Creek, 55,929,000 cf at Los Cerritos Channel, and 6,936,000 cf at the Dominguez Gap Pump Station.

The percent storm captures (percentage of the total storm event volume effectively represented by the flow-weighted composite sample) were acceptable (>90%) in all cases except the "first flush" event. As described earlier, unexpected heavy rain during the "first flush" event resulted in lower storm captures.

Figure 5.1 Cumulative Rainfall for the 2004/2005 Wet Weather Season.

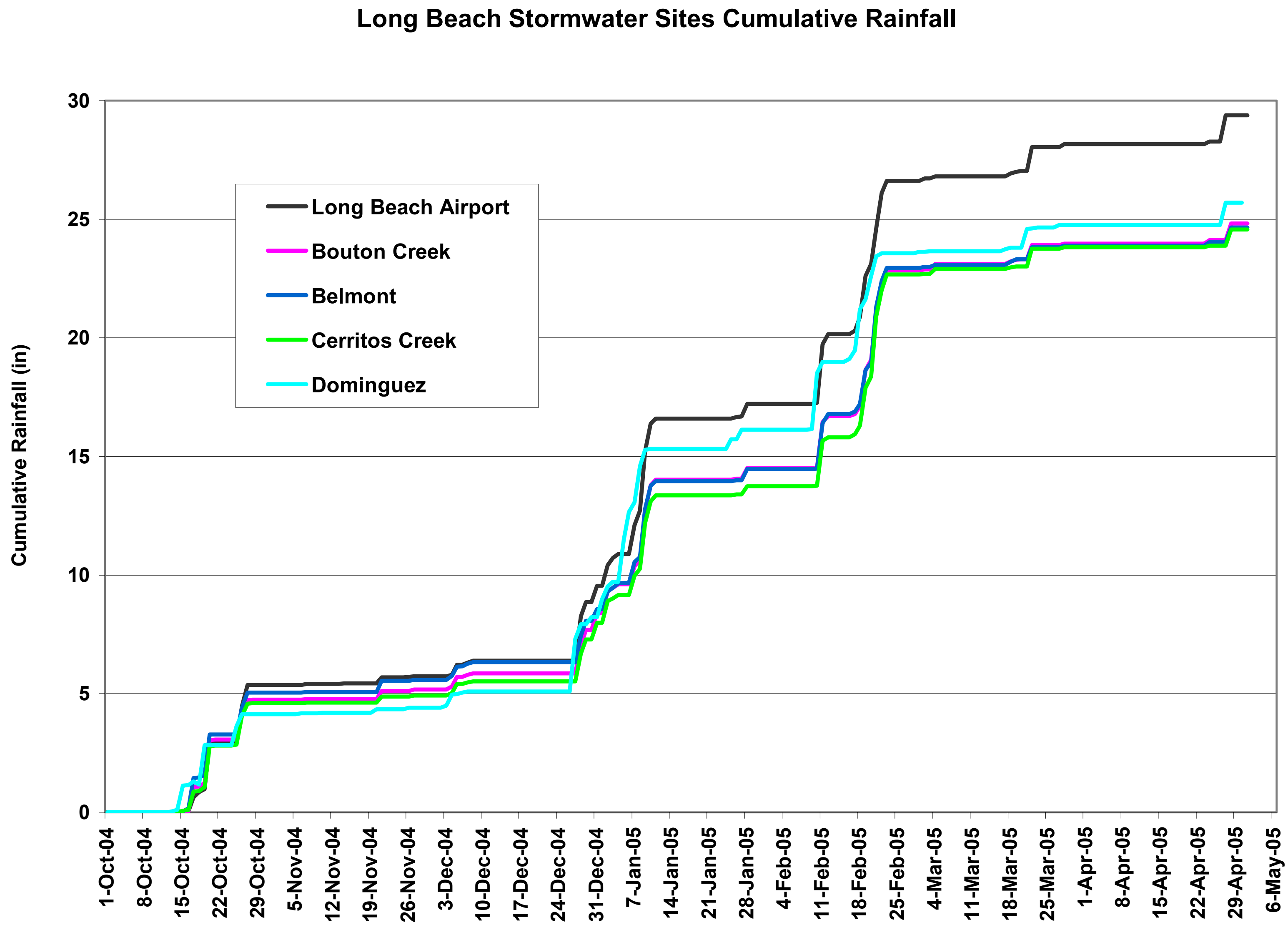
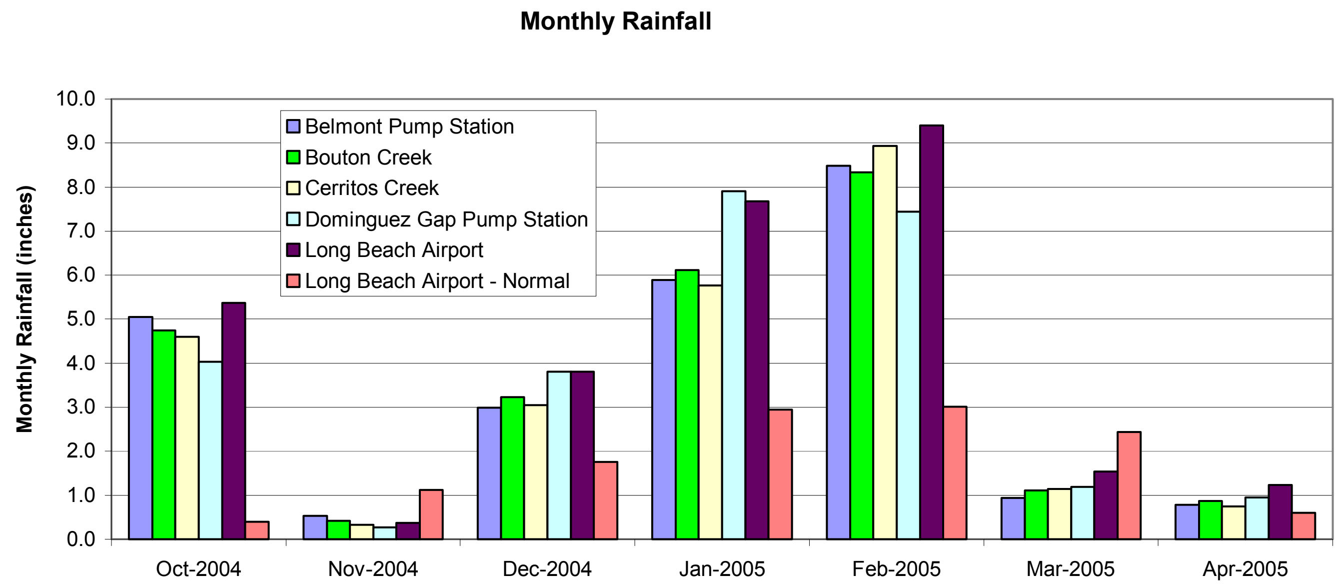
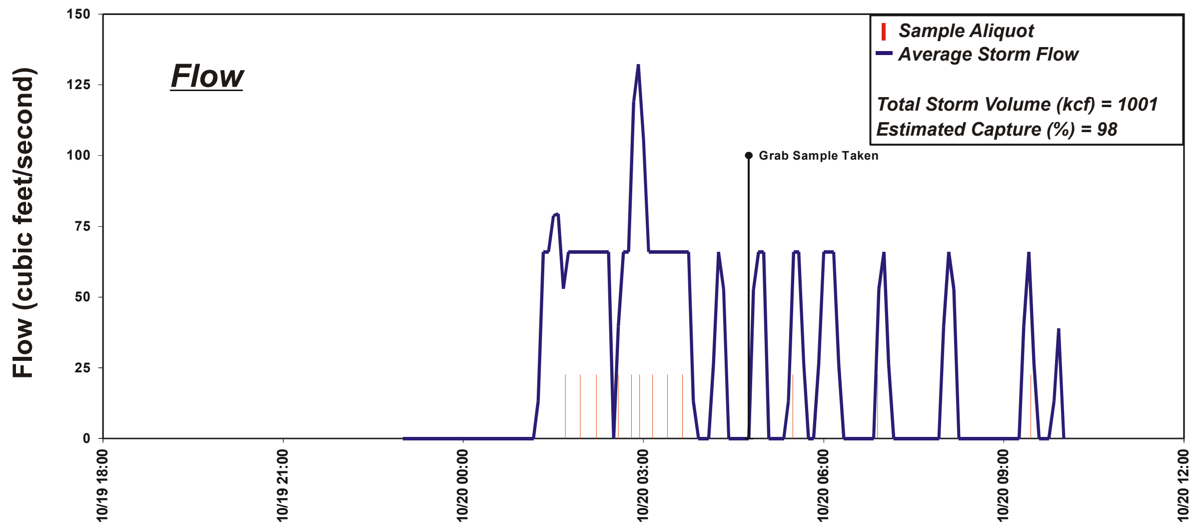


Figure 5.2 Monthly Rainfall Totals for the 2004/2005 Wet Weather Season and Normal Rainfall at Long Beach Daugherty Air Field.



	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05
Belmont Pump Station	5.05	0.53	2.99	5.89	8.48	0.94	0.78
Bouton Creek	4.75	0.42	3.23	6.11	8.34	1.11	0.87
Cerritos Creek	4.60	0.33	3.05	5.77	8.93	1.14	0.75
Dominguez Gap Pump Station	4.03	0.27	3.81	7.90	7.44	1.19	0.95
Long Beach Airport	5.37	0.37	3.80	7.68	9.40	1.54	1.23
Long Beach Airport - Normal	0.40	1.12	1.76	2.95	3.01	2.43	0.60

Figure 5. 3 Belmont Pump Station – Event 1 (October 19 and 20, 2004).



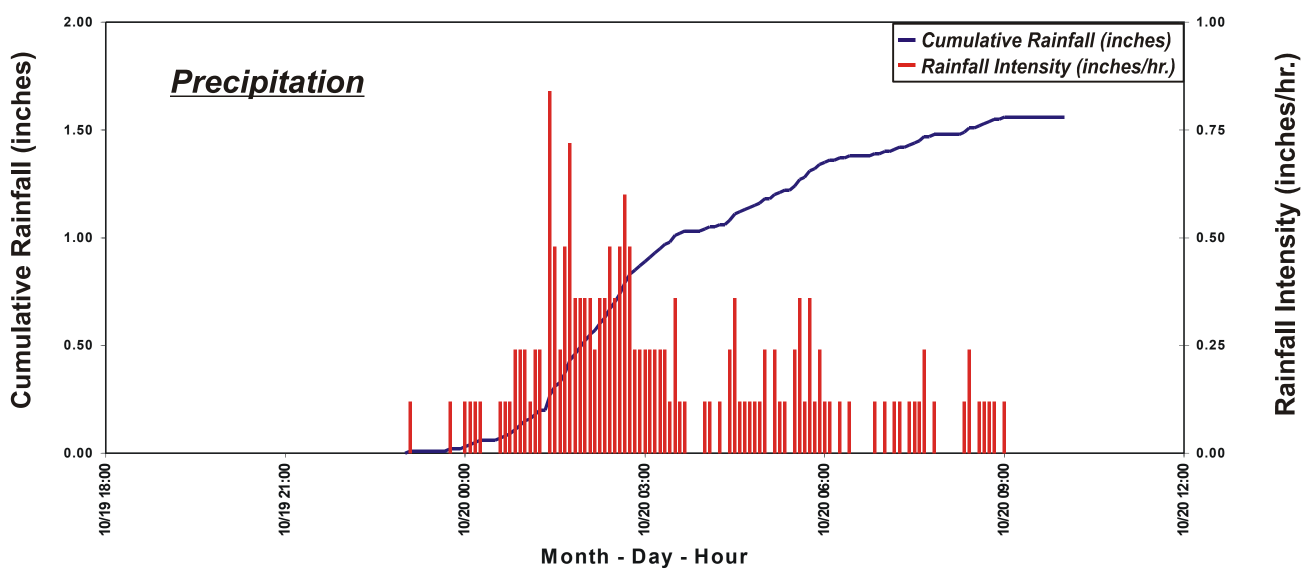


Figure 5. 4 Bouton Creek – Event 1 (October 17, 2004).

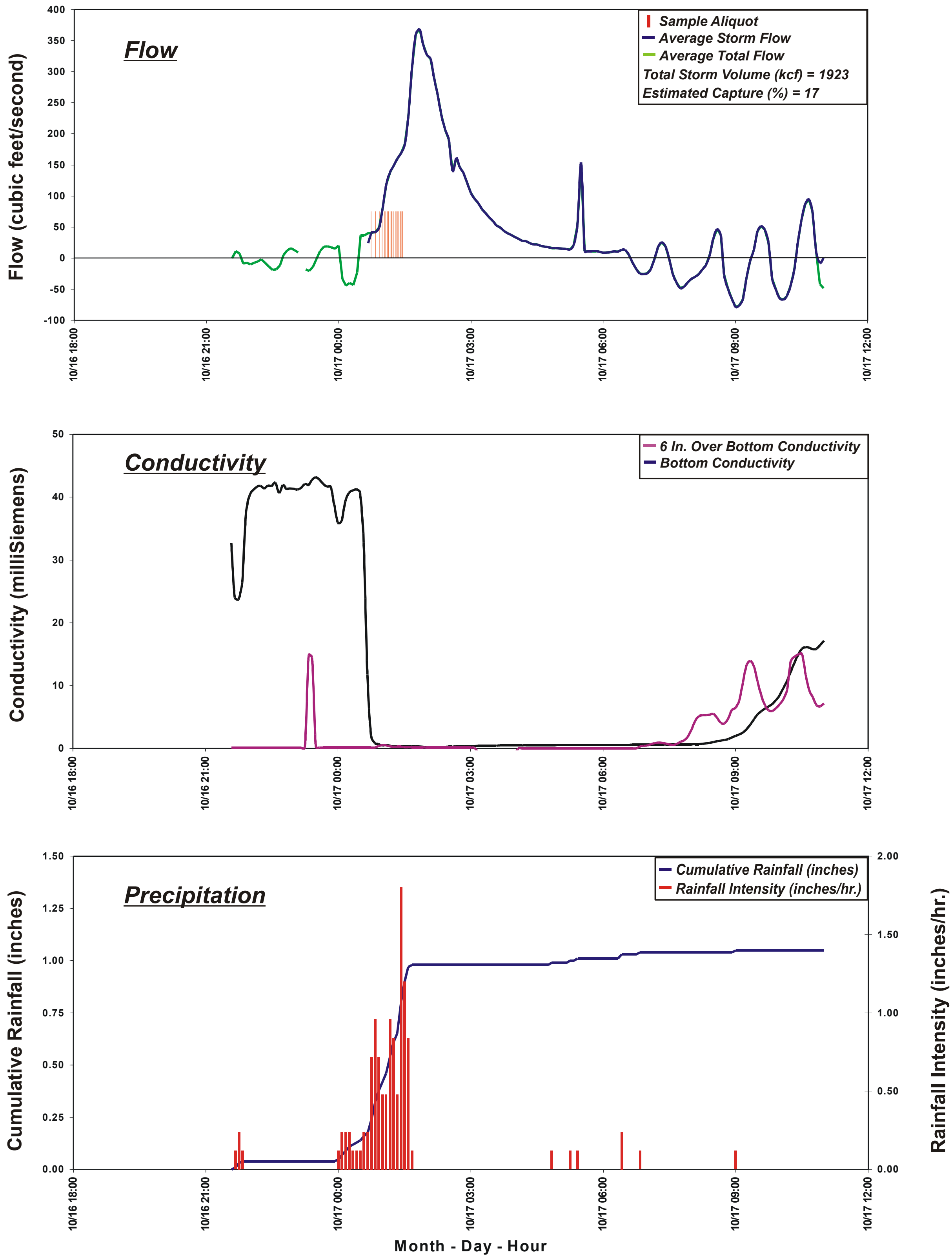
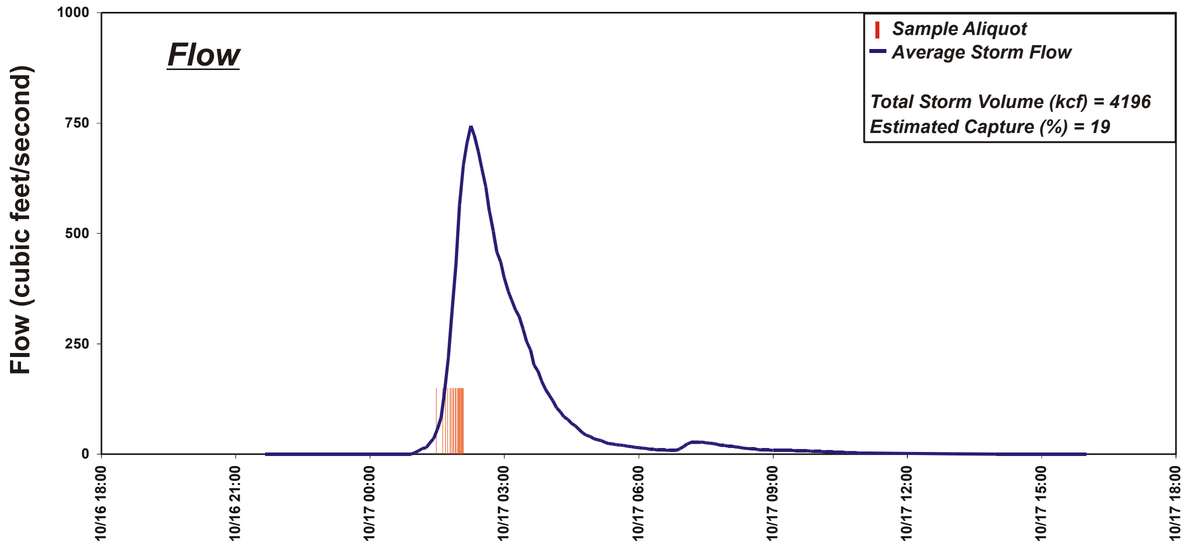


Figure 5. 5 Los Cerritos Channel – Event 1 (October 17, 2004).



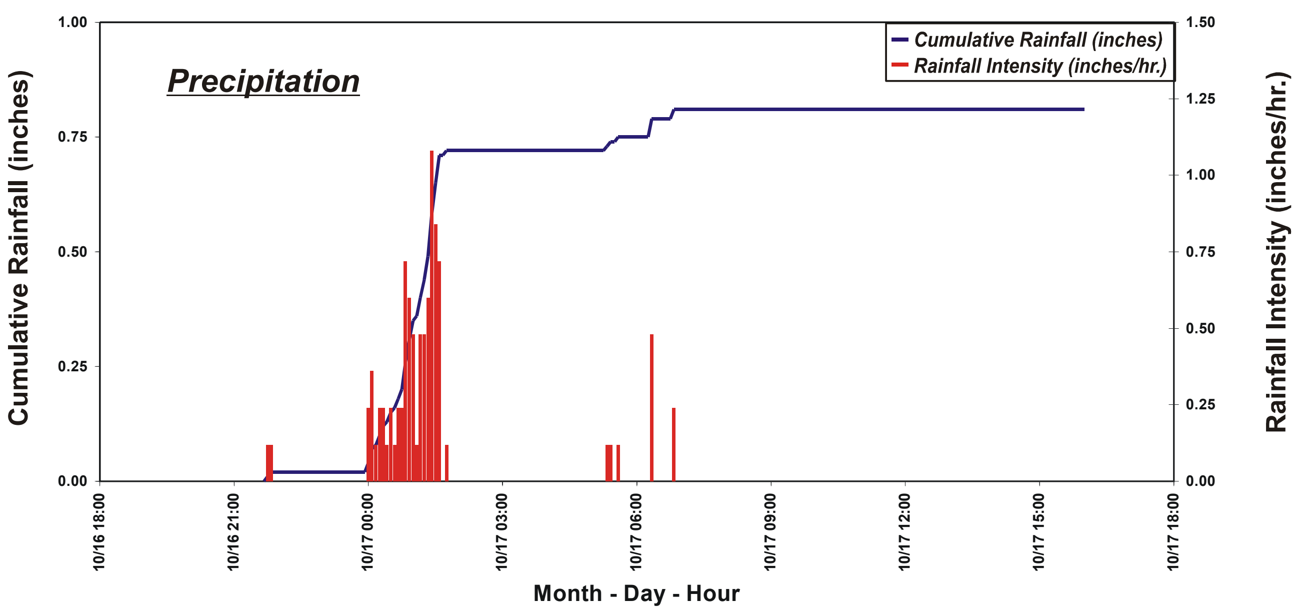
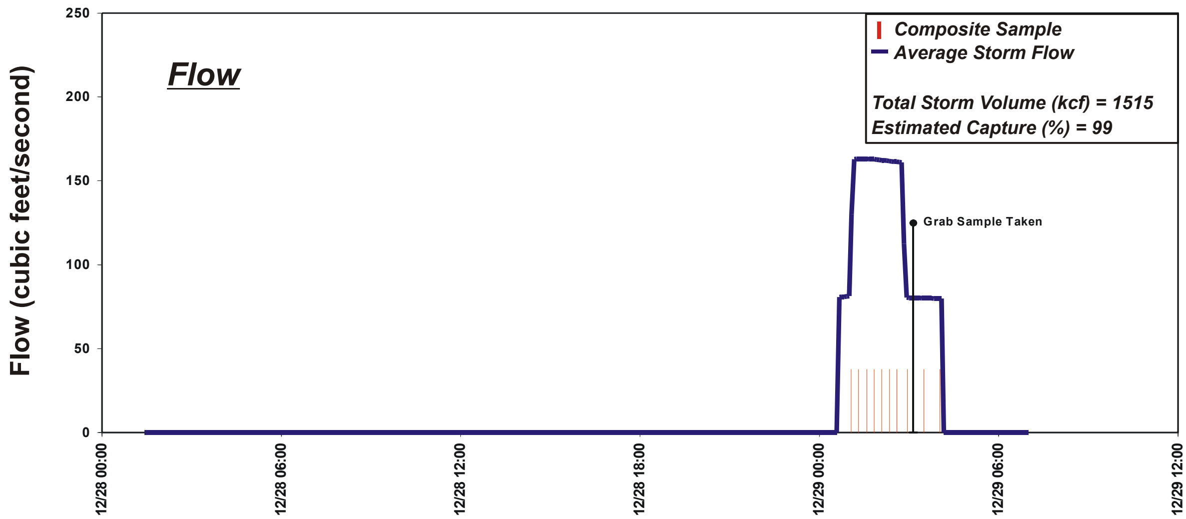


Figure 5. 6 Dominguez Gap Pump Station – Event 1 (December 28, 2004).



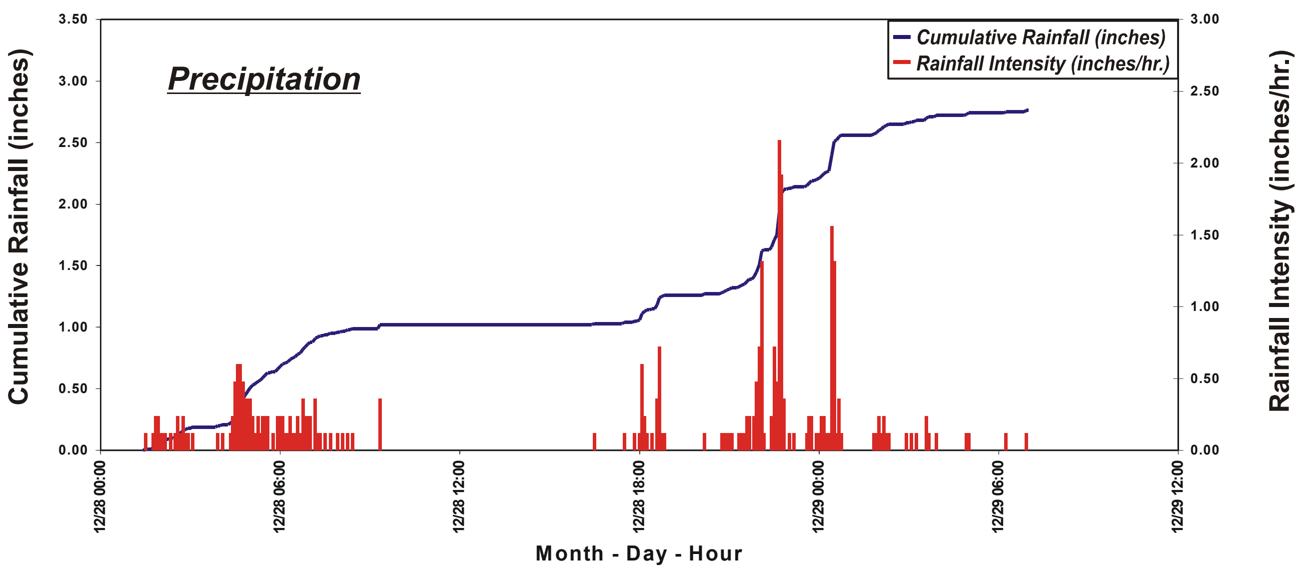
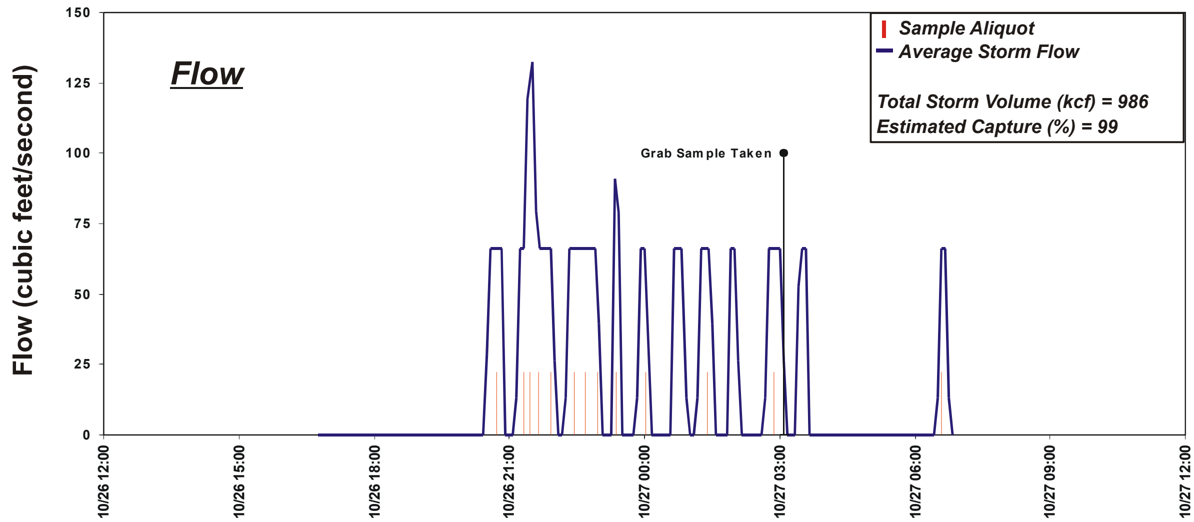


Figure 5. 7 Belmont Pump Station – Event 2 (October 26 and 27, 2004).



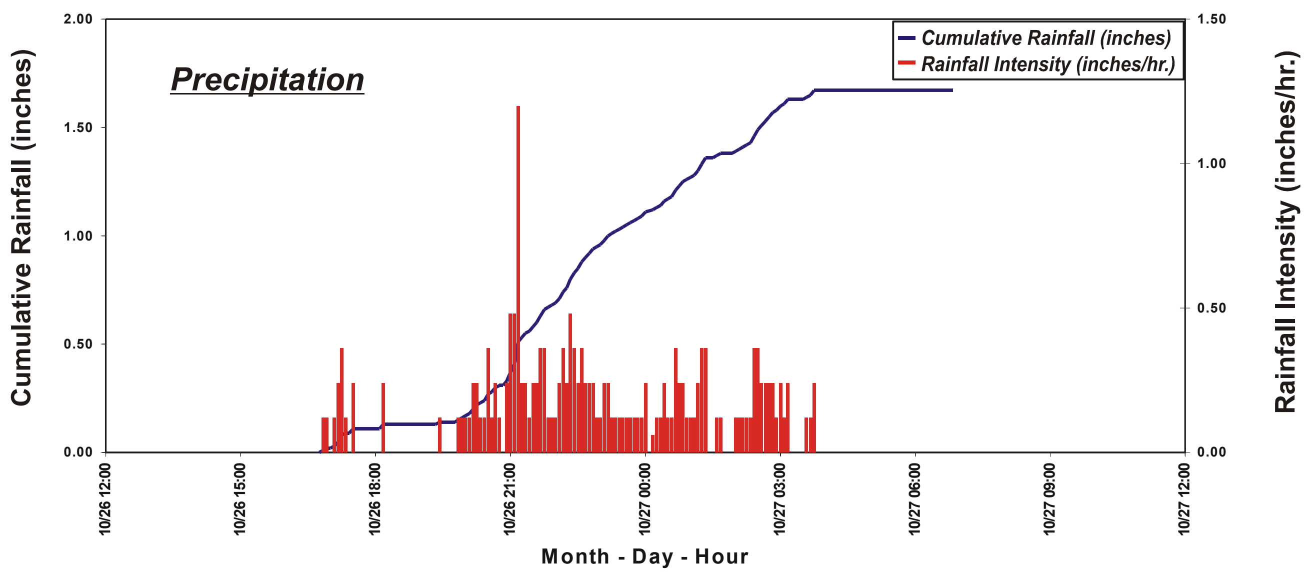


Figure 5. 8 Bouton Creek – Event 2 (October 19 and 20, 2004).

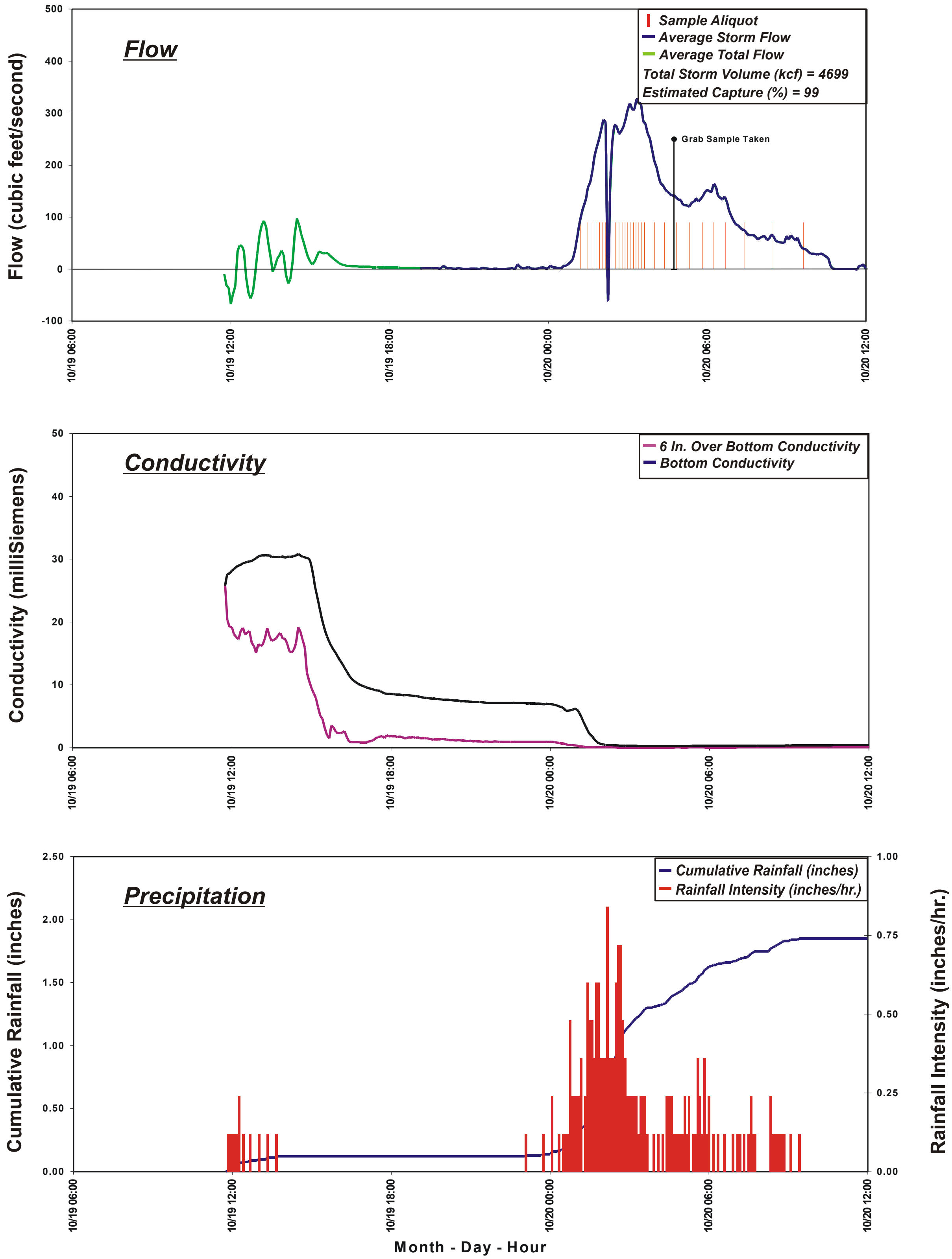


Figure 5. 9 Los Cerritos Channel – Event 2 (October 19 and 20, 2004).

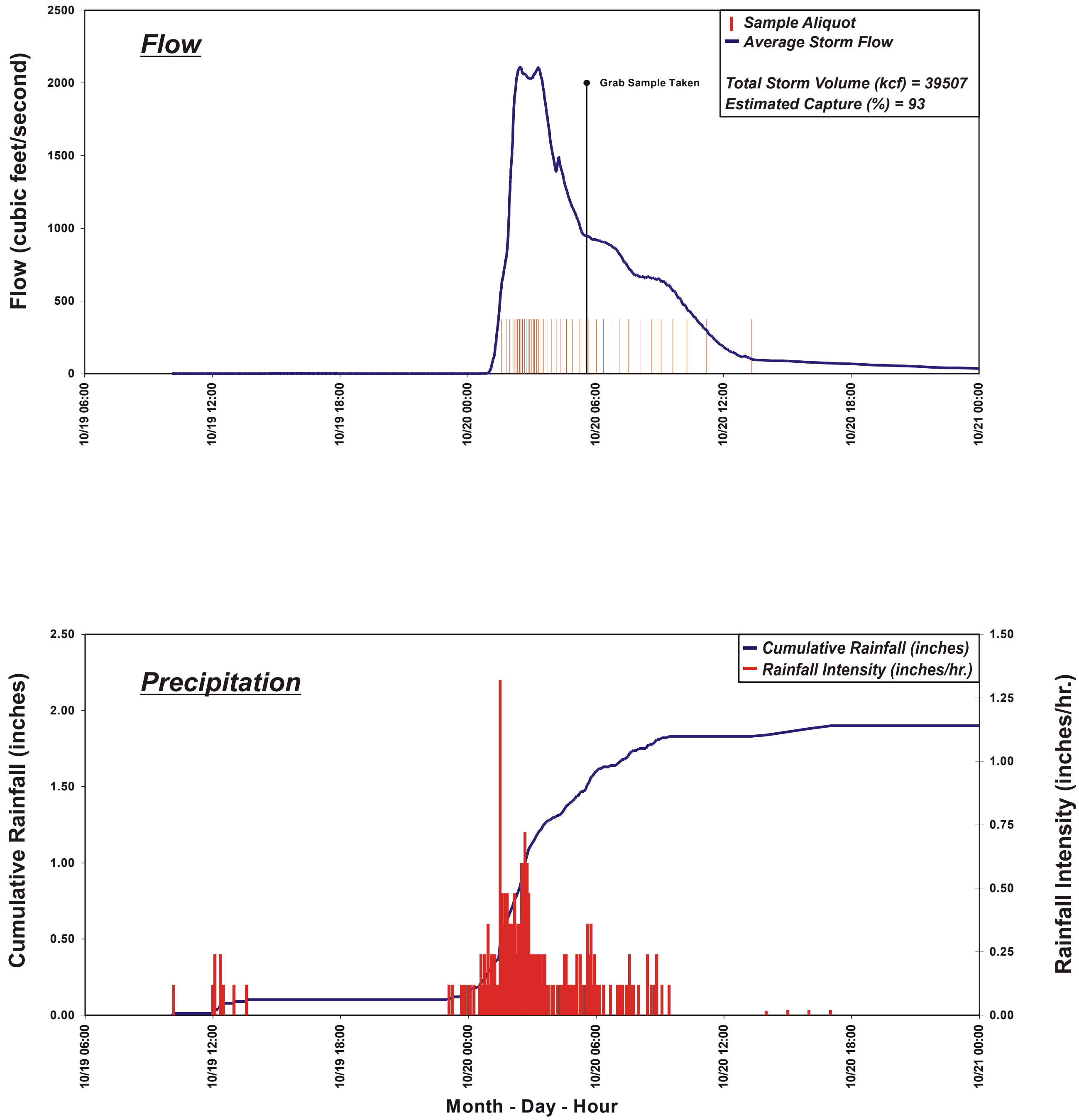
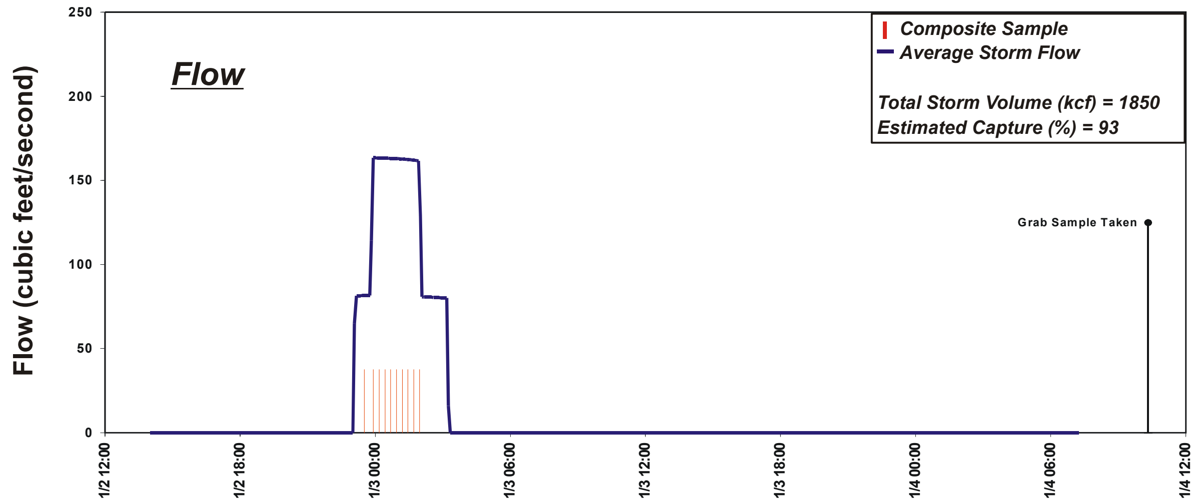


Figure 5. 10 Dominguez Gap Pump Station – Event 2 (January 2 and 3, 2005).



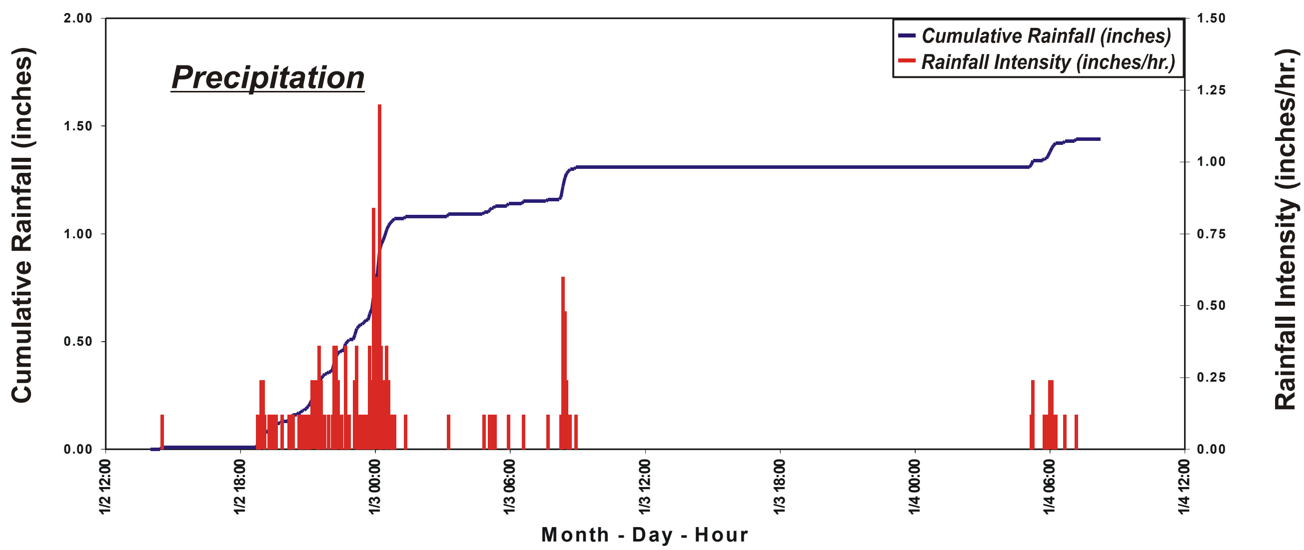
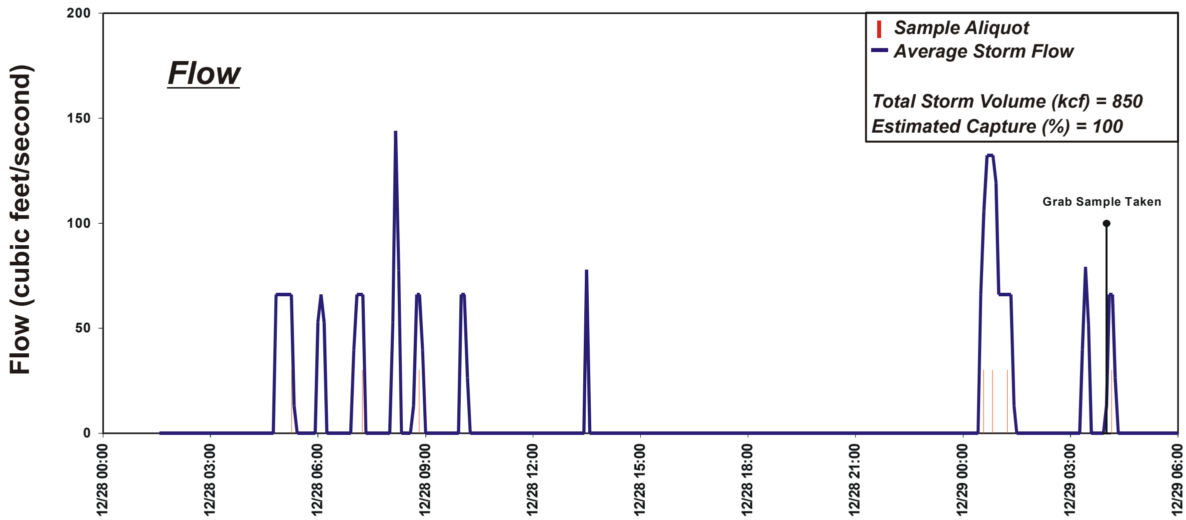


Figure 5. 11 Belmont Pump Station – Event 3 (December 28 and 29, 2004).



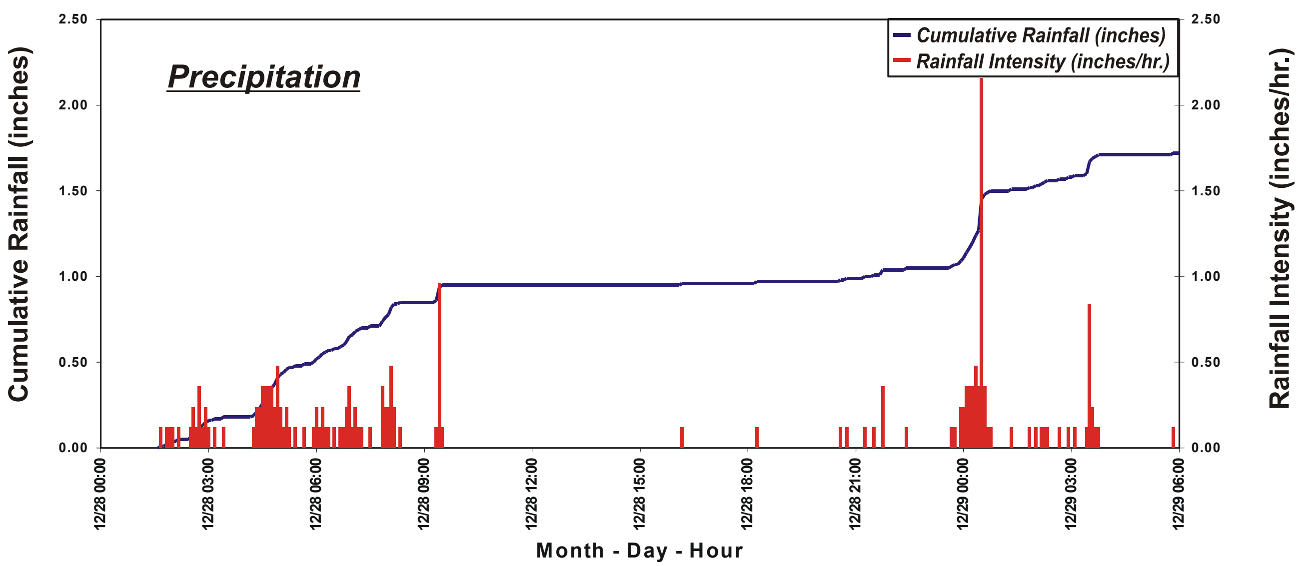


Figure 5.12 Bouton Creek – Event 3 (October 26 and 27, 2004).

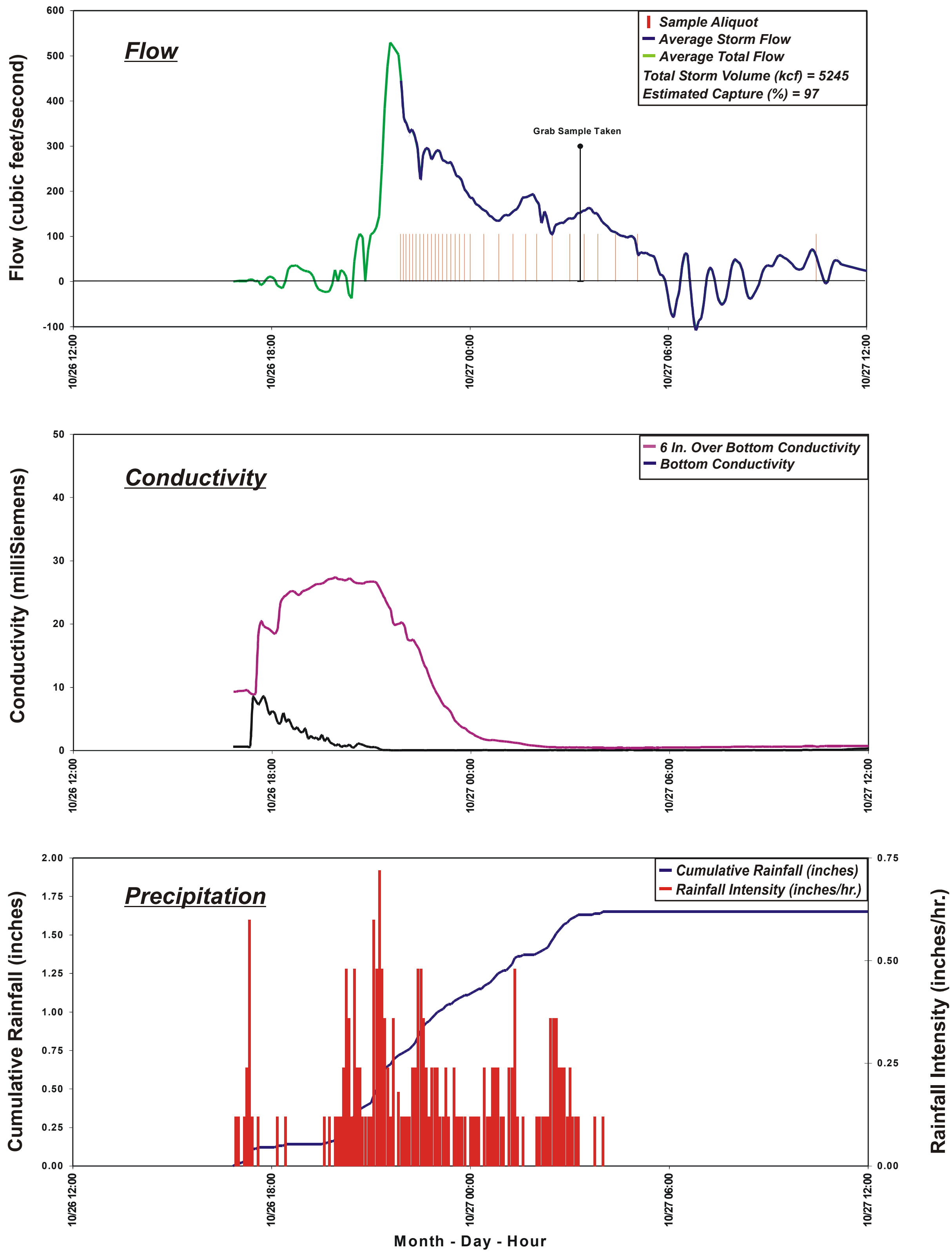
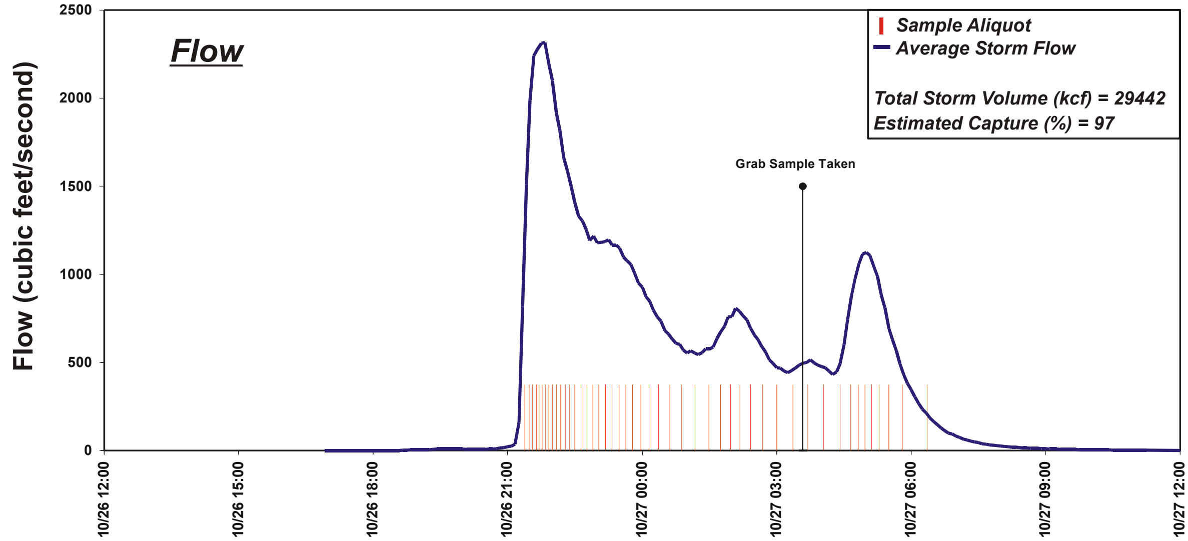


Figure 5.13 Los Cerritos Channel – Event 3 (October 26 and 27, 2004).



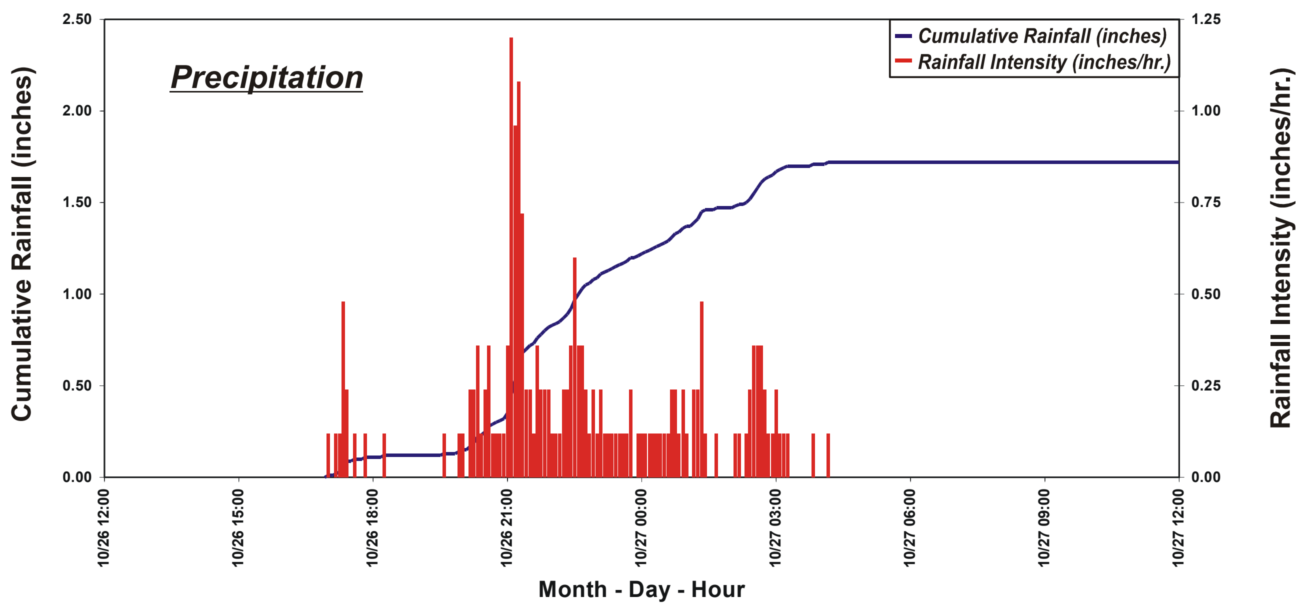
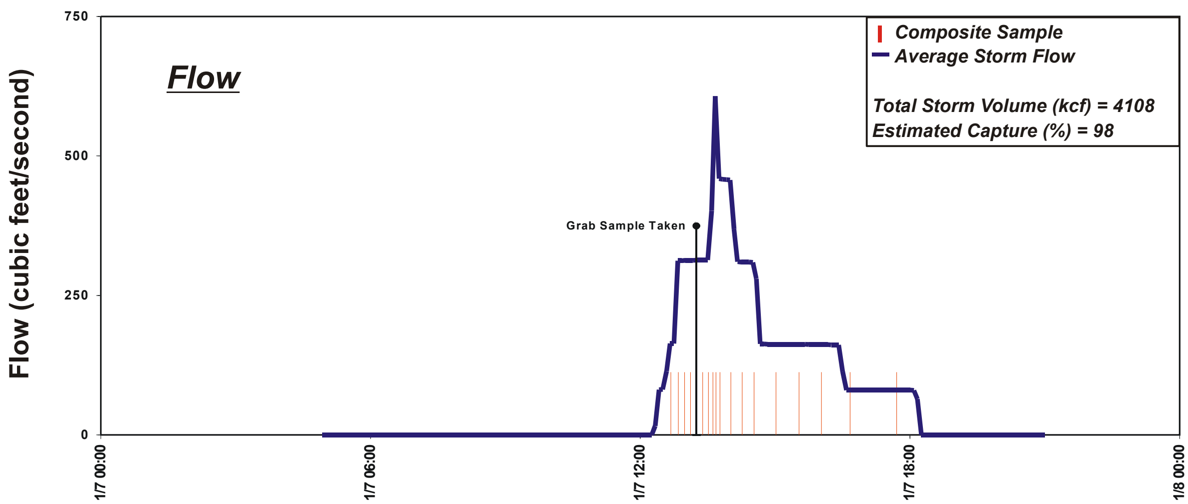


Figure 5.14 Dominguez Gap Pump Station – Event 3 (January 7 and 8, 2005).



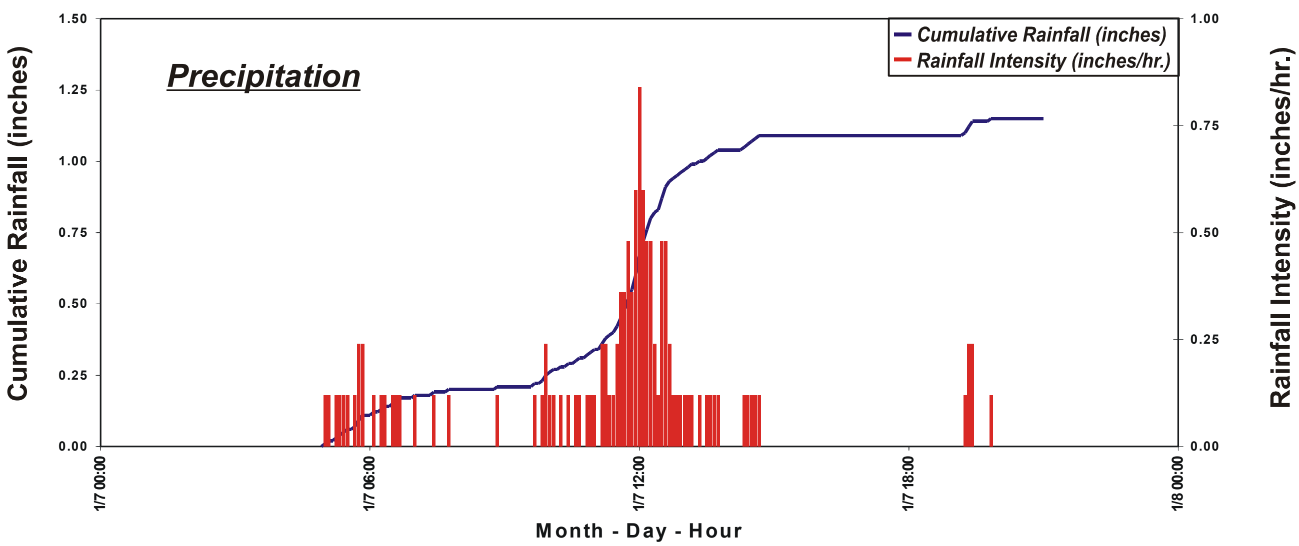
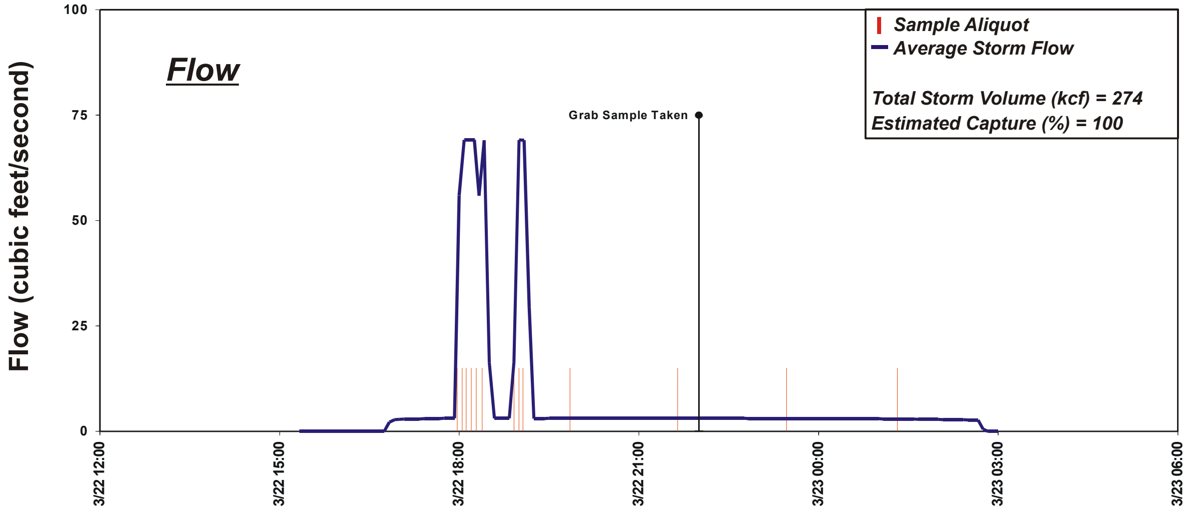


Figure 5.15   Belmont Pump Station – Event 4 (March 22, 2005).



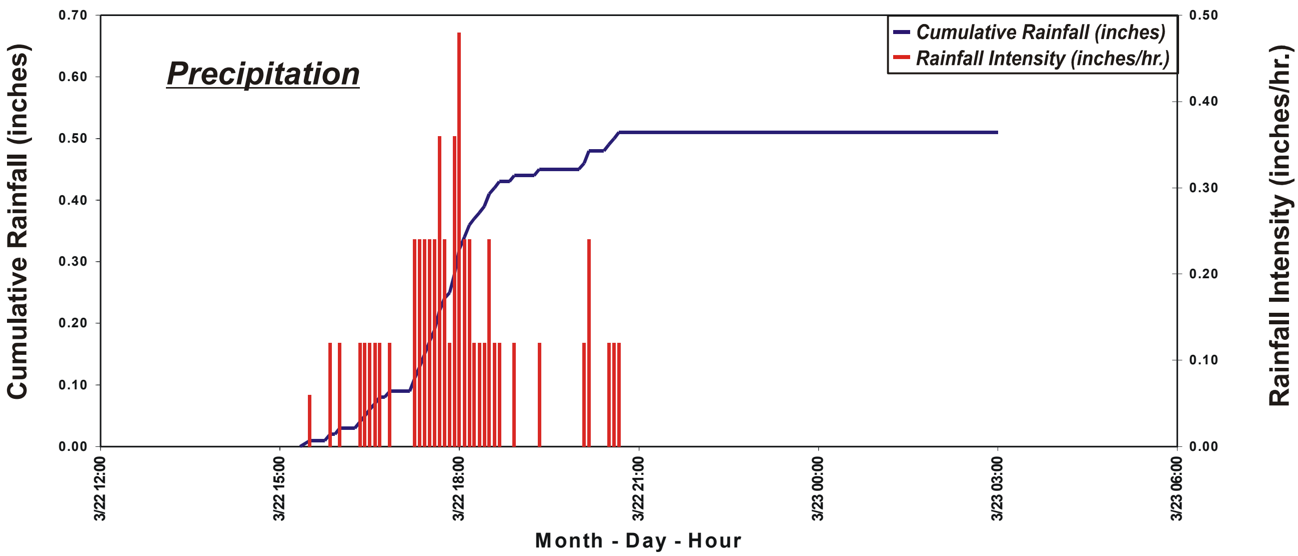


Figure 5.16 Bouton Creek – Event 4 (December 5, 2004).

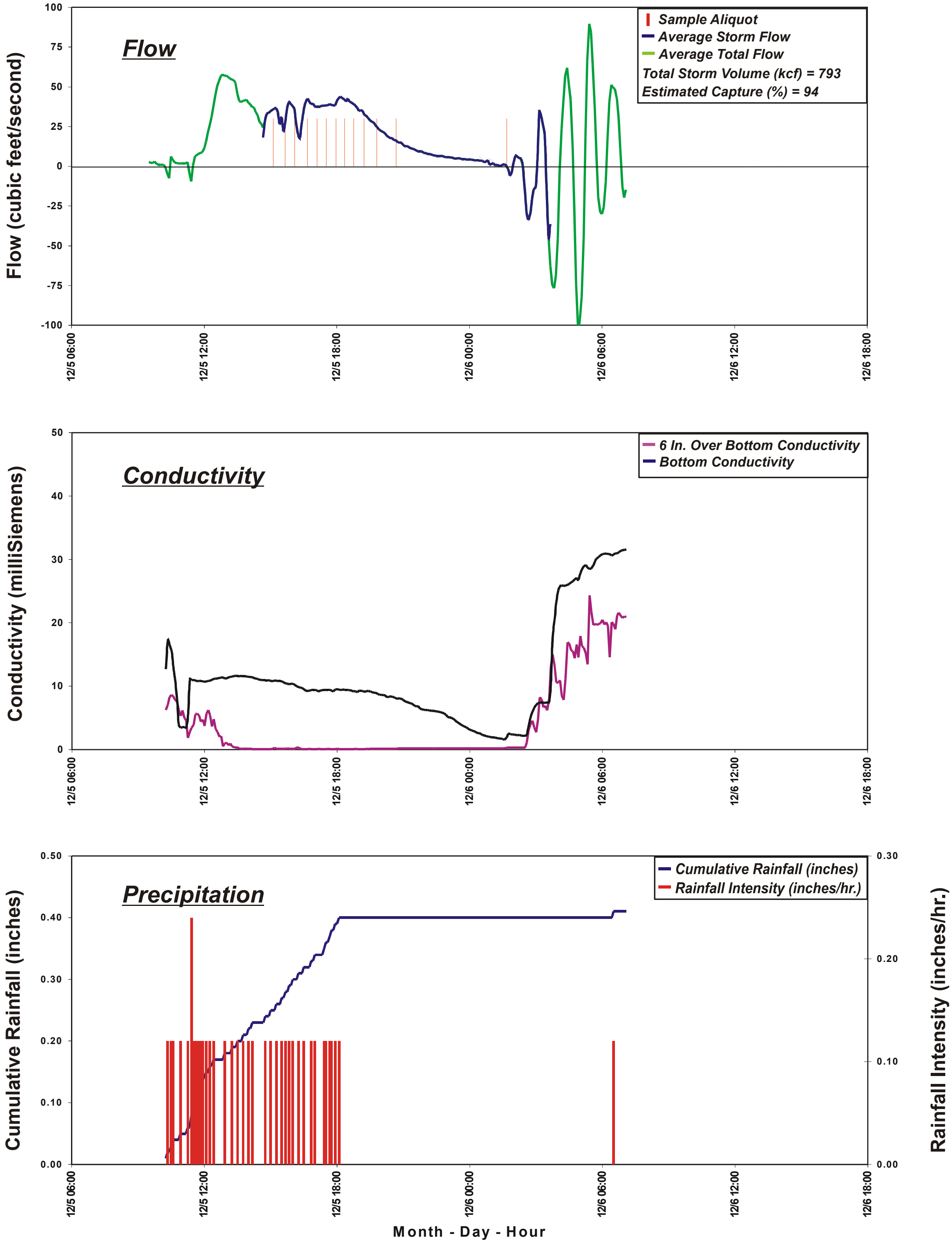
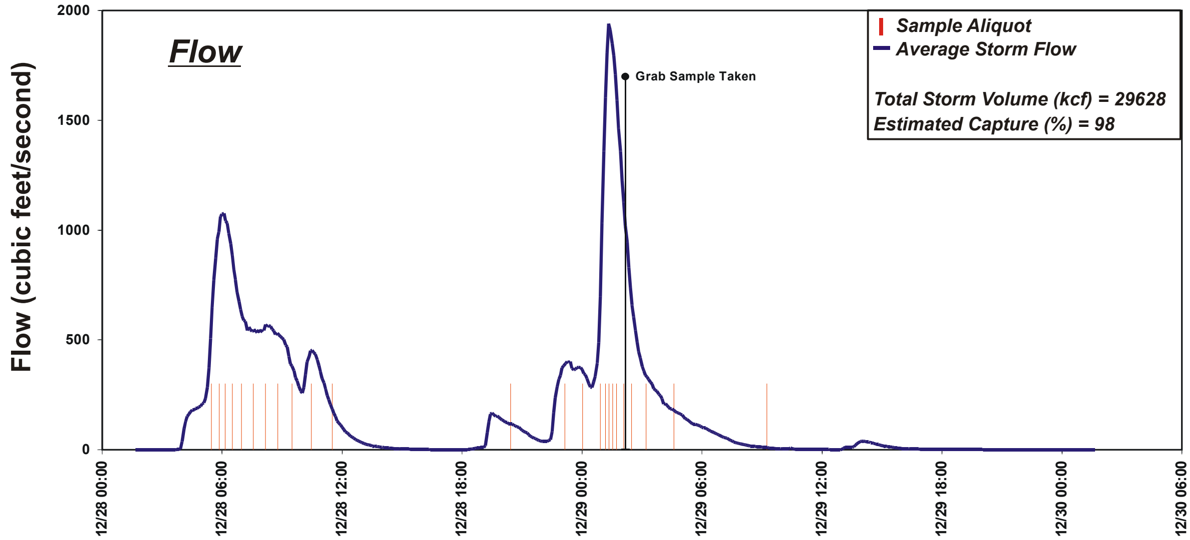


Figure 5.17 Los Cerritos Channel – Event 4 (December 28 and 29, 2004)



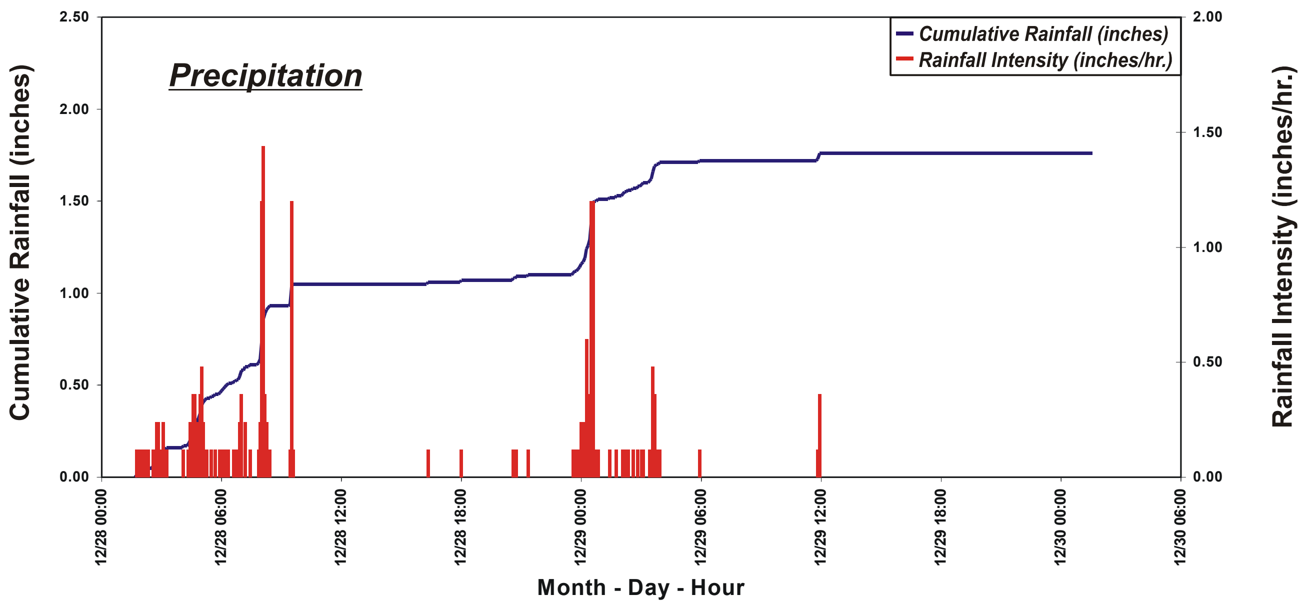
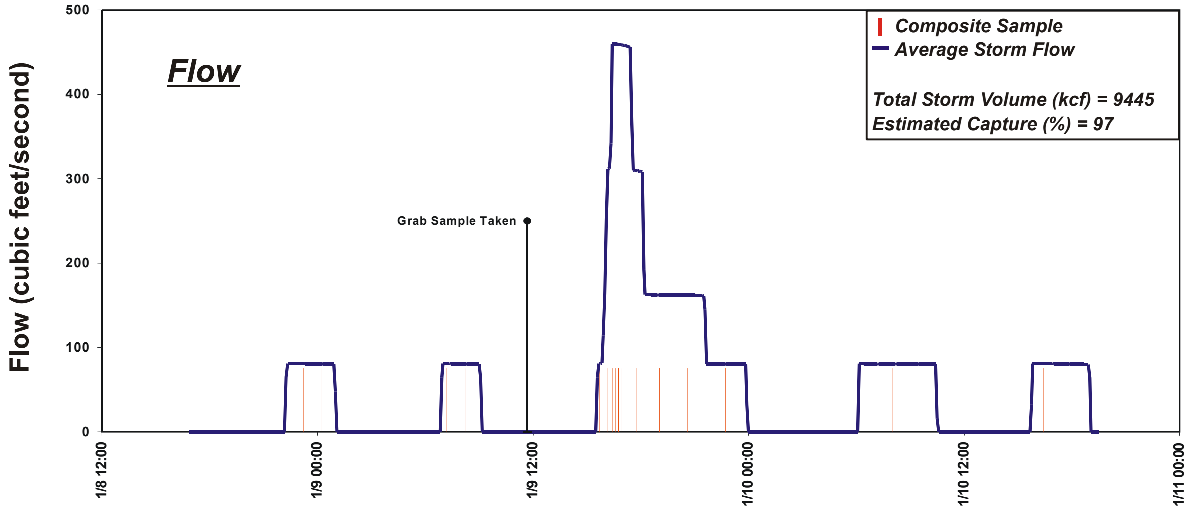


Figure 5.18 Dominguez Gap Pump Station – Event 4 (January 8-10, 2005)



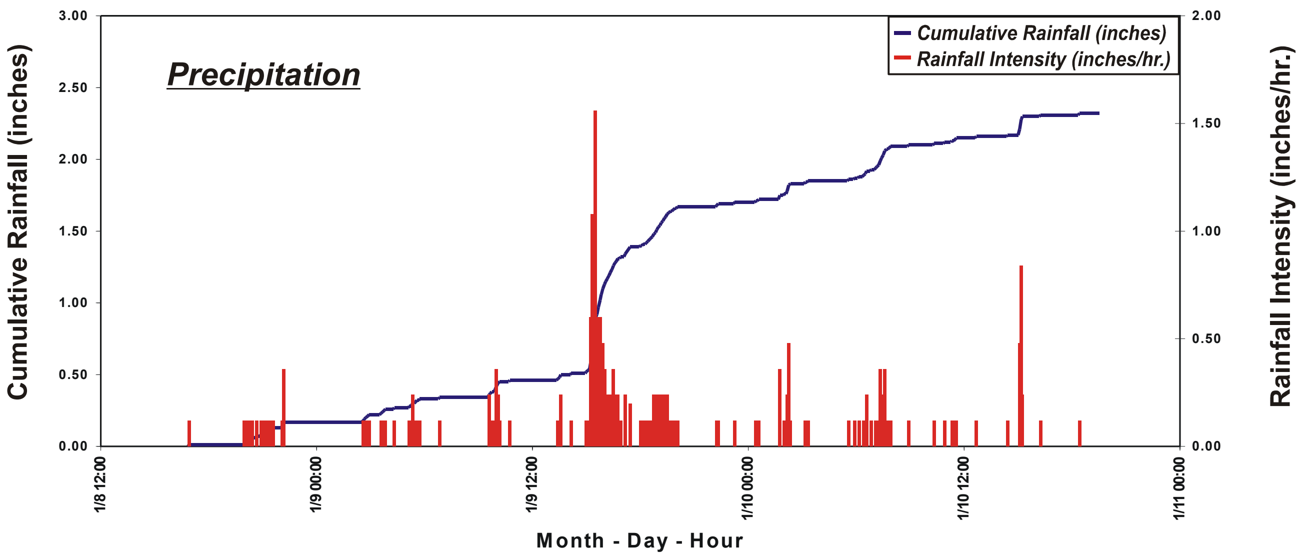


Table 5.1 Daily Rainfall Data at Belmont Pump Station During the 2003/2004 and 2004/2005 Wet Weather Seasons.

	October		November		December		January		February		March		April		Season Total	
Day	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2003/2004**	**2004/2005**
1	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
2	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.60	0.05	0.00	0.00		
3	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.15	0.67	0.00	0.03	0.00	0.00	0.00		
4	0.00	0.00	0.05	0.00	0.00	0.17	0.00	0.19	0.00	0.00	0.00	0.09	0.00	0.00		
5	0.00	0.00	0.01	0.00	0.01	0.39	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00		
6	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
7	0.00	0.00	0.00	0.02	0.00	0.12	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00		
8	0.00	0.00	0.00	0.01	0.15	0.06	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00		
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	0.00	0.00	0.00	0.00	0.00	0.00		
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.02	0.00	0.00	0.00	0.00		
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	1.92	0.00	0.00	0.00	0.00		
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00		
13	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
14	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
15	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
16	0.00	0.12	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
17	0.00	1.29	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00		
18	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.13	0.03	0.00		
19	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.26	1.43	0.00	0.10	0.00	0.00		
20	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00		
21	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.00		
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	1.10	0.00	0.51	0.00	0.00		
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.54	0.00	0.00	0.00	0.00		
24	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15		
25	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
26	0.00	1.11	0.00	0.00	0.21	0.00	0.00	0.03	0.73	0.00	0.00	0.00	0.00	0.00		
27	0.00	0.64	0.00	0.05	0.00	0.00	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00		
28	0.00	0.01	0.00	0.00	0.00	1.11	0.02	0.47	0.00	0.00	0.00	0.06	0.00	0.63		
29	0.00	0.00	0.00	0.00	0.00	0.63	0.15	0.00	0.00		0.00	0.00	0.00	0.00		
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00		
31	0.00	0.00			0.00	0.50	0.00	0.00			0.00	0.00				
Total	0	5.05	0.23	0.53	0.68	2.99	0.64	5.89	3.26	8.48	0.63	0.94	0.03	0.78	5.47	24.66

Table 5.2 Daily Rainfall Data at Bouton Creek During the 2003/2004 and 2004/2005 Wet Weather Seasons.

	October		November		December		January		February		March		April		Season Total	
Day	2003	2004	2003	2004	2003	2004	2004	2005	2004	2005	2004	2005	2004	2005	2003/2004	2004/2005
1	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
2	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.94	0.00	0.00	0.53	0.03	0.01	0.00		
3	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.11	0.77	0.00	0.10	0.00	0.00	0.00		
4	0.00	0.00	0.12	0.00	0.00	0.14	0.00	0.15	0.00	0.00	0.01	0.23	0.00	0.00		
5	0.00	0.00	0.01	0.00	0.00	0.40	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00		
6	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
7	0.00	0.00	0.00	0.03	0.00	0.08	0.00	0.77	0.00	0.00	0.00	0.00	0.00	0.00		
8	0.00	0.00	0.00	0.00	0.17	0.06	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00		
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	0.00	0.00	0.00	0.00	0.00	0.00		
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.00	0.02	0.00	0.00	0.00	0.00		
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	1.92	0.00	0.00	0.00	0.00		
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00		
13	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
15	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
16	0.00	0.05	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
17	0.00	1.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00		
18	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.12	0.04	0.00		
19	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.26	1.52	0.00	0.06	0.00	0.00		
20	0.00	1.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.03	0.00	0.00		
21	0.00	0.02	0.00	0.34	0.00	0.00	0.00	0.00	0.00	2.03	0.00	0.00	0.00	0.00		
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	1.08	0.00	0.58	0.00	0.00		
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.67	0.00	0.00	0.00	0.00		
24	0.00	0.00	0.00	0.00	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.15		
25	0.00	0.02	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
26	0.01	1.12	0.00	0.00	0.52	0.00	0.00	0.05	0.81	0.00	0.00	0.00	0.00	0.00		
27	0.00	0.54	0.00	0.05	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00		
28	0.00	0.01	0.00	0.00	0.00	1.17	0.02	0.44	0.00	0.00	0.00	0.06	0.00	0.72		
29	0.00	0.00	0.00	0.00	0.00	0.66	0.18	0.00	0.00		0.00	0.00	0.00	0.00		
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00		
31	0.00	0.00			0.00	0.71	0.00	0.00			0.00	0.00				
Total	0.01	4.75	0.26	0.42	0.92	3.23	0.53	6.11	3.44	8.34	0.64	1.11	0.05	0.87	5.85	24.83

Table 5.3 Daily Rainfall Data at Los Cerritos Channel During the 2003/2004 and 2004/2005 Wet Weather Seasons.

	October		November		December		January		February		March		April		Season Total	
Day	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2003/2004**	**2004/2005**
1	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
2	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.92	0.00	0.00	0.52	0.02	0.01	0.00		
3	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.11	0.76	0.00	0.08	0.00	0.00	0.00		
4	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.15	0.01	0.00	0.00	0.20	0.00	0.00		
5	0.00	0.00	0.01	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
6	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
7	0.00	0.00	0.00	0.03	0.00	0.05	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.00		
8	0.00	0.00	0.00	0.00	0.13	0.05	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00		
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.92	0.00	0.00	0.00	0.00	0.00	0.00		
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.02	0.00	0.00	0.00	0.00		
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	1.88	0.00	0.00	0.00	0.00		
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00		
13	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
15	0.00	0.06	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
16	0.00	0.04	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
17	0.00	0.78	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00		
18	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.06	0.03	0.00		
19	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.29	1.60	0.00	0.05	0.00	0.00		
20	0.00	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.01	0.00	0.00		
21	0.00	0.01	0.00	0.25	0.00	0.00	0.00	0.00	0.00	2.54	0.00	0.00	0.00	0.00		
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	1.11	0.00	0.73	0.00	0.00		
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.66	0.00	0.00	0.00	0.00		
24	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07		
25	0.00	0.04	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
26	0.00	1.22	0.00	0.00	0.47	0.00	0.00	0.05	0.73	0.00	0.00	0.00	0.00	0.00		
27	0.00	0.52	0.00	0.05	0.01	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00		
28	0.00	0.01	0.00	0.00	0.00	1.16	0.02	0.35	0.00	0.00	0.00	0.07	0.00	0.68		
29	0.00	0.00	0.00	0.00	0.00	0.60	0.12	0.00	0.00		0.00	0.00	0.00	0.00		
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00		
31	0.00	0.00			0.00	0.70	0.00	0.00			0.00	0.00				
Total	0.00	4.60	0.26	0.33	0.81	3.05	0.37	5.77	3.12	8.93	0.60	1.14	0.04	0.75	5.20	24.57

Table 5.4 Daily Rainfall Data at the Dominguez Gap Pump Station During the 2003/2004 and 2004/2005 Wet Weather Seasons.

	October		November		December		January		February		March		April		Season Total	
Day	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2003/2004**	**2004/2005**
1	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
2	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.60	0.06	0.00	0.00		
3	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.54	0.42	0.00	0.00	0.01	0.00	0.00		
4	0.00	0.00	0.06	0.00	0.00	0.09	0.00	0.18	0.00	0.00	0.00	0.02	0.00	0.00		
5	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00		
6	0.00	0.00	0.00	0.00	0.01	0.01	0.00	1.79	0.00	0.00	0.00	0.00	0.00	0.00		
7	0.00	0.00	0.00	0.04	0.00	0.07	0.00	1.15	0.00	0.00	0.00	0.00	0.00	0.00		
8	0.00	0.00	0.00	0.00	0.21	0.05	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00		
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.53	0.00	0.00	0.00	0.00	0.00	0.00		
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.02	0.00	0.00	0.00	0.00		
11	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.05	0.00	2.38	0.00	0.00	0.00	0.00		
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.00		
13	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
14	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
15	0.00	0.06	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
16	0.00	0.04	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
17	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00		
18	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.09	0.03	0.00		
19	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.24	1.72	0.00	0.05	0.00	0.00		
20	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00		
21	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.01	0.98	0.00	0.00	0.00	0.00		
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.83	0.00	0.80	0.00	0.00		
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.12	0.00	0.03	0.00	0.00		
24	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01		
25	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
26	0.01	0.79	0.00	0.00	0.40	0.00	0.00	0.40	0.57	0.00	0.00	0.00	0.00	0.00		
27	0.00	0.50	0.00	0.06	0.00	0.00	0.00	0.00	0.54	0.00	0.00	0.00	0.00	0.00		
28	0.00	0.01	0.00	0.00	0.00	2.21	0.03	0.39	0.00	0.00	0.00	0.10	0.00	0.94		
29	0.00	0.00	0.00	0.00	0.00	0.62	0.12	0.00	0.00		0.00	0.00	0.00	0.00		
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00		
31	0.00	0.00			0.00	0.29	0.00	0.00			0.00	0.00				
Total	0.01	4.03	0.39	0.27	0.88	3.81	0.46	7.90	2.31	7.44	0.60	1.19	0.03	0.95	4.68	25.59

Table 5.5 Rainfall for Monitored Events during the 2004/2005 Wet Weather Season.

	Start Rain		End Rain							
Site/Event	**Date**	**Time**	**Date**	**Time**	**Duration Rain (hrs:mins)**	**Total Rain (inches)**	**Max Intensity (Inches/hr)**	**Antecedent Rain (days)**	**Antecedent Rain (inches)**	**Sampling Code**
Event 1										
BELMONT PUMP ST.	10/16/2004	21:35	10/17/2004	1:35	4:00:00	1.36	1.44	229	0.63	MF
BOUTON CREEK	10/16/2004	21:40	10/17/2004	9:00	11:20:00	1.05	1.8	228	0.64	Full
LOS CERRITOS	10/16/2005	21:45	10/17/2005	6:50	9:05:00	0.81	1.08	229	0.6	Full
Event 2										
BELMONT PUMP ST.	10/19/2004	23:05	10/20/2004	9:00	9:55:00	1.56	0.84	1.7	1.41	Full
BOUTON CREEK	10/19/2004	11:45	10/20/2004	9:25	21:40:00	1.85	0.72	0.8	0.10	Full
LOS CERRITOS	10/19/2004	10:10	10/21/2004	4:00	41:50:00	1.91	1.08	1.4	0.84	Full
DOMINGUEZ PUMP ST.	10/19/2004	23:50	10/20/2004	16:00	16:10:00	1.83	0.96	1.4	0.84	ND
Event 3										
BELMONT PUMP ST.	10/26/2004	16:50	10/27/2004	3:45	10:55:00	1.67	1.2	6.0	1.74	Full
BOUTON CREEK	10/26/2004	16:55	10/27/2004	4:00	11:05:00	1.65	0.72	6.0	1.95	Full
LOS CERRITOS	10/26/2004	17:00	10/27/2004	4:10	11:10:00	1.72	1.2	5.5	1.91	Full
DOMINGUEZ PUMP ST.	10/26/2004	17:20	10/27/2004	14:40	21:20:00	1.28	1.68	6.0	1.69	ND
Event 4										
BELMONT PUMP ST.	12/5/2004	4:55	12/5/2004	18:30	13:35:00	0.39	0.24	14	0.45	TSS
BOUTON CREEK	12/5/2004	9:35	12/5/2004	18:05	8:30:00	0.4	0.24	14.1	0.34	Full
LOS CERRITOS	12/5/2004	9:05	12/5/2004	21:55	12:50:00	0.39	0.24	13.8	0.25	TSS
DOMINGUEZ PUMP ST.	12/4/2004	18:20	12/5/2004	19:30	25:10:00	0.54	0.36	13.5	0.15	ND
Event 5										
BELMONT PUMP ST.	12/28/2004	1:40	12/29/2004	5:50	28:10:00	1.71	2.16	20	0.18	Full
BOUTON CREEK	12/28/2004	1:35	12/29/2004	7:05	29:30:00	1.8	1.92	20	0.14	TSS
LOS CERRITOS	12/28/2004	1:45	12/29/2004	11:55	34:10:00	1.76	1.44	20.1	0.10	Full
DOMINGUEZ PUMP ST.	12/28/2004	1:30	12/29/2004	14:00	36:30:00	2.83	2.16	20	0.12	Full

Table 5.5 Rainfall for Monitored Events during the 2004/2005 Wet Weather Season.

Site/Event	Start Rain Date	Start Rain Time	End Rain Date	End Rain Time	Duration Rain (hrs:mins)	Total Rain (inches)	Max Intensity (Inches/hr)	Antecedent Rain (days)	Antecedent Rain (inches)	Sampling Code
Event 6										
BELMONT PUMP ST.	12/31/2004	7:35	12/31/2004	11:20	3:45:00	0.5	0.84	1.8	1.74	TSS
BOUTON CREEK	12/31/2004	2:15	12/31/2004	11:30	9:15:00	0.71	1.2	1.8	1.80	TSS
LOS CERRITOS	12/31/2004	1:45	12/31/2004	11:30	9:45:00	0.7	1.44	1.6	1.76	TSS
DOMINGUEZ PUMP ST.	12/31/2004	7:25	12/31/2004	11:30	4:05:00	0.29	0.36	1.7	2.83	ND
Event 7										
BELMONT PUMP ST.	1/2/2005	19:10	1/3/2005	15:00	19:50:00	0.88	0.96	2.3	0.50	TSS
BOUTON CREEK	1/2/2005	15:10	1/4/2005	7:20	40:10:00	1.14	0.72	2.2	0.71	TSS
LOS CERRITOS	1/2/2005	19:15	1/3/2005	10:30	15:15:00	1.03	0.72	2.4	0.70	TSS
DOMINGUEZ PUMP ST.	1/2/2005	14:30	1/3/2005	8:55	18:25:00	1.31	1.2	2.1	0.29	Full
Event 8										
BELMONT PUMP ST.	1/7/2005	5:05	1/8/2005	6:05	25:00:00	0.96	0.24	1.9	0.2	TSS
BOUTON CREEK	1/7/2005	5:05	1/8/2005	8:05	27:00:00	0.87	0.24	2.9	1.14	TSS
LOS CERRITOS	1/7/2005	5:05	1/8/2005	8:10	27:05:00	0.95	0.48	2.3	0.15	TSS
DOMINGUEZ PUMP ST.	1/7/2005	5:00	1/8/2005	7:20	26:20:00	1.39	0.96	1.8	0.19	Full
Event 9										
BELMONT PUMP ST.	1/8/2005	18:05	1/10/2005	21:50	51:45:00	3.01	0.84	0.5	0.96	TSS
BOUTON CREEK	1/8/2005	17:25	1/10/2005	17:50	48:25:00	3.11	1.08	0.4	0.87	TSS
LOS CERRITOS	1/8/2005	17:05	1/10/2005	21:55	52:50:00	2.89	1.56	0.4	0.95	TSS
DOMINGUEZ PUMP ST.	1/8/2005	16:55	1/10/2005	18:25	49:30:00	2.32	1.44	0.4	1.39	Full
Event 10										
BELMONT PUMP ST.	1/10/2005	23:00	1/11/2005	4:20	5:20:00	0.31	0.72	0.2	3.97	TSS
BOUTON CREEK	1/10/2005	22:45	1/11/2005	5:05	6:20:00	0.38	0.6	0.2	3.98	TSS
LOS CERRITOS	1/10/2005	23:05	1/11/2005	12:00	12:55:00	0.34	0.6	0.1	3.84	TSS
DOMINGUEZ PUMP ST.	1/10/2005	22:40	1/11/2005	3:35	4:55:00	0.1	0.12	0.2	3.71	ND

Table 5.5 Rainfall for Monitored Events during the 2004/2005 Wet Weather Season.

Site/Event	Start Rain		End Rain		Duration Rain (hrs:mins)	Total Rain (inches)	Max Intensity (Inches/hr)	Antecedent Rain (days)	Antecedent Rain (inches)	Sampling Code
	Date	Time	Date	Time						
Event 11										
BELMONT PUMP ST.	1/28/2005	7:35	1/28/2005	13:50	6:15:00	0.47	0.84	17.1	4.28	TSS
BOUTON CREEK	1/28/2005	8:50	1/28/2005	14:45	5:55:00	0.44	0.36	17.1	4.36	TSS
LOS CERRITOS	1/28/2005	7:50	1/28/2005	14:10	6:20:00	0.35	0.48	16.8	4.18	TSS
DOMINGUEZ PUMP ST.	1/28/2005	7:25	1/28/2005	14:10	6:45:00	0.39	0.36	1.6	0.4	ND
Event 12										
BELMONT PUMP ST.	2/10/2005	23:30	2/12/2005	6:45	31:15:00	2.33	0.6	13.4	0.47	TSS
BOUTON CREEK	2/10/2005	23:20	2/12/2005	6:45	31:25:00	2.19	0.72	13.4	0.44	MF
LOS CERRITOS	2/10/2005	23:35	2/12/2005	5:25	29:50:00	2.07	0.72	13.4	0.35	TSS
DOMINGUEZ PUMP ST.	2/10/2005	23:25	2/12/2005	5:10	29:45:00	2.86	0.84	13.4	0.39	TSS
Event 13										
BELMONT PUMP ST.	2/17/2005	14:25	2/21/2005	22:05	103:40:00	4.51	5.16	5.3	2.33	TSS
BOUTON CREEK	2/17/2005	14:25	2/19/2005	10:35	44:10:00	1.95	5.16	5.3	2.19	TSS
LOS CERRITOS	2/17/2005	14:35	2/19/2005	10:50	44:15:00	2.08	5.4	5.4	2.07	MF
DOMINGUEZ PUMP ST.	2/17/2005	14:15	2/21/2005	21:10	102:55:00	3.49	2.64	5.4	2.86	TSS
Event 14										
BELMONT PUMP ST.	3/22/2005	15:30	3/22/2005	20:40	5:10:00	0.51	0.48	3.2	1.63	Full
BOUTON CREEK	3/22/2005	15:25	3/22/2005	20:40	5:15:00	0.57	0.6	2.6	0.21	TSS
LOS CERRITOS	3/22/2005	15:55	3/22/2005	20:40	4:45:00	0.73	0.72	3.5	0.1	TSS
DOMINGUEZ PUMP ST.	3/22/2005	15:15	3/23/2005	6:10	14:55:00	0.83	2.04	3.5	0.12	ND

Sampling Codes
Full = Sampled for full suite of chemical constituents
TSS = Sampled for TSS only
MF = Sampler or other equipment malfunction
ND = No discharge

Table 5.6 Descriptive Statistics - Rainfall and Flow Data for Full Suite Events (2004/2005).

Site / Parameter	n	Min	Max	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile
BELMONT PUMP ST.								
Duration Flow (days)	4	0.4	0.98	0.54	0.29	0.40	0.42	0.56
Total Flow (kcf)	4	274	1001	778	343	706	918	990
Duration Rain (days)	4	0.22	1.17	0.56	0.42	0.36	0.43	0.63
Total Rain (in)	4	0.51	1.71	1.36	0.57	1.30	1.62	1.68
Max Intensity (in/hr)	4	0.48	2.16	1.17	0.72	0.75	1.02	1.44
Antecedent Dry (days)	4	1.7	20.0	7.7	8.4	2.8	4.6	9.5
Antecedent Rain (in)	4	0.18	1.74	1.24	0.72	1.10	1.52	1.66
BOUTON CREEK								
Duration Flow (days)	4	0.43	0.92	0.67	0.20	0.60	0.67	0.75
Total Flow (kcf)	4	793	5245	3165	2149	1641	3311	4836
Duration Rain (days)	4	0.35	0.90	0.55	0.24	0.43	0.47	0.58
Total Rain (in)	4	0.40	1.85	1.24	0.65	0.89	1.35	1.70
Max Intensity (in/hr)	4	0.24	1.80	0.87	0.66	0.60	0.72	0.99
Antecedent Dry (days)	4	0.8	228	62.2	110.6	4.7	10.1	67.6
Antecedent Rain (in)	4	0.10	1.95	0.76	0.83	0.28	0.49	0.97
LOS CERRITOS								
Duration Flow (days)	4	0.63	2.72	1.29	0.98	0.64	0.90	1.55
Total Flow (kcf)	4	4196	39507	25693	15083	23131	29535	32098
Duration Rain (days)	4	0.38	1.74	1.00	0.68	0.44	0.94	1.50
Total Rain (in)	4	0.81	1.91	1.55	0.50	1.49	1.74	1.80
Max Intensity (in/hr)	4	1.08	1.44	1.20	0.17	1.08	1.14	1.26
Antecedent Dry (days)	4	1.4	229	64.0	110.3	4.5	12.8	72.3
Antecedent Rain (in)	4	0.25	1.91	0.90	0.72	0.51	0.72	1.11
DOMINGUEZ GAP PUMP ST.								
Duration Flow (days)	4	0.15	1.87	0.82	0.83	0.17	0.64	1.29
Total Flow (kcf)	4	1515	9445	4230	3663	1766	2979	5442
Duration Rain (days)	4	0.77	2.06	1.36	0.56	1.01	1.31	1.66
Total Rain (in)	4	1.31	2.83	1.96	0.74	1.37	1.86	2.45
Max Intensity (in/hr)	4	0.96	2.16	1.44	0.52	1.14	1.32	1.62
Antecedent Dry (days)	4	0.4	20.0	6.1	9.3	1.4	1.9	6.6
Antecedent Rain (in)	4	0.12	1.39	0.50	0.60	0.17	0.24	0.57

Table 5.7 Flow for Monitored Events during the 2004/2005 Wet Weather Season.

Site/Event	Start Flow Date	Start Flow Time	End Flow Date	End Flow Time	Flow or Discharge Duration (hrs:mins)	Total Flow (kcf)	No. of Sample Aliquots Collected	Peak Flow (cfs)	% Storm Capture	Peak Capture	Sampling Code
Event 1											
BELMONT PUMP ST.	10/17/2004	0:19	10/17/2004	2:10	1:51:00	705	0	247	0	N	MF
BOUTON CREEK	10/17/2004	0:35	10/17/2004	10:55	10:20:00	1923	19	369	16.8	N	Full
LOS CERRITOS	10/17/2004	0:00	10/17/2004	15:00	15:00:00	4196	19	744	19.4	N	Full
DOMINGUEZ PUMP ST.	No Discharge										ND
Event 2											
BELMONT PUMP ST.	10/20/2004	1:15	10/20/2004	9:53	8:38:00	1001	13	132	97.8	Y	Full
BOUTON CREEK	10/19/2004	19:10	10/20/2004	10:50	15:40:00	4699	29	327	98.6	Y	Full
LOS CERRITOS	10/19/2004	13:30	10/20/2004	5:00	15:30:00	39507	40	2157	92.7	Y	Full
DOMINGUEZ PUMP ST.	No Discharge										ND
Event 3											
BELMONT PUMP ST.	10/26/2004	20:28	10/27/2004	6:41	10:13:00	986	13	132	99.2	Y	Full
BOUTON CREEK	10/26/2004	21:54	10/27/2004	20:00	22:06:00	5245	31	445	96.7	Y	Full
LOS CERRITOS	10/26/2004	17:15	10/27/2004	21:00	27:45:00	29442	48	2404	9.7	Y	Full
DOMINGUEZ PUMP ST.	No Discharge										ND
Event 4											
BELMONT PUMP ST.	12/5/2004	17:16	12/5/2004	17:31	0:15:00	58	1	66	100	Y	TSS
BOUTON CREEK	12/5/2004	10:45	12/6/2004	3:25	16:40:00	793	13	44	94	Y	Full
LOS CERRITOS	12/5/2004	11:25	12/6/2004	2:45	15:20:00	2048	6	96	100	Y	TSS
DOMINGUEZ PUMP ST.	No Discharge										ND

Table 5.7 Flow for Monitored Events during the 2004/2005 Wet Weather Season.

	Start Flow		End Flow								
Site/Event	Date	Time	Date	Time	Flow or Discharge Duration (hrs:mins)	Total Flow (kcf)	No. of Sample Aliquots Collected	Peak Flow (cfs)	% Storm Capture	Peak Capture	Sampling Code
Event 5											
BELMONT PUMP ST.	12/28/2004	4:46	12/29/2004	4:12	23:26:00	850	7	144	100	Y	Full
BOUTON CREEK	12/28/2004	12:30	12/29/2004	7:25	18:55:00	2997	37	321	73.5	Y	TSS
LOS CERRITOS	12/28/2004	2:30	12/30/2004	19:40	65:10:00	29628	24	1940	98.2	Y	Full
DOMINGUEZ PUMP ST.	12/29/2004	0:35	12/29/2004	4:05	3:30:00	1515	10	163	99	Y	Full
Event 6											
BELMONT PUMP ST.	12/31/2004	9:42	12/31/2004	13:24	3:42:00	316	5	66	100	Y	TSS
BOUTON CREEK	12/31/2004	9:55	12/31/2004	10:20	0:25:00	333	8	256	100	Y	TSS
LOS CERRITOS	12/31/2004	7:45	12/31/2004	21:00	13:15:00	8779	19	1126	65.5	Y	TSS
DOMINGUEZ PUMP ST.	No Discharge										ND
Event 7											
BELMONT PUMP ST.	1/2/2005	20:19	1/3/2005	8:55	12:36:00	424	3	125	100	Y	TSS
BOUTON CREEK	1/2/2005	16:20	1/4/2005	10:55	42:35:00	3883	19	202	90.8	Y	TSS
LOS CERRITOS	1/2/2005	19:40	1/3/2005	19:35	23:55:00	13476	11	987	99.9	Y	TSS
DOMINGUEZ PUMP ST.	1/2/2005	23:01	1/3/2005	3:11	4:10:00	1850	11	163	93	Y	Full
Event 8											
BELMONT PUMP ST.	1/7/2005	7:26	1/8/2005	3:58	20:32:00	477	7	69	100	Y	TSS
BOUTON CREEK	1/7/2005	10:40	1/8/2005	16:35	29:55:00	2916	24	260	99.9	Y	TSS
LOS CERRITOS	1/7/2005	5:40	1/8/2005	17:05	35:25:00	27139	45	2666	99.5	Y	TSS
DOMINGUEZ PUMP ST.	1/7/2005	12:19	1/7/2005	18:09	5:50:00	4108	18	607	98.3	Y	Full

Table 5.7 Flow for Monitored Events during the 2004/2005 Wet Weather Season.

Site/Event	Start Flow Date	Start Flow Time	End Flow Date	End Flow Time	Flow or Discharge Duration (hrs:mins)	Total Flow (kcf)	No. of Sample Aliquots Collected	Peak Flow (cfs)	% Storm Capture	Peak Capture	Sampling Code
Event 9											
BELMONT PUMP ST.	1/8/2005	17:43	1/10/2005	16:05	46:22:00	2268	64	132	100	Y	TSS
BOUTON CREEK	1/8/2005	20:50	1/10/2005	20:30	47:40:00	12,262	100	731	95	Y	TSS
LOS CERRITOS	1/8/2005	21:00	1/10/2005	22:50	49:50:00	55,929	93	4143	100	Y	TSS
DOMINGUEZ PUMP ST.	1/8/2005	22:11	1/10/2005	18:59	44:48:00	9445	16	460	96.7	Y	Full
Event 10											
BELMONT PUMP ST.	1/10/2005	22:45	1/11/2005	9:57	11:12:00	320	9	69	100	Y	TSS
BOUTON CREEK	1/10/2005	23:20	1/11/2005	23:00	23:40:00	1850	13	103	87.6	Y	TSS
LOS CERRITOS	1/10/2005	22:51	1/11/2005	18:00	19:09:00	2664	4	187	99.9	Y	TSS
DOMINGUEZ PUMP ST.	No Discharge										ND
Event 11											
BELMONT PUMP ST.	1/28/2005	12:53	1/29/2005	1:14	12:21:00	247	16	66	100	Y	TSS
BOUTON CREEK	1/28/2005	13:00	1/28/2005	21:30	8:30:00	1149	38	147	95.9	Y	TSS
LOS CERRITOS	1/28/2005	12:31	1/28/2005	22:15	9:44:00	2508	16	329	100	Y	TSS
DOMINGUEZ PUMP ST.	No Discharge										ND
Event 12											
BELMONT PUMP ST.	2/10/2005	23:56	2/13/2005	3:11	51:15:00	1336	44	135	100	Y	TSS
BOUTON CREEK	No Sample Collected Due to Sensor Failure										MF
LOS CERRITOS	2/11/2005	2:25	2/12/2005	15:00	36:35:00	31,898	95	1425	89.4	Y	TSS
DOMINGUEZ PUMP ST.	2/11/2005	21:40	2/12/2005	5:37	7:57:00	2684	52	369	100	Y	TSS

Table 5.7 Flow for Monitored Events during the 2004/2005 Wet Weather Season.

Site/Event	Start Flow Date	Start Flow Time	End Flow Date	End Flow Time	Flow or Discharge Duration (hrs:mins)	Total Flow (kcf)	No. of Sample Aliquots Collected	Peak Flow (cfs)	% Storm Capture	Peak Capture	Sampling Code
Event 13											
BELMONT PUMP ST.	2/17/2005	22:00	2/22/2005	2:40	100:40:00	3642	95	282	78.5	Y	TSS
BOUTON CREEK	2/17/2005	17:39	2/19/2005	17:55	48:16:00	6570	95	800	86.9	Y	TSS
LOS CERRITOS	2/17/2005	17:15	2/19/2005	22:40	53:25:00	35687	0	3204	0	N	MF
DOMINGUEZ PUMP ST.	2/19/2005	4:04	2/21/2005	12:44	56:40:00	6936	95	230.2	68.5	Y	TSS
Event 14											
BELMONT PUMP ST.	3/22/2005	16:46	3/23/2005	2:41	9:55:00	274	13	69	100	Y	Full
BOUTON CREEK	3/22/2005	18:10	3/23/2005	19:00	24:50:00	2714	45	309	97.2	Y	TSS
LOS CERRITOS	3/22/2005	16:15	3/23/2005	7:00	14:45:00	14239	47	1792	100	Y	TSS
DOMINGUEZ PUMP ST.	No Discharge										ND

Sampling Codes
Full = Sampled for full suite of chemical constituents
TSS = Sampled for TSS only
MF = Sampler or other equipment malfunction
ND = No discharge

6.0 CHEMISTRY RESULTS

6.0 CHEMISTRY RESULTS

6.1 Wet Weather Chemistry Results

Due to extremely high rainfall during the past year, a total of 14 events were monitored during the 2004/2005 season (Table 6.1). Four storm events were monitored for the full set of analytical constituents at each of the four monitoring sites for the first time since the permit was issued. Between two and eight additional events were successfully monitored at each site for TSS measurements (shaded events in Table 6.1). In all but one case composite samples collected during these storm events were also tested for toxicity with two species, the water flea (freshwater crustacean) and sea urchin (marine). Sample volumes during the second event at Los Cerritos Channel were not sufficient to conduct the toxicity testing.

A total of six events were monitored from the Dominguez Gap Pump Station site this season. Prior to this year, no more than three events have been captured during the wet season. As in previous years, early season events were not sufficient to cause stormwater discharges at this site due to the large capacity of the site for infiltration. The first event at this location did not occur until late December 2004 (Table 6.1).

Grab samples were not collected during the first monitored storm event October 17, 2004 (Table 6.1) at the Bouton Creek and Los Cerritos Channel sites. This event was forecasted as a marginal event that was to yield 0.20 to 0.25 inches of rainfall. The actual rainfall was four to five times the forecast and generally fell during a short period of time between 00:00 and 02:00 hours in the morning. Field crews were not mobilized for grab sampling due to the marginal nature of the storm and flow levels dropped off rapidly after the conclusion of the rain event. In the case of Bouton Creek, reverse tidal flows were evident by mid-morning.

Grab samples were also not collected during the fourth monitored storm event December 6, 2004 (Table 6.1) at the Bouton Creek site. The field crew was not mobilized for grab sampling for this event when the original forecast for this event was being continually downgraded and the bacteriological laboratory provided notification that they were not ready to receive samples.

The results of the chemical analysis of these composite and grab stormwater samples are summarized in Tables 6.2 through 6.6. Toxicity results for the composite samples and the receiving water samples from these monitored events are given in Section 7 below.

6.2 Wet Weather Load Calculations

Estimates of total pollutant loads associated with stormwater runoff during each storm event are provided in Tables 6.7 through 6.11. Load calculations were made by multiplying the measured concentration times the total stormwater discharge along with the appropriate unit conversion factors. 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 site

$$(940 \text{ mg/L}) \times [(4196 \text{ kcf})(28317 \text{ L/kcf})] \times (1 \text{ pound}/453592 \text{ mg}) = 246{,}232 \text{ pounds}$$

Among the four mass emission sites, the Los Cerritos Channel consistently results in the highest overall loads of solids and total metals. Estimates of solids discharged at the Los Cerritos Channel 10 monitored events ranged from 8,822 to 647,365 pounds. Estimates of total copper ranged from 40 to 72 pounds for the four events that included all analytes. In contrast, the Belmont Pump Station was estimated to discharge between 401 and 15,688 pounds of solids in association with 12 events. The load of total copper discharged from the Belmont Pump Station during the four fully monitored events ranged from 1 to 3 pounds.

Loading estimates for solids from the Dominguez Gap Pump Station were 6 to 68 times lower than those from the Los Cerritos Channel during the three storms when both sites were monitored. Estimated loads of total recoverable metals such as copper and lead discharged from the Dominguez Gap Pump Station were 30 to 50 times lower than the load measured in runoff from the Los Cerritos Channel. The drainage area for the Dominguez Gap Pump station is approximately 42% of the drainage area for the Los Cerritos Channel site.

6.3 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 12 dry weather surveys have now been conducted since issuance of the permit in 1999 (Table 6.12). Events 11 and 12 conducted during the 2004/2005 season are shaded. Field measurements are provided in Table 6.13 for the 2004/2005 season. Chemical analyses performed in the laboratory are summarized in Table 6.14 for the 2004/2005 season.

6.3.1 Basin 14: Dominguez Gap Monitoring Site

Inspections for dry weather flow were conducted at the Dominguez Gap Pump Station on August 30, 2004 and on May 23, 2005. No dry weather flow was observed on either occasion.

6.3.2 Basin 20: Bouton Creek Monitoring Site

Bouton Creek was sampled 2-3 hours after the low tide on August 31, 2004 from 08:05 to 08:20 a.m. and on May 25, 2005 from 09:10 to 09:30 a.m. At these times, flow in the creek was not impeded by seawater backing into the creek. This assured that the flow was fresh water flowing downstream and that the saline tidal water did not commingle with the dry weather discharge of fresh water.

Continuous sampling over a period of 15 minutes was performed to collect water from the Creek when the effects of residual salinity in the channel were minimized. Samples were collected from the creek and deposited into two 20-liter borosilicate glass bottles using the pump on the automatic sampler operating in manual mode. Grab samples for TPH and bacteria were collected near the beginning of the pumped sampling on August 31, 2004 at 08:00 and on May 25, 2005 at 09:15.

6.3.3 Basin 23: Belmont Pump Station Monitoring Site

Time-weighted composite sampling was conducted over a 24-hour period starting on August 30, 2004 and ending on August 31, 2004. Samples were collected from the sump using the automated sampler installed inside of the pump house. Samples were collected into 20-liter borosilicate bottles. Every half-hour for 24 hours, an aliquot of approximately 0.75 liters of water was pumped from the sump into a 20-liter bottle. The bottles were changed every 12 hours and chilled to 4°C with ice during sampling and transportation. Following completion of the sampling, the bottles of water were combined into a composite. Upon completion of the 24-hour sampling, on August 31, 2004 at 11:00 a.m., grab samples for TPH and bacteria were manually collected from the sump.

Time-weighted composite sampling was again conducted over a 24-hour period starting on May 24, 2005 and ending on May 25, 2005. At the end of the 24-hour period, on May 25, 2005 at 10:50 a.m., grab samples for TPH and bacteria were manually collected from the sump.

6.3.4 Portions of Basins 18, 19, 27 and 29: Los Cerritos Channel Monitoring Site

Time-weighted sampling of the water flowing down the channel was conducted over a 24-hour period. Sampling began on August 30, 2004 and ended on August 31, 2004. A separate sampling event began on May 24, 2005 and ended on May 25, 2005.

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 that is used for sampling stormwater was extended an additional 33-38 feet to reach the low flow channel. Every half-hour for 24 hours, an aliquot of approximately 0.75 liters of water was pumped into a 20-liter bottle. The bottles were changed every 12 hours and chilled to 4°C with ice during sampling and transportation. Following completion of the sampling, the bottles of water were combined into a composite sample. Grab samples were manually collected for TPH and bacteria at the end of the 24-hour sampling on August 31, 2004 at 9:40 am and at the end of the 24-hour sampling on May 25, 2005 at 8:05 am.

Table 6.1 Monitored Storm Events, 2004/2005.

Global Event	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7
Dates	17-Oct-04	20-Oct-04	27-Oct-04	6-Dec-04	29-Dec-04	31-Dec-04	4-Jan-05
Belmont Pump		S-1	S-2	S-3	S-4	S-5	S-6
Bouton Creek	S-1	S-2	S-3	S-4	S-5	S-6	S-7
Los Cerritos Channel	S-1	S-2	S-3	S-4	S-5	S-6	
Dominguez Gap					S-1		S-2

Global Event	Event 8	Event 9	Event 10	Event 11	Event 12	Event 13	Event 14
Dates	7-Jan-05	10-Jan-05	11-Jan-05	28-Jan-05	13-Feb-05	21-Feb-05	23-Mar-05
Belmont Pump		S-7	S-8	S-9	S-10	S-11	S-12
Bouton Creek		S-8	S-9	S-10		S-11	S-12
Los Cerritos Channel		S-7	S-8	S-9	S-10		
Dominguez Gap	S-3	S-4			S-5	S-6	

Shading indicates TSS sampling event only

Table 6.2 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Bouton Creek Station

Chemical Category	Analyte Name	17-Oct-04	20-Oct-04	27-Oct-04	6-Dec-04
Conventionals	Alkalinity as CaCO3	38	16	11	22
(mg/L unless noted)	pH (pH Units)	**6.13**[2]	8.02	**6.38**[2]	7.24
	Biochemical Oxygen Demand	82	7.2	7.8J+	6.2
	Chemical Oxygen Demand	360	39	22	51
	Chloride	74	7.4	6	16
	Fluoride	0.29	0.16	0.13	0.23
	Hardness as CaCO3	98	15	12	21
	MBAS	**0.61**[2]	0.098	0.033	0.25
	Total Ammonia (as N)	2.2	0.19	0.1U	0.38
	Total Kjeldahl Nitrogen	10	0.98	0.71	1.4
	Nitrate (as N)	4.2	0.36	0.21	0.47
	Nitrite (as N)	0.1U	0.1U	0.1U	0.1U
	Oil and Grease	-	5U	5U	-
	Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U
	Total Phosphorus	2.4	0.52	0.4	0.36
	Total Orthophosphate (as P)	0.51	0.29	0.22	0.23
	Conductivity (umhos/cm)	280	76	65	110
	Total Dissolved Solids	360	12	29	100
	Total Suspended Solids	570	53	48	29
	Total Volatile Solids	290	36	33	14
	Total Organic Carbon	89	12	7.9	14
	Turbidity (NTU)	72	41	41	32
Dissolved Metals	Aluminum	120	56J	47J	37J
(ug/L)	Arsenic	2.5J-	1.1J-	1.1J-	1.1
	Cadmium	0.18J	0.25U	0.25U	0.25U
	Chromium	0.39J	0.24J	0.5	1.5
	Copper	**14**[5,6]	**5.5**[5,6]	**3.1**[5]	**8.3**[5,6]
	Iron	490	100	130	75
	Lead	**5.0**[5]	**1.2**[5]	**0.64**[5]	**1.2**[5]
	Nickel	5.9	1U	0.66J	3.2
	Selenium	1U	1U	1U	0.34J
	Silver	0.25U	0.25U	0.25U	0.25U
	Zinc	**240**[5,6]	**42**[5]	16	**45**[5]
Total Metals	Aluminum	**12000J**[2]	**1500**[2]	**1900**[2]	650
(ug/L)	Arsenic	7.4	1.3	2.4	1.8
	Cadmium	3.3	0.35	0.24J	0.21J
	Chromium	27	2.7	3	20
	Copper	**180**[1]	**13**[1]	9.3	**16**[1]
	Iron	23000	3300	2600	1100
	Lead	**100**[1]	**9.8**[1]	**11**[1]	**9**[1]
	Nickel	**32**[1]	3.1	2.7	10
	Selenium	0.26J	1U	1U	0.12J
	Silver	2.2	0.25U	0.25U	0.12J
	Zinc	**1800**[1]	**93**[1]	65	**100**[1]

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate.

Table 6.2 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Bouton Creek Station (continued)

Chemical Category	Analyte Name	17-Oct-04	20-Oct-04	27-Oct-04	6-Dec-04
Bacteria	Total Coliform	-	**1600000** [1 2]	**300000** [1 2]	-
(MPN/100 ml)	Enterococcus	-	**70000** [2]	**72000** [2]	-
	Fecal Coliform	-	**110000** [1 2]	**30000** [1 2]	-
Aroclors	Aroclor 1016	0.5U	0.5U	0.5U	0.5U
(ug/L)	Aroclor 1221	0.5U	0.5U	0.5U	0.5U
	Aroclor 1232	0.5U	0.5U	0.5U	0.5U
	Aroclor 1242	0.5U	0.5U	0.5U	0.5U
	Aroclor 1248	0.5U	0.5U	0.5U	0.5U
	Aroclor 1254	0.5U	0.5U	0.5U	0.5U
	Aroclor 1260	0.5U	0.5U	0.5U	0.5U
Chlorinated Pesticides	4,4'-DDD	0.025U	0.05U	0.05U	0.05U
(ug/L)	4,4'-DDE	0.025U	0.05U	0.05U	0.05U
	4,4'-DDT	0.025U	0.01U	0.01U	0.01U
	Aldrin	0.025U	0.005U	0.005U	0.008U
	Dieldrin	0.025U	0.01U	0.01U	0.01U
	Endrin	0.025U	0.01U	0.01U	0.01U
	Endrin aldehyde	0.025UJ	0.01U	0.01U	0.01U
	Endrin ketone	0.025U	0.01U	0.01U	0.01U
	alpha-BHC	0.025U	0.01U	0.01U	0.01U
	beta-BHC	0.025U	0.005U	0.005U	0.043Y
	delta-BHC	0.025U	0.005U	0.005U	0.008U
	gamma-BHC (Lindane)	0.025U	0.02U	0.02U	0.02U
	Endosulfan I	0.025U	0.02U	0.02U	0.02U
	Endosulfan II	0.025U	0.01U	0.01U	0.01U
	Endosulfan sulfate	0.025U	0.05U	0.05U	0.05U
	alpha-Chlordane	0.025U	0.1U	0.1U	0.1U
	gamma-Chlordane	0.025U	0.1U	0.1U	0.1U
	Heptachlor	0.025U	0.01U	0.01U	0.01U
	Heptachlor epoxide	0.025U	0.01U	0.01U	0.01U
	Methoxychlor	0.025U	0.01U	0.01U	0.01U
	Toxaphene	0.5U	0.5U	0.5U	0.5U
Organophosphates	Atrazine	2U	2U	2U	2U
(ug/L)	Chlorpyrifos	0.026J	0.05U	0.05U	0.05U
	Cyanazine	2U	2U	2U	2U
	Diazinon	0.05U	0.05U	0.05U	0.05U
	Malathion	1U	0.085J	1U	1U
	Prometryn	2U	2U	2U	2U
	Simazine	2U	0.12J	2U	2U

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate.

Table 6.3 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Belmont Pump Station

Chemical Category	Analyte Name	20-Oct-04	27-Oct-04	29-Dec-04	23-Mar-05
Conventionals	Alkalinity as CaCO3	17	13	33	22
(mg/L unless noted)	pH (pH Units)	**6.47** [2]	7.22	7.02	8.02
	Biochemical Oxygen Demand	9.3	17J+	14	10
	Chemical Oxygen Demand	44	30	88	74
	Chloride	10	11	11	16
	Fluoride	0.15	0.16	0.21	0.1U
	Hardness as CaCO3	17	15	19	25
	MBAS	0.13	0.081	0.086U	0.12
	Total Ammonia (as N)	0.17	0.10	0.26	0.19
	Total Kjeldahl Nitrogen	1.2	1.0	1.5	1.6J+
	Nitrate (as N)	0.47	0.34	0.33	0.90
	Nitrite (as N)	0.1U	0.1U	0.1U	0.1U
	Oil and Grease	5U	7.4	5U	5U
	Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U
	Total Phosphorus	0.52	0.41	0.63	0.48
	Total Orthophosphate (as P)	0.36	0.35	0.25	0.18
	Conductivity (umhos/cm)	93	90	83	130
	Total Dissolved Solids	41	23	29	64
	Total Suspended Solids	37	44	130	83
	Total Volatile Solids	35	29	46	13
	Total Organic Carbon	9.5	7.8	10	9.5
	Turbidity (NTU)	18	19	49	50
Dissolved Metals	Aluminum	24J	11J	15J	29J
(ug/L)	Arsenic	1.2J-	1J-	1.2	3.5
	Cadmium	0.1J	0.25U	0.056J	0.074J
	Chromium	0.49J	0.64	0.43J	1.4J+
	Copper	**8.6** [5,6]	**6.1** [5,6]	**6.8** [5,6]	**10** [5,6]
	Iron	59	44	53	44U
	Lead	**0.77** [5]	**0.63** [5]	**0.92** [5]	**1.4** [5]
	Nickel	1.0U	1.5	1.3	1.6J-
	Selenium	1.0U	0.1J	1.0U	1.0U
	Silver	0.25U	0.25U	0.075J	0.2U
	Zinc	**54** [5]	**31** [5]	**38** [5]	**60J+** [5]
Total Metals	Aluminum	910	980	**3700** [2]	**1400** [2]
(ug/L)	Arsenic	2.1	2.1	3.1	6.6
	Cadmium	0.55	0.38	1.1	0.49
	Chromium	2.5	2.5	9.9	4.3
	Copper	**21** [1]	**17** [1]	**49** [1]	**34** [1]
	Iron	2100	1200	3900	3100
	Lead	**15** [1]	**15** [1]	**60** [1]	**22** [1]
	Nickel	4.3	3.0	8.4	4.9
	Selenium	0.18J	1.0U	0.19J	1.0U
	Silver	0.25U	0.25U	0.19J	0.041J
	Zinc	**130** [1]	**110** [1]	**380** [1]	**190** [1]

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate.

Table 6.3 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Belmont Pump Station (continued)

Chemical Category	Analyte Name	20-Oct-04	27-Oct-04	29-Dec-04	23-Mar-05
Bacteria	Total Coliform	**300000** [1,2]	**240000** [1,2]	**240000** [1,2]	**90000** [1,2]
(MPN/100 ml)	Enterococcus	**72000** [2]	**73000** [2]	**51000** [2]	**36000** [2]
	Fecal Coliform	**30000** [1,2]	**50000** [1,2]	**11000** [1,2]	**11000** [1,2]
Aroclors	Aroclor 1016	0.5U	0.5U	0.5U	0.5U
(ug/L)	Aroclor 1221	0.5U	0.5U	0.5U	0.5U
	Aroclor 1232	0.5U	0.5U	0.5U	0.5U
	Aroclor 1242	0.5U	0.5U	0.5U	0.5U
	Aroclor 1248	0.5U	0.5U	0.5U	0.5U
	Aroclor 1254	0.5U	0.5U	0.5U	0.5U
	Aroclor 1260	0.5U	0.5U	0.5U	0.5U
Chlorinated Pesticides	4,4'-DDD	0.05U	0.05U	0.05U	0.01U
(ug/L)	4,4'-DDE	0.05U	0.05U	0.016J	0.01U
	4,4'-DDT	0.01U	**0.029** [5,6]	0.02U	0.01U
	Aldrin	0.005U	0.005U	0.007U	0.01U
	Dieldrin	0.01U	0.01U	0.01U	0.01U
	Endrin	0.01U	0.01U	0.01U	0.01U
	Endrin aldehyde	0.01U	0.01U	0.01U	0.01U
	Endrin ketone	0.01U	0.01U	0.01U	0.01U
	alpha-BHC	0.01U	0.01U	0.01U	0.01U
	beta-BHC	0.005U	0.005U	0.006U	0.01U
	delta-BHC	0.005U	0.005U	0.005U	0.01U
	gamma-BHC (Lindane)	0.02U	0.02U	0.02U	0.01U
	Endosulfan I	0.02U	0.02U	0.02U	0.01U
	Endosulfan II	0.05U	0.01U	0.01U	0.01U
	Endosulfan sulfate	0.05U	0.05U	0.05U	0.01U
	alpha-Chlordane	0.1U	0.1U	0.023J	0.01U
	gamma-Chlordane	0.1U	0.1U	0.1U	0.01U
	Heptachlor	0.01U	0.01U	0.01U	0.01U
	Heptachlor epoxide	0.01U	0.01U	0.01U	0.01U
	Methoxychlor	0.01U	0.01U	0.01U	0.01U
	Toxaphene	0.5U	0.5U	0.5U	0.5U
Organophosphates	Atrazine	2U	2U	2U	2U
(ug/L)	Chlorpyrifos	0.05U	0.05U	0.05U	0.05U
	Cyanazine	2U	2U	2U	2U
	Diazinon	**0.28Y** [3]	**0.19Y** [3]	0.05U	0.05U
	Malathion	0.16J	0.31J	0.16J	0.41J
	Prometryn	2U	2U	2U	2U
	Simazine	2U	2U	2U	2U

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate, Y=difference between columns exceeds 40%, value is considered an estimate.

Table 6.4 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Los Cerritos Channel

Chemical Category	Analyte Name	17-Oct-04	20-Oct-04	27-Oct-04	29-Dec-04
Conventionals	Alkalinity as CaCO3	58	21	13	43
(mg/L unless noted)	pH (pH Units)	7.07	6.8	7.02	7.02
	Biochemical Oxygen Demand	120	7.4	23J+	8.9
	Chemical Oxygen Demand	380	59	64	76
	Chloride	19	4.6	2.9	4.4
	Fluoride	0.5	0.16	0.16	0.16
	Hardness as CaCO3	100	21	16	29
	MBAS	**0.88** [2]	0.025U	0.025U	0.04
	Total Ammonia (as N)	**2.5** [1]	0.19	0.12	0.26
	Total Kjeldahl Nitrogen	12	1.3	0.9	1.5
	Nitrate (as N)	3.3	0.44	0.26	0.28
	Nitrite (as N)	0.1U	0.1U	0.1U	0.1U
	Oil and Grease	-	5U	5U	5U
	Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U
	Total Phosphorus	5.9	0.59	0.53	0.72
	Total Orthophosphate (as P)	0.46	0.23	0.17	0.18
	Conductivity (umhos/cm)	360	77	57	64
	Total Dissolved Solids	240	44	15	52
	Total Suspended Solids	940	130	170	350
	Total Volatile Solids	350	80	44	61
	Total Organic Carbon	76	10	11	8.2
	Turbidity (NTU)	200	120	140	190
Dissolved Metals	Aluminum	46	130	110	99J
(ug/L)	Arsenic	4.6J-	1.4J-	1.2J-	1.3
	Cadmium	0.25U	0.12J	0.25U	0.057J
	Chromium	0.53	0.75	0.76	0.65
	Copper	**12** [5,6]	**5.7** [5,6]	**3.5** [5,6]	**3.9** [5,6]
	Iron	940	550	540	650
	Lead	**3.3** [5]	**0.65** [5]	0.4J	0.32J
	Nickel	6.5	0.59J	0.9J	0.94J
	Selenium	1U	1U	1U	0.21J
	Silver	0.25U	0.25U	0.25U	0.055J
	Zinc	**130** [5,6]	**32** [5]	11	9.8
***Total Metal**s*	Aluminum	**23000J** [2]	**5600** [2]	**6500** [2]	**12000** [2]
(ug/L)	Arsenic	16	4.8	4.1	5.3
	Cadmium	**8.3** [1,2]	1.2	0.8	1.2
	Chromium	**51** [2]	9.9	9.9	21
	Copper	**240** [1]	**27** [1]	**22** [1]	**39** [1]
	Iron	56000	11000	8700	14000
	Lead	**210** [1]	**26** [1]	**28** [1]	**55** [1]
	Nickel	**61** [1]	9.6	8.4	15
	Selenium	0.3J	1U	1U	0.37J
	Silver	0.82	0.25U	0.1J	0.21J
	Zinc	**2600** [1]	**240** [1]	**180** [1]	**360** [1]

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate.

Table 6.4 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Los Cerritos Channel (continued)

Chemical Category	Analyte Name	17-Oct-04	20-Oct-04	27-Oct-04	29-Dec-04
Bacteria	Total Coliform	-	**900000** [1,2]	**1600000** [1,2]	**240000** [1,2]
(MPN/100 ml)	Enterococcus	-	**94000** [2]	**70000** [2]	**39000** [2]
	Fecal Coliform	-	**70000** [1,2]	**110000** [1,2]	**22000** [1,2]
Aroclors	Aroclor 1016	1U	0.5U	0.5U	0.5U
(ug/L)	Aroclor 1221	1U	0.5U	0.5U	0.5U
	Aroclor 1232	1U	0.5U	0.5U	0.5U
	Aroclor 1242	1U	0.5U	0.5U	0.5U
	Aroclor 1248	1U	0.5U	0.5U	0.5U
	Aroclor 1254	1U	0.5U	0.5U	0.5U
	Aroclor 1260	1U	0.5U	0.5U	0.5U
Chlorinated Pesticides	4,4'-DDD	0.05U	0.05U	0.05U	0.05U
(ug/L)	4,4'-DDE	0.05U	0.05U	0.05U	0.05U
	4,4'-DDT	0.05U	0.01U	0.01U	0.02U
	Aldrin	0.05U	0.005U	0.005U	0.007U
	Dieldrin	0.05U	0.01U	0.01U	0.01U
	Endrin	0.05U	0.01U	0.01U	0.01U
	Endrin aldehyde	0.05UJ	0.01U	0.01U	0.01U
	Endrin ketone	0.05U	0.01U	0.01U	0.01U
	alpha-BHC	0.05U	0.01U	0.01U	0.01U
	beta-BHC	0.05U	0.012	0.005U	0.006U
	delta-BHC	0.05U	0.005U	0.005U	0.005U
	gamma-BHC (Lindane)	0.05U	0.02U	0.02U	0.02U
	Endosulfan I	0.05U	0.02U	0.02U	0.02U
	Endosulfan II	0.05U	0.01U	0.01U	0.01U
	Endosulfan sulfate	0.05U	0.05U	0.05U	0.05U
	alpha-Chlordane	0.05U	0.1U	0.1U	0.1U
	gamma-Chlordane	0.05U	0.1U	0.1U	0.1U
	Heptachlor	0.05U	0.01U	0.01U	0.01U
	Heptachlor epoxide	0.05U	0.01U	0.01U	0.01U
	Methoxychlor	0.05U	0.01U	0.01U	0.01U
	Toxaphene	1U	0.5U	0.5U	0.5U
Organophosphates	Atrazine	2U	2U	2U	2U
(ug/L)	Chlorpyrifos	**0.06J** [3,4]	**0.55** [3,4]	0.05U	0.05U
	Cyanazine	2U	2U	2U	2U
	Diazinon	**0.66J** [3]	0.1U	0.05U	**0.2Y** [3]
	Malathion	0.93J	0.18J	0.2J	0.084J
	Prometryn	2U	2U	2U	2U
	Simazine	2U	2U	2U	0.85J

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate.

Table 6.5 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Dominguez Pump Station

Chemical Category	Analyte Name	29-Dec-04	4-Jan-05	7-Jan-05	10-Jan-05
Conventionals	Alkalinity as CaCO3	27	13	16	23
(mg/L unless noted)	pH (pH Units)	7.71	**6.47** [2]	6.5	**6.4** [2]
	Biochemical Oxygen Demand	7.4	4.7J+	6.1J	5.0J
	Chemical Oxygen Demand	43	29	42	39
	Chloride	5.2	1.8	4.2	4.2
	Fluoride	0.15	0.1U	0.1U	0.1U
	Hardness as CaCO3	16	13	15	20
	MBAS	0.04U	0.082	0.041	0.037
	Total Ammonia (as N)	0.18	0.16	0.2	0.13
	Total Kjeldahl Nitrogen	1.3	1.1	1.7	1.4
	Nitrate (as N)	0.34	0.33	0.61J	0.44J
	Nitrite (as N)	0.1U	0.1U	0.1UJ	0.1U
	Oil and Grease	5U	5U	5U	5U
	Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U
	Total Phosphorus	0.6	0.44	0.5J	0.75J
	Total Orthophosphate (as P)	0.38	0.29	0.29	0.30
	Specific Conductance (umhos/cm)	63	50	55	68
	Total Dissolved Solids	40	49	150	62
	Total Suspended Solids	100	54	89	78
	Total Volatile Solids	17	18	22	19
	Total Organic Carbon	8.9	8.1	5.7	7.5
	Turbidity (NTU)	93	67	64J	61J
Dissolved Metals	Aluminum	63J	84J	74J	72J
(ug/L)	Arsenic	1.6	1.1	1.4	1.7
	Cadmium	0.039J	0.038J	0.027J	0.038J
	Chromium	0.26J	0.61	0.71	0.77
	Copper	**3.4** [5,6]	**3.4** [5,6]	**3.1** [5]	**4.1** [5,6]
	Iron	260	110	230	180
	Lead	**0.57** [5]	0.43J	0.44J	0.48J
	Nickel	0.84J	0.4J	0.48J	0.79J
	Selenium	0.23J	0.18J	0.28J	0.25J
	Silver	0.10J	0.03J	0.25UJ	0.25UJ
	Zinc	11	16	17	19
Total Metals	Aluminum	**5300** [2]	**2800** [2]	**4600** [2]	**4400** [2]
(ug/L)	Arsenic	3.7	3.2	3.6	3.6
	Cadmium	0.40	0.26	0.57	0.43
	Chromium	8.8	5.8	10	9.3
	Copper	**17** [1]	12	**30** [1]	**22** [1]
	Iron	6000	3300	4500	4000
	Lead	**24** [1]	**14** [1]	**31** [1]	**25** [1]
	Nickel	6.4	4.4	7.5	6.2
	Selenium	0.12J	0.18J	0.33J	0.17J
	Silver	0.14J	0.056J	0.11J	0.08J
	Zinc	**120** [1]	**83** [1]	**170** [1]	**130** [1]

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate.

Table 6.5 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, Dominguez Pump Station (continued)

Chemical Category	Analyte Name	29-Dec-04	4-Jan-05	7-Jan-05	10-Jan-05
Bacteria	Total Coliform	**110000** [1,2]	**35000** [1,2]	**240000** [1,2]	**22000** [1,2]
(MPN/100 ml)	Enterococcus	**50000** [2]	**9300** [2]	**43000** [2]	**14900** [2]
	Fecal Coliform	**13000** [1,2]	**5000** [1,2]	**14000** [1,2]	**5000** [1,2]
Aroclors	Aroclor 1016	0.5U	0.5U	0.5U	0.5U
(ug/L)	Aroclor 1221	0.5U	0.5U	0.5U	0.5U
	Aroclor 1232	0.5U	0.5U	0.5U	0.5U
	Aroclor 1242	0.5U	0.5U	0.5U	0.5U
	Aroclor 1248	0.5U	0.5U	0.5U	0.5U
	Aroclor 1254	0.5U	0.5U	0.5U	0.5U
	Aroclor 1260	0.5U	0.5U	0.5U	0.5U
Chlorinated Pesticides	4,4'-DDD	0.05U	0.05U	0.05U	0.05U
(ug/L)	4,4'-DDE	0.05UU	0.05U	0.05U	0.05U
	4,4'-DDT	0.02U	0.02U	0.02U	0.02U
	Aldrin	0.007U	0.007U	0.007U	0.007U
	Dieldrin	0.01U	0.01U	0.01U	0.01U
	Endrin	0.01U	0.01U	0.01U	0.01U
	Endrin aldehyde	0.01U	0.01U	0.01U	0.01U
	Endrin ketone	0.01U	0.01U	0.01U	0.01U
	alpha-BHC	0.01U	0.01U	0.01U	0.01U
	beta-BHC	0.006U	0.006U	0.006U	0.006U
	delta-BHC	0.005U	0.005U	0.005U	0.005U
	gamma-BHC (Lindane)	0.02U	0.02U	0.02U	0.02U
	Endosulfan I	0.02U	0.02U	0.02U	0.02U
	Endosulfan II	0.01U	0.01U	0.01U	0.01U
	Endosulfan sulfate	0.05U	0.05U	0.05U	0.05U
	alpha-Chlordane	0.1U	0.1U	0.0071J	0.0055J
	gamma-Chlordane	0.1U	0.1U	0.1U	0.1U
	Heptachlor	0.01U	0.01U	0.01U	0.01U
	Heptachlor epoxide	0.01U	0.01U	0.01U	0.01U
	Methoxychlor	0.01U	0.01U	0.01U	0.01U
	Toxaphene	0.5U	0.5U	0.5U	0.5U
Organophosphates	Atrazine	2U	2U	2U	2U
(ug/L)	Chlorpyrifos	0.05U	0.05U	0.05U	0.05U
	Cyanazine	2U	2U	2U	2U
	Diazinon	0.05U	0.05U	0.05U	0.05U
	Malathion	0.12J	1U	1U	1U
	Prometryn	2U	2U	2U	2U
	Simazine	0.7J	2U	2U	2U

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate.

Table 6.6 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project 2004/2005, TSS Events

Storm Event	TSS (mg/L)			
	Belmont Pump	Bouton Creek	Dominguez Gap	Los Cerritos Channel
06-Dec-2004	110	-	-	69
29-Dec-2004	-	130	-	-
31-Dec-2004	80	110	-	210
04-Jan-2005	60	39	-	-
10-Jan-2005	43	90	-	86
11-Jan-2005	33	25	-	220
28-Jan-2005	104	76	-	148
13-Feb-2005	55	-	32	150
21-Feb-2005	69	101	75	-
23-Mar-2005	-	79	-	-

Table 6.7 Load Calculations (pounds) for Each Storm Event at Bouton Creek.

Chemical Category	Analyte Name	17-Oct-04	20-Oct-04	27-Oct-04	06-Dec-04
Conventionals	Alkalinity as CaCO3	4562	4694	3602	1089
	BOD	9844	2112	2554	307
	Chemical Oxygen Demand	43218	11441	7204	2525
	Chloride	8884	2171	1965	792
	Fluoride	35	47	43	11
	Hardness as CaCO3	11765	4400	3929	1040
	MBAS	73	29	11	12
	Total Ammonia (as N)	264	56	ND	19
	Total Kjeldahl Nitrogen	1200	287	232	69
	Nitrate (as N)	504	106	69	23
	Nitrite (as N)	ND	ND	ND	ND
	Oil and Grease	-	ND	ND	-
	Total Recoverable Phenolics	ND	ND	ND	ND
	Total Phosphorus	288	153	131	18
	Total Orthophosphate (as P)	61	85	72	11
	Total Dissolved Solids	43218	3520	9496	4951
	Total Suspended Solids	68428	15547	15717	1436
	Total Volatile Solids	34814	10561	10805	693
	Total Organic Carbon	10684	3520	2587	693
Dissolved Metals	Aluminum	14	16	15	2
	Arsenic	0.3	0.3	0.4	0.1
	Cadmium	0.0	ND	ND	ND
	Chromium	0.0	0.1	0.2	0.1
	Copper	1.7	1.6	1.0	0.4
	Iron	59	29	43	4
	Lead	0.6	0.4	0.2	0.1
	Nickel	0.7	ND	0.2	0.2
	Selenium	ND	ND	ND	ND
	Silver	ND	ND	ND	ND
	Zinc	29	12	5	2
Total Metals	Aluminum	1441	440	622	32
	Arsenic	0.9	0.4	0.8	0.1
	Cadmium	0.4	0.1	0.1	0.0
	Chromium	3.2	0.8	1.0	1.0
	Copper	22	4	3	1
	Iron	2761	968	851	54
	Lead	12.0	2.9	3.6	0.4
	Nickel	3.8	0.9	0.9	0.5
	Selenium	0.0	ND	ND	0.0
	Silver	0.3	ND	ND	0.0
	Zinc	216	27	21	5

Notes:
ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.
A "0.0" or "0.00" indicates the calculated load was less than 0.005 pounds.

Table 6.7 Load Calculations (pounds) for Each Storm Event at Bouton Creek. (continued)

Chemical Category	Analyte Name	17-Oct-04	20-Oct-04	27-Oct-04	06-Dec-04
Aroclors	Aroclor 1016	ND	ND	ND	ND
	Aroclor 1221	ND	ND	ND	ND
	Aroclor 1232	ND	ND	ND	ND
	Aroclor 1242	ND	ND	ND	ND
	Aroclor 1248	ND	ND	ND	ND
	Aroclor 1254	ND	ND	ND	ND
	Aroclor 1260	ND	ND	ND	ND
Chlorinated Pesticides	4,4'-DDD	ND	ND	ND	ND
	4,4'-DDE	ND	ND	ND	ND
	4,4'-DDT	ND	ND	ND	ND
	Aldrin	ND	ND	ND	ND
	Dieldrin	ND	ND	ND	ND
	Endrin	ND	ND	ND	ND
	Endrin aldehyde	0.00	ND	ND	ND
	Endrin ketone	ND	ND	ND	ND
	alpha-BHC	ND	ND	ND	ND
	beta-BHC	ND	ND	ND	0.00
	delta-BHC	ND	ND	ND	ND
	gamma-BHC (Lindane)	ND	ND	ND	ND
	Endosulfan I	ND	ND	ND	ND
	Endosulfan II	ND	ND	ND	ND
	Endosulfan sulfate	ND	ND	ND	ND
	alpha-Chlordane	ND	ND	ND	ND
	gamma-Chlordane	ND	ND	ND	ND
	Heptachlor	ND	ND	ND	ND
	Heptachlor epoxide	ND	ND	ND	ND
	Methoxychlor	ND	ND	ND	ND
	Toxaphene	ND	ND	ND	ND
Organophosphates	Atrazine	ND	ND	ND	ND
	Chlorpyrifos	0.00	ND	ND	ND
	Cyanazine	ND	ND	ND	ND
	Diazinon	ND	ND	ND	ND
	Malathion	ND	0.02	ND	ND
	Prometryn	ND	ND	ND	ND
	Simazine	ND	0.04	ND	ND

Notes:
ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.
A “0.0” or “0.00” indicates the calculated load was less than 0.005 pounds.

Table 6.8 Load Calculations (pounds) for Each Storm Event at the Belmont Pump Station.

Chemical Category	Analyte Name	20-Oct-04	27-Oct-04	29-Dec-04	23-Mar-05
Conventionals	Alkalinity as CaCO3	1063	800	1751	376
	BOD	581	1046	743	171
	Chemical Oxygen Demand	2750	1846	4670	1266
	Chloride	625	677	584	274
	Fluoride	9	10	11	0
	Hardness as CaCO3	1063	923	1008	428
	MBAS	8	5	0	2
	Total Ammonia (as N)	11	6	14	3
	Total Kjeldahl Nitrogen	75	62	80	27
	Nitrate (as N)	29	21	18	15
	Nitrite (as N)	ND	ND	ND	ND
	Oil and Grease	ND	455	265	ND
	Total Recoverable Phenolics	ND	ND	ND	ND
	Total Phosphorus	33	25	33	8
	Total Orthophosphate (as P)	23	22	13	3
	Total Dissolved Solids	2563	1415	1539	1095
	Total Suspended Solids	2313	2707	6898	1420
	Total Volatile Solids	2188	1784	2441	222
	Total Organic Carbon	594	480	531	162
Dissolved Metals	Aluminum	2	1	1	0
	Arsenic	0.1	0.1	0.1	0.1
	Cadmium	0.0	ND	0.0	0.0
	Chromium	0.0	0.0	0.0	0.0
	Copper	0.5	0.4	0.4	0.2
	Iron	4	3	3	0
	Lead	0.0	0.0	0.0	0.0
	Nickel	ND	0.1	0.1	0.0
	Selenium	ND	0.0	ND	ND
	Silver	ND	ND	0.0	ND
	Zinc	3	2	2	1
Total Metals	Aluminum	57	60	196	24
	Arsenic	0.1	0.1	0.2	0.1
	Cadmium	0.0	0.0	0.1	0.0
	Chromium	0.2	0.2	0.5	0.1
	Copper	1	1	3	1
	Iron	131	74	207	53
	Lead	0.9	0.9	3.2	0.4
	Nickel	0.3	0.2	0.4	0.1
	Selenium	0.0	ND	0.0	ND
	Silver	ND	ND	0.0	0.0
	Zinc	8	7	20	3

Notes:
ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.
A “0.0” or “0.00” indicates the calculated load was less than 0.005 pounds.

Table 6.8 Load Calculations (pounds) for Each Storm Event at the Belmont Pump Station. (continued)

Chemical Category	Analyte Name	20-Oct-04	27-Oct-04	29-Dec-04	23-Mar-05
Aroclors	Aroclor 1016	ND	ND	ND	ND
	Aroclor 1221	ND	ND	ND	ND
	Aroclor 1232	ND	ND	ND	ND
	Aroclor 1242	ND	ND	ND	ND
	Aroclor 1248	ND	ND	ND	ND
	Aroclor 1254	ND	ND	ND	ND
	Aroclor 1260	ND	ND	ND	ND
Chlorinated Pesticides	4,4'-DDD	ND	ND	ND	ND
	4,4'-DDE	ND	ND	0.00	ND
	4,4'-DDT	ND	0.00	ND	ND
	Aldrin	ND	ND	ND	ND
	Dieldrin	ND	ND	ND	ND
	Endrin	ND	ND	ND	ND
	Endrin aldehyde	ND	ND	ND	ND
	Endrin ketone	ND	ND	ND	ND
	alpha-BHC	ND	ND	ND	ND
	beta-BHC	ND	ND	ND	ND
	delta-BHC	ND	ND	ND	ND
	gamma-BHC (Lindane)	ND	ND	ND	ND
	Endosulfan I	ND	ND	ND	ND
	Endosulfan II	ND	ND	ND	ND
	Endosulfan sulfate	ND	ND	ND	ND
	alpha-Chlordane	ND	ND	0.00	ND
	gamma-Chlordane	ND	ND	ND	ND
	Heptachlor	ND	ND	ND	ND
	Heptachlor epoxide	ND	ND	ND	ND
	Methoxychlor	ND	ND	ND	ND
	Toxaphene	ND	ND	ND	ND
Organophosphates	Atrazine	ND	ND	ND	ND
	Chlorpyrifos	ND	ND	ND	ND
	Cyanazine	ND	ND	ND	ND
	Diazinon	0.02	0.01	ND	ND
	Malathion	0.01	0.02	0.01	0.01
	Prometryn	ND	ND	ND	ND
	Simazine	ND	ND	ND	ND

Notes:
ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.
A “0.0” or “0.00” indicates the calculated load was less than 0.005 pounds.

Table 6.9 Load Calculations (pounds) for Each Storm Event at the Los Cerritos Channel Station.

Chemical Category	Analyte Name	17-Oct-04	20-Oct-04	27-Oct-04	29-Dec-04
Conventionals	Alkalinity as CaCO3	15193	51793	23894	79533
	BOD	31434	18251	42274	16462
	Chemical Oxygen Demand	99540	145514	117632	140571
	Chloride	4977	11345	5330	8138
	Fluoride	131	395	294	296
	Hardness as CaCO3	26195	51793	29408	53639
	MBAS	231	ND	ND	74
	Total Ammonia (as N)	655	469	221	481
	Total Kjeldahl Nitrogen	3143	3206	1654	2774
	Nitrate (as N)	864	1085	478	518
	Nitrite (as N)	ND	ND	ND	ND
	Oil and Grease	-	ND	ND	ND
	Total Recoverable Phenolics	ND	ND	ND	ND
	Total Phosphorus	1545	1455	974	1332
	Total Orthophosphate (as P)	120	567	312	333
	Total Dissolved Solids	62867	108519	27570	96180
	Total Suspended Solids	246231	320624	312461	647365
	Total Volatile Solids	91682	197307	80872	112827
	Total Organic Carbon	19908	24663	20218	15167
Dissolved Metals	Aluminum	12	321	202	183
	Arsenic	1.2	3.5	2.2	2.4
	Cadmium	ND	0.3	ND	0.1
	Chromium	0.1	1.8	1.4	1.2
	Copper	3.1	14.1	6.4	7.2
	Iron	246	1356	993	1202
	Lead	0.9	1.6	0.7	0.6
	Nickel	1.7	1.5	1.7	1.7
	Selenium	ND	ND	ND	0.4
	Silver	ND	ND	ND	0.1
	Zinc	34	79	20	18
Total Metals	Aluminum	6025	13812	11947	22195
	Arsenic	4.2	12	7.5	9.8
	Cadmium	2.2	3.0	1.5	2.2
	Chromium	13	24	18	39
	Copper	63	67	40	72
	Iron	14669	27130	15991	25895
	Lead	55	64	52	102
	Nickel	16.0	23.7	15	28
	Selenium	0.1	ND	ND	0.7
	Silver	0.2	ND	0.2	0.4
	Zinc	681	592	331	666

Notes:
ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.
A "0.0" or "0.00" indicates the calculated load was less than 0.005 pounds.

Table 6.9 Load Calculations (pounds) for Each Storm Event at the Los Cerritos Channel Station. (continued)

Chemical Category	Analyte Name	17-Oct-04	20-Oct-04	27-Oct-04	29-Dec-04
Aroclors	Aroclor 1016	ND	ND	ND	ND
	Aroclor 1221	ND	ND	ND	ND
	Aroclor 1232	ND	ND	ND	ND
	Aroclor 1242	ND	ND	ND	ND
	Aroclor 1248	ND	ND	ND	ND
	Aroclor 1254	ND	ND	ND	ND
	Aroclor 1260	ND	ND	ND	ND
Chlorinated Pesticides	4,4'-DDD	ND	ND	ND	ND
	4,4'-DDE	ND	ND	ND	ND
	4,4'-DDT	ND	ND	ND	ND
	Aldrin	ND	ND	ND	ND
	Dieldrin	ND	ND	ND	ND
	Endrin	ND	ND	ND	ND
	Endrin aldehyde	ND	ND	ND	ND
	Endrin ketone	ND	ND	ND	ND
	alpha-BHC	ND	ND	ND	ND
	beta-BHC	ND	0.03	ND	ND
	delta-BHC	ND	ND	ND	ND
	gamma-BHC (Lindane)	ND	ND	ND	ND
	Endosulfan I	ND	ND	ND	ND
	Endosulfan II	ND	ND	ND	ND
	Endosulfan sulfate	ND	ND	ND	ND
	alpha-Chlordane	ND	ND	ND	ND
	gamma-Chlordane	ND	ND	ND	ND
	Heptachlor	ND	ND	ND	ND
	Heptachlor epoxide	ND	ND	ND	ND
	Methoxychlor	ND	ND	ND	ND
	Toxaphene	ND	ND	ND	ND
Organophosphates	Atrazine	ND	ND	ND	ND
	Chlorpyrifos	0.02	1.36	ND	ND
	Cyanazine	ND	ND	ND	ND
	Diazinon	0.17	ND	ND	0.37
	Malathion	0.24	0.44	0.37	0.16
	Prometryn	ND	ND	ND	ND
	Simazine	ND	ND	ND	1.57

Notes:
ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.
A "0.0" or "0.00" indicates the calculated load was less than 0.005 pounds.

Table 6.10 Load Calculations (pounds) for Each Storm Event at the Dominguez Gap Pump Station.

Chemical Category	Analyte Name	29-Dec-04	4-Jan-05	7-Jan-05	10-Jan-05
Conventionals	Alkalinity as CaCO3	2554	1501	4103	13562
	BOD	700	543	1564	2948
	Chemical Oxygen Demand	4067	3349	10771	22996
	Chloride	492	208	1077	2476
	Fluoride	14	ND	ND	ND
	Hardness as CaCO3	1513	1501	3847	11793
	MBAS	ND	9	11	22
	Total Ammonia (as N)	17	18	51	77
	Total Kjeldahl Nitrogen	123	127	436	825
	Nitrate (as N)	32	38	156	259
	Nitrite (as N)	ND	ND	ND	ND
	Oil and Grease	ND	ND	ND	ND
	Total Recoverable Phenolics	ND	ND	ND	ND
	Total Phosphorus	57	51	128	442
	Total Orthophosphate (as P)	36	33	74	177
	Total Dissolved Solids	3783	5659	38468	36557
	Total Suspended Solids	9458	6237	22824	45991
	Total Volatile Solids	1608	2079	5642	11203
	Total Organic Carbon	842	935	1462	4422
Dissolved Metals	Aluminum	6	10	19	42
	Arsenic	0.2	0.1	0.4	1.0
	Cadmium	0.0	0.0	0.0	0.0
	Chromium	0.0	0.1	0.2	0.5
	Copper	0.3	0.4	0.8	2.4
	Iron	25	13	59	106
	Lead	0.1	0.0	0.1	0.3
	Nickel	0.1	0.0	0.1	0.5
	Selenium	0.0	0.0	0.1	0.1
	Silver	0.0	0.0	ND	ND
	Zinc	1	2	4	11
Total Metals	Aluminum	501	323	1180	26
	Arsenic	0.3	0.4	0.9	2.1
	Cadmium	0.0	0.0	0.1	0.3
	Chromium	0.8	0.7	2.6	5.5
	Copper	2	1	8	13
	Iron	567	381	1154	24
	Lead	2.3	1.6	8.0	14.7
	Nickel	0.6	0.5	1.9	3.7
	Selenium	0.0	0.0	0.1	0.1
	Silver	0.0	0.0	0.0	0.0
	Zinc	11	10	44	77

Notes:
ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.
A “0.0” or “0.00” indicates the calculated load was less than 0.005 pounds.

Table 6.10 Load Calculations (pounds) for Each Storm Event at the Dominguez Gap Pump Station. (continued)

Chemical Category	Analyte Name	29-Dec-04	4-Jan-05	7-Jan-05	10-Jan-05
Aroclors	Aroclor 1016	ND	ND	ND	ND
	Aroclor 1221	ND	ND	ND	ND
	Aroclor 1232	ND	ND	ND	ND
	Aroclor 1242	ND	ND	ND	ND
	Aroclor 1248	ND	ND	ND	ND
	Aroclor 1254	ND	ND	ND	ND
	Aroclor 1260	ND	ND	ND	ND
Chlorinated Pesticides	4,4'-DDD	ND	ND	ND	ND
	4,4'-DDE	ND	ND	ND	ND
	4,4'-DDT	ND	ND	ND	ND
	Aldrin	ND	ND	ND	ND
	Dieldrin	ND	ND	ND	ND
	Endrin	ND	ND	ND	ND
	Endrin aldehyde	ND	ND	ND	ND
	Endrin ketone	ND	ND	ND	ND
	alpha-BHC	ND	ND	ND	ND
	beta-BHC	ND	ND	ND	ND
	delta-BHC	ND	ND	ND	ND
	gamma-BHC (Lindane)	ND	ND	ND	ND
	Endosulfan I	ND	ND	ND	ND
	Endosulfan II	ND	ND	ND	ND
	Endosulfan sulfate	ND	ND	ND	ND
	alpha-Chlordane	ND	ND	0.00	0.00
	gamma-Chlordane	ND	ND	ND	ND
	Heptachlor	ND	ND	ND	ND
	Heptachlor epoxide	ND	ND	ND	ND
	Methoxychlor	ND	ND	ND	ND
	Toxaphene	ND	ND	ND	ND
Organophosphates	Atrazine	ND	ND	ND	ND
	Chlorpyrifos	ND	ND	ND	ND
	Cyanazine	ND	ND	ND	ND
	Diazinon	ND	ND	ND	ND
	Malathion	0.01	ND	ND	ND
	Prometryn	ND	ND	ND	ND
	Simazine	0.07	ND	ND	ND

Notes:
ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.
A “0.0” or “0.00” indicates the calculated load was less than 0.005 pounds.

Table 6.11 Load Calculations (pounds) for TSS Storm Events at Each Station.

Storm Events	TSS (Pounds)			
	Bouton Creek	Belmont Pump	Dominguez Gap Pump	Los Cerritos Channel
6-Dec-04	-	401	-	8822
29-Dec-04	24323	-	-	-
31-Dec-04	2286	1577	-	115092
4-Jan-05	9454	1587	-	-
10-Jan-05	68894	6088	-	300272
11-Jan-05	2887	659	-	36588
28-Jan-05	5416	1604	-	23172
13-Feb-05	-	4588	5362	298699
21-Feb-05	41425	15688	32475	-
23-Mar-05	13385	-	-	-

Table 6.12 Monitored Dry Weather Events, 1999-2005

MONITORING SITE	EVENT 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
Bouton Creek		X	X	X	X	X
Belmont Pump		X	X	X	X	X
Los Cerritos Channel				X	X	X
Dominguez Gap		X[1]	X[1]	X[1]	X[1]	X[1]
Alamitos Bay	X	X	X	X	X	X

MONITORING SITE	EVENT 7 9/5/02	8 5/20/03	9 9/ll/03	10 5/4/04	11 8/4/04	12 5/4/05
Bouton Creek	X	X	X	X	X	X
Belmont Pump	X	X	X	X	X	X
Los Cerritos Channel	X	X	X	X	X	X
Dominguez Gap	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]
Alamitos Bay						

1 Intake to basin was observed to be dry. Therefore, no samples were collected.
Shading indicates 2004/2005 Dry Weather Surveys included in this report.

Table 6.13 Field Measurements for Bouton Creek, Belmont Pump, and Los Cerritos Channel, Dry Weather Season (2004/2005).

	Bouton Creek		Belmont Pump		Los Cerritos	
Date	**8/31/04**	**5/25/05**	**8/31/04**	**5/25/05**	**8/31/04**	**5/25/05**
Time	**0806**	**0910**	**1040**	**1045**	**0945**	**0730**
Temperature (^{0}C)	21.7	21.1	22.5	20.4	26.5	19.8
pH (instream, composite)	8.33, 7.69	8.40, 8.22	8.79, 8.55	8.28, 8.20	8.98, 9.34[3]	8.21, 7.93
Conductivity (mS/cm)	1.957	4.778	3.01	2.683	1.170	1.052
Flow (cfs)	2.50[(1)]	1.07[(1)]	0.03[(2)]	0.03[(2)]	2.50[(1)]	1.61[(1)]
Dissolved Oxygen (mg/L)	8.68	9.95	6.75	5.1	17.75	5.8

1 Flow was determined by measuring the depth and width of the water channel, as well as the velocity of a floating object in the water.
2 The flow rate was determined by measuring changes in water level in the sump area over a 22.25-hour period and corresponds to the average flow over those 22.25 hours. The volume of water discharged was calculated for each pump-down and summed over the sampling period.
3 The composite sample value exceeded trigger value of 9.0 that requires an upstream investigation.

Table 6.14 Summary of Chemical Analyses of Dry Weather Monitoring, 2004/2005.

	Constituents	Bouton Creek 31-Aug-04	Bouton Creek 25-May-05	Belmont Pump 31-Aug-04	Belmont Pump 25-May-05	Los Cerritos Channel 31-Aug-04	Los Cerritos Channel 25-May-05
Bacteria	Total Coliform	5000	9000	900	9000	**16000**[1,2]	2400
(MPN/100 ml)	Enterococcus	**690**[2]	**730**[2]	**3300**[2]	**1160**[2]	**3100**[2]	**1440**[2]
	Fecal Coliform	170	**2400**[1,2]	**500**[1,2]	**800**[1,2]	**5000**[1,2]	80
Conventionals	Alkalinity as CaCO3	160	170	420	450	140	120
(mg/L unless noted)	pH *(pH units)*	8.33	8.22	**8.79**[2]	8.2	**8.98**[2]	7.93
	Biochemical Oxygen Demand	2.7J	3.4	3.4J	2.9	26J	22
	Chemical Oxygen Demand	67	160	99	100	150	110
	Chloride	400	1100	630	440	190	160
	Fluoride	0.89	0.76	1.6	1.7	0.75	0.75
	Hardness as CaCO3	180	460	320	180	200	180
	MBAS	0.034	0.05	0.066	0.05	0.13	0.05
	Total Ammonia (as N)	0.1U	0.10U	0.16	0.18	0.14	0.12
	Total Kjeldahl Nitrogen	0.48	0.63	0.99	1.1	4.4	3.0
	Nitrate (as N)	0.1U	0.10U	1.3	0.63	0.11	0.10U
	Nitrite (as N)	0.1U	0.10U	0.1U	0.10U	0.1U	0.10U
	Oil and Grease	5U	5U	5U	5U	5U	5U
	Total Recoverable Phenolics	0.1U	0.10U	0.1U	0.10U	0.1U	0.10U
	Total Phosphorus	0.046	0.067	0.94	0.8	0.47	0.22
	Total Orthophosphate (as P)	0.01U	0.01	0.9	0.6	0.01U	0.01
	Conductivity *(umhos/cm)*	1800	3900	3000	2600	1100	1100
	Total Dissolved Solids	910	1.0U	1700	1.6	590	11
	Total Suspended Solids	1U	2300	1U	1500	41	690
	Total Volatile Solids	88	1.0U	170	1.2	120	9.2
	Total Organic Carbon	4.7	7	12	8.6	50	15
	Turbidity *(NTU)*	1.6	2.4	3.9	4.6	22	13

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate, Y=values differed by more than 40% between columns, reported values are considered as estimates.

Table 6.14 Summary of Chemical Analyses of Dry Weather Monitoring, 2004/2005 (continued)

	Constituents	Bouton Creek 31-Aug-04	Bouton Creek 25-May-05	Belmont Pump 31-Aug-04	Belmont Pump 25-May-05	Los Cerritos Channel 31-Aug-04	Los Cerritos Channel 25-May-05
Dissolved Metals	Aluminum	100U	50U	100U	50U	100U	50U
(ug/L)	Arsenic	1.1		4.4		1.8	
	Cadmium	0.25U	0.2U	0.25U	0.2U	0.25U	0.31
	Chromium	0.86	4.4	1.3	6.9	0.67	1.7
	Copper	1.4	**3.9** [6]	**4.1** [6]	3	**9.8** [6]	**8.4** [6]
	Iron	25U	25U	58	53	25U	25U
	Lead	0.5U	0.5U	0.5U	0.5U	0.71	0.7
	Nickel	1.1	1.7	3.5	2.6	5	3.7
	Selenium	1U		1U		1U	
	Silver	0.25U	0.2U	0.25U	0.2U	0.25U	0.2U
	Zinc	4.4	4.1	7.8	11	8.2	14
Total Metals	Aluminum	100U	50U	100U	50U	110	50U
(ug/L)	Arsenic	1.4		4.4		1.9	
	Cadmium	0.25U	0.091J	0.25U	0.18J	0.29	0.42
	Chromium	0.52	1.2	1.1	2.5	1.1	1
	Copper	2.2	5.8	5.5	4.9	**16** [1]	11
	Iron	27	32	200	400	390	83
	Lead	0.5U	0.57	1.6	1.1	6.8	1.2
	Nickel	1.1	2.1	4.4	3.2	6	4.4
	Selenium	1U		1U		1U	
	Silver	0.25U	0.2U	0.25U	0.2U	0.25U	0.2U
	Zinc	5.1	5.5	15	18	33	22
Organophosphates	Atrazine	2U	2U	2U	2U	2U	2U
(ug/L)	Chlorpyrifos	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
	Cyanazine	2U	2U	2U	2U	2U	2U
	Diazinon	0.05U	0.01U	0.05U	0.01U	0.71Y [3]	0.01U
	Malathion	1U	1U	1U	1U	1U	1U
	Prometryn	2U	2U	2U	2U	2U	2U
	Simazine	2U	2U	2U	2U	2U	2U

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate, Y=values differed by more than 40% between columns, reported values are considered as estimates.

Table 6.14 Summary of Chemical Analyses of Dry Weather Monitoring, 2004/2005 (continued)

	Constituents	Bouton Creek 31-Aug-04	Bouton Creek 25-May-05	Belmont Pump 31-Aug-04	Belmont Pump 25-May-05	Los Cerritos Channel 31-Aug-04	Los Cerritos Channel 25-May-05
Aroclors (ug/L)	Aroclor 1016	0.2U	0.5U	0.2U	0.5U	0.2U	0.5U
	Aroclor 1221	0.2U	0.5U	0.2U	0.5U	0.2U	0.5U
	Aroclor 1232	0.2U	0.5U	0.2U	0.5U	0.2U	0.5U
	Aroclor 1242	0.2U	0.5U	0.2U	0.5U	0.2U	0.5U
	Aroclor 1248	0.2U	0.5U	0.2U	0.5U	0.2U	0.5U
	Aroclor 1254	0.2U	0.5U	0.2U	0.5U	0.2U	0.5U
	Aroclor 1260	0.2U	0.5U	0.2U	0.5U	0.2U	0.5U
***Chlorinated Pesticides** (ug/L)*	4,4'-DDD	0.01U	0.05U	0.01U	0.05U	0.01U	0.05U
	4,4'-DDE	0.01U	0.05U	0.01U	0.05U	0.01U	0.05U
	4,4'-DDT	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
	Aldrin	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
	Dieldrin	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
	Endrin	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
	Endrin aldehyde	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
	Endrin ketone	0.01U	-	0.01U	-	0.01U	-
	alpha-BHC	0.01U	0.01U	0.01U	0.01U	0.038Y	0.01U
	beta-BHC	0.005U	0.005U	0.005U	0.005U	0.026	0.005U
	delta-BHC	0.005U	0.005U	0.005U	0.005U	0.005U	0.0049J
	gamma-BHC (Lindane)	0.01U	0.02U	0.01U	0.02U	0.01U	0.02U
	Endosulfan I	0.01U	0.02U	0.01U	0.02U	0.01U	0.02U
	Endosulfan II	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
	Endosulfan sulfate	0.01U	0.05U	0.01U	0.05U	0.01U	0.05U
	alpha-Chlordane	0.01U	0.1U	0.01U	0.1U	0.01U	0.1U
	gamma-Chlordane	0.01U	0.1U	0.01U	0.1U	0.01U	0.1U
	Heptachlor	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
	Heptachlor epoxide	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
	Methoxychlor	0.01U	-	0.01U	-	0.01U	-
	Toxaphene	0.2U	0.5U	0.2U	0.5U	0.2U	0.5U

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; U=not detected at the detection limit, J=value is considered an estimate, J-=value is considered to be a low estimate, J+=values is considered to be a high estimate, Y=values differed by more than 40% between columns, reported values are considered as estimates.

7.0 TOXICITY RESULTS

7.0 TOXICITY RESULTS

Toxicity tests were conducted on subsamples of the composites collected for chemical analysis. Wet weather samples were collected from six storm events: October 17, 2004; October 20, 2004; October 27, 2004; December 6, 2004; December 29, 2004; and March 23, 2005. Composite samples were collected during each of the storm events and were tested with two species, the water flea (freshwater crustacean - *Ceriodaphnia dubia*), and the sea urchin (marine echinoderm - *Strongylocentrotus purpuratus*).

Dry weather sampling occurred on August 31, 2005 and May 25, 2005.

7.1 Wet Weather Discharge

Toxicity tests on wet weather discharges were performed on four samples from each of three monitoring sites. The results of tests conducted at each station are summarized in the following sections.

7.1.1 Belmont Pump

Toxicity results from the Belmont Pump station are presented in Table 7.1 and Figure 7.1. The first sample from the Belmont Pump station was collected on October 20, 2004. This sample caused measurable toxic effects only in the sea urchin, with the sea urchin fertilization test showing a NOEC of 6.25% sample (16 TU_c) and a LOEC of 12.5% sample. No concentration tested produced a reduction of fertilization as high as 50%, and there were <2 TU_a in this sample. Neither of the water flea test endpoints (survival or reproduction) showed the presence of toxicity.

The second Belmont Pump sample was collected on October 27 2004 and produced no toxic responses in water flea survival/reproduction (NOEC = 100% sample). There was minor toxicity detected in sea urchin fertilization, where the NOEC was 25% sample (4 TU_c) and the EC50 was >50% sample (<2 TU_a).

The third Belmont Pump sample was collected on December 29 2004 and produced no toxic responses in either the water flea survival/reproduction or sea urchin fertilization tests.

The fourth Belmont Pump sample was collected on March 23, 2005 and produced minor toxicity to water flea survival and sea urchin fertilization. There was no significant reduction of water flea reproduction. The NOEC for water flea survival was 50% sample (2 TU_c) and the LC50 was 100% sample (1 TU_a). The urchin fertilization NOEC was 25% sample (4TU_c) and the EC50 was >50% sample (<2 TU_a).

7.1.2. Bouton Creek

Toxicity results from the Bouton Creek station are presented in Table 7.2 and Figure 7.2. The first sample from the Bouton Creek station was collected on October 17, 2004. Toxicity to this sample was detected by both water fleas and sea urchins. The water flea bioassay did not show detectably decreased survival (NOEC = 100% sample), but did show significantly decreased reproduction, with a NOEC of 25% sample (4 TU_c) and an IC50 of 54.6% sample (1.8 TU_a). The sea urchin fertilization bioassay showed a NOEC of 25% sample (4 TU_c) and an EC50 of >50% (< 2 TU_a).

The second Bouton Creek sample was collected on October 20, 2004 and did not cause toxic responses in either sea urchins or water fleas. The NOEC for both survival and reproduction in the water flea was 100% sample (1 TU_c) and the sea urchin fertilization NOEC was 50% sample (2 TU_c).

The third Bouton Creek sample was collected on October 27, 2004 and produced no toxic responses in water flea survival/reproduction (NOEC = 100% sample, 1 TU_c and LC/IC50 = >100%, <1 TU_a). Likewise, no toxicity was detected in the sea urchin fertilization test (NOEC = 50%, 2 TU_c and EC50 = >50%, <2 TU_a).

The fourth Bouton Creek sample was collected on December 6, 2004 and produced no toxic response in water flea survival/reproduction. Minor toxicity to sea urchin fertilization was apparent, with a NOEC of 25% sample (4 TU_c) and an EC50 of >50% (<2 TU_a).

7.1.3 Los Cerritos Channel

Toxicity results from the Los Cerritos Channel station are presented in Table 7.3 and Figure 7.3. The first sample from the Los Cerritos Channel station was collected on October 17, 2004. This sample caused toxic responses in both water flea survival/reproduction and sea urchin fertilization. The NOEC for water flea survival was 12.5% sample (8 TU_c) and the LC50 was 18.1% sample (5.5 TU_a). For water flea reproduction, the NOEC was 12.5% sample (8 TU_c) and the IC50 was 16.1% sample (6.2 TU_a). For sea urchin fertilization the NOEC was 6.25% sample (16 TU_c) and the EC50 was >50% sample (<2 TU_a). A water flea TIE was triggered by this sample.

The second Los Cerritos Channel sample was collected on October 20, 2004 and elicited no toxic response in either water flea survival or reproduction (NOEC = 100%). The sea urchin test also showed no measurable toxicity. The NOEC for fertilization was 50% sample (2 TU_c) and the EC50 was >50% sample (<2 TU_a).

The third Los Cerritos Channel sample was collected on October 27, 2004, and showed no toxicity to water flea survival or reproduction (NOEC = 100% sample). The sea urchin test, however, showed minor toxicity. The NOEC for fertilization was 25% sample (4 TU_c) and the EC50 was >50% sample (<2 TU_a).

The fourth Los Cerritos Channel sample was collected on December 29, 2004. This sample produced no toxic responses in water flea survival or reproduction (NOEC = 100% sample), but showed minor toxicity to sea urchin fertilization. The NOEC for sea urchin fertilization was 12.5% sample (8 TU_c), and the EC50 was 47.8% sample (2.09 TU_a).

7.2 Toxicity Identification Evaluations (TIEs) of Stormwater

A TIE was initiated when a LC50 of ≤40% (equivalent to ≥2.5 TU_a) was obtained for water flea survival or an EC50 of ≤40% (≥2.5 TU_a) was obtained for the sea urchin fertilization test. Sample manipulations were performed when the TIE trigger was exceeded, but the manipulated samples were subjected to toxicity evaluations only if the baseline toxicity showed persistent toxicity of at least 2 TU_a. There was only one TIE initiated during wet weather testing (Table 7.4).

During the monitoring period, a water flea TIE was triggered for the October 17 sampling event by the sample from Los Cerritos Channel. The initial 96-hour sample toxicity was 6.1 TU_a, and baseline toxicity remained well above 2 TU_a (5.0 TU_a), so the TIE was evaluated.

7.2.1 Los Cerritos Channel Station

A TIE was conducted on the October 17 stormwater from Los Cerritos Channel using the water flea survival test. The TIE results obtained for this sample showed that both addition of PBO and C18 column extraction virtually eliminated the toxicity of the sample. Centrifugation and treatment with EDTA both slightly decreased the toxicity of the sample, and STS treatment produced an enhancement of toxicity. Overall, the results suggest that non-polar organics, probably organophosphate pesticides, were the primary toxicants in this sample. Particulate-borne toxicants and/or divalent metals (cadmium, copper, mercury, manganese, lead or zinc) may also have contributed toxicity to this sample. These results are presented graphically in Figure 7.4.

7.3 Dry Weather Discharge

Toxicity tests were conducted on samples from two dry weather sampling events, on August 31, 2004 and May 25, 2005. The Bouton Creek sample collected in August 2004 contained, about 1.6 ppt salinity, which is about 0.44X the LC50 for the water flea. This level of salinity was considered to have only a minor potential to affect the water flea toxicity data The May 2005 Bouton Creek sample contained only a slightly higher salinity level (2.1 ppt) which was also considered to have low potential to affect water flea toxicity response.

7.3.1 Belmont Pump Station

In August 2004, no concentration of the Belmont Pump sample produced either measurably decreased survival/reproduction in the water flea, or a measurable decrease in sea urchin fertilization (Table 7.5 and Figure 7.5).

The May 2005 dry weather sample likewise did not produce measurable toxic responses in either water flea survival/reproduction or sea urchin fertilization (Table 7.5 and Figure 7.6).

7.3.2 Bouton Creek

The August 2004 bioassays showed significantly decreased survival of *Ceriodaphnia* in the 50% and 100% test concentrations. The NOEC for survival was 25% sample (4 TU_c) and the LC50 for survival was 50% sample (2 TU_a). There was significantly decreased water flea reproduction in the 100%, 50% and 25% sample concentrations. The NOEC for reproduction was 12.5% sample (8 TU_c) and the IC50 for reproduction was 28.7% sample (3.48 TU_a) (Table 7.5 and Figure 7.5).

No toxicity to water fleas was demonstrated in the May 2005 dry weather sample. The NOEC for both survival and reproduction was 100% sample (1 TU_c), the LC50/IC50, respectively, for both test endpoints was >100% sample (<1 TU_a) (Table 7.5 and Figure 7.6).

No measurable toxicity to sea urchins (NOEC = 50% and EC50 = >50%) was demonstrated in either the August 2004 or the May 2005 sample (Table 7.5 and Figures 7.5 and 7.6).

7.3.3 Los Cerritos Channel

The August 2004 sample from Los Cerritos Channel produced a NOEC for both survival and reproduction of <6.25% (>16 TU_c) in *Ceriodaphnia*. The LC50 was 3.3% sample (30.3 TU_a) and the IC50 was 3.15% sample (31.7 TU_a). A *Ceriodaphnia* TIE was performed on this sample. There was no significant reduction in sea urchin fertilization produced by any concentration of this sample. The NOEC was 50% sample (2 TU_c) and the EC50 was >50% sample (<2 TU_a) (Table 7.5 and Figure 7.5).

The May 2005 Los Cerritos Channel dry weather sample showed slightly higher toxicity to water fleas, with a survival NOEC of 12.5% (8 TU_c) and an LC50 of 20.3% sample (4.9 TU_a). The reproduction NOEC was 6.25% (16 TU_c) and the IC50 was 8.84 % (11.3 TU_a). A *Ceriodaphnia* TIE was performed on this sample. The sea urchin fertilization test showed no measurable toxicity (EC50 > 50%, < 2TU_a) (Table 7.5 and Figure 7.6).

7.4 Dry Weather Toxicity Identification Evaluations

A water flea TIE was initiated on the August 31, 2004 dry weather sample from the Los Cerritos Channel station. Baseline 96-hour toxicity decreased to 28.3 TU from the initial toxicity of 32 TU. Sample toxicity was essentially unaffected by both EDTA treatment and by centrifugation, but was virtually eliminated by C18 SPE treatment. PBO treatments produced either slightly decreased sample toxicity (25.9 TU) or somewhat enhanced toxicity (39 TU, depending on the PBO concentration used. STS treatment resulted in markedly elevated toxicity (>200 TU), with substantial STS blank toxicity (Figure 7.7).

These results suggest that a non-polar organic compound was the primary toxicant. Organophosphate pesticides were probably not important toxicants in this sample since PBO treatment did not substantially reduce toxicity. Sample toxicity increased about 12% with the addition of 500 ppb of PBO. Since PBO may act as a pyrethroid synergist, this effect suggests that pyrethroid pesticides may have contributed to sample toxicity. Since neither EDTA nor centrifugation had any significant effect on sample toxicity, particulates and divalent metals are not suggested as toxicants. Note that there was substantial blank toxicity in the STS treatment.

A water flea TIE was performed on the May 25 2005 sample collected from Los Cerritos Channel. At 3.9 TU_a, baseline toxicity was diminished 32% from initial toxicity (5.7 TU_a). Treatment with 125 ppb of PBO reduced toxicity by 17% (to 3.2 TU_a), while treatment with 250 ppb and 500 ppb of PBO increased toxicity by 38% and 13%, respectively. C18 SPE treatment virtually eliminated toxicity (<2.9 TU_a), while centrifugation had no effect on sample toxicity. The two lowest EDTA concentrations increased toxicity by 9-20%, while the highest (.2 ml) EDTA showed a 4% toxicity reduction. STS treatment produced blank toxicity in the two highest concentrations, and showed no toxicity reduction in the lowest concentration (Figure 7.8).

These results implicate a non-polar organic compound as the primary toxicant. PBO treatments both increased and decreased toxicity. It is possible that both organophosphates and pyrethroids were active toxicants in this sample, since PBO reduces organophosphate toxicity and synergizes pyrethroid toxicity. Enzyme linked immunosorbant assay (ELISA) analyses performed 20 days after field collection showed approximately 1.5 TU of organophosphate toxicity (80 ppt of Chlorpyrifos and 105 ppt of Diazinon. The lowest concentration of PBO (125 ppb) produced 17% toxicity reduction. The increased toxicity at the 250 ppb PBO concentration might be attributed to pyrethroids synergistically affected by PBO, while the increased toxicity at 500 ppb PBO may be due to toxicity of the PBO itself. Particle-bound toxicants, divalent cations and oxidizable constituents were not implicated as toxicants in the sample due to their lack of toxicity reducing effects.

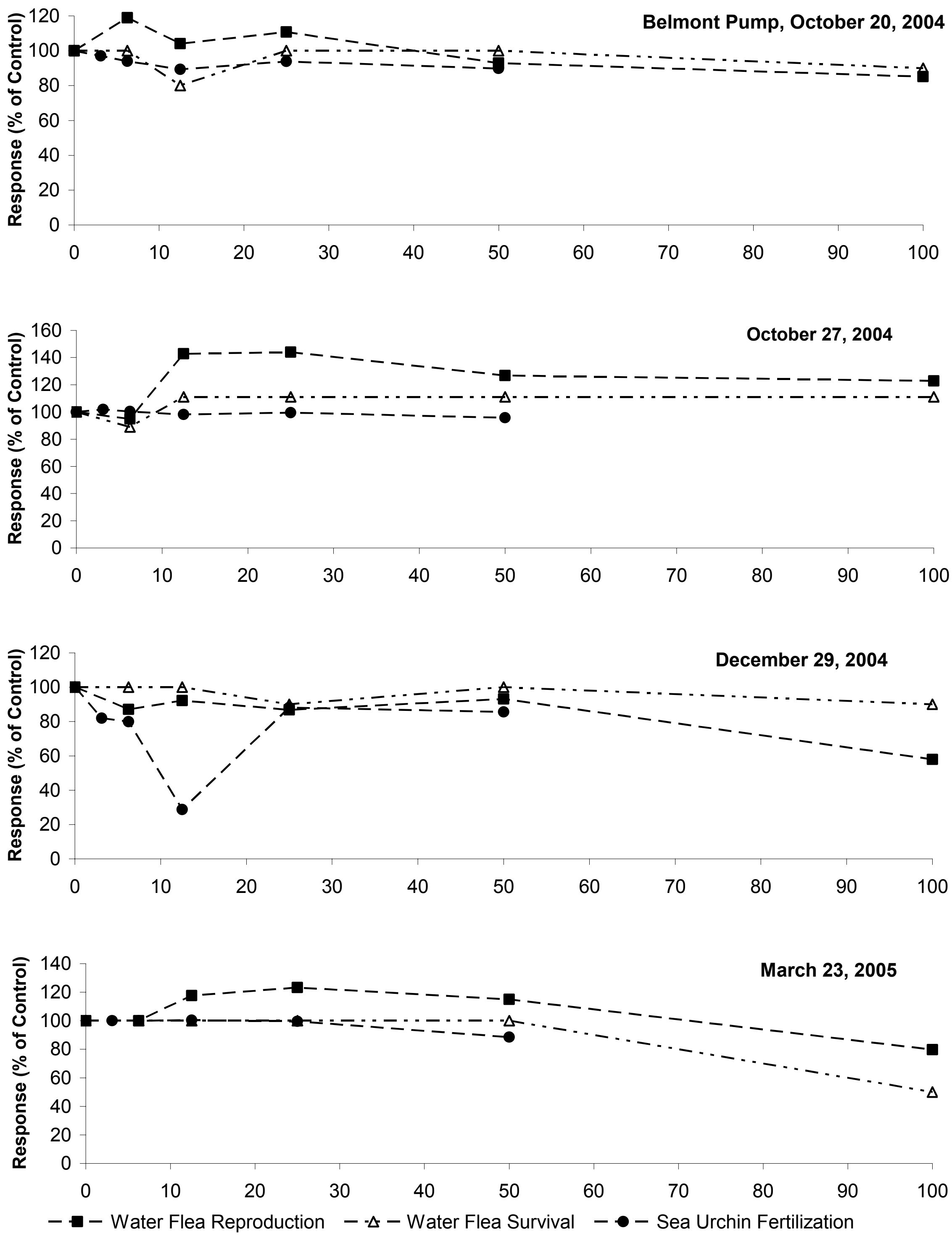


Figure 7.1 Toxicity Dose Response Plots for Storm Water Samples Collected from Belmont Pump.

Dose response plots for March 23, 2005 are based upon 6.25 percent concentration.

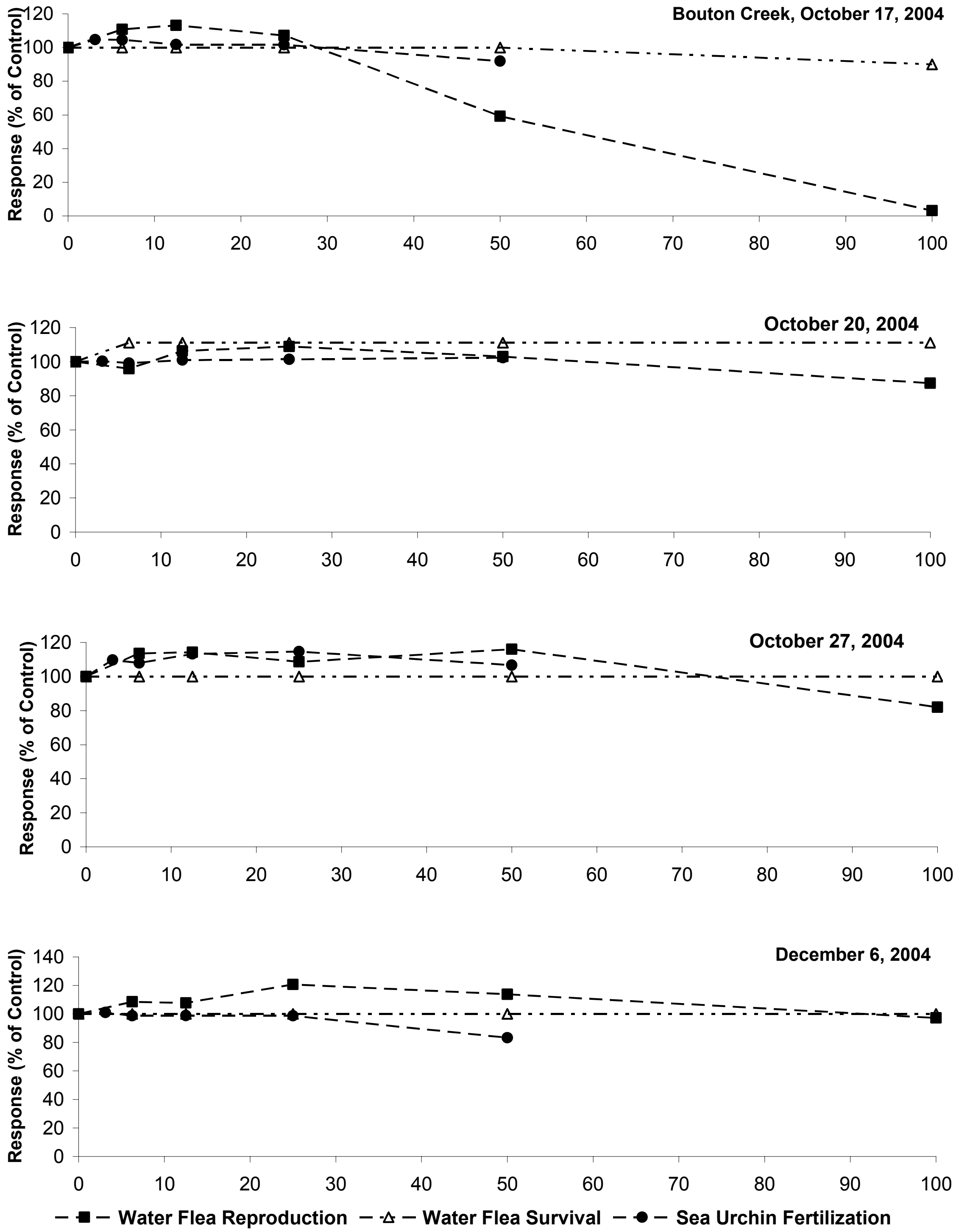


Figure 7.2 Toxicity Dose Response Plots for Storm Water Samples Collected from Bouton Creek.

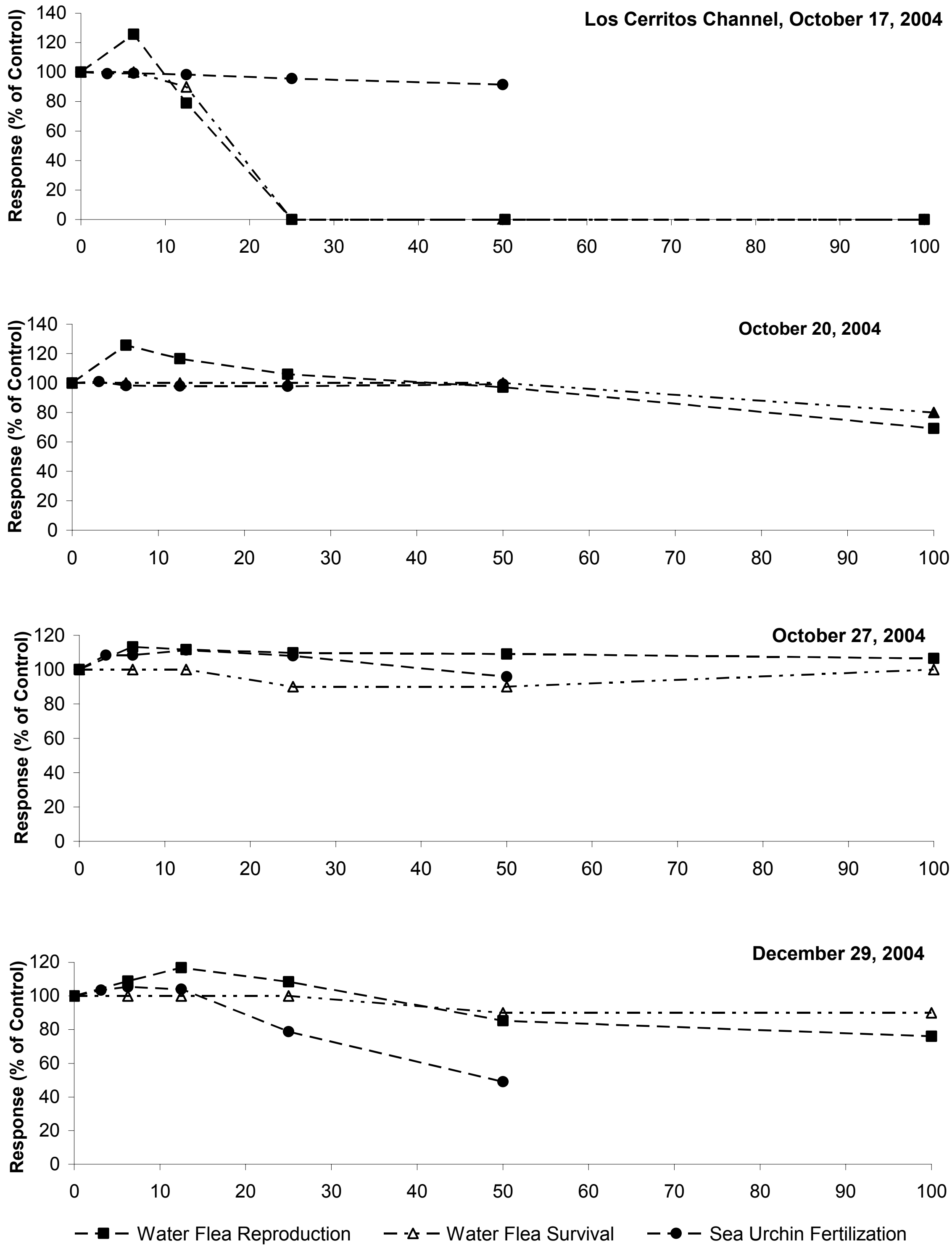


Figure 7.3 Toxicity Dose Response Plots for Storm Water Samples Collected from Los Cerritos Channel.

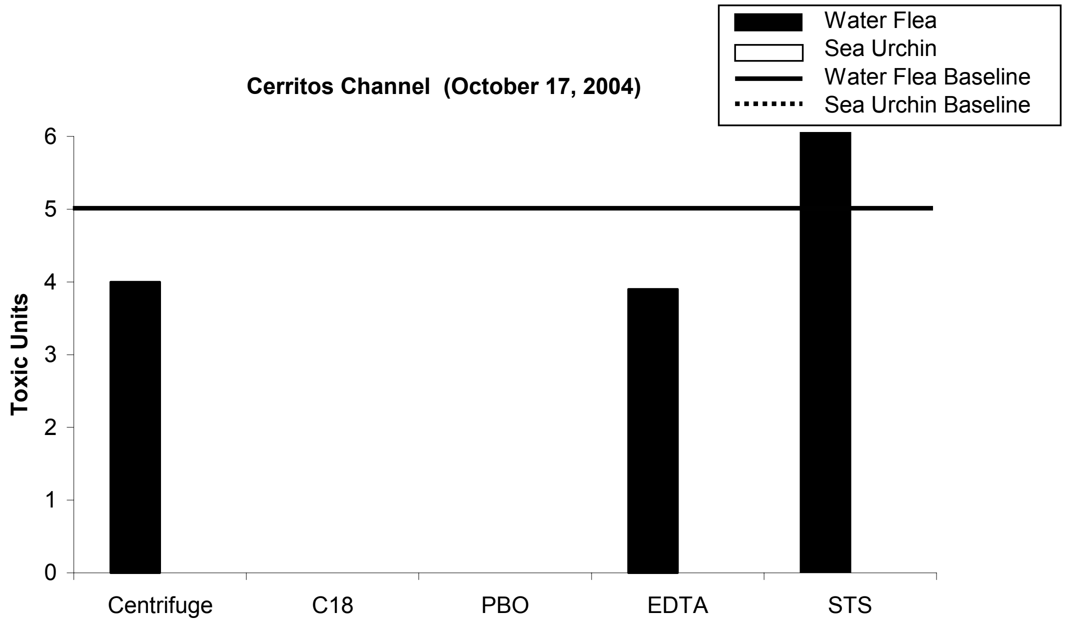


Figure 7.4 Summary of Phase I TIE Analyses on Stormwater Samples from the Los Cerritos Channel Station October 17, 2004.

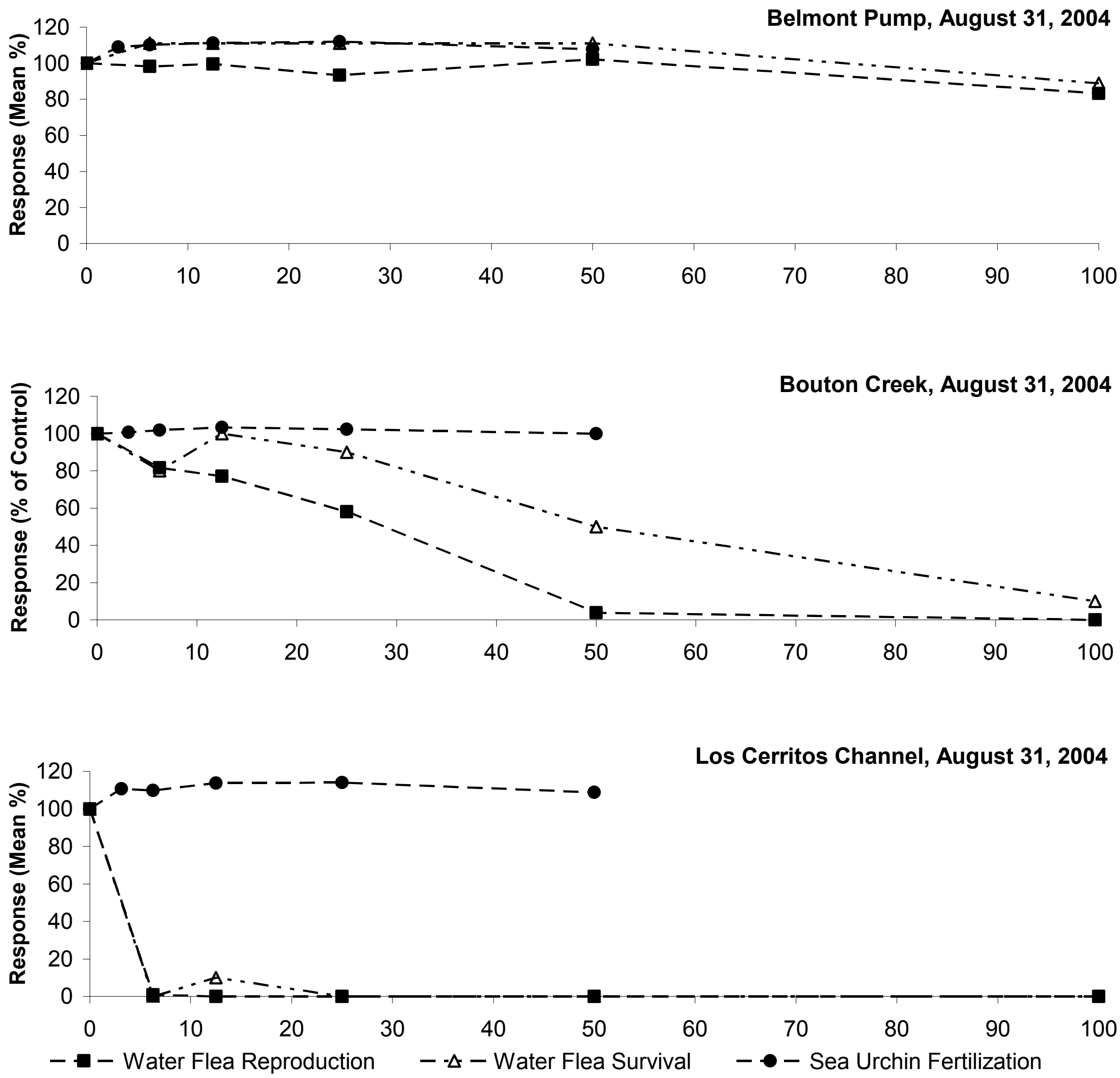


Figure 7.5 Toxicity Dose Response Plots for the August Dry Weather Samples Collected from Belmont Pump, Bouton Creek and Los Cerritos Channel.

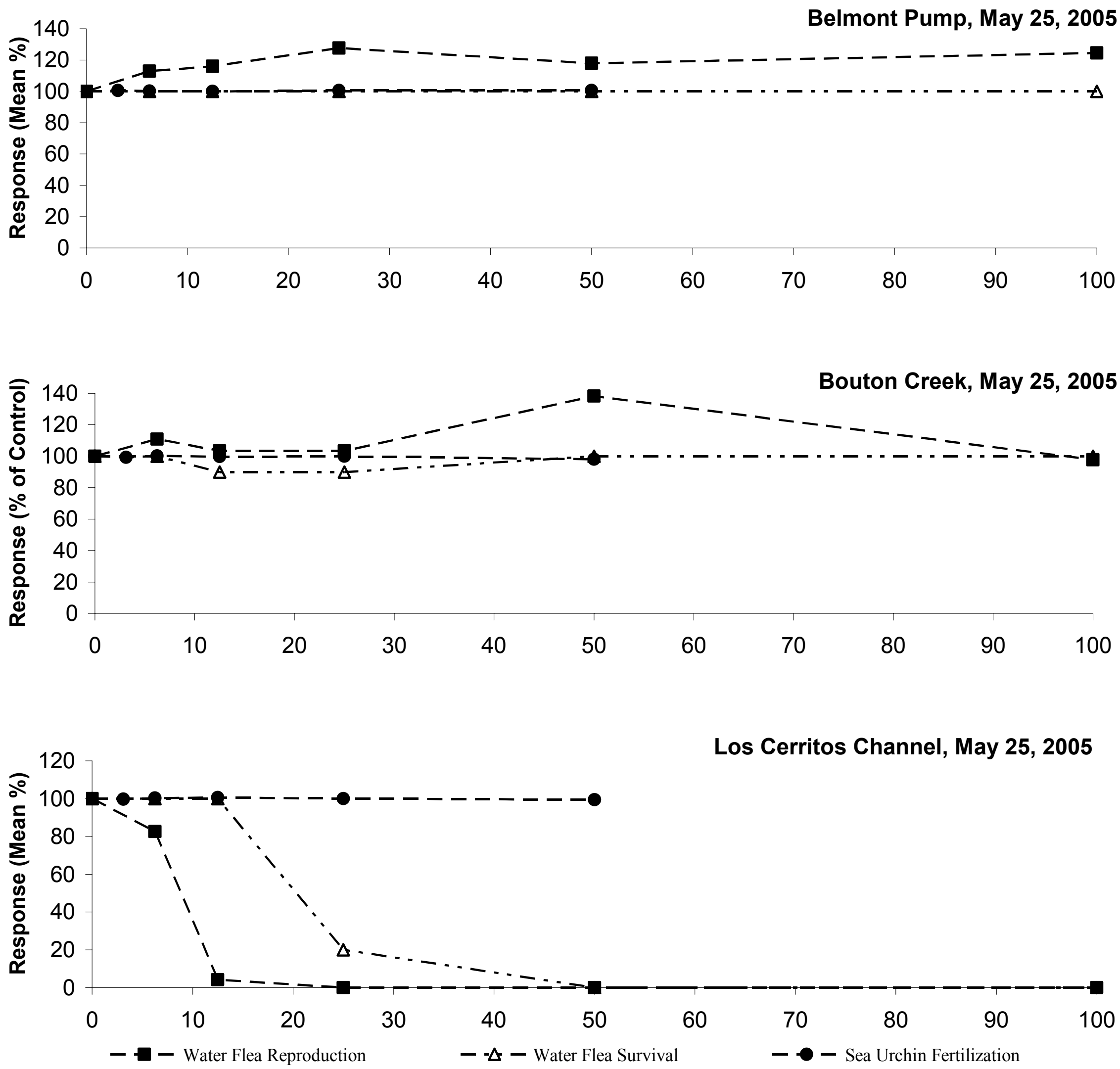


Figure 7.6 Toxicity Dose Response Plots for the May Dry Weather Samples Collected from Belmont Pump, Bouton Creek and Los Cerritos Channel.

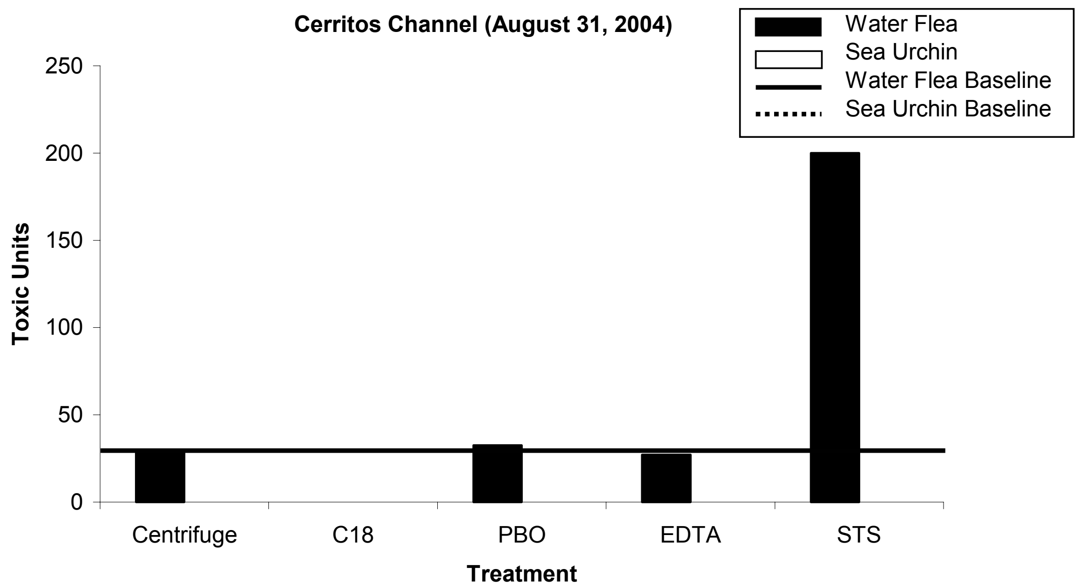


Figure 7.7 Summary of Phase I TIE Analyses on Dry Weather Samples from the Los Cerritos Channel Station August 31, 2004.

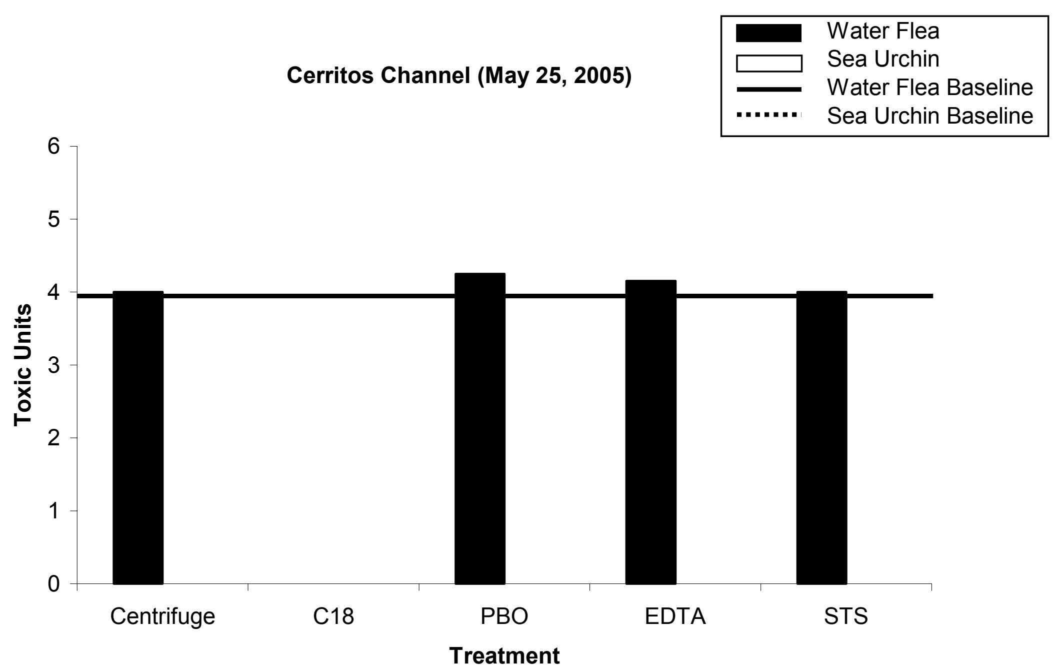


Figure 7.8 Summary of Phase I TIE Analyses on Dry Weather Samples from the Los Cerritos Channel Station May 25, 2005.

Table 7.1 Toxicity of Wet Weather Samples Collected from the City of Long Beach Belmont Pump Station During the 2004/2005 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]		
10/20/04	Water Flea Survival	100	>100	>100	<1	1
10/20/04	Water Flea Reproduction	100	>100	>100	<1	1
10/20/04	**Sea Urchin Fertilization**	**6.25**	**12.5**	**>50**	<2	**16**
10/27/04	Water Flea Survival	100	>100	>100	<1	1
10/27/04	Water Flea Reproduction	100	>100	>100	<1	1
10/27/04	**Sea Urchin Fertilization**	**25**	**50**	**>50**	<2	**4**
12/29/04	Water Flea Survival	100	>100	>100	<1	1
12/29/04	Water Flea Reproduction	100	>100	>100	<1	1
12/29/04	Sea Urchin Fertilization	50	>50	>50	<2	2
3/23/05	Water Flea Survival	50	100	100	1	2
3/23/05	Water Flea Reproduction	100	>100	>100	<1	1
3/23/05	**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 (LC50), 50% inhibition in water flea reproduction (IC50), or 50% reduction in sea urchin fertilization (EC50).
[d] Acute toxicity units = 100/LC50.
[e] Chronic toxicity units = 100/NOEC.

Table 7.2 Toxicity of Wet Weather Samples Collected from the City of Long Beach Bouton Creek Station During the 2004/2005 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]		
10/17/04	Water Flea Survival	100	>100	>100	<1	1
10/17/04	**Water Flea Reproduction**	**25**	**50**	**54.6**	**1.8**	**4**
10/17/04	**Sea Urchin Fertilization**	**25**	**50**	**>50**	<2	**4**
10/20/04	Water Flea Survival	100	>100	>100	<1	1
10/20/04	Water Flea Reproduction	100	>100	>100	<1	1
10/20/04	Sea Urchin Fertilization	50	>50	>50	<2	2
10/27/04	Water Flea Survival	100	>100	>100	<1	1
10/27/04	Water Flea Reproduction	100	>100	>100	<1	1
10/27/04	Sea Urchin Fertilization	50	>50	>50	<2	2
12/06/04	Water Flea Survival	100	>100	>100	<1	1
12/06/04	Water Flea Reproduction	100	>100	>100	<1	1
12/06/04	**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 (LC50), 50% inhibition in water flea reproduction (IC50), or 50% reduction in sea urchin fertilization (EC50).
[d] Acute toxicity units = 100/LC50.
[e] Chronic toxicity units = 100/NOEC.

Table 7.3 Toxicity of Wet Weather Samples Collected from the City of Long Beach Los Cerritos Channel Station During the 2004/2005 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]		
10/17/04	**Water Flea Survival**	**12.5**	**25**	**18.1**	**5.5**	**8**
10/17/04	**Water Flea Reproduction**	**12.5**	**25**	**16.1**	**6.2**	**8**
10/17/04	**Sea Urchin Fertilization**	**6.25**	**12.5**	**>50**	<2	**16**
10/20/04	Water Flea Survival	100	>100	>100	<1	1
10/20/04	Water Flea Reproduction	100	>100	>100	<1	1
10/20/04	Sea Urchin Fertilization	50	>50	>50	<2	2
10/27/04	Water Flea Survival	100	>100	>100	<1	1
10/27/04	Water Flea Reproduction	100	>100	>100	<1	1
10/27/04	**Sea Urchin Fertilization**	**25**	**50**	**>50**	<2	**4**
12/29/04	Water Flea Survival	100	>100	>100	<1	1
12/29/04	Water Flea Reproduction	100	>100	>100	<1	1
12/29/04	**Sea Urchin Fertilization**	**12.5**	**25**	**47.8**	**2.09**	**8**

[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 (LC50), 50% inhibition in water flea reproduction (IC50), or 50% reduction in sea urchin fertilization (EC50).
[d] Acute toxicity units = 100/LC50.
[e] Chronic toxicity units = 100/NOEC.

Table 7.4 Summary of TIE Activities. Acute Toxic Units (TU_a's) for the initial (TU-I) and TIE baseline (TU-B) tests are shown (96 hr exposure time for water flea), along with the TIE-related action taken. TIEs were abandoned when the baseline TU_a value fell below 2.0.

Date	Test	Water Flea TU-I	Water Flea TU-B	Action
Wet Weather Events				
10/17/04	Los Cerritos	5.5	5.0	Proceed
Dry Weather Events				
8/31/04	Los Cerritos	32	28.3	Proceed
5/25/05	Los Cerritos	5.7	3.9	Proceed

Table 7.5 Toxicity of Dry Weather Samples from the City of Long Beach. Test results indicating toxicity are shown in bold type.

Station	Date	Test	Test Response (% sample)			TUa[d]	TUc[e]
			NOEC[a]	LOEC[b]	Median Response[c]		
Belmont	8/31/04	Water Flea Survival	100	>100	>100	<1	1
Belmont	8/31/04	Water Flea Reproduction	100	>100	>100	<1	1
Belmont	8/31/04	Sea Urchin Fertilization	50	>50	>50	<2	2
Bouton	**8/31/04**	**Water Flea Survival[e]**	**25**	**50**	**50**	**2**	**4**
Bouton	**8/31/04**	**Water Flea Reproduction[e]**	**12.5**	**25**	**28.7**	**3.48**	**8**
Bouton.	8/31/04	Sea Urchin Fertilization	50	>50	>50	<2	2
Los Cerritos	**8/31/04**	**Water Flea Survival**	**<6.25**	**6.25**	**3.3**	**30.3**	**>16**
Los Cerritos	**8/31/04**	**Water Flea Reproduction**	**<6.25**	**6.25**	**3.15**	**31.7**	**>16**
Los Cerritos	8/31/04	Sea Urchin Fertilization	50	>50	>50	<2	2
Belmont	5/25/05	Water Flea Survival	100	>100	>100	<1	1
Belmont	5/25/05	Water Flea Reproduction	100	>100	>100	<1	1
Belmont	5/25/05	Sea Urchin Fertilization	50	>50	>50	<2	2
Bouton	5/25/05	Water Flea Survival	100	>100	>100	<1	1
Bouton	5/25/05	Water Flea Reproduction	100	>100	>100	<1	1
Bouton	5/25/05	Sea Urchin Fertilization	50	>50	>50	<2	2
Los Cerritos	5/25/05	**Water Flea Survival**	**12.5**	**25**	**20.3**	**4.9**	**8**
Los Cerritos	5/25/05	**Water Flea Reproduction**	**6.25**	**12.5**	**8.84**	**11.3**	**16**
Los Cerritos	5/25/05	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 (LC50), 50% inhibition in water flea reproduction (IC50), or 50% reduction in sea urchin fertilization (EC50).
[d] Acute toxicity units = 100/LC50.
[e] Chronic toxicity units = 100/NOEC.

8.0 ALAMITOS BAY PILOT RECEIVING WATER STUDY RESULTS

8.0 ALAMITOS BAY PILOT RECEIVING WATER STUDY RESULTS

8.1 Vertical and Horizontal Extent of the Stormwater Plume

Runoff during the October 19-20, 2004 storm resulted in a surface plume that extended from the lower reaches of Los Cerritos Channel and upper reaches of Marine Stadium throughout Alamitos Bay. A low salinity lens was even found up to 1.5 kilometers outside the jetty mouth (Figure 8.1). Rainfall measures at the Long Beach mass emission sites ranged from 1.55 inches to 1.83 inches over a period of roughly ten hours from approximately 2300 hours on the night of October 19, 2004 to 0900 hours on the morning of October 20, 2004. The plume characteristics were evaluated on the afternoon of October 20, 2004 from 1223 to 1659 hours.

Based upon the plume characteristics, the Los Cerritos Channel was the major source of stormwater entering Alamitos Bay. The surface salinity increased from nearly fresh levels in the Los Cerritos Channel to 75% seawater closer to the harbor entrance. Measured surface salinity within Alamitos Bay ranged from 1.5 to 24 ppt. The lowest salinities were found within the lower reaches of the Los Cerritos Channel near the Pacific Coast Highway Bridge. The higher surface salinities occurred nearer the Bay entrance and offshore, but all of the surface salinities were below open coast salinity levels. Although salinity was relatively low within the upper reaches of Marine Stadium, the plume from this portion of the watershed was minor in comparison to the plume emanating from the Los Cerritos Channel. Similar conditions have been noted during previous plume tracking efforts.

The vertical extent of the stormwater plume was determined through the eleven depth profiles taken in Cerritos Channel, throughout Alamitos Bay and just offshore of the harbor mouth (Figure 8.1). The fresher stormwater formed a surface plume that was typically one to three feet in depth (Figures 8.2d and 8.2i). The layer was thickest and most distinct in Cerritos Creek (Casts # 8 and #9, Figures 8.2h and 8.2i) and the upper reaches of Marine Stadium (Cast #10, Figure 8.2j). The structure of the plume became increasing indistinct at the entrance to Alamitos Bay (Casts # 3, Figure 8.2c), but reappeared in a lens of low salinity water 1.5 kilometers offshore (Cast #2, Figure 8.2b). This decrease in salinity off the entrance of Alamitos Bay was most likely attributable to the plume from the Los Angeles River.

The stormwater plume tended to be only slightly cooler than the underlying marine waters. Surface temperatures in the plume ranged from 0.03 to 1.51 degrees centigrade lower at the surface than the deeper marine waters. Turbidity in the surface plume ranged from 7.92 to 37.9 NTU. Marine water under the plume was relatively clear with turbidity measurements typically in the range of 2.3 to 3 NTU. Exceptions occurred for the two offshore casts and the cast at the harbor entrance where wave action was mixing up the bottom sediments. At these sites, turbidity of the underlying marine waters ranged from 9.9 to 15.7 NTU.

8.2 Chemical Characterization

After mapping the plume, four Receiving Water sites within the plume were selected on the basis of salinity. The location of these sites is shown in Figure 8.3. Sampling was initiated at RW1 where salinity within the plume was 8.3 ppt. Three additional sites were sampled with recorded salinities of 12 ppt (RW2), 16 ppt (RW3) and 21 ppt (RW4). Influence of stormwater would, therefore, be highest at RW1 and lowest at RW4. The water quality results for the Receiving Water samples are summarized in Table 8.1. None of the analytes exceeded the threshold levels set by the California Ocean Plan 2002 (SWRCB 2002), the LA Basin Plan (CRWQCB, Los Angeles 1999), or California Toxics Rule Saltwater criteria (USEPA 2000).

Total suspended solids (TSS) did not vary much amongst the four stations (ranging from 9.8 to 13 mg/L) and was not correlated with surface salinity. Total metal concentrations increased with decreasing salinity (or increasing stormwater influence) for each of the metals tested. Total lead and nickel concentrations increased minimally as the salinity decreased, while total zinc increased fourfold with decreasing salinity. Concentrations were highest nearest to Cerritos Channel and lowest at station RW4 in Alamitos Bay approaching the harbor. Total cadmium, though measured, was below the required detection limit for the project.

Only one of the dissolved metals showed a clear pattern of stormwater influence. Concentrations of dissolved zinc decreased from station RW1 to RW4. Concentrations of dissolved zinc at the site with the highest stormwater content (RW1) showed a fourfold increase over concentrations of dissolved zinc at the site with the least stormwater content (RW4). Concentrations of dissolved cadmium and lead were essentially the same at each of the stations, while station RW3 showed elevated levels of copper in comparison to the other three stations. The dissolved nickel data were rejected based upon a review of the QA/QC data.

None of the organophosphate (OP) pesticides were detectable in the receiving water samples.

8.3 Toxicological Characterization

Water samples from the four plume sites were tested for toxicity using the sea urchin fertilization test. Samples from each of the Receiving Water stations were tested at five concentrations (3.1%, 6.25%, 12.5%, 25%, and 50%) and each showed negligible toxicity. (Table 8.2, Figure 8.4). NOECs ranged from 25% to 50% sample, and EC_{50}s were all >50%. The mean proportion of fertilized eggs in the highest (50%) sample concentrations ranged from 93.5% to 99.3% compared to laboratory control fertilization of 93.1% to 98.8%.

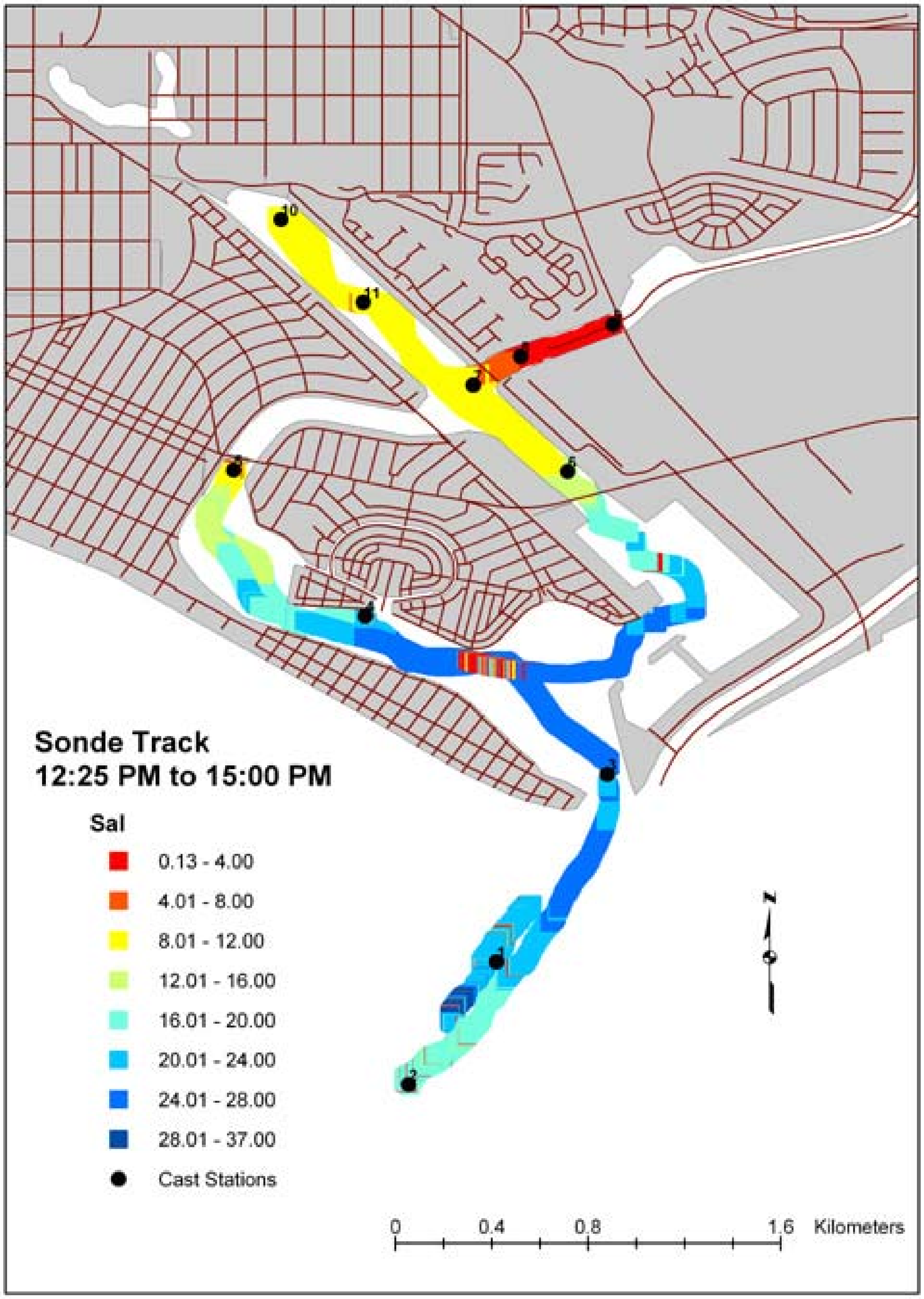


Figure 8.1 Map of Surface Salinity in Alamitos Bay with Locations of Eleven Water Quality Profiling Sites, 10/20/2004.

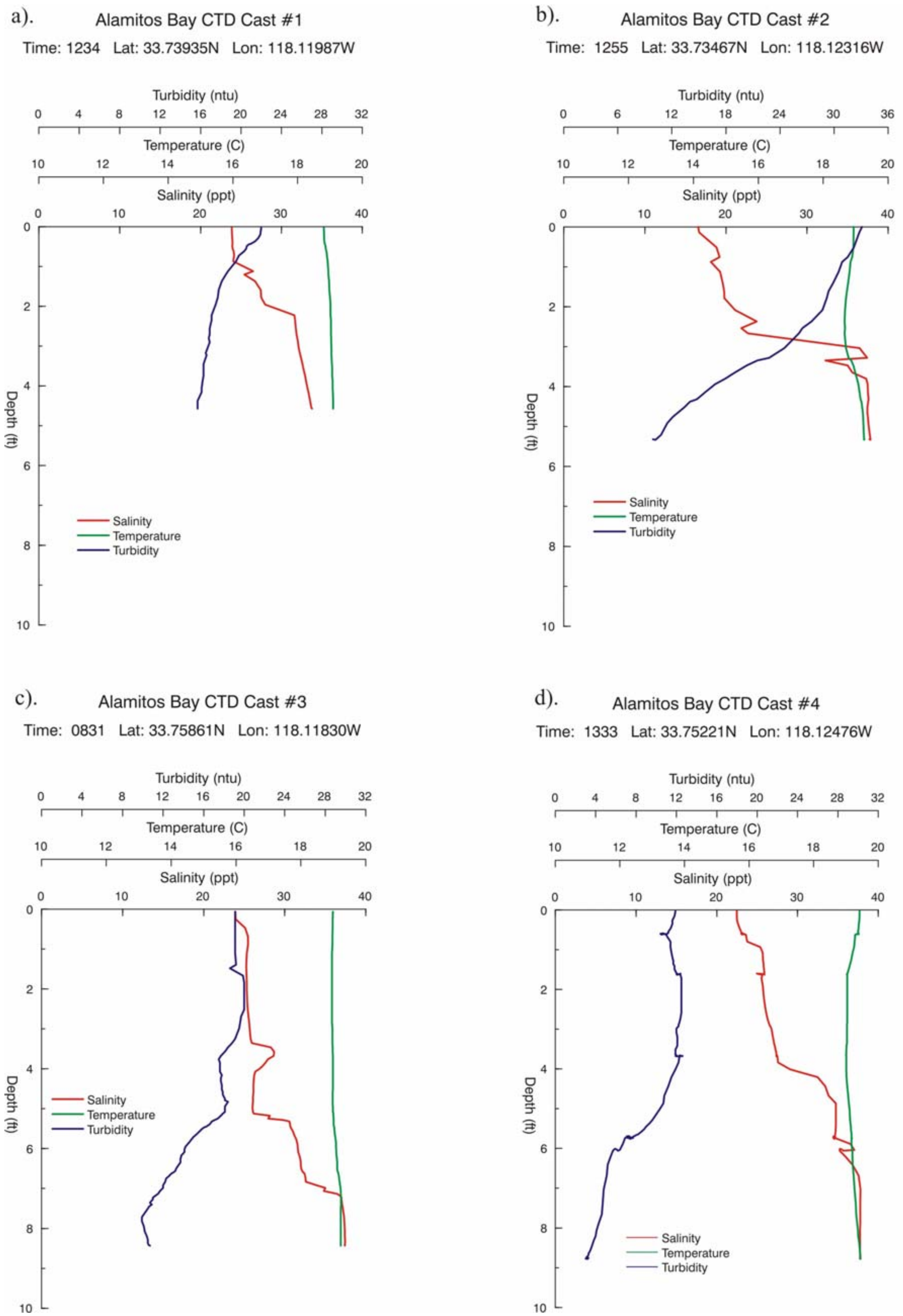
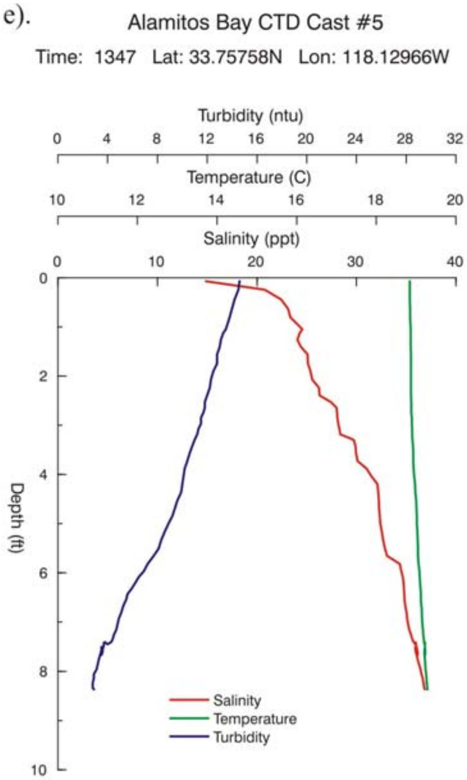
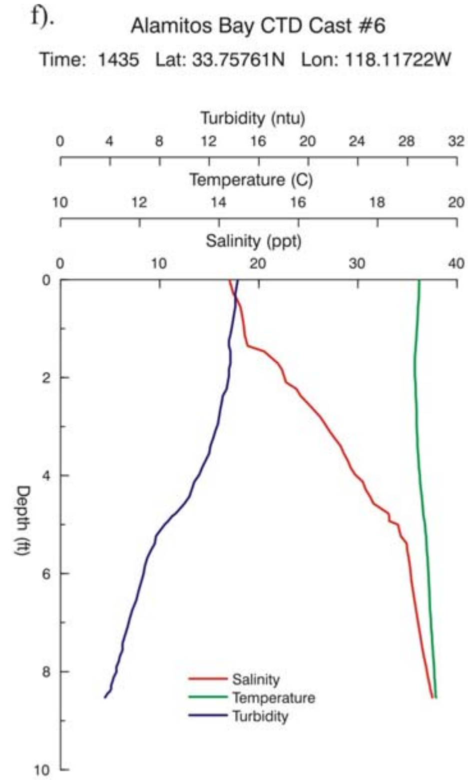


Figure 8.2(a-d) CTD Casts Taken During Alamitos Bay Receiving Water Study.

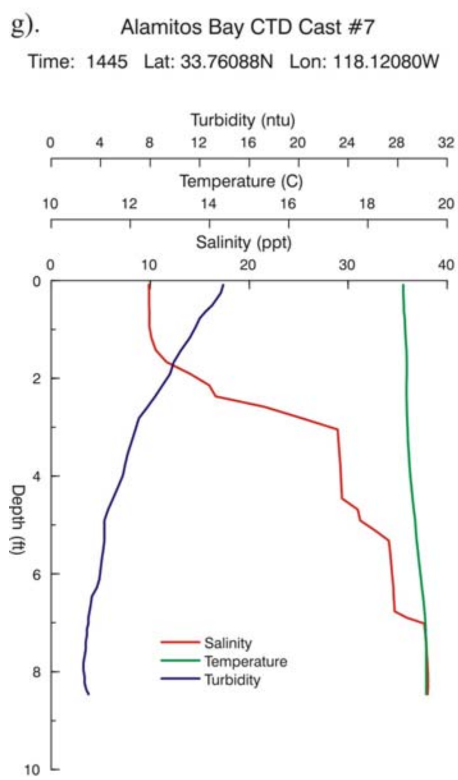
e).



f).



g).



h).

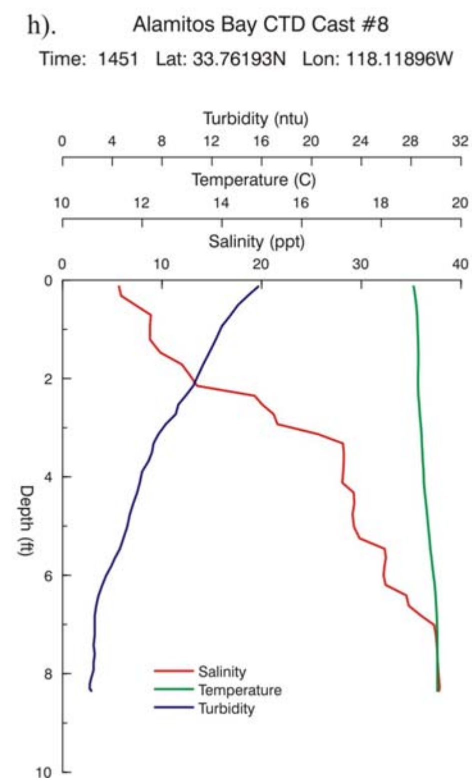
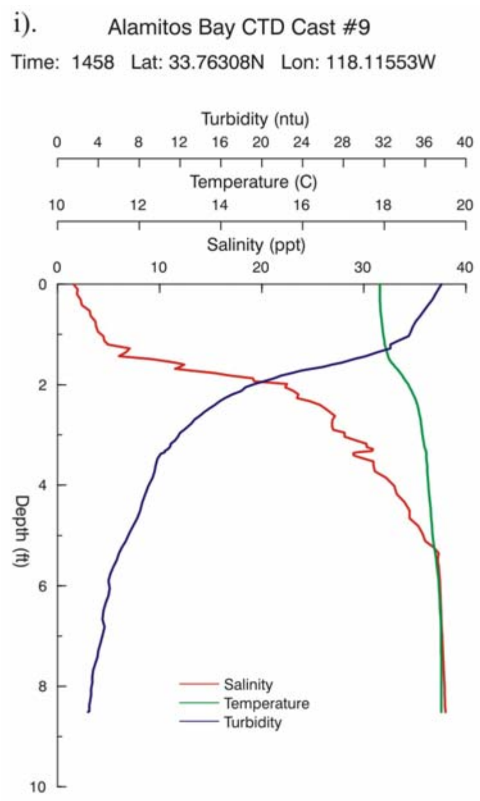
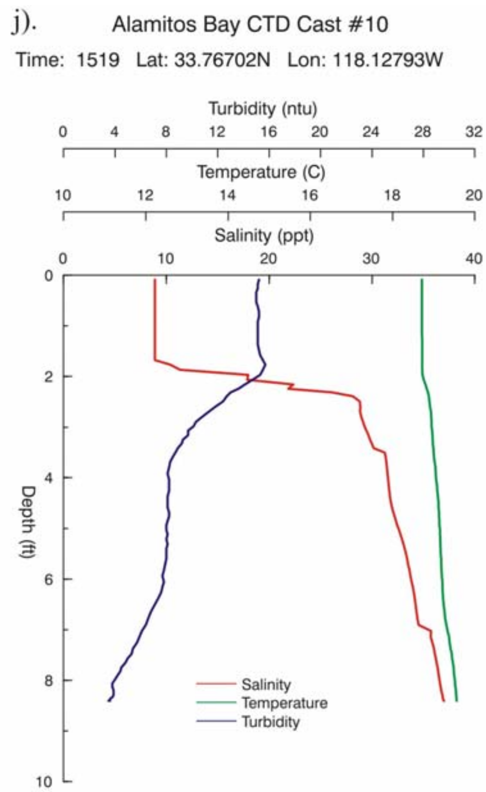


Figure 8.2(e-h) CTD Casts Taken During Alamitos Bay Receiving Water Study. (Locations of each cast are shown on Figure 8.1)





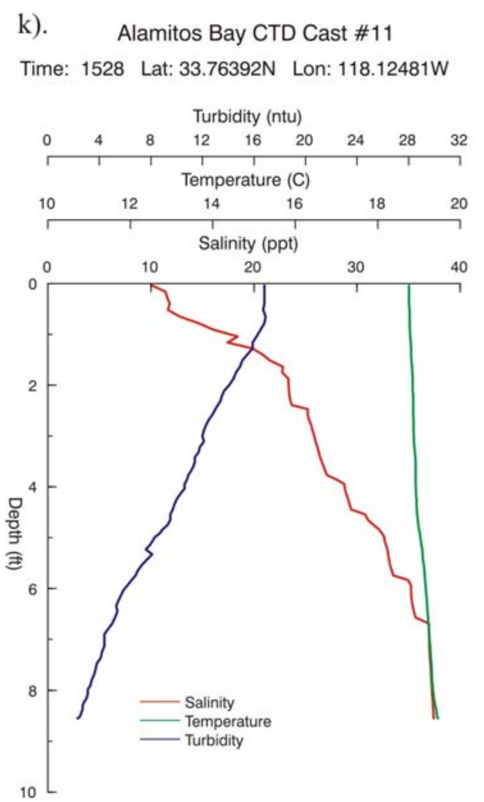


Figure 8.2(i-k) CTD Casts Taken During Alamitos Bay Receiving Water Study. (Locations of each cast are shown on Figure 8.1)

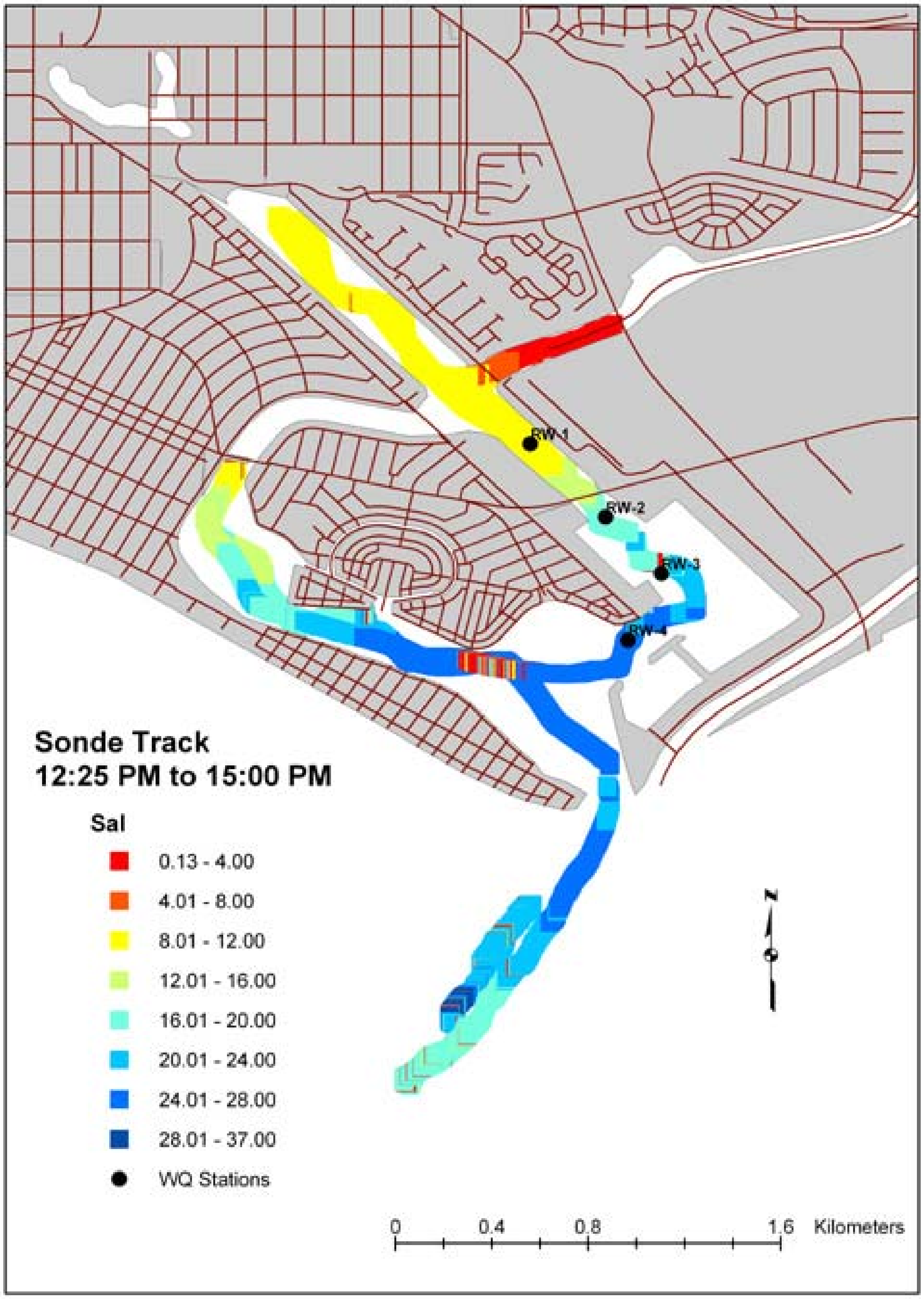


Figure 8.3 Map of Surface Salinity in Alamitos Bay with Water Quality Sampling Locations, 10/20/2004.

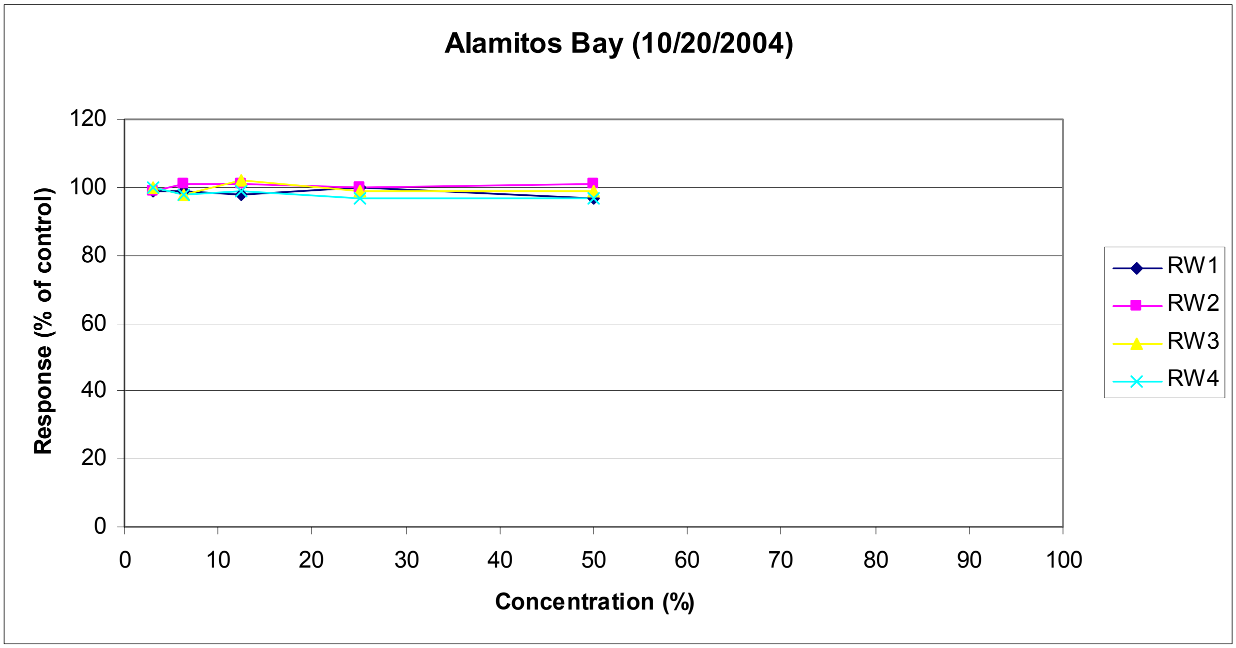


Figure 8.4 Toxicity Dose Response Plots for Sea Urchin Fertilization Tests using Stormwater Plume Samples collected from Alamitos Bay.

Table 8.1 Summary of Receiving Water Quality in Stormwater Plume Samples from Alamitos Bay.

	Receiving Water Monitoring Sites			
ANALYTE	**RW1**	**RW2**	**RW3**	**RW4**
Conventionals				
pH	6.9	7.2	7.5	7.9
Specific Conductance (EC – µmhos/cm)	15000	21000	28000	38000
Salinity (ppt)	8.3	12	16	21
Total Suspended Solids (mg/L)	12	13	9.8	11
Ammonia as N (mg/L)	0.15	0.22	0.34	0.13
Total Metals (µg/L)				
Cd	0.134	0.101	0.088	0.087
Cu	8.5	8.42	8.69	3.46
Ni	2.26	2.01	1.98	1.64
Pb	2.63	2.27	1.93	1.89
Zn	56.1	47.7	38.6	15.8
Dissolved Metals (µg/L)*				
Cd	1U	1U	1U	1U
Cu	2.9	2.9	4	2.3
Ni	R	R	R	R
Pb	1U	1U	1U	1U
Zn	25	18	18	5.7
Organophosphate Pesticides (µg/L)				
Chlorpyrifos (Dursban)	0.05U	0.05U	0.05U	0.05U
Diazinon	0.05U	0.05U	0.05U	0.05U
Atrazine	2U	2U	2U	2U
Cyanazine	2U	2U	2U	2U
Malathion	1U	1U	1U	1U
Prometryn	2U	2U	2U	2U
Simazine	2U	2U	2U	2U

U=Analyte was not detected at the associated reporting limit.
R=Value was rejected
*Total and Dissolved Metals were analyzed at different laboratories and were all properly QA/QCed.

Table 8.2 Toxicity of Receiving Water Samples Collected from Alamitos Bay during the 2004/2005 Storm Season.

		Receiving Water Monitoring Sites			
Test Species	**Endpoint**	**RW1**	**RW2**	**RW3**	**RW4**
S. purpuratus Fertilization	EC_{50}	>50%	>50%	>50%	>50%
	NOEC	25%	50%	50%	50%

9.0 DISCUSSION

9.0 DISCUSSION

The following sections discuss the quality of stormwater and dry weather discharges from the four 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 six years are examined for principal contaminants of concern. Loading rates calculated for each monitored watershed are examined to more effectively identify areas that contribute to excessive loads. Identification of such areas is intended to provide information needed to prioritize BMP implementation. Lastly, 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.

9.1 Comparison to Water Quality Criteria

Numerical standards are not available for stormwater discharges. Water quality criteria or objectives, however, can provide valuable reference points for assessing the relative importance of various stormwater contaminants. 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 in Table 9.1 for the receiving waters associated with each discharge point. Water quality criteria used as benchmarks are summarized in Table 9.2.

9.1.1 Wet Season Water Quality

Tables 9.3 through 9.6 provide a comparison of Event Mean Concentrations (EMCs) for each measured constituent with various water quality criteria. These benchmarks are intended to serve as a tool for interpreting the stormwater quality data and assuring beneficial uses are not impacted. 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.

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 9.2 are based upon a default hardness of 50 mg/L. Evaluation of any possible exceedance is based upon the actual hardness EMC for that site and event. 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 the CTR saltwater values since Alamitos Bay and the coastal waters of Long Beach are considered enclosed bays and estuaries. Values provided for the Basin Plan are primarily based upon 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).

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. In Southern California, the National Atmospheric Deposition Program (NADP 2003) indicates that pH associated with rainfall is typically 5.2. During the 2002/2003 monitoring period between 50 and 67 percent of the stormwater samples had measured pH values that were below the lower Basin Plan limits of 6.5. In each case pH concentrations were in the range of 6.2 to 6.5. The following year (2003/2004) none of the pH measurements were below 6.5. The only exceedance of Basin Plan criteria was a slightly elevated pH of 8.78 in stormwater discharged from the Dominguez Gap Pump Station. This season, 25 percent of the pH measurements were less than the lower receiving water quality criteria of 6.5 but no cases of elevated pH values were encountered. The larger Los Cerritos Creek watershed was the only site where pH values stayed within Basin Plan water quality objectives. Alkalinity, which provides an indication of buffering capacity of the water, was less than 58 mg/L at all sites and showed no correlation with pH.

All grab samples taken for bacteria exceeded Basin Plan water quality criteria. As previously noted in this and other stormwater programs, bacteria are commonly found at very high concentrations in stormwater.

Benchmark reference values were commonly exceeded at least once for a total of four different total recoverable metals. These included aluminum, copper, lead, and zinc. The aluminum drinking water quality criteria of 1000 ug/L was exceeded in 50% of the samples from the Belmont Pump Station ,75% of the samples from Bouton Creek, and all stormwater samples from Los Cerritos Channel and the Dominguez Gap Pump Station (Tables 9.3 through 9.6). Concentrations of total recoverable copper, lead and zinc in runoff from the mass emission sites routinely exceeded Ocean Plan criteria. The Ocean Plan total recoverable lead criterion was exceeded for all events at all locations. Similarly, the Ocean Plan total recoverable zinc criterion was exceeded in all cases except for the third storm event in Bouton Creek. Total recoverable copper concentrations exceeded the Ocean Plan daily maximum criterion of 12 ug/L in all cases except for one monitored event at the Bouton Creek station and another event at the Dominguez Gap Pump Station monitoring site.

Water quality criteria were exceeded for three other total recoverable metals during the first flush sampling event at the Los Cerritos Channel monitoring site. Concentrations of cadmium, chromium and nickel were detected at concentrations approximately five times greater than in stormwater from subsequent events at this site. These elevated concentration were associated with exceptionally high levels of suspended solids (TSS=940 mg/L).

Benchmark reference values were frequently exceeded for dissolved forms of the three metals most common in stormwater runoff. The CTR freshwater criterion was exceeded during all events at all sites for dissolved copper. Dissolved copper was also found to be equal to or greater than the CTR saltwater criterion in all cases. Concentrations of dissolved lead frequently exceeded the CTR freshwater criterion; however, this was often due to extremely low hardness values typical of many urban catchments. In 11 out of 16 cases, hardness values in the composite samples were less than 25 mg/L. In five of these cases, hardness measured between 11 and 17 mg/L. Historically, EPA had recommended that the criteria be calculated using a hardness value of 25 mg/L when measured hardness values were less than 25 mg/L. This was due to the fact that most of the toxicity data used to develop the criteria were based upon water with hardness values between 25 and 400 mg/L. The CTR (USEPA, 2000) changed this guidance to require use of the actual measured value whenever this condition occurred. Using the CTR guidance, the freshwater criterion for dissolved lead is less than half the current project reporting limit of 0.5 ug/L. A recent Stormwater Monitoring Coalition (SMC) laboratory guidance document (Gossett, Renfrew and Schiff, 2004) recommends use of a target reporting limit of 1.0 ug/L for lead.

Exceedances of the CTR freshwater criterion for dissolved zinc were less common than observed for either dissolved copper or lead (Tables 9.3 through 9.6). Concentrations of dissolved zinc exceeded the criterion during all storm events monitored at the Belmont Pump Station, 75% of the events monitored at the Bouton Creek site and 50% of those at the Los Cerritos Channel monitoring site. Concentrations of dissolved zinc in stormwater discharges from the Dominguez Gap Pump Station were all below the freshwater criteria.

Stormwater runoff from the City of Long Beach has typically contained very few organic compounds in excess of available reference criteria in runoff from the four mass emission sites. This trend continued during the past season. Only one chlorinated pesticides, 4-4' DDT, was detected in stormwater at levels above receiving water quality criteria during a single event at the Belmont Pump Station.

Organophosphate pesticides continue to be the most common organic compounds detected, however occurrences of these compounds were limited to two of the four mass emission monitoring sites. These compounds were below detection limits in all stormwater collected from the Bouton Creek and Dominguez Gap Pump Station. Concentrations of diazinon exceeded CDF&G water quality criteria in 50% of the samples from the other two sites, Belmont Pump Station and the Los Cerritos Channel. Water quality criteria for chlorypyrifos were only exceeded during the first two storm event of the season in runoff from the Los Cerritos Channel.

9.1.2 Dry Season Water Quality

Water quality of dry weather discharges has been generally consistent of the past six years. Dry season water quality has not tended to vary greatly between sites or sampling dates. In general, the concentrations of suspended particulates and total recoverable metal concentrations are low in dry weather runoff. Trace metals are predominantly in the dissolved form. Hardness is also consistently high which tends to mitigate the effects of the dissolved metals (Table 9.7 through 9.9). As a result, most trace metals were below CTR freshwater criteria during both dry weather sampling events. The only metal criterion exceeded in dry weather flows was the dissolved copper CTR saltwater criterion. This benchmark was exceeded in both dry weather samples from the Los Cerritos Channel and one event at both the Bouton Creek and Belmont Pump Station monitoring locations. The CTR specifies that saltwater criteria apply when salinity of the receiving water is equal to or greater than 10ppt for 95% of the time. Similarly, freshwater criteria apply when the receiving water body is 1ppt or less for 95% of the time. In the case of salinities between 1ppt and 10ppt, the most stringent of the two criteria apply.

9.2 Temporal Trends of Stormwater Contaminants

We have continued to examine temporal trends for selected trace metals, two organophosphate pesticides, TSS and bacteria. 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 (Figures 9.1 through 9.12). Time series are presented for total and dissolved concentrations of five trace metals including cadmium, copper, nickel, lead and zinc. Due to the typically large differences between total and dissolved lead concentrations, a separate graphic is included to detail changes in dissolved lead over time. Time series are also provided for two important organophosphate pesticides, chlorpyrifos and diazinon, that have been implicated as major sources of toxicity. Temporal comparisons of bacteria include total and fecal coliform as well as enterococcus (Figures 9.13 through 9.16). The figures include all wet and dry weather data for the past six years at each monitoring site. Periods of dry weather are indicated by the shaded areas.

With a few possible exceptions, temporal trends in total and dissolved concentrations of trace metals have remained consistent over the life of the permit. For the most part, dissolved concentrations of cadmium, copper, and nickel do not vary substantially during wet and dry weather periods. In the first few years of the permit, dissolved lead was also found to be comparable during both wet and dry weather periods. In recent years, concentrations of dissolved lead in dry weather discharges have tended to be lower than observed during stormwater events. Concentrations of dissolved lead measured in dry weather discharges over the past two years are typically at or near the detection limit of 0.5 ug/L. In the first two years of the program dissolved lead commonly ranged from 1 to 3 ug/L. Although this is promising, it is too early to determine whether this is a real trend or simply an artifact of changing seasonal weather patterns. Dissolved zinc concentrations differ from most other metal in that they are often higher during storm events. Elevation in dissolved zinc has often been associated with increasing toxicity in the sea urchin fertilization test.

Concentrations of total copper, lead and zinc are consistently higher in association with storm flows. Analysis of data from the first five years of this program (Kinnetic Laboratories, Inc., 2004) demonstrated that these metals, particularly lead, were strongly correlated with TSS. The relationship between concentrations of metals and TSS differed among sites with suspended solids from the Belmont Pump Station exhibiting substantially higher concentrations of copper, lead and zinc. Seasonal differences in total cadmium and nickel are less evident but the highest concentrations still tend to occur during winter storm events.

Concentrations of chlorpyrifos and diazinon, the two organophosphate compounds of greatest concern, do not appear to exhibit any long term trends. Occurrence of these compounds in both dry and wet weather runoff continue to be erratic as might be expected since the presence of either compound will typically represent localized, recent use of these pesticides.

Stormwater discharges from the Dominguez Gap Pump Station continue to have the lowest concentrations of total metals despite increases in concentrations reported in association with this season's storm events. The observed increase in concentrations of most total metals was associated with a series of closely spaced, large storm events that limited the time for infiltration and settling of particulates.

Fecal indicator bacteria often exceed Basin Plan water quality criteria during both wet and dry weather monitoring (Figures 9.13 through 9.16). Exceedances of these criteria are more common during storm events than during dry weather surveys. During recent dry weather surveys, concentrations of bacteria were notably less than experienced during storm events. This is partially due to higher concentrations of bacteria present during the large storm events that were monitored this past season.

Bacterial concentrations in dry weather runoff from Bouton Creek over the past six years of monitoring continue to have lower total and fecal coliform concentrations than typically encountered at the other two sites. Concentrations total and fecal coliform have been below Basin Plan single sample criteria in over 50% of the dry weather samples. Land use in the lower portion of this drainage is dominated by institutional use. It is possible that the lower densities of domestic animals associated with institutional land use is a factor contributing to the lower concentrations of total and fecal coliform bacteria at this site during dry weather.

9.3 Loading Rate Assessment

Estimates of pollutant loading rates were developed for selected constituents at each site by normalizing loads to a unit of 1000 acres. By normalizing the loads, direct comparisons can be made between drainage areas to assist in differentiating potential problem areas.

For illustration purposes, loading rates were developed for copper, lead, zinc, and diazinon. Loading rates for total and dissolved copper, lead and zinc are generally similar at both the Belmont Pump Station and Bouton Creek sites (Figures 9.17 through 9.20). Loading rates for these same metals at the Dominguez Gap Pump Station are typically much lower. The lower loading rates from the Dominguez Gap Pump Station are most evident during the larger storm events of relatively short duration. When the region experiences a series of closely-spaced, high-volume storm events such as occurred in late December and early January, loading rates tend to increase due to insufficient time for settling and infiltration. Despite the increases in loading rates this year at the Dominguez Gap Pump Stations, loading rates remained lower or comparable to the other sites for trace metals.

Overall total metals loading rates from the Los Cerritos Channel tend to be among highest measured at the four mass emission sites. Increased total metals loading rates are particularly evident in association with larger rainfall events. This pattern suggests that possible mobilization of an upstream source of particulate metals in the watershed or resuspension of instream sources.

9.4 Stormwater Toxicity

A total of twelve wet weather samples were analyzed for toxicity during the monitoring period. All twelve of those samples were tested with water fleas (*Ceriodaphnia*) and sea urchins (24 total bioassays).

The six storms were collected over a period of approximately five months, with the first three storms sampled within a ten-day period in October. Two additional storms were sampled during December and the final storm sample was collected in late March.

The Belmont Pump station was sampled during the second and third October storms, one late December storm and in late March. Each storm produced generally similar toxicity results in the Belmont Pump samples; there was virtually no toxicity to *Ceriodaphnia* and consistent, minor toxicity to sea urchins.

The Bouton Creek samples were collected during four successive storms, including all three October storms and the first December storm. Toxicity to water fleas was seen only in the first storm of the year, while sea urchin toxicity was detected in the first storm of the year and again in the December storm.

Samples from the Los Cerritos Channel station were collected during all three October storms and during the late December storm. A high level of acute toxicity to *Ceriodaphnia* triggered a TIE in the first event which was the first major storm event of the season. No water flea toxicity was seen in association with the subsequent three samples. Toxicity to sea urchins was detected in three of four storm samples. The magnitude of sea urchin chronic toxicity was somewhat elevated, ranging from 2 to 16 TU_c, but acute toxicity was near or below the detection threshold.

The toxicity of the wet weather samples analyzed during the monitoring period was somewhat less than that measured during the previous monitoring period (Figure 9.21). One Belmont Pump sample and one Los Cerritos Channel sample contained 16 TU_c of toxicity to sea urchins, but both samples showed low acute toxicity (<2 TU_a). Neither Belmont Pump nor Bouton Creek samples showed urchin toxicity as high as that measured in previous monitoring years, and water flea toxicity at those stations remained at the low level seen previously. Los Cerritos Channel samples were generally less toxic to urchins than those tested in previous years, but showed slightly elevated chronic toxicity compared with the previous monitoring period. With the exception of the first storm sample, toxicity to the water flea was generally absent at the Los Cerritos Channel monitoring station during this monitoring period.

9.4.1 Dry Weather Toxicity

Neither the August 2004 nor the May 2005 dry weather discharge samples collected from Belmont Pump station produced any decrease in water flea survival or reproduction. Results from the previous monitoring period were generally similar, showing only reduced reproduction in the undiluted sample of September 2003 and no decreased survival or reproduction in May 2004.

There was no measurable decrease in sea urchin fertilization in either the August 2004 or the May 2005 Belmont Pump sample. The September 2003 dry weather Belmont sample was mildly toxic to sea urchins, producing decreased fertilization in the 50% concentration only. There was no urchin toxicity in the May 2004 sample.

The salinity of the dry weather sample collected from Bouton Creek in August 2004 was 1.6 ppt. This slightly elevated salinity was expected to have only a minor influence on water flea toxicity data. This sample showed both lethal and reproductive toxicity to water fleas. The survival NOEC was 25% sample and the LC50 was 50% sample. The NOEC for reproduction was 12.5% sample and the EC50 was 28.7% sample. In May 2005 there was again a slight elevation of sample salinity (2.1 ppt) which was not expected to substantially influence toxicity responses. There was no reduction of either survival or reproduction of water fleas in the May 2005 bioassays. The magnitude of the water flea toxicity in the August 2004 sample was much less than that seen in the September 2003 dry weather test, probably because the markedly elevated salinity of the 2003 sample affected the test performance of this freshwater organism. The Bouton Creek sample of May 2005 showed lower toxicity than that of May 2004, again probably because of the relatively high salinity of the 2004 sample.

Neither the August 2004 nor the May 2005 dry weather sample from Bouton Creek was measurably toxic to sea urchins, with TU_a values of <2. There was minor urchin toxicity (4 TU_c, <2 TU_a) seen in two of the four wet weather samples tested in the current monitoring period. There was no measurable toxicity in either the September 2003 or the May 2004 Bouton Creek samples.

The August 2004 dry weather sample from Los Cerritos Channel produced >16 TU_c of lethal toxicity and >16 TU_c of reproductive toxicity to water fleas, The May 2005 dry weather sample also showed toxicity to water fleas, producing 8-16 TU_c. The magnitude of dry weather toxicity to water fleas was generally greater than that seen in 2004-2005 wet weather samples and also greater than that seen in the 2003-2004 dry weather data.

There was no measurable sea urchin toxicity in the Los Cerritos Channel dry weather sample in either August 2004 or May 2005. Wet weather urchin chronic toxicity was present in all but one 2004/2005 Los Cerritos Channel sample. TU_cs ranged from 2-16. Acute toxicities were low, however, ranging from <2 to 2.09 TU_a. The magnitude of dry weather toxicity to urchins was less than that exhibited in September 2003 (4 TU_c), but similar to that in May 2004.

In the 2000/2001 and 2001/2002 monitoring periods, dry weather samples collected in the spring generally tended to be less toxic than stormwater samples collected in those respective winters. These toxicity results were cited to support the indication that "there are significant differences in the composition of stormwater and dry weather discharge from the City of Long Beach" (Kinnetic Laboratories Inc. and Southern California Coastal Water Research Project, July 2002)

Data from the 2002/2003 monitoring period indicated that the magnitude of toxicity of spring dry weather samples was less than wet weather toxicity at the Belmont Pump station. At the Bouton Creek station, spring dry weather and wet weather toxicities were of similar magnitude, while at the Los Cerritos Channel station spring dry weather discharge showed generally greater toxicity than stormwaters, with particularly elevated toxicity to sea urchins in the May 2003 collection.

Toxicity results from the 2003/2004 monitoring period suggested that at the Belmont Pump Station, wet weather toxicity to sea urchins was greater than spring dry weather toxicity, while toxicity to water fleas was absent. Bouton Creek samples were more toxic to water fleas during both dry weather sampling periods than during storms, probably due in large part to elevated sample salinity during dry weather. Cerritos Channel samples generally showed no toxicity to sea urchins during both wet and dry weather (except for the second storm). Toxicity to water fleas was much enhanced in the spring dry weather sample.

Data from the current (2004/2005) monitoring period indicate that at Belmont Pump, toxicity to water fleas was very low during both wet and dry weather periods, with only the last wet weather sample showing measurable toxicity. Urchin toxicity at Belmont was present during three of four storms, but there was no measurable toxicity in either dry weather sample. Bouton Creek samples were measurably toxic to water fleas in the spring dry weather sample, but not in any storm sample or in the fall dry weather sample. Neither of the Bouton Creek dry weather samples was toxic to sea urchins, while moderate urchin toxicity was seen in the first and fourth storm samples. Toxicity to water fleas of dry weather Los Cerritos Channel samples was generally higher than that of wet weather samples. Only the first storm of the season produced *Ceriodaphnia* toxicity in water from the Los Cerritos Channel, while both spring and fall dry season samples showed sufficient toxicity to trigger water flea TIEs. In contrast, sea urchins showed no measurable dry weather toxicity while showing reduced fertilization in three of four wet weather samples from Los Cerritos Channel.

Toxicity data from recent monitoring periods, then, do not support the hypothesis that spring dry weather samples, collected after the storm season has passed, show consistently decreased toxicity and possible seasonally-related composition. Data from the most recent monitoring periods suggests a species-related toxicity difference with respect to wet and dry weather samples; sea urchins at all three stations showed lower toxicity in dry weather samples than in storm samples, while toxicity to water fleas appears to be enhanced in dry weather, especially at Cerritos Channel (see Section 9.4.3).

9.4.2 Temporal Toxicity Patterns

The toxicity data from the 2000/2001, 2001/2002, 2002/2003 and 2003/2004 monitoring periods suggest that seasonal flushing may be an important factor affecting the variability in stormwater toxicity, and current data from the 2004/2005 monitoring period generally support that suggestion.

The Belmont Pump station was not sampled during the first storm event, but the second storm, just three days later, showed significant toxicity to sea urchins (16 TU_c, <2 TU_a). The third storm, collected one week after the second, showed lower urchin toxicity (4 TU_c, <2 TU_a). The fifth storm (three weeks later) produced no measurable toxicity to urchins, while the sixth storm, collected almost two months after the fifth storm, showed toxicity (4 TU_c, <2 TU_a) to sea urchins. Only the sixth storm showed any toxicity to water flea survival (2 TU_c, 1 TU_a).

Bouton Creek samples showed minor toxicity to sea urchins only in the first and fourth storms, with 4 TU_c in each storm. *Ceriodaphnia* showed minor reproductive toxicity only in the first storm.

Los Cerritos Channel samples produced toxicity to sea urchins in the first storm (16 TU_c), no urchin toxicity in the second storm, minor toxicity (4 TU_c) in the third storm and slightly increased (8 TU_c) toxicity to urchins in the fifth storm. *Ceriodaphnia* results show 8TU_c in the first storm and no toxicity in storms two, three and five.

With the possible exception of storm two at Belmont Pump, there is a clear trend toward decreasing toxicity with increased flushing

In previous studies, it was found that early season storm water runoff from Ballona Creek (Los Angeles County) was more toxic than samples obtained later in the season (Bay, Jones and Schiff. 1999).

9.4.3 Comparative Sensitivity of Test Species

There were a total of twelve wet weather samples tested for toxicity with both water fleas and sea urchins. Toxicity was detected to one or both species in eight of those samples and the sea urchin fertilization test was the most sensitive toxicity test method in seven (88%) of those samples. In the eighth sample the two species showed equal sensitivity. The water flea survival/reproduction test showed substantial toxicity in a single stormwater sample (the October 17 sample from Los Cerritos Channel (5.5 TU_a, 8 TU_c). That same sample produced 16 TU_c and <2 TU_a to sea urchins. A second sample (Belmont Pump, March 23) showed minimally reduced water flea survival (2 TU_c), no decrease in water flea reproduction (1 TU_c), and 4 TU_c of sea urchin toxicity.

There were six dry weather discharge samples tested using water fleas and sea urchins. Of those samples none showed toxicity to sea urchins and, three showed toxicity to water flea survival and reproduction. Thus, of the three dry weather samples showing toxicity, the *Ceriodaphnia* test was the more sensitive in all three (100%). Note that none of the six samples produced sea urchin toxicity.

This pattern of sensitivity (sea urchin>water flea) in storm waters was similar to that observed during the 2000/2001, 2001/2002 and 2002/2003 monitoring programs and in a study of urban stormwater toxicity in San Diego (Southern California Coastal Water Research Project, 1999). Species sensitivity in dry weather discharge samples was completely reversed (water flea>sea urchin). This dry weather species sensitivity reversal is markedly different from data in recent monitoring periods. In 2001/2002, urchins were generally the more sensitive species in dry weather samples, while in both 2002/2003 and 2003/2004 the two species showed approximately equal sensitivities.

9.4.4 Relative Toxicity of Stormwater

Table 9.10 compares the frequency and magnitude of stormwater toxicity from the Long Beach stations in 2004/2005 with that of stormwater samples from Long Beach in previous years and with toxicity in other southern California watersheds. The data suggest little change from the previous year in the frequency of Long Beach stormwater toxicity to sea urchins. The magnitude of 2003/2004 toxicity also seems similar to previous years.

There was a return of toxicity frequency for water fleas in 2004/2005 to levels seen before the 2003/2004 monitoring year, while magnitude of toxic responses was elevated over the previous two monitoring periods.

Results from the Chollas Creek and Ballona Creek studies would be expected to be similar to the Long Beach study, as these samples were obtained from smaller highly urbanized watersheds, relative to the samples from the L.A. River and San Gabriel River. Stormwater toxicity testing conducted at the four City of Long Beach mass emission sites further demonstrates the general comparability of these watersheds. Toxicity in Long Beach samples and in those from other watersheds is variable among storms, and stormwater toxicity is most often detected using the sea urchin fertilization test.

9.4.5 Toxicity Characterization

The TIE testing program for this monitoring period was largely successful. Phase I TIEs were performed on one wet and two dry weather samples and both yielded useful information. There were fewer successful TIEs performed during this monitoring period than in previous years. The results of the 2004/2005 dry weather TIE analyses were similar to the data obtained from the previous year (Table 9.11).

This year's water flea TIE data for the Cerritos Channel dry weather sample of 31 August 2004 indicated that a non-polar organic (NPO) was the most likely category of the toxic constituents. This conclusion is supported by the effectiveness of the C18 solid phase extraction (SPE) treatment for eliminating toxicity to the water flea. Organophosphate pesticides (OPs), a frequent cause of runoff toxicity to water fleas, did not seem to be an important toxicant in this sample because the C18 treatment was effective whereas the piperonyl butoxide (PBO) treatments did not substantially reduce toxicity. At the highest PBO concentration toxicity was enhanced, which suggests the possibility that pyrethroid pesticides may have contributed to sample toxicity, since PBO acts as a pyrethroid synergist.

The water flea TIE performed on the Los Cerritos Channel dry weather sample of 25 May 2005 yielded essentially similar results. Once again, C18 SPE was completely effective in eliminating toxicity. Neither ethylenediaminetetraacetic acid (EDTA) nor sodium thiosulfate (STS) treatment was effective. Centrifugation was equally ineffective. PBO treatment produced some toxicity reduction at the lowest treatment concentration, and enhanced toxicity at the two higher concentrations. ELISA analysis suggested the presence of two OP pesticides (diazinon and chlorpyrifos) at concentrations which would be expected to produce toxicity. The suggested non-polar organic toxicants were those two OP pesticides plus a possible contribution from pyrethroids.

The water flea TIE results for the wet weather Los Cerritos Channel sample of 17 October 2005 identified PBO and C18 extraction as the most effective treatments for removing toxicity, both treatments virtually eliminating sample toxicity. Centrifugation and EDTA treatment produced slight toxicity reductions. Non-polar organic compound(s) were suggested as the primary toxicant(s) in the sample, and the likely compound(s) were organophosphate pesticides. There may have been a minor toxic contribution from particle-bound compounds and divalent metals.

Correlation analysis of the toxicity and chemistry data provides an additional test of the association between stormwater toxicity and chemical contamination. The data from all four storms during the 2004/2005 monitoring period were pooled for the correlation analyses. The correlation analyses generally confirm the conclusion from the previous study years, that the toxic responses measured in this study are related to the chemical composition of the stormwater samples. The toxic responses of sea urchins and/or water fleas were significantly correlated with increased concentrations of several stormwater constituents, including dissolved metals, TSS, and TOC (Table 9.12). Dissolved copper, lead, nickel and zinc were significantly correlated with toxicity to both species. In last years report, zinc and copper showed equally strong correlations with reduced sea urchin fertilization, closely followed by nickel. There was a weaker correlation with lead. Results from the current testing year were slightly different from those rankings, with nickel and copper showing equally strong correlations with urchin fertilization followed by zinc and lead. Data from 2002/2003 were similar to those from last year, but differed from monitoring data from earlier study years, which showed significant correlations only with dissolved copper and zinc.

A larger number of constituents were significantly correlated with toxicity to the water flea, including TSS, TOC, and dissolved metals including cadmium, copper, lead, nickel and zinc (Table 9.12). Increased concentrations of the OP pesticide diazinon had significant correlations with water flea toxicity (r=0.40 to 0.49) that were slightly elevated from the values reported in 2003/2004 (r=0.39-0.43) and markedly elevated from 2002/2003 (r=0.22-0.24). Correlations in 2001/2002 were better (r=0.54) and were clearly statistically significant.

Two of three water flea TIEs suggested that organophosphate pesticides were probably implicated as primary toxicants while correlation analysis suggested that diazinon was significantly correlated with water flea toxicity. The third water flea TIE, however, did not implicate organophosphates. Correlations provide information to help identify key constituents of concern, but the statistical results do not prove that those constituents are the cause of toxicity. The true cause of toxicity may be another (possibly unmeasured) constituent that has a similar pattern of occurrence in the samples.

A third method, comparing the measured and predicted toxic units of the samples was used to assess the importance of zinc, copper, and pesticides as a cause of the toxicity of Long Beach stormwater (Figures 9.22a, b, and c). The predicted toxicity of the sample was calculated from the measured concentrations of the chemical constituents and their corresponding EC50 or LC50. This toxic unit comparison was of limited value for this storm year, since only one wet weather sample showed measurable acute toxicity to sea urchins, and the magnitude of that toxicity was not sufficient to trigger a TIE. There were two samples (Bouton Creek and Los Cerritos) from the first storm (17 October 2004) that showed zinc concentrations that were predicted to produce substantial toxicity (8.2 and 4.4 Toxic Units, respectively) to sea urchins, but which did not show acute toxicity in bioassays (Figure 9.22c).

Comparison of the measured and predicted toxic units for the water flea tests (Figures 9.23a and b) also yielded little useful information, since virtually all of the wet weather samples were not toxic to the water fleas. The toxicity of the one sample containing substantial toxicity (Los Cerritos Channel, 17 October 2004) could not be completely accounted for by the measured concentrations of zinc, diazinon, and chlorpyrifos. The measured concentrations of OP pesticides and zinc accounted for only about 55% of the toxicity of this Los Cerritos sample, suggesting that additional unmeasured toxicants are present. The TIE results, which implicated an organophosphate pesticide as a primary toxicant and suggested a smaller toxic contribution from divalent metals, do not agree with the measured/predicted approach. As was the case with sea urchins, there were two samples that contained predicted toxicity in excess of that which was observed in bioassays. The Bouton Creek sample of 17 October 2004 contained about 2.4 predicted TUs of zinc, while bioassays showed no measurable effect on survival. Even more dramatically, the Los Cerritos sample of 20 October 2004 showed 5.5 TUs of the organophosphate pesticide chlorpyrifos with no observable toxicity in bioassays.

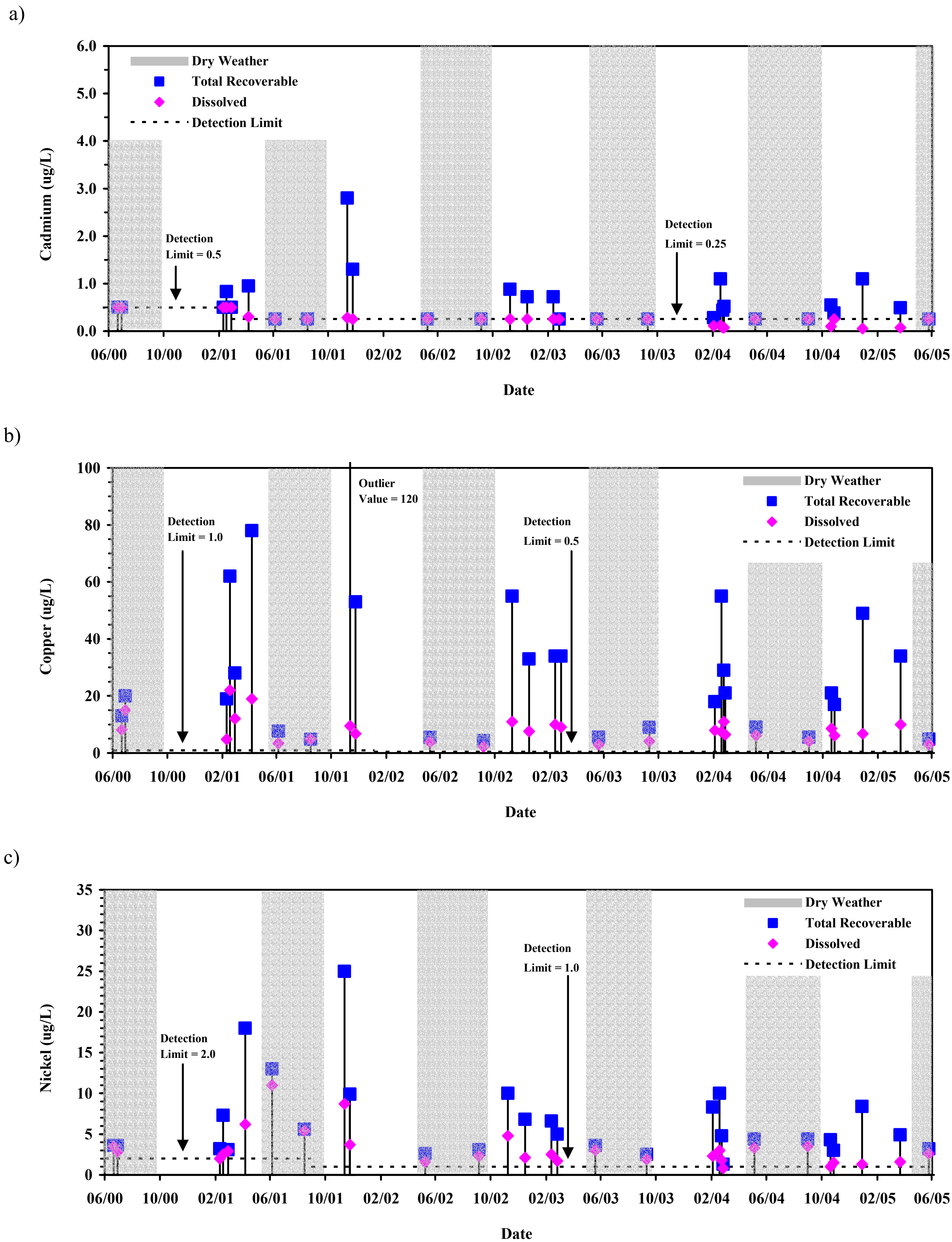
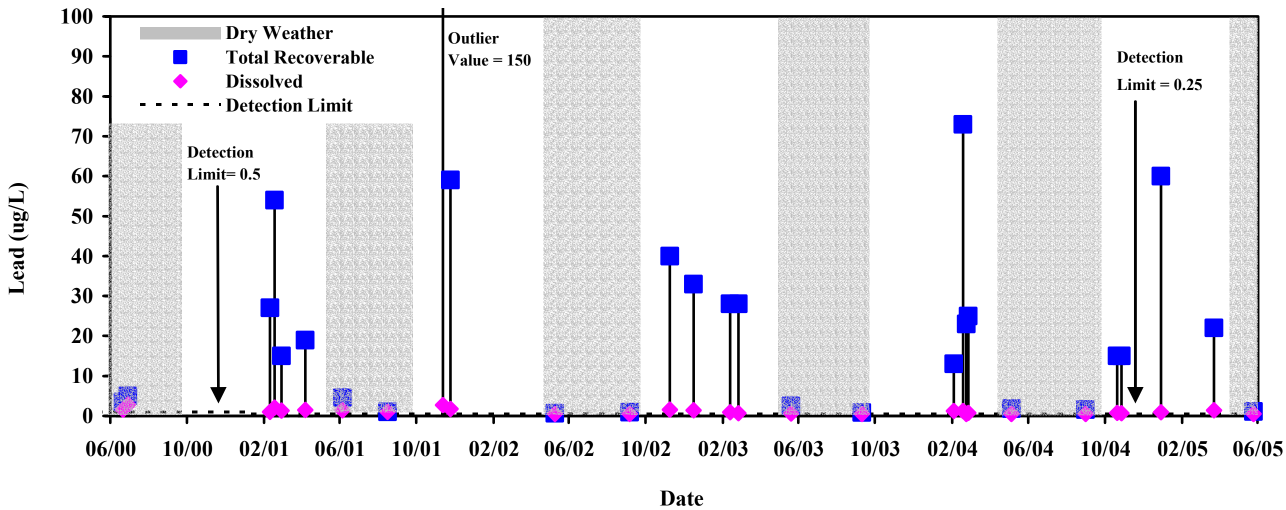
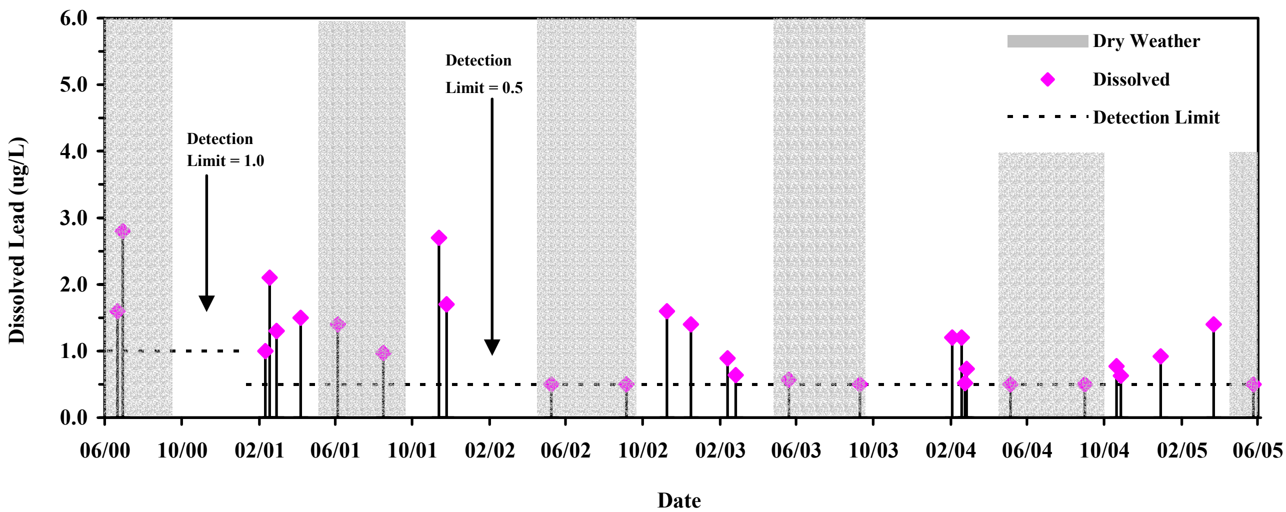


Figure 9.1 Belmont Pump Station Chemistry Results: a) Cadmium; b) Copper; c) Nickel.

a)



b)



c)

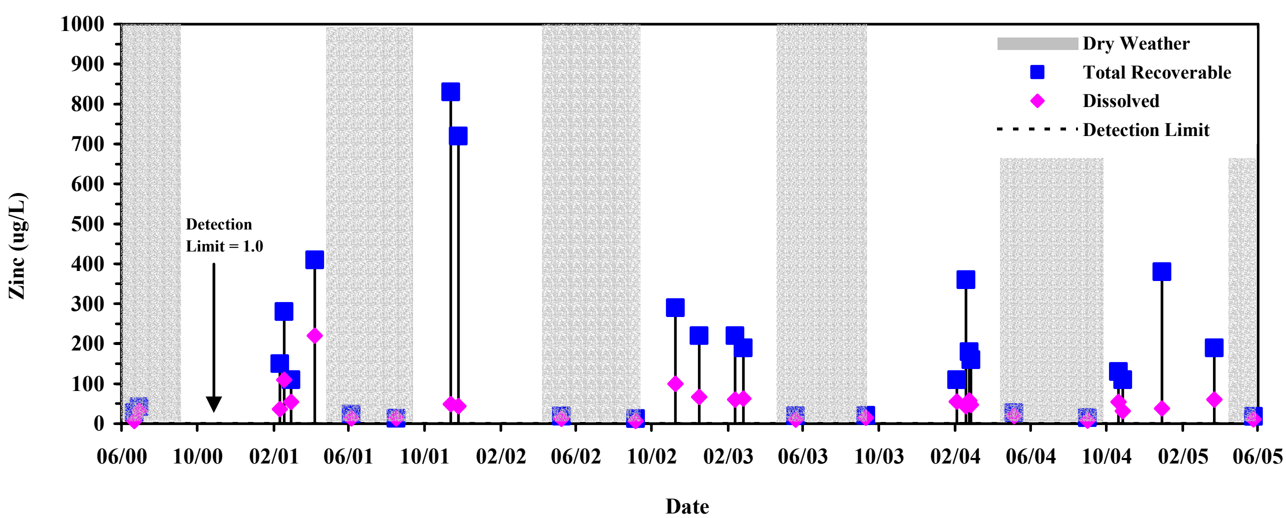


Figure 9.2 Belmont Pump Station Chemistry Results: a) Lead (total and dissolved); b) Lead (dissolved only); c) Zinc.

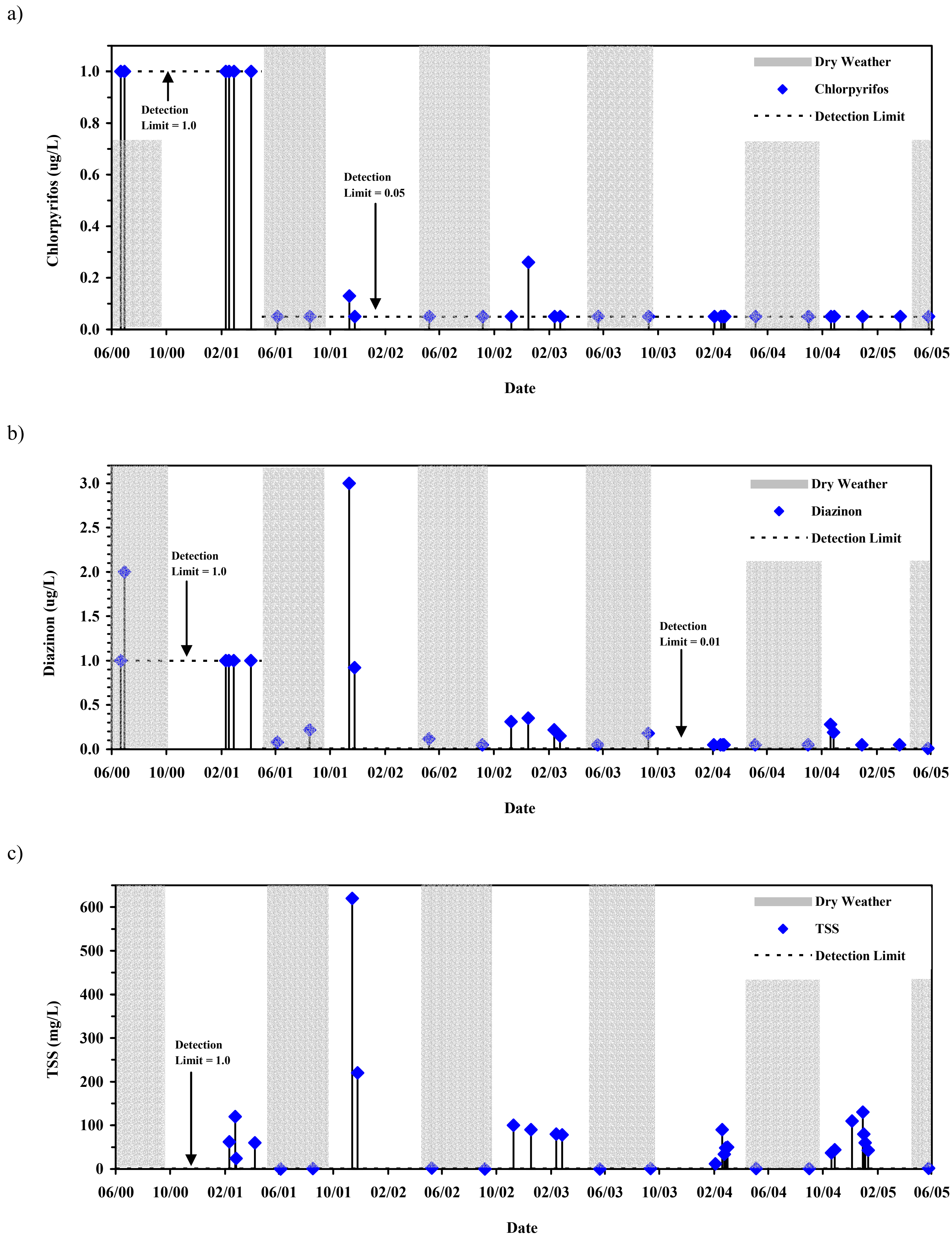


Figure 9.3 Belmont Pump Station Chemistry Results: a) Chlorpyrifos; b) Diazinon; c) TSS.

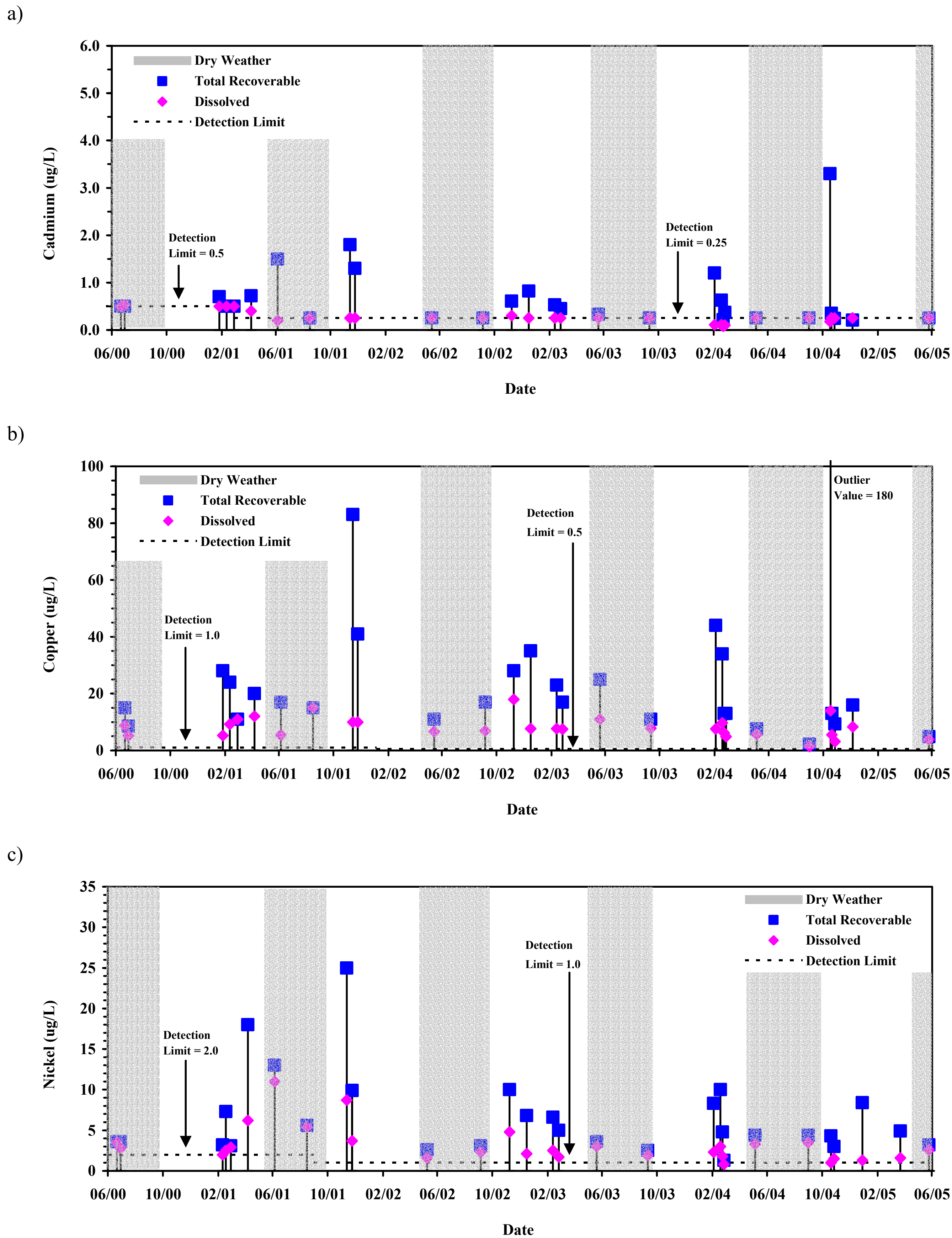
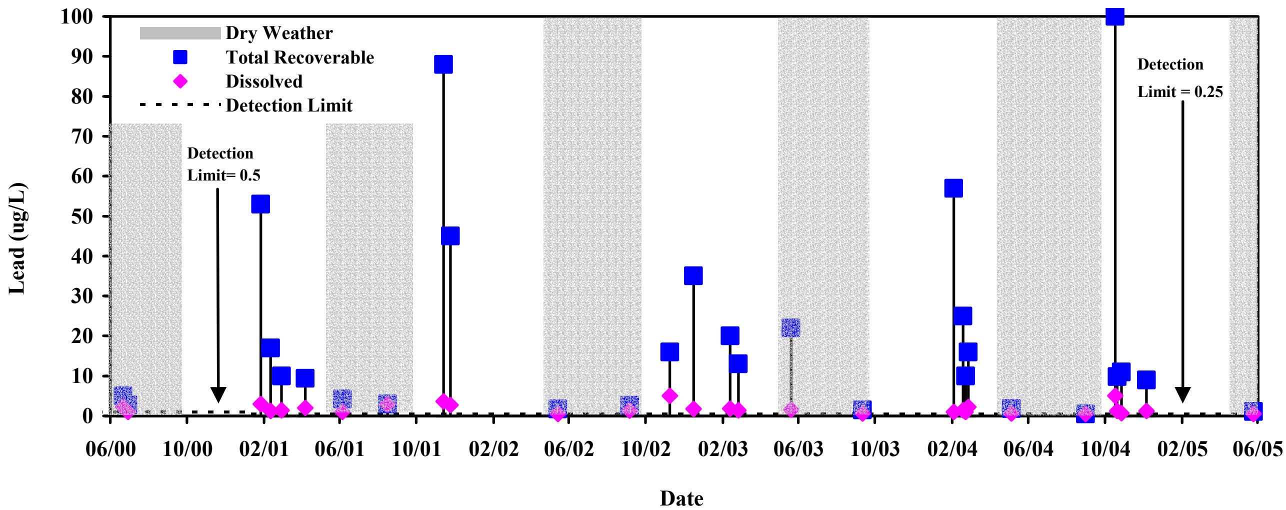
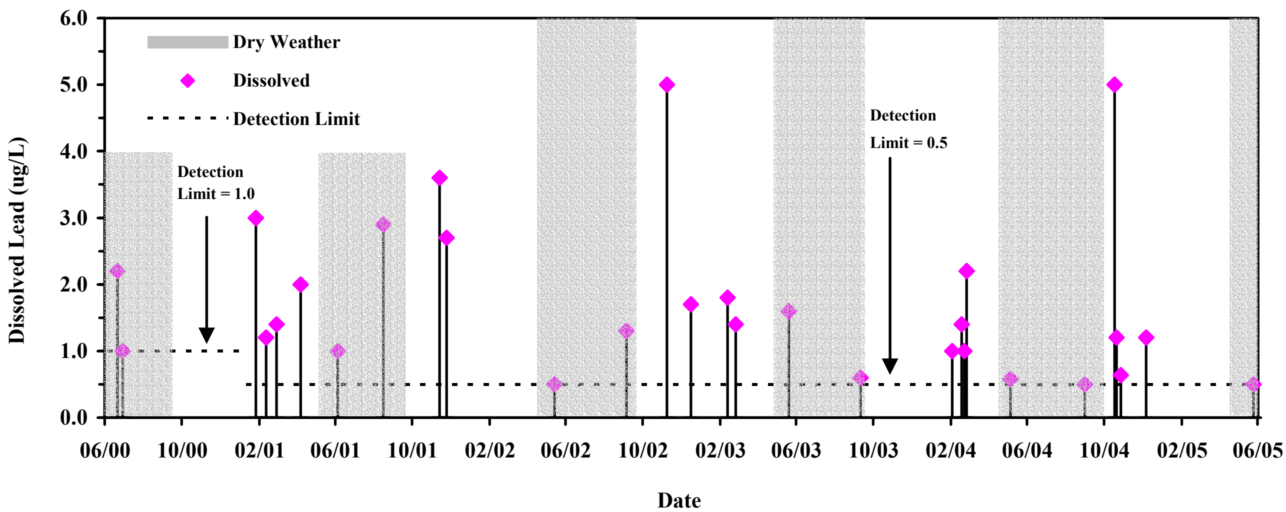


Figure 9.4 **Bouton Creek Chemistry Results: a) Cadmium; b) Copper; c) Nickel.**

a)



b)



c)

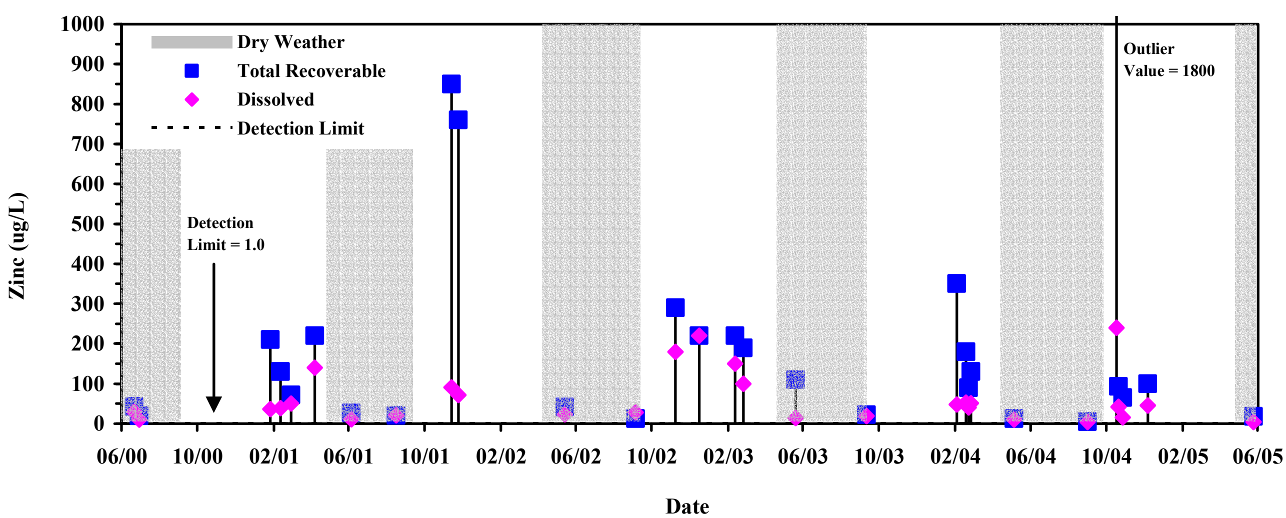
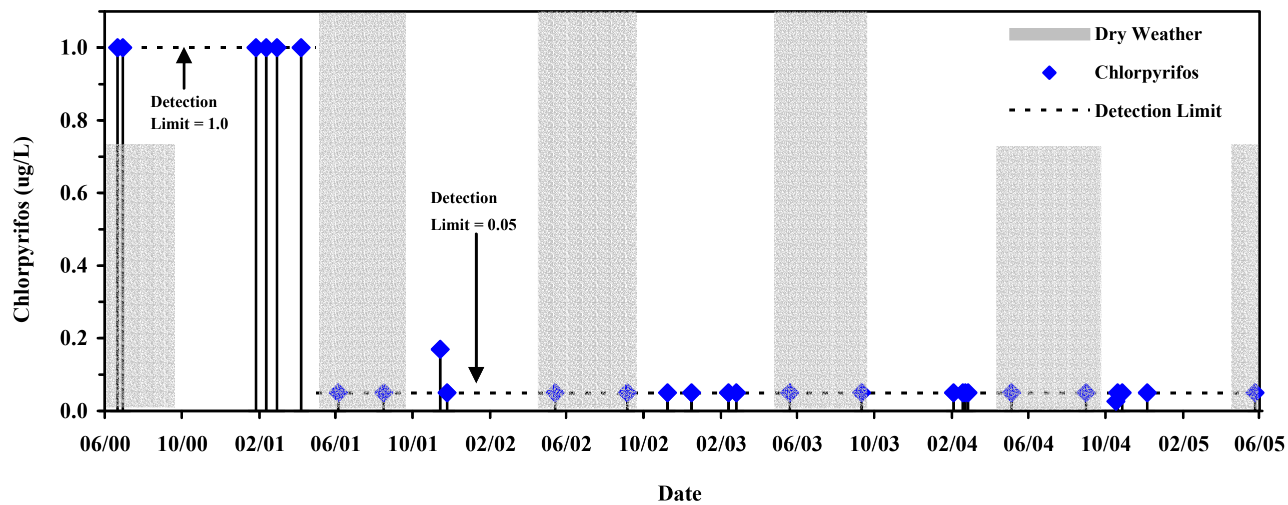
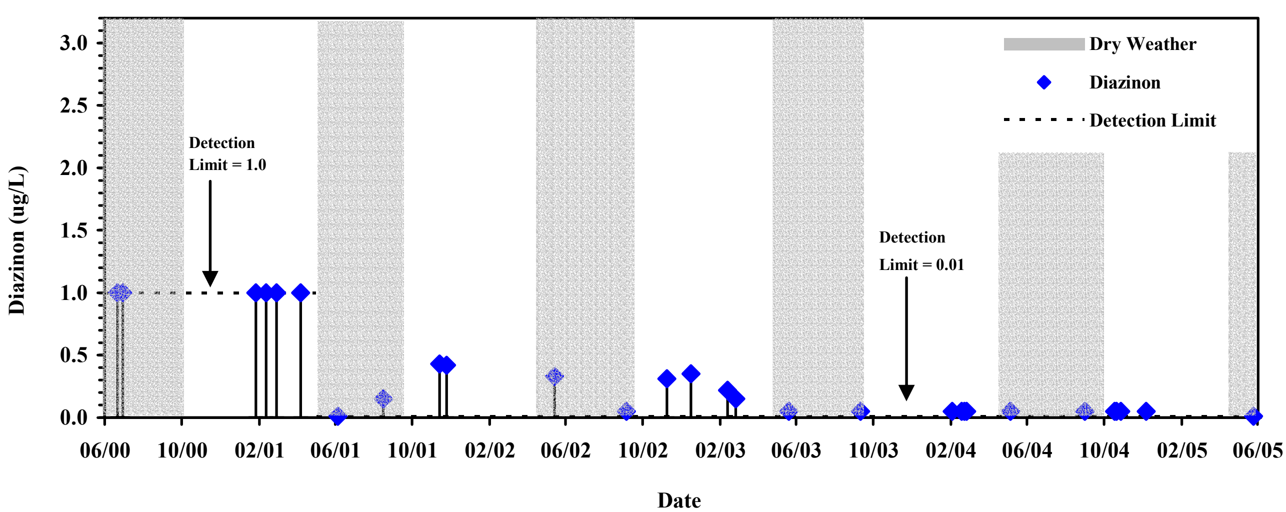


Figure 9.5 **Bouton Creek Chemistry Results: a) Lead (total and dissolved); b) Lead (dissolved only); c) Zinc.**

a)



b)



c)

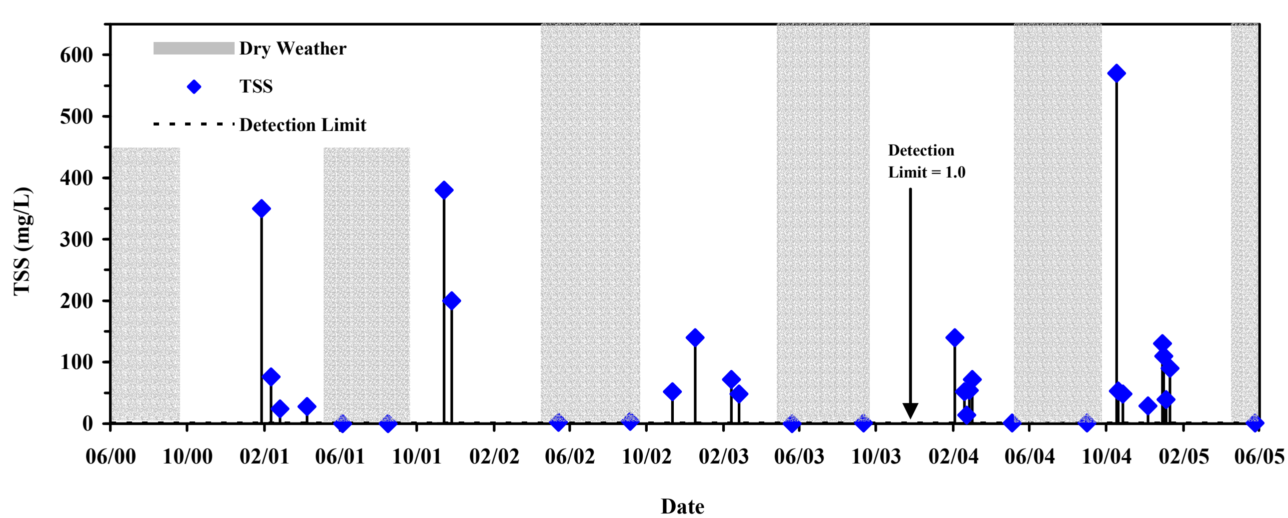
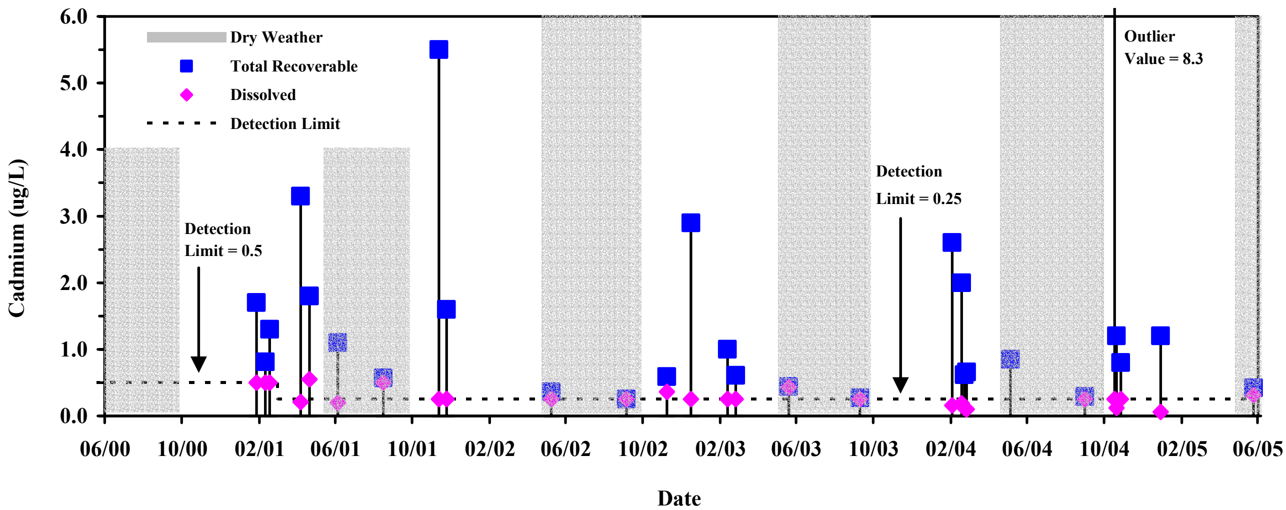
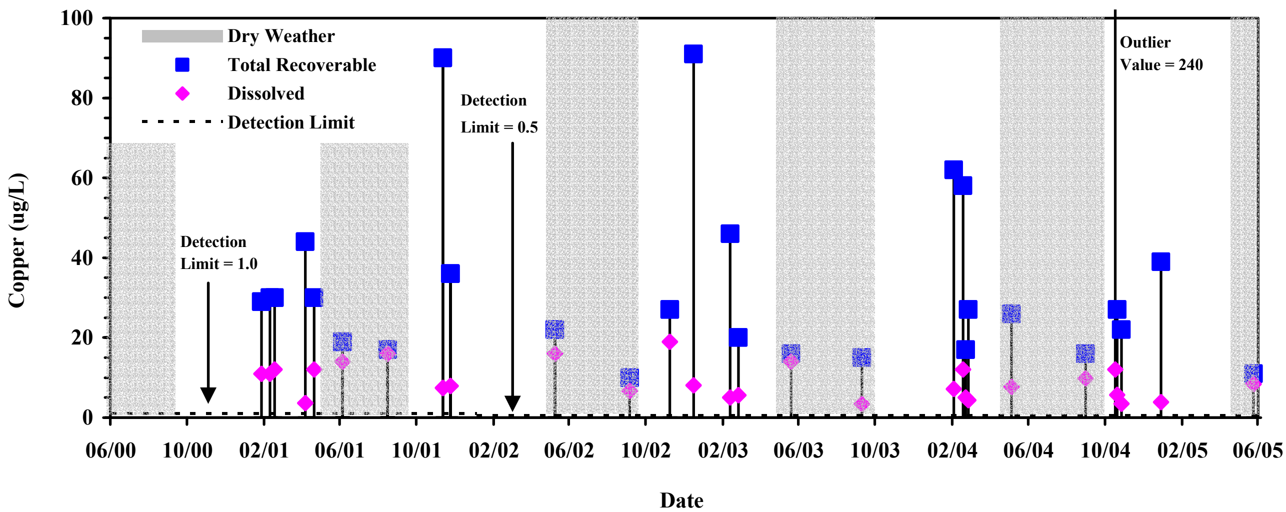


Figure 9.6 Bouton Creek Chemistry Results: a) Chlorpyrifos; b) Diazinon; c) TSS.

a)



b)



c)

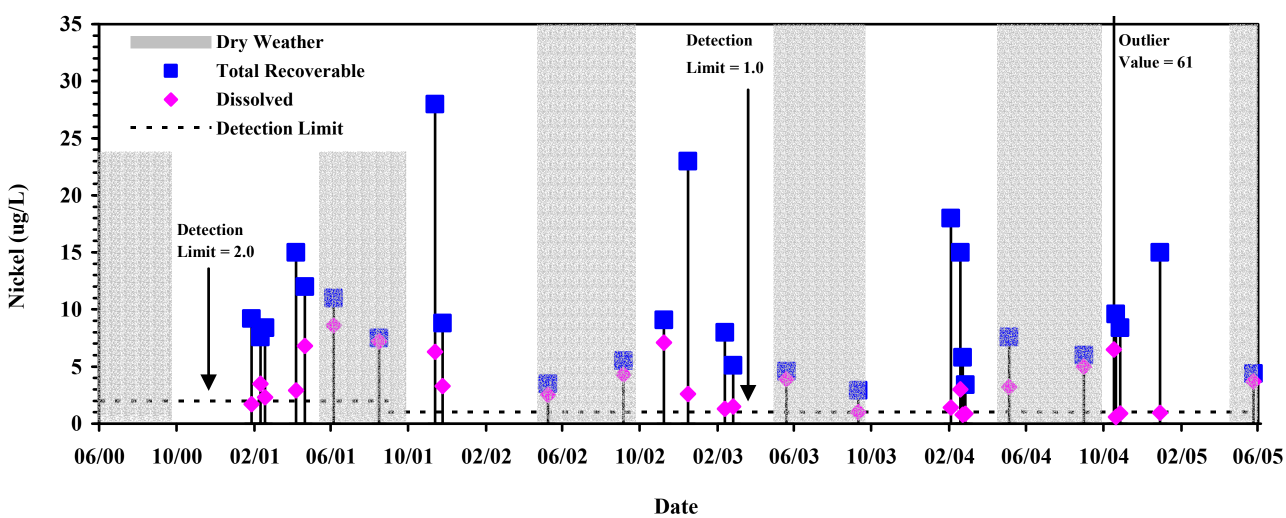


Figure 9.7 Los Cerritos Channel Chemistry Results: a) Cadmium; b) Copper; c) Nickel.

a)

b)

c)

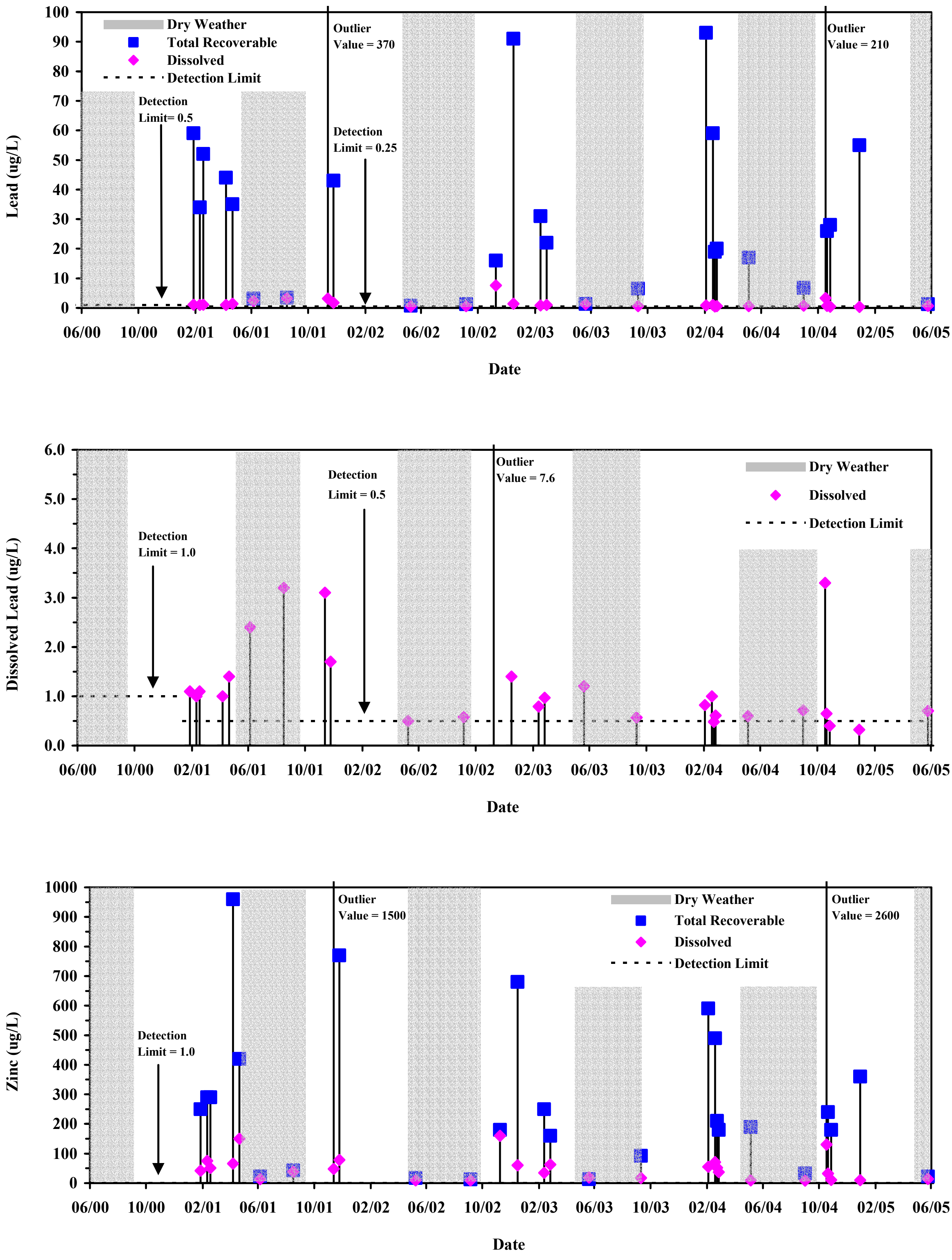


Figure 9.8 **Los Cerritos Channel Chemistry Results: a) Lead (total and dissolved); b) Lead (dissolved only); c) Zinc.**

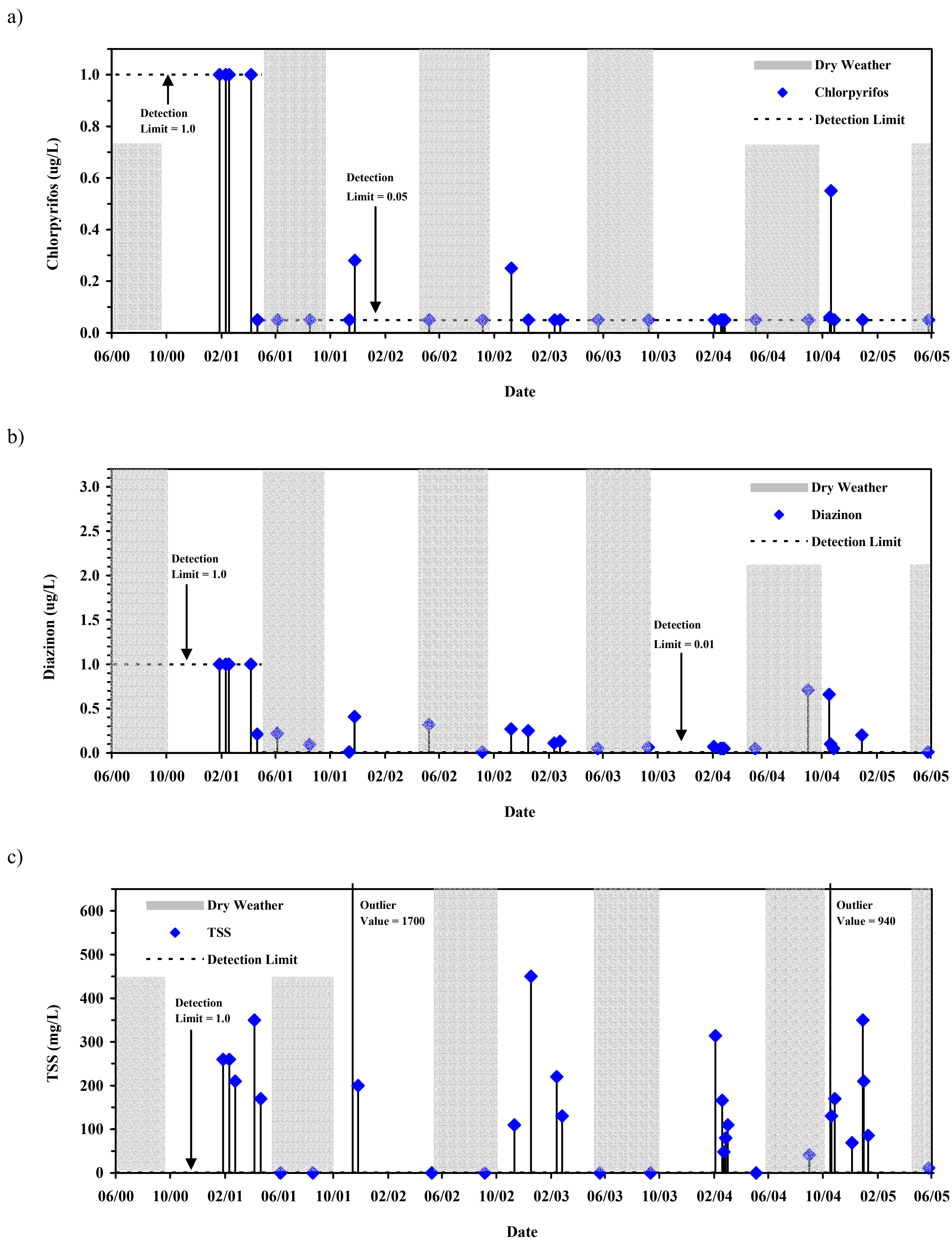


Figure 9.9 Los Cerritos Channel Chemistry Results: a) Chlorpyrifos; b) Diazinon; c) TSS.

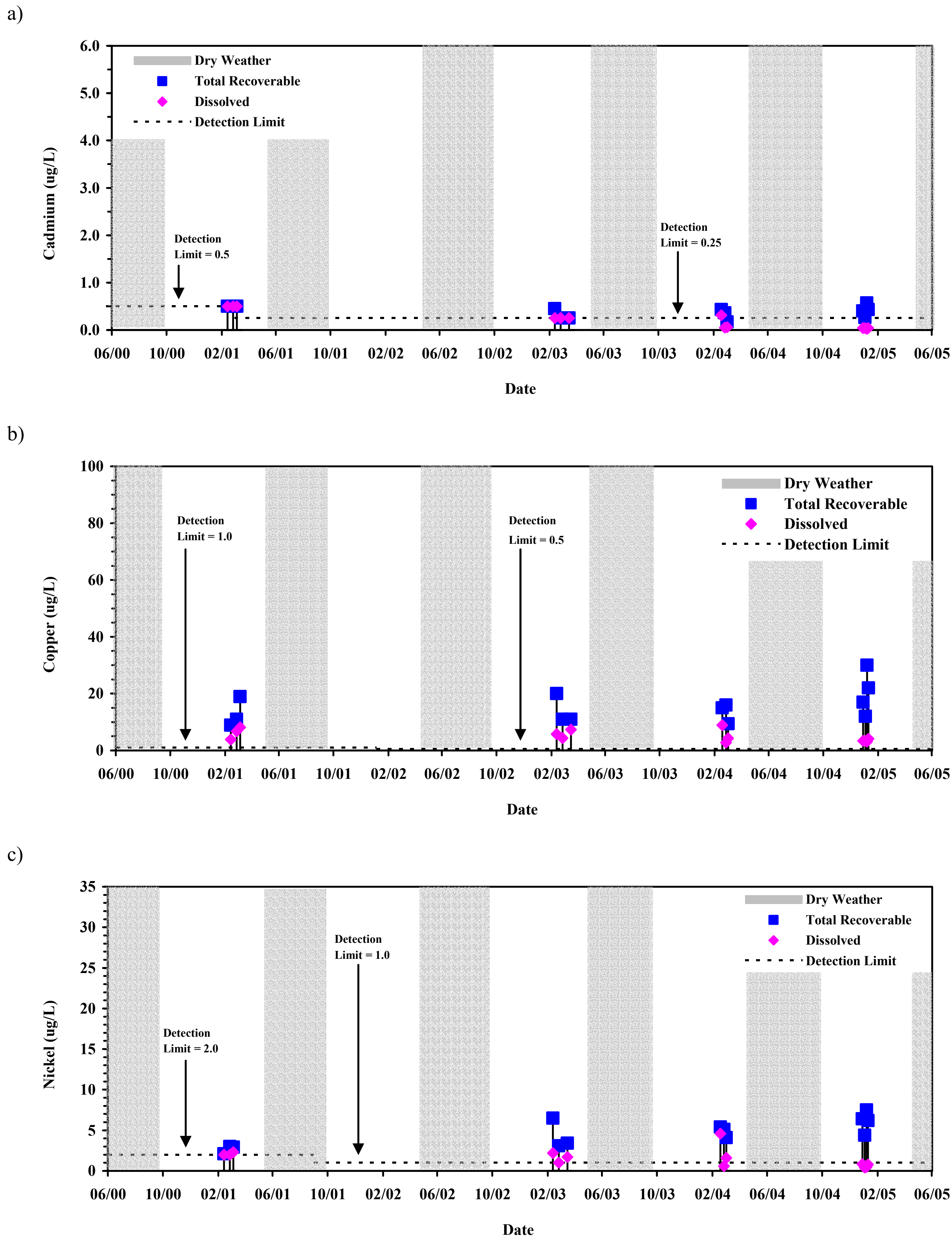
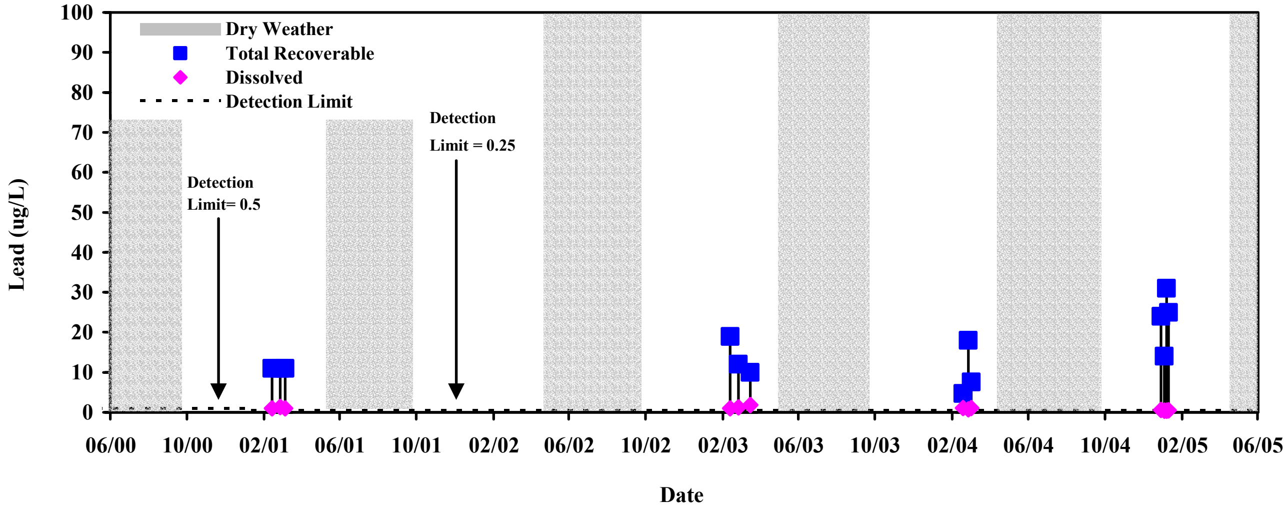
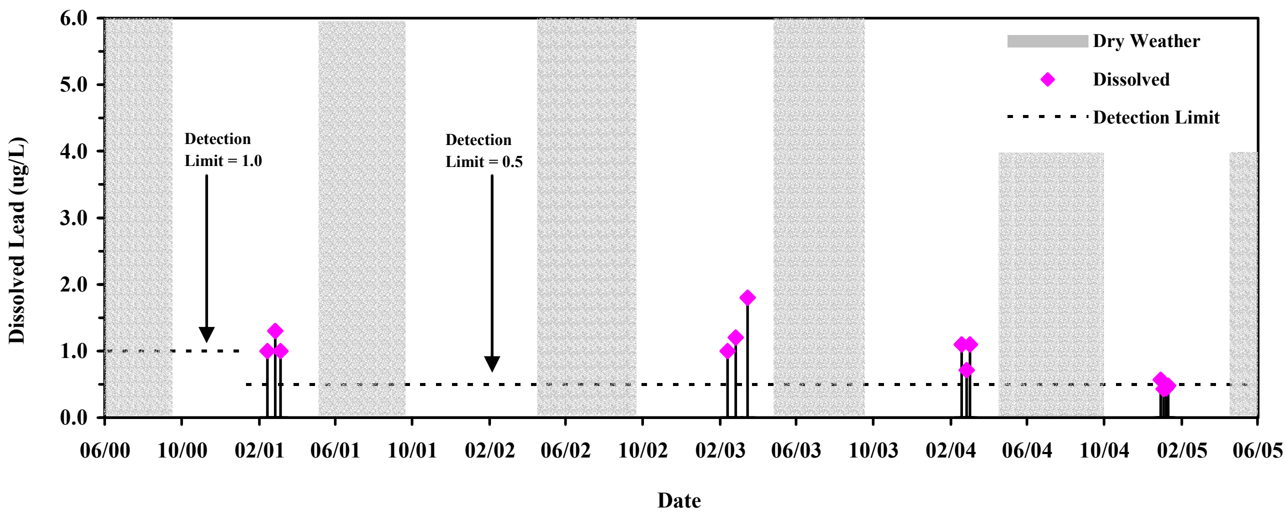


Figure 9.10 Dominquez Gap Chemistry Results: a) Cadmium; b) Copper; c) Nickel.

a)



b)



c)

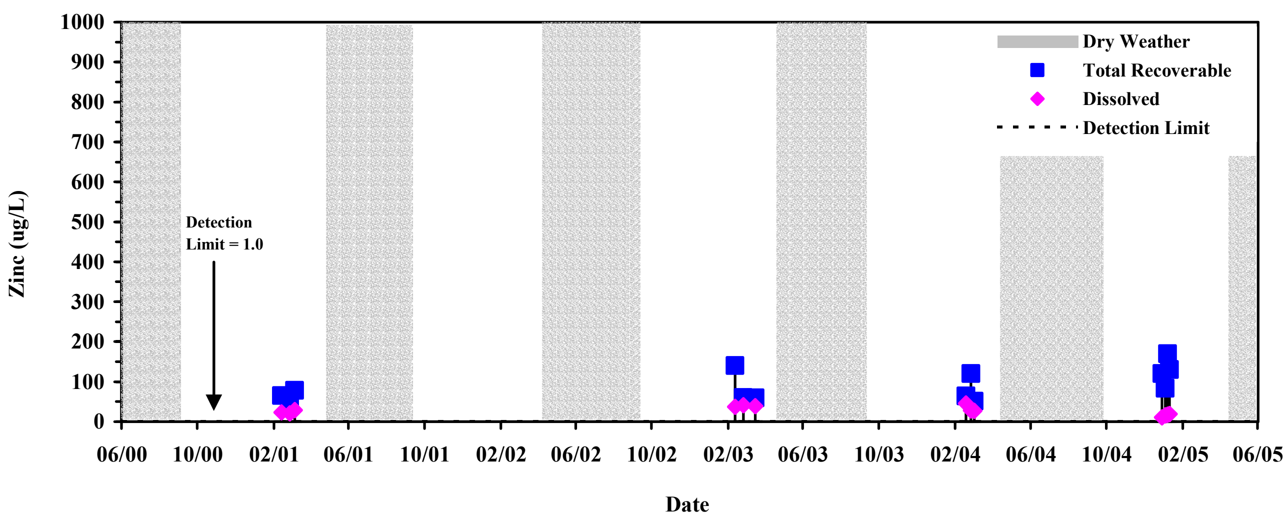


Figure 9.11 Dominquez Gap Chemistry Results: a) Lead (total and dissolved); b) Lead (dissolved only); c) Zinc.

a)

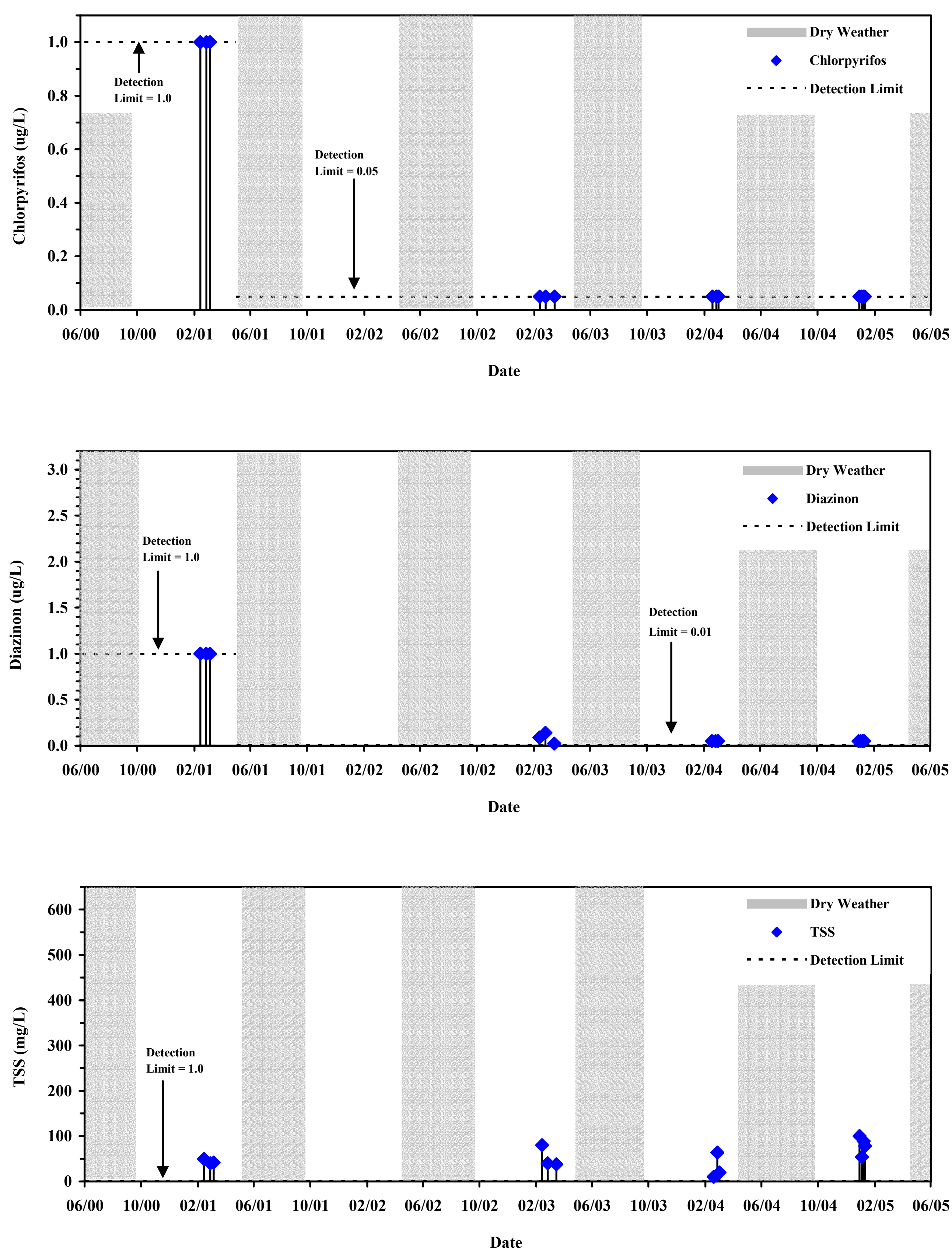


Figure 9.12 Dominquez Gap Chemistry Results: a) Chlorpyrifos; b) Diazinon; c) TSS.

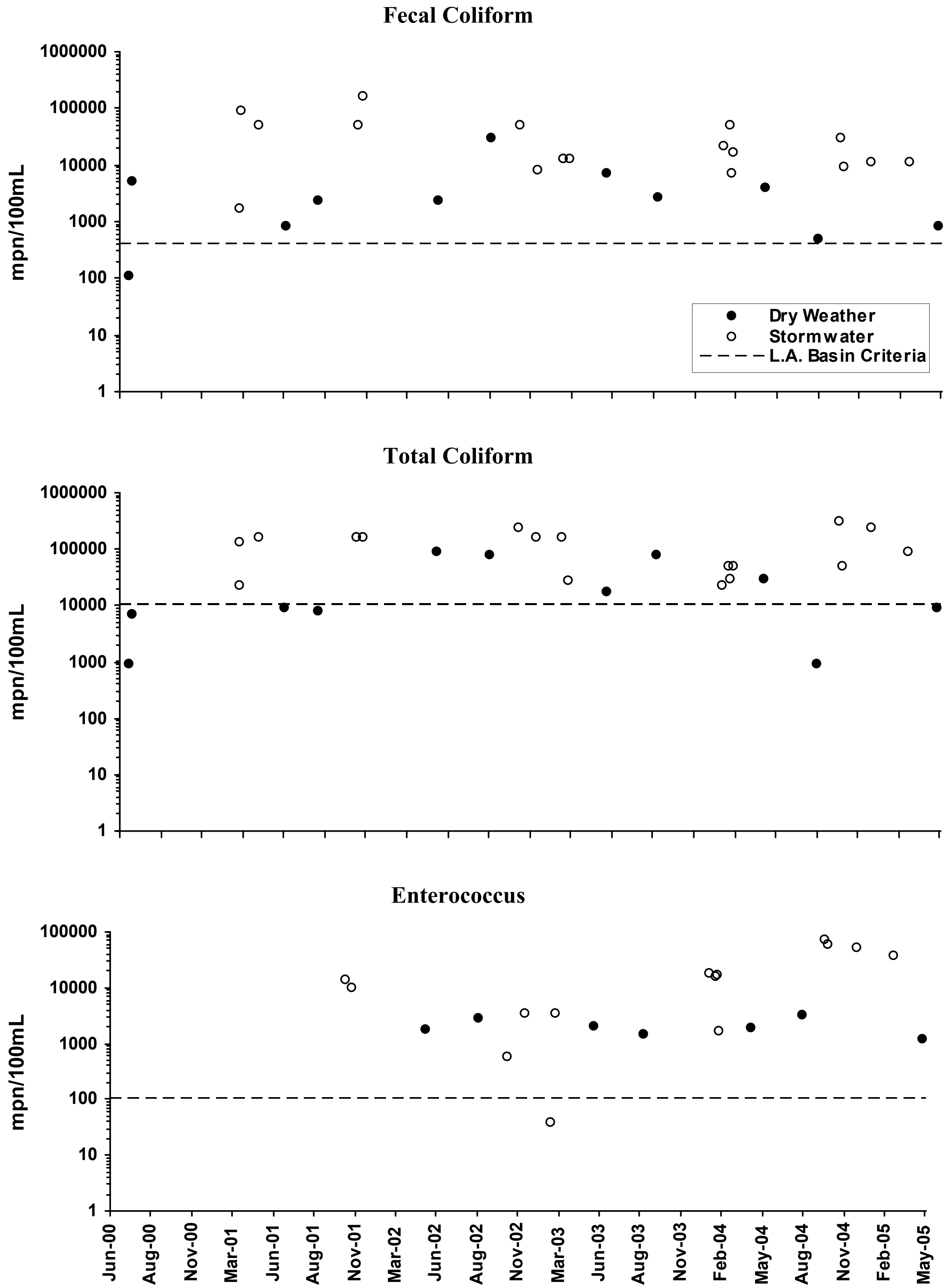


Figure 9.13 **Belmont Pump Station bacteria concentrations for 2000 through 2004.** The dashed lines indicate the species-specific, single sample criteria based on the L.A. Basin Plan.

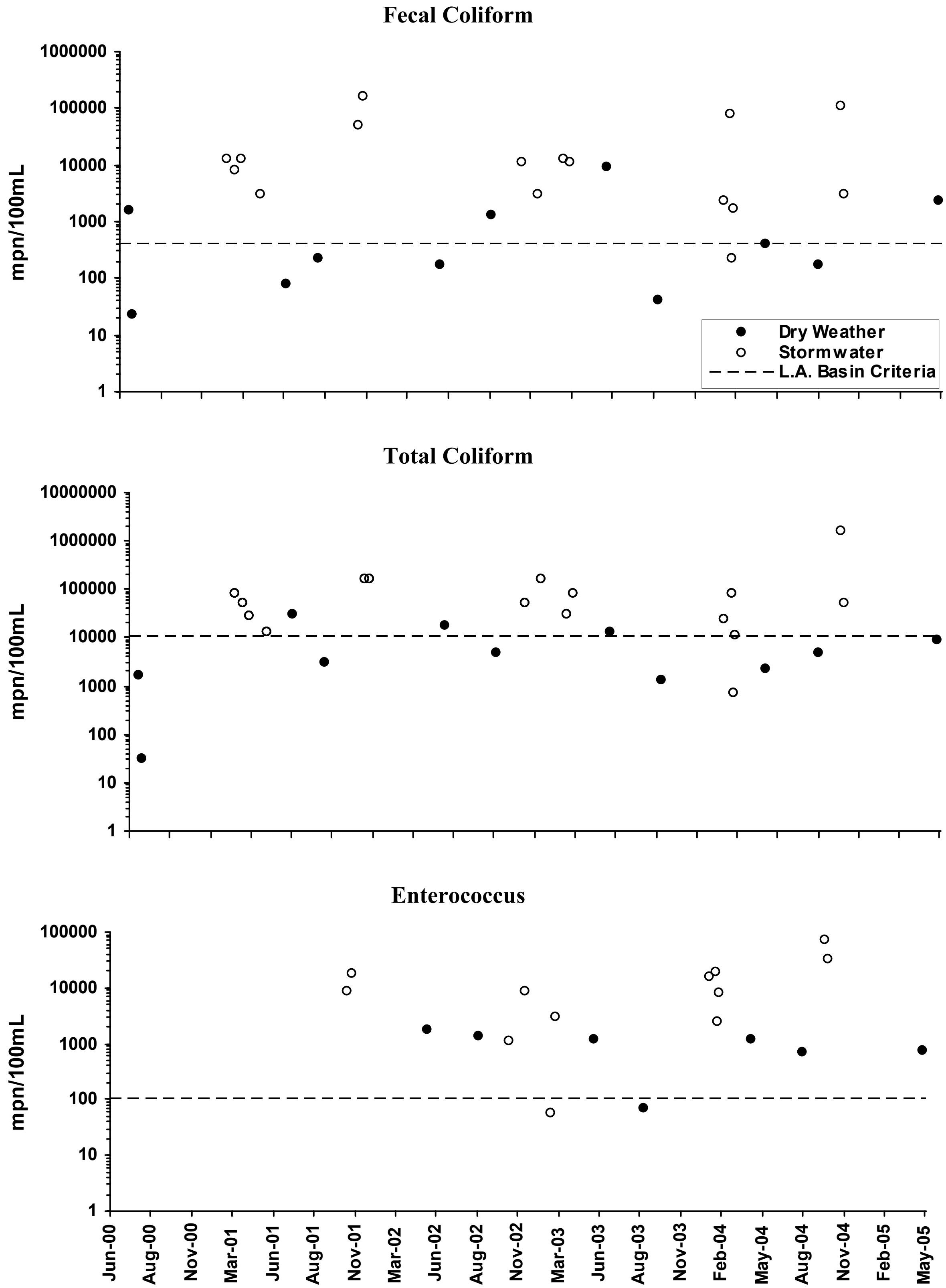


Figure 9.14 **Bouton Creek bacteria concentrations for 2000 through 2004.** The dashed lines indicate the species-specific, single sample criteria based on the L.A. Basin Plan.

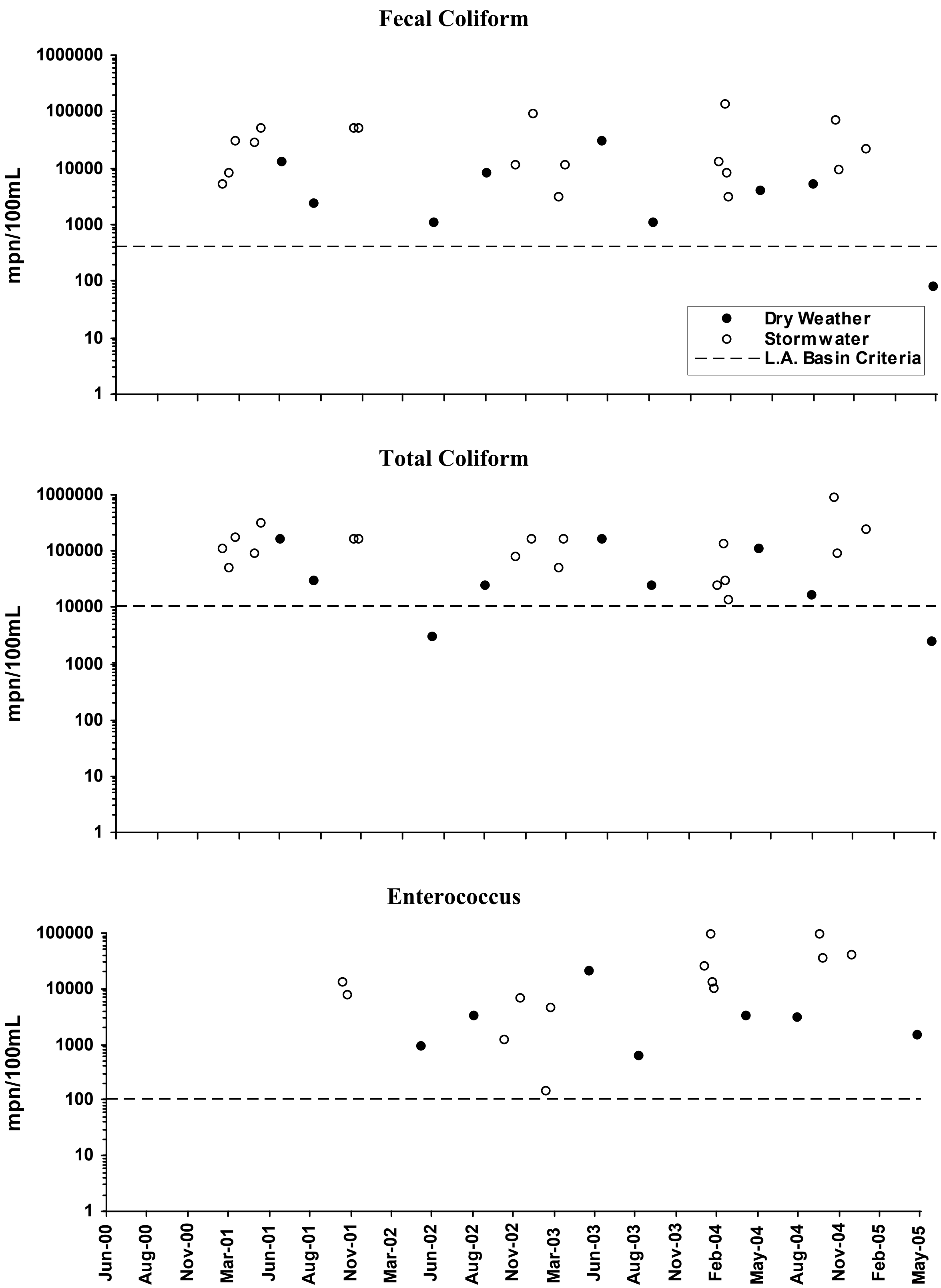


Figure 9.15 Los Cerritos Channel bacteria concentrations for 2000 through 2004. The dashed lines indicate the species-specific, single sample criteria based on the L.A. Basin Plan.

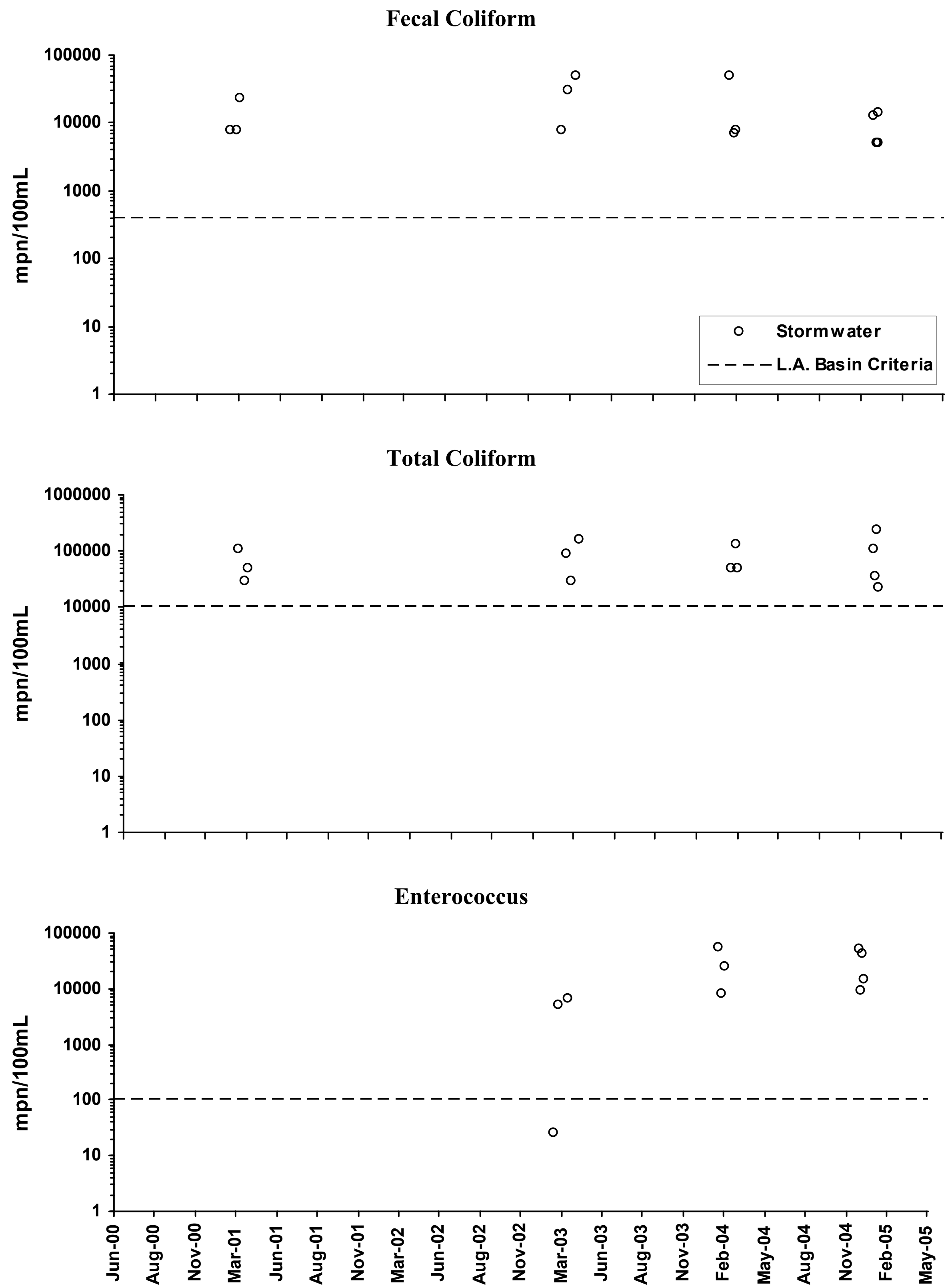


Figure 9.16 Dominguez Gap Bacteria Concentrations for 2000 through 2005. The dashed lines indicate the species-specific, single sample criteria based on the L.A. Basin Plan.

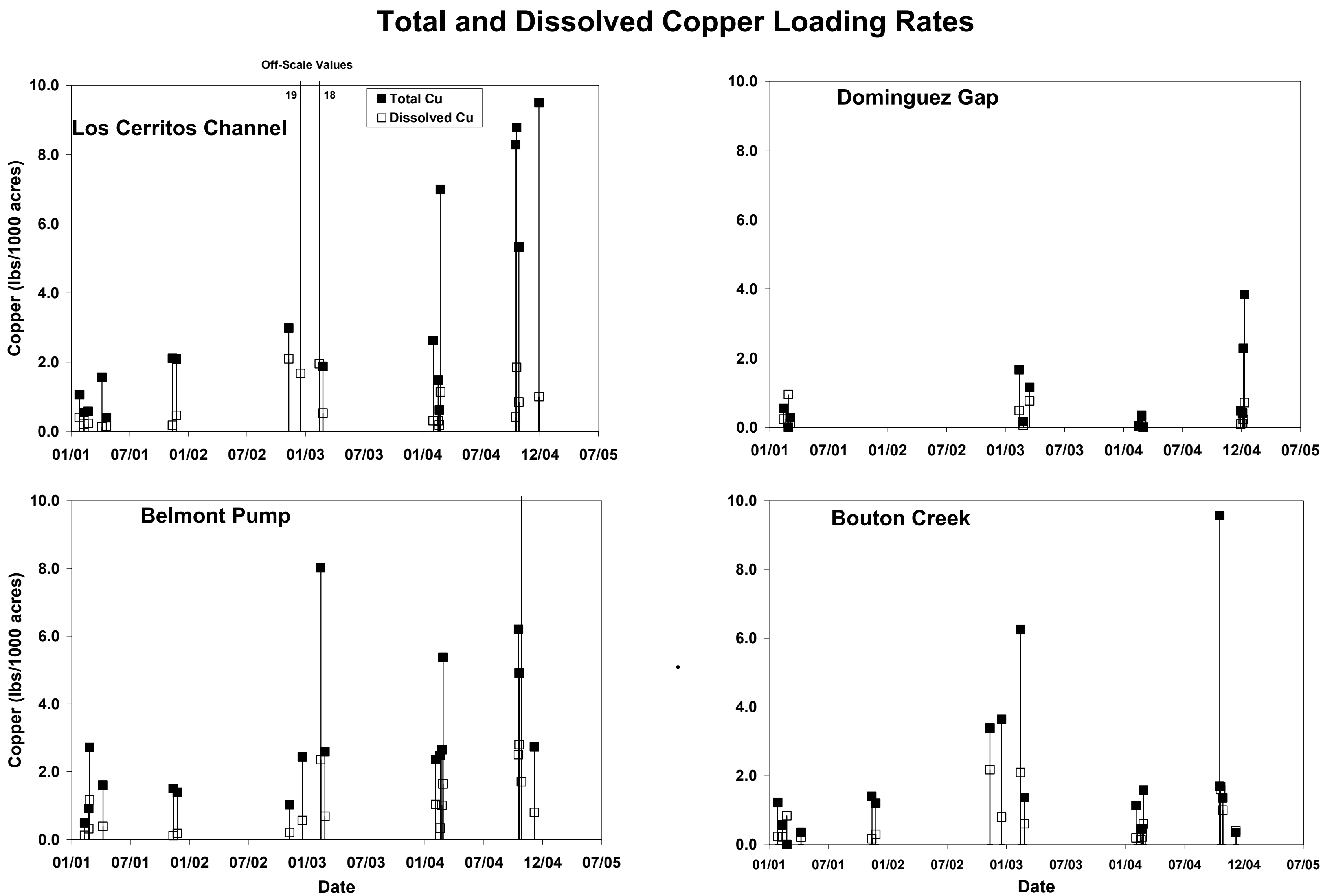


Figure 9.17 Total and Dissolved Copper Loading Rates Calculated for all Monitored Storm Events, 2001-2005.

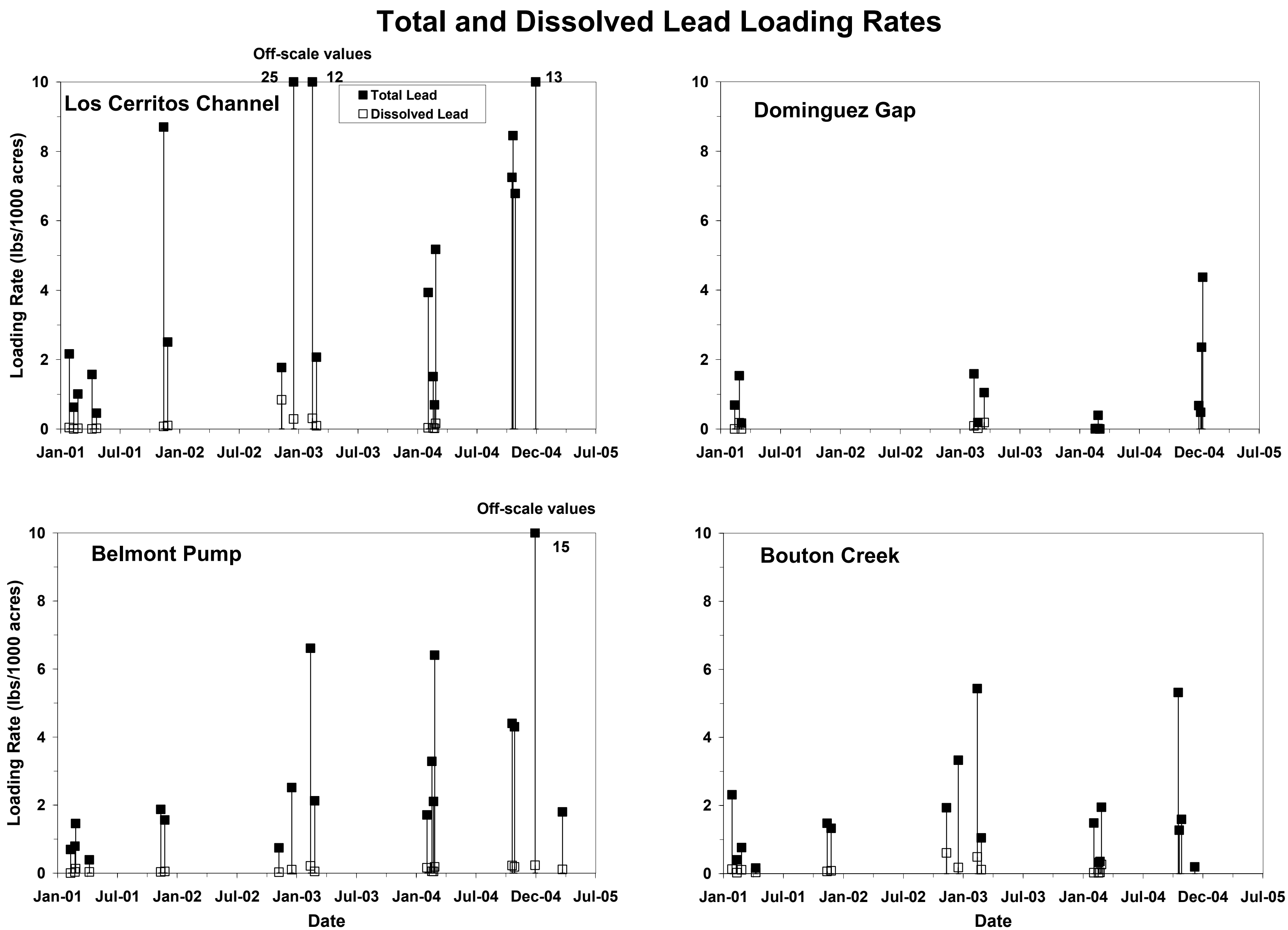


Figure 9.18 Total and Dissolved Lead Loading Rates Calculated for all Monitored Storm Events, 2001-2005.

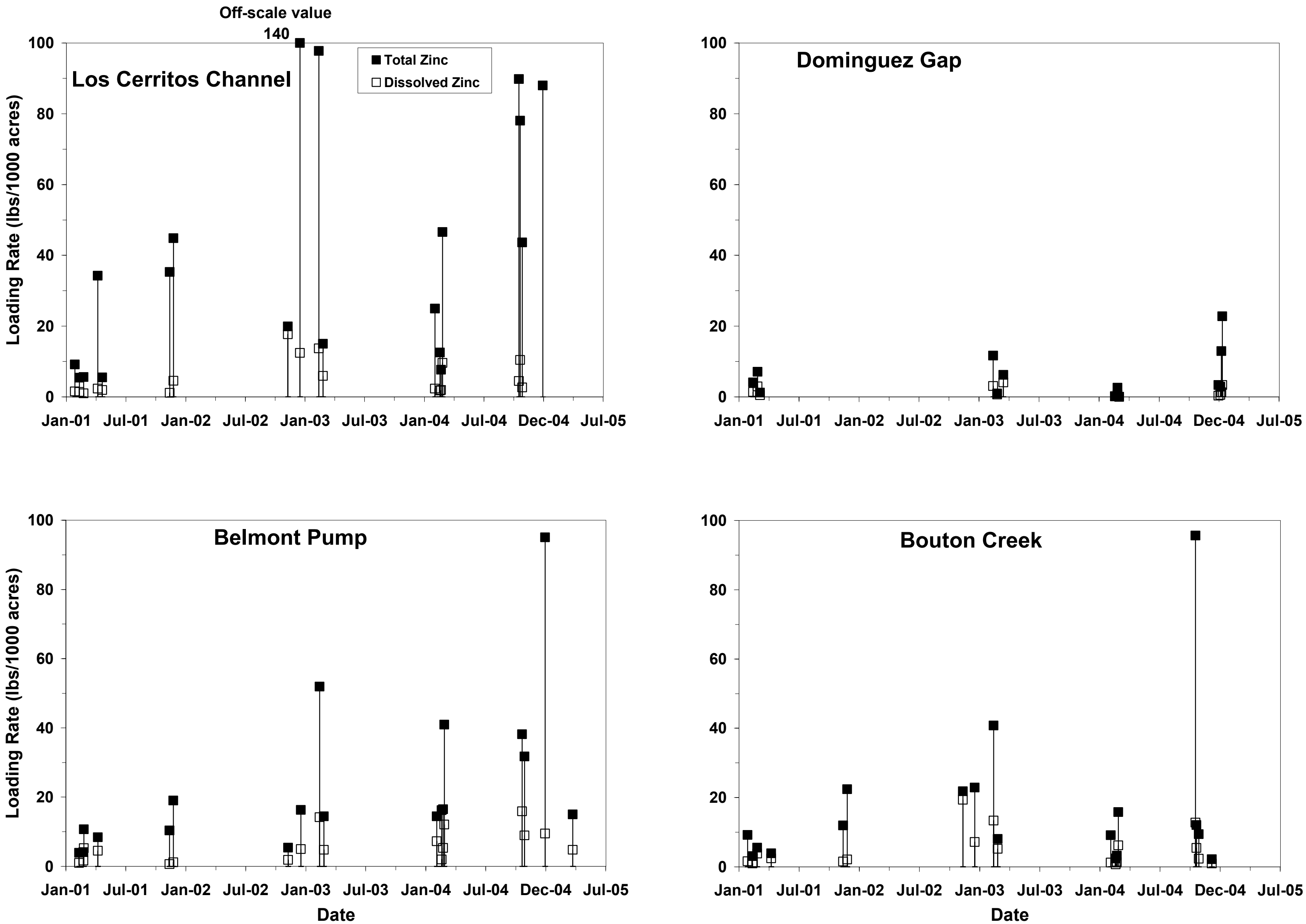


Figure 9.19 Total and Dissolved Zinc Loading Rates Calculated for all Monitored Storm Events, 2001-2005.

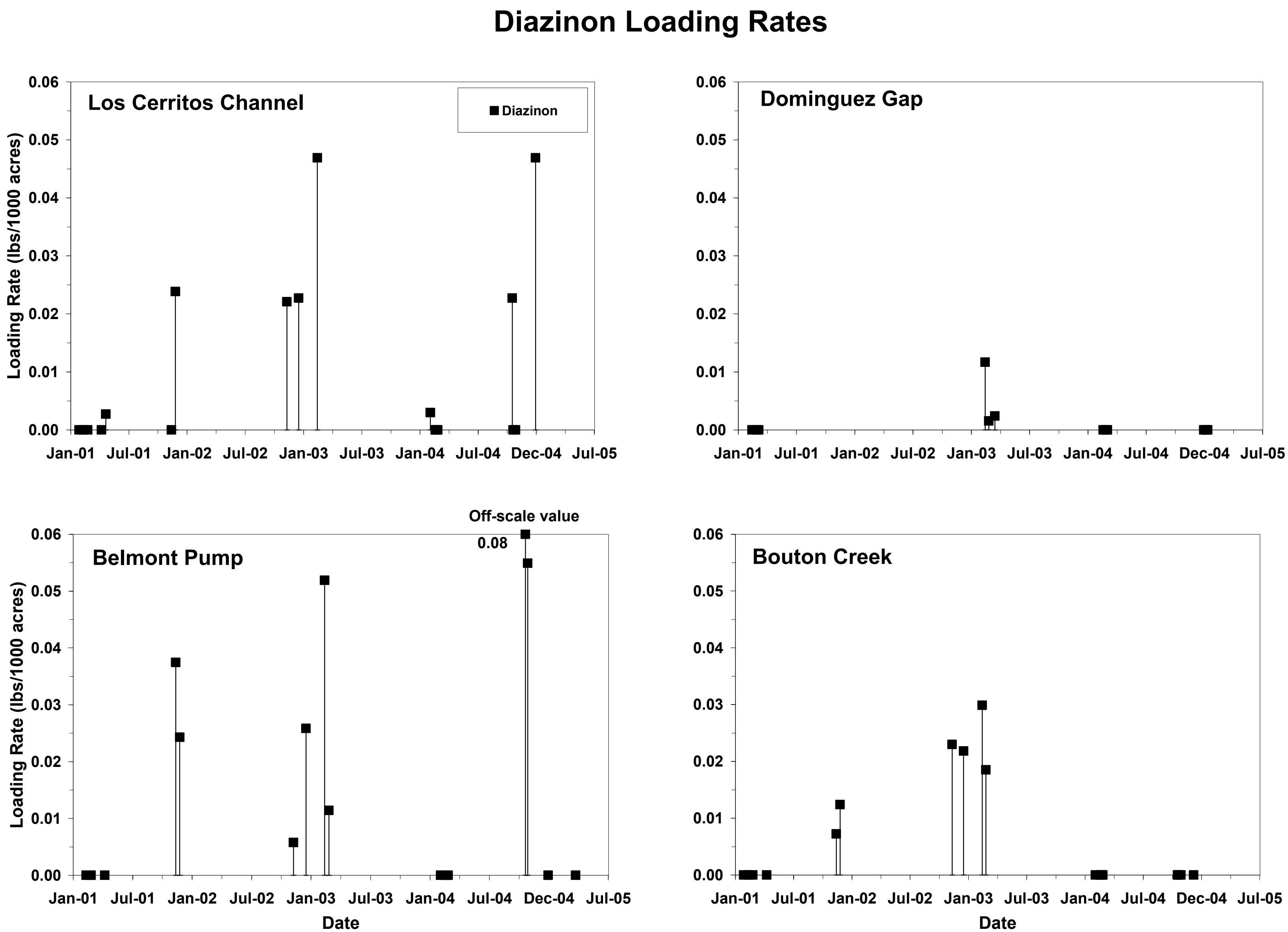


Figure 9.20 Diazinon Loading Rates Calculated for all Monitored Storm Events, 2001-2005.

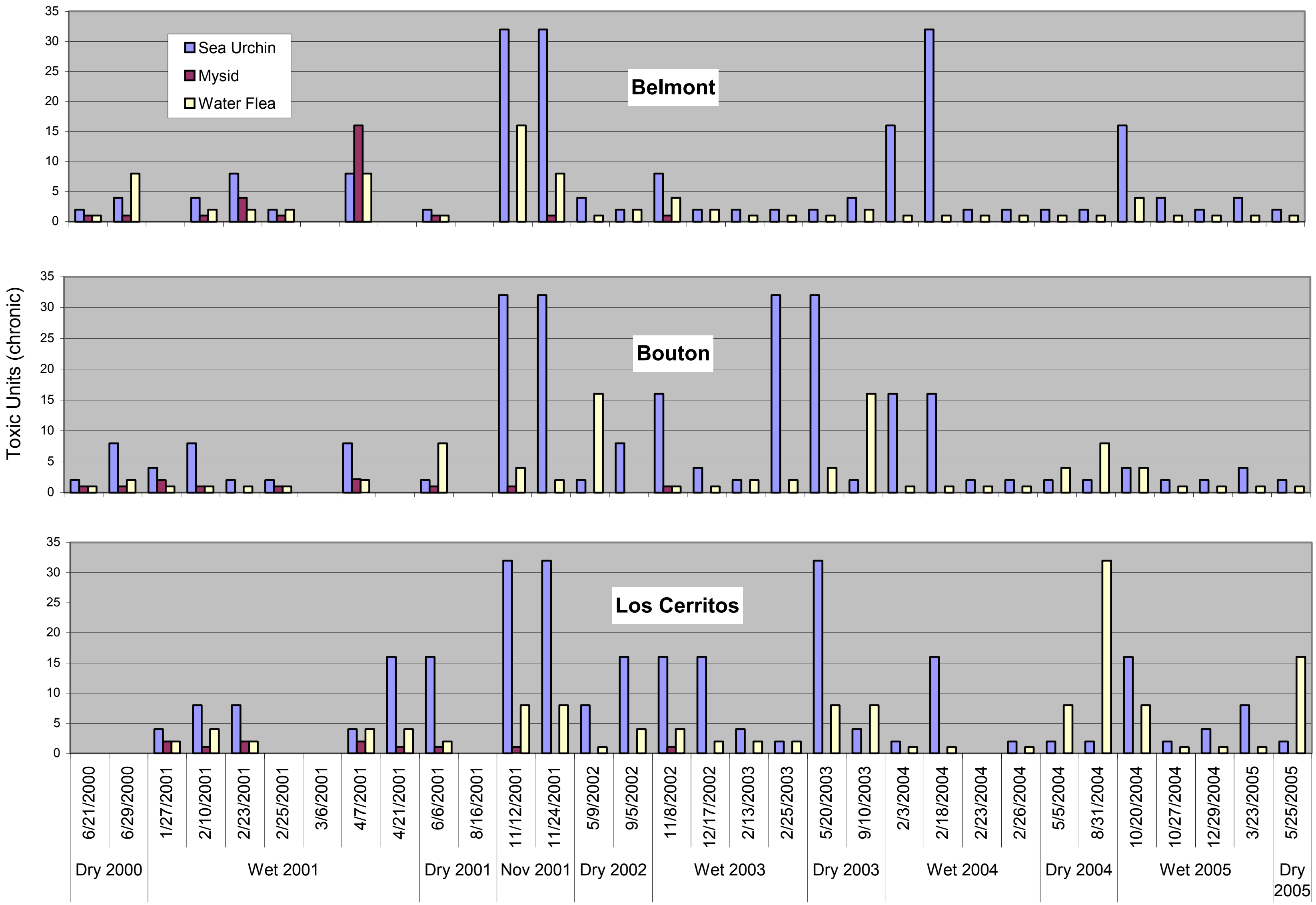
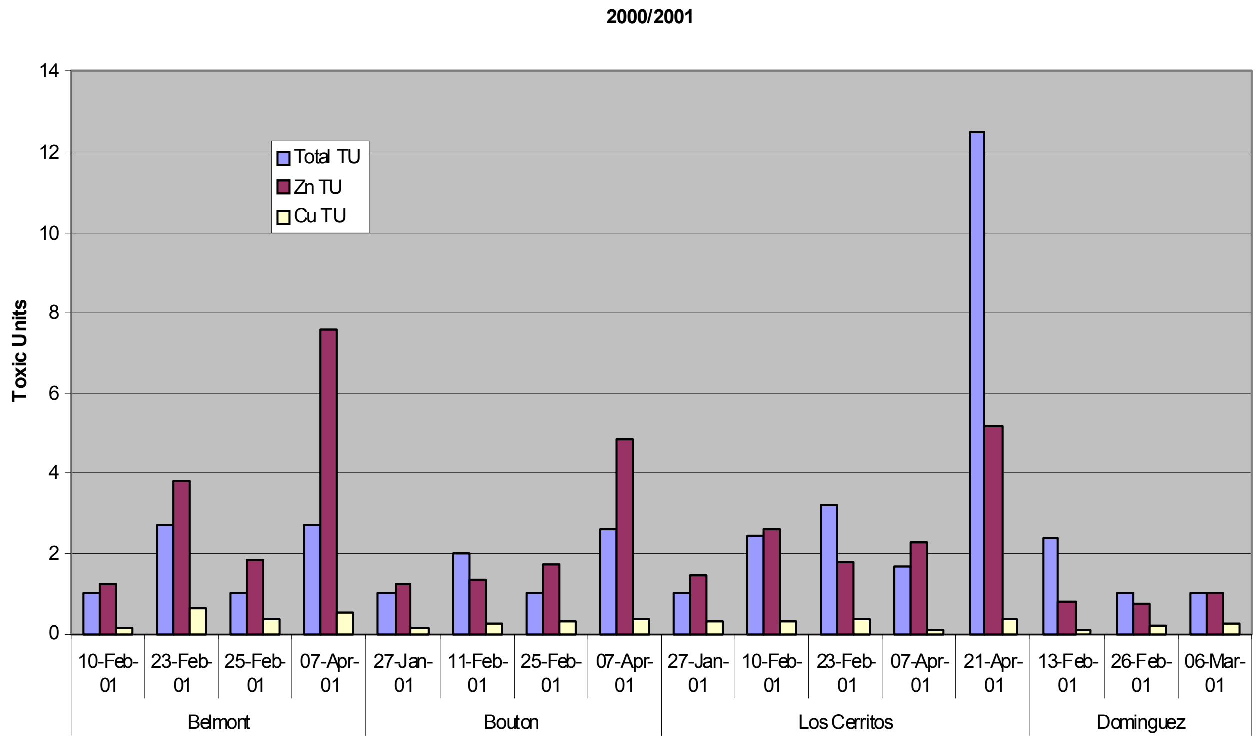


Figure 9.21 Summary of Wet and Dry Weather Toxicity Results for all Long Beach Samples.



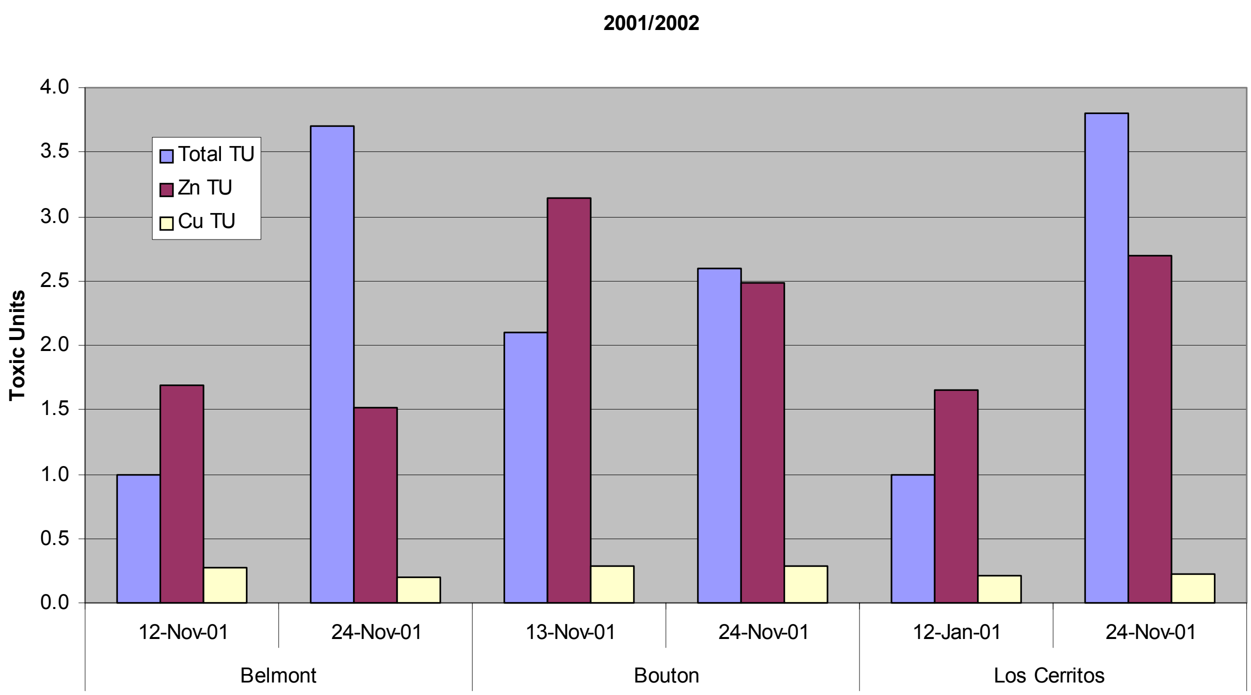


Figure 9.22a Comparison of Measured (Total) Toxic Units for the Sea Urchin Fertilization Test and Toxic Units Predicted from the Dissolved Concentrations of Copper and Zinc in the Test Samples. Measured toxic units are based on the EC50 (100/EC50). A value of 1 toxic unit was assigned to low/non-toxic samples have an estimated EC50>100%.

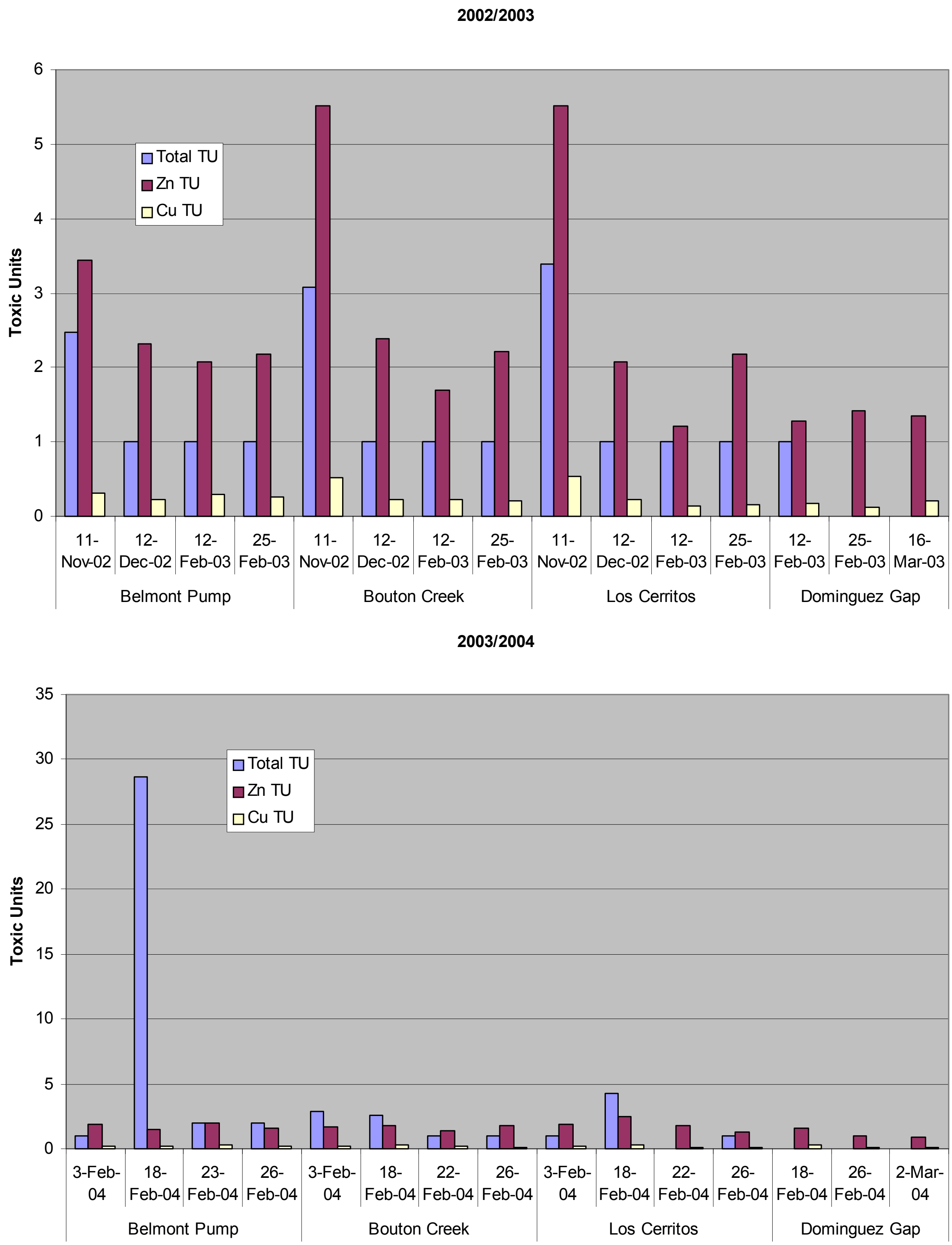


Figure 9.22b Comparison of Measured (Total) Toxic Units for the Sea Urchin Fertilization Test and Toxic Units Predicted from the Dissolved Concentrations of Copper and Zinc in the Test Samples. Measured toxic units are based on the EC50 (100/EC50). A value of 1 toxic unit was assigned to low/non-toxic samples have an estimated EC50>100%.

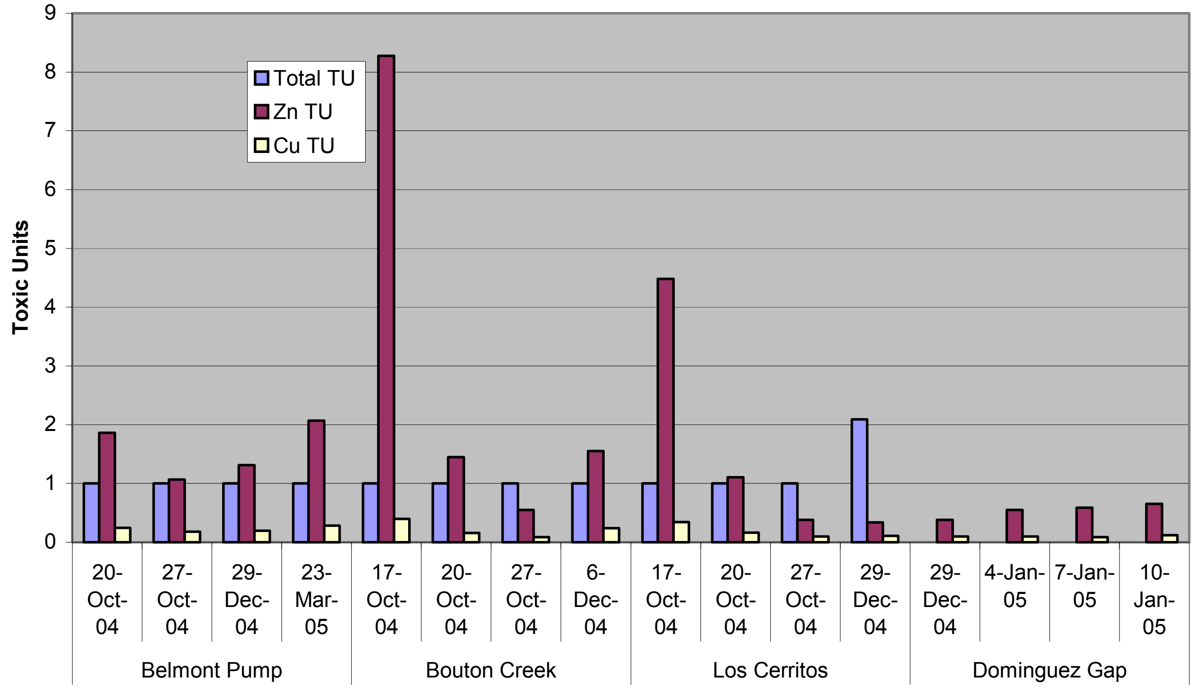


Figure 9.22c Comparison of Measured (Total) Toxic Units for the Sea Urchin Fertilization Test and Toxic Units Predicted from the Dissolved Concentrations of Copper and Zinc in the Test Samples. Measured toxic units are based on the EC50 (100/EC50). A value of 1 toxic unit was assigned to low/non-toxic samples have an estimated EC50>100%.

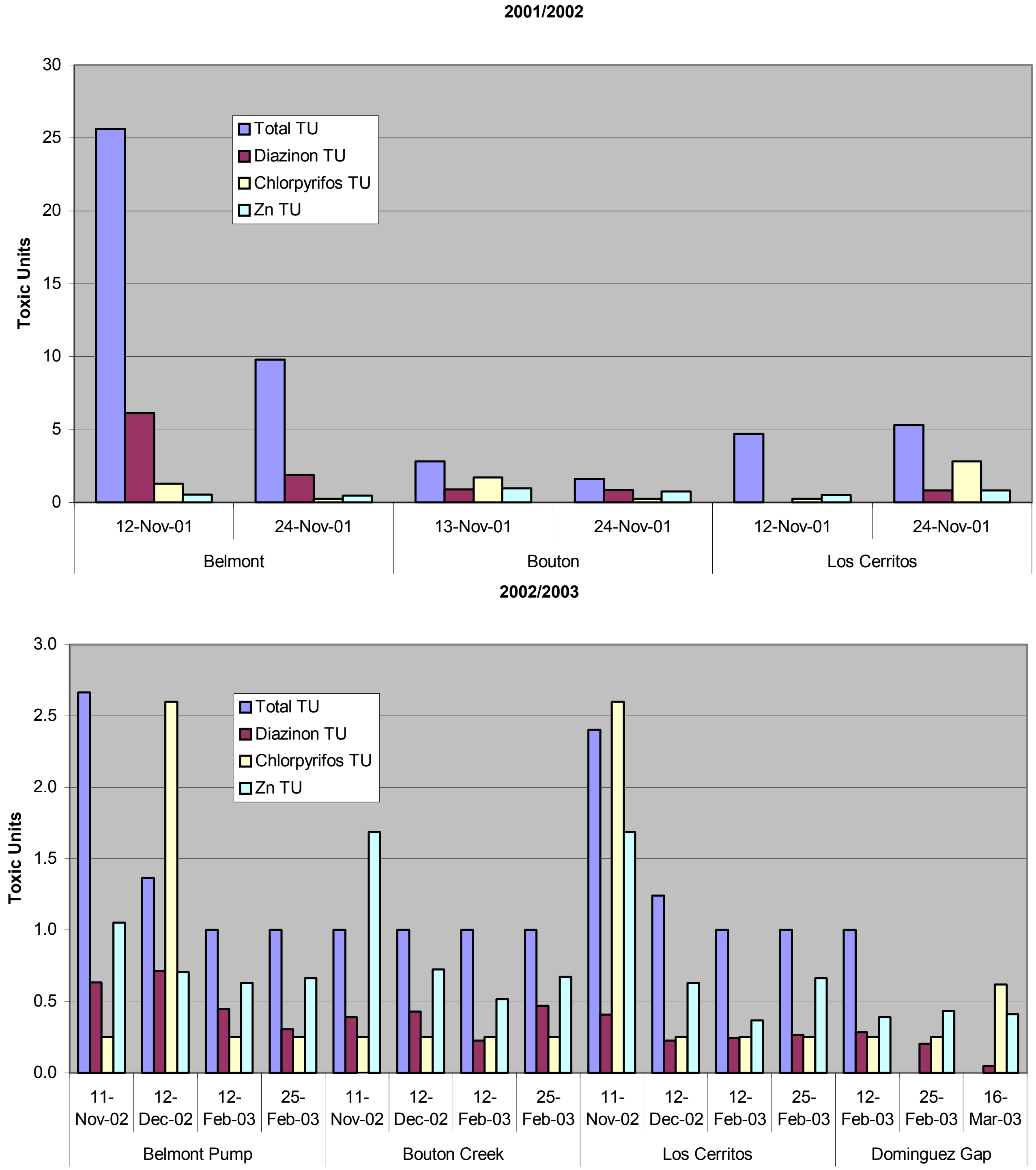
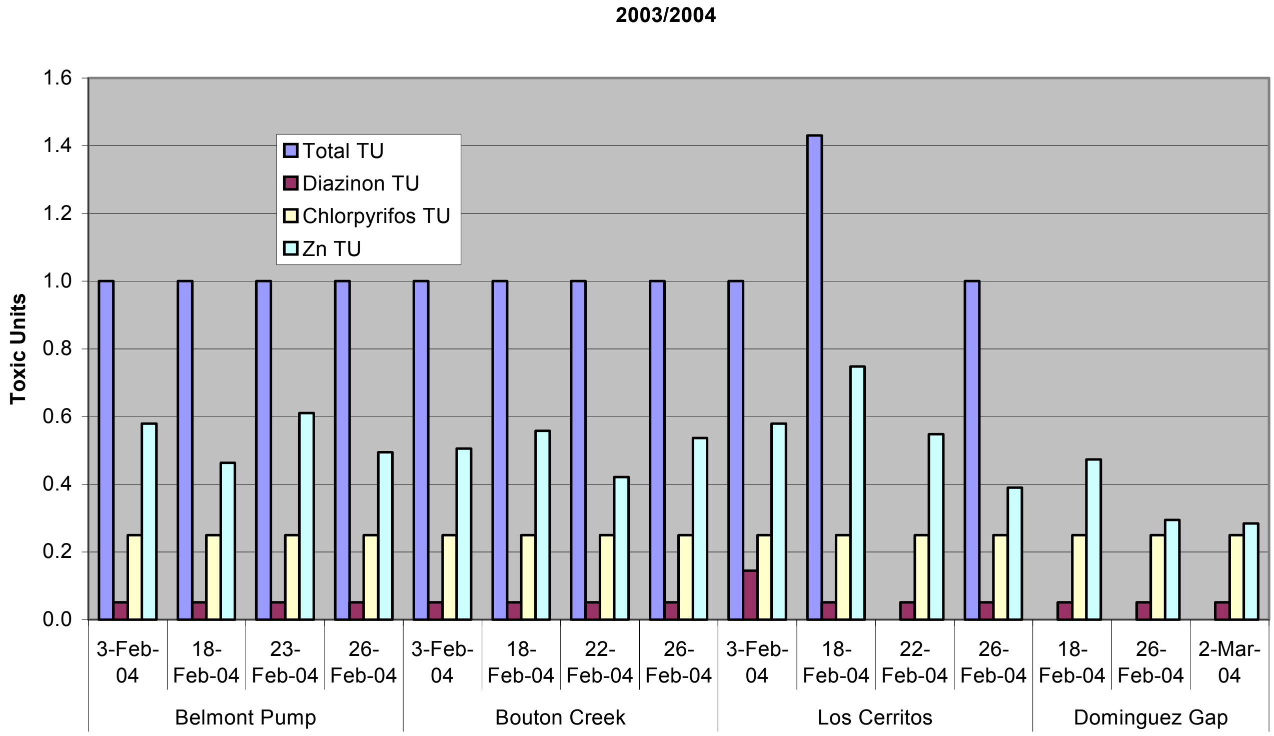


Figure 9.23a Comparison of Measured (Total) Toxic Units for the Water Flea Survival Test and Toxic Units Predicted from the Concentrations of Chlorpyrifos, Diazinon, and Dissolved Zinc in the Test Samples. Measured toxic units are based on the EC50 (100/EC50). A value of 1 toxic unit was assigned to low/non-toxic samples have an estimated EC50>100%.



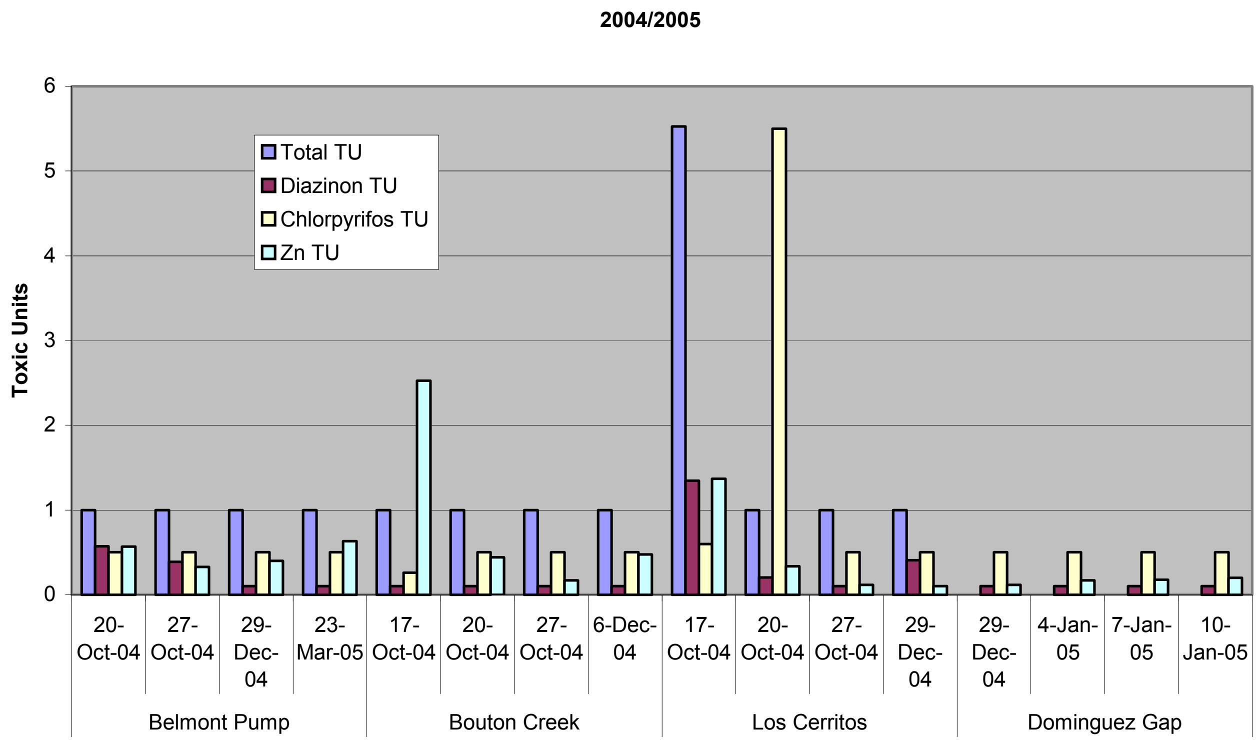


Figure 9.23b Comparison of Measured (Total) Toxic Units for the Water Flea Survival Test and Toxic Units Predicted from the Concentrations of Chlorpyrifos, Diazinon, and Dissolved Zinc in the Test Samples. Measured toxic units are based on the EC50 (100/EC50). A value of 1 toxic unit was assigned to low/non-toxic samples have an estimated EC50>100%.

Table 9.1 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 9.2 Summary of Available Benchmarks and Guidelines used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites.

Analyte Name	Long Beach 2004-2005 ML	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Conventionals *(mg/L unless noted)*							
Alkalinity as CaCO3	2						
pH (pH Units)	6.5		<[6.5-8.5]<				
Biochemical Oxygen Demand	2						
Chemical Oxygen Demand	20						
Chloride	2						
Fluoride	0.1						
Hardness as CaCO3	2						
MBAS	0.5		0.5				
Total Ammonia (as N)	0.1	2.4					
Total Kjeldahl Nitrogen	0.1						
Nitrate (as N)	0.1						
Nitrite (as N)	0.1						
Oil and Grease	5						
Total Recoverable Phenolics	0.1						
Total Phosphorus	0.05						
Total Orthophosphate (as P)	0.05						
Conductivity (umhos/cm)	1						
Total Dissolved Solids	2						
Total Suspended Solids	2						
Total Volatile Solids	2						
Total Organic Carbon	1						
Turbidity (NTU)	0.1						
Dissolved Metals *(ug/L)*							
Aluminum	100						
Arsenic	1					150	36
Cadmium	0.25					1.3	9.3
Chromium	0.5						
Copper	0.5					5	3.1
Iron	100						
Lead	0.5					1.2	8.1
Nickel	1					29	8.2
Selenium	1					5	71
Silver	0.25					1.1	1.9
Zinc	1					66	81
Total Metals *(ug/L)*							
Aluminum	100		1000				
Arsenic	1	32	50				
Cadmium	0.25	4	5				
Chromium	0.5		50				
Copper	0.5	12					
Iron	100						
Lead	0.5	8					
Nickel	1	20	100				
Selenium	1	60	50				
Silver	0.25	2.8					
Zinc	1	80					

Table 9.2 Summary of Available Benchmarks and Guidelines used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites. (continued)

Analyte Name	Long Beach 2004-2005 ML	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Bacteria *(MPN/100 ml)*							
Total Coliform	20	10000	10000				
Enterococcus	20		104				
Fecal Coliform	20	400	400				
Ratio of Fecal to Total Coliform	20		FC/TC>0.1 & TC>1000				
Aroclors *(ug/L)*							
Aroclor 1016	0.5						
Aroclor 1221	0.5						
Aroclor 1232	0.5						
Aroclor 1242	0.5						
Aroclor 1248	0.5						
Aroclor 1254	0.5						
Aroclor 1260	0.5						
Chlorinated Pesticides *(ug/L)*							
4,4'-DDD	0.05						
4,4'-DDE	0.05						
4,4'-DDT	0.01					0.001	0.001
Aldrin	0.005	0.000022				3	1.3
Dieldrin	0.01	0.00004				0.056	0.0019
Endrin	0.01	0.004	0			0.036	0.023
Endrin aldehyde	0.01						
Endrin ketone	0.01						
alpha-BHC	0.01						
beta-BHC	0.005						
delta-BHC	0.005						
gamma-BHC (Lindane)	0.02					0.95	0.16
Endosulfan I	0.02					0.056	0.0087
Endosulfan II	0.01					0.056	0.0087
Endosulfan sulfate	0.05						
alpha-Chlordane	0.1						
gamma-Chlordane	0.1						
Heptachlor	0.01	0.00005	0.01			0.0038	0.0036
Heptachlor epoxide	0.01	0.00002	0.01			0.0038	0.0036
Methoxychlor	0.05						
Toxaphene	0.5	0.00021	2			0.0002	0.0002
Organophosphates *(ug/L)*							
Atrazine	2		3				
Chlorpyrifos	0.05			0.02	0.02		
Cyanazine	2						
Diazinon	0.01			0.08			
Malathion	1						
Prometryn	2						
Simazine	2		4				

Notes to Table 9.2:

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 method. analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.
- Criteria continuous concentration (CCC) equals the highest concentration of pollutant to which aquatic life can be exposed for an extended period of time without deleterious effects.
- Criteria maximum concentration (CMC) equals the highest concentration of pollutant to which aquatic life can be exposed for a short period of time with deleterious effects.

California Toxics Rule

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

Ocean Plan and LA Basin Plan

- Bacteria are instantaneous or single sample criteria.

California Fish and Game

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

Table 9.3 Comparison of Stormwater Quality Measurements from Bouton Creek with Guidelines and Standards.

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Conventionals								
Alkalinity as CaCO3	4	4						
pH	6	6		2				
BOD_5	4	4						
COD	4	4						
Chloride	4	4						
Fluoride	4	4						
Hardness as CaCO3	4	4						
MBAS	4	4		1				
Total Ammonia (as N)	4	3	0					
Total Kjeldahl Nitrogen	4	4						
Nitrate (as N)	4	4						
Nitrite (as N)	4	0						
Oil and Grease	2	0						
Total Rec. Phenolics	4	0						
Total Phosphorus	4	4						
Total Orthophosphate -P	4	4						
Specific Conductance	4	4						
Total Dissolved Solids	4	4						
Total Suspended Solids	12	12						
Total Volatile Solids	4	4						
Total Organic Carbon	4	4						
Turbidity	4	4						
Dissolved Metals								
Aluminum	4	1						
Arsenic	4	4					0	0
Cadmium	4	0					0	0
Chromium	4	1						
Copper	4	4					4	3
Iron	4	2						
Lead	4	4					4	0
Nickel	4	2					0	0
Selenium	4	0					0	0
Silver	4	0					0	0
Zinc	4	4					3	1
Total Metals								
Aluminum	4	4		3				
Arsenic	4	4	0	0				
Cadmium	4	2	0	0				
Chromium	4	4		0				
Copper	4	4	3					
Iron	4	4						
Lead	4	4	4					
Nickel	4	4	1	0				
Selenium	4	0	0	0				
Silver	4	1	0					
Zinc	4	4	3					

Table 9.3 Comparison of Stormwater Water Quality Measurements from Bouton Creek with Guidelines and Standards. (continued)

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Bacteria								
Total Coliform	2	2	2	2				
Enterococcus	2	2		2				
Fecal Coliform	2	2	2	2				
Ratio Fecal:Total Coliform	2	2		0				
Aroclors								
Aroclor 1016	4	0						
Aroclor 1221	4	0						
Aroclor 1232	4	0						
Aroclor 1242	4	0						
Aroclor 1248	4	0						
Aroclor 1254	4	0						
Aroclor 1260	4	0						
Chlorinated Pesticides								
4,4'-DDD	4	0						
4,4'-DDE	4	0						
4,4'-DDT	4	0					0	0
Aldrin	4	0	0				0	0
Dieldrin	4	0	0				0	0
Endrin	4	0	0	0			0	0
Endrin aldehyde	4	0						
Endrin ketone	4	0						
alpha-BHC	4	0						
beta-BHC	4	1						
delta-BHC	4	0						
gamma-BHC (Lindane)	4	0					0	0
Endosulfan I	4	0					0	0
Endosulfan II	4	0					0	0
Endosulfan sulfate	4	0						
alpha-Chlordane	4	0						
gamma-Chlordane	4	0						
Heptachlor	4	0	0	0			0	0
Heptachlor epoxide	4	0	0	0			0	0
Methoxychlor	4	0						
Toxaphene	4	0	0	0			0	0
Organophosphates								
Atrazine	4	0		0				
Chlorpyrifos	4	0			0	0		
Cyanazine	4	0						
Diazinon	4	0			0			
Malathion	4	0						
Prometryn	4	0						
Simazine	4	0		0				

Table 9.4 Comparison of Stormwater Water Quality Measurements from Belmont Pump Station with Guidelines and Standards.

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Conventionals								
Alkalinity as CaCO3	4	4						
pH	4	4		2				
BOD_5	4	4						
COD	4	4						
Chloride	4	4						
Fluoride	4	3						
Hardness as CaCO3	4	4						
MBAS	4	3		0				
Total Ammonia (as N)	4	4	0					
Total Kjeldahl Nitrogen	4	4						
Nitrate (as N)	4	4						
Nitrite (as N)	4	0						
Oil and Grease	4	2						
Total Rec. Phenolics	4	0						
Total Phosphorus	4	4						
Total Orthophosphate -P	4	4						
Specific Conductance	4	4						
Total Dissolved Solids	4	4						
Total Suspended Solids	12	12						
Total Volatile Solids	4	4						
Total Organic Carbon	4	4						
Turbidity	4	4						
Dissolved Metals								
Aluminum	4	0						
Arsenic	4	4					0	0
Cadmium	4	0					0	0
Chromium	4	2						
Copper	4	4					3	4
Iron	4	3						
Lead	4	4					0	0
Nickel	4	3					0	0
Selenium	4	0					0	0
Silver	4	0					0	0
Zinc	4	4					1	0
Total Metals								
Aluminum	4	4		2				
Arsenic	4	4	0	0				
Cadmium	4	4	0	0				
Chromium	4	4		0				
Copper	4	4	4					
Iron	4	4						
Lead	4	4	4					
Nickel	4	4	0	0				
Selenium	4	0	0	0				
Silver	4	0	0					
Zinc	4	4	4					

Table 9.4 Comparison of Stormwater Water Quality Measurements from Belmont Pump Station with Guidelines and Standards. (continued)

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Bacteria								
Total Coliform	4	4	4	4				
Enterococcus	4	4		4				
Fecal Coliform	4	4	4	4				
Ratio Fecal:Total Coliform	4	4		2				
Aroclors								
Aroclor 1016	4	0						
Aroclor 1221	4	0						
Aroclor 1232	4	0						
Aroclor 1242	4	0						
Aroclor 1248	4	0						
Aroclor 1254	4	0						
Aroclor 1260	4	0						
Chlorinated Pesticides								
4,4'-DDD	4	0						
4,4'-DDE	4	0						
4,4'-DDT	4	1					1	1
Aldrin	4	0	0				0	0
Dieldrin	4	0	0				0	0
Endrin	4	0	0	0			0	0
Endrin aldehyde	4	0						
Endrin ketone	4	0						
alpha-BHC	4	0						
beta-BHC	4	0						
delta-BHC	4	0						
gamma-BHC (Lindane)	4	0					0	0
Endosulfan I	4	0					0	0
Endosulfan II	4	0					0	0
Endosulfan sulfate	4	0						
alpha-Chlordane	4	0						
gamma-Chlordane	4	0						
Heptachlor	4	0	0	0			0	0
Heptachlor epoxide	4	0	0	0			0	0
Methoxychlor	4	0						
Toxaphene	4	0	0	0			0	0
Organophosphates								
Atrazine	4	0		0				
Chlorpyrifos	4	0			0	0		
Cyanazine	4	0						
Diazinon	4	2			2			
Malathion	4	0						
Prometryn	4	0						
Simazine	4	0		0				

Table 9.5 Comparison of Stormwater Water Quality Measurements from Los Cerritos Channel with Guidelines and Standards.

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Conventionals								
Alkalinity as CaCO3	4	4						
pH	5	5		0				
BOD_5	4	4						
COD	4	4						
Chloride	4	4						
Fluoride	4	4						
Hardness as CaCO3	4	4						
MBAS	4	3		1				
Total Ammonia (as N)	4	4	1					
Total Kjeldahl Nitrogen	4	4						
Nitrate (as N)	4	4						
Nitrite (as N)	4	0						
Oil and Grease	3	0						
Total Rec. Phenolics	4	0						
Total Phosphorus	4	4						
Total Orthophosphate -P	4	4						
Specific Conductance	4	4						
Total Dissolved Solids	4	4						
Total Suspended Solids	10	10						
Total Volatile Solids	4	4						
Total Organic Carbon	4	4						
Turbidity	4	4						
Dissolved Metals								
Aluminum	4	2						
Arsenic	4	4					0	0
Cadmium	4	0					0	0
Chromium	4	4						
Copper	4	4					4	4
Iron	4	4						
Lead	4	2					3	0
Nickel	4	1					0	0
Selenium	4	0					0	0
Silver	4	0					0	0
Zinc	4	4					2	1
Total Metals								
Aluminum	4	4		4				
Arsenic	4	4	0	0				
Cadmium	4	4	1	1				
Chromium	4	4		1				
Copper	4	4	4					
Iron	4	4						
Lead	4	4	4					
Nickel	4	4	1	0				
Selenium	4	0	0	0				
Silver	4	1	0					
Zinc	4	4	4					

Table 9.5 Comparison of Stormwater Water Quality Measurements from Los Cerritos Channel with Guidelines and Standards. (continued)

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Bacteria								
Total Coliform	3	3	3	3				
Enterococcus	3	3		3				
Fecal Coliform	3	3	3	3				
Ratio Fecal:Total Coliform	3	3		0				
Aroclors								
Aroclor 1016	4	0						
Aroclor 1221	4	0						
Aroclor 1232	4	0						
Aroclor 1242	4	0						
Aroclor 1248	4	0						
Aroclor 1254	4	0						
Aroclor 1260	4	0						
Chlorinated Pesticides								
4,4'-DDD	4	0						
4,4'-DDE	4	0						
4,4'-DDT	4	0					0	0
Aldrin	4	0	0				0	0
Dieldrin	4	0	0				0	0
Endrin	4	0	0	0			0	0
Endrin aldehyde	4	0						
Endrin ketone	4	0						
alpha-BHC	4	0						
beta-BHC	4	1						
delta-BHC	4	0						
gamma-BHC (Lindane)	4	0					0	0
Endosulfan I	4	0					0	0
Endosulfan II	4	0					0	0
Endosulfan sulfate	4	0						
alpha-Chlordane	4	0						
gamma-Chlordane	4	0						
Heptachlor	4	0	0	0			0	0
Heptachlor epoxide	4	0	0	0			0	0
Methoxychlor	4	0						
Toxaphene	4	0	0	0			0	0
Organophosphates								
Atrazine	4	0		0				
Chlorpyrifos	4	2			2	2		
Cyanazine	4	0						
Diazinon	4	2			2			
Malathion	4	0						
Prometryn	4	0						
Simazine	4	0		0				

Table 9.6 Comparison of Stormwater Water Quality Measurements from Dominguez Pump Station with Guidelines and Standards.

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Conventionals								
Alkalinity as CaCO3	4	4						
pH	4	4		2				
BOD_5	4	4						
COD	4	4						
Chloride	4	3						
Fluoride	4	1						
Hardness as CaCO3	4	4						
MBAS	4	3		0				
Total Ammonia (as N)	4	4	0					
Total Kjeldahl Nitrogen	4	4						
Nitrate (as N)	4	4						
Nitrite (as N)	4	0						
Oil and Grease	4	0						
Total Rec. Phenolics	4	0						
Total Phosphorus	4	4						
Total Orthophosphate -P	4	4						
Specific Conductance	4	4						
Total Dissolved Solids	4	4						
Total Suspended Solids	6	6						
Total Volatile Solids	4	4						
Total Organic Carbon	4	4						
Turbidity	4	4						
Dissolved Metals								
Aluminum	4	0						
Arsenic	4	4					0	0
Cadmium	4	0					0	0
Chromium	4	3						
Copper	4	4					4	3
Iron	4	4						
Lead	4	1					1	0
Nickel	4	0					0	0
Selenium	4	0					0	0
Silver	4	0					0	0
Zinc	4	4					0	0
Total Metals								
Aluminum	4	4		4				
Arsenic	4	4	0	0				
Cadmium	4	4	0	0				
Chromium	4	4		0				
Copper	4	4	3					
Iron	4	4						
Lead	4	4	4					
Nickel	4	4	0	0				
Selenium	4	0	0	0				
Silver	4	0	0					
Zinc	4	4	4					

Table 9.6 Comparison of Stormwater Water Quality Measurements from Dominguez Pump Station with Guidelines and Standards.

Analyte Name	No. of Samples	No. of Detects above ML	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Bacteria								
Total Coliform	4	4	4	4				
Enterococcus	4	4		4				
Fecal Coliform	4	4	4	4				
Ratio Fecal:Total Coliform	4	4		3				
Aroclors								
Aroclor 1016	4	0						
Aroclor 1221	4	0						
Aroclor 1232	4	0						
Aroclor 1242	4	0						
Aroclor 1248	4	0						
Aroclor 1254	4	0						
Aroclor 1260	4	0						
Chlorinated Pesticides								
4,4'-DDD	4	0						
4,4'-DDE	4	0						
4,4'-DDT	4	0					0	0
Aldrin	4	0	0				0	0
Dieldrin	4	0	0				0	0
Endrin	4	0	0	0			0	0
Endrin aldehyde	4	0						
Endrin ketone	4	0						
alpha-BHC	4	0						
beta-BHC	4	0						
delta-BHC	4	0						
gamma-BHC (Lindane)	4	0					0	0
Endosulfan I	4	0					0	0
Endosulfan II	4	0					0	0
Endosulfan sulfate	4	0						
alpha-Chlordane	4	0						
gamma-Chlordane	4	0						
Heptachlor	4	0	0	0			0	0
Heptachlor epoxide	4	0	0	0			0	0
Methoxychlor	4	0						
Toxaphene	4	0	0	0			0	0
Organophosphates								
Atrazine	4	0		0				
Chlorpyrifos	4	0			0	0		
Cyanazine	4	0						
Diazinon	4	0			0			
Malathion	4	0						
Prometryn	4	0						
Simazine	4	0		0				

Table 9.7 Comparison of Dry Weather Water Quality Measurements from Bouton Creek with Guidelines and Standards.

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Conventionals								
Alkalinity as CaCO3	2	2						
pH	2	2		0				
BOD	2	2						
COD	2	2						
Chloride	2	2						
Fluoride	2	2						
Hardness as CaCO3	2	2						
MBAS	2	1		0				
Total Ammonia (as N)	2	0	0					
Total Kjeldahl Nitrogen	2	2						
Nitrate (as N)	2	0						
Nitrite (as N)	2	0						
Oil and Grease	2	0						
Total Rec. Phenolics	2	0						
Total Phosphorus	2	2						
Total Orthophosphate-P	2	0						
Conductivity	2	2						
Total Dissolved Solids	2	2						
Total Suspended Solids	2	0						
Total Volatile Solids	2	1						
Total Organic Carbon	2	2						
Turbidity	2	2						
Dissolved Metals								
Aluminum	2	0						
Arsenic	2	1					0	0
Cadmium	2	0					0	0
Chromium	2	2						
Copper	2	2					0	1
Iron	2	0						0
Lead	2	0					0	0
Nickel	2	2					0	0
Selenium	2	0					0	0
Silver	2	0					0	0
Zinc	2	2					0	0
Total Metals								
Aluminum	2	0		0				
Arsenic	2	1	0	0				
Cadmium	2	0	0	0				
Chromium	2	2		0				
Copper	2	2	0					
Iron	2	2						
Lead	2	1	0					
Nickel	2	2	0	0				
Selenium	2	0	0	0				
Silver	2	0	0					
Zinc	2	2	0					

Table 9.7 Comparison of Dry Weather Water Quality Measurements from Bouton Creek with Guidelines and Standards. (continued)

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Bacteria								
Total Coliform	2	2	0	0				
Enterococcus	2	2		2				
Fecal Coliform	2	2	1	1				
Ratio Fecal:Total Coliform	2	2		1				
Aroclors								
Aroclor 1016	2	0						
Aroclor 1221	2	0						
Aroclor 1232	2	0						
Aroclor 1242	2	0						
Aroclor 1248	2	0						
Aroclor 1254	2	0						
Aroclor 1260	2	0						
Chlorinated Pesticides								
4,4'-DDD	2	0						
4,4'-DDE	2	0						
4,4'-DDT	2	0					0	0
Aldrin	2	0	0				0	0
Dieldrin	2	0	0				0	0
Endrin	2	0	0	0			0	0
Endrin aldehyde	2	0						
Endrin ketone	2	0						
alpha-BHC	2	0						
beta-BHC	2	0						
delta-BHC	2	0						
gamma-BHC (Lindane)	2	0					0	0
Endosulfan I	2	0					0	0
Endosulfan II	2	0					0	0
Endosulfan sulfate	2	0						
alpha-Chlordane	2	0						
gamma-Chlordane	2	0						
Heptachlor	2	0	0	0			0	0
Heptachlor epoxide	2	0	0	0			0	0
Methoxychlor	2	0						
Toxaphene	2	0	0	0			0	0
Organophosphates								
Atrazine	2	0		0				
Chlorpyrifos	2	0			0	0		
Cyanazine	2	0						
Diazinon	2	0			0			
Malathion	2	0						
Prometryn	2	0						
Simazine	2	0		0				

Table 9.8 Comparison of Dry Weather Water Quality Measurements from Belmont Pump Stations with Guidelines and Standards.

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Conventionals								
Alkalinity as CaCO3	2	2						
pH	2	2		1				
BOD	2	2						
COD	2	2						
Chloride	2	2						
Fluoride	2	2						
Hardness as CaCO3	2	2						
MBAS	2	1		0				
Total Ammonia (as N)	2	2	0					
Total Kjeldahl Nitrogen	2	2						
Nitrate (as N)	2	2						
Nitrite (as N)	2	0						
Oil and Grease	2	0						
Total Rec. Phenolics	2	0						
Total Phosphorus	2	2						
Total Orthophosphate-P	2	2						
Conductivity	2	2						
Total Dissolved Solids	2	2						
Total Suspended Solids	2	1						
Total Volatile Solids	2	2						
Total Organic Carbon	2	2						
Turbidity	2	2						
Dissolved Metals								
Aluminum	2	0						
Arsenic	2	1					0	0
Cadmium	2	0					0	0
Chromium	2	2						
Copper	2	2					0	1
Iron	2	2						
Lead	2	0					0	0
Nickel	2	2					0	0
Selenium	2	0					0	0
Silver	2	0					0	0
Zinc	2	2					0	0
Total Metals								
Aluminum	2	0		0				
Arsenic	2	1	0	0				
Cadmium	2	0	0	0				
Chromium	2	2		0				
Copper	2	2	0					
Iron	2	2						
Lead	2	2	0					
Nickel	2	2	0	0				
Selenium	2	0	0	0				
Silver	2	0	0					
Zinc	2	2	0					

Table 9.8 Comparison of Dry Weather Water Quality Measurements from Belmont Pump Stations with Guidelines and Standards. (continued)

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Bacteria								
Total Coliform	2	2	0	0				
Enterococcus	2	2		2				
Fecal Coliform	2	2	2	2				
Ratio Fecal:Total Coliform	2	2		0				
Aroclors								
Aroclor 1016	2	0						
Aroclor 1221	2	0						
Aroclor 1232	2	0						
Aroclor 1242	2	0						
Aroclor 1248	2	0						
Aroclor 1254	2	0						
Aroclor 1260	2	0						
Chlorinated Pesticides								
4,4'-DDD	2	0						
4,4'-DDE	2	0						
4,4'-DDT	2	0					0	0
Aldrin	2	0	0				0	0
Dieldrin	2	0	0				0	0
Endrin	2	0	0	0			0	0
Endrin aldehyde	2	0						
Endrin ketone	2	0						
alpha-BHC	2	0						
beta-BHC	2	0						
delta-BHC	2	0						
gamma-BHC (Lindane)	2	0					0	0
Endosulfan I	2	0					0	0
Endosulfan II	2	0					0	0
Endosulfan sulfate	2	0						
alpha-Chlordane	2	0						
gamma-Chlordane	2	0						
Heptachlor	2	0	0	0			0	0
Heptachlor epoxide	2	0	0	0			0	0
Methoxychlor	2	0						
Toxaphene	2	0	0	0			0	0
Organophosphates								
Atrazine	2	0		0				
Chlorpyrifos	2	0			0	0		
Cyanazine	2	0						
Diazinon	2	0			0			
Malathion	2	0						
Prometryn	2	0						
Simazine	2	0		0				

Table 9.9 Comparison of Dry Weather Water Quality Measurements from Los Cerritos Channel with Guidelines and Standards.

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Conventionals								
Alkalinity as CaCO3	2	2						
pH	2	2		1				
BOD	2	2						
COD	2	2						
Chloride	2	2						
Fluoride	2	2						
Hardness as CaCO3	2	2						
MBAS	2	1		0				
Total Ammonia (as N)	2	2	0					
Total Kjeldahl Nitrogen	2	2						
Nitrate (as N)	2	1						
Nitrite (as N)	2	0						
Oil and Grease	2	0						
Total Rec. Phenolics	2	0						
Total Phosphorus	2	2						
Total Orthophosphate-P	2	0						
Conductivity	2	2						
Total Dissolved Solids	2	2						
Total Suspended Solids	2	2						
Total Volatile Solids	2	2						
Total Organic Carbon	2	2						
Turbidity	2	2						
Dissolved Metals								
Aluminum	2	0						
Arsenic	2	1					0	0
Cadmium	2	1					0	0
Chromium	2	2						
Copper	2	2					0	2
Iron	2	0						
Lead	2	2					0	0
Nickel	2	2					0	0
Selenium	2	0					0	0
Silver	2	0					0	0
Zinc	2	2					0	0
Total Metals								
Aluminum	2	1		0				
Arsenic	2	1	0	0				
Cadmium	2	2	0	0				
Chromium	2	2		0				
Copper	2	2	1					
Iron	2	2						
Lead	2	2	0					
Nickel	2	2	0	0				
Selenium	2	0	0	0				
Silver	2	0	0					
Zinc	2	2	0					

Table 9.9 Comparison of Dry Weather Water Quality Measurements from Los Cerritos Channel with Guidelines and Standards. (continued)

Analyte Name	No. of Samples	No. of Detects	Ocean Plan	LA Basin Plan	California Fish and Game Freshwater	California Fish and Game Saltwater	California Toxics Rule Freshwater	California Toxics Rule Saltwater
Bacteria								
Total Coliform	2	2	2	2				
Enterococcus	2	2		2				
Fecal Coliform	2	2	2	2				
Ratio Fecal:Total Coliform	2	2		2				
Aroclors								
Aroclor 1016	2	0						
Aroclor 1221	2	0						
Aroclor 1232	2	0						
Aroclor 1242	2	0						
Aroclor 1248	2	0						
Aroclor 1254	2	0						
Aroclor 1260	2	0						
Chlorinated Pesticides								
4,4'-DDD	2	0						
4,4'-DDE	2	0						
4,4'-DDT	2	0					0	0
Aldrin	2	0	0				0	0
Dieldrin	2	0	0				0	0
Endrin	2	0	0	0			0	0
Endrin aldehyde	2	0						
Endrin ketone	2	0						
alpha-BHC	2	1						
beta-BHC	2	1						
delta-BHC	2	0						
gamma-BHC (Lindane)	2	0					0	0
Endosulfan I	2	0					0	0
Endosulfan II	2	0					0	0
Endosulfan sulfate	2	0						
alpha-Chlordane	2	0						
gamma-Chlordane	2	0						
Heptachlor	2	0	0	0			0	0
Heptachlor epoxide	2	0	0	0			0	0
Methoxychlor	2	0						
Toxaphene	2	0	0	0			0	0
Organophosphates								
Atrazine	2	0		0				
Chlorpyrifos	2	0			0	0		
Cyanazine	2	0						
Diazinon	2	1			1			
Malathion	2	0						
Prometryn	2	0						
Simazine	2	0		0				

Table 9.10 Summary of Toxicity Characteristics of Stormwater from Various Southern California Watersheds. Test Types: SF = sea urchin fertilization, MS = mysid survival/growth, DS = daphnid survival/reproduction.

Location	Date	Test Type	Number of Samples	%Toxic	TU_c
Long Beach	2004-2005	SF	12	58	2-16
	2004-2005	DS	12	25	1-8
Long Beach	2003-2004	SF	11	45	<2-32
	2003-2004	DS	11	9	1-2
Long Beach	2002-2003	SF	13	46	≤2-32
	2002-2003	DS	13	31	1-4
Long Beach	2000-2002	SF	22	86	≤2-32
	2000-2002	MS	20	55	1-16
	2000-2002	DS	22	77	1->16
Los Angeles River	1997-1999	SF	4	100	4-8
San Gabriel River	1997-1999	SF	4	50	≤2-4
Ballona Creek	1996-1997	SF	13	85	≤4-32
Chollas Creek	1999-2000	SF	5	100	8-32
	1999	MS	3	0	1
	1999	DS	3	67	1-2

Table 9.11 Summary of TIE Results for Each Sample. The primary toxicant category indicates the chemical class most strongly indicated by the results. The secondary category indicates the chemical class indicated from partially effective TIE treatments.

Date	Station	Water Flea		Sea Urchin	
		Primary Category[1]	Secondary Category[1]	Primary Category	Secondary Category
Wet Weather Event:					
10/17/04	Cerritos	OP	METAL(?)	METAL	NPO
Dry Weather Events:					
8/31/04	Cerritos	NPO		--	--
5/25/05	Cerritos	NPO			

[1] OP = organophosphate pesticide, METAL = divalent cationic trace metal, NPO = unspecified nonpolar organic

Table 9.12 Spearman Rank Correlation coefficients (r_s) were calculated using selected toxicity data gathered from samples taken during five wet weather seasons from 2001 to 2005. The nonparametric tests show the relationship between paired chemical concentrations and toxic units (TU) for either acute or chronic bioassy toxicity tests. Toxic units are based on either the median response (EC_{50} or LC_{50}, acute TUa) or the NOEC (chronic TUc) concentration. Values of r_s in bold text are significant at $p \leq 0.05$ and indicate that each significant ranked pair series approach the same positive or negative order and are statistically different from an order that is random. For all constituents n=56.

	Sea Urchin Fertilization	Water Flea Survival	Water Flea Reproduction
Constituent	**TU_a**	**TU_a**	**TU_c**
Conventionals			
TSS	0.137	**0.482**	**0.575**
TDS	0.179	**0.393**	**0.435**
TOC	**0.333**	**0.557**	**0.641**
Dissolved Metals			
Cadmium	0.251	**0.388**	**0.303**
Chromium	0.235	-0.044	-0.118
Copper	**0.457**	**0.441**	**0.444**
Lead	**0.343**	**0.483**	**0.537**
Nickel	**0.465**	**0.561**	**0.599**
Zinc	**0.368**	**0.486**	**0.539**
Organophosphate Pesticide			
Diazinon	0.147	**0.489**	**0.404**

***In bold**, significant values at the level of significance alpha=0.050 (two-tailed test).*

10.0 CONCLUSIONS

10.0 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, 65 wet weather monitoring events have been conducted at the four Long Beach mass emission stations for the full set of analytes, along with 48 dry weather inspections/monitoring events. In addition 27 wet weather events have been monitored to develop Event Mean Concentrations (EMCs) for total suspended solids only. For the past three years, annual studies have been conducted in Alamitos Bay to characterize the vertical and horizontal extent of the stormwater plume and document potential toxicity effects in the receiving waters in the Bay.

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. Also, since numerical stormwater quality standards do not exist, it was desired to measure the impacts of these discharges in the Long Beach receiving waters.

A number of conclusions can be made based upon both the results of the 2004/2005 monitoring effort and the cumulative results of the first six years of the City of Long Beach Stormwater Monitoring Program. Many of these conclusions have been stated previously in each annual report. The body of evidence to support these basic conclusions has continued to build over the course of the past six years. These include:

- Exceedances of available benchmark values based upon receiving water, ocean water, drinking water or other available comparisons are common for several metals (copper, lead and zinc). Exceedances of benchmark values are less common for diazinon and chlorpyrifos (organophosphate pesticides). Exceedances of the diazinon and chlorpyrifos benchmarks have not followed any consistent seasonal or spatial pattern.

- With the exception of a few measurements, indicator bacterial counts tend to exceed Basin Plan single sample criteria during storm events. During recent dry weather investigations, indicator bacteria have been consistently lower than measured at the same sites during storm events. Total and fecal coliform concentrations in Bouton Creek continue to be unique. Concentrations of total and fecal coliform are below Basin Plan single sample criteria approximately 50% of the time during dry weather discharges.

- Concentrations of dissolved cadmium, copper, nickel and lead are relatively comparable during both wet and dry weather periods compared to concentrations of the total recoverable forms. Although the concentrations of many dissolved metals remain relatively consistent between storm events and dry weather flows, higher levels of hardness during dry weather conditions tend to prevent frequent exceedances of freshwater CTR water quality criteria.

- Unlike these four metals, dissolved zinc concentrations are consistently higher during storm events.

- Concentrations of total copper, lead and zinc are distinctly higher in association with storm flows. Regressions developed in the previous, five-year report (Kinnetic Laboratories, Inc., 2004) provided evidence of strong relationships to the concentration of total suspended solids at each site.

- Stormwater discharges from the Dominguez Gap Pump Station are consistently of a higher quality than the other mass emission sites. In addition, stormwater discharges are less frequent at Dominguez Gap because of the storage capacity and infiltration that occurs in the basin associated with this pump station. Exceptions to this occur in situations when unusually high volume storm events occur repeatedly over a relatively short time interval.

- Stormwater discharges have consistently shown measured toxicity to freshwater and marine test species, but lesser or no toxicity after a series of storms or very large runoff events.

- Toxicity Identification Evaluations (TIEs) typically implicate organophosphate pesticides (diazinon and chlorpyrifos) in causing toxicity to the freshwater water flea (freshwater test). Over the past two years, fewer TIEs were conducted due to lower incidence of toxicity but results have implicated possible added toxicity due to pyrethoid pesticides as well as cationic metals.

- Stormwater plumes that develop in Alamitos Bay have consistently shown little evidence of toxicity. The largest storm events show the least evidence of toxicity. This contrasts with similar studies of stormwater plumes from in Santa Monica Bay from Ballona Creek and in San Diego Bay from Chollas Creek. In the latter studies, toxicity was measured in receiving waters when the plume consisted of as little as 10 to 25 percent stormwater. Minimal toxicity was evident in the stormwater plume in Alamitos Bay where the plume consisted of up to 68% stormwater.

- Occasional elevations of pH during dry weather surveys in open concrete channels of the Los Cerritos Channel are consistent with normal diurnal variations associated with periods with high photosynthetic activity. Evidence suggests that pH increases during the day. Algae in the channels consume carbon dioxide (CO_2) while undergoing photosynthesis. 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 the night, respiration of the algae and bacteria in the channel cause CO_2 to be released and oxygen to be consumed. This allows the pH drop during the night. The diurnal cycling of pH is a common occurrence in open waterways.

11.0 REFERENCES

11.0 REFERENCES CITED

Bay, S., B.H. Jones, and K. Schiff. 1999. Study of the Impact of Stormwater Discharge on Santa Monica Bay. Executive Summary. Sea Grant Program, University of Southern California. Los Angeles.

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.

City of Long Beach, 2001. City of Long Beach Stormwater Management Program. Section 3. Geographic Characteristics.

City of Long Beach, 1994. City of Long Beach GIS Database. Dept. of Technology, Long Beach.

Gossett, R., D. Renfrew and K. Schiff, 2004. Stormwater Monitoring Coalition Laboratory Guidance Document. SCCWRP Technical Report #420.

Kinnetic Laboratories, Inc. 2000. City of Long Beach Storm Water Monitoring Report 1999-2000. NPDES Permit No. CAS0040003 (CI 8052), July, 2000.

Kinnetic Laboratories, Inc. and Southern California Coastal Water Research Project. 2001. City of Long Beach Storm Water Monitoring Report 2000-2001. NPDES Permit No. CAS004003 (CI 8052), July, 2001.

Kinnetic Laboratories, Inc. and Southern California Coastal Water Research Project. 2002. City of Long Beach Storm Water Monitoring Report 2001-2002. NPDES Permit No. CAS004003 (CI 8052), July, 2002.

Kinnetic Laboratories, Inc. 2003. City of Long Beach Storm Water Monitoring Report 2002-2003. NPDES Permit No. CAS0040003 (CI 8052), July, 2003.

Kinnetic Laboratories, Inc. 2004. City of Long Beach Storm Water Monitoring Report 2003-2004. NPDES Permit No. CAS0040003 (CI 8052), July, 2004.

Miles, S.R. and C.B. Goudey. 1998. Ecological Subregions of California. Internet number R5-EM-TP-005 NET. Available at: http://www.r5.pswfs.gov/ecoregions. [Access Date June 6, 2001]

NADP [National Atmospheric Deposition Program]. 2003. (NRSP-3)/National Trends Network. NADP Program Office, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820. (Isopleth maps of annual average pH in rainfall throughout the continental United States. http://nadp.sws.uiuc.edu/isopleths/annualmaps.asp.)

NCDC [National Climate Data Center]. 2000. TD 9641 CLIM 81 1961-1990 NORMALS. Available at: http:// www.worldclimate.com [Access Date June, 2002].

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

State of California Department of Finance Demographic Research Unit. 2005. Population Estimate as of January 1, 2005.

SWRCB [State Water Resources Control Board]. 2002. Water Quality Control Plan, Ocean Waters of California, California Ocean Plan 2001.

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]. 1994a. Short term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms (Third Edition). Vol. EPA-600/4-91/002. Cincinnati, OH: U.S. Environmental Protection Agency, National Exposure Research Laboratory:

USEPA [U.S. Environmental Protection Agency]. 1995a. Guidance on documentation and evaluation of trace metals data collected for the Clean Water Act compliance monitoring. Vol. EPA/821/B-95/002. Washington D.C.: U.S. Environmental Protection Agency, Office of Water, Engineering, and Analysis Division.

USEPA [U.S. Environmental Protection Agency]. 1995b. 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]. 2000. Federal Register, Part III. "California Toxics Rule: Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule."

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

USEPA [U.S. Environmental Protection Agency], 2002. USEPA Functional Guidelines for Inorganic Data Review. EPA 540-R-01-008.

APPENDICES

Appendix A

Quality Assurance/Quality Control Assessment

APPENDIX A: ANALYTICAL CHEMISTRY QUALITY ASSURANCE/QUALITY CONTROL 2004-2005 LONG BEACH STORMWATER MONITORING PROJECT

Kinnetic Laboratories and ToxScan conduct all activities in accordance with formal QA/QC procedures. Quality Assurance and Quality Control (QA/QC) consists of evaluating the field duplicates and laboratory quality control samples for compliance associated with the field sampling and laboratory. Field QA/QC samples are used to evaluate potential contamination and sampling error introduced prior to submittal to the analytical laboratories. Laboratory QA/QC assess

1.0 QA/QC METHODS

The 2004-2005 Long Beach Stormwater Monitoring Project Quality Assurance/Quality Control (QA/AC) chemistry records were inspected using the EPA documents for organic and inorganic review for guidance and compared to the Sampling and Analysis Plan.

The dataset accumulated this project year contains more than 5500 records. That breaks down to nearly 2500 individual sample chemistry records, 54 toxicity records, and considerably more than 3000 laboratory QC records. Each record was examined individually and also in related groups such as sampling event or QC batch to determine that the overall quality of the dataset.

The overall quality of the dataset is determined to a large degree by the thoroughness, accuracy and precision of the laboratory QC records which explains why the majority of this section is devoted to examining them in detail. The QC is tabulated by category and each is discussed individually. Generally the results were well within the appropriate ranges and limits and any significant exceptions and any resulting data qualifications are presented in detail in this section and reflected in the summary tables found in the main body of the document.

1.1 Precision

Precision provides an assessment of mutual agreement between repeated measurements. These measures may apply to blind field duplicates (FD), laboratory duplicates (DUP), matrix spike duplicates (MSD) and laboratory control sample duplicates (LCSD). Monitoring of precision through the process allows for the evaluation of the consistency of field sampling and laboratory analysis.

The Relative Percent Difference (RPD) is used to evaluate duplicate samples. The RPD is the difference between the two samples divided by their average expressed as percent and is calculated as:

$$RPD = 200 * \left(\frac{|x_1 - x_2|}{(x_1 + x_2)} \right)$$

where:
x_1 = Concentration of sample 1 of the pair
x_2 = Concentration of sample 2 of the pair

1.2 Accuracy

An assessment of the accuracy of measurements is based on determining the difference between measured values and the known or "true" value and is applied to Matrix Spikes (MS), Laboratory Control Samples (LCS) and Standard Reference Material (SRM).

In general, Percent Recovery is calculated as:

$$\%R = 100 * \left(\frac{Measured\_Value}{True\_Value} \right)$$

Matrix Spike recoveries take into account the concentration of the source sample.

$$\%R_{MS} = 100 * \left(\frac{Measured\_Value - Sample\_Value}{True\_Value} \right)$$

1.3 Representativeness, Comparability and Completeness

Representativeness is the degree to which data accurately and precisely represents the natural environment.

Comparability is the measure of confidence with which one dataset can be compared to another. The use of standardized methods of chemical analysis and field sampling and processing are ways of insuring comparability. The implementation of thorough QA/QC methods such as field duplicates and laboratory QC is essential.

Completeness is a measure of the percentage of the data judged valid after comparison with specific validation criteria. This includes data lost through accidental breakage of sample containers or other activities that result in irreparable loss of samples. Implementation of standardized Chain-of-Custody procedures which track samples as they are transferred between custodians is one method of maintaining a high level of completeness.

A high level of completeness is essential to all phases of this study due to the limited number of samples. Of course, the overall goal is to obtain completeness of one hundred percent however a realistic data quality objective of 95% will insure an adequate level of data return.

Close adherence to 'Standard Operating Procedures' (SOP's) assures that the resulting data is representative, complete and comparable. The results are further assessed with a thorough validation process.

2.0 DATA QUALITY ASSESSMENT PROCESS

2.1 Verification

Data verification was the first step in the data quality assessment process. The verification process generally included checks to verify compliance with the sampling plan and with the QA/QC practices. Information contained in the laboratory reports was verified to be complete, correct and free of inconsistencies.

2.2 Validation

Data validation was performed in accordance with the National Functional Guidelines for Organic Review (EPA 540-R-99-008, October 1999), National Functional Guidelines for Low Concentration Organic Review (EPA 540-R-00-006, June 2001) and Inorganic Data Review (EPA.540-R-01-008, July

2002). All laboratory and field data generated under the program were reviewed for accuracy, precision and completeness. The review included:

- Data package completeness
- Chain-of-Custody
- Use of specified analytical methods
- Holding times for extraction and analysis
- Blanking results (equipment, bottle, filter, and method blanks) relative to the reporting limits and sample concentrations
- Field duplicate frequency and precision
- Laboratory duplicates, frequency and precision
- Laboratory Control Sample frequency, compounds and recoveries
- Surrogate standard frequency, compounds and recoveries
- Matrix spike frequency, compounds and recoveries
- Matrix spike duplicate frequency and relative percent differences
- Reporting limits and dilution factors

2.3 Data Qualifiers

Where appropriate, data qualifiers were associated with the results using the following standard notations from the EPA guidance documents

Data Review Qualifiers

U	The compound was analyzed for but was not detected. The associated value is the sample reporting limit
UJ	The compound was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise
J-	The associated value is a low estimate
J	The associate value is an estimated quantity
J+	The associated value is a high estimate
Y	The difference between two columns is greater than 40% (Organics Only)
R	The data are unusable. The analyte may or may not be present

The EPA guidance documents are clear that data review and qualification rules are to be tempered using professional judgment and the specifics are discussed in the following section of this report.

3.0 PROJECT SPECIFIC DATA REVIEW

3.1 Holding Times

Holding times were generally met during the project year. The exceptions are noted.

Total Kjeldahl Nitrogen was run 3 days over the 28 day holding time. This is within 10% of meeting the hodling time and the associated sample results were not qualified. Total Phenols for the same event were run 2 days over the 28 day hold time and the associated samples were also not qualified.

Six conventional analytes for Storm Events 8 and 9 were run out of hold time: BOD, Nitrate, Nitrite, Total Phosphorous and Turbidity. The associated samples for Storm Event 8 were qualified with a J when the analyte was detected and UJ for non-detects. The BOD sample for Storm 9 was also qualified with J for detects and UJ for non-detects. The other analytes for Storm 9 were not qualified.

3.2 Equipment Blanks

The results of field-related blanking activities are summarized in Table A.1. Blanks were analyzed to assess potential contamination from monitoring site intake hoses, the sub-sampling process, composite bottles and laboratory sample containers. Equipment was tested for Total Metals (Al, As, Cd, Cr. Cu, Pb, Ni, Ag, Zn) and four conventional contaminates (COD, TOC, Nitrate as N, and Total Phosphorus).

In general, if a contaminate is found in an equipment blanking study, all associated samples that have a concentration less than five times the blank hit are qualified with a 'J+' flag. Samples with relatively high concentrations are unaffected. In the blanking studies associated with the Long Beach 2004/2005 storm season no samples were qualified as a result of an equipment blanking hit.

3.3 Intake Hose Blanks

An intake hose is installed at each station and leads from the sample basin to the sampler. One blank analysis was performed on the set of hoses and no contaminates were detected.

3.4 Field Duplicates

A summary of field duplicate stations and dates are summarized in Table A.3. Sample volumes were sufficient for 4 of the events during the project year, both dry weather events and two storm events. The field duplicate results are summarized in Table A.3.

Strict criteria are not established for the evaluation of field duplicates. Rather samples are evaluated based upon best professional judgment. Relative percent differences where highlighted when greater than 50% and were given closer scrutiny. As a general rule, values are considered to be of concern if above 50% provided both values are greater than five times the reporting limit. In cases where one or both values are less than five times the reporting limit then those values are considered to be of potential concern if the difference between the two values are greater than twice the reporting limit.

3.5 Grabs

Oil and grease and bacteria samples were collected manually as grab samples. True field duplicates were collected for these constituents. Sampling was preformed sequentially maintaining a minimum period of time between each sample.

High RPD's encountered for bacteria are typical of repeated measurements of microbial constituents in receiving waters. Out of the 30 bacteria duplicates 21 have RPD's less than 50%. Of the nine remaining samples one is over 150%, three are between 100 and 150% and five are between 50 and 100%.

3.6 Composites-Sub-sampling Splits

Sub-sampling splits of the composite samples, while not true field duplicates, are assessed as field duplicates. They indicate that the sub-sampling process was, in most cases, able to effectively obtain representative samples from the composite during the project. High variability as observed for only a small number of constituents during the project year and they are shown in bold in the tables.

Only three of the composite field duplicates have RPD's greater than 50%. The field duplicate RPD for Storm Event 3 TDS is 57% but the other QC records are fine and the associated samples were not qualified. The dissolved aluminum RPD is 71% for that same event and the samples values were qualified as estimates (J). Total iron's RPD for the second dry weather event is 102% and the associated samples were qualified as estimates (J).

4.0 LABORATORY QUALITY ASSURANCE AND CONTROL

This section address procedures and errors associated with laboratory handling and analysis. In most cases, the QA/QC results have been summarized for each type of assessment.

4.1 Reporting Limits

Achieved reporting limits were closely examined to verify that the minimum level was met. A reporting limit of 0.01 ug/L was requested for diazinon. Rather, diazinon was reported down to the laboratory's Method Detection Limit (MDL) of 0.01 ug/L and the results were qualified as estimates (J) when detected below the reporting limit. The other cases where the reporting limits were not met were based on each individual run and the matrix specific interferences.

4.2 Method and Filter Blanks

The laboratory method and filter blank results are shown in Table A.4. Estimated values between the MDL and RL are included in the table and indicated with a (J) qualifier. Overall the analyses for the project year were free of blank contamination. There was only one case where contamination was observed above the reporting limit. TKN for Storm Event 14 was reported with a blank hit of 0.36 with a detection limit of 0.l mg/L. All samples whose values were less than 10 times the blank hit were qualified with a J+ to indicate a high bias.

4.3 Laboratory Duplicates

To evaluate precision of laboratory analysis, replicate samples were analyzed and reported in Table A.5. Those duplicates with an RPD greater than 20% were examined more closely and those results that professional judgment determines to be affected are qualified

Laboratory Duplicates where both values are less than the reporting limit and their difference is less than the reporting limit are not qualified. There were a number of such cases because the laboratories often reported the values down to their MDL.

Generally the lab duplicates were well within range. There were four exceptions noted during the Long Beach 2004-2005 project. BOD was reported with a RPD of 22% for Dry Weather Event 1 and the associated samples were qualified with J when detected and (UJ) when not. The relative percent difference for total aluminum associated with Storm Event 1 was 20.5%. The sample values were qualified with J- to indicate a low bias when detected in the sample and UJ when not. The RPD for both total and dissolved silver for Storm Event 5 were reported at 35.6% and 22.7% respectively and the associated samples were qualified as estimates, J for detects and UJ for non-detects.

4.4 Matrix Spikes

Matrix Spike and Matrix Spike Duplicates (MS/MSD) percent recoveries were evaluated to determine acceptable accuracy based on method-specific percent recoveries. Precision was evaluated by calculating the RPD of the MS/MSD recovery results. QA/QC guidelines indicate that no action need be taken on MS/MSD data alone. The data reviewer may use the MS/MSD results in conjunction with other QC criteria when determining the need for further qualification. The MS/MSD results are summarized in table A.6

Generally, the Matrix Spike and their duplicates were recovered within range during the Long Beach 2004-2005 project. There were only ten MS or MSD samples that were recovered outside of range. The bulk of them were related to the organic analyses. Both Endrin aldehyde matrix spikes associated with Storm Event 1 were recovered below the appropriate limit and the associated samples were qualified as low estimates (J-) for detections and UJ for non-detects. Malathion was recovered in one or both spikes above range for Storm Event 5, 8 and 9. The associated samples were qualified as high estimates (J+) when detected and non-detects were not qualified. Chlorpyrifos was recovered at 126%, 1% over the upper limit, for Storm 5. The spike duplicate was recovered at 119% and the associated samples were not qualified. The dissolved silver MS associated with Storm Events 7, 8 and 9 was recovered low and the associated samples were qualified as low estimates (J-) for detects or UJ for non-detects.

4.5 Laboratory Control Samples

Laboratory Control Spikes and their duplicates (LCS/LCSD) are solutions of known compounds and selected concentrations. Precision and accuracy are evaluated in a similar fashion as MS/MSDs with the exception that there is no source sample to subtract and no matrix interference issues. The LCS/LCSD results are presented in table A.7.

The Laboratory Control Spikes were recovered within range with only the exception of Malathion which was recovered at 204% in the LCS associated with Storms 8 and 9, 132% in the LSC associated with Storm 14 samples and 145% in the LCS associated with the second dry weather events. The affected sample values detected were qualified as high estimates (J+) and non-detects were unaffected.

4.6 Standard Reference Material

Standard Reference Material (SRM) is analyzed to evaluate accuracy. The results are presented in Table A.8 and show that the data quality objectives were met in most cases for the Long Beach 2004/2005 year with the following exceptions:

SRM material is used primarily with metals analysis. The total and dissolved arsenic SRM associated with Storm Events 1,2 and 3 were recovered at 67.9%. The associated sample values were qualifed as low estimates (J-) when detected and UJ when not. The dissolved chromium SRM was recovered at 130% and 127% at two different dilutions. The associated sample values were qualified as high estimates (J+) when detected.

4.7 Surrogate Recoveries

Surrogate analytes behave similarly to the target analytes. Surrogate spikes are introduced into the samples at specific concentrations and are used to provide a measure of instrument and method performance and to indicate sample-specific matrix effects. In logic similar to that offered for matrix spikes no action is required based on surrogate recoveries alone but should be taken in context with other QC records. Surrogate recovery results are summarized in Table A.9.

Surrogate recoveries for the chlorinated pesticides were within range for the entire project. Organophosphate recoveries had the following exceptions. The Surrogate tributylphosphate associated with Los Cerritos Channel for Storm Event 1 was recovered at 413%. The tributylphosphate surrogate spike was also recovered high for Los Cerritos for Storm Events 3 and 5. All detected organophosphate analytes for those Los Cerritos samples were qualified as high estimates (J+) if detected. Non-detects were not qualified. The surrogate triphenylphosphate was recovered high for all sites for Storm Event-03 and those analytes that were detected were also qualified as high estimates (J+).

4.8 Total and Dissolved Metals

A comparison of nearly 300 total-dissolved metal pair show 10 cases, all dry weather events, where the dissolved fraction was greater than the total. The two analytes of concern are chromium and arsenic. Arsenic was found to be within 2 ppb of each other in the two fractions for all four stations during the second dry weather event. The reporting limit for arsenic is 1 ppb. The difference in the total and dissolved chromium fractions at two stations for the first dry weather event were within 0.5 ppb and the detection limit for chromium is .5 ppb. The differences found for all four stations during the second dry weather event were larger, ranging from 1 to nearly 6 ppb. These results suggest that the arsenic in the last dry weather event is nearly all dissolved. This may be the explanation for the first dry weather event's chromium results. The second dry weather event is not explained so easily.

4.9 Assessment of Toxicity Analyses

The majority of toxicity tests met critical test acceptability criteria (TACs)and the results were judged to be valid. One of the *Cerodaphnia* tests did not meet all of the TACs but was nevertheless judged to have produced valid toxicity results. A few additional tests experienced minor procedural deviations that had no significant effect on the results. All deviations are described in the following paragraphs and summarized in Table A-10.

4.9.1 Water Flea Tests

The water flea toxicity tests were conducted according to USEPA protocol guidelines, and there were no procedural problems with tests conducted on most storm samples or from dry weather collections.

The bioassay conducted on the Belmont Pump sample collected during the last wet weather event, however, did not meet the minimum control performance standard for reproduction. Although control survival was acceptable (100%), fewer than 15 neonates per control female were produced. Despite this poor control performance, however, the stormwater samples showed no apparent toxicity, with abundant neonate production in all test concentrations. The concurrent reference toxicant test also showed poor reproductive performance in the controls, while yielding LC50 and EC50 values that were within control chart limits. In our best professional judgement, these test results strongly suggested that toxicity was absent in the sample, and the test was not repeated.

In all water flea bioassays, dissolved oxygen and pH measurements remained within acceptable limits, while there were very small (< 0.5C) temperature excursions outside protocol recommendations which were corrected by adjusting room temperature controls. Samples were renewed each day with aliquots within the recommended pH range. All reference toxicant tests produced LC50s and EC50s that were within laboratory control chart limits.

4.9.2 Sea Urchin Tests

Sea urchin fertilization tests were conducted according to protocol guidelines. There were three samples that failed to meet TAC upon initial testing:

The brine control associated with the Belmont, Bouton and Cerritos wet weather samples collected on 20 October 2004 failed minimum (70%) fertilization requirements and all were retested on 22 October 2004.

With the exceptions detailed above, all sea urchin tests met TACs, all environmental monitoring values were within recommended ranges and all reference toxicant tests produced EC50s that were within laboratory control chart limits.

4.9.3 Sample Holding Times

The holding time for each sample and test is presented in Table A-11. The objective of <36 hours holding before test initiation was met for 47% of the samples; and tests for 89% of the samples were started within the allowable extended holding time window of 72 hours. In general, failure to meet the 36 hour holding time was due to laboratory loading problems.

The effect of extended cold storage on stormwater toxicity is unpredictable. The 36 hr storage objective used in this program was adapted from guidance for wastewater effluent testing developed by USEPA. The same guidance allows an extension of holding time to 72 hours when required by sample shipping or other logistic considerations. Extended storage times may have resulted in toxicity loss due to contaminant degradation or sorption to the storage container. The impact of such potential losses in this program cannot be assessed, since toxicity was not present in samples that experienced the most extended storage.

Table A.1 Summary of Blanking Results Associated with Field Activities.

Analyte	Reporting Limit	Installed Intake Hose		Subsampling Hose		Composite Bottles		Laboratory Container Blanks		Peristaltic Hose	
		Number of Detections	Number of Analyses	Number of Detections	Number of Analyses	Number of Detections	Number of Analyses	Number of Detections	Number of Analyses	Number of Detections	Number of Analyses
CONVENTIONALS (mg/L)											
Chemical Oxygen Demand (COD)	4.0	0	1	0	1	0	7	0	1	0	0
Total Organic Carbon (TOC)	0.5-1.0	0	1	0	1	0	7	0	1	0	0
Nitrate-N	0.10	0	1	0	1	0	7	0	1	0	0
Total P	0.01-0.002	0	1	0	1	0	7	0	1	0	0
TOTAL METALS (ug/L)											
Aluminum	100	0	1	0	1	0	7	0	1	0	0
Arsenic	1.0	0	1	0	1	0	7	0	1	0	0
Cadmium	0.25	0	1	0	1	0	7	0	1	0	0
Chromium	0.50	0	1	0	1	0	7	0	1	0	0
Copper	0.50	0	1	0	1	0	7	0	1	0	0
Lead	0.50	0	1	0	1	0	7	0	1	0	0
Nickel	1.0	0	1	0	1	0	7	0	1	0	0
Silver	0.25	0	1	0	1	0	7	0	1	0	0
Zinc	1.0	0	1	0	1	0	7	0	1	0	0

Table A.2 Field Duplicate Stations for Each Event.

Event Category	Global Event ID	Sample Date	Composite or Grab	Duplicated Station
Dry Weather	Event-01	31-Aug-2004	Comp	Los Cerritos Channel
Dry Weather	Event-01	31-Aug-2004	Grab	Los Cerritos Channel
Storm	Event-02	20-Oct-2004	Comp	Los Cerritos Channel
Storm	Event-02	20-Oct-2004	Grab	Bouton Creek
Storm	Event-03	27-Oct-2004	Comp	Los Cerritos Channel
Storm	Event-03	27-Oct-2004	Grab	Los Cerritos Channel
Storm	Event-05	29-Dec-2004	Comp	Los Cerritos Channel
Storm	Event-05	29-Dec-2004	Grab	Los Cerritos Channel
Dry Weather	Event-02	25-May-2005	Comp	Belmont Pump
Dry Weather	Event-02	25-May-2005	Grab	Belmont Pump

Tables A.3 Relative Percent Differences of Field Duplicates for all Sampling Events.

	Dry Event-01 31-Aug-04			Storm Event-02 20-Oct-04			Storm Event-03 27-Oct-04		
	Result	DUP	RPD	Result	DUP	RPD	Result	DUP	RPD
Conventionals									
Alkalinity as CaCO3	140	140	0	21	22	4.7	13	13	0
Biochemical Oxygen Demand	26	30	14	7.4	8	7.8	23	24	4.3
Chemical Oxygen Demand	150	140	6.9	59	58	1.7	64	69	7.5
Chloride	190	190	0	4.6	4.4	4.4	2.9	3	3.4
Fluoride	0.75	0.75	0	0.16	0.16	0	0.16	0.16	0
Hardness as CaCO3	180	180	0	21	21	0	16	17	6.1
MBAS	0.13	0.12	8	0.025U	0.025U	N/A	0.025U	0.025U	N/A
Total Ammonia (as N)	0.14	0.16	13	0.19	0.21	10	0.12	0.11	8.7
Total Kjeldahl Nitrogen	4.4	4.2	4.7	1.3	1.2	8	0.9	1	11
Nitrate (as N)	0.11	0.11	0	0.44	0.44	0	0.26	0.26	0
Nitrite (as N)	0.1U	0.1U	N/A	0.1U	0.1U	N/A	0.1U	0.1U	N/A
Oil and Grease	5U	5U	N/A	5U	5U	N/A	5U	6	N/A
Total Recoverable Phenolics	0.1U	0.1U	N/A	0.1U	0.1U	N/A	0.1U	0.1U	N/A
Total Phosphorus	0.47	0.67	35	0.59	0.61	3.3	0.53	0.53	0
Total Orthophosphate (as P)	0.01U	0.01U	N/A	0.23	0.23	0	0.17	0.17	0
Conductivity	1100	1100	0	77	78	1.3	57	58	1.7
Total Dissolved Solids	590	690	16	44	48	8.7	15	27	**57**
Total Suspended Solids	41	36	13	130	130	0	170	160	6.1
Total Volatile Solids	120	120	0	80	110	32	44	47	6.6
Total Organic Carbon	50	51	2.0	10	12	18	11	10	9.5
Turbidity	22	23	4.4	120	120	0	140	130	7.4
Dissolved Metals									
Aluminum	100U	100U	N/A	130	170	27	110	230	**71**
Arsenic	1.8	1.8	0	1.4	1.3	7.4	1.2	1	18
Cadmium	0.25U	0.25U	N/A	0.12U	0.12J	N/A	0.25U	0.25U	N/A
Chromium	0.67	0.72	7.2	0.75	0.72	4.1	0.76	0.79	3.9
Copper	9.8	10	2.0	5.7	5.7	0	3.5	3.5	0
Iron	25U	25	N/A	550	410	29	540	580	7.1
Lead	0.71	0.74	4.1	0.65	0.68	4.5	0.4U	0.4J	N/A
Nickel	5	5.1	2.0	0.59U	0.51J	N/A	0.9U	0.9J	N/A
Selenium	1U	1U	N/A	1U	1U	N/A	1U	1U	N/A
Silver	0.25U	0.25U	N/A	0.25U	0.25U	N/A	0.25U	0.25U	N/A
Zinc	8.2	7.8	5	32	32	0	11	12	8.7
Total Metals									
Aluminum	110	110	0	5600	5000	11	6500	6800	4.5
Arsenic	1.9	1.9	0	4.8	5.1	6.1	4.1	4.6	11
Cadmium	0.29	0.32	9.8	1.2	1.1	8.7	0.8	1	22
Chromium	1.1	1.1	0	9.9	8.7	13	9.9	11	11
Copper	16	17	6.1	27	25	7.7	22	31	34
Iron	390	410	5	11000	47000	124	8700	8500	2.3
Lead	6.8	3.4	67	26	24	8	28	33	16
Nickel	6	6.3	4.9	9.6	9.9	3.1	8.4	11	27
Selenium	1U	1U	N/A	1U	1U	N/A	1U	0.18J	N/A
Silver	0.25U	0.25U	N/A	0.25U	0.25U	N/A	0.1U	0.11J	N/A
Zinc	33	36	8.7	240	230	4.3	180	230	24

1-Bolded values are outside of QC limits

Tables A.3 Relative Percent Differences of Field Duplicates for all Sampling Events (Continued).

	Dry Weather Event-01 31-Aug-04			Storm Event-02 20-Oct-04			Storm Event-03 27-Oct-04		
	Result	DUP	RPD	Result	DUP	RPD	Result	DUP	RPD
Bacteria									
Coliform, Total	16000	16000	0	1600000	240000	**148** [1]	90000	50000	**57** [1]
Enterococcus	3100	1580	**65** [1]	70000	73000	4.2	35000	41000	16
Fecal Coliform	5000	1300	**117** [1]	110000	50000	**75** [1]	9000	9000	0
Aroclors									
PCB-1016 (Aroclor 1016)	0.2U	0.2U	N/A	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1221 (Aroclor 1221)	0.2U	0.2U	N/A	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1232 (Aroclor 1232)	0.2U	0.2U	N/A	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1242 (Aroclor 1242)	0.2U	0.2U	N/A	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1248 (Aroclor 1248)	0.2U	0.2U	N/A	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1254 (Aroclor 1254)	0.2U	0.2U	N/A	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1260 (Aroclor 1260)	0.2U	0.2U	N/A	0.5U	0.5U	N/A	0.5U	0.5U	N/A
Chlorinated Pesticides									
4,4'-DDD	0.01U	0.01U	N/A	0.05U	0.05U	N/A	0.05U	0.05U	N/A
4,4'-DDE	0.01U	0.01U	N/A	0.05U	0.05U	N/A	0.05U	0.17	N/A
4,4'-DDT	0.01U	0.01U	N/A	0.01U	0.01U	N/A	0.01U	0.4	N/A
Aldrin	0.005U	0.005U	N/A	0.005U	0.005U	N/A	0.005U	0.005U	N/A
Dieldrin	0.01U	0.01U	N/A	0.01U	0.01U	N/A	0.01U	0.05U	N/A
Endrin	0.01U	0.01U	N/A	0.01U	0.01U	N/A	0.01U	0.097	N/A
Endrin aldehyde	0.01U	0.01U	N/A	0.01U	0.01U	N/A	0.01U	0.05U	N/A
Endrin ketone	0.01U	0.01U	N/A	0.01U	0.01U	N/A	0.01U	0.05U	N/A
alpha-BHC	0.038	0.01U	N/A	0.01U	0.01U	N/A	0.01U	0.01U	N/A
beta-BHC	0.026	0.022	17	0.012	0.011	8.7	0.005U	0.005U	N/A
delta-BHC	0.005U	0.005U	N/A	0.005U	0.005U	N/A	0.005U	0.005U	N/A
gamma-BHC (Lindane)	0.01U	0.01U	N/A	0.02U	0.02U	N/A	0.02U	0.02U	N/A
Endosulfan I	0.01U	0.01U	N/A	0.02U	0.02U	N/A	0.02U	0.05U	N/A
Endosulfan II	0.01U	0.01U	N/A	0.01U	0.01U	N/A	0.01U	0.05U	N/A
Endosulfan sulfate	0.01U	0.01U	N/A	0.05U	0.05U	N/A	0.05U	0.05U	N/A
alpha-Chlordane	0.01U	0.01U	N/A	0.1U	0.1U	N/A	0.1U	0.05U	N/A
gamma-Chlordane	0.01U	0.01U	N/A	0.1U	0.1U	N/A	0.1U	0.05U	N/A
Heptachlor	0.01U	0.01U	N/A	0.01U	0.01U	N/A	0.01U	0.01U	N/A
Heptachlor epoxide	0.01U	0.01U	N/A	0.01U	0.01U	N/A	0.01U	0.05U	N/A
Methoxychlor	0.01U	0.01U	N/A	0.01U	0.01U	N/A	0.01U	0.05U	N/A
Toxaphene	0.2U	0.2U	N/A	0.5U	0.5U	N/A	0.5U	1.2	N/A
Organophosphates									
Atrazine	2U	2U	N/A	2U	2U	N/A	2U	2U	N/A
Chlorpyrifos	0.05U	0.05U	N/A	0.55	0.1U	N/A	0.05U	0.05U	N/A
Cyanazine	2U	2U	N/A	2U	2U	N/A	2U	2U	N/A
Diazinon	0.71	0.65Y	8.8	0.1U	0.1U	N/A	0.05U	0.05U	N/A
Malathion	1U	1U	N/A	0.18U	0.23J	N/A	0.2U	0.16J	N/A
Prometryn	2U	2U	N/A	2U	2U	N/A	2U	2U	N/A
Simazine	2U	2U	N/A	2U	2U	N/A	2U	2U	N/A
Simazine	2U	2U	N/A	2U	2U	N/A	2U	2U	N/A
Simazine	2U	2U	N/A	2U	2U	N/A	2U	2U	N/A
Simazine	2U	2U	N/A	2U	2U	N/A	2U	2U	N/A
Simazine	2U	2U	N/A	2U	2U	N/A	2U	2U	N/A

1-Bolded values are outside of QC limits

Tables A.3 Relative Percent Differences of Field Duplicates for all Sampling Events (Continued).

	Storm Event-05 29-Dec-04			Dry Event-02 25-May-05		
	Result	DUP	RPD	Result	DUP	RPD
Conventionals						
Alkalinity as CaCO3	43	38	12	450	440	2.2
Biochemical Oxygen Demand	8.9	8.8	1.1	2.9	2.9	0
Chemical Oxygen Demand	76	68	11	100	110	9.5
Chloride	4.4	4.4	0	440	440	0
Fluoride	0.16	0.16	0	1.7	1.7	0
Hardness as CaCO3	29	32	9.8	180	300	50
MBAS	0.04	0.04	0	0.05U	0.05U	N/A
Total Ammonia (as N)	0.26	0.26	0	0.18	0.18	0
Total Kjeldahl Nitrogen	1.5	1.6	6.5	1.1	0.97	13
Nitrate (as N)	0.28	0.28	0	0.63	0.62	1.6
Nitrite (as N)	0.1U	0.1U	N/A	0.1U	0.1U	N/A
Oil and Grease	5U	5U	N/A	5U	5U	N/A
Total Recoverable Phenolics	0.1U	0.1U	N/A	0.1U	0.1U	N/A
Total Phosphorus	0.72	0.67	7.2	0.8	0.78	2.5
Total Orthophosphate (as P)	0.18	0.18	0	0.6	0.6	0
Conductivity	64	64	0	2600	2500	3.9
Total Dissolved Solids	52	62	18	1500	1600	6.5
Total Suspended Solids	350	340	2.9	1.6	1.3	21
Total Volatile Solids	61	48	24	1.2	1.2	0
Total Organic Carbon	8.2	7.6	7.6	8.6	8.5	1.2
Turbidity	190	210	10	4.6	4.8	4.3
Dissolved Metals						
Aluminum	99U	100	N/A	50U	50U	N/A
Arsenic	1.3	1.5	14	5.8	6.1	5
Cadmium	0.057U	0.056J	N/A	0.2U	0.2U	N/A
Chromium	0.65	0.65	0	6.9	8.1	16
Copper	3.9	3.9	0	3	3	0
Iron	650	630	3.1	53	54	1.9
Lead	0.32U	0.32J	N/A	0.5U	0.5U	N/A
Nickel	0.94U	0.98J	N/A	2.6	2.5	3.9
Selenium	0.21U	0.27J	N/A	0.13J	1U	N/A
Silver	0.055U	0.046J	N/A	0.2U	0.2U	N/A
Zinc	9.8	10	2.0	11	11	0
Total Metals						
Aluminum	12000	13000	8	50U	50U	N/A
Arsenic	5.3	5.5	3.7	4.9	4.8	2
Cadmium	1.2	1.5	22	0.2U	0.2U	N/A
Chromium	21	24	13	2.5	2.5	0
Copper	39	45	14	4.9	4.8	2.1
Iron	14000	14000	0	400	130	**102** [1]
Lead	55	62	12	1.1	1	9.5
Nickel	15	18	18	3.2	3.2	0
Selenium	0.37U	0.37J	N/A	0.29J	0.10J	N/A
Silver	0.21U	0.21J	N/A	0.2U	0.2U	N/A
Zinc	360	420	15	18	18	0

1-Bolded values are outside of QC limits

Tables A.3 Relative Percent Differences of Field Duplicates for all Sampling Events (Continued).

	Storm Event-05 29-Dec-04			Dry Event-02 25-May-05		
	Result	DUP	RPD	Result	DUP	RPD
Bacteria						
Coliform, Total	240000	130000	**59** [1]	2400	16000	**148** [1]
Enterococcus	39000	27000	36	1440	990	37
Fecal Coliform	22000	13000	**51** [1]	80	1300	**177** [1]
Aroclors						
PCB-1016 (Aroclor 1016)	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1221 (Aroclor 1221)	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1232 (Aroclor 1232)	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1242 (Aroclor 1242)	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1248 (Aroclor 1248)	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1254 (Aroclor 1254)	0.5U	0.5U	N/A	0.5U	0.5U	N/A
PCB-1260 (Aroclor 1260)	0.5U	0.5U	N/A	0.5U	0.5U	N/A
Chlorinated Pesticides						
4,4'-DDD	0.05U	0.05U	N/A	0.05U	0.05U	N/A
4,4'-DDE	0.05U	0.05U	N/A	0.05U	0.05U	N/A
4,4'-DDT	0.02U	0.02U	N/A	0.01U	0.01U	N/A
Aldrin	0.007U	0.007U	N/A	0.005U	0.005U	N/A
Dieldrin	0.01U	0.01U	N/A	0.01U	0.01U	N/A
Endrin	0.01U	0.01U	N/A	0.01U	0.01U	N/A
Endrin aldehyde	0.01U	0.01U	N/A	0.01U	0.01U	N/A
Endrin ketone	0.01U	0.01U	N/A	-	-	-
alpha-BHC	0.01U	0.01U	N/A	0.01U	0.01U	N/A
beta-BHC	0.006U	0.006U	N/A	0.005U	0.005U	N/A
delta-BHC	0.005U	0.005U	N/A	0.0049U	0.005U	N/A
gamma-BHC (Lindane)	0.02U	0.02U	N/A	0.02U	0.02U	N/A
Endosulfan I	0.02U	0.02U	N/A	0.02U	0.02U	N/A
Endosulfan II	0.01U	0.01U	N/A	0.01U	0.01U	N/A
Endosulfan sulfate	0.05U	0.05U	N/A	0.05U	0.05U	N/A
alpha-Chlordane	0.1U	0.1U	N/A	0.1U	0.1U	N/A
gamma-Chlordane	0.1U	0.1U	N/A	0.1U	0.1U	N/A
Heptachlor	0.01U	0.01U	N/A	0.01U	0.01U	N/A
Heptachlor epoxide	0.01U	0.01U	N/A	0.01U	0.01U	N/A
Methoxychlor	0.01U	0.01U	N/A	-	-	-
Toxaphene	0.5U	0.5U	N/A	0.5U	0.5U	N/A
Organophosphates						
Atrazine	2U	2U	N/A	2U	2U	N/A
Chlorpyrifos	0.05U	0.05U	N/A	0.05U	0.05U	N/A
Cyanazine	2U	2U	N/A	2U	2U	N/A
Diazinon	0.2	0.05U	N/A	0.01U	0.01U	N/A
Malathion	0.084U	0.075J	N/A	1U	1U	N/A
Prometryn	2U	2U	N/A	2U	2U	N/A
Simazine	0.85U	0.77J	N/A	2U	2U	N/A
Simazine	0.85U	0.77J	N/A	2U	2U	N/A
Simazine	0.85U	0.77J	N/A	2U	2U	N/A
Simazine	0.85U	0.77J	N/A	2U	2U	N/A
Simazine	0.85U	0.77J	N/A	2U	2U	N/A

1-Bolded values are outside of QC limits

Table A.4 Method Blanks for Each Sampling Event.

	ML	Dry Event-01 31-Aug-04	Storm Event-01 17-Oct-04	Storm Event-02 20-Oct-04	Storm Event-03 27-Oct-04	Storm Event-04 6-Dec-04	Storm Event-05 29-Dec-04
Conventionals (mg/L)							
Alkalinity as CaCO3	2	1U	1U	1U	1U	1U	1U
Biochemical Oxygen Demand	2	2U	2U	2U	2U	2U	2U
Chemical Oxygen Demand	20	4U	4U	4U	4U	4U	4U
Chloride	2	1U	1U	1U	1U	1U	1U
Fluoride	0.1	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Hardness as CaCO3	2	1U	1U	1U	1U	1U	1U
MBAS	0.5	0.025U	0.025U	0.025U	0.025U	0.025U	0.025U
Total Ammonia (as N)	0.1	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Total Kjeldahl Nitrogen	0.1	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Nitrate (as N)	0.1	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Nitrite (as N)	0.1	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Oil and Grease	5	5U	-	5U	5U	-	5U
Total Recoverable Phenolics	0.1	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Total Phosphorus	0.05	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
Total Orthophosphate (as P)	0.05	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
Conductivity (umhos/cm)	1	1U	1U	1U	1U	1U	1U
Total Dissolved Solids	2	10U	10U	10U	10U	10U	10U
Total Suspended Solids	2	1U	1U	1U	1U	1U	1U
Total Volatile Solids	2	10U	10U	10U	10U	10U	10U
Total Organic Carbon	1	1U	1U	1U	1U	1U	1U
Turbidity (NTU)	0.1	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Dissolved Metals (ug/L)							
Aluminum	100	100U	25U	50U	100U	25U	50U
Arsenic	1	1U	1U	1U	1U	0.223J	0.223J
Cadmium	0.25	0.25U	0.25U	0.25U	0.25U	0.25U	0.25U
Chromium	0.5	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Copper	0.5	0.5U	0.5U	0.5U	0.5U	0.1U	0.5U
Iron	100	25U	25U	25U	25U	25U	25U
Lead	0.5	0.5U	0.5U	12U	0.5U	0.05U	0.5U
Nickel	1	1U	1U	25U	0.0396J	0.147J	1U
Selenium	1	1U	1U	1U	1U	0.28J	0.28J
Silver	0.25	0.25U	0.25U	0.25U	0.25U	0.04U	0.25U
Zinc	1	1U	1U	25U	0.125J	1U	0.08U
Total Metals (ug/L)							
Aluminum	100	100U	25U	100U	100U	0.429J	50U
Arsenic	1	1U	1U	1U	1U	1U	1U
Cadmium	0.25	0.25U	0.25U	0.25U	0.25U	0.25U	0.25U
Chromium	0.5	0.5U	0.5U	0.147J	0.147J	0.411J	0.5U
Copper	0.5	0.5U	0.5U	0.0461J	0.0461J	0.0695J	0.5U
Iron	100	25U	25U	25U	25U	25U	25U
Lead	0.5	0.5U	0.5U	0.0464J	0.0464J	0.0195J	0.5U
Nickel	1	1U	1U	1U	1U	1U	1U
Selenium	1	1U	1U	1U	1U	0.28J	0.28J
Silver	0.25	0.25U	0.25U	0.25U	0.25U	0.0364J	0.25U
Zinc	1	1U	1U	1U	1U	0.138J	0.08U

1-Bolded values are outside of QC limits

Table A.4 Method Blanks for Each Sampling Event (Continued).

	ML	Dry Event-01 31-Aug-04	Storm Event-01 17-Oct-04	Storm Event-02 20-Oct-04	Storm Event-03 27-Oct-04	Storm Event-04 6-Dec-04	Storm Event-05 29-Dec-04
Aroclors (ug/L)							
Aroclor 1016	0.5	0.2U	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1221	0.5	0.2U	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1232	0.5	0.2U	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1242	0.5	0.2U	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1248	0.5	0.2U	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1254	0.5	0.2U	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1260	0.5	0.2U	0.5U	0.5U	0.5U	0.5U	0.5U
Chlorinated Pesticides (ug/L)							
4,4'-DDD	0.05	0.01U	0.05U	0.05U	0.05U	0.05U	0.05U
4,4'-DDE	0.05	0.01U	0.05U	0.05U	0.05U	0.05U	0.05U
4,4'-DDT	0.01	0.01U	0.01U	0.01U	0.01U	0.01U	0.02U
Aldrin	0.005	0.005U	0.005U	0.005U	0.005U	0.005U	0.007U
Dieldrin	0.01	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
Endrin	0.01	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
Endrin aldehyde	0.01	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
Endrin ketone	0.01	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
alpha-BHC	0.01	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
beta-BHC	0.005	0.005U	0.005U	0.005U	0.005U	0.005U	0.006U
delta-BHC	0.005	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
gamma-BHC (Lindane)	0.02	0.01U	0.02U	0.02U	0.02U	0.02U	0.02U
Endosulfan I	0.02	0.01U	0.02U	0.02U	0.02U	0.02U	0.02U
Endosulfan II	0.01	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
Endosulfan sulfate	0.05	0.01U	0.05U	0.05U	0.05U	0.05U	0.05U
alpha-Chlordane	0.1	0.01U	0.1U	0.1U	0.1U	0.1U	0.1U
gamma-Chlordane	0.1	0.01U	0.1U	0.1U	0.1U	0.1U	0.1U
Heptachlor	0.01	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
Heptachlor epoxide	0.01	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
Methoxychlor	0.05	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U
Toxaphene	0.5	0.2U	0.5U	0.5U	0.5U	0.5U	0.5U
Organophosphates (ug/L)							
Atrazine	2	2U	2U	2U	2U	2U	2U
Chlorpyrifos	0.05	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
Cyanazine	2	2U	2U	2U	2U	2U	2U
Diazinon	0.01	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
Malathion	1	1U	1U	1U	1U	1U	1U
Prometryn	2	2U	2U	2U	2U	2U	2U
Simazine	2	2U	2U	2U	2U	2U	2U

1-Bolded values are outside of QC limits

Table A.4 Method Blanks for Each Sampling Event (Continued).

	ML	Storm Event-07 4-Jan-05	Storm Event-08 7-Jan-05	Storm Event-09 10-Jan-05	Storm Event-14 23-Mar-05	Dry Event-02 25-May-05
Conventionals (mg/L)						
Alkalinity as CaCO3	2	1U	1U	1U	1U	1U
Biochemical Oxygen Demand	2	2U	2U	2U	2U	2U
Chemical Oxygen Demand	20	4U	4U	4U	4U	4U
Chloride	2	1U	1U	1U	1U	1U
Fluoride	0.1	0.1U	0.1U	0.1U	0.1U	0.1U
Hardness as CaCO3	2	1U	1U	1U	1U	1U
MBAS	0.5	0.025U	0.025U	0.025U	0.025U	0.025U
Total Ammonia (as N)	0.1	0.1U	0.1U	0.1U	0.1U	0.1U
Total Kjeldahl Nitrogen	0.1	0.1U	0.1U	0.1U	**0.36** [1]	0.1U
Nitrate (as N)	0.1	0.1U	0.1U	0.1U	0.1U	0.1U
Nitrite (as N)	0.1	0.1U	0.1U	0.1U	0.1U	0.1U
Oil and Grease	5	5U	5U	5U	5U	5U
Total Recoverable Phenolics	0.1	0.1U	0.1U	0.1U	0.1U	0.1U
Total Phosphorus	0.05	0.01U	0.01U	0.01U	0.01U	0.01U
Total Orthophosphate (as P)	0.05	0.01U	0.01U	0.01U	0.01U	0.01U
Conductivity (umhos/cm)	1	1U	1U	1U	1U	1U
Total Dissolved Solids	2	10U	10U	10U	10U	10U
Total Suspended Solids	2	1U	1U	1U	0.1U	1U
Total Volatile Solids	2	10U	10U	10U	10U	10U
Total Organic Carbon	1	1U	1U	1U	1U	1U
Turbidity (NTU)	0.1	0.1U	0.1U	0.1U	0.1U	0.1U
Dissolved Metals (ug/L)						
Aluminum	100	50U	50U	50U	100U	50U
Arsenic	1	0.223J	0.223J	0.223J	1U	1U
Cadmium	0.25	0.25U	0.25U	0.25U	0.25U	0.2U
Chromium	0.5	0.5U	0.5U	0.5U	0.5U	0.5U
Copper	0.5	0.5U	0.5U	0.5U	0.5U	0.0726J
Iron	100	25U	25U	25U	25U	25U
Lead	0.5	0.5U	0.5U	0.5U	0.5U	0.5U
Nickel	1	1U	1U	1U	1U	0.192J
Selenium	1	0.28J	0.28J	0.28J	1U	1U
Silver	0.25	0.0978J	0.0978J	0.0978J	0.25U	0.2U
Zinc	1	0.0991J	0.0991J	0.0991J	1U	0.132J
Total Metals (ug/L)						
Aluminum	100	50U	50U	50U	50U	50U
Arsenic	1	1U	1U	1U	1U	1U
Cadmium	0.25	0.0428J	0.0428J	0.0428J	0.25U	0.2U
Chromium	0.5	0.353J	0.353J	0.353J	0.5U	0.435J
Copper	0.5	0.0755J	0.0755J	0.0755J	0.5U	1U
Iron	100	25U	25U	25U	25U	25U
Lead	0.5	0.192J	0.192J	0.192J	0.5U	0.5U
Nickel	1	0.075J	0.075J	0.075J	1U	1U
Selenium	1	0.28J	0.28J	0.28J	1U	1U
Silver	0.25	0.0255J	0.0255J	0.0255J	0.25U	0.158J
Zinc	1	0.588J	0.588J	0.588J	1U	1U

1-Bolded values are outside of QC limits

Table A.4 Method Blanks for Each Sampling Event (Continued).

	ML	Storm Event-07 4-Jan-05	Storm Event-08 7-Jan-05	Storm Event-09 10-Jan-05	Storm Event-14 23-Mar-05	Dry Event-02 25-May-05
Aroclors (ug/L)						
Aroclor 1016	0.5	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1221	0.5	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1232	0.5	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1242	0.5	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1248	0.5	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1254	0.5	0.5U	0.5U	0.5U	0.5U	0.5U
Aroclor 1260	0.5	0.5U	0.5U	0.5U	0.5U	0.5U
Chlorinated Pesticides (ug/L)						
4,4'-DDD	0.05	0.05U	0.05U	0.05U	0.05U	0.05U
4,4'-DDE	0.05	0.05U	0.05U	0.05U	0.05U	0.05U
4,4'-DDT	0.01	0.02U	0.02U	0.02U	0.02U	0.02U
Aldrin	0.005	0.007U	0.007U	0.007U	0.007U	0.007U
Dieldrin	0.01	0.01U	0.01U	0.01U	0.01U	0.01U
Endrin	0.01	0.01U	0.01U	0.01U	0.01U	0.01U
Endrin aldehyde	0.01	0.01U	0.01U	0.01U	0.01U	0.01U
Endrin ketone	0.01	0.01U	0.01U	0.01U	0.01U	0.01U
alpha-BHC	0.01	0.01U	0.01U	0.01U	0.01U	0.01U
beta-BHC	0.005	0.006U	0.006U	0.006U	0.006U	0.006U
delta-BHC	0.005	0.005U	0.005U	0.005U	0.005U	0.005U
gamma-BHC (Lindane)	0.02	0.02U	0.02U	0.02U	0.02U	0.02U
Endosulfan I	0.02	0.02U	0.02U	0.02U	0.02U	0.02U
Endosulfan II	0.01	0.01U	0.01U	0.01U	0.01U	0.01U
Endosulfan sulfate	0.05	0.05U	0.05U	0.05U	0.05U	0.05U
alpha-Chlordane	0.1	0.1U	0.1U	0.1U	0.1U	0.1U
gamma-Chlordane	0.1	0.1U	0.1U	0.1U	0.1U	0.1U
Heptachlor	0.01	0.01U	0.01U	0.01U	0.01U	0.01U
Heptachlor epoxide	0.01	0.01U	0.01U	0.01U	0.01U	0.01U
Methoxychlor	0.05	0.01U	0.01U	0.01U	0.01U	0.01U
Toxaphene	0.5	0.5U	0.5U	0.5U	0.5U	0.5U
Organophosphates (ug/L)						
Atrazine	2	2U	2U	2U	2U	2U
Chlorpyrifos	0.05	0.05U	0.05U	0.05U	0.05U	0.05U
Cyanazine	2	2U	2U	2U	2U	2U
Diazinon	0.01	0.05U	0.05U	0.05U	0.05U	0.05U
Malathion	1	1U	1U	1U	1U	1U
Prometryn	2	2U	2U	2U	2U	2U
Simazine	2	2U	2U	2U	2U	2U

1-Bolded values are outside of QC limits

Table A.5 Laboratory Duplicate Relative Percent Differences for Each Sampling Event.

	Dry Weather Event-01 31-Aug-04	Storm Event-01 17-Oct-04	Storm Event-02 20-Oct-04	Storm Event-03 27-Oct-04	Storm Event-04 6-Dec-04	Storm Event-05 29-Dec-04
Conventionals						
Alkalinity as CaCO3	4.72	0	0	0	1.86	2.67
Biochemical Oxygen Demand	**22.22**[1]	5.13	5.13	0.57	2.37	2.22
Chemical Oxygen Demand	7.98	5.51	5.51	5.51	6.39	8.44
Chloride	1.7	2.39	2.39	0.17	0.9	0.23
Fluoride	3.92	6.06	6.06	8	4.44	3.75
Hardness as CaCO3	0.63	0.3	0.3	0.29	0.81	0
MBAS	2.31	N/A	N/A	5.8	0.81	N/A
Total Ammonia (as N)	N/A	N/A	N/A	N/A	2.84	0.39
Total Kjeldahl Nitrogen	10.31	15.73	15.73	1.23	7.19	6.74
Nitrate (as N)	0	0.83	0.83	0	2.36	0.36
Nitrite (as N)	N/A	N/A	N/A	N/A	N/A	N/A
Oil and Grease	N/A	-	N/A	N/A	-	N/A
Total Recoverable Phenolics	N/A	N/A	N/A	N/A	N/A	N/A
Total Phosphorus	15.71	3.3	3.3	12.32	2.21	0
Total Orthophosphate (as P)	N/A	0.43	0.43	0.45	0.87	1.12
Conductivity	0.9	0	0	1.55	0	0.31
Total Dissolved Solids	1.58	11.07	11.07	1.28	7.73	0.14
Total Suspended Solids	15.38	5.28	5.28	2.81	1.83	9.12
Total Volatile Solids	5.76	8.38	8.38	10.1	10.53	2.06
Total Organic Carbon	0.04	1.8	1.8	1.8	0.45	1.38
Turbidity	4.26	0	0	0	1.5	1.45
Dissolved Metals						
Aluminum	3.3	N/A	3.82	-	5.83	N/A
Arsenic	-	-	-	-	3.96	3.96
Cadmium	4.08	N/A	8.61	-	0.18	11.0
Chromium	3.07	8.13	48.1	-	0.772	4.65
Copper	0.717	2.02	0.233	-	2.05	0
Iron	N/A	1.06	3.33	3.33	0.74	N/A
Lead	4.47	2.53	2.06	-	2.7	4.26
Nickel	2.76	14.3	N/A	-	0	3.68
Selenium	-	-	-	-	90.9[2]	90.9[2]
Silver	87.3	N/A	N/A	-	N/A	**22.7**[1]
Zinc	1.6	1.61	0.557	-	2.47	1.83
Total Metals						
Aluminum	1.98	**20.5**[1]	0.525	0.525	0	1.20
Arsenic	-	-	-	-	4.99	4.99
Cadmium	0.425	0.837	2.11	2.11	N/A	1.37
Chromium	0.966	0.837	0.995	0.995	18.6	0.159
Copper	7.55	0.786	1.28	1.28	8.25	0
Iron	1.7	5.53	2.93	5.53	4.99	0.6
Lead	0.604	1.8	4.44	4.44	5.83	3.92
Nickel	2.69	2.63	0	0	N/A	0.434
Selenium	-	-	-	-	90.9[2]	90.9[2]
Silver	87.3	9.37	N/A	N/A	N/A	**35.6**[1]
Zinc	1.18	1.98	0.154	0.154	8	0.270

1-Bolded values are outside of QC limits
2-One or both of the values are less than the RL and the difference between the two values is less than the RL

Table A.5 Laboratory Duplicate Relative Percent Differences for Each Sampling Event (Continued).

	Storm Event-07 4-Jan-05	Storm Event-08 7-Jan-05	Storm Event-09 10-Jan-05	Storm Event-14 23-Mar-05	Dry Weather Event-02 25-May-05
Conventionals					
Alkalinity as CaCO3	2.23	1.75	1.75	0	0.45
Biochemical Oxygen Demand	4.17	2.96	2.96	5.2	7.14
Chemical Oxygen Demand	2.13	2.13	2.13	8.73	1.35
Chloride	9.11	1.41	1.41	0.79	2.43
Fluoride	N/A	N/A	N/A	8.7	0.4
Hardness as CaCO3	0	0.41	0.41	0	6.9
MBAS	8.19	8.45	8.45	6.01	N/A
Total Ammonia (as N)	N/A	N/A	N/A	N/A	8.8
Total Kjeldahl Nitrogen	6.74	6.74	6.74	5	8.43
Nitrate (as N)	8.37	6.56	6.56	N/A	N/A
Nitrite (as N)	N/A	N/A	N/A	N/A	N/A
Oil and Grease	N/A	N/A	N/A	N/A	N/A
Total Recoverable Phenolics	N/A	N/A	N/A	N/A	N/A
Total Phosphorus		1.09	1.09	0	4.03
Total Orthophosphate (as P)	0	2.94	2.94	2.2	1.49
Conductivity	0	1.46	1.46	1.02	0.79
Total Dissolved Solids	5.85	0.89	0.89	1.02	2.77
Total Suspended Solids	0.68	9.17	9.17	12.64	3.7
Total Volatile Solids	8.22	0	0	7.49	4.44
Total Organic Carbon	1.38	2.3	2.3	2.58	2.11
Turbidity	2.94	4.8	4.8	1.44	2.2
Dissolved Metals					
Aluminum	1.13	1.13	1.13	42.4	N/A
Arsenic	3.96	3.96	3.96	3.39	1.59
Cadmium	0.766	0.766	0.766	7.56	0.159
Chromium	0.59	0.59	0.59	30.2	5.85
Copper	1.94	1.94	1.94	0	2.03
Iron	6.33	14.83	14.83	2.25	N/A
Lead	3.64	3.64	3.64	2.47	3.54
Nickel	8.04	8.04	8.04	8.33	1.78
Selenium	90.9[2]	90.9[2]	90.9[2]	N/A	-
Silver	N/A	N/A	N/A	N/A	33.2[2]
Zinc	3.01	3.01	3.01	3.25	0.487
Total Metals					
Aluminum	30.3[1]	30.3[1]	30.3[1]	1.78	14.3
Arsenic	4.99	4.99	4.99	3.39	1.12
Cadmium	2.33	2.33	2.33	15.2	5.88
Chromium	2.58	2.58	2.58	6.33	8.7
Copper	34.4	34.4	34.4	2.34	4.59
Iron	1.75	0.25	0.25	5.95	3.81
Lead	5.73	5.73	5.73	0.766	7.08
Nickel	3.62	3.62	3.62	51.5	9.48
Selenium	90.9[2]	90.9[2]	90.9[2]	N/A	-
Silver	68.4[2]	68.4[2]	68.4[2]	N/A	33.2
Zinc	13.4	13.4	13.4	1.65	5.42

1-Bolded values are outside of QC limits
2-One or both of the values are less than the RL and the difference between the two values is less than the RL

Table A.6 Matrix Spike/Spike Duplicates and Relative Percent Difference for each Sampling Event.

	Dry Weather Event-01 31-Aug-04			Storm Event-01 17-Oct-04			Storm Event-02 20-Oct-04		
	MS	DUP	RPD	MS	DUP	RPD	MS	DUP	RPD
Conventionals									
Alkalinity as CaCO3	-	-	-	-	-	-	-	-	-
Biochemical Oxygen Demand	-	-	-	-	-	-	-	-	-
Chemical Oxygen Demand	-	-	-	-	-	-	-	-	-
Chloride	95.8	88.4	2.6	96.9	99.5	1.92	96.9	99.5	1.92
Fluoride	118	108	3.8	102	108	4.38	102	108	4.38
Hardness as CaCO3	-	-	-	-	-	-	-	-	-
MBAS	-	-	-	-	-	-	-	-	-
Total Ammonia (as N)	102	108	5.71	112	96	15.38	112	96	15.38
Total Kjeldahl Nitrogen	105.8	102.8	2.54	97.5	102.2	3.64	97.5	102.2	3.64
Nitrate (as N)	94.8	94.3	0.45	96	99.1	2.73	96.0	99.1	2.73
Nitrite (as N)	105.9	107.6	1.54	104.3	108.6	4.02	104.3	108.6	4.02
Oil and Grease	-	-	-	-	-	-	-	-	-
Total Recoverable Phenolics	93.2	93.2	5.22	96.2	99.8	3.67	96.2	99.8	3.67
Total Phosphorus	98.5	91.5	4.91	93.3	94.9	1.09	93.3	94.9	1.09
Total Orthophosphate (as P)	112	114	1.77	106	104	1.56	106.0	104.0	1.56
Conductivity	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	-	-	-	-	-	-	-
Total Volatile Solids	-	-	-	-	-	-	-	-	-
Total Organic Carbon	109.6	107.1	1.07	86	88.4	0.72	86	88.4	0.72
Turbidity	-	-	-	-	-	-	-	-	-
Dissolved Metals									
Aluminum	88.8	88.8	0	88.6	87.6	1.14	100	98.9	1.57
Arsenic	94.5	94.1	6.23	99.6	106	6.23	99.6	106	6.23
Cadmium	100	99.5	0.8	106	106	0	110	109	0.783
Chromium	97.4	97.4	0	112	109	2.71	90.8	90	0.881
Copper	91.2	91.2	0	106	106	0.734	87.5	88.3	0.844
Iron	101.3	102.7	1.39	97	97	0	94.6	93.3	1.09
Lead	97.4	99	1.62	112	112	0.535	98.6	99.4	0.803
Nickel	87.6	87.6	0	101	101	0	84.8	84.8	0
Selenium	105	103	1.92	79	80	1.26	79	80	1.26
Silver	86.9	87.3	0.458	108	107	1.12	102	102	0
Zinc	94.9	96.5	1.61	113	115	1.38	99.3	103	2.92
Total Metals									
Aluminum	90.5	88.5	2.14	101	103	1.12	100	95.2	1.92
Arsenic				115	108	6.28	115	108	6.28
Cadmium	95	96.6	1.67	85.4	86.2	0.922	104	103	0.772
Chromium	93.9	91.9	2.11	92.8	95.2	2.32	102	102	0
Copper	90	89.2	0.813	83.2	83.2	0	78.2	78.2	0
Iron	95.5	96.9	0.91	83.5	86.3	1.09	88.0	90.1	1.27
Lead	108	108	0.366	114	114	0.608	103	102	1.44
Nickel	87.2	86	1.32	79.2	80.8	1.74	77.2	76.7	0.607
Selenium	-	-	-	88.7	88.2	0.565	88.7	88.2	0.565
Silver	91.8	91.8	0	88.5	89.3	0.897	78.6	78.4	0.306
Zinc	84.7	83.9	0.905	86.4	84.8	0.491	75.8	74.2	1.87

1-Bolded values are outside of QC limits

Table A.6 Matrix Spike/Spike Duplicates and Relative Percent Difference for each Sampling Event (Continued).

	Dry Weather Event-01 31-Aug-04			Storm Event-01 17-Oct-04			Storm Event-02 20-Oct-04		
	MS	DUP	RPD	MS	DUP	RPD	MS	DUP	RPD
Aroclors									
Aroclor 1016	-	-	-	-	-	-	60	-	-
Aroclor 1221	-	-	-	-	-	-	-	-	-
Aroclor 1232	-	-	-	-	-	-	-	-	-
Aroclor 1242	-	-	-	-	-	-	-	-	-
Aroclor 1248	-	-	-	-	-	-	-	-	-
Aroclor 1254	-	-	-	-	-	-	-	-	-
Aroclor 1260	-	-	-	-	-	-	77	56.5	6.0
Chlorinated Pesticides									
4,4'-DDD	-	-	-	53.8	56.5	4.8	67.3	64.5	4.3
4,4'-DDE	-	-	-	56.2	60.8	8.0	65.2	66.3	1.8
4,4'-DDT	-	-	-	54.8	60.3	9.6	66	64.5	2.3
Aldrin	-	-	-	38.8	47.2	19.4	54.2	56.7	4.5
Dieldrin	-	-	-	59.0	64.0	8.1	69.7	67.8	2.7
Endrin	-	-	-	67.2	73.3	8.8	72.8	72.2	0.92
Endrin aldehyde	-	-	-	**37.5** [1]	**38.8** [1]	3.5	66.2	64	3.3
Endrin ketone	-	-	-	66.3	68.2	2.7	81.7	80.5	1.4
alpha-BHC	-	-	-	62.3	68.8	9.9	69.3	72.5	4.5
beta-BHC	-	-	-	51.8	52.3	0.96	66.2	72.5	6.2
delta-BHC	-	-	-	35.0	37.5	6.9	42.7	42.8	0.39
gamma-BHC (Lindane)	-	-	-	60.2	64.5	7.0	68.8	72.2	4.7
Endosulfan I	-	-	-	55.8	60.8	8.1	66.2	65.8	0.51
Endosulfan II	-	-	-	54.8	60.2	9.3	66.8	65.3	2.3
Endosulfan sulfate	-	-	-	48.7	52.7	7.9	62.3	60.7	2.7
alpha-Chlordane	-	-	-	60.3	65.7	8.5	67.2	67.2	0
gamma-Chlordane	-	-	-	56.8	62.5	9.5	66	69.2	4.7
Heptachlor	-	-	-	42.8	50.0	15.4	63	66	4.7
Heptachlor epoxide	-	-	-	59.8	64.3	7.2	68.3	68.3	1.5
Methoxychlor	-	-	-	52.3	54.5	4.1	64.5	63	2.4
Toxaphene	-	-	-	-	-	-	-	-	-
Organophosphates									
Atrazine	-	-	-	-	-	-	102	99.8	2.2
Chlorpyrifos	-	-	-	-	-	-	107	93.4	13.6
Cyanazine	-	-	-	-	-	-	111	110	0.9
Diazinon	-	-	-	-	-	-	114	107	6.3
Malathion	-	-	-	-	-	-	95	91	3.6
Prometryn	-	-	-	-	-	-	100	101	1
Simazine	-	-	-	-	-	-	138	133	3.7

1-Bolded values are outside of QC limits

Table A.6 Matrix Spike/Spike Duplicates and Relative Percent Difference for each Sampling Event (Continued).

	Storm Event-03 27-Oct-04			Storm Event-04 6-Dec-04			Storm Event-05 29-Dec-04		
	MS	DUP	RPD	MS	DUP	RPD	MS	DUP	RPD
Conventionals									
Alkalinity as CaCO3	-	-	-	-	-	-	-	-	-
Biochemical Oxygen Demand	-	-	-	-	-	-	-	-	-
Chemical Oxygen Demand	-	-	-	-	-	-	-	-	-
Chloride	93.8	98.5	3.69	98.3	94.3	2.29	98.7	95.2	2.95
Fluoride	94	98	3.28	110	106	2.6	106	100.8	3.86
Hardness as CaCO3	-	-	-	-	-	-	-	-	-
MBAS	-	-	-	-	-	-	-	-	-
Total Ammonia (as N)	112	96	15.38	102.2	102.6	0.22	104.2	106	1.27
Total Kjeldahl Nitrogen	91	97.3	4.65				99.3	98.3	0.75
Nitrate (as N)	92	95.6	3.43	98.7	94.7	3.39	97.8	94.2	3.27
Nitrite (as N)	97.4	98.4	1.01	112.5	104.3	7.59	97.4	98.4	1.01
Oil and Grease	-	-	-	-	-	-	-	-	-
Total Recoverable Phenolics	96.2	99.8	3.67	93	101.2	8.44	96.4	93.2	3.38
Total Phosphorus	92	93	0.75	85.6	98.8	8.06	102.8	102.8	0
Total Orthophosphate (as P)	105.3	103	1.59	107	104	2.33	100	103	1.07
Conductivity	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	-	-	-	-	-	-	-
Total Volatile Solids	-	-	-	-	-	-	-	-	-
Total Organic Carbon	86	88.4	0.72	93.8	94.8	0.62	109.2	108	0.87
Turbidity	-	-	-	-	-	-	-	-	-
Dissolved Metals									
Aluminum	84.7	81.5	3.81	90	89.6	0.426	90.6	92	1.53
Arsenic	99.6	106	6.23	94.4	88	5.82	94.4	88	5.82
Cadmium	103	104	0.772	107	107	0	100	101	0.597
Chromium	104	106	1.52	97.2	96	1.18	97.2	98	0.802
Copper	84.7	84.7	0	93.6	89.6	3.47	88.4	88.2	0.217
Iron	94.6	93.3	1.09	96.6	96	0.64	101.9	103.2	1.31
Lead	83.5	83.5	0	116	118	1.7	103	102	1.17
Nickel	84.4	86	1.85	92.4	90.4	2.1	87.4	87.8	0.441
Selenium	79	80	1.26	105	109	3.74	105	109	3.74
Silver	90.4	98.4	8.47	95.2	95.2	0	80.7	81.5	0.973
Zinc	80.2	80	0.188	109	103	4.03	93.6	92.8	0.784
Total Metals									
Aluminum	100	95.2	1.92	91.2	96	4.62	103	-	-
Arsenic	115	108	6.28	98	101	2.8	98	101	2.8
Cadmium	104	103	0.772	98.4	97.6	0.816	99.6	-	-
Chromium	102	102	0	91.4	93.8	2.58	97.2	-	-
Copper	78.2	78.2	0	90.2	93.4	3.36	82.8	-	-
Iron	83.5	86.3	1.09	97.3	95.8	0.92	91.5	101.8	9.77
Lead	103	102	1.44	104	103	0.772	102	-	-
Nickel	77.2	76.7	0.607	91.2	94.4	3.45	81.2	-	-
Selenium	88.7	88.2	0.565	105	109	3.74	105	109	3.74
Silver	78.6	78.4	0.306	100	99.2	0.803	98.7	-	-
Zinc	75.8	74.2	1.87	88.6	92	3.64	90.4	-	-

1-Bolded values are outside of QC limits

Table A.6 Matrix Spike/Spike Duplicates and Relative Percent Difference for each Sampling Event (Continued).

	Storm Event-03 27-Oct-04			Storm Event-04 6-Dec-04			Storm Event-05 29-Dec-04		
	MS	DUP	RPD	MS	DUP	RPD	MS	DUP	RPD
Aroclors									
Aroclor 1016	71.5	70	2.1	-	-	-	88.4	93.1	5.2
Aroclor 1221	-	-	-	-	-	-	-	-	-
Aroclor 1232	-	-	-	-	-	-	-	-	-
Aroclor 1242	-	-	-	-	-	-	-	-	-
Aroclor 1248	-	-	-	-	-	-	-	-	-
Aroclor 1254	-	-	-	-	-	-	-	-	-
Aroclor 1260	75	72	4.1	-	-	-	98	103	5
Chlorinated Pesticides									
4,4'-DDD	70.7	66	6.8	-	-	-	79.7	79	0.84
4,4'-DDE	69.8	67.7	3.2	-	-	-	74.9	70.9	5.3
4,4'-DDT	69.5	67.7	2.7	-	-	-	83.7	81.7	2.4
Aldrin	63.2	61.3	2.9	-	-	-	56	56.3	0.59
Dieldrin	71.3	69.7	2.4	-	-	-	79	74.3	6.1
Endrin	74.7	71.7	4.1	-	-	-	87.3	82.7	5.5
Endrin aldehyde	67.3	60.5	10.7	-	-	-	75	73.3	2.2
Endrin ketone	83.3	79.7	4.5	-	-	-	95.3	93.7	1.8
alpha-BHC	67.2	64.8	3.5	-	-	-	72.3	67	7.7
beta-BHC	69.5	66	5.2	-	-	-	69.3	67.7	2.4
delta-BHC	40	37.8	5.6	-	-	-	34	33.7	0.99
gamma-BHC (Lindane)	68.5	65	5.2	-	-	-	74.3	71	4.6
Endosulfan I	67.7	67.7	0	-	-	-	79.3	76	4.3
Endosulfan II	68.5	66.7	2.7	-	-	-	76.7	74.3	3.1
Endosulfan sulfate	63.3	59.7	6	-	-	-	68.7	69.3	0.97
alpha-Chlordane	70.5	58.2	19.2	-	-	-	77.7	74.7	3.9
gamma-Chlordane	69.7	69.5	0.24	-	-	-	77	74	4
Heptachlor	65	64.7	0.51	-	-	-	62.7	62.3	0.53
Heptachlor epoxide	70.5	69.8	0.95	-	-	-	76	75.3	0.88
Methoxychlor	68.2	65.5	4	-	-	-	92.3	91.7	0.72
Toxaphene	-	-	-	-	-	-	-	-	-
Organophosphates									
Atrazine	-	-		-	-	-	94.4	103	8.7
Chlorpyrifos	119	113	5.2	-	-	-	**126**[1]	119	5.5
Cyanazine	-	-	-	-	-	-	104	111	6.7
Diazinon	120	117	2.5	-	-	-	117	111	5.5
Malathion	114	123	7.6	-	-	-	**135**[1]	124	7.3
Prometryn	96.6	102	5.4	-	-	-	112	117	4.7
Simazine	-	-	-	-	-	-	58.0	94.0	13.7

1-Bolded values are outside of QC limits

Table A.6 Matrix Spike/Spike Duplicates and Relative Percent Difference for each Sampling Event (Continued).

	Storm Event-07			Storm Event-08			Storm Event-09		
	4-Jan-05			7-Jan-05			10-Jan-05		
	MS	DUP	RPD	MS	DUP	RPD	MS	DUP	RPD
Conventionals									
Alkalinity as CaCO3	-	-	-	-	-	-	-	-	-
Biochemical Oxygen Demand	-	-	-	-	-	-	-	-	-
Chemical Oxygen Demand	-	-	-	-	-	-	-	-	-
Chloride	86.5	83	3.62	98	104.7	5.51	98	104.7	5.51
Fluoride	114	110	3.28	108	112	3.64	108	112	3.64
Hardness as CaCO3	-	-	-	-	-	-	-	-	-
MBAS	-	-	-	-	-	-	-	-	-
Total Ammonia (as N)	98	100	2.02	105.6	100.4	5.05	105.6	100.4	5.05
Total Kjeldahl Nitrogen	99.3	98.3	0.75	99.3	98.3	0.75	99.3	98.3	0.75
Nitrate (as N)	105.3	101.3	3.38	93.4	100	5.71	93.4	100	5.71
Nitrite (as N)	104.9	100.3	4.49	109.5	112.5	2.67	109.5	112.5	2.67
Oil and Grease	-	-	-	-	-	-	-	-	-
Total Recoverable Phenolics	96.4	93.2	3.38	96.4	93.2	3.38	96.4	93.2	3.38
Total Phosphorus				99	105	2.11	99	105	2.11
Total Orthophosphate (as P)	110	107	2.18	105	106	0.74	105	106	0.74
Conductivity	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	-	-	-	-	-	-	-
Total Volatile Solids	-	-	-	-	-	-	-	-	-
Total Organic Carbon	109.2	108	0.87	108.9	106.9	1.21	108.9	106.9	1.21
Turbidity	-	-	-	-	-	-	-	-	-
Dissolved Metals									
Aluminum	96.6	97.8	1.21	96.6	97.8	1.21	96.6	97.8	1.21
Arsenic	94.4	88	5.82	94.4	88	5.82	94.4	88	5.82
Cadmium	106	105	0.377	106	105	0.377	106	105	0.377
Chromium	109	109	0.345	109	109	0.345	109	109	0.345
Copper	99.6	99.2	0.364	99.6	99.2	0.364	99.6	99.2	0.364
Iron	103.5	106.7	2.6	92.3	94.9	2.17	92.3	94.9	2.17
Lead	113	113	0.704	113	113	0.704	113	113	0.704
Nickel	99.7	102	2.3	99.7	102	2.3	99.7	102	2.3
Selenium	105	109	3.74	105	109	3.74	105	109	3.74
Silver	69.6	71.6	2.83	69.6	71.6	2.83	69.6	71.6	2.83
Zinc	108	108	0	108	108	0	108	108	0
Total Metals									
Aluminum	95.8	97.4	1.65	95.8	97.4	1.65	95.8	97.4	1.65
Arsenic	98	101	2.8	98	101	2.8	98	101	2.8
Cadmium	105	104	1.15	105	104	1.15	105	104	1.15
Chromium	95.8	95.8	0	95.8	95.8	0	95.8	95.8	0
Copper	99.6	99.2	0.399	99.6	99.2	0.399	99.6	99.2	0.399
Iron	96	97.6	0.7	96	97.6	0.7	96	97.6	0.7
Lead	97.8	97.4	0.409	97.8	97.4	0.409	97.8	97.4	0.409
Nickel	92.5	92.9	0.421	92.5	92.9	0.421	92.5	92.9	0.421
Selenium	105	109	3.74	105	109	3.74	105	109	3.74
Silver	101	102	0.784	101	102	0.784	101	102	0.784
Zinc	103	103	0	103	103	0	103	103	0

1-Bolded values are outside of QC limits

Table A.6 Matrix Spike/Spike Duplicates and Relative Percent Difference for each Sampling Event (Continued).

	Storm Event-07 4-Jan-05			Storm Event-08 7-Jan-05			Storm Event-09 10-Jan-05		
	MS	DUP	RPD	MS	DUP	RPD	MS	DUP	RPD
Aroclors									
Aroclor 1016	-	-	-	-	-	-	-	-	-
Aroclor 1221	-	-	-	-	-	-	-	-	-
Aroclor 1232	-	-	-	-	-	-	-	-	-
Aroclor 1242	-	-	-	-	-	-	-	-	-
Aroclor 1248	-	-	-	-	-	-	-	-	-
Aroclor 1254	-	-	-	-	-	-	-	-	-
Aroclor 1260	-	-	-	86.5	82	5.3	86.5	82	5.3
Chlorinated Pesticides									
4,4'-DDD	-	-	-	84.5	83.8	0.79	84.5	83.8	0.79
4,4'-DDE	-	-	-	87.3	84.7	3.1	87.3	84.7	3.1
4,4'-DDT	-	-	-	97.7	93.8	4	97.7	93.8	4
Aldrin	-	-	-	81.7	81.2	0.61	81.7	81.2	0.61
Dieldrin	-	-	-	86.7	85.8	0.97	86.7	85.8	0.97
Endrin	-	-	-	92.7	94	1.4	92.7	94	1.4
Endrin aldehyde	-	-	-	78.5	81.5	3.8	78.5	81.5	3.8
Endrin ketone	-	-	-	104	105	0.8	104	105	0.8
alpha-BHC	-	-	-	85.8	86.2	0.39	85.8	86.2	0.39
beta-BHC	-	-	-	74.2	74.8	0.89	74.2	74.8	0.89
delta-BHC	-	-	-	62.8	63.2	0.53	62.8	63.2	0.53
gamma-BHC (Lindane)	-	-	-	90.2	87.8	2.6	90.2	87.8	2.6
Endosulfan I	-	-	-	87.8	86	2.1	87.8	86	2.1
Endosulfan II	-	-	-	84.8	86.3	1.8	84.8	86.3	1.8
Endosulfan sulfate	-	-	-	78.3	80.3	2.5	78.3	80.3	2.5
alpha-Chlordane	-	-	-	85	85.8	0.96	85	85.8	0.96
gamma-Chlordane	-	-	-	86.5	86	0.58	86.5	86	0.58
Heptachlor	-	-	-	91.7	90.7	1.1	91.7	90.7	1.1
Heptachlor epoxide	-	-	-	87.8	85.8	2.3	87.8	85.8	2.3
Methoxychlor	-	-	-	102	101	0.49	102	101	0.49
Toxaphene	-	-	-	-	-	-	-	-	-
Organophosphates									
Atrazine	-	-	-	111	99.4	11	111	99.4	11
Chlorpyrifos	-	-	-	106	106	0	106	106	0
Cyanazine	-	-	-	118	99.3	17.2	118	99.3	17.2
Diazinon	-	-	-	100	97.5	2.5	100	97.5	2.5
Malathion	-	-	-	145	143	1.4	145	143	1.4
Prometryn	-	-	-	95	101	6.1	95	101	6.1
Simazine	-	-	-	174	154	12.2	174	154	12.2

1-Bolded values are outside of QC limits

Table A.6 Matrix Spike/Spike Duplicates and Relative Percent Difference for each Sampling Event (Continued).

	Storm Event-14 23-Mar-05			Dry Weather Event-02 25-May-05		
	MS	DUP	RPD	MS	DUP	RPD
Conventionals						
Alkalinity as CaCO3	-	-	-	-	-	-
Biochemical Oxygen Demand	-	-	-	-	-	-
Chemical Oxygen Demand	-	-	-	-	-	-
Chloride	94.3	95.9	0.35	80	80	0
Fluoride	102	98	8.7	116	114	0.75
Hardness as CaCO3	-	-	-	-	-	-
MBAS	-	-	-	-	-	-
Total Ammonia (as N)	96.2	99.4	3.27	93.8	92.4	1.09
Total Kjeldahl Nitrogen	91	91	0	99.5	94.5	4.03
Nitrate (as N)	104.9	99.6	5.19	119.5	115.5	3.39
Nitrite (as N)				112.5	108.2	3.87
Oil and Grease	-	-	-	-	-	-
Total Recoverable Phenolics	87.6	95.6	8.73	89.1	86.5	2.96
Total Phosphorus	101	103	1.08	103	104	0.54
Total Orthophosphate (as P)	105	107	0.7	11	112	0.58
Conductivity	-	-	-	-	-	-
Total Dissolved Solids	-	-	-	-	-	-
Total Suspended Solids	-	-	-	-	-	-
Total Volatile Solids	-	-	-	-	-	-
Total Organic Carbon	98.3	97.4	0.59	105.8	105.2	0.31
Turbidity	-	-	-	-	-	-
Dissolved Metals						
Aluminum	101	99.8	0.797	84.4	86.4	2.34
Arsenic	130	126	3.12	95.6	96.8	1.03
Cadmium	114	114	0	93.3	94.9	1.69
Chromium	120	118	2.01	97.6	97.6	0
Copper	70.4	69.6	0.712	81.6	82.4	0.82
Iron	99.8	100.7	0.78	99.3	100.3	1.01
Lead	99.2	98.4	0.411	101	113	11.9
Nickel	106	105	0.743	80.8	81.2	0.456
Selenium	111	116	4.41	94.2	-	-
Silver	106	106	0.755	74.8	74	1.08
Zinc	132	131	0.473	78.3	79.1	0.976
Total Metals						
Aluminum	95.4	95.4	0	98.8	99.2	0.385
Arsenic	130	126	3.12	81.6	81.6	0
Cadmium	98.2	98.2	0	91.2	90.8	0.438
Chromium	107	107	0	93.2	92.4	0.82
Copper	97.8	97	0.797	74	73.6	0.412
Iron	85	80.0	1.47	95.7	94.0	1.65
Lead	111	113	0.741	104	103	1.13
Nickel	103	101	1.56	74.4	74	0.484
Selenium	111	116	4.41	117	-	-
Silver	100	99.2	0.803	78.7	78.3	0.509
Zinc	87	86.6	0.541	66.5	65.7	1.14

1-Bolded values are outside of QC limits

Table A.6 Matrix Spike/Spike Duplicates and Relative Percent Difference for each Sampling Event (Continued).

	Storm Event-14			Dry Weather Event-02		
	23-Mar-05			25-May-05		
	MS	DUP	RPD	MS	DUP	RPD
Aroclors						
Aroclor 1016	-	-	-	76.5	80.5	5.1
Aroclor 1221	-	-	-	-	-	-
Aroclor 1232	-	-	-	-	-	-
Aroclor 1242	-	-	-	-	-	-
Aroclor 1248	-	-	-	-	-	-
Aroclor 1254	-	-	-	-	-	-
Aroclor 1260	-	-	-	83	87	4.7
Chlorinated Pesticides						
4,4'-DDD	-	-	-	96.8	65.2	39.1
4,4'-DDE	-	-	-	94	59.2	45.5
4,4'-DDT	-	-	-	99.3	62.7	45.3
Aldrin	-	-	-	48	28.8	49.9
Dieldrin	-	-	-	97.8	63	43.3
Endrin	-	-	-	96	63	41.5
Endrin aldehyde	-	-	-	82	56.5	36.8
Endrin ketone	-	-	-	-	-	-
Alpha-BHC	-	-	-	91.8	56	48.5
beta-BHC	-	-	-	87	56.7	42.2
delta-BHC	-	-	-	79.5	49.3	46.8
gamma-BHC (Lindane)	-	-	-	89.7	56.8	44.8
Endosulfan I	-	-	-	91.7	59.8	42
Endosulfan II	-	-	-	94	61.5	41.8
Endosulfan sulfate	-	-	-	93	61.5	40.8
Alpha-Chlordane	-	-	-	90.2	56.8	45.4
gamma-Chlordane	-	-	-	92	58.2	45.1
Heptachlor	-	-	-	63.7	39.7	46.5
Heptachlor epoxide	-	-	-	91.3	59.5	42.2
Methoxychlor	-	-	-	-	-	-
Toxaphene	-	-	-	-	-	-
Organophosphates						
Atrazine	-	-	-	129	113	13.2
Chlorpyrifos	-	-	-	110	113	2.7
Cyanazine	-	-	-	138	124	10.7
Diazinon	-	-	-	106	104	1.9
Malathion	-	-	-	120	126	4.9
Prometryn	-	-	-	89.2	77.8	13.7
Simazine	-	-	-	165	142	15

1-Bolded values are outside of QC limits

Table A.7 Summary of Laboratory Control Spikes and Spike Duplicate Results and Relative Percent Difference for Each Sampling Event.

	Dry Weather Event-01 31-Aug-04			Storm Event-01 17-Oct-04			Storm Event-02 20-Oct-04		
	LCS	DUP	RPD	LCS	DUP	RPD	LCS	DUP	RPD
Conventionals								-	-
Alkalinity as CaCO3	97.5	-	-	103.6	-	-	103.6	-	-
Biochemical Oxygen Demand	113.9	-	-	108.6	-	-	108.6	-	-
Chemical Oxygen Demand	104.1	-	-	103.7	-	-	103.7	-	-
Chloride	97.7	-	-	98.1	-	-	98.1	-	-
Fluoride	105	-	-	98.9	-	-	98.9	-	-
Hardness as CaCO3	105.3	-	-	98.4	-	-	98.4	-	-
MBAS	111.7	-	-	-	-	-	-	-	-
Total Ammonia (as N)	95.6	-	-	95.4	-	-	95.4	-	-
Total Kjeldahl Nitrogen	112.2	-	-	95.8	-	-	95.8	-	-
Nitrate (as N)	96.1	-	-	96.6	-	-	96.6	-	-
Nitrite (as N)	94.4	-	-	100.3	-	-	100.3	-	-
Oil and Grease	92.4	-	-	-	-	-	111.1	-	-
Total Recoverable Phenolics	84.8	-	-	99.5	-	-	99.5	-	-
Total Phosphorus	94.9	-	-	95.3	-	-	95.3	-	-
Total Orthophosphate (as P)	103.7	-	-	99.5	-	-	99.5	-	-
Conductivity	102.9	-	-	103.7	-	-	-	-	-
Total Dissolved Solids	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	-	-	-	-	-	-	-
Total Volatile Solids	-	-	-	-	-	-	-	-	-
Total Organic Carbon	108	-	-	107.8	-	-	107.8	-	-
Turbidity	-	-	-	-	-	-		-	-
Dissolved Metals									
Aluminum	98	98.8	0.813	97.2	97.2	0	106	105	1.52
Arsenic	-	-	-	-	-	-	-	-	-
Cadmium	103	104	1.16	108	108	0.741	104	104	0.385
Chromium	104	103	0.775	116	115	0.692	98.8	98	0.813
Copper	106	105	0.758	106	106	0.378	95.6	98.4	2.89
Iron	112.7	-	-	112.4	-	-	104.9	-	-
Lead	103	103	0.388	109	109	0	100	99.2	0.803
Nickel	101	102	0.394	103	103	0	97.2	98	0.82
Selenium	-	-	-	-	-	-	-	-	-
Silver	104	103	0.387	121	120	0.664	99.6	99.6	0
Zinc	103	102	0.778	107	106	0.749	97.6	100	2.43
Total Metals	-	-	-	-	-	-	-	-	-
Aluminum	98	98.8	0.813	96.8	97.2	0.412	101	102	0.791
Arsenic	-	-	-	-	-	-	-	-	-
Cadmium	103	104	1.16	104	104	0.384	102	103	0.39
Chromium	104	103	0.775	92.8	93.6	0.858	103	102	0.39
Copper	106	105	0.758	101	100		76.8	76	1.05
Iron	111.1	-	-	108	-	-	114.5	-	-
Lead	103	103	0.388	106	106	0	75.6	75.6	0
Nickel	101	102	0.394	88.8	89.6	0.897	75.6	75.6	0
Selenium	-	-	-	-	-	-	-	-	-
Silver	104	103	0.387	111	111	0.36	76	76.4	0.525
Zinc	100	99.2	0.778	106	106	0	72.2	71.4	1.11

1-Bolded values are outside of QC limits

Table A.7 Summary of Laboratory Control Spikes and Spike Duplicate Results and Relative Percent Difference for Each Sampling Event (Continued).

	Dry Weather Event-01 31-Aug-04			Storm Event-01 17-Oct-04			Storm Event-02 20-Oct-04		
	LCS	DUP	RPD	LCS	DUP	RPD	LCS	DUP	RPD
Aroclors									
Aroclor 1016	74	-	-	58.7			70.2		
Aroclor 1221	-	-	-	-	-	-	-	-	-
Aroclor 1232	-	-	-	-	-	-	-	-	-
Aroclor 1242	-	-	-	-	-	-	-	-	-
Aroclor 1248	-	-	-	-	-	-	-	-	-
Aroclor 1254	-	-	-	-	-	-	-	-	-
Aroclor 1260	83.1	-	-	74.5	-	-	80.9	-	-
Chlorinated Pesticides		-	-						
4,4'-DDD	73	-	-	77	-	-	63.3	-	-
4,4'-DDE	64.3	-	-	72.3	-	-	59.0	-	-
4,4'-DDT	69.7	-	-	69.3	-	-	60.3	-	-
Aldrin	44.7	-	-	51	-	-	32.2	-	-
Dieldrin	73.3	-	-	74.7	-	-	63.7	-	-
Endrin	69.7	-	-	75.7	-	-	65.3	-	-
Endrin aldehyde	68.0	-	-	73.3	-	-	66.3	-	-
Endrin ketone	87.0	-	-	88.0	-	-	76.3	-	-
alpha-BHC	74.3	-	-	69.0	-	-	59.7	-	-
beta-BHC	76.3	-	-	75.7	-	-	64.7	-	-
Delta-BHC	76.3	-	-	50.0	-	-	40.0	-	-
gamma-BHC (Lindane)	78.3	-	-	74.7	-	-	55.7	-	-
Endosulfan I	71.7	-	-	72.7	-	-	62.0	-	-
Endosulfan II	71.7	-	-	71.7	-	-	63.7	-	-
Endosulfan sulfate	73.3	-	-	67.7	-	-	58.7	-	-
alpha-Chlordane	68.0	-	-	72.0	-	-	59.7	-	-
gamma-Chlordane	63.7	-	-	71.0	-	-	55.7	-	-
Heptachlor	51.7	-	-	55.3	-	-	37.0	-	-
Heptachlor epoxide	73.7	-	-	76.0	-	-	62.7	-	-
Methoxychlor	68.3	-	-	69.3	-	-	61.0	-	-
Toxaphene	-	-	-	-	-	-	-	-	-
Organophosphates		-	-						
Atrazine	100	-	-	89.8	-	-	102	86.4	16.4
Chlorpyrifos	81.8	-	-	73.6	-	-	89.0	99.0	10.6
Cyanazine	124	-	-	111	-	-	105	86.8	19.0
Diazinon	90.8	-	-	70.8	-	-	90.4	98.4	8.5
Malathion	78.4	-	-	75.6	-	-	91.2	89.2	2.2
Prometryn	-	-	-	92.8	-	-	92.0	84.4	8.6
Simazine	126	-	-	83.6	-	-	115	99	15.3

1-Bolded values are outside of QC limits

Table A.7 Summary of Laboratory Control Spikes and Spike Duplicate Results and Relative Percent Difference for Each Sampling Event (Continued).

	Storm Event-03			Storm Event-04			Storm Event-05		
	27-Oct-04			6-Dec-04			29-Dec-04		
	LCS	DUP	RPD	LCS	DUP	RPD	LCS	DUP	RPD
Conventionals									
Alkalinity as CaCO3	99.2	-	-	103.9	-	-	97.1	-	-
Biochemical Oxygen Demand	111.3	-	-	129.8	-	-	111.3	-	-
Chemical Oxygen Demand	103.7	-	-	10.7	-	-	107.5	-	-
Chloride	96.7	-	-	99.7	-	-	97.7	-	-
Fluoride	94.2	-	-	107.4	-	-	105.8	-	-
Hardness as CaCO3	97.4	-	-	98.4	-	-	98	-	-
MBAS	112.2	-	-	104	-	-	96	-	-
Total Ammonia (as N)	95.4	-	-	111	-	-	98.3	-	-
Total Kjeldahl Nitrogen	85.8	-	-	100.6	-	-	104	-	-
Nitrate (as N)	95	-	-	97	-	-	95	-	-
Nitrite (as N)	97.7	-	-	95.7	-	-	103.3	-	-
Oil and Grease	101.6	-	-	-	-	-	94.4	-	-
Total Recoverable Phenolics	99.5	-	-	95.9	-	-	91.4	-	-
Total Phosphorus	100.8	-	-	94.1	-	-	95.7	-	-
Total Orthophosphate (as P)	99.5	-	-	97.3	-	-	94.1	-	-
Conductivity	98	-	-	95.9	-	-	99.8	-	-
Total Dissolved Solids	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	-	-	-	-	-	-	-
Total Volatile Solids	-	-	-	-	-	-	-	-	-
Total Organic Carbon	107.8	-	-	102.2	-	-	112.5	-	-
Turbidity	-	-	-	-	-	-	93.1	-	-
Dissolved Metals									
Aluminum	102	102	0.784	94.8	95.6	0.84	90	89.6	0.445
Arsenic	-	-	-	92.4	91.2	1.31	92.4	91.2	1.31
Cadmium	101	101	0	102	102	0.393	100	101	0.794
Chromium	101	96.6	1.2	99.6	99.6	0	92	92	0
Copper	85.6	84.8	0.939	101	102	1.18	92.4	92	0.434
Iron	104.9	-	-	104.5	-	-	111	-	-
Lead	83.2	83.2	0	100	101	1.19	98.4	99.2	0.81
Nickel	85.2	84	1.42	101	102	0.394	90.4	90.3	0
Selenium	-	-	-	-	-	-	-	-	-
Silver	85.2	84.4	0.943	105	105	0.381	102	102	0.784
Zinc	79.1	79.2	0.101	103	106	2.3	95.2	94.4	0.844
Total Metals	-	-	-	-	-	-	-	-	-
Aluminum	101	102	0.791	92.4	94	1.72	88	86.4	1.83
Arsenic	-	-	-	92.4	91.2	1.31	92.4	91.2	1.31
Cadmium	102	103	0.39	101	101	0	101	101	0.396
Chromium	103	102	0.39	93.2	93.6	0.428	102	100	1.19
Copper	76.8	76	1.05	100	99.2	1.2	92	92.4	0.434
Iron	108	-	-	108.1	-	-	114.2	-	-
Lead	75.6	75.6	0	103	102	0.781	100	98.4	1.61
Nickel	75.6	75.6	0	98	96.4	1.65	90.3	92	1.75
Selenium	-	-	-	-	-	-	-	-	-
Silver	76	76.4	0.525	102	102	0	107	107	0.374
Zinc	72.2	71.4	1.11	105	102	2.32	93.6	93.6	0

1-Bolded values are outside of QC limits

Table A.7 Summary of Laboratory Control Spikes and Spike Duplicate Results and Relative Percent Difference for Each Sampling Event (Continued).

	Storm Event-03 27-Oct-04			Storm Event-04 6-Dec-04			Storm Event-05 29-Dec-04		
	LCS	DUP	RPD	LCS	DUP	RPD	LCS	DUP	RPD
Aroclors									
Aroclor 1016	97.3			76.6	-	-	96.2	-	-
Aroclor 1221	-	-	-	-	-	-	-	-	-
Aroclor 1232	-	-	-	-	-	-	-	-	-
Aroclor 1242	-	-	-	-	-	-	-	-	-
Aroclor 1248	-	-	-	-	-	-	-	-	-
Aroclor 1254	-	-	-	-	-	-	-	-	-
Aroclor 1260	81.9	-	-	77.5	-	-	93.7	-	-
Chlorinated Pesticides									
4,4'-DDD	72.0	-	-	96.3	-	-	69.3	-	-
4,4'-DDE	74.7	-	-	96.3	-	-	63.3	-	-
4,4'-DDT	79.3	-	-	86.0	-	-	67.3	-	-
Aldrin	68.0	-	-	78.3	-	-	39.7	-	-
Dieldrin	74.3	-	-	96.0	-	-	67	-	-
Endrin	75.7	-	-	87.0	-	-	70.7	-	-
Endrin aldehyde	74.3	-	-	89.0	-	-	62.7	-	-
Endrin ketone	85.0	-	-	104	-	-	78.7	-	-
alpha-BHC	69.3	-	-	97.0	-	-	60.3	-	-
beta-BHC	75.0	-	-	85.7	-	-	56	-	-
delta-BHC	41.7	-	-	47.0	-	-	29.6	-	-
gamma-BHC (Lindane)	71.3	-	-	99.0	-	-	62.7	-	-
Endosulfan I	70.7	-	-	94.3	-	-	63.7	-	-
Endosulfan II	71.0	-	-	94.3	-	-	65.3	-	-
Endosulfan sulfate	65.7	-	-	81.7	-	-	58.3	-	-
alpha-Chlordane	61.0	-	-	86.3	-	-	58.7	-	-
gamma-Chlordane	72.0	-	-	90.7	-	-	58	-	-
Heptachlor	69.7	-	-	77.0	-	-	46	-	-
Heptachlor epoxide	74.0	-	-	93.3	-	-	62	-	-
Methoxychlor	71.3	-	-	83.0	-	-	75.3	-	-
Toxaphene	-	-	-	-	-	-	-	-	-
Organophosphates									
Atrazine	94.8	-	-	114	-	-	88.8	-	-
Chlorpyrifos	50.8	-	-	87.6	-	-	104	-	-
Cyanazine	99.2	-	-	102	-	-	96	-	-
Diazinon	49.4	-	-	88.6	-	-	104	-	-
Malathion	97.2	-	-	94.6	-	-	117	-	-
Prometryn	92.4	-	-	84	-	-	108	-	-
Simazine	98.6	-	-	122	-	-	108	-	-

1-Bolded values are outside of QC limits

Table A.7 Summary of Laboratory Control Spikes and Spike Duplicate Results and Relative Percent Difference for Each Sampling Event (Continued).

	Storm Event-07 4-Jan-05			Storm Event-08 7-Jan-05			Storm Event-09 10-Jan-05		
	LCS	DUP	RPD	LCS	DUP	RPD	LCS	DUP	RPD
Conventionals									
Alkalinity as CaCO3	98.2	-	-	99.6	-	-	99.6	-	-
Biochemical Oxygen Demand	137.7	-	-	103.3	-	-	103.3	-	-
Chemical Oxygen Demand	104.4	-	-	104.4	-	-	104.4	-	-
Chloride	88.1	-	-	95.5	-	-	95.5	-	-
Fluoride	105.8	-	-	93.1	-	-	93.1	-	-
Hardness as CaCO3	98	-	-	99.7	-	-	99.7	-	-
MBAS	92	-	-	104	-	-	104	-	-
Total Ammonia (as N)	94.9	-	-	94.9	-	-	94.9	-	-
Total Kjeldahl Nitrogen	104	-	-		-	-	104	-	-
Nitrate (as N)	102.3	-	-	102.2	-	-	102.2	-	-
Nitrite (as N)	93.8	-	-	106.3	-	-	106.3	-	-
Oil and Grease	108.9	-	-	96.6	-	-	96.6	-	-
Total Recoverable Phenolics	91.4	-	-	91.4	-	-	91.4	-	-
Total Phosphorus	95.7	-	-	91.3	-	-	91.3	-	-
Total Orthophosphate (as P)	100	-	-	103.7	-	-	103.7	-	-
Conductivity	104.3			104	-	-	104	-	-
Total Dissolved Solids	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	-	-	-	-	-	-	-
Total Volatile Solids	-	-	-	-	-	-	-	-	-
Total Organic Carbon	112.5	-	-	105.9	-	-	105.9	-	-
Turbidity	98.4	-	-	97	-	-	97	-	-
Dissolved Metals									
Aluminum	93.6	94.8	1.27	93.6	94.8	1.27	93.6	94.8	1.27
Arsenic	92.4	91.2	1.31	92.4	91.2	1.31	92.4	91.2	1.31
Cadmium	102	102	0	102	102	0	102	102	0
Chromium	99.6	101	1.59	99.6	101	1.59	99.6	101	1.59
Copper	105	105	0.381	105	105	0.381	105	105	0.381
Iron	106.3	-	-	101.6	-	-	101.6	-	-
Lead	94	95.2	1.27	94	95.2	1.27	94	95.2	1.27
Nickel	102	103	1.17	102	103	1.17	102	103	1.17
Selenium	-	-	-	-	-	-	-	-	-
Silver	99.2	99.2	0	99.2	99.2	0	99.2	99.2	0
Zinc	96	96.8	0.83	96	96.8	0.83	96	96.8	0.83
Total Metals	-	-	-	-	-	-	-	-	-
Aluminum	102	103	1.17	102	103	1.17	102	103	1.17
Arsenic	92.4	91.2	1.31	92.4	91.2	1.31	92.4	91.2	1.31
Cadmium	101	102	0.791	101	102	0.791	101	102	0.791
Chromium	103	104	0.775	103	104	0.775	103	104	0.775
Copper	101	101	0	101	101	0	101	101	0
Iron	106.6	-	-	106.6	-	-	105.8	-	-
Lead	99.6	98	1.62	99.6	98	1.62	99.6	98	1.62
Nickel	98	99.2	1.22	98	99.2	1.22	98	99.2	1.22
Selenium	-	-	-	-	-	-	-	-	-
Silver	102	104	1.56	102	104	1.56	102	104	1.56
Zinc	100	99.2	0.803	100	99.2	0.803	100	99.2	0.803

1-Bolded values are outside of QC limits

Table A.7 Summary of Laboratory Control Spikes and Spike Duplicate Results and Relative Percent Difference for Each Sampling Event (Continued).

	Storm Event-07 4-Jan-05			Storm Event-08 7-Jan-05			Storm Event-09 10-Jan-05		
	LCS	DUP	RPD	LCS	DUP	RPD	LCS	DUP	RPD
Aroclors									
Aroclor 1016	64.1	-	-	66.9	-	-	66.9	-	-
Aroclor 1221	-	-	-	-	-	-	-	-	-
Aroclor 1232	-	-	-	-	-	-	-	-	-
Aroclor 1242	-	-	-	-	-	-	-	-	-
Aroclor 1248	-	-	-	-	-	-	-	-	-
Aroclor 1254	-	-	-	-	-	-	-	-	-
Aroclor 1260	72.6	-	-	74.2	-	-	74.2	-	-
Chlorinated Pesticides									
4,4'-DDD	83.3	-	-	91.7	-	-	91.7	-	-
4,4'-DDE	82.3	-	-	87	-	-	87	-	-
4,4'-DDT	93	-	-	89	-	-	89	-	-
Aldrin	54.7	-	-	56.3	-	-	56.3	-	-
Dieldrin	84	-	-	87.7	-	-	87.7	-	-
Endrin	83.7	-	-	92.3	-	-	92.3	-	-
Endrin aldehyde	82.3	-	-	84.7	-	-	84.7	-	-
Endrin ketone	103	-	-	103	-	-	103	-	-
alpha-BHC	76	-	-	77	-	-	77	-	-
beta-BHC	74.3	-	-	75.3	-	-	75.3	-	-
Delta-BHC	38	-	-	66.3	-	-	66.3	-	-
gamma-BHC (Lindane)	81	-	-	82.7	-	-	82.7	-	-
Endosulfan I	84.3	-	-	88.7	-	-	88.7	-	-
Endosulfan II	81.7	-	-	88.3	-	-	88.3	-	-
Endosulfan sulfate	72.7	-	-	79.7	-	-	79.7	-	-
alpha-Chlordane	80.7	-	-	86.3	-	-	86.3	-	-
gamma-Chlordane	78.7	-	-	84	-	-	84	-	-
Heptachlor	68.3	-	-	61.3	-	-	61.3	-	-
Heptachlor epoxide	81.3	-	-	86	-	-	86	-	-
Methoxychlor	99	-	-	95.7	-	-	95.7	-	-
Toxaphene	-	-	-	-	-	-	-	-	-
Organophosphates									
Atrazine	84.6	-	-	108	-	-	108	-	-
Chlorpyrifos	97.6	-	-	106	-	-	106	-	-
Cyanazine	91	-	-	106	-	-	106	-	-
Diazinon	94.8	-	-	102	-	-	102	-	-
Malathion	123	-	-	**204**[1]	-	-	**204**[1]	-	-
Prometryn	100	-	-	94.2	-	-	94.2	-	-
Simazine	101	-	-	124	-	-	124	-	-

1-Bolded values are outside of QC limits

Table A.7. Summary of Laboratory Control Spikes and Spike Duplicate Results and Relative Percent Difference for Each Sampling Event (Continued).

	Storm Event-14 23-Mar-05			Dry Weather Event-02 25-May-05		
	LCS	DUP	RPD	LCS	DUP	RPD
Conventionals						
Alkalinity as CaCO3	93	-	-	98.9	-	-
Biochemical Oxygen Demand	106	-	-	108.6	-	-
Chemical Oxygen Demand	107.4	-	-	96.7	-	-
Chloride	93.8	-	-	92.6	-	-
Fluoride	95.4	-	-	112.1	-	-
Hardness as CaCO3	97.6	-	-	93.5	-	-
MBAS	102.7	-	-	92	-	-
Total Ammonia (as N)	102	-	-	98.9	-	-
Total Kjeldahl Nitrogen	102	-	-	95.9	-	-
Nitrate (as N)	100.8	-	-	110.6	-	-
Nitrite (as N)	95.4	-	-	108.6	-	-
Oil and Grease	102.1	-	-	100.2	-	-
Total Recoverable Phenolics	96.1	-	-	90.8	-	-
Total Phosphorus	97.6	-	-	94.5	-	-
Total Orthophosphate (as P)	104.8	-	-	100.5	-	-
Conductivity	95.9	-	-	101.6	-	-
Total Dissolved Solids	-	-	-	-	-	-
Total Suspended Solids	-	-	-	-	-	-
Total Volatile Solids	-	-	-	-	-	-
Total Organic Carbon	113.3	-	-	108.3	-	-
Turbidity	92	-	-	94.9	-	-
Dissolved Metals						
Aluminum	95.6	96.8	1.25	99.2	99.2	2
Arsenic	-	-	-	101	101	0
Cadmium	104	104	0.385	109	110	1.1
Chromium	115	115	0.348	112	114	1.41
Copper	102	103	0.781	111	112	1.43
Iron	107.9	-	-	100.5	-	-
Lead	98.4	99.2	0.81	98	98.8	0.813
Nickel	102	102	0.393	107	107	0
Selenium	-	-	-	96.5	95.0	1.57
Silver	107	107	0.374	110	110	0
Zinc	100	101	0.797	106	106	0
Total Metals	-	-	-	-	-	-
Aluminum	93.6	93.6	0	100	100	0.399
Arsenic	-	-	-	103	103	0
Cadmium	104	104	0	108	108	0.37
Chromium	107	106	0.375	99.2	100	0.803
Copper	98.4	97.6	0.816	111	112	0.719
Iron	109.7	-	-	106	-	-
Lead	92.8	94.4	1.71	93.2	93.6	0.428
Nickel	96	96	0	106	107	0.749
Selenium	-	-	-	96.5	95.0	1.57
Silver	101	101	0.396	100	100	0.399
Zinc	96.8	96.8	0	102	102	0.784

1-Bolded values are outside of QC limits

Table A.7 Summary of Laboratory Control Spikes and Spike Duplicate Results and Relative Percent Difference for Each Sampling Event (Continued).

	Storm Event-14 23-Mar-05			Dry Weather Event-02 25-May-05		
	LCS	DUP	RPD	LCS	DUP	RPD
Aroclors						
Aroclor 1016	100	-	-	75.7	-	-
Aroclor 1221	-	-	-	-	-	-
Aroclor 1232	-	-	-	-	-	-
Aroclor 1242	-	-	-	-	-	-
Aroclor 1248	-	-	-	-	-	-
Aroclor 1254	-	-	-	-	-	-
Aroclor 1260	106	-	-	82.8	-	-
Chlorinated Pesticides						
4,4'-DDD	95.3	-	-	109	-	-
4,4'-DDE	98.3	-	-	98.3	-	-
4,4'-DDT	97.7	-	-	107	-	-
Aldrin	64	-	-	45	-	-
Dieldrin	96.7	-	-	105	-	-
Endrin	104	-	-	103	-	-
Endrin aldehyde	88	-	-	99.7	-	-
Endrin ketone	93.3	-	-	-	-	-
alpha-BHC	101	-	-	96	-	-
beta-BHC	97	-	-	98	-	-
delta-BHC	82	-	-	79	-	-
gamma-BHC (Lindane)	105	-	-	85.3	-	-
Endosulfan I	96.7	-	-	101	-	-
Endosulfan II	94	-	-	106	-	-
Endosulfan sulfate	90.7	-	-	97	-	-
alpha-Chlordane	94.3	-	-	68.7	-	-
gamma-Chlordane	91.3	-	-	88.7	-	-
Heptachlor	70.3	-	-	57.7	-	-
Heptachlor epoxide	96	-	-	103	-	-
Methoxychlor	95.3	-	-	-	-	-
Toxaphene	-	-	-	-	-	-
Organophosphates						
Atrazine	95.4	-	-	127	-	-
Chlorpyrifos	107	-	-	120	-	-
Cyanazine	99	-	-	132	-	-
Diazinon	105	-	-	103	-	-
Malathion	**132** [1]	-	-	**145** [1]	-	-
Prometryn	103	-	-	114	-	-
Simazine	107	-	-	151	-	-

1-Bolded values are outside of QC limits

Table A.8 Summary of Standard Reference Material (SRM) Percent Recoveries for Each Sampling Event.

	Dry Weather Event-01 31-Aug-04	Storm Event-01 17-Oct-04	Storm Event-02 20-Oct-04	Storm Event-03 27-Oct-04	Storm Event-04 6-Dec-04	Storm Event-05 29-Dec-04	Storm Event-07 4-Jan-05	Storm Event-08 7-Jan-05	Storm Event-09 10-Jan-05	Storm Event-14 23-Mar-05	Dry Weather Event-02 25-May-05
Dissolved Metals											
Aluminum	100	112	103	108	98.3	101	83.3	83.3	83.3	117	117
Arsenic	-	**67.9** [1]	**67.9** [1]	**67.9** [1]	95.8	95.8	95.8	95.8	95.8	92.7	108
Cadmium	106	112	107	97.9	104	102	99.6	99.6	99.6	107	113
Chromium	103	111	83	83.7	99.3	92.6	95.6	95.6	95.6	**130** [1]	125
Copper	103	100	84.6	84	98.1	90.7	109	109	109	108	114
Iron	-	-	-	-	-	-	-	-	-	-	-
Lead	108	112	96.6	88.2	106	104	97.4	97.4	97.4	105	104
Nickel	101	96.6	79.4	85.6	100	90.4	108	108	108	110	113
Selenium	-	83.1	83.1	83.1	72.3	72.3	72.3	72.3	72.3	101	102
Silver	105	120	98	85.2	106	104	98	98	98	109	113
Zinc	107	107	93.3	83.5	106	95.7	103	103	103	111	114
Total Metals											
Aluminum	100	106	105	105	95.7	91.7	110	110	110	110	113
Arsenic	94.9	**67.9** [1]	**67.9** [1]	**67.9** [1]	94.9	94.9	94.9	94.9	94.9	92.7	-
Cadmium	106	108	102	102	101	103	100	100	100	110	114
Chromium	103	85.9	81.5	81.5	101	99.3	108	108	108	122	104
Copper	103	98.8	78.4	78.4	89.5	95.1	103	103	103	104	113
Iron	-	-	-	-	-	-	-	-	-	-	-
Lead	108	110	83.7	83.7	103	104	101	101	101	101	96.7
Nickel	101	82.5	79.4	79.4	91.2	95.8	103	103	103	101	109
Selenium	103	79.0	79.0	79.0	72.3	72.3	72.3	72.3	72.3	101	102
Silver	105	113	80.9	80.9	102	109	101	101	101	105	102
Zinc	107	111	81.7	81.7	93.3	102	108	108	108	112	110

1-Bolded values are outside of QC limits

Table A.9 Summary of Surrogate Recoveries for Each Sampling Event.

	Bouton	Belmont	Los Cerritos	Dominguez	MB	LCM	MS	MSD
Dry Weather Event-01								
Chlorinated Pesticides								
DECA	68	69.9	58.6	58.6	68.6	62	-	-
TCmX	45.5	45.5	38.2	38.2	36.3	40	-	-
Organophosphates								
Tributylphosphate	92.7	93.9	102	102	95.7	93.9	-	-
Triphenylphosphate	89.5	80.3	96.5	96.5	89.4	88.6	-	-
Storm Event-01								
Chlorinated Pesticides								
DECA	36.6	-	38.5	-	59.4	41.7	47.5	51.0
TCmX	34.5	-	39.2	-	29.5	39.7	36.7	43.7
Organophosphates								
Tributylphosphate	81.4	-	**413** [1]	-	85.1	84.5	84.5	98.5
Triphenylphosphate	91.9	-	93.5	-	84.9	88.7	91.0	102
Storm Event-02								
Chlorinated Pesticides								
DECA	42.4	44.5	85.8	-	58.2	56.7	58.3	55.7
TCmX	61.1	62.4	59.8	-	32.3	21.5	46.7	51.2
Organophosphates								
Tributylphosphate	114	110	136	-	88.3	96.8	134	129
Triphenylphosphate	123	122	103	-	89.9	106	119	112
Storm Event-03								
Chlorinated Pesticides								
DECA	52.5	54.9	50.5	-	65.0	46.7	63.8	62.0
TCmX	56.3	57.7	55.7	-	50.1	52.7	48.8	44.2
Organophosphates								
Tributylphosphate	124	135	**282** [1]	-	89.8	94.7	105	113
Triphenylphosphate	**133** [1]	**136** [1]	**137** [1]	-	93.1	97.3	114	121
Storm Event-04								
Chlorinated Pesticides								
DECA	73.2	-	-	-	77.8	69.3	-	-
TCmX	78.2	-	-	-	41.9	72.0	-	-
Organophosphates								
Tributylphosphate	113	-	-	-	81.8	93.2	-	-
Triphenylphosphate	116	-	-	-	87.4	102	-	-
Storm Event-05								
Chlorinated Pesticides								
DECA	-	64.4	68.7	69.3	69.9	55.3	70.3	
TCmX	-	66.2	65.5	67.5	58.8	37.0	49.3	
Organophosphates								
Tributylphosphate	-	128	**327** [1]	125	98.5	98.2	114	108
Triphenylphosphate	-	122	132	119	89.8	94.9	105	99.3

1-Bolded values are outside of QC limits

Table A.9 Summary of Surrogate Recoveries for Each Sampling Event (Continue).

	Bouton	Belmont	Los Cerritos	Dominguez	MB	LCM	MS	MSD
Storm Event-07								
Chlorinated Pesticides								
DECA	-	-	-	74.3	97.1	75.0	-	-
TCmX	-	-	-	62.7	50.1	44.7	-	-
Organophosphates								
Tributylphosphate	-	-	-	123	104	105	-	-
Triphenylphosphate	-	-	-	86.2	94.6	96.6	-	-
Storm Event-08								
Chlorinated Pesticides								
DECA	-	-	-	63.6	77.2	81.3	89	83.7
TCmX	-	-	-	69.0	55.1	38.7	69.7	68.3
Organophosphates								
Tributylphosphate	-	-	-	106	90.5	91.8	100	108
Triphenylphosphate	-	-	-	99.3	80.2	86.2	96.5	102
Storm Event-09								
Chlorinated Pesticides								
DECA	-	-	-	59.3	77.2	81.3	89	83.7
TCmX	-	-	-	61.7	55.1	38.7	69.7	68.3
Organophosphates								
Tributylphosphate	-	-	-	95.5	90.5	91.8	100	108
Triphenylphosphate	-	-	-	84.4	80.2	86.2	96.5	102
Storm Event-14								
Chlorinated Pesticides								
DECA	-	60.4	-	-	89.7	91.3	-	-
TCmX	-	36.2	-	-	64.8	60.3	-	-
Organophosphates								
Tributylphosphate	-	85.8	-	-	102	110	-	-
Triphenylphosphate	-	93.4	-	-	106	113	-	-
Dry Weather Event-02								
Chlorinated Pesticides								
DECA	80.1	72.9	49.1	-	100	96	84.0	58.2
TCmX	67.5	68.7	52.1	-	88.1	74.3	74.2	47.8
Organophosphates								
Tributylphosphate	109	103	83.5	-	115	123	100	111
Triphenylphosphate	105	103	81.0	-	118	122	102	109

1-Bolded values are outside of QC limits

Table A-10 Long Beach Stormwater Toxicity Testing QA Exceptions.

Sample Date	Experiment	Species	Sample	Description
10/20/2004	410041	Sea Urchin	Bouton, Belmont,Cerritos	Brine control <70% fertilization, retested outside holding time (>36 hours).
3/23/2005	503033	Water Flea	Belmont	Control reproduction <15 neonates per female in both sample and reference toxoicant tests. Results judged to provide valid toxicity asessment.

Table A-11 Sampling Holding Times Long Beach Stormwater Samples, 2004-2005.

Date Collected	Sample Location	Hours Held Before Testing	
		Water Flea	Sea Urchin
8/31/04	Belmont Pump	28	32
8/31/04	Bouton Creek	26	29
8/31/04	Cerritos Channel	26	30
10/17/04	Bouton Creek	37	62
10/17/04/	Cerritos Channel	36	61
10/20/04	Belmont Pump	63	62
10/20/04	Bouton Creek	57	56
10/20/04	Cerritos Channel	53	52
10/27/04	Belmont Pump	32	**80**
10/27/04	Bouton Creek	29	**76**
10/27/04	Cerritos Channel	33	**80**
12/6/04	Bouton Creek	22	**109**
12/29/04	Belmont Pump	57	37
12/29/04	Cerritos Channel	52	32
3/23/05	Belmont Pump	34	35
5/25/05	Belmont Pump	25	26
5/25/05	Bouton Creek	26	27
5/25/05	Cerritos Channel	27	28

Bold typeface: Test initiation exceeded 72 hour hold time.

Appendix B

Los Cerritos Channel Dry Weather Upstream Investigation

APPENDIX B
LOS CERRITOS CHANNEL DRY WEATHER UPSTREAM INVESTIGATION

1.0 DRY WEATHER UPSTREAM INVESTIGATIONS

Several dry weather surveys conducted early in the program found occasional high pH values at monitoring sites located in open concrete channels. In 2002, the Regional Board added a requirement to conduct upstream investigations if pH values of 9.0 or greater were encountered during the surveys. Elevated pH values were measured in the composite dry weather sample taken at the Los Cerritos Channel station during the August 31, 2004. Upon measurement of the composite bottle pH, an immediate upstream investigation was initiated.

The field crew initially walked approximately 1000 feet upstream in the Los Cerritos Channel to look for possible sources. Measurements of pH tended to increase from 10.02 at the monitoring site to 10.42 to 10.52 at all upstream sites. No sources of water with elevated pH were identified. The crew then went upstream to Spring Street near the junction of the Los Cerritos and Palo Verde Channels. Similar, high pH measurements (10.14 to 10.43) were found in waters above the confluence of these channels, at the mouth of the Palo Verde Channel, and downstream of the confluence. Further investigations were conducted upstream of this site in the vicinity of the Clark Channel. The pH measurements in this region of the Los Cerritos Channel were lower (9.30 to 9.82) but still elevated. Further investigation was halted due to the late hour and approaching darkness.

Since the source could not be quickly located, a follow-up watershed investigation was conducted on September 3, 2004. Eleven sites (Figure 1, Table 1) were visited throughout the watershed including the two major tributaries to the Los Cerritos Channel starting from the Los Cerritos Channel monitoring site (Figure 2). Field estimates of flow were taken using conventional dry weather flow procedures. The average width and depth of the flow were measured for a 10 foot section of the channel. Velocity over the 10-foot section was measured based upon measuring the time required for particles to drift through the segment. Dissolved oxygen was measured with a YSI Model 58 meter. Temperature, salinity and pH were measured with a YSI Model 63 meter. Water samples for measurement of alkalinity were taken for measurement in the laboratory.

Partial measurements were taken at two additional sites. A pH measurement was taken from a trickle flow entering the Clark Channel beneath the Conant Street Bridge (Clark – Outfall; Figure 3). The measured value of 8.17 from this small pipe was the lowest value recorded during the survey. Although pH of water from this outfall was within normal ranges, this site had an unusual mineral formation. In another case only flow was measured at the mouth of the Palo Verde Channel for comparison with flow in the Los Cerritos Channel downstream of the junction of the two conveyances.

The results of this survey are shown in Table 2 and Figures 4 through 8. The survey showed evidence of high pH water throughout the open conveyances of the Los Cerritos Channel and both major tributaries, the Palo Verde and Clark Channels. Measured pH values typically ranged from 9.45 to 10.90. An initial pH check conducted in the morning (0845) at site CC1-A resulted in a pH of 8.93, just under the trigger of 9.0 that was set to initiate upstream investigations. Three hours later (1146), pH had risen to 9.50 and the upstream investigation was started. Flows generally decreased at upstream sites with the exception of flows measured at CC2-A located in the Los Cerritos Channel just downstream of the mouth of the Palo Verde Channel. Total alkalinity ranged from 90 to 173 mg/L. Alkalinity provides an indication of the buffering capacity of the water. Alkalinity values of 100 to 200 would be expected to have a stabilizing effect.

Water temperature and dissolved oxygen were extremely high at all sites. Temperatures ranged from 23.8 to 31.5 °C. Temperatures also tended to increase over the course of the day reaching the higher portion of the range around 1500. Dissolved oxygen levels ranged from just over 11 mg/L to greater than 20 mg/L at several sites.

The results of this investigation support the initial hypothesis that the elevated pH values in these shallow open concrete channels are caused by photosynthetic activity. Evidence suggests that pH increases during the day. Algae in the channels consume carbon dioxide (CO_2) while undergoing photosynthesis. Algal growths typical of open channels during summer, dry weather conditions are shown in a photograph of flows observed during the upstream investigation in the Del Amo Channel (Figure 9) at the upper end of the watershed. Evidence of 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 the night, respiration of the algae and bacteria in the channel would cause CO_2 to be released and oxygen to be consumed. This allows the pH drop during the night. The diurnal cycling of pH is a common occurrence in open waterways. Alkalinity provides buffering capacity such that high alkalinity water should be expected to have less extreme diurnal changes in pH.

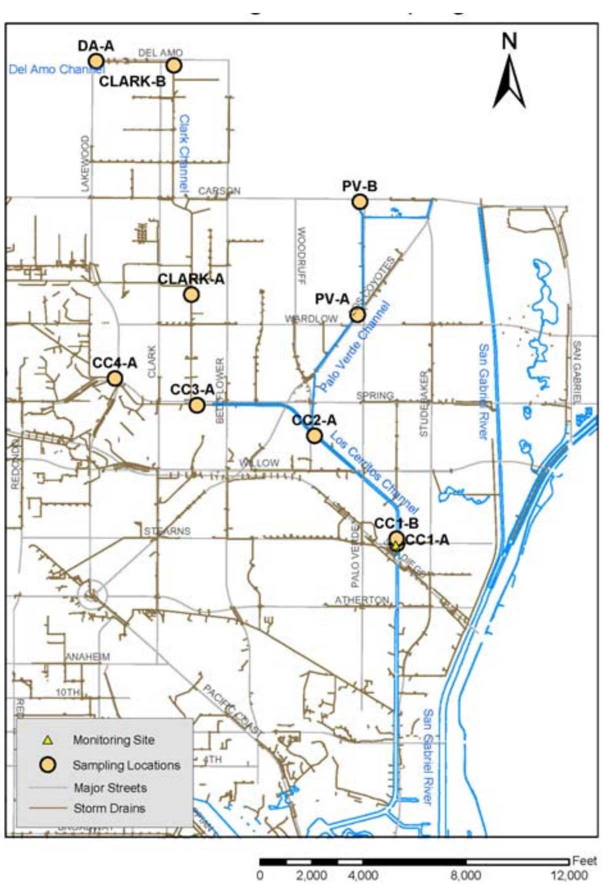


Figure 2. Los Cerritos Channel Watershed Investigation Sites

Figure 1. Dry Weather Flow at the Los Cerritos Monitoring Station, 9/3/04.

Figure 3. Concretions from Outfall into the Clark Channel under the Conant St. Bridge.

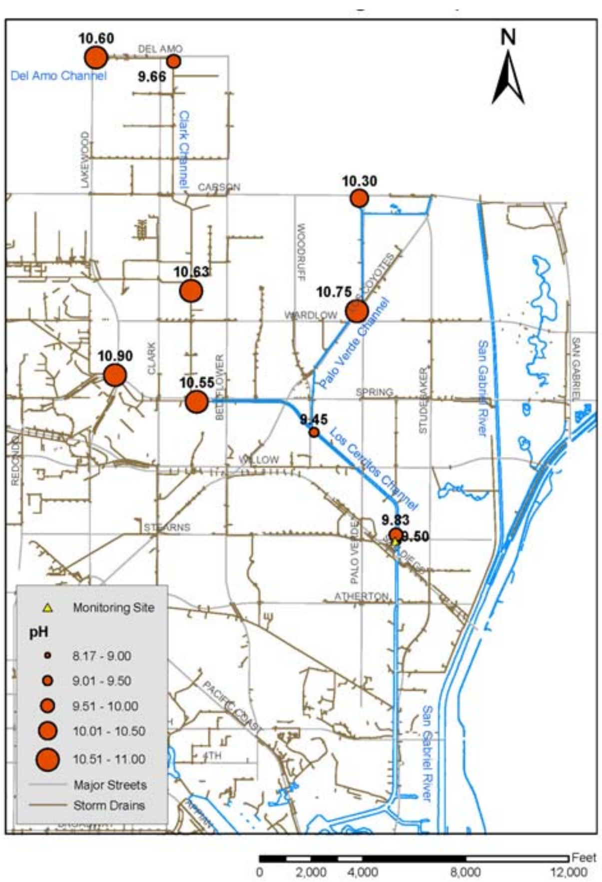


Figure 4. Measured pH at each Los Cerritos Channel Watershed Site.

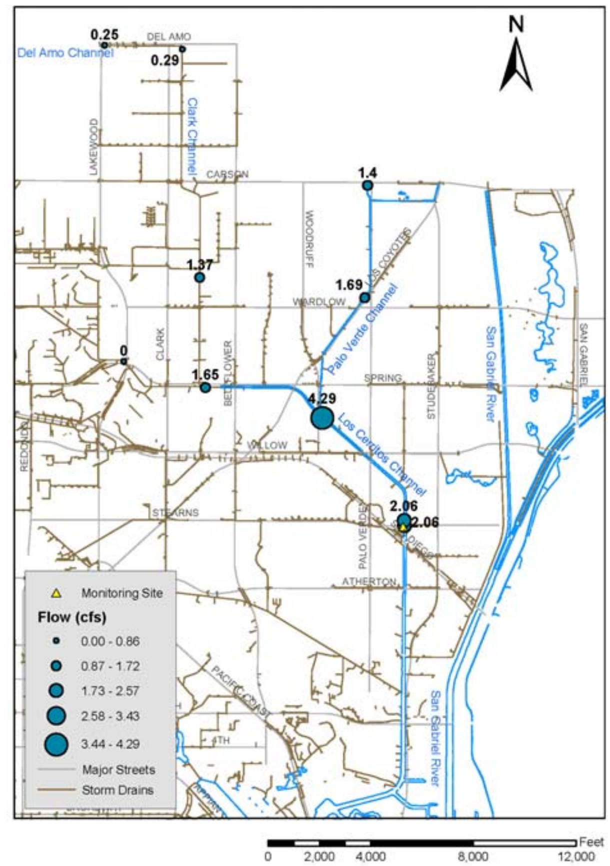


Figure 5. Flow measured at each Los Cerritos Channel Watershed Site.

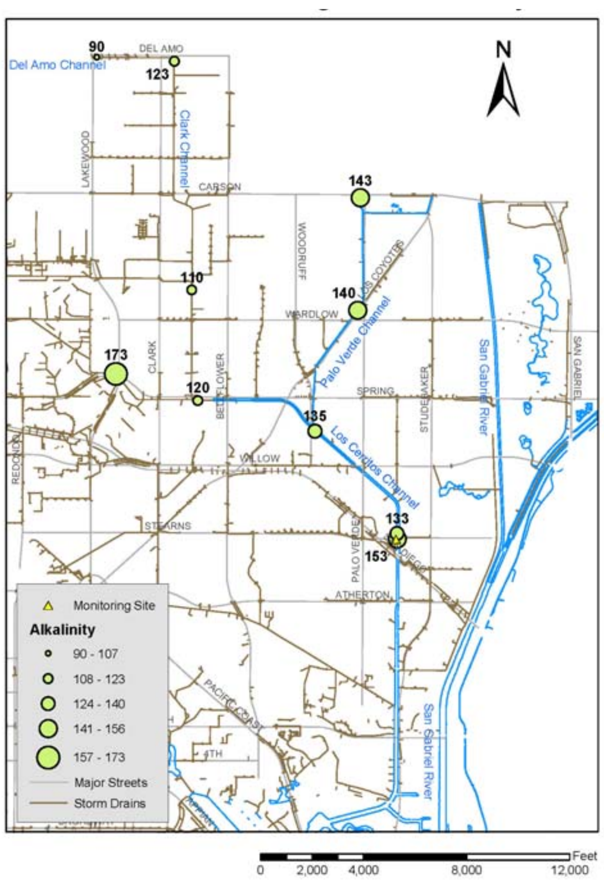


Figure 7. Total Alkalinity measured at each Los Cerritos Channel Watershed Site.

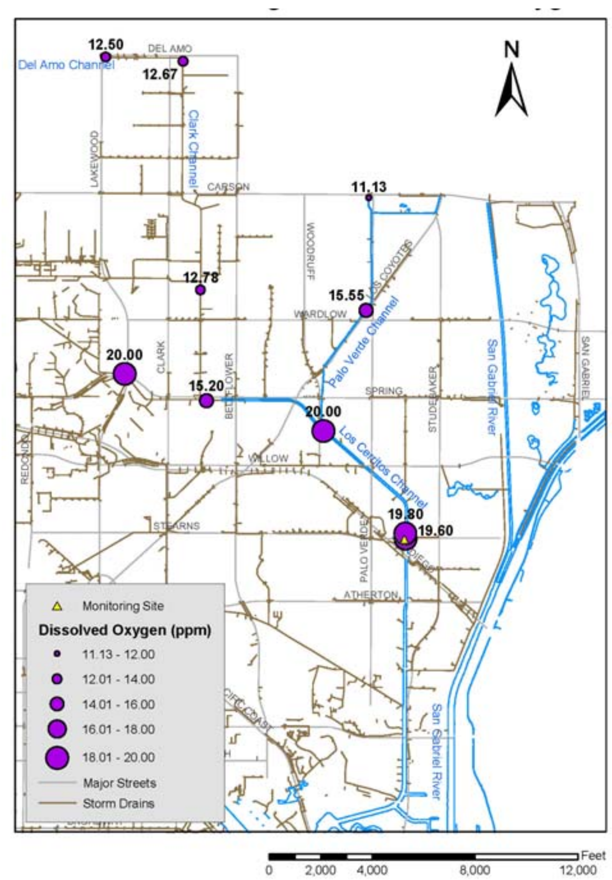


Figure 6. Dissolved Oxygen measured at each Los Cerritos Channel Watershed Site.

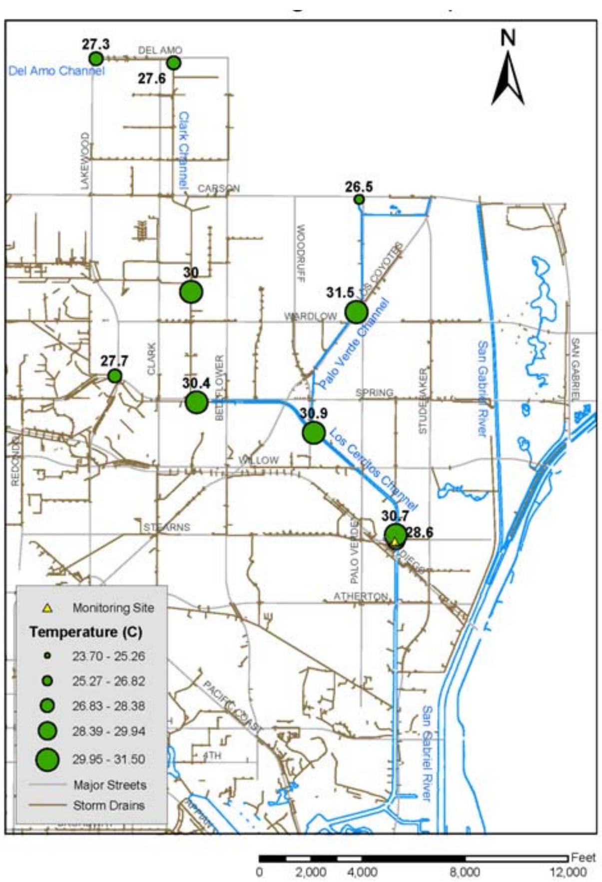


Figure 9. Water Temperature measured at each Los Cerritos Watershed Site.

Figure 8. Dry Weather Flow in the Del Amo Channel showing Typical Dry Season Algal Growth found in Open Channels with Consistent Low Flows.

Table 1. Sampling Locations in the Los Cerritos Channel Watershed

Site Name	Site Description	Latitude[1]	Longitude
CC1-A	Los Cerritos Channel Below Stearns St. bridge	33.79544	118.10352
CC1-B	Los Cerritos Channel at first outfall upstream of Stearns	33.79601	118.10356
CC2-A	Los Cerritos Channel below confluence with Palo Verde Channel	33.80695	118.11408
PV-MOUTH	Palo Verde Channel above confluence with Los Cerritos Channel	33.81070	118.11408
PV-A	Palo Verde Channel west of Palo Verde Ave. and Los Coyotes Diagonal	33.81987	118.10862
PV-B	Palo Verde Channel south of Carson St.	33.83192	118.10832
CC3-A	Los Cerritos Channel below confluence w/ Clark Channel	33.81020	118.12907
CLARK-A	Clark Channel below Monlaco Rd.	33.82201	118.12982
CLARK-OUTFALL	39-inch outfall (106+25) into Clark Channel under the Conant St. bridge	33.82509	118.12982
CLARK-B	Clark Channel south of Del Amo Blvd. Below the confluence of the Clark and Del Amo Channels	33.84647	118.13210
DA-A	Del Amo Channel east of Lakewood Ave.	33.84690	118.14201
CC4-A	Los Cerritos Channel west of Lakewood Ave., north of Spring St.	33.81301	118.13953

1. All positions based upon NAD 1983 datum

Table 2. Summary of the Results of the Upstream Investigation in the Los Cerritos Channel Watershed.

Site Name	Arrival Time	Temp °C	pH	DO mg/L	Salinity (ppt)	Flow (cfs)	Alkalinity (mg/L)			
							Bicarbonate	Carbonate	Hydroxide	Total Alkalinity
CC1-A	8:45	23.8	8.93	15.25	0.5	2.06				
CC1-A	11:46	28.6	9.50	19.60	0.4	2.06	95.0	45.0	< 5.0	153
CC1-B	12:16	30.7	9.83	19.80	0.4	2.06	52.0	54.0	< 5.0	133
CC2-A	12:46	30.9	9.45	>20	0.4	4.29	49.0	57.0	< 5.0	135
PV-MOUTH	12:50					1.63				
PV-A	13:21	31.5	10.75	15.55	0.5	1.69	< 5.0	60.0	14.0	140
PV-B	14:00	26.5	10.30	11.13	0.4	1.40	< 5.0	84.0	< 5.0	143
CC3-A	15:35	30.4	10.55	15.20	0.4	1.65	< 5.0	69.0	< 5.0	120
CLARK-A	15:54	30.0	10.63	12.78	0.8	1.37	< 5.0	57.0	5.1	110
CLARK-OUTFALL	16:21	23.7	8.17							
CLARK-B	16:40	27.6	9.66	12.67	0.4	0.29	34.0	51.0	< 5.0	123
DA-A	17:00	27.3	10.60	12.50	0.4	0.25	< 5.0	51.0	< 5.0	90
CC4-A	17:45	27.7	10.90	>20	0.4	0.00	< 5.0	87.0	9.0	173