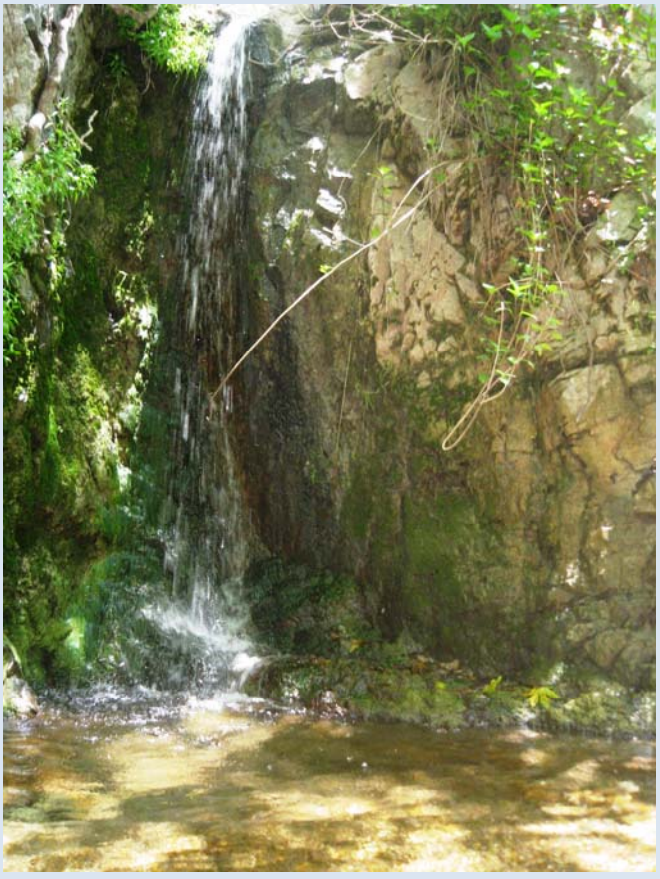
Los Angeles River Watershed Monitoring Program Annual Report – 2008



Los Angeles River Watershed Monitoring Program Work Group

LOS ANGELES RIVER WATERSHED MONITORING PROGRAM

ANNUAL REPORT ON MONITORING ACTIVITIES FOR 2008

AND

SUMMARY OF 2005 SWAMP WATERSHED SURVEY

The Los Angeles and San Gabriel Rivers Watershed Council
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Los Angeles, CA 90012

August 2009

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Executive Summary

This report presents the summary and analysis of data collected during the first year of monitoring in 2008 in the Los Angeles River Watershed. The Los Angeles River Watershed Monitoring Program (LARWMP) is a new watershed-scale regional monitoring effort by stakeholders with responsibilities and interests in the watershed. This is the first in a series of annual summary reports leading to a more comprehensive State of the Los Angeles River Watershed report that will be generated following the fifth year of monitoring in 2012. This and subsequent annual reports are intended to describe the year's monitoring activities and to answer five specific questions of interest to a broad range of stakeholders in the watershed:

1. What is the condition of streams in the watershed?
2. Are conditions at areas of unique interest getting better or worse?
3. Are receiving waters near discharges meeting water quality objectives?
4. Is it safe to swim?
5. Are locally caught fish safe to eat?

Sampling in 2008 focused only on Questions 1, 2, and 3 as the complete program is being phased in over a two-year period. This phased implementation will allow for finalizing funding and contracting arrangements required for full implementation. The complete monitoring program, addressing all five management questions, will be fully implemented during 2009. The program combines both randomized and targeted, or fixed, sampling in order to answer questions at the appropriate spatial scale and to provide a broader context for interpreting data from fixed stations. Table 1 summarizes the overall program design and Figure 1 shows the distribution of monitoring sites sampled during 2008.

In addition to analysis of data collected by the LARWMP during 2008, this report analyzes data collected by the State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP) during 2005. Because the SWAMP study design was based on a combination of randomized and targeted sites and measured a similar set of indicators, this provided an opportunity to broaden the scope of this initial evaluation of watershed conditions.

Monitoring results are presented in three levels of detail. The main body of the report summarizes the findings and presents representative data analyses that support these findings. The appendices include additional data analysis results not included in the main body of the report. Raw data are archived on the website of the Los Angeles and San Gabriel Rivers Watershed Council (www.lasgrwc.org) and are available from SWAMP on request. Data summarized in this report were collected in accordance with Quality Assurance Project Plans (QAPP) that describe field sampling and laboratory analysis methods for each participating entity. A QAPP for the LARWMP will be developed by the program's contractor for 2009.

The data and findings in this first annual report are preliminary in some respects, because of standardization and quality assurance and quality control (QA/QC) issues that are still being resolved. Future annual reports will build on the analyses presented here and include additional analyses as needed. Nevertheless, a number of results are apparent from the first year's data. These results will be re-evaluated and expanded upon in coming years. These include:

- There are clear differences among the major subregions of the watershed, both in terms of chemistry and biology.
- There was little or no toxicity observed during the study.

- For most metals, dissolved concentrations were highest in the effluent and urban runoff dominated portions of the watershed. The total concentration for several metals was highest in the natural portions of the watershed. These metals were primarily earth metals derived from natural sources.
- Nutrient values were highest in the effluent dominated portion of the watershed; however, nutrient patterns are biased somewhat by the fact that data from the 2005 SWAMP survey were collected prior to the implementation of denitrification at inland water reclamation plants in the watershed.
- Pesticide values at the SWAMP targeted sites were, with few exceptions, below detection limits.
- IBI scores, which indicate stream habitat quality, from all sites in the developed portions of the watershed were substantially lower than those in the natural portion of the watershed. These differences were apparently due primarily to differences in habitat, since toxicity was generally low throughout the watershed.
- The variety of data collected at the random sites (invertebrates, aquatic chemistry, aquatic toxicity, physical habitat) provides an opportunity for investigating the factors most responsible for maintaining or degrading stream condition. This report presented a very preliminary step toward such an analysis and this will be expanded in future reports as more data become available.
- The chemistry sample from the estuary showed elevated levels of metals and many pesticides in sediments; however both aquatic and sediment toxicity at this site was low.

The first year results clearly demonstrate the value of combining randomized watershed scale sampling with both targeted sampling at sites of unique interest and permit-mandated monitoring of discharge impacts. The ability to compare data from fixed sites to the overall watershed condition provides valuable context, as some of the above findings illustrate. In addition, the randomized design provides the ability to draw conclusions about the relative status of the watershed as a whole. The variety of data collected by the LARWMP (invertebrates, aquatic chemistry, aquatic toxicity, physical habitat) will provide a basis for investigating the factors most responsible for maintaining or degrading stream condition. This will allow managers to begin addressing pollutant sources, their impacts, and trends in water quality and aquatic resource condition at a watershed scale and to prioritize problems and management actions based on more comprehensive information.

Table 1. Proposed monitoring design for the Los Angeles River Watershed Monitoring Program (LARWMP). Portions of the program implemented during the first year of sampling (2008) are highlighted. Changes to routine compliance monitoring (Question 3) will be implemented during 2009.

Question	Approach	Sites	Indicators	Frequency
Q1: What is the condition of streams?	Randomized design for streams in entire watershed, except 1st and 2nd order[1] streams Streams assigned to natural, effluent dominated, urban runoff dominated subpopulations	10 in Year 1 10 randomly selected in each following year	Triad: bioassessment, water chemistry, toxicity	Annually, in spring
Q2: What is the trend of condition at unique areas?	Fixed stations in estuary and freshwater	12 (approx) in freshwater • 6 (approx) high[2] value • 4 confluence of tribs/mainstem • 1 or 2 background 1 in estuary	Freshwater: • Riparian habitat using CRAM • Triad: bioassessment, water chemistry, toxicity • Riparian habitat using CRAM Estuary: • Conventional water quality • Full suite water quality • Sediment chemistry, toxicity, infauna	 Annually, in spring Annually, in spring Annually, in spring Not determined Annually Annually
Q3: Are receiving waters near discharges meeting objectives?	Improve coordination Improve efficiency Reduce overlap	Remove 18 sites, move 3 sites	Drop water column chlorophyll a Use only *E. coli* for as bacterial indicator Renumber stations to remove duplicate names	
Q4: Is it safe to swim?	Focus on high-use areas	6 – 10 in river 9 sentinel 15 beach	*E. coli* Total & fecal coliforms, *Enterococcus*	Weekly in swim season Weekly year round
Q5: Is it safe to eat locally caught fish?	2-yr pilot study Focus on: • Popular fishing sites • Commonly caught species • High-risk chemicals	3 lakes 2 river 1 estuary	Commonly caught fish at each location Mercury, DDTs, PCBs,	Annually in summer

[1] Stream order is defined by a tributary's position in the branching network, with 1st order streams being headwater streams, 2nd order streams those with one tributary above them, and so on.
[2] High value sites are locations of relatively isolated unique habitat.

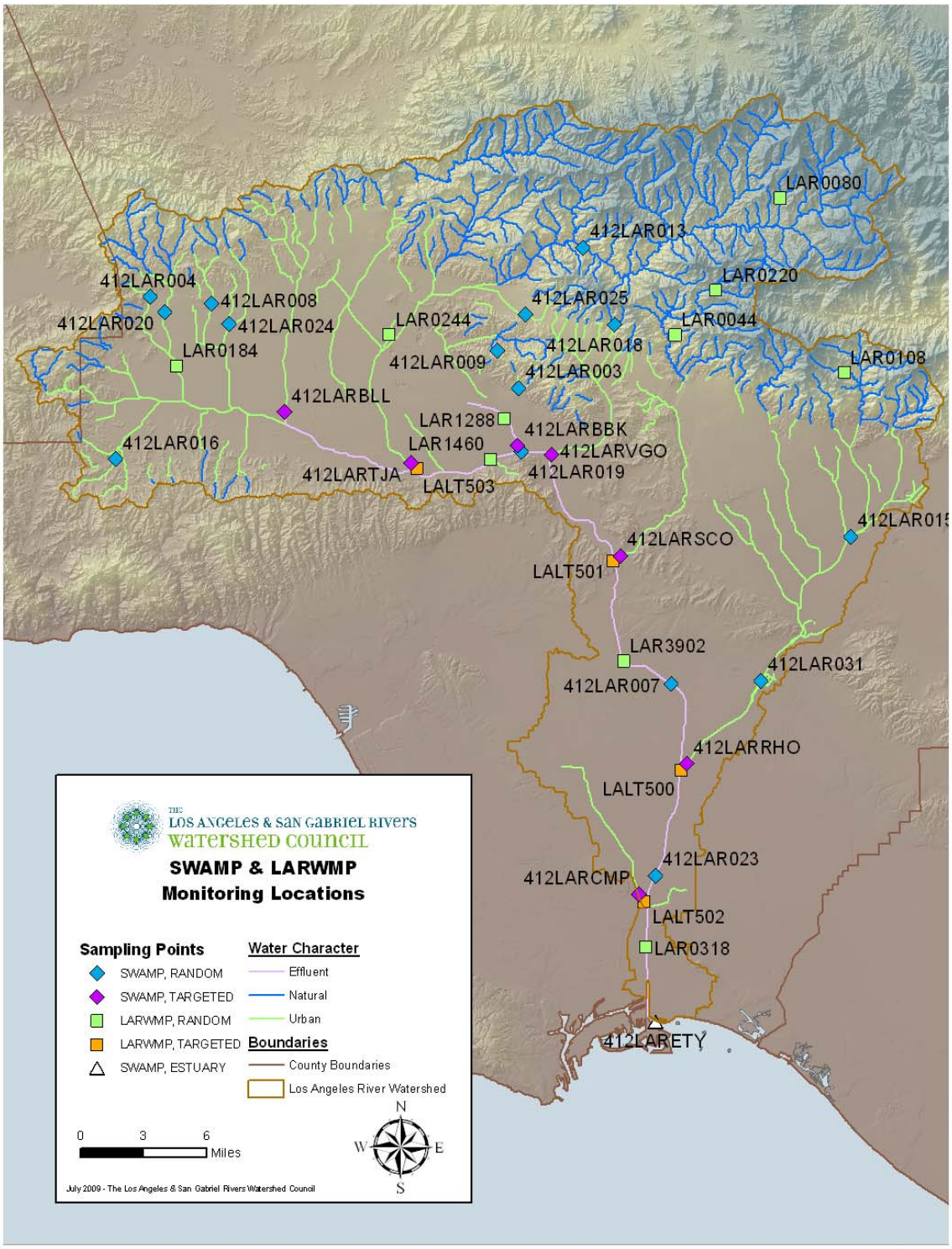

Figure 1. Distribution of random and targeted sites for the SWAMP survey in 2005 and the LARWMP survey in 2008. The estuary was sampled separately as a reconnaissance element of the SWAMP survey. In the caption, “natural” refers to natural areas, “effluent” to effluent dominated streams, and “urban” to urban runoff dominated streams.

Introduction

The Los Angeles River Watershed Monitoring Program (LARWMP) was developed during 2007 by a group of stakeholders representing major permittees, regulatory and management agencies, and conservation groups. The objectives of the program are to increase awareness of the importance of water-related issues at the watershed scale and to improve the coordination and integration of monitoring efforts for both compliance and ambient conditions. The LARWMP has incorporated some elements of traditional water quality and biological monitoring that focus around discharge points and extended this to cover the entire watershed. The sampling design, which integrates both randomized and targeted sampling at fixed sites, provides the ability to track trends at these fixed sites and evaluate them in the context of conditions in the watershed as a whole (random sites). The program thus expands monitoring beyond the traditional focus on individual discharge points. In the future, the LARWMP will include monitoring directed at questions related to swimming safety and seafood consumption that previously received little systematic attention within the watershed.

This report is the first of a series of annual reports, leading up to a more comprehensive State of the Los Angeles River Watershed report analyzing five years of monitoring data in 2012. Annual reports are intended to describe the year's monitoring activities and present highlights of the data summaries and analyses. Data and analyses thus will be delivered in three complementary levels of detail:

- Highlights and principal findings, presented in the main body of the report.
- Complete analysis results for all parameters and sites, presented in appendices to the report.
- Raw data, available on the program's website after the release of each annual report.

As described below, only a portion of the program was conducted in 2008 as part of a phased implementation plan that will see full implementation in 2009. In addition, the data and findings in this first annual report are preliminary in some respects, because of standardization and quality assurance and quality control (QA/QC) issues that are still being resolved. Future annual reports will build on the analyses presented here and include additional analyses as needed.

In addition to the 2008 data collected by the LARWMP, this report also includes data from the 2005 survey of the watershed conducted by the Surface Water Ambient Monitoring Program (SWAMP) which used a similar monitoring design and thus helps to provide a more comprehensive picture of conditions in the watershed. While the independent SWAMP survey has not been repeated, SWAMP resources contributed to the planning and implementation of both the LARWMP and the neighboring San Gabriel River Regional Monitoring Program (SGRRMP).

The following subsections provide background on the regional setting, and the genesis and intent of the LARWMP. A more complete description of the LARWMP motivating questions, its technical design, and its implementation approach can be found in the program document (LASGRWC 2008).

Regional setting

The Los Angeles River watershed is located in the south-central portion of Los Angeles County. It is bounded by the San Gabriel Mountains to the north, and watershed divides with the San Gabriel River to the east. Several smaller Santa Monica Bay and Dominguez Channel watersheds to the south drain into Santa Monica Bay, and the Santa Clara and Calleguas watersheds bound the watershed to the north and west. The Los Angeles River's headwaters originate in the Santa Monica, Santa Susana, Verdugo, and San Gabriel Mountains and the river flows eastward to the northern corner of Griffith Park where the

channel turns southward through the Glendale Narrows before it flows across the coastal plain and into San Pedro Bay near the City of Long Beach. There are eight major tributaries to the river.

The 834 square mile watershed includes approximately 360 square miles of undisturbed riparian, chaparral, and woodland habitats in its northern upper reaches, much of which is in the Angeles National Forest. The mainstem of the river flows through heavily developed commercial and residential areas of the San Fernando Valley in the west and then through developed areas in Los Angeles and the industrial areas serving the Ports of Los Angeles and Long Beach. With few exceptions, much of the river (48 out of 51 miles) is lined with concrete as a flood control measure. The Sepulveda Flood Control Basin, upstream of the Sepulveda Dam in the San Fernando Valley, is a large (3.3 square mile) open space area, which remains mostly undeveloped and is designed to collect flood waters during major storm events. Northwest of downtown Los Angeles, the Glendale Narrows also retains an unlined bottom and provides riparian habitats supported in part by natural springs. In addition to the Sepulveda Dam, there are approximately 50 other man-made flood control and groundwater recharge structures within the watershed.

Tertiary-treated effluent from up to four publicly-owned treatment works (Las Virgenes Municipal Water District's Tapia Wastewater Treatment Plant rarely discharges to the Los Angeles River watershed) enters the river along the mainstem, along with discharges from an additional 130 National Pollutant Discharge Elimination System (NPDES) permittees. In addition, the watershed is covered under one NPDES municipal separate stormwater sewer system (MS4) permit for Los Angeles County. The current dry weather flow in the river is effluent-dominated with approximately 80 percent of its flow originating at dischargers and the remaining flow coming from urban runoff and springs. Several reaches within the Los Angeles River watershed have impaired water quality. These reaches are located primarily in the middle and lower portions of the basin.

More details can be found on the website of the Los Angeles Regional Water Quality Control Board at: http://www.waterboards.ca.gov/losangeles/water_issues/programs/regional_program/wmi/ws_losangeles.shtml.

Background

As in many urban watersheds, monitoring in the Los Angeles River watershed has been largely uncoordinated and unbalanced, with several agencies independently collecting data from a defined portion of the watershed, mostly around discharges for permit compliance purposes, while much of the watershed was unmonitored (LASGRWC 2007a). The lack of coordination among programs has historically resulted in limited data comparability, redundancies between monitoring programs, and key data gaps. Realization of these deficiencies led to the development of a coordinated watershed monitoring program that integrates permit-mandated and ambient monitoring. The LARWMP was developed by a multi-stakeholder workgroup during 2007 and 2008 to provide a framework for monitoring at the watershed scale. The program accomplishes this by expanding monitoring of ambient conditions, improving coordination and cost-effectiveness of disparate monitoring efforts, and providing a framework for periodic and comprehensive assessments of watershed conditions (LASGRWC 2008).

The development of the monitoring design brought together watershed stakeholders comprising representatives from state and federal regulatory agencies, key permittees in the watershed, other resource management agencies, non-profit organizations and citizen monitoring groups. The resulting technical workgroup facilitates ongoing dialogue between stakeholders with regard to monitoring, assessment, and regulatory issues as they relate to the ongoing implementation of the LARWMP.

The first steps in the development of the LARWMP included creating a list of core monitoring questions and assessing the ability of current monitoring efforts in the watershed to answer these questions. The workgroup then recommended monitoring designs to effectively and efficiently answer these questions and achieve multiple objectives. The resulting program (Table 1) is a multi-level monitoring framework that combines probabilistic and targeted sampling for water quality, toxicity, bioassessment, habitat condition, and human health issues.

Portions of the proposed program related to questions about overall watershed condition and about specific areas of concern were implemented in 2008, through a set of cooperative efforts and one-time offsets to permit-mandated monitoring. Features of many of these offsets were included in the long-term program's permanent adjustments to permit-mandated monitoring in the watershed. The present report summarizes the results of the 2008 monitoring effort and provides an initial assessment of current watershed conditions and spatial patterns.

Table 1. Proposed monitoring design for the Los Angeles River Watershed Monitoring Program (LARWMP). Portions of the program implemented during the first year of sampling (2008) are highlighted. Changes to routine compliance monitoring (Question 3) will be implemented during 2009.

Question	Approach	Sites	Indicators	Frequency
Q1: What is the condition of streams?	Randomized design for streams in entire watershed, except 1st and 2nd order[1] streams Streams assigned to natural, effluent dominated, urban runoff dominated subpopulations	10 in Year 1 10 randomly selected in each following year	Triad: bioassessment, water chemistry, toxicity	Annually, in spring
Q2: What is the trend of condition at unique areas?	Fixed stations in estuary and freshwater	12 (approx) in freshwater • 6 (approx) high[2] value • 4 confluence of tribs/mainstem • 1 or 2 background 1 in estuary	Freshwater: • Riparian habitat using CRAM • Triad: bioassessment, water chemistry, toxicity • Riparian habitat using CRAM Estuary: • Conventional water quality • Full suite water quality • Sediment chemistry, toxicity, infauna	 Annually, in spring Annually, in spring Annually, in spring Not determined Annually Annually
Q3: Are receiving waters near discharges meeting objectives?	Improve coordination Improve efficiency Reduce overlap	Remove 18 sites, move 3 sites	Drop water column chlorophyll a Use only *E. coli* for as bacterial indicator Renumber stations to remove duplicate names	
Q4: Is it safe to swim?	Focus on high-use areas	6 – 10 in river 9 sentinel 15 beach	*E. coli* Total & fecal coliforms, *Enterococcus*	Weekly in swim season Weekly year round
Q5: Is it safe to eat locally caught fish?	2-yr pilot study Focus on: • Popular fishing sites • Commonly caught species • High-risk chemicals	3 lakes 2 river 1 estuary	Commonly caught fish at each location Mercury, DDTs, PCBs,	Annually in summer

[1] Stream order is defined by a tributary's position in the branching network, with 1st order streams being headwater streams, 2nd order streams those with one tributary above them, and so on.
[2] High value sites are locations of relatively isolated unique habitat

Program Design

This report presents a combined analysis of data from two programs: a one-time survey conducted by SWAMP in 2005 and a subsequent survey conducted in 2008 by the LARWMP and intended as the first in a series of annual monitoring in the watershed.

LARWMP design

The LARWMP design is intended to address three key shortcomings of the existing, permit-mandated monitoring system that was focused primarily around point sources. These included:

- The concentration of monitoring efforts in a few portions of the watershed, with virtually no monitoring of conditions in the upper watershed,
- An emphasis on point source impacts, in particular on the mainstem river, with little or no assessment of conditions at other locations, and
- A relative lack of attention to ambient conditions in general and to human health issues, specifically fish consumption and body contact recreation in popular swimming areas.

The development of a monitoring program that addresses these shortcomings was driven by a three-part monitoring philosophy:

- Monitoring should be question-driven and prioritized to benefit managers, residents of the watershed, and other stakeholders.
- Monitoring should be adaptive and should be focused where risks appear highest.
- The design should be built around a three-part framework that includes
  - Regional or watershed scale assessment of ambient conditions,
  - Site-specific monitoring of locations of special concern, and
  - Special studies to address issues not requiring long-term monitoring.

The LARWMP is designed to address five core management questions:

1. What is the condition of streams in the watershed?
2. Are conditions at areas of unique interest getting better or worse?
3. Are receiving waters near discharges meeting water quality objectives?
4. Is it safe to swim?
5. Are locally caught fish safe to eat?

An evaluation of the design of existing monitoring programs, and the information they currently produce (LASGRWC 2007a), demonstrated that only Question 3 was being answered with any degree of completeness. For example, there were insufficient monitoring sites in the upper watershed to answer Question 1 (condition of streams). Nor was there routine monitoring of bacterial indicators needed for answering Question 4 (swimming safety) in popular swimming areas, which are typically well away from the discharges where permit-mandated monitoring has traditionally occurred.

The overall program design addresses each of the five core management questions in turn, providing the rationale for the recommended design approach, selection of indicators and monitoring frequency, appropriate data products, and coordination with other efforts, as well as a preliminary estimate of costs. The monitoring is focused on collecting data to assist in decision making. The monitoring design is also intended to be adaptive in terms of its ability to both trigger follow-on studies as needed and make

necessary mid-course corrections based on monitoring findings. The program design is summarized briefly in Table 1 and the detailed list of constituents measured for aquatic chemistry is provided in Appendix 1. The current version of the full program document (LASGRWC 2008), and the companion report *Summary of Existing Monitoring Programs in the Los Angeles River Watershed* (LASGRWC 2007a), may be obtained from the Los Angeles and San Gabriel Rivers Watershed Council.[1]

The design of the regional monitoring program is based on clear statements of rationale and criteria for decision making about design options. The regional monitoring program also reflects a high degree of consensus among a broadly representative group of stakeholders in the watershed. It represents a significant advance towards regional integration of monitoring efforts and assessment of watershed condition. It is important to recognize, however, that while the program will enhance the ability to assess the status of some beneficial uses, it will not provide the means, across the entire watershed, for fully determining compliance with water quality objectives, defining impairment, or meeting the requirements of the 303(d) listing/delisting process. Such purposes require more spatially and temporally intensive sampling efforts that are fulfilled by only some of the components of the regional monitoring program.

The regional monitoring design can be seen as a watershed-scale counterpart to existing larger-scale regional monitoring efforts that attempt to address questions and concerns about regional condition and trends, and is designed to complement and/or coordinate with these programs, for example the state Surface Water Ambient Monitoring Program (SWAMP), U.S. EPA Western Environmental Monitoring and Assessment Program (EMAP), and the Stormwater Monitoring Coalition regional perennial streams survey. This includes both the coordination of sampling effort and the use of consistent field sampling and laboratory analysis methods. In addition, the proposed program uses tools developed by the California Department of Fish and Game and the Southern California Wetlands Recovery Project for the regional assessment of biologic conditions in streams and channels, as well as monitoring design approaches developed by the Stormwater Monitoring Coalition's model stormwater monitoring program (SCCWRP 2004).

In addition to these broader goals, this effort considered improving the overall cost effectiveness of monitoring efforts in the watershed. To this end, a number of recommendations were presented to reduce redundancies within and between programs, target constituent lists more directly on contaminants of concern, and adjust monitoring locations and sampling frequencies to better respond to management priorities. Efficiencies achieved by making adjustments to existing permit-mandated monitoring programs have been used to offset costs of additional components of the program. Ongoing implementation of the LARWMP is managed by the Los Angeles and San Gabriel Rivers Watershed Council with continued oversight by the technical workgroup that includes broad stakeholder participation.

SWAMP design

The 2005 SWAMP survey in the Los Angeles and San Gabriel River watersheds was part of an effort to conduct comprehensive monitoring of conditions in perennial streams throughout the state, using standardized sampling and assessment methods.[2] While the SWAMP survey in these watersheds has not been repeated independently, SWAMP resources have contributed to the program planning and the initial sampling efforts for the recently implemented regional watershed monitoring programs in the San Gabriel River and Los Angeles River watersheds (SGRRMP and LARWMP, respectively).

[1] http://www.lasgrwc.org/programsandprojects/larwmp.aspx
[2] (see the SWAMP website for detailed methods descriptions: http://www.waterboards.ca.gov/water_issues/programs/swamp/.

The SWAMP monitoring design is similar to that used by the LARWMP in 2008. It included a random component of 15 stations spread throughout the watershed, and a targeted component of seven stations focused on areas of particular concern because of their higher potential for contamination. The triad of bioassessment, aquatic chemistry, and aquatic toxicity was conducted at both sets of stations, although the suite of chemical constituents sampled differed at the random and targeted sites (Appendix 1). For example, chemical analyses at the targeted sites focused more intensively on pesticides.

Monitoring Effort

While the LARWMP's design includes monitoring to address all five core questions, the first year monitoring effort addressed only Questions 1 – 3. This resulted from the decision to phase in full implementation over a two-year period to allow for finalizing funding and contracting arrangements. Consequently, monitoring during 2008, the startup year, was based on adjustments to existing efforts and one-time offsets that allowed for shifting monitoring effort to the watershed program. Figure 1 shows the distribution of sites sampled during 2008 and Table 2 shows the division of field monitoring and laboratory analysis responsibilities among the several organizations participating in the first year's effort.

Table 1 summarizes the categories of indicators designed to answer each monitoring question. Those measured during the 2008 monitoring effort are highlighted. A more complete listing and description of these parameters is presented in LARWMP (2007a) and Appendix 1. It is important to emphasize the preliminary nature of the first year data, as well as the conclusions drawn from them. Chemistry analyses were performed at two laboratories, and, while both laboratories have participated in intercalibration studies for metals and nutrients, a full evaluation of QA/QC issues will not be conducted until the program is fully implemented in 2009. Some apparent differences between sites may therefore be due to inherent differences between the laboratories conducting the chemical analyses. In addition, both the fieldwork and the laboratory processing of macroinvertebrate samples for the bioassessment portion of the program were performed by two parties. While they both used a standard protocol, there may be differences in the way this protocol was applied. This potential source of variability has not yet been evaluated. While combining the LARWMP data from 2008 with the SWAMP data from 2005 expands the spatial coverage, it also introduces another potential source of variability in the data. Finally, the data represent a relatively short span of conditions across a large and diverse watershed. The patterns described in this report should therefore be considered as a first attempt at describing watershed-scale patterns that provide a basis for data analyses in subsequent years.

Table 2. Distribution of sampling and laboratory analysis responsibilities among the collaborating partners during 2008.

SPRING/SUMMER 2008 SAMPLING		*Chemistry*			*Benthos*			*Toxicity*		
Targeted Samples	**Site ID**	**sampling**	**lab analysis**	**funding**	**sampling**	**lab analysis**	**funding**	**sampling**	**lab analysis**	**funding**
Confluence Rio Hondo and mainstem of LA River	LALT500	Weston	CRG	LACDWP	Weston	Weston	LACDWP	Weston	Weston	LACDWP
Confluence Arroyo Seco and mainstem of LA River	LALT501	Weston	CRG	LACDWP	Weston	Weston	LACDWP	Weston	Weston	LACDWP
Confluence Compton Creek and mainstem of LA River	LALT502	Weston	CRG	LACDWP	Weston	Weston	LACDWP	Weston	Weston	LACDWP
Confluence Tujunga Creek and mainstem of LA River	LALT503	Weston	CRG	LACDWP	Weston	Weston	LACDWP	Weston	Weston	LACDWP
Random Samples (10)										
Unnamed: Natural	LAR0044	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities
Unnamed: Natural	LAR0080	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities
Winter Creek: Natural	LAR0108	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities
Arroyo Seco: Natural	LAR0220	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities
Los Angeles River: Effluent	LAR0318	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities
Burbank Western Channel Effluent	LAR1288	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities
Los Angeles River: Effluent	LAR1460	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities
Los Angeles River: Effluent	LAR3902	ABC	EMD	Cities	ABC	ABC	Cities	ABC	ABC	Cities
Browns Canyon Wash: Urban	LAR0184	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities
Unnamed: Urban	LAR0244	ABC	EMD	Cities	ABC	ABC	Cities	ABC	ABC	Cities

ABC: Aquatic Bioassay and Consulting Laboratories
Cities: Combined support from Cities of Los Angeles and Burbank
EMD: Environmental Monitoring Division, City of Los Angeles
LACDPW: Los Angeles County Department of Public Works
Weston: Weston Solutions

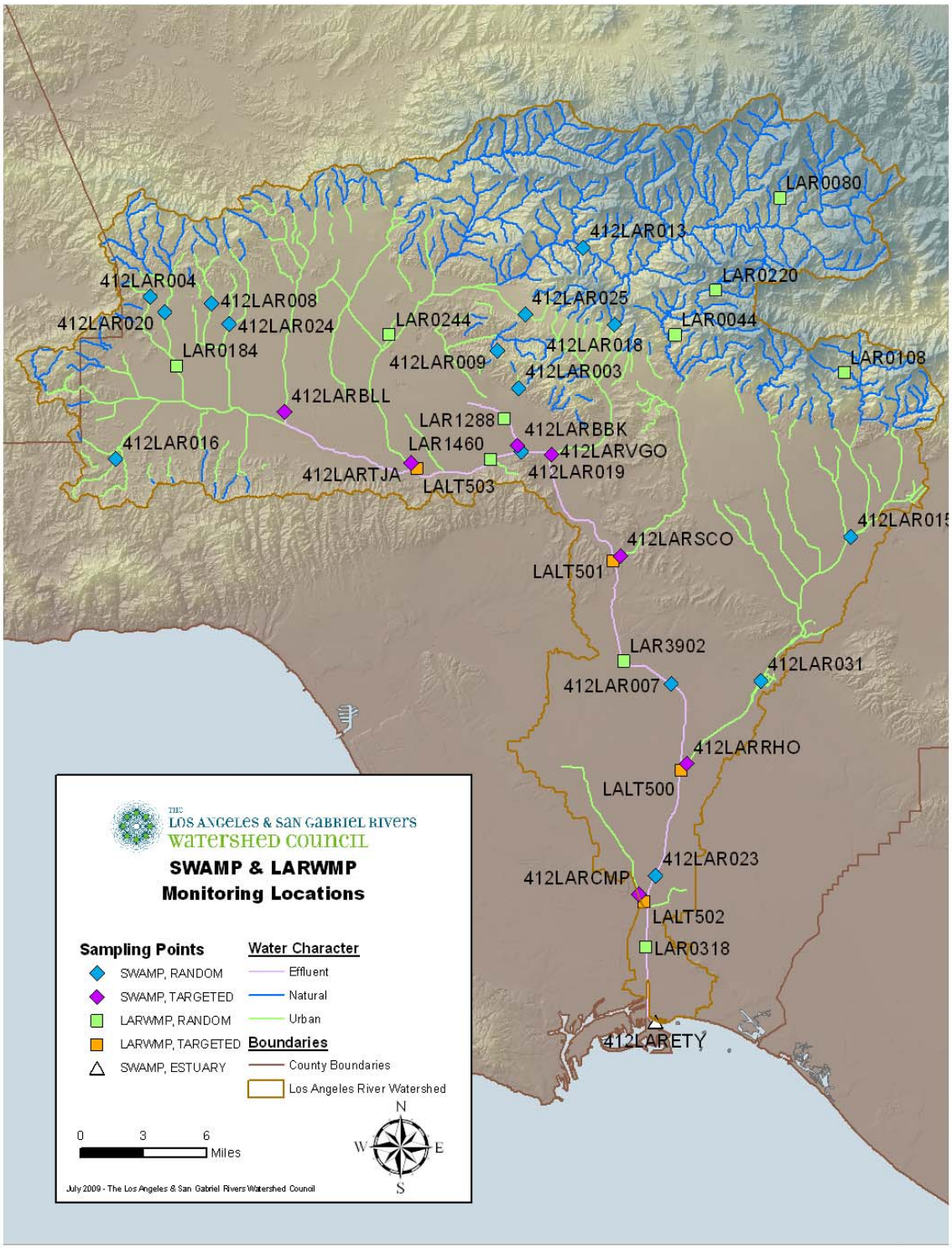

Figure 1. Distribution of random and targeted sites for the SWAMP survey in 2005 and the LARWMP survey in 2008. The estuary was sampled separately as a reconnaissance element of the SWAMP survey. In the caption, “natural” refers to natural areas, “effluent” to effluent dominated streams, and “urban” to urban runoff dominated streams.

Field sampling and laboratory analysis methods in subsequent years will comply with a program Quality Assurance Project Plan (QAPP) similar to that used by the sister program in the neighboring San Gabriel River watershed (LASGRWC 2007b). Because the LARWMP QAPP had not yet been developed, sampling and laboratory analysis methods were based on consensus among participants and the best practices used by individual participants. The following subsections briefly describe methods used during 2008 and include references to reports and other documents with additional detail.

Monitoring of overall stream status for Questions 1 – 3 was based on the triad approach, in which bioassessment (and its associated suite of physical habitat measurements), aquatic toxicity, and water column chemistry data provide a variety of perspectives on ecological conditions at a site. The triad of measurements provides an opportunity to assess whether there are apparent linkages between observed levels of chemicals of concern, toxicity, and/or changes to physical habitat and impacts on the instream community itself. Ten random sites and four targeted sites located at major confluences located throughout the watershed were visited in 2008 (Table 1). Based on land use and other characteristics, streams were assigned to one of three subpopulations: natural, effluent (i.e., Publically Owned Treatment Works (POTW)) dominated, or urban runoff dominated (Figure 1). In general, natural streams were in the upper watershed, effluent dominated streams were located in the mainstem and the lower reaches of some tributaries, and urban runoff dominated streams were the developed portions of tributaries. NPDES receiving water data collected by the City of Los Angeles for its Tillman and Glendale Water Reclamation Plants were used to assess question 3, "Are receiving waters near discharges meeting water quality objectives?" These monitoring sites focused on POTW discharges and were thus all in the effluent dominated portion of the watershed.

Bioassessment, a measure of the structure of one or more components of the instream biological community, provides a direct measure of the ecological status of instream benthic macroinvertebrate (BMIs) communities. The field protocols and assessment procedures followed the Surface Water Ambient Monitoring Program, which have been adjusted somewhat between 2005 and 2008, with the most current version described in SWAMP (2007). BMIs collected from each site were identified to Level II as specified by the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) (Richards and Rogers 2006). From the BMI data, biological metrics including diversity, average tolerance scores, functional feeding groups and others were calculated. From these metrics, the multi-metric Southern California IBI was calculated for each site (Ode, et al., 2005). The IBI score derived for each site allows the biological community found there to be compared against reference site conditions in southern California. IBI Scores below 40 (on a scale of 100) represent "poor" conditions and those 40 and above represent sites where biological community conditions are similar to reference site conditions in the region.

Physical habitat conditions were assessed inconsistently and, as a result, these data were of only limited utility in the present analysis. The 2005 SWAMP survey used a method originally developed by the USEPA and modified by SWAMP for use in California. This method focuses on the habitat conditions found in the streambed and banks. However, these data were not readily available. In the 2008 LARWMP survey, an updated (as of 2007) version of the SWAMP physical habitat protocol was used at both random and targeted sites. A method for summarizing these data that would allow for comparison of overall habitat conditions across sites is not yet available, however. A related method, the California Rapid Assessment Method (CRAM), focuses on both instream and riparian habitat, and does have a method for deriving site scores. While this method is envisioned to be a routine part of the LARWMP in future years, budget constraints in this first year prevented collection of the data needed for the CRAM protocol. As a result, only a few basic physical habitat parameters were evaluated as part of this year's analyses.

Aquatic toxicity bioassays provided another measure of potential impact; although the use of test organisms in the laboratory makes bioassays a less direct indicator of site-specific impacts than the bioassessment leg of the triad. However, aquatic toxicity bioassay tests can furnish a more direct measure of potential impacts from chemical contaminants. During 2008 the water flea (*Ceriodaphnia dubia*) survival test was used at each freshwater site.

Water chemistry was sampled at all sites although the list of constituents differed somewhat depending on the specific goals of each program component. Appendix 1 lists the chemistry parameters monitored for each of the three components addressed during 2008.

The 2005 SWAMP survey used an earlier version of these methods for bioassessment, physical habitat measures, and toxicity testing.[3] The constituents sampled for water chemistry differed somewhat from those sampled by the LARWMP. In addition, the SWAMP 2005 survey focused much greater attention on chemical constituents at its seven targeted sites than at the ten random sites. Appendix 1 lists all chemistry parameters monitored by both components of SWAMP's stream surveys.

In addition to stream sampling, the 2005 SWAMP survey included one site in the Los Angeles river estuary.

[3] http://mpsl.mlml.calstate.edu/swsops.htm.

Data Summary and Analysis

The following sections present highlights of the data from the LARWMP first year of monitoring, combined with the results of SWAMP 2005 survey in the watershed. As described in the Introduction, the following sections of the report focus on highlights and principal findings, with the full set of analysis results for all parameters and all sites contained in the report appendices. Raw data for the 2008 survey will be available on the program website after the release of the report. SWAMP data are available from the Water Boards program website.[4]

The monitoring and analysis during the LARWMP first year focused on Questions 1 – 3:

1. What is the condition of streams in the watershed?
2. Are conditions at areas of unique interest getting better or worse?
3. Are receiving waters near discharges meeting water quality objectives?

The data presentation and analysis methods for addressing these questions combine the following:

- Basic watershed description, illustrating spatial and temporal patterns, and including comparisons between sub-regions of the watershed
- Placing the unique areas of interest (targeted sites) and the permit-mandated monitoring sites into the larger context created by the overall watershed description
- Integrative analyses that examine the relationships between different data types

This general framework will provide a basis for the analysis of subsequent years monitoring data, although findings and conclusions based on the first year's data are preliminary. Within the general analysis framework, specific types of analyses may be added or subtracted each year in order to adapt the program to shifting information needs and to the improving knowledge of the watershed.

Methodological note

The following sections use two data summarization methods that may require some explanation. The first is the cumulative frequency distribution (Figures 6 – 8) used to illustrate the distribution of values for various indicators. In these figures, the curve begins at 0% and rises to 100%. The curve is generated by adding the additional percentage of values that occur in each interval, moving from left to right along the x-axis. The second is the box and whisker plots (Figure 9) used to show the median and range of different indicators, as in the example below (Figure 2):

[4] http://www.waterboards.ca.gov/water_issues/programs/swamp/.

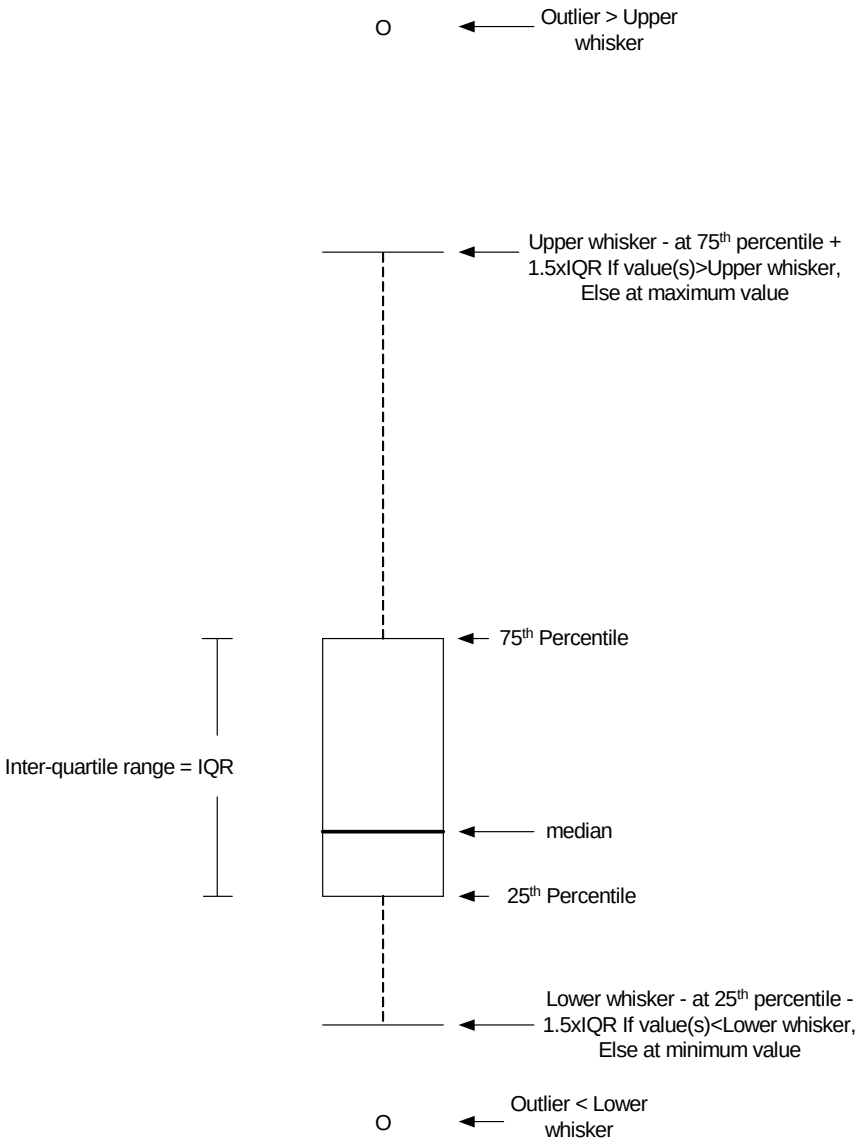

Figure 2. Box and Whisker Plot

Values below detection limit were reported in a variety of ways by the different laboratories that analyzed aquatic and sediment chemistry samples. These values were standardized in the dataset available on the Watershed Council's website. Values below the detection limit are reported as the detection limit and flagged with a minus sign. All means in this report (e.g., bar charts and appendix tables) were calculated using the detection limit as the default value.

Differences in sampling patterns between the 2005 SWAMP survey and the 2008 LARWMP survey led to a few artifacts in the data summaries. For example, Appendix 2 includes a few instances where the value for the dissolved fraction of a constituent is larger than the value for the total. This results from the fact that the SWAMP survey did not measure total and dissolved fractions at all stations; consequently means for dissolved and total fractions were not always calculated from the same sets of samples.

Question 1: What is the condition of streams in the watershed?

Question 1 is addressed with data collected from the 25 random sites (15 SWAMP sites from 2005 and 10 LARWMP sites from 2008), which were intended to provide information about the watershed as a whole (Figure 1). Streams in the watershed were divided into three general subpopulations to ensure adequate distribution of sites throughout the watershed: natural streams in the upper reaches of both the mainstem and tributaries; effluent dominated reaches in the mainstem and the lower portions of some estuaries, and urban runoff dominated reaches of tributaries flowing through developed portions of the watershed (Figure 1).

The following sections present information on the aquatic chemical, toxicological, and biological (stream invertebrates) characteristics of the stream segments, along with preliminary conclusions about the potential relationships among these three aspects of overall condition. The complete set of summary data tables and graphs used to make these assessments are presented in the appendices.

Aquatic chemistry

Comparison of chemical constituent concentrations from the three subpopulations of random sites from the 2005 and 2008 surveys suggests differences in water chemistry based on watershed position. For virtually all constituents sampled, the lowest concentrations were found in natural conditions in the upper watershed (Figure 3, Appendix 3). For nutrients, the highest levels were found in effluent dominated portions of the watershed, as shown in the representative pattern for total nitrogen and orthophosphate. Only one nitrite result exceeded the established Basin Plan Objective of 1.0 mg/L-N and this sample was from the 2005 SWAMP survey, conducted before denitrification was implemented at water reclamation plants in the watershed, and at a station (412LAR007) in the effluent domination portion of the watershed (Figure 1). In addition, all nitrogen as nitrate plus nitrite-nitrogen results were well below the Basin Plan Objective of 10 mg/L-N.

For metals (except titanium), the highest levels in the dissolved phase were observed in the urban runoff and effluent dominated sites, as opposed to the natural sites, as shown in the representative pattern for dissolved cadmium, copper, and zinc (Figure 3). The pattern for total metals, however, differed from that seen for dissolved metals. For several metals (aluminum, arsenic, barium, beryllium, chromium, cobalt, iron, lead, manganese, strontium, titanium), levels were highest (for total metals) in the natural portion of the watershed (Figure 4, Appendix 3). This may be from a number of potential factors that can be suggested but not thoroughly evaluated without additional data. For example, earth metals (e.g., aluminum) that are not generally associated with anthropogenic sources would be expected to be more prevalent in the undeveloped portion of the watershed. In addition, the relative distribution of metals between dissolved and particulate phases can be driven by the physical characteristics of the water (e.g., pH, temperature), and is also sensitive to the distribution of particle sizes in the samples, which in turn is affected by water velocity. Further comparisons across the watershed areas in the future should take these factors into account before drawing conclusions about their significance or implications for the relative importance of various sources.

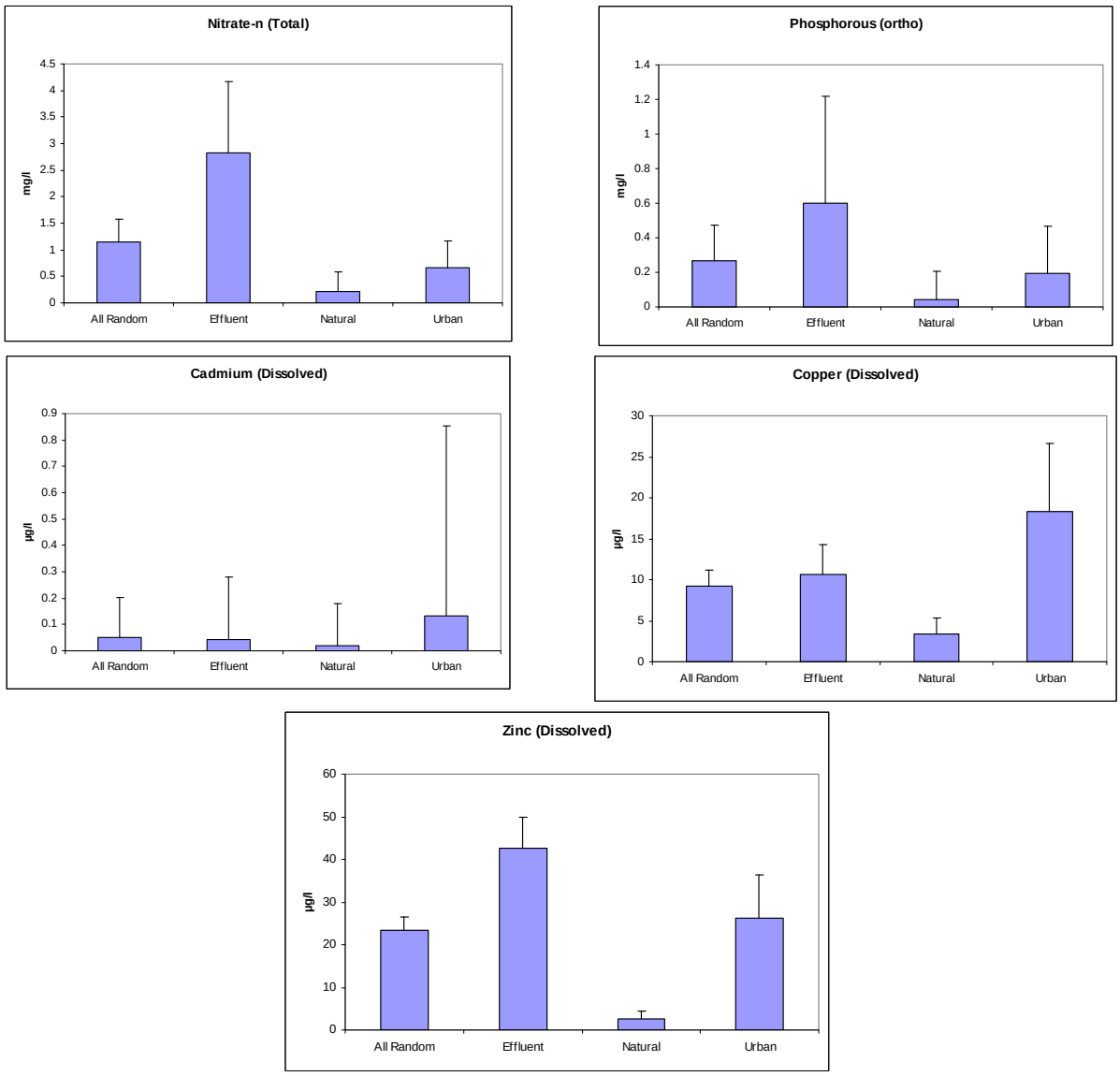

Figure 3. Average (± 95% CI) concentrations of representative constituents measured in each of the three Los Angeles River watershed regions. Note that "Effluent" refers to effluent dominated and "Urban" to urban runoff dominated. Data are from the combined 2005 SWAMP and 2008 LARWMP surveys. Metals data are from 2008 because the SWAMP survey did not sample metals at the random sites (see Appendix 1).

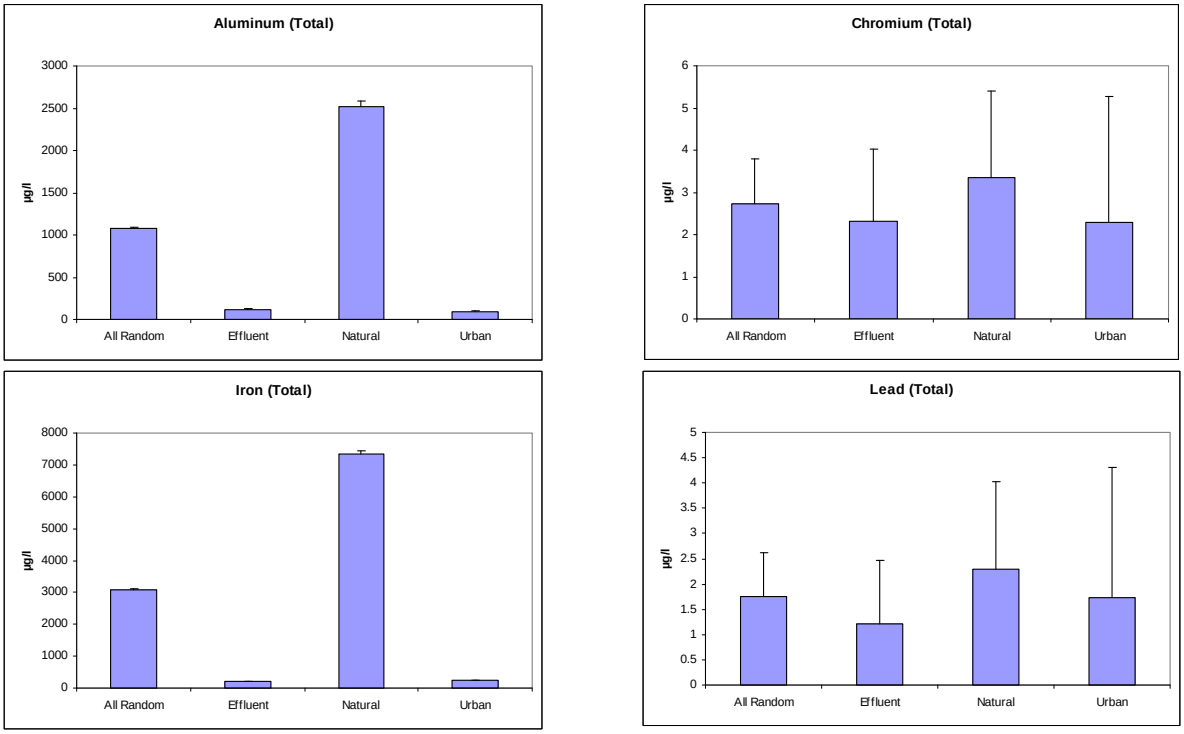

Figure 4. Average (± 95% CI) concentrations of representative metals for which the total concentration is higher in natural streams than in those dominated by urban runoff. Note that "Effluent" refers to effluent dominated and "Urban" to urban runoff dominated. Data are from the combined 2005 SWAMP and 2008 LARWMP surveys. Metals data are from 2008 because the SWAMP survey did not sample metals at the random sites (see Appendix 1).

Conclusions about spatial patterns can be affected by the frequency of measurements that are below the method detection limit (i.e. non-detects). The frequency of non-detects varied by constituent; however, in all cases except for nitrate, the majority of non-detects occurred in the natural portion of the watershed and the least occurred in the area dominated by water reclamation plant effluent (Table 3) (although metals data are not available for the effluent dominated portion of the watershed). Because non-detects were assigned a value equal to the detection limit, the actual values in the bar charts in Figures 3 and 4 and in Appendices 2 and 3, could be slightly lower than those reported. However, other approaches to estimating non-detect levels would not change the relative patterns among the watershed subregions described above.

Table 3. Frequency of non-detects and distribution of non-detect values at the random sites, grouped by watershed position. All metals data are for dissolved metals. Metals data are from 2008 because the SWAMP survey did not sample metals at the random sites.

				% of total ND		
	Max MDL (µg/L)	# ND	% ND	Natural	Effluent	Urban
Ammonia	50	13	52	46%	15%	38%
Nitrate	20	5	20	60%	0%	40%
Ortho Phosphorous	50	4	16	75%	25%	0%
Phosphorous Total	50	1	4	100%	0%	0%
Arsenic	0.2	3	20	100%	0%	0%
Cadmium	0.02	8	80	50%	38%	12%
Chromium	0.09	0	0	0%	0%	0%
Copper	0.08	0	0	0%	0%	0%
Lead	0.11	0	0	0%	0%	0%
Nickel	0.2	0	0	0%	0%	0%
Selenium	0.2	3	30	100%	0%	0%
Zinc	0.4	0	0	0%	0%	0%

The majority of metals observed at the random sites were in the more bioavailable dissolved phase (Table 4). This is consistent with observations of others that during non-storm conditions the dissolved fraction of metals predominates (Stein and Ackerman, 2007). There are some exceptions to this overall pattern at sites in the natural portion of the watershed (Table 4). This may reflect the fact that lower water velocities in the effluent- and urban runoff-dominated portions of the watershed (where elevation gradients are not as steep) more readily allow particulates to settle out, thus increasing the dissolved fraction.

Table 4. Percent dissolved fraction for representative metals in various watershed positions at random sites sampled in 2005 and 2008. Percentages are based on a comparison of the total vs. dissolved metal concentration for all sites combined (Overall) and each of the three watershed regions separately. Therefore, the sums of the individual percentages do not equal 100%. Metals data are from 2008 because SWAMP did not sample metals at random sites in 2005.

	% Dissolved			
	Overall	Natural	Effluent	Urban
Cadmium	93	100	89	88
Copper	75	53	92	86
Lead	41	19	52	60
Nickel	82	66	94	92
Zinc	63	39	84	68

Toxicity

Toxicity was evaluated with the *Ceriodaphnia* acute survival test in both the 2005 SWAMP and 2008 LARWMP surveys, and with the *Pimephales promelas* acute survival test in the 2005 SWAMP survey. Little toxicity was observed during the random assessment, with only two sites (both from the 2005 survey) with a survival rate lower than 80% (Table 5). These were sites 412LAR024 and 412LAR025, both in the urban runoff dominated portion of the watershed, and with *Ceriodaphnia* survival rates of 70% and 20%, respectively. Both sites have very low IBI scores and very low diversity (Figures 5 and 6). Only one species occurred at 412LAR024 and three at 412LAR025. Despite their elevated toxicity, there is nothing in the available chemistry data that distinguishes these two stations. All values for general chemistry and nutrients are near or below the mean values for random stations in the watershed.

Table 5. Summary of acute toxicity at random sites during the 2005 SWAMP and 2008 LARWMP watershed surveys.

Watershed area	*Ceriodaphnia*	*Pimephales promelas*
Natural	95.0	96.0
Effluent dominated	93.6	94.3
Urban runoff dominated	85.9	92.3
All random	90.6	93.4

Other recent studies in the neighboring San Gabriel River watershed indicate that toxicity in the mainstem and lower watershed of that system is rare and sporadic (Schiff, et al., 2006 and Bailey, et al., 1995). These studies also measured the occurrence of low level toxicity in the upper watershed at a level that indicated that water column toxicity in the watershed was rare and sporadic. Identifying the agents responsible for the low levels of toxicity found in the watershed is difficult since the evaluations used to find them require moderate to high levels of persistent toxicity.

Biological Communities

A total of 25 benthic macroinvertebrate samples were collected by the 2005 SWAMP and 2008 LARWMP surveys from random sites located in all three portions of the watershed. These data were explored using several techniques including multimetric and multivariate statistical techniques based on the Triad approach which attempts to relate biological condition to measure of aquatic chemistry, toxicity, and physical habitat.

Southern California IBI

The Southern California Index of Biological Integrity (So CA IBI) is a multimetric index that incorporates seven biological metrics that respond to different environmental stressors; the So CA IBI was developed using data collected from over 200 sites throughout southern California, including both relatively pristine reference sites and sites influenced by human activities (Ode et al. 2005). As a result, the So CA IBI allows benthic assemblages found at annual monitoring sites to be compared against reference conditions. Scores of 40 or below are considered to be impacted, while those greater than 40 are considered to be more like reference conditions (Ode et al. 2005).

For benthic macroinvertebrate data collected in both the 2005 and 2008 surveys, there was a clear demarcation in IBI scores between the natural areas of the watershed and those streams dominated by effluent and urban runoff (Table 6, Figure 5). Several of the sites in the natural portion of the watershed had IBI scores exceeding 40, while all sites in the effluent and urban runoff dominated regions had scores

below 40 and two had scores of 0. Interestingly, one site in the natural portion of the watershed had an IBI score that indicated impacted conditions. This was one of the SWAMP sites sampled in the spring of 2005 following the heaviest rain season in 100 years. It is probable that the macroinvertebrate community at this site was still in the process of becoming reestablished following these storms.

Sites in the effluent and urban runoff dominated areas of the watershed were probably influenced more by physical habitat than by flow conditions or chemical characteristics. All of these sites are located in highly urbanized areas with streambed and riparian zone habitats that typically have been highly altered by dredging, shoring, and channelization.

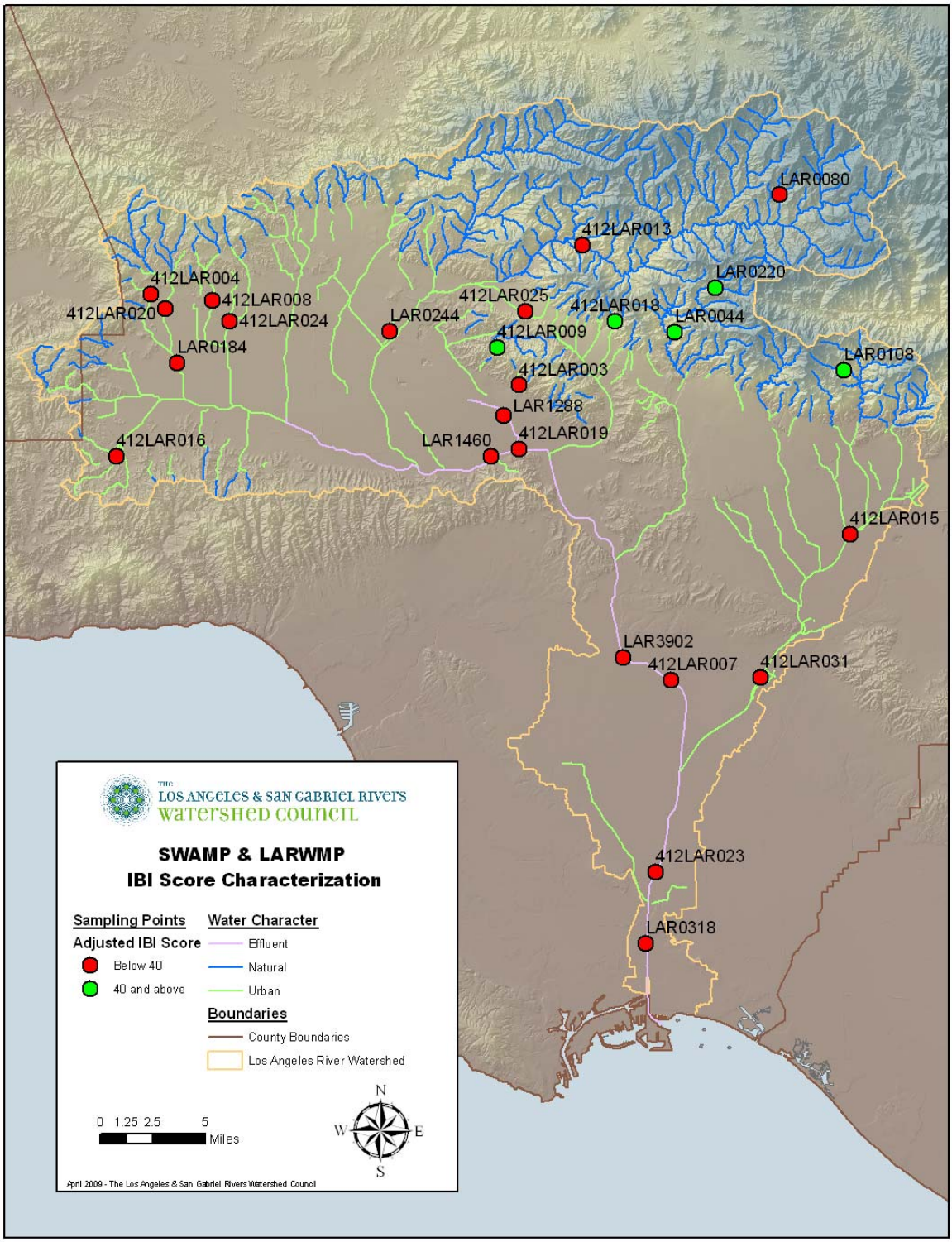

Figure 5. Southern California Index of Biotic Integrity (So CA IBI) scores for each random site in the 2005 SWAMP and 2008 LARWMP surveys. As in Figure 1, "natural" refers to natural areas, "effluent" to effluent dominated streams, and "urban" to urban runoff dominated streams.

Table 6. Southern California Index of Biotic Integrity (So CA IBI) metrics, scores, and ratings for the random watershed sites sampled during the 2005 SWAMP and 2008 LARWMP surveys. Top portion of the table are SWAMP stations and the bottom portion the LARWMP stations.

IBI Metric	412 LAR003	412 LAR004	412 LAR007	412 LAR008	412 LAR009	412 LAR013	412 LAR015	412 LAR016	412 LAR018	412 LAR019	412 LAR020	412 LAR023	412 LAR024	412 LAR025	412 LAR031
EPT Taxa	0	0	0	0	1	0	0	1	4	0	0	0	0	0	0
Predator Taxa	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
Coleoptera Taxa	2	0	0	0	4	0	0	0	4	0	0	0	0	0	0
% Non-Insect Taxa	1	6	0	0	9	4	10	0	8	10	10	0	0	6	0
% Intolerant Individuals	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0
% Tolerant Taxa	0	4	0	3	10	2	10	5	10	2	4	10	10	10	0
% Collector Individuals	0	0	0	0	2	0	0	4	2	0	0	0	0	0	0
Total	3	10	0	3	29	6	20	10	34	12	14	10	10	16	0
Adjusted Total	4.29	14.3	0	4.29	41.47	8.58	28.6	14.3	48.62	17.16	20.02	14.3	14.3	22.88	0
Rating	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**	**Fair**	**Very Poor**	**Poor**	**Very Poor**	**Fair**	**Very Poor**	**Poor**	**Very Poor**	**Very Poor**	**Poor**	**Very Poor**

IBI Metric	LAR0044	LAR0080	LAR0108	LAR0184	LAR0220	LAR0244	LAR0318	LAR1288	LAR1460	LAR3902
EPT Taxa	6	1	7	0	3	0	2	2	1	2
Predator Taxa	10	3	9	0	4	0	0	0	0	0
Coleoptera Taxa	10	2	4	0	7	0	0	0	0	0
% Non-Insect Taxa	7	6	7	2	9	10	1	7	4	3
% Intolerant Individuals	3	4	3	0	0	0	0	0	0	0
% Tolerant Taxa	6	6	7	5	7	10	2	5	0	1
% Collector Individuals	4	3	3	0	0	0	0	2	0	0
Total	46	25	40	7	30	20	5	16	5	6
Adjusted Total	65.78	35.75	57.2	10.01	42.9	28.6	7.15	22.88	7.15	8.58
Rating	**Good**	**Poor**	**Fair**	**Very Poor**	**Fair**	**Poor**	**Very Poor**	**Poor**	**Very Poor**	**Very Poor**

Cluster Analysis

Cluster analysis is a multivariate statistical method used to group sites based on composition of species and their relative abundances, so that sites that have similar communities of insects will group together. The station and species dendrograms derived from this analysis can be grouped into a single two way table of species by site clusters or groups. The ecological characteristics of each site group can then be assessed by looking at the pollution tolerance and feeding strategies of the species that fall into each group. Figure 6 shows the two-way coincidence table of the relative distribution of species at each site from the 2005 and 2008 surveys. Horizontal and vertical lines on the two-way coincidence table identify major groupings of species and sites, respectively, and Figure 7 shows the distribution across the watershed of stations in the four site groups. The abundance of each species was standardized in terms of its maximum at each site over all surveys. Smaller symbols represent a lower proportion of maximum abundance and larger symbols a larger proportion.

There are clear differences in species composition across the four site groups, with a gradient of declining species diversity from site group 1 to site group 4. There was a clear separation in species composition between the natural sites in the high relief areas of the upper watershed (site group 1) and the remaining three site groups, indicating that the biological communities found in these areas were consistently different from one another (Figures 6 and 7). The natural flowing upper watershed sites were characterized by a diverse array of intolerant, semi-tolerant, and tolerant organisms typical of southern California coastal mountain habitats. Although not completely devoid of tolerant organisms that are more typical of poor habitat quality, these species did not dominate the upper watershed sites. Feeding strategies in the upper watershed sites included a healthy mixture of predators, scrapers, shredders, and collector gatherers/filterers. Site group 2 consists of sites located near or in the foothills where habitat complexity is somewhat greater than in the lower watershed channels that make up site groups 3 and 4. However, none of the sites in these lower watershed areas dominated by urban runoff and effluent contained any pollution intolerant organisms (i.e., species groups A – D in Figure 6). Feeding strategies within these urban/effluent dominated sites consisted primarily of collector gatherers/filterers and scrapers. A lack of benthic macroinvertebrate diversity, in conjunction with a rather monotypic feeding strategy throughout all urban/effluent sites is indicative of aquatic systems heavily affected by anthropogenic stressors, such as lined conveyance systems with very low habitat structure or diversity.

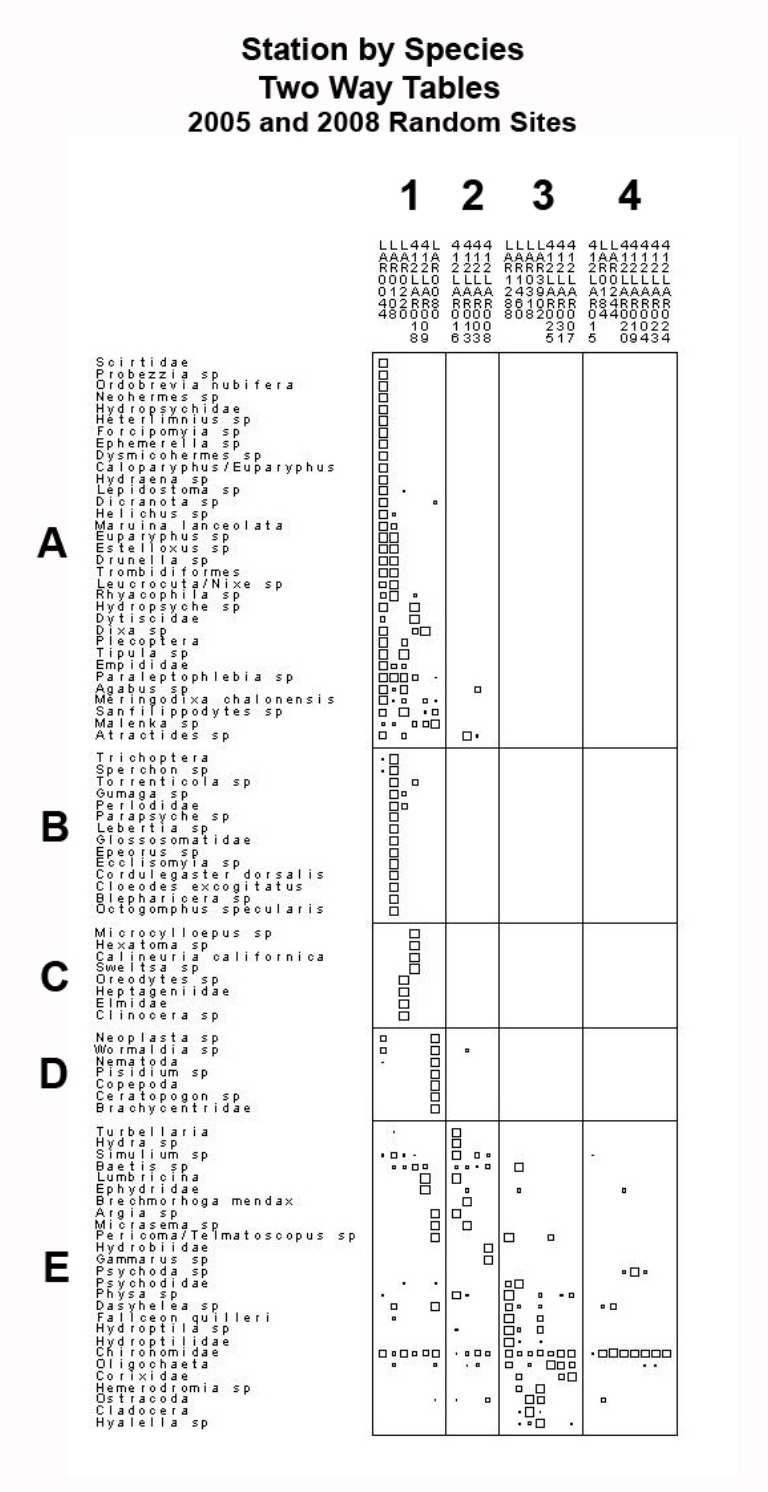

Figure 6. Two-way coincidence table of species and site groups from the cluster analyses for the combined random sites from 2005 and 2008. The size of each symbol indicates relative abundance of each species at each site, standardized in terms of each species' maximum abundance.

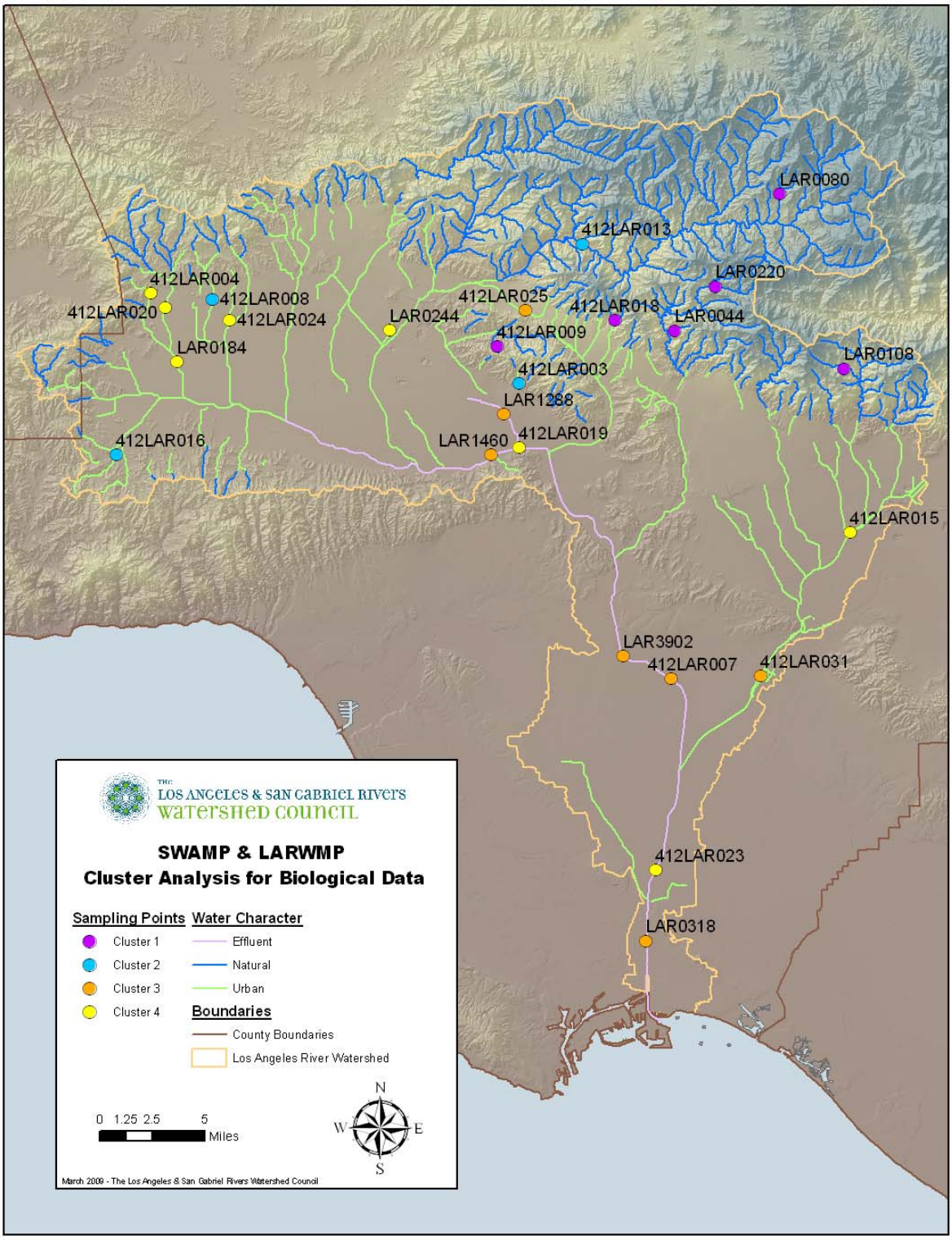

Figure 7. Locations of stations within each of the four site groups defined in Figure 6. The three watershed subareas are also delineated by different colored waterways. As in Figure 1, "natural" refers to natural areas, "effluent" to effluent dominated streams, and "urban" to urban runoff dominated streams.

Differences among the major portions of the watershed are also readily apparent when species in the three portions of the watershed are combined into ecological groupings (Figure 8). The combination of feeding types represented in a habitat can provide information regarding the position of a site in the watershed and also its ecological health. In general, organisms that use collecting as their feeding strategy will be more prevalent in the lower portion of watersheds where dissolved organic matter (DOM) is most prevalent (Vannote et al. 1980). Conversely, shredders are more common in upper watershed locations where coarse particulate organic material (CPOM) is prevalent. Scrapers and grazers are prevalent when reductions in overhead canopy cover can increase periphyton (attached algae) growth due to the increased sunlight. In addition, when more feeding strategies are represented in a habitat, it usually indicates that a relatively healthy macroinvertebrate community is present. Conversely, when few feeding strategies are represented, it can indicate poorer water quality conditions, as illustrated by the patterns described in the following paragraph.

Figure 8 shows the proportion of feeding groups represented in each of the three watershed areas for all random sites combined for the 2005 and 2008 surveys. The watershed as a whole was dominated by collectors, although the natural area had six other feeding types also represented. The presence of filterers is generally indicative of better water quality conditions (Vannote et al. 1980), and this was the second most prevalent group in both the natural and urban runoff dominated portions of the watershed. Interestingly, grazers and scrapers were almost completely absent from the effluent dominated and urban runoff dominated portions of the watershed, even though concrete lined channels with little or no canopy cover typically provide ideal conditions for the growth of periphyton, the main food source for grazers and scrapers.

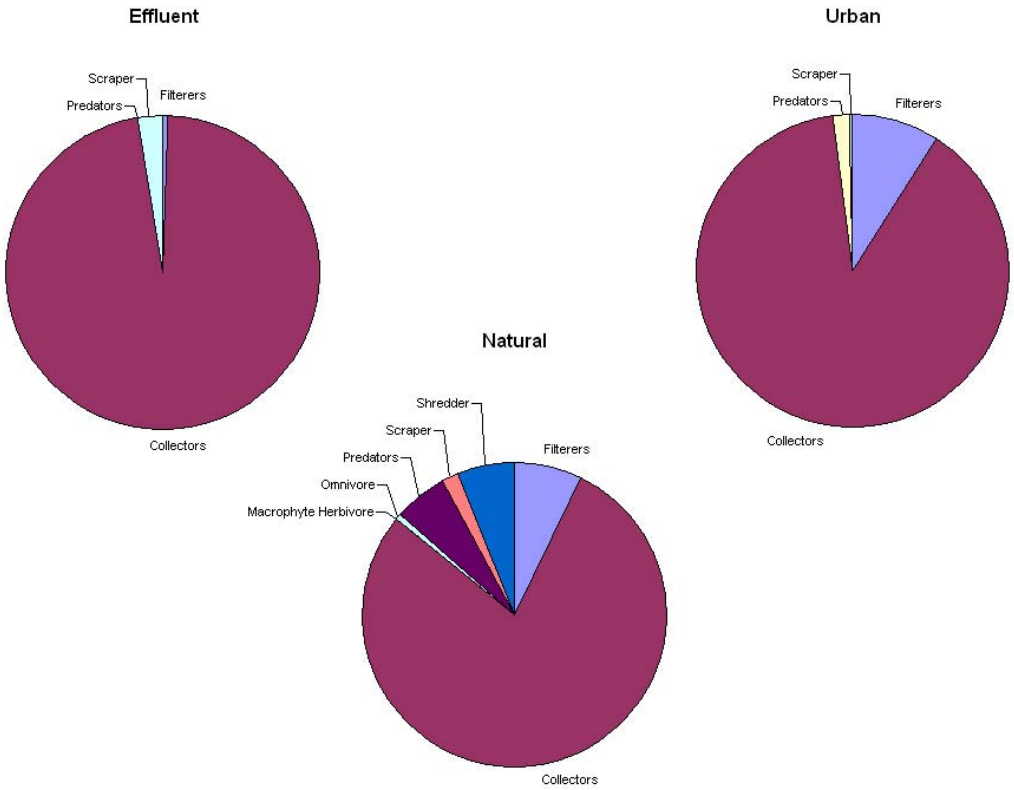

Figure 8. Relative proportion of macroinvertebrate functional feeding groups in each watershed area-region for random sites from the combined 2005 SWAMP and 2008 LARWMP surveys.

Relationships among Chemical, Toxicological, Physical and Biotic Conditions

The final step in the process of assessing the condition of streams in the watershed is to determine how the chemical, toxicological, physical habitat, and biotic conditions measured might relate to one another. Assessing these indicators in combination helps to explain the patterns found in the biological data.

The site groups from the cluster analysis (Figures 6 and 7) identify the major features of the biological pattern in the watershed's streams. Figure 9 shows how the values of selected physical habitat parameters vary across the four site groups (Box and whisker plots for all measured parameters can be found in Appendix 4). For reference, the first box and whisker plot shows that the separation into site groups is clearly related to differences in So CA IBI scores across the site groups. Sites located in the upper watershed group had the greatest median IBI scores of the four site groups and in most cases were similar to conditions found at southern California reference sites (IBI score >40). IBI scores at all sites in site groups 2, 3, and 4 were below the impairment threshold of <40; however, there was no clear trend in the IBI scores that reflected the gradient of biological conditions shown in the two-way table in Figure 6. This may be due to the fact that site groups 2, 3, and 4 are all impacted, as can be seen by the relatively small number of species in these sites (Figure 6), and the biological differences among the site groups are too small to be reflected clearly in the aggregate IBI scores.

The pattern of IBI scores across site groups can be compared to the water quality and physical habitat measurements to determine how they might be related. Figure 9 highlights selected parameters that differed across the four site groups. For example, dissolved organic carbon was higher in site group 4, and cadmium and copper increased from site group 1 to site group 4. Higher dissolved organic carbon is typically associated with a higher number of collectors, but Table 6 shows that these species were not at higher levels in the sites in site group 4. In addition, the low level of toxicity throughout the watershed suggests that higher levels of metals in the sites with low IBI scores are not the cause of the biological impact. However, overall, Figure 9 shows that a number of parameters associated with more developed watersheds are highest in site groups 3 and 4, which occur in the most developed portions of the lower watershed dominated by water reclamation plant effluent and urban runoff.

Alterations to physical habitat have been shown in other similar studies to be highly correlated with biological impact. However, a thorough analysis of the relationship between biological pattern and physical habitat is currently not possible for this preliminary study because different sets of physical habitat parameters were measured in 2005 and 2008, and because a method for deriving overall habitat scores has not yet been developed for the newer set of parameters. The composite physical habitat score, derived as the simple average of epifaunal substrate available cover, sediment deposition, and channel alteration at LAWRMP stations sampled in 2008, shows that physical habitat is more disturbed and of lower value at urban runoff dominated sites than at natural sites (Table 7).[5] Channels in these portions of the watershed are much more likely to lack complex, natural substrates, and riparian vegetation that diverse aquatic insect communities require. These reaches in many cases are concrete lined and are routinely maintained for flood control purposes. Higher water temperatures in these sites are also likely due to channel modification and the lack of riparian vegetation.

[5] Effluent dominated sites were not sampled in 2008 and physical habitat data from 2005 were not available.

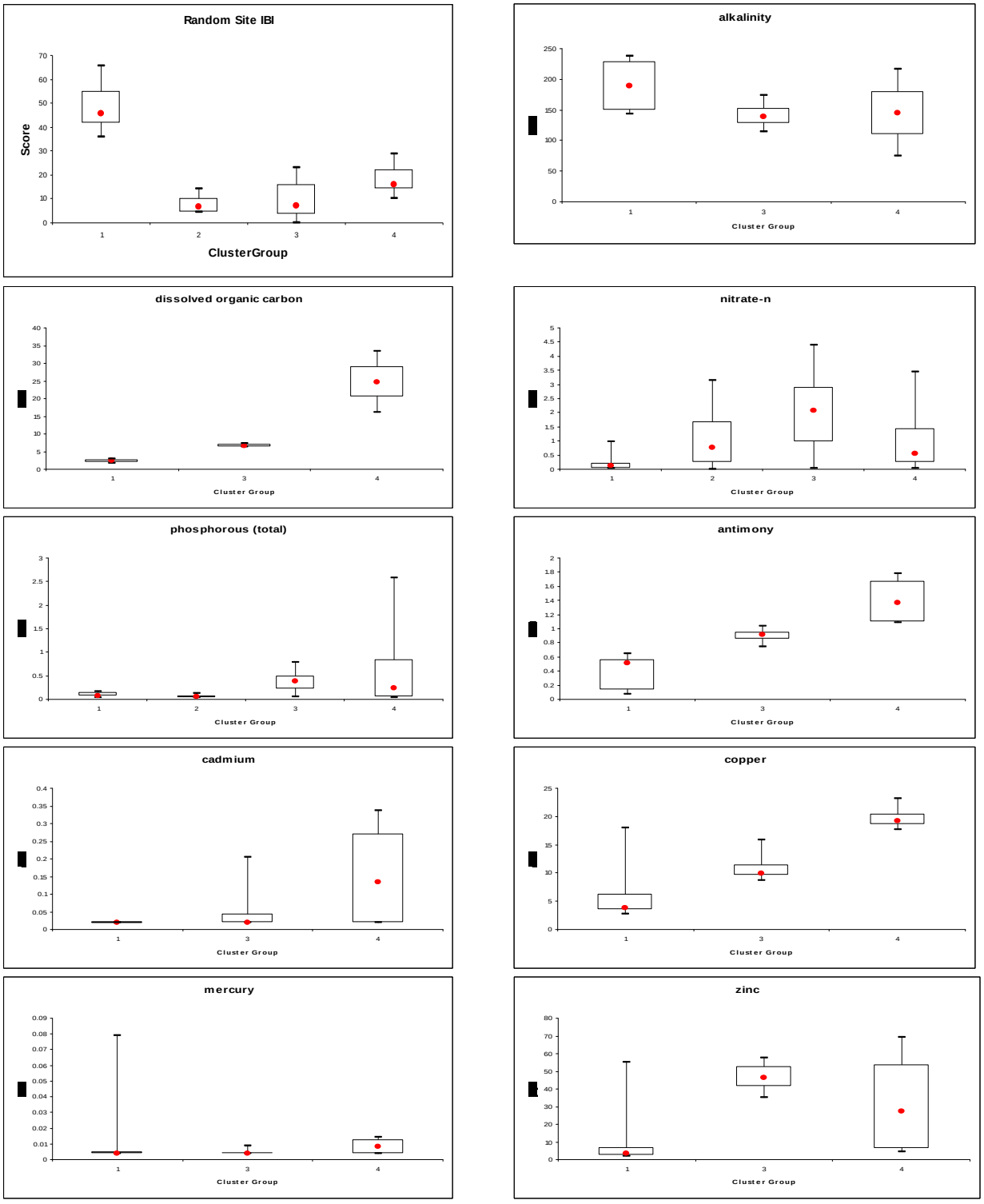

Figure 9. Box and whisker plots showing the median and range of IBI and selected chemistry variables for sites within each of the site groups from the cluster analysis illustrated in Figures 6 and 7, using available data from the random sites sampled in 2005 and 2008.

Table 7. Composite physical habitat scores for LARWMP random sites sampled in 2008, compared to IBI scores at the same sites.

Site	Type	Composite PHAB	IBI	Average	
				PHAB	IBI
LAR0044	Natural	16.7	65.78		
LAR0080	Natural	15.0	35.75		
LAR0108	Natural	14.3	57.2		
LAR0220	Natural	13.7	42.9	14.9	50.41
LAR0184	Urban runoff	5.3	10.01		
LAR0244	Urban runoff	5.7	28.6		
LAR0318	Urban runoff	2.0	7.15		
LAR1288	Urban runoff	0.7	22.88		
LAR1460	Urban runoff	0.3	7.15		
LAR3902	Urban runoff	5.0	8.58	3.2	14.06

Questions 2 & 3: Conditions at targeted and permit-mandated sites

Questions 2 and 3 focus on specific locations (Figure 1) that are of interest because they represent unique areas of special concern (Question 2) or help document the potential impact of discharges (Question 3). This chapter summarizes data from four types of sites, each intended to address a particular question of interest (Table 8).

Table 8. The four types of targeted sites included in the combined SWAMP and LARWMP datasets and the management questions associated with each.

Type of site	Management question
1. SWAMP targeted sites located throughout the watershed at locations thought to have higher than average levels of pollution	Are levels of pollution higher at SWAMP targeted sites than in the ambient background?
2. SWAMP sites in the harbor and estuary, intended to provide a basic description of these areas	What are the biological and chemical conditions characteristic of the harbor and estuary?
3. LARWMP targeted sites, located at confluences where major tributaries enter the mainstem of the Los Angeles River, intended to measure the cumulative effect of tributary inputs	How do conditions in the mainstem of the Los Angeles River where major tributaries join the mainstem compare to each other and to the ambient background?
4. Permit-mandated sites intended to measure the effects of water reclamation plant discharges	How do sites directly influenced by water reclamation plant discharge compare to the ambient background?

At this early stage in the program development, these questions can be addressed with a common approach that involves summarizing data values at these sites and then comparing them to the overall background condition of the watershed. As for Question 1, this is done for both aquatic chemistry and biological indicators. However, because they are not freshwater habitats, data from the harbor and estuary, sampled during the 2005 SWAMP survey, cannot be compared to the watershed background condition and are presented separately. As more data accumulate in subsequent years, these questions will be addressed independently.

Aquatic chemistry

Values of individual constituents from the watershed as a whole, as estimated from the random site data, can be compared to values at both the SWAMP and LARWMP targeted sites to determine if levels at these locations are comparable to ambient conditions.

In general the mean values for the random and targeted sites were comparable with a few notable exceptions (Table 9). Chlorophyll a, chromium, and iron were all substantially higher at the random sites than at the targeted sites. In contrast, lead was substantially higher at the targeted sites than at the random sites.

Table 9. Mean concentrations of selected water quality parameters for random and targeted sites, where targeted sites include both the SWAMP targeted sites from 2005 and the LARWMP targeted (confluence) sites from 2008. SD = standard deviation. See Appendix 2 for mean values for all parameters.

		Random		Targeted	
Parameter	**Units**	**Mean**	**SD**	**Mean**	**SD**
General					
Chloride	mg/l	83.4	9.4	95.2	10.5
Chlorophyll a	µg/l	32.2	5.9	12.4	3.8
Total hardness	mg/l	372.4	19.7	230.6	16.4
Dissolved organic carbon	mg/l	8.5	3.1	12.9	4.1
Total organic carbon	mg/l	10.4	3.4	12.0	4.0
Total suspended solids	mg/l	17.4	4.4	11.3	3.9
Metals					
Arsenic total	µg/l	2.7	1.7	2.2	1.7
Cadmium total	µg/l	0.1	0.3	0.2	0.5
Chromium total	µg/l	2.7	1.7	0.4	0.8
Copper total	µg/l	12.4	3.7	9.0	3.5
Iron total	µg/l	3070	58.4	359.9	21.9
Lead total	µg/l	1.8	1.4	12.7	4.1
Mercury total	µg/l	0.0	0.1	0.0	0.1
Nickel total	µg/l	4.5	2.2	3.6	2.2
Selenium total	µg/l	1.8	1.4	0.7	0.9
Zinc total	µg/l	35.2	6.3	30.8	6.4
Nutrients					
Ammonia-n	mg/l	0.1	0.3	0.2	0.5
Nitrate-n	mg/l	1.1	1.1	1.2	1.2
Nitrite-n	mg/l	0.1	0.4	0.1	0.3
Phosphorous (ortho)	mg/l	0.3	0.5	0.2	0.4
Phosphorous (total)	mg/l	0.4	0.6	0.1	0.4

Concentrations of pesticides were of particular interest to SWAMP during the 2005 survey, where a large suite of pesticides was measured, but the large majority of pesticide samples, at both the SWAMP and LARWMP targeted stations, were below their detection limit (Appendix 1).

In addition to comparing mean concentrations, as in Table 9, cumulative frequency distributions can be used to compare data from targeted and permit-mandated stations to the background for the watershed as a whole established by the random sites (Figure 10). Figure 10 illustrates an approach that has provided useful insights in other ambient monitoring programs; however, the specific results presented in Figure 10 should be viewed with some caution for two main reasons. Cumulative frequency distributions for all measured parameters is provided in Appendix 5. First, metals were sampled only at the 15 LARWMP stations in 2008 and not at the 2005 SWAMP random stations, and this small number of data points means that the cumulative frequency distributions (i.e., the curves in Figure 10) may not be accurate representations of ambient conditions across the watershed. Second, the combination of data from different programs and laboratories, some collected three years apart, raises the possibility that observed differences may be due to methods rather than reflecting actual conditions in the watershed. These issues will be resolved beginning in 2009 as the program's contractor begins to implement standardized methods across the

program's various monitoring elements. Despite these caveats, Figure 10 does illustrate patterns that provide a basis for further analysis beginning in subsequent years.

For example, Figure 10 suggests that the range of dissolved copper, cadmium, lead, and zinc values at the targeted and permit-mandated sites reflect the range of dissolved metals concentrations seen across the watershed as a whole. The same is true of nutrient values. This pattern differs from that seen in the neighboring San Gabriel River watershed, where metals concentrations at the targeted and permit-mandated stations are typically in the lower 25% of values observed throughout the watershed. However, as mentioned in the preceding paragraph, this pattern may be an artifact of the small number of random sites with available metals data.

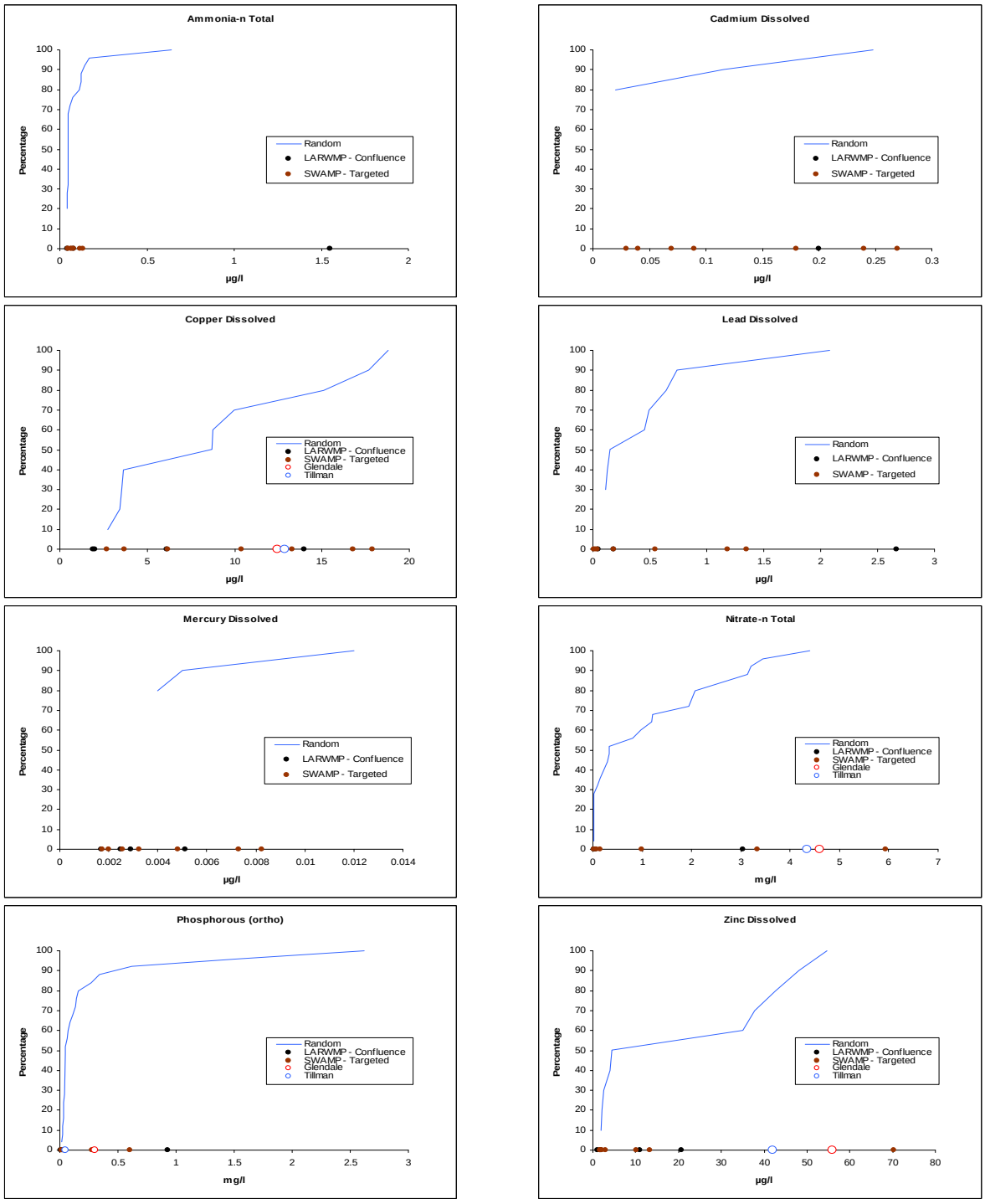

Figure 10. Cumulative frequency distributions illustrating the relationship of the values of representative parameters measured at targeted and permit-mandated monitoring stations to the ambient background represented by the random watershed sites.

Toxicity

Toxicity was evaluated with the *Ceriodaphnia* acute survival test in both the 2005 SWAMP and 2008 LARWMP surveys, and with the *Pimephales promelas* acute survival test in the 2005 SWAMP survey (Table 10). Little toxicity was observed except at the SWAMP targeted sites on urban runoff dominated waterways. This low average survival resulted from a finding of complete mortality (i.e., 0% survival) at three stations, 412LARBLL, 412LARRHO, and 412LARVGO. Surprisingly, Table 11 shows that IBI scores at these three sites were not at the low end of the scale for targeted sites in the watershed, and Figure 11 shows that these sites were not unusually low in species diversity compared to other sites in their site grouping. Chemical constituents at these three sites were close to the mean for the watershed, with the exception of copper and selenium at 412LARBLL and 412LARRHO, which were both substantially higher than the mean for both random and targeted stations, and sulfate at 412LARRHO, which was substantially higher than the mean for sulfate at the targeted stations, but close to the mean for sulfate at the random stations. There were no anomalous chemistry values at station 412LARVGO.

Table 10. Summary of acute toxicity at targeted sites during the 2005 SWAMP and 2008 LARWMP watershed surveys. * Notes a category with only one site.

Type of targeted site	% survival	Test type
LARWMP confluence of tributary with mainstem	91.2	*Ceriodaphnia*
SWAMP targeted on effluent dominated *	100.0	*Ceriodaphnia*
SWAMP targeted on effluent dominated *	95.0	*Pimephales promelas*
SWAMP targeted on urban runoff dominated	43.3	*Ceriodaphnia*
SWAMP targeted on urban runoff dominated	96.7	*Pimephales promelas*

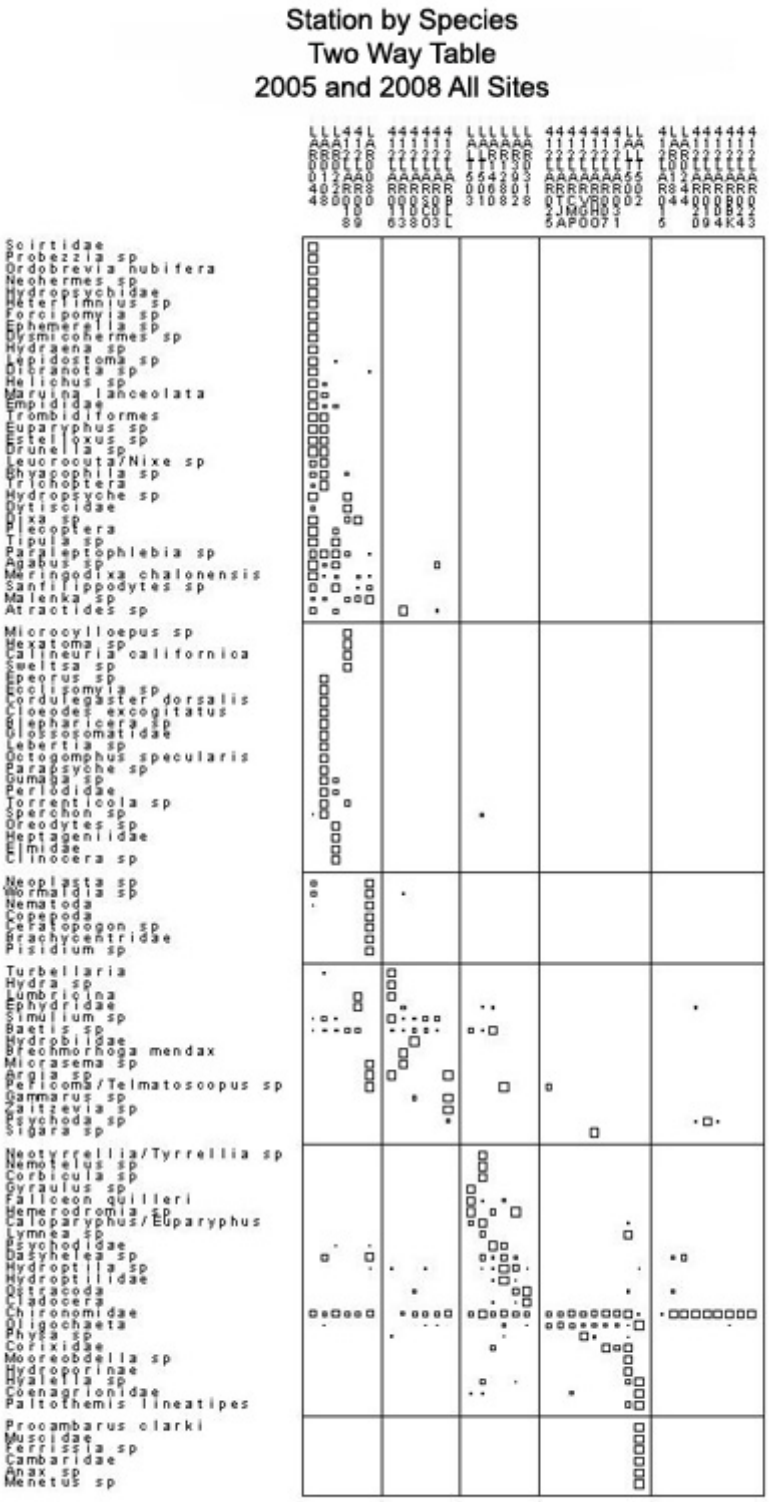

Figure 11. Two-way coincidence table of species and site groups from the cluster analyses for all watershed stations from the 2005 and 2008 surveys. The size of each symbol indicates relative abundance of each species at each site, standardized in terms of each species' maximum abundance.

Biology

Based on the IBI scores for the targeted sites sampled during both the SWAMP and the LARWMP surveys, all seven sites rated as "very poor" (Table 11).

Table 11. Southern California Index of Biotic Integrity (So CA IBI) metrics, scores, and ratings for the targeted sites sampled during the 2005 SWAMP and 2008 LARWMP surveys. Top portion of the table are SWAMP stations and the bottom portion the LARWMP stations. All sites have Very Poor scores.

IBI Metric	412 LARBBK	412 LARBLL	412 LARCMP	412 LARRHO	412 LARSCO	412 LARTJA	412 LARVGO
EPT Taxa	0	1	0	0	1	0	0
Predator Taxa	0	0	0	0	0	0	0
Coleoptera Taxa	0	2	0	0	0	0	0
% Non-Insect Taxa	0	4	6	0	5	0	0
% Intolerant Individuals	0	0	0	0	0	0	0
% Tolerant Taxa	10	5	4	0	7	2	0
% Collector Individuals	0	0	0	1	0	0	4
Total	10	12	10	1	13	2	4
Adjusted Total	14.3	17.16	14.3	1.43	18.59	2.86	5.72
Rating	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**

IBI Metric	LALT500	LALT501	LALT502	LALT503
EPT Taxa	0	1	0	1
Predator Taxa	1	0	1	0
Coleoptera Taxa	2	0	0	0
% Non-Insect Taxa	0	2	0	2
% Intolerant Individuals	0	0	0	0
% Tolerant Taxa	0	0	0	0
% Collector Individuals	0	0	1	0
Total	3	3	2	3
Adjusted Total	4.29	4.29	2.86	4.29
Rating	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**

As for the aquatic chemistry, IBI scores from the targeted sites can be compared to the watershed background using cumulative frequency distributions. Figure 12 shows that targeted sites from both the 2005 SWAMP and 2008 LARWMP surveys are concentrated at the low end of the scale. This is not surprising, given that these sites are located in highly modified channels in the urbanized portion of the watershed, while the random sites are spread throughout a range of habitat types across the watershed.

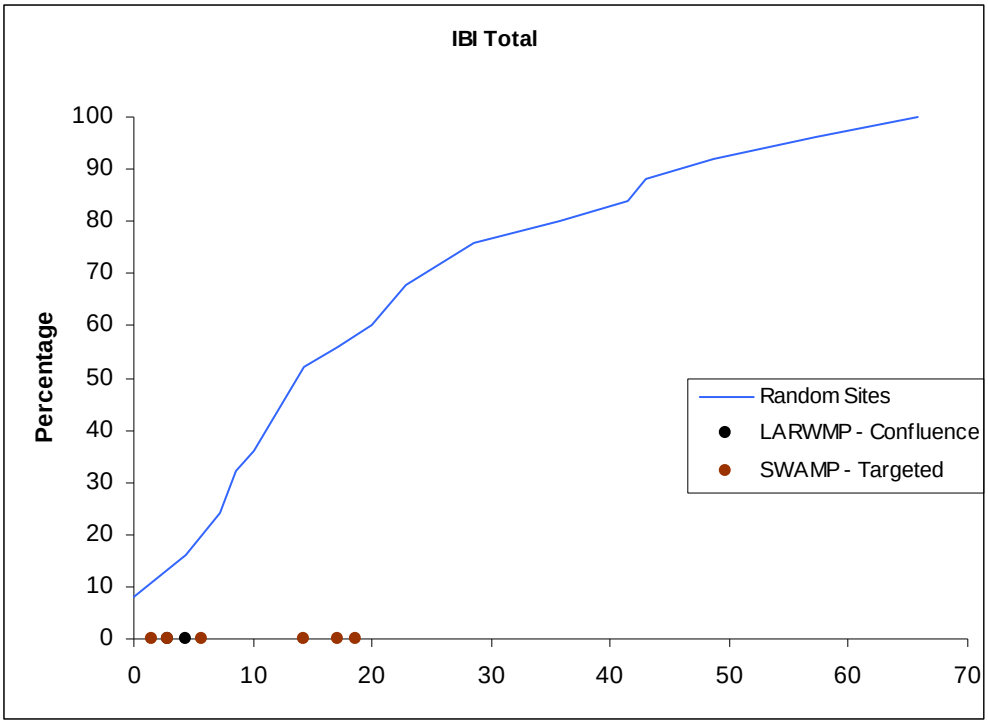

Figure 12. Cumulative frequency distribution illustrating the relationship of IBI values measured at targeted and permit-mandated monitoring stations to the ambient background represented by the random watershed sites.

In addition, the cluster analysis can be expanded to include the targeted sites. Figure 11 shows that the targeted sites are spread throughout the site groups, with the exception of the first site group which is made up of sites in the natural portion of the watershed. This indicates that the targeted sites are not consistently biologically different from the random sites in the urban runoff and effluent dominated portions of the watershed.

Los Angeles River Estuary

The 2005 SWAMP survey sampled one station in the Los Angeles River estuary (4112LARETY) (Figure 13). Appendix 6 presents results of all aquatic and sediment chemical analyses. Several metals had elevated levels in sediment samples, but only copper, manganese, and zinc had elevated levels in water samples. Virtually all pesticides were at the detection limit in water samples, while most pesticides had elevated levels in the sediment.

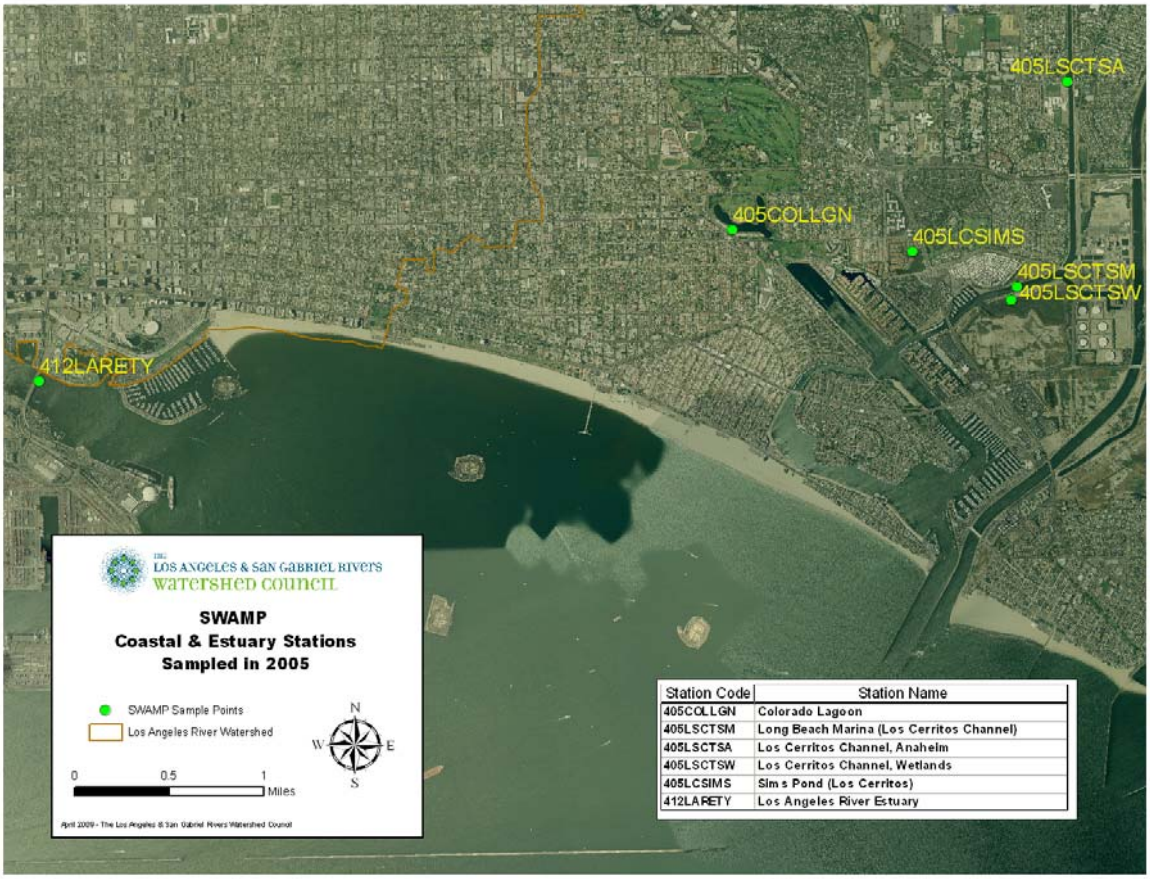

Figure 13. Locations of harbor and estuary stations sampled during the 2005 SWAMP survey.

There was no indication of toxicity in the one test from this station (Table 12).

Table 12. Results of aquatic and sediment acute toxicity tests at harbor /estuary stations during the 2005 SWAMP survey. Since % survival is based on a comparison with control tests, values greater than 100% are possible.

Station	Location	Matrix	% survival	Test type
412LARETY	Estuary	Water	103	Mytilus galloprovincialis

Appendix 7 presents results of the benthic infaunal sampling at the estuary station. There is little that can be learned from this one sample, except to note that the species present are typical of harbor and estuarine systems in southern California. *Capitella capitata*, in particular, has long been considered an indicator of heavy organic enrichment.

Summary

The LARWMP first year of implementation in 2008 demonstrated the viability and utility of the program design and its collaborative structure. While human health issues related to swimming and to fish consumption and questions about some sites of unique ecological interest were not addressed in this first year, the watershed-scale monitoring for overall condition provided new insights into the overall condition of the watershed and provided a broader context for interpreting monitoring results from fixed sites.

Some preliminary conclusions from the 2008 data include:

- There are clear differences among the major portions of the watershed, both in terms of chemistry and biology.
- There was little or no toxicity observed during the study, with the exception of three samples.
- Dissolved concentrations for most metals were highest in the effluent and urban runoff dominated portions of the watershed, while nutrient values were highest in the effluent dominated portion of the watershed. However, nutrient patterns are biased somewhat by the fact that data from the 2005 SWAMP survey were collected prior to the implementation of denitrification at inland water reclamation plants in the watershed.
- Total concentrations for several metals were highest in the natural portions of the watershed. Many of these were earth metals that derive from natural sources.
- Pesticide values at the SWAMP targeted sites were, with few exceptions, below detection limits.
- IBI scores from all sites in the developed portions of the watershed were substantially lower than those in the natural portion of the watershed. These differences were apparently due primarily to differences in habitat, since toxicity was generally low throughout the watershed.
- The variety of data collected at the random sites (invertebrates, aquatic chemistry, aquatic toxicity, physical habitat) provides an opportunity for investigating the factors most responsible for maintaining or degrading stream condition. This report presented a very preliminary step toward such an analysis and this will be expanded in future reports as more data become available.
- The chemistry sample from the estuary showed elevated levels of metals and many pesticides in sediments; however both aquatic and sediment toxicity at this site was low.

These conclusions will be evaluated in more depth as data from subsequent years become available. However, they do provide, for the first time, an overall view of the watershed and of how conditions vary across portions of the watershed.

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Appendix 1: Chemical Constituents Sampled

Appendix 1 provides a detailed list of chemistry constituents sampled for each component of the LARWMP and SWAMP surveys.

Table A1.1. Numbers of general chemistry and nutrient samples collected for each freshwater component of the LARWMP 2008 and SWAMP 2005 programs.

		LARWMP		SWAMP	
Analyte Fraction	**Fraction**	**Random**	**Targeted**	**Random**	**Targeted**
alkalinity	Total	10			
ammonia-n	Total	10	4	15	7
calcium	Dissolved	10	4		
calcium	Total	10			
chloride	Total			15	7
chlorophyll a	Total			15	7
dissolved organic carbon	Dissolved	10	4		
nitrate-n	Total	10	4	15	7
nitrite-n	Total	10	4	15	7
organic nitrogen	Total	10			
oxygen, dissolved				15	7
oxygen, saturation				15	7
ph	Total		4	15	7
phosphorous (ortho)	Total	10	4	15	7
phosphorous (total)	Total	10		15	7
salinity			4	16	6
specific conductivity				16	7
sulfate	Total			15	7
temperature				16	7
total hardness	Total	10		15	7
total kjeldahl nitrogen	Total		4	15	7
total organic carbon	Total	10	4		
total phosphorus-low range	Total		4		
total suspended solids	Total	10	4		
turbidity				15	6
velocity				9	2

Table A1.2. Numbers of trace metal samples collected for each freshwater component of the LARWMP 2008 and SWAMP 2005 programs.

		LARWMP		SWAMP	
Parameter	**Fraction**	**Random**	**Targeted**	**Random**	**Targeted**
aluminum	Dissolved	10	4		7
antimony	Dissolved	10	4		
arsenic	Dissolved	10	4		7
barium	Dissolved	10	4		
beryllium	Dissolved	10	4		
cadmium	Dissolved	10	4		7
chromium	Dissolved	10	4		7
cobalt	Dissolved	10	4		
copper	Dissolved	10	4		7
iron	Dissolved	10	4		
lead	Dissolved	10	4		7
magnesium	Dissolved	10	4		
manganese	Dissolved	10	4		7
mercury	Dissolved	10	4		7
molybdenum	Dissolved	10	4		
nickel	Dissolved	10	4		7
selenium	Dissolved	10	4		7
silver	Dissolved	10	4		7
strontium	Dissolved	10	4		
thallium	Dissolved	10	4		
tin	Dissolved	10	4		
titanium	Dissolved	10	4		
vanadium	Dissolved	10	4		
zinc	Dissolved	10	4		7
aluminum	Total	10	4		
antimony	Total	10	4		
arsenic	Total	10	4		
barium	Total	10	4		
beryllium	Total	10	4		
cadmium	Total	10	4		
chromium	Total	10	4		
cobalt	Total	10	4		
copper	Total	10	4		
iron	Total	10	4		
lead	Total	10	4		
magnesium	Total	10			
manganese	Total	10	4		
mercury	Total	10	4		
molybdenum	Total	10	4		
nickel	Total	10	4		
selenium	Total	10	4		
silver	Total	10	4		
strontium	Total	10	4		
thallium	Total	10	4		

		LARWMP		SWAMP	
Parameter	**Fraction**	**Random**	**Targeted**	**Random**	**Targeted**
tin	Total	10	4		
titanium	Total	10	4		
vanadium	Total	10	4		
zinc	Total	10	4		

Table A1.3. Numbers of volatile hydrocarbon, including pesticides, samples collected for each freshwater component of the LARWMP 2008 and SWAMP 2005 programs. ND in the last column of the table indicates the number of nondetects for each pesticide. The large majority of pesticides were below detection limits.

		LARWMP		SWAMP		ND
Parameter	**Fraction**	**Random**	**Targeted**	**Random**	**Targeted**	
benzene	Total					7
bolstar (sulprofos)	Total		4			4
bromobenzene	Total				7	7
bromochloromethane	Total				7	7
bromodichloromethane	Total				7	5
bromoform	Total				7	6
butylbenzene, n-	Total				7	6
butylbenzene, sec-	Total				7	7
butylbenzene, tert-	Total				7	7
carbon tetrachloride	Total				7	7
chlorobenzene	Total				7	7
chloroform	Total				7	2
chlorotoluene, 2-	Total				7	7
chlorotoluene, 4-	Total				7	7
chlorpyrifos	Total		4			4
demeton	Total		4			4
diazinon	Total		4			4
dibromo-3-chloropropane, 1,2-(dbcp)	Total				7	7
dibromochloromethane	Total				7	5
dibromoethane, 1,2-	Total				7	7
dibromomethane	Total				7	6
dichlorobenzene, 1,2-	Total				7	7
dichlorobenzene, 1,3-	Total				7	6
dichlorobenzene, 1,4-	Total				7	6
dichloroethane, 1,1-	Total				7	6
dichloroethane, 1,2-	Total				7	6
dichloroethylene, 1,1-	Total				7	6
dichloroethylene, cis 1,2-	Total				7	7
dichloroethylene, trans 1,2-	Total				7	7
dichloropropane, 1,2-	Total				7	7
dichloropropane, 1,3-	Total				7	7
dichloropropane, 2,2-	Total				7	7
dichloropropene, 1,1-	Total				7	6
dichlorvos	Total		4			4
dimethoate	Total		4			4
disulfoton	Total		4			4
ethoprop (ethoprofos)	Total		4			4
ethylbenzene	Total				7	5
fenchlorphos (ronnel)	Total		4			4
fensulfothion	Total		4			4
fenthion	Total		4			4

		LARWMP		SWAMP		ND
Parameter	**Fraction**	**Random**	**Targeted**	**Random**	**Targeted**	
hexachlorobutadiene	Total				7	6
isopropylbenzene	Total				7	7
isopropyltoluene, p-	Total				7	6
malathion	Total		4			3
merphos	Total		4			4
methyl parathion	Total		4			4
mevinphos (phosdrin)	Total		4			4
mtbe	Total				7	5
naphthalene	Total				7	7
phorate	Total		4			4
propylbenzene, n-	Total				7	7
tetrachloroethane, 1,1,1,2-	Total				7	7
tetrachloroethane, 1,1,2,2-	Total				7	7
tetrachloroethylene	Total				7	6
tetrachlorvinphos (stirofos)	Total		4			4
tokuthion	Total		4			4
toluene	Total				7	2
trichlorobenzene, 1,2,3-	Total				7	7
trichlorobenzene, 1,2,4-	Total				7	7
trichloroethane, 1,1,1-	Total				7	7
trichloroethane, 1,1,2-	Total				7	7
trichloroethylene	Total				7	7
trichloronate	Total		4			4
trichloropropane, 1,2,3-	Total				7	7
trimethylbenzene, 1,2,4-	Total				7	6
trimethylbenzene, 1,3,5-	Total				7	7
xylene, m/p-	Total				7	5
xylene, o-	Total				7	6

Appendix 2: Average Concentrations for Random and Targeted Sites

Mean concentrations of water quality parameters for random and targeted sites, where targeted sites include both the SWAMP targeted sites from 2005 and the LARWMP targeted (confluence) sites from 2008. SD = standard deviation.

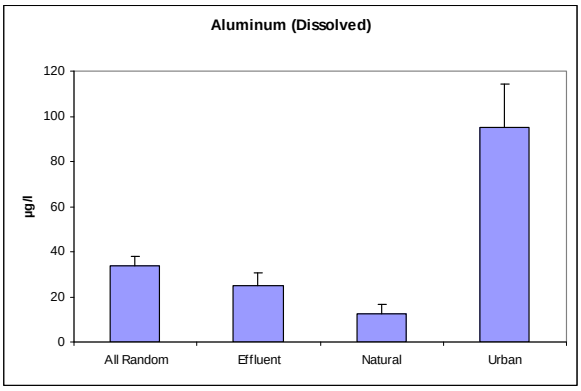
			Random			Targeted		
Parameter	Fraction	Unit	n	Mean	SD	n	Mean	SD
General								
dissolved organic carbon	Diss	mg/l	10	8.6	3.1	4	12.9	4.2
Metals								
aluminum	Diss	µg/l	10	34	6.1	11	8.	3.1
antimony	Diss	µg/l	10	0.7	0.9	4	1.3	1.3
arsenic	Diss	µg/l	10	1.6	1.3	11	2.3	1.6
barium	Diss	µg/l	10	39.5	6.6	4	89.4	10.9
beryllium	Diss	µg/l	10	0.0	0.2	4	0.2	0.5
cadmium	Diss	µg/l	10	0.0	0.2	11	0.2	0.4
calcium	Diss	mg/l	10	59.7	8.1	4	36.0	6.9
chromium	Diss	µg/l	10	1.8	1.4	11	0.5	0.7
cobalt	Diss	µg/l	10	0.4	0.7	4	0.1	0.4
copper	Diss	µg/l	10	9.2	3.2	11	8.6	3.1
iron	Diss	µg/l	10	59.9	8.2	4	95.1	11.3
lead	Diss	µg/l	10	0.5	0.7	11	0.6	0.8
magnesium	Diss	mg/l	10	20.9	4.8	4	21.0	5.3
manganese	Diss	µg/l	10	10.5	3.4	11	14.4	4.0
mercury	Diss	µg/l	10	0.049	0.1	11	0.0	0.1
molybdenum	Diss	µg/l	10	14.1	4.0	4	5.9	2.8
nickel	Diss	µg/l	10	3.4	1.9	11	2.2	1.5
selenium	Diss	µg/l	10	1.7	1.4	11	4.8	2.3
silver	Diss	µg/l	10	0.1	0.4	11	0.2	0.5
strontium	Diss	µg/l	10	453.8	22.5	4	677.8	30.1
thallium	Diss	µg/l	10	0.2	0.4	4	0.1	0.4
tin	Diss	µg/l	10	0.3	0.6	4	0.1	0.4
titanium	Diss	µg/l	10	32.4	6.0	4	0.3	0.7
vanadium	Diss	µg/l	10	0.8	1.0	4	3.2	2.0
zinc	Diss	µg/l	10	23.3	5.1	11	12.4	3.7
General								
chloride	Total	mg/l	15	83.4	9.4	7	95.2	10.5
chlorophyll a	Total	µg/l	15	32.2	5.9	7	12.4	3.8
total hardness	Total	mg/l	25	372.4	19.7	7	230.6	16.4
total organic carbon	Total	mg/l	10	10.4	3.4	4	12.0	4.0
total suspended solids	Total	mg/l	10	17.4	4.4	4	11.3	3.9
Metals								
aluminum	Total	µg/l	10	1073	34.5	4	152.1	14.2
antimony	Total	µg/l	10	0.8	1.0	4	1.4	1.3

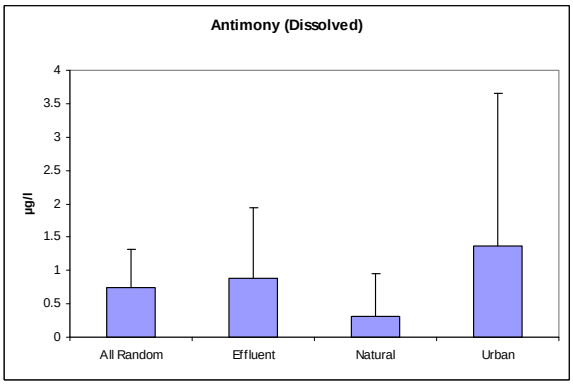
Parameter	Fraction	Unit	Random			Targeted		
			n	Mean	SD	n	Mean	SD
arsenic	Total	µg/l	10	2.7	1.7	4	2.2	1.7
barium	Total	µg/l	10	68.5	8.7	4	100.7	11.6
beryllium	Total	µg/l	10	0.1	0.2	4	0.2	0.5
cadmium	Total	µg/l	10	0.1	0.3	4	0.2	0.5
chromium	Total	µg/l	10	2.7	1.7	4	0.4	0.8
cobalt	Total	µg/l	10	2.6	1.7	4	0.2	0.5
copper	Total	µg/l	10	12.4	3.7	4	9.0	3.5
iron	Total	µg/l	10	3070	58.4	4	359.9	21.9
lead	Total	µg/l	10	1.8	1.4	4	12.7	4.1
manganese	Total	µg/l	10	301.9	18.3	4	58.8	8.9
mercury	Total	µg/l	10	0.0	0.1	4	0.0	0.1
molybdenum	Total	µg/l	10	14.5	4.0	4	5.2	2.6
nickel	Total	µg/l	10	4.5	2.2	4	3.6	2.2
selenium	Total	µg/l	10	1.8	1.4	4	0.7	0.9
silver	Total	µg/l	10	0.2	0.5	4	0.5	0.8
strontium	Total	µg/l	10	499	23.5	4	710.5	30.8
sulfate	Total	mg/l	15	254.2	16.5	7	152.7	13.3
thallium	Total	µg/l	10	0.2	0.4	4	0.1	0.4
tin	Total	µg/l	10	0.3	0.6	4	0.1	0.4
titanium	Total	µg/l	10	65.9	8.6	4	6.5	2.9
vanadium	Total	µg/l	10	6.4	2.7	4	3.6	2.2
zinc	Total	µg/l	10	35.2	6.3	4	30.8	6.4
Nutrients								
ammonia-n	Total	mg/l	25	0.1	0.3	11	0.2	0.5
nitrate-n	Total	mg/l	25	1.1	1.1	11	1.2	1.2
nitrite-n	Total	mg/l	25	0.1	0.4	11	0.1	0.3
phosphorous (ortho)	Total	mg/l	25	0.3	0.5	11	0.2	0.4
phosphorous (total)	Total	mg/l	25	0.4	0.6	7	0.1	0.4
total kjeldahl nitrogen	Total	mg/l	15	1.2	1.1	11	2.0	1.5

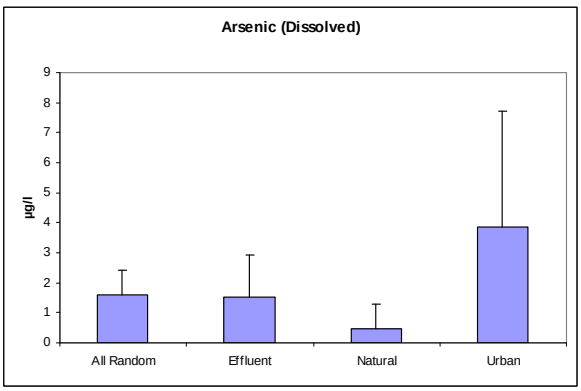
Appendix 3: Average Concentrations in Watershed Areas

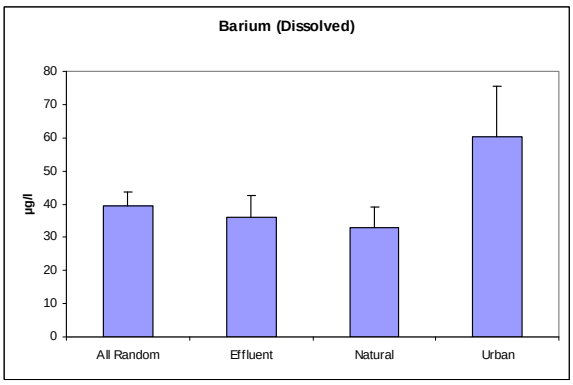
The following figures present average (± 95% CI) concentrations of general chemistry, nutrient, and metal constituents measured in each of the three Los Angeles River watershed regions. Note that "Effluent" refers to effluent dominated and "Urban" to urban runoff dominated. Data are from the combined 2005 SWAMP and 2008 LARWMP surveys. Metals data are from 2008 because the SWAMP survey did not sample metals at the random sites (see Appendix 1).

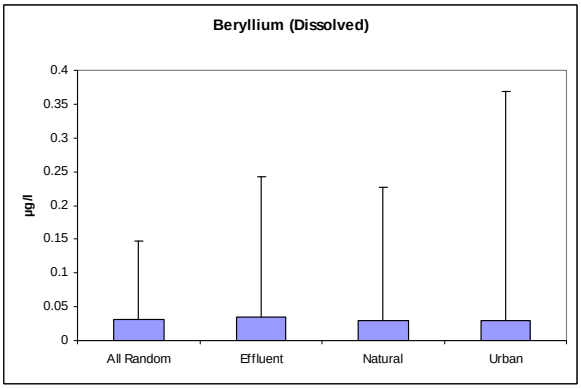
Data on dissolved fractions are presented first for all constituents, followed by data for the total amount measured.

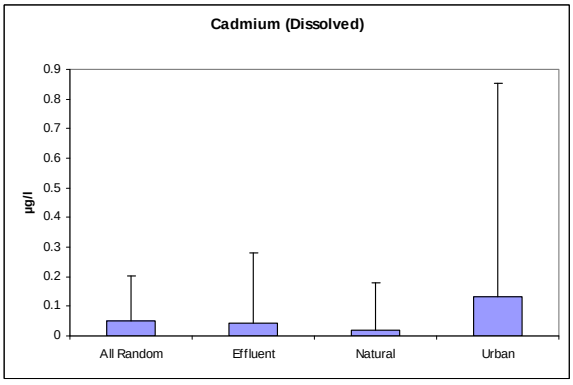


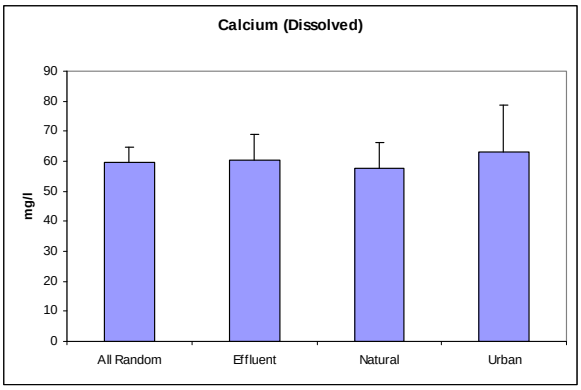


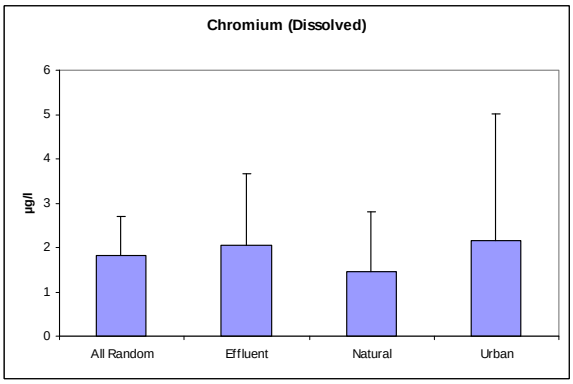


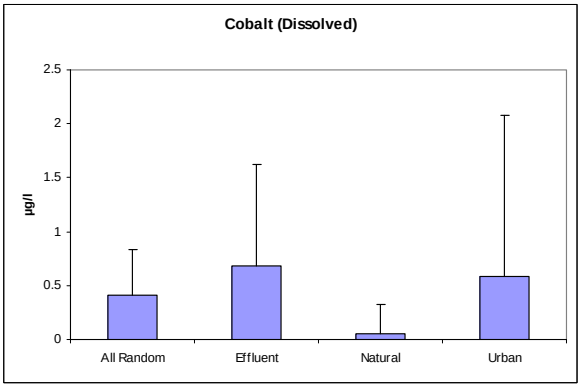


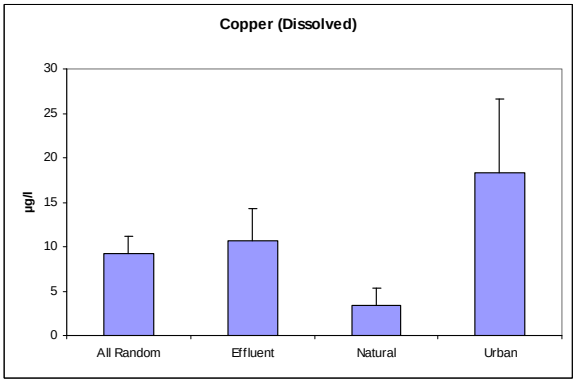


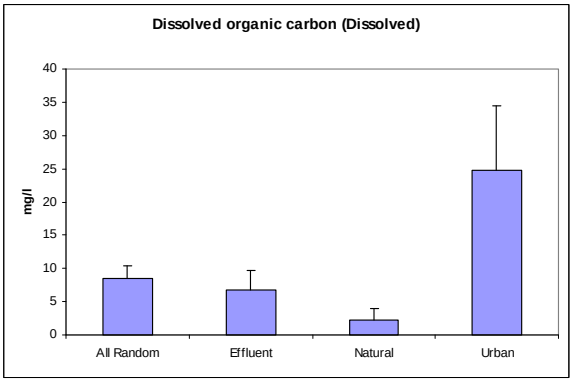


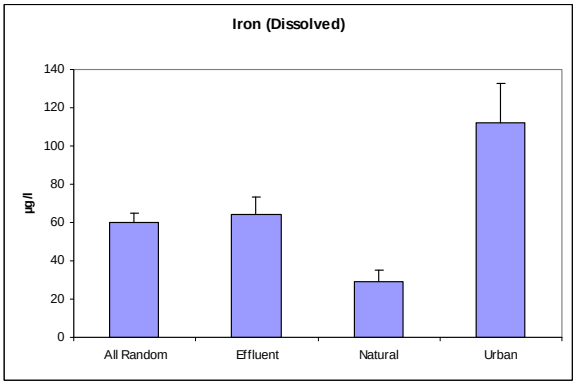

Calcium (Dissolved)
mg/l
90
80
70
60
50
40
30
20
10
0
All Random
Effluent
Natural
Urban

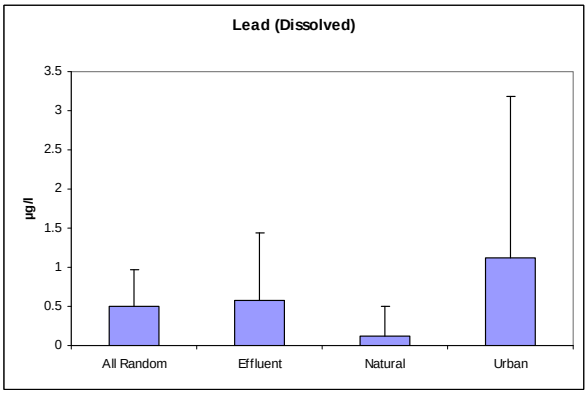

Chromium (Dissolved)
µg/l
6
5
4
3
2
1
0
All Random
Effluent
Natural
Urban

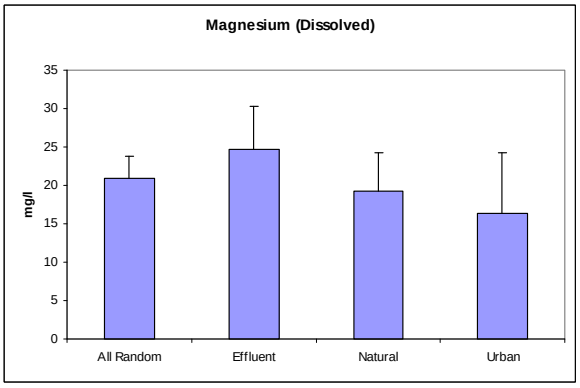

Cobalt (Dissolved)
µg/l
2.5
2
1.5
1
0.5
0
All Random
Effluent
Natural
Urban

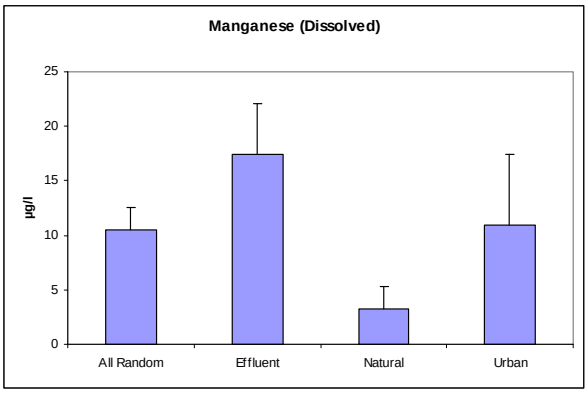

Copper (Dissolved)
µg/l
30
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

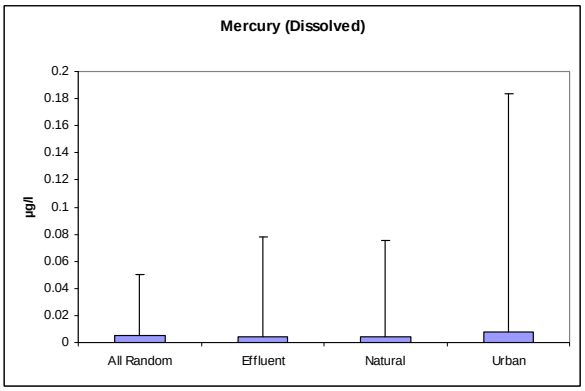

Dissolved organic carbon (Dissolved)
mg/l
40
35
30
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

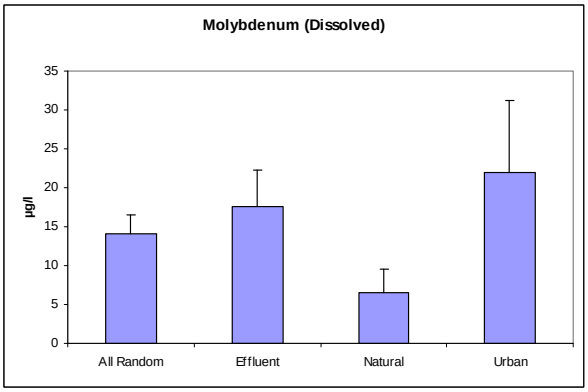

Iron (Dissolved)
µg/l
140
120
100
80
60
40
20
0
All Random
Effluent
Natural
Urban

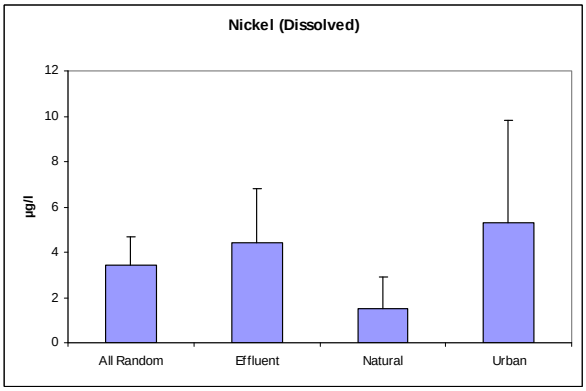

Lead (Dissolved)
µg/l
3.5
3
2.5
2
1.5
1
0.5
0
All Random
Effluent
Natural
Urban

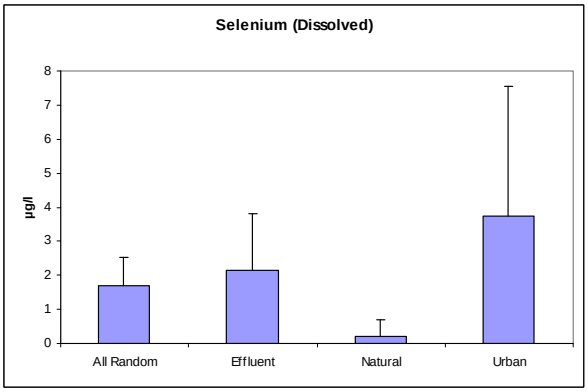

Magnesium (Dissolved)
mg/l
35
30
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

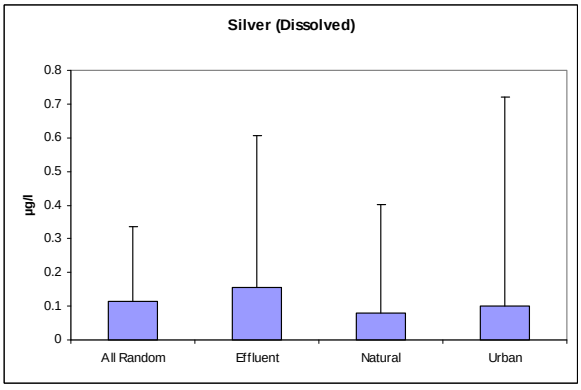

Manganese (Dissolved)
µg/l
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

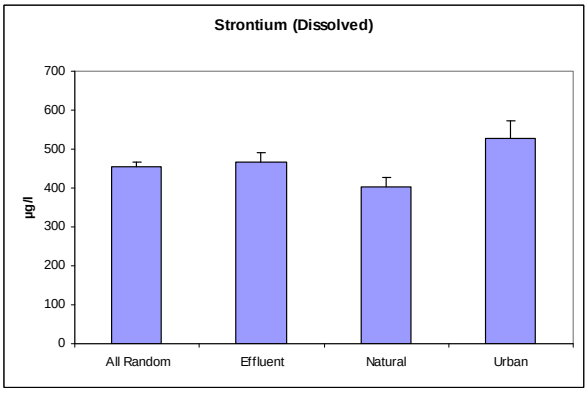

Mercury (Dissolved)
µg/l
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
All Random
Effluent
Natural
Urban

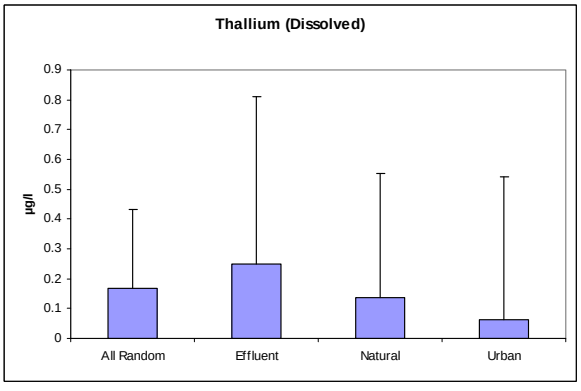

Molybdenum (Dissolved)
µg/l
35
30
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

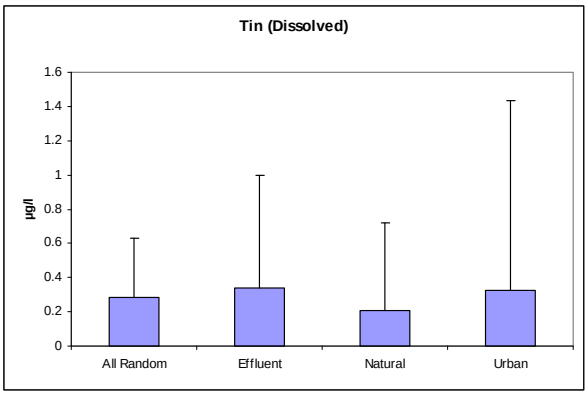

Nickel (Dissolved)
µg/l
12
10
8
6
4
2
0
All Random
Effluent
Natural
Urban

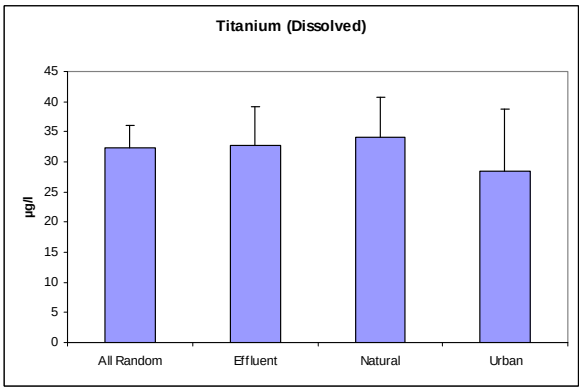

Selenium (Dissolved)
µg/l
8
7
6
5
4
3
2
1
0
All Random
Effluent
Natural
Urban

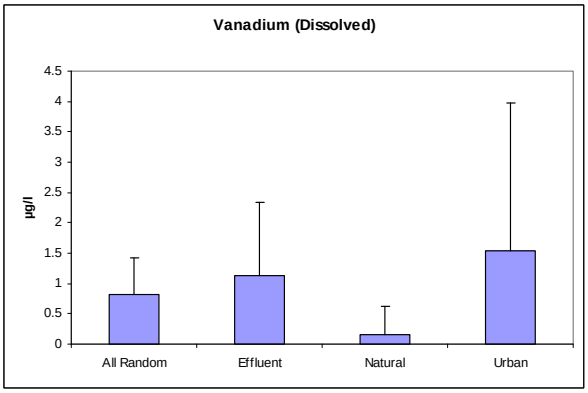

Silver (Dissolved)
µg/l
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
All Random
Effluent
Natural
Urban

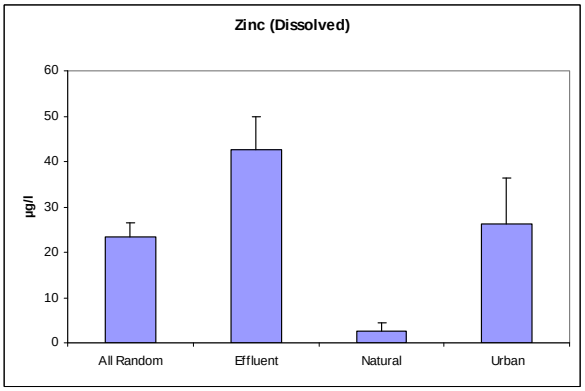

Strontium (Dissolved)
µg/l
700
600
500
400
300
200
100
0
All Random
Effluent
Natural
Urban

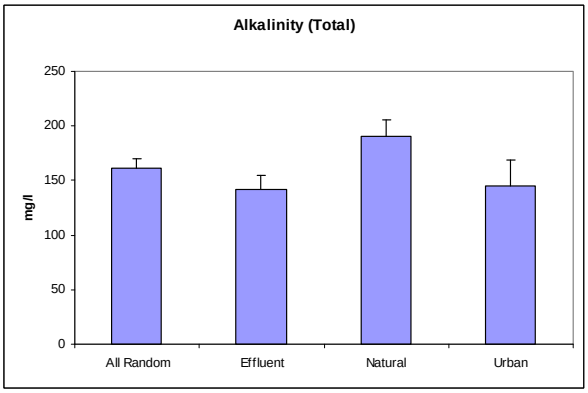

Thallium (Dissolved)
µg/l
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
All Random
Effluent
Natural
Urban

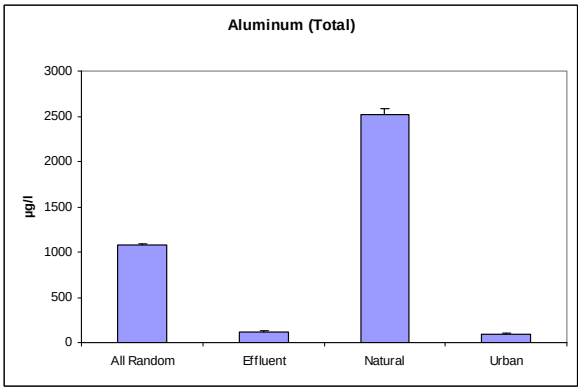

Tin (Dissolved)
µg/l
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
All Random
Effluent
Natural
Urban

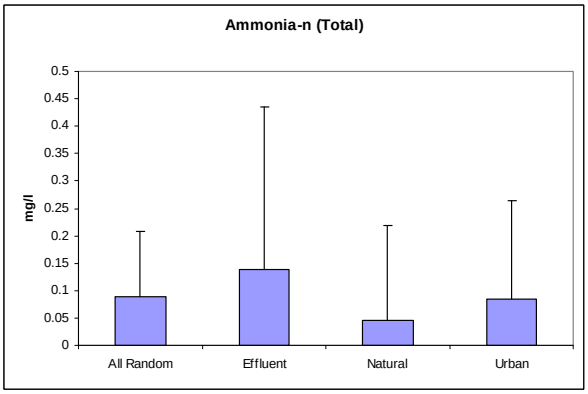

Titanium (Dissolved)
µg/l
45
40
35
30
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

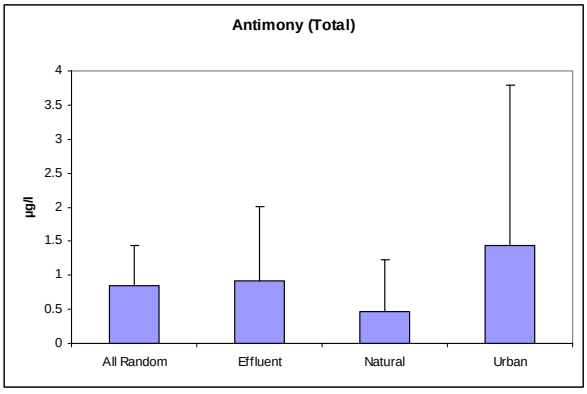

Vanadium (Dissolved)
µg/l
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
All Random
Effluent
Natural
Urban

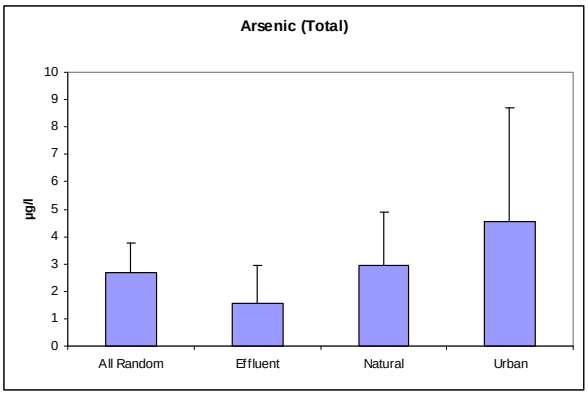

Zinc (Dissolved)
µg/l
60
50
40
30
20
10
0
All Random
Effluent
Natural
Urban

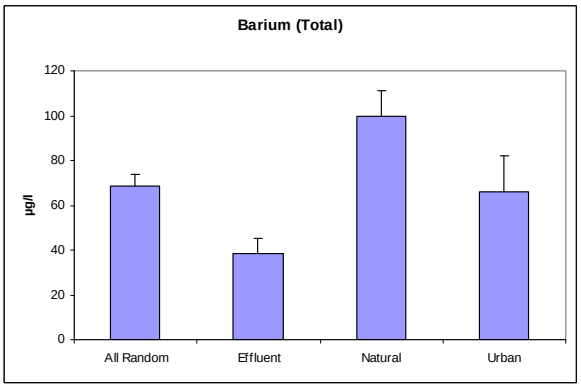

Alkalinity (Total)
mg/l
250
200
150
100
50
0
All Random
Effluent
Natural
Urban

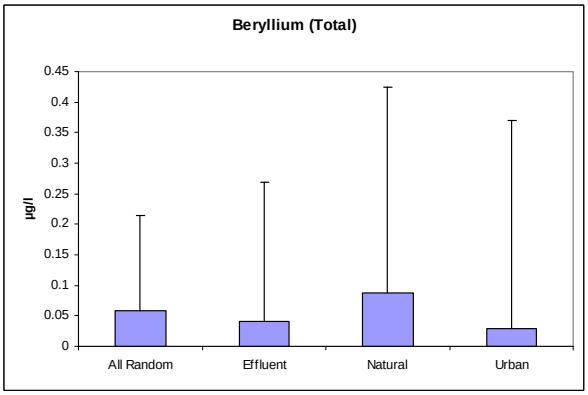

Aluminum (Total)
µg/l
3000
2500
2000
1500
1000
500
0
All Random
Effluent
Natural
Urban

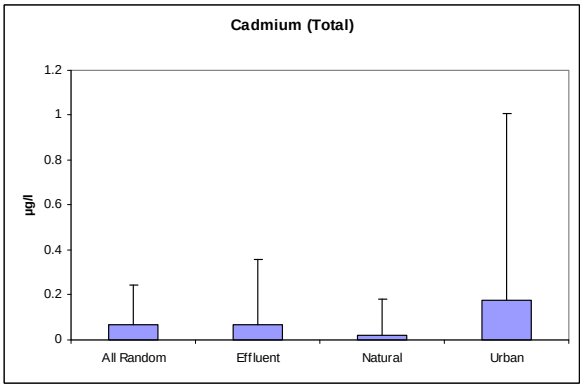

Ammonia-n (Total)
mg/l
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
All Random
Effluent
Natural
Urban

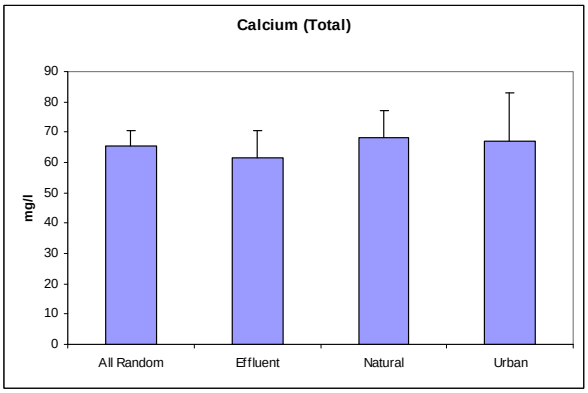

Antimony (Total)
µg/l
4
3.5
3
2.5
2
1.5
1
0.5
0
All Random
Effluent
Natural
Urban

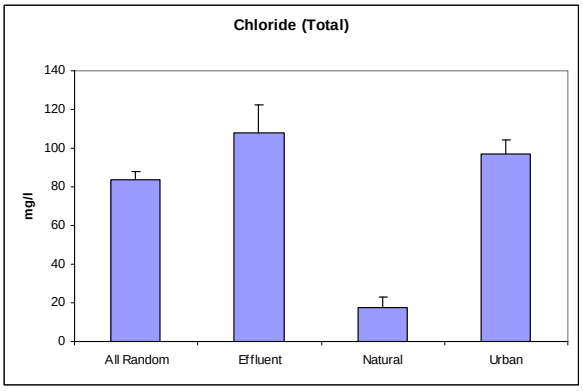

Arsenic (Total)
µg/l
0
1
2
3
4
5
6
7
8
9
10
All Random
Effluent
Natural
Urban

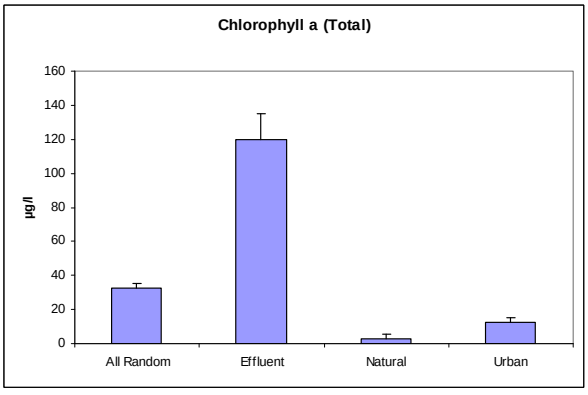

Barium (Total)
µg/l
0
20
40
60
80
100
120
All Random
Effluent
Natural
Urban

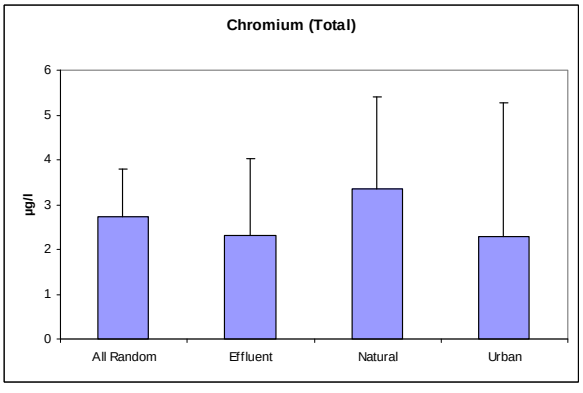

Beryllium (Total)
µg/l
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
All Random
Effluent
Natural
Urban

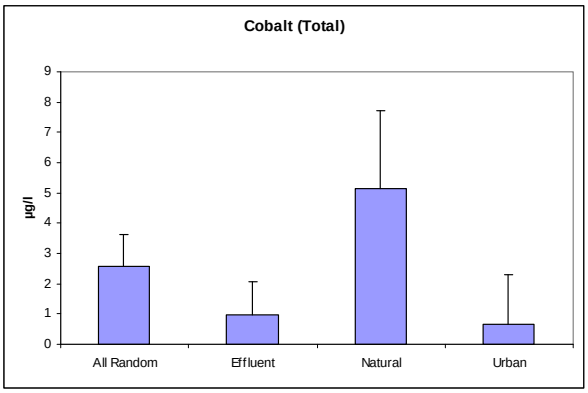

Cadmium (Total)
µg/l
0
0.2
0.4
0.6
0.8
1
1.2
All Random
Effluent
Natural
Urban

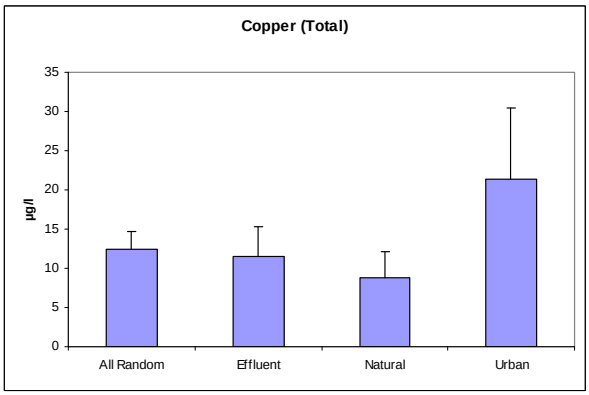

Calcium (Total)
mg/l
0
10
20
30
40
50
60
70
80
90
All Random
Effluent
Natural
Urban


Chloride (Total)
mg/l
0
20
40
60
80
100
120
140
All Random
Effluent
Natural
Urban

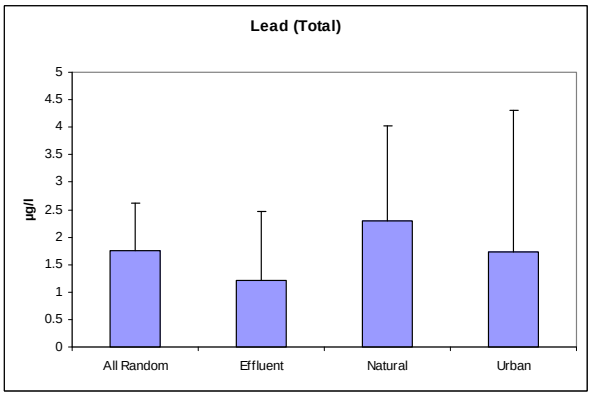

Chlorophyll a (Total)
µg/l
0
20
40
60
80
100
120
140
160
All Random
Effluent
Natural
Urban

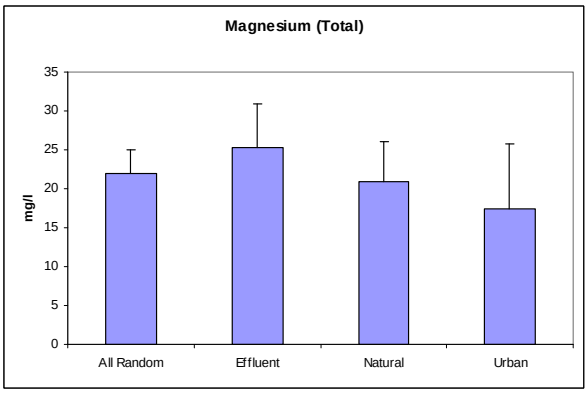

Chromium (Total)
µg/l
0
1
2
3
4
5
6
All Random
Effluent
Natural
Urban

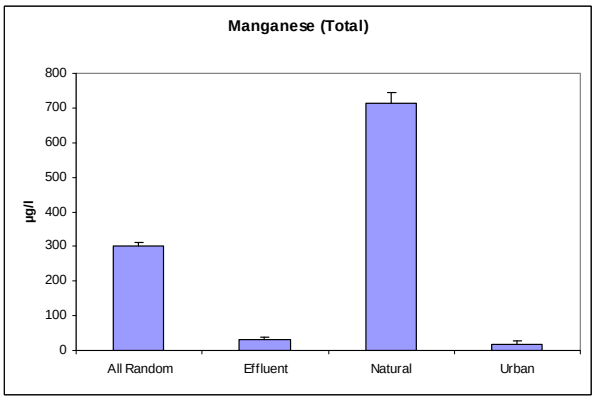

Cobalt (Total)
µg/l
9
8
7
6
5
4
3
2
1
0
All Random
Effluent
Natural
Urban

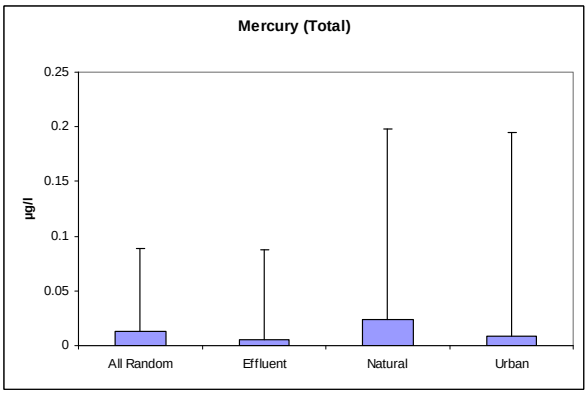

Copper (Total)
µg/l
35
30
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

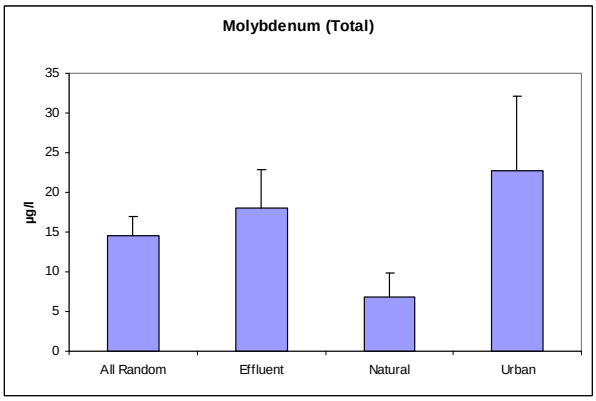
Iron (Total)
µg/l
8000
7000
6000
5000
4000
3000
2000
1000
0
All Random
Effluent
Natural
Urban

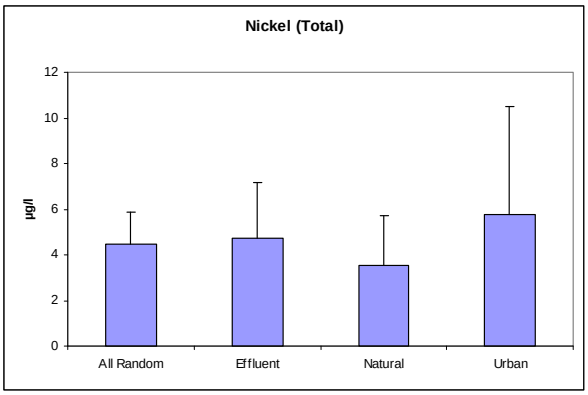

Lead (Total)
µg/l
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
All Random
Effluent
Natural
Urban

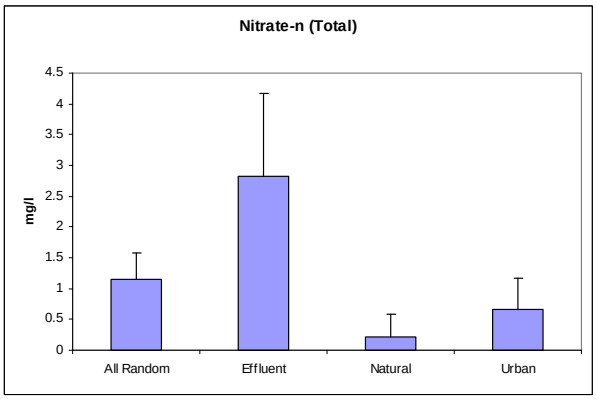

Magnesium (Total)
mg/l
35
30
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

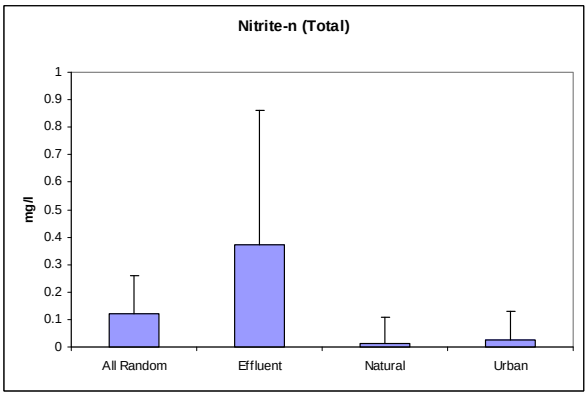

Manganese (Total)
µg/l
800
700
600
500
400
300
200
100
0
All Random
Effluent
Natural
Urban

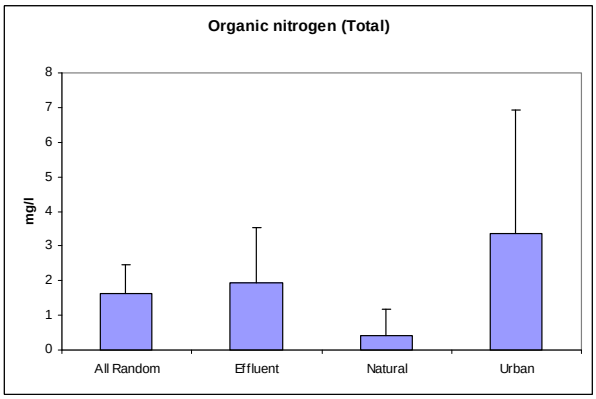

Mercury (Total)
µg/l
0.25
0.2
0.15
0.1
0.05
0
All Random
Effluent
Natural
Urban

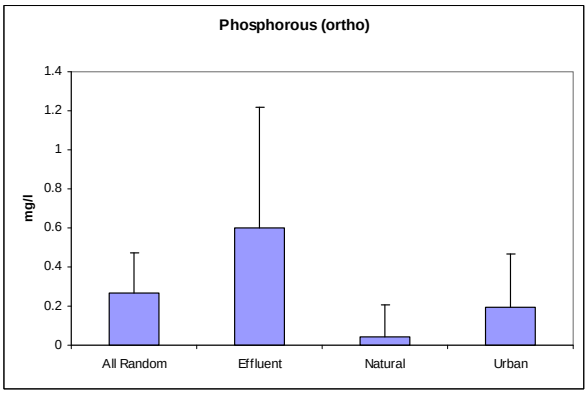

Molybdenum (Total)
µg/l
35
30
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

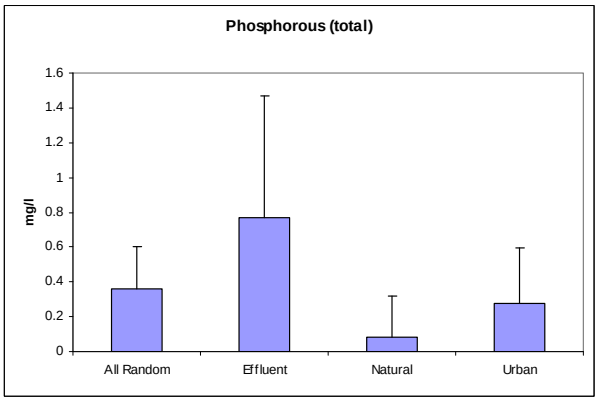

Nickel (Total)
µg/l
12
10
8
6
4
2
0
All Random
Effluent
Natural
Urban

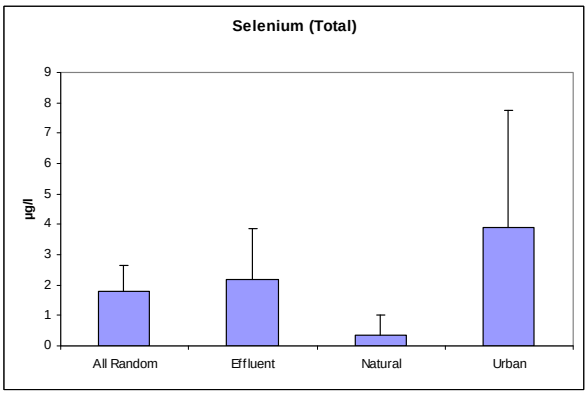

Nitrate-n (Total)
mg/l
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
All Random
Effluent
Natural
Urban

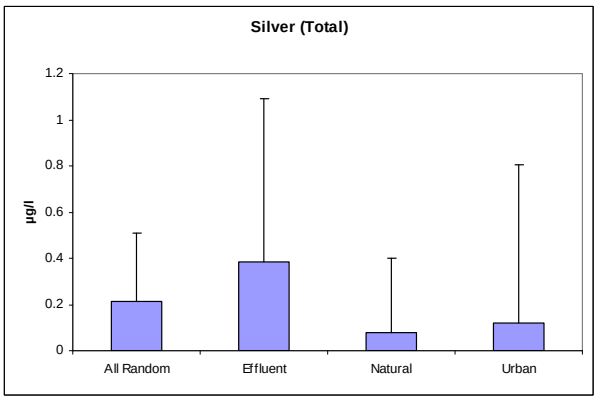

Nitrite-n (Total)
mg/l
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
All Random
Effluent
Natural
Urban

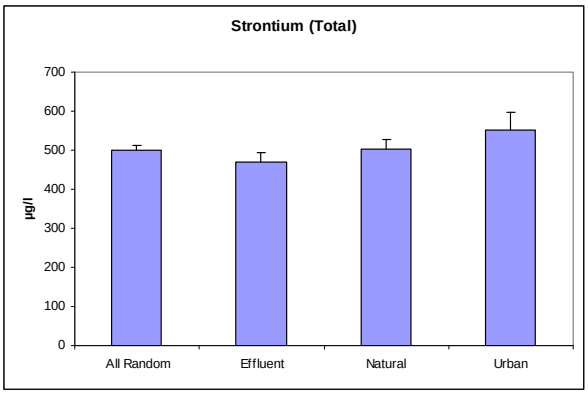

Organic nitrogen (Total)
mg/l
8
7
6
5
4
3
2
1
0
All Random
Effluent
Natural
Urban

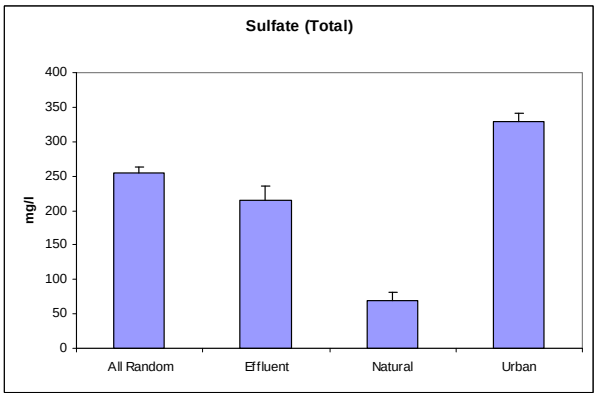

Phosphorous (ortho)
mg/l
1.4
1.2
1
0.8
0.6
0.4
0.2
0
All Random
Effluent
Natural
Urban

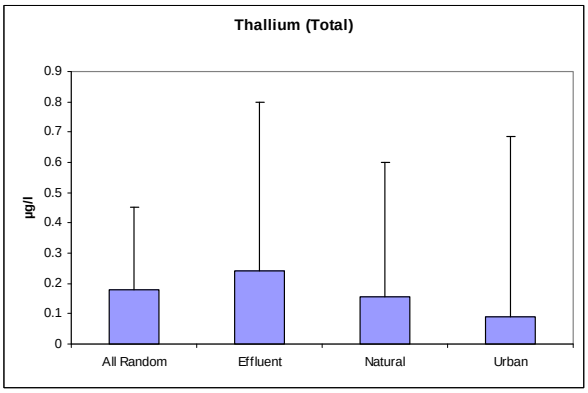

Phosphorous (total)
mg/l
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
All Random
Effluent
Natural
Urban

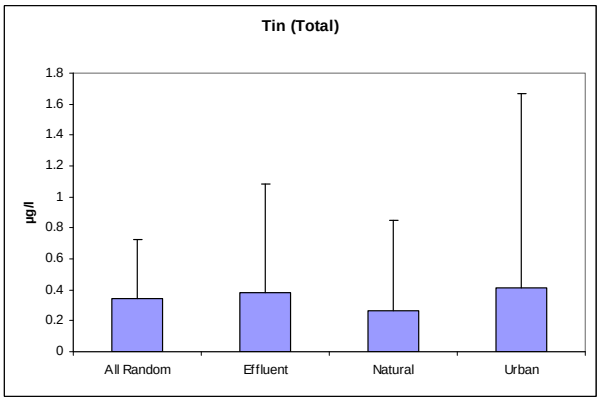

Selenium (Total)
µg/l
9
8
7
6
5
4
3
2
1
0
All Random
Effluent
Natural
Urban

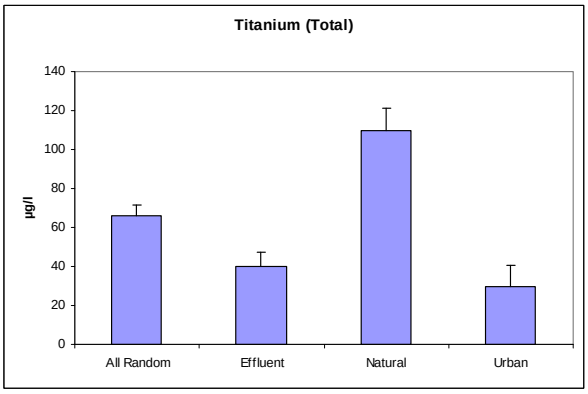

Silver (Total)
µg/l
1.2
1
0.8
0.6
0.4
0.2
0
All Random
Effluent
Natural
Urban

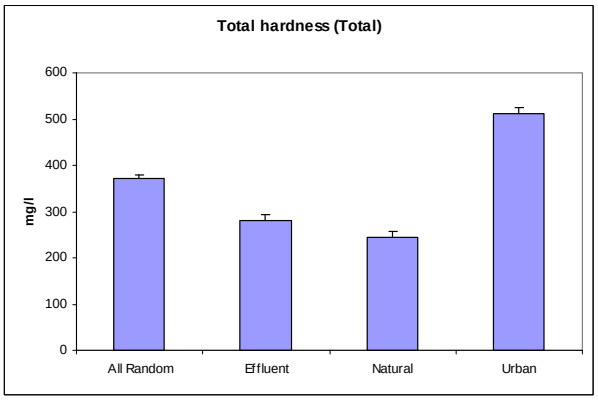

Strontium (Total)
µg/l
700
600
500
400
300
200
100
0
All Random
Effluent
Natural
Urban

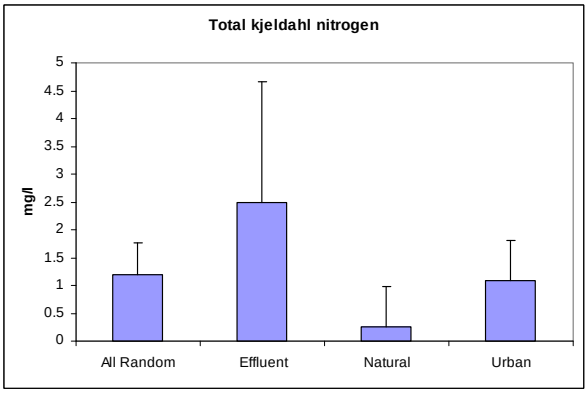

Sulfate (Total)
mg/l
400
350
300
250
200
150
100
50
0
All Random
Effluent
Natural
Urban

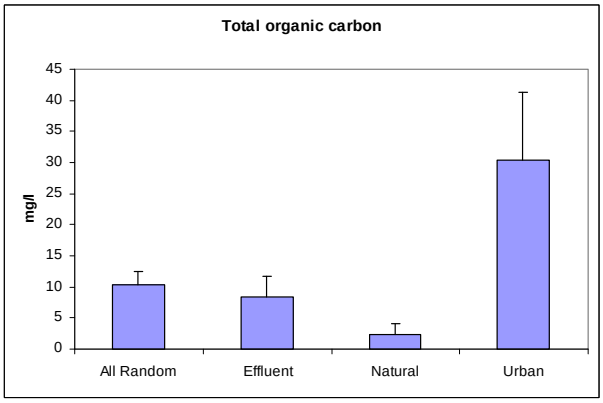

Thallium (Total)
µg/l
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
All Random
Effluent
Natural
Urban

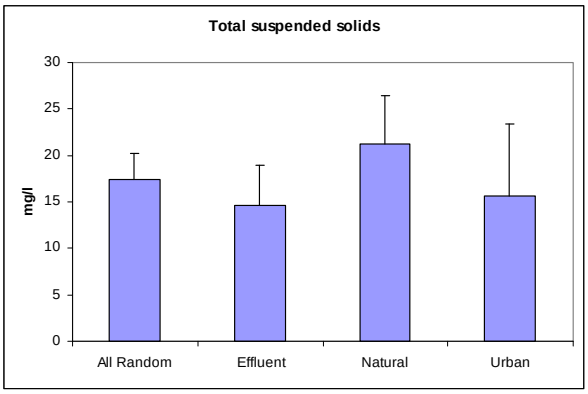

Tin (Total)
µg/l
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
All Random
Effluent
Natural
Urban

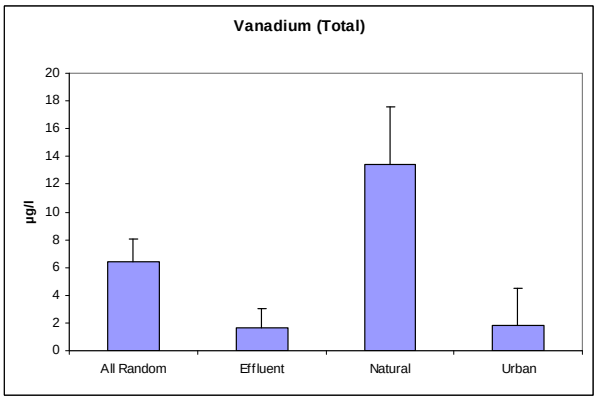

Titanium (Total)
µg/l
140
120
100
80
60
40
20
0
All Random
Effluent
Natural
Urban

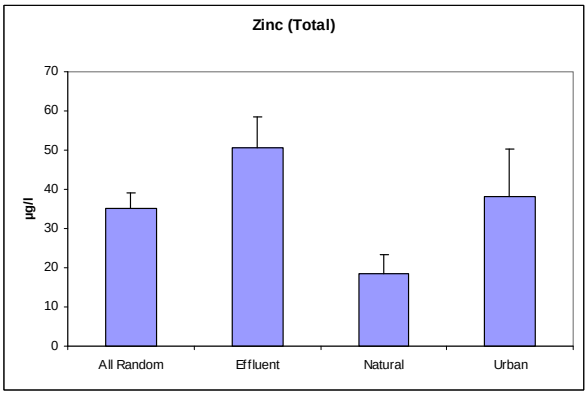

Total hardness (Total)
mg/l
600
500
400
300
200
100
0
All Random
Effluent
Natural
Urban


Total kjeldahl nitrogen
mg/l
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
All Random
Effluent
Natural
Urban


Total organic carbon
mg/l
45
40
35
30
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

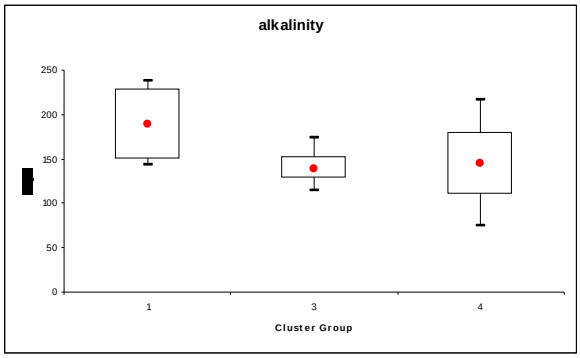

Total suspended solids
mg/l
30
25
20
15
10
5
0
All Random
Effluent
Natural
Urban

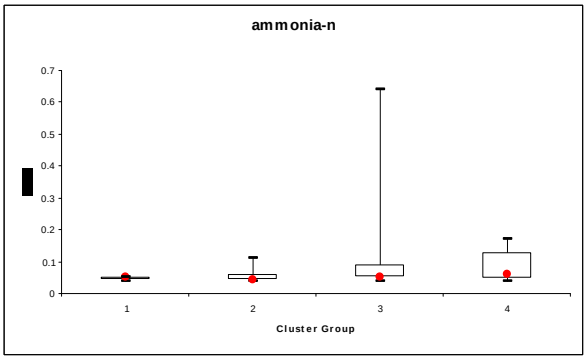

Vanadium (Total)
µg/l
20
18
16
14
12
10
8
6
4
2
0
All Random
Effluent
Natural
Urban

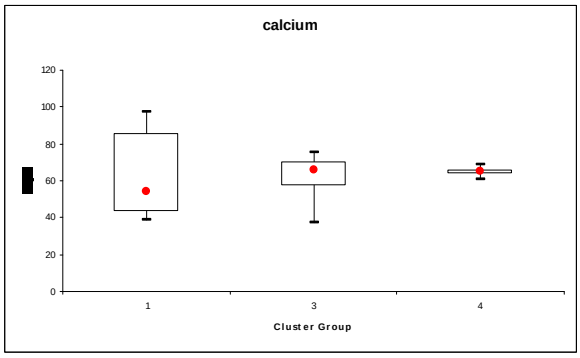

Zinc (Total)
µg/l
70
60
50
40
30
20
10
0
All Random
Effluent
Natural
Urban

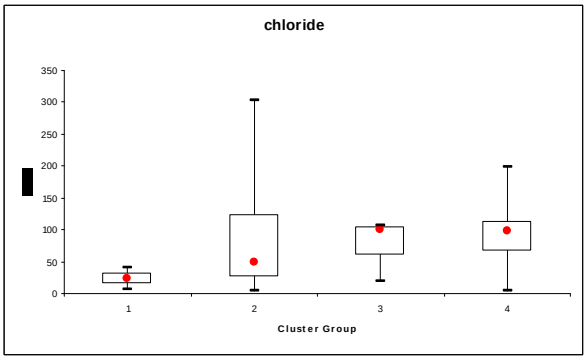
Appendix 4: Average Concentrations in Cluster Site Groups

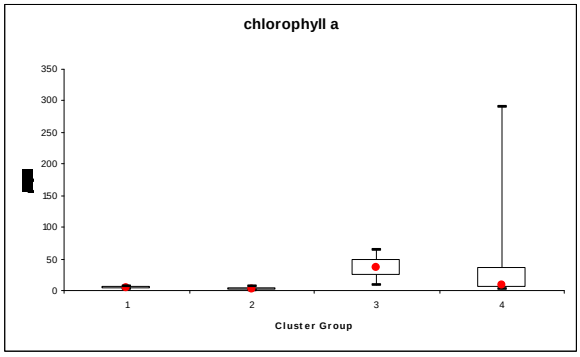
Box and whisker plots showing the median and range of IBI and chemistry variables for sites within each of the site groups from the cluster analysis illustrated in Figures 6 and 7 in the main body of the report, using available data from the random sites sampled in 2005 and 2008.

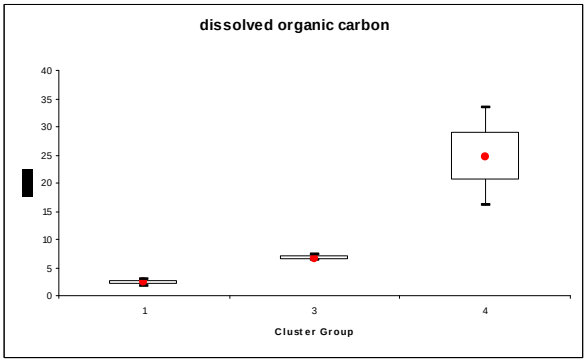


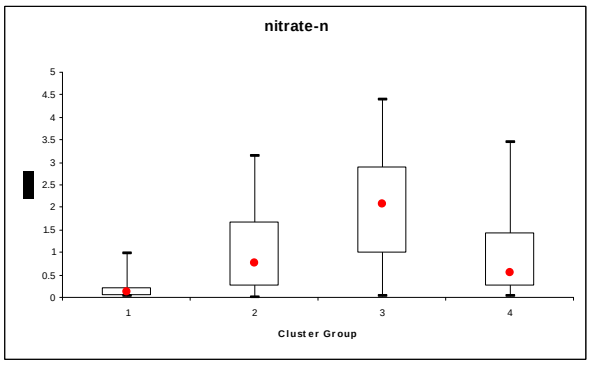


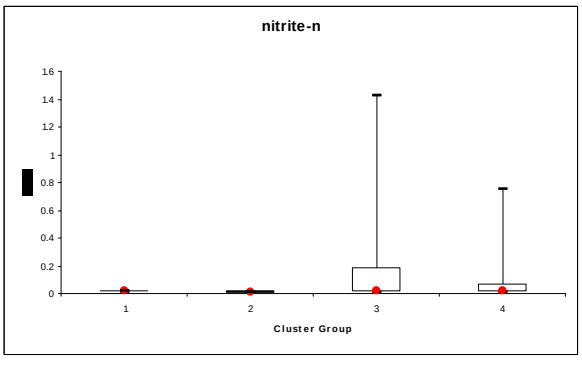


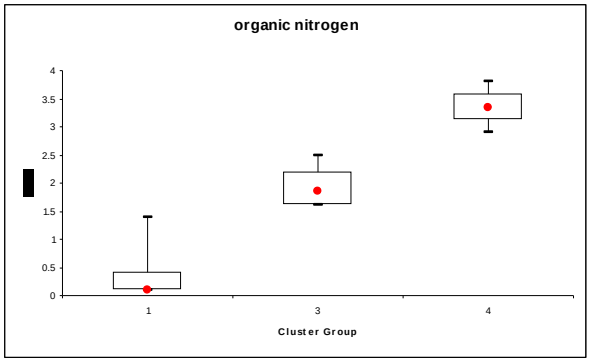


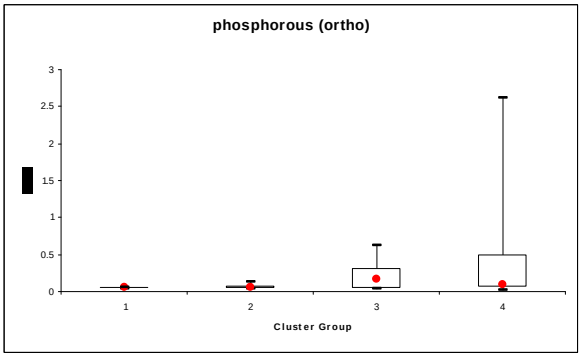


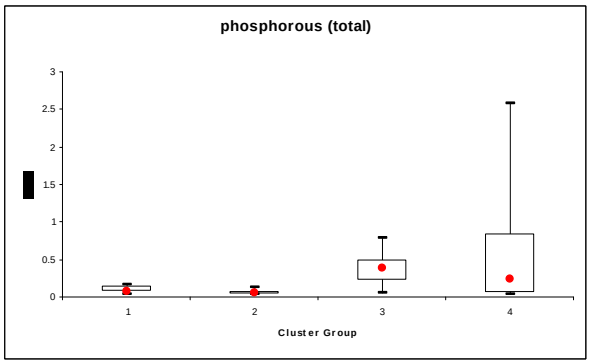


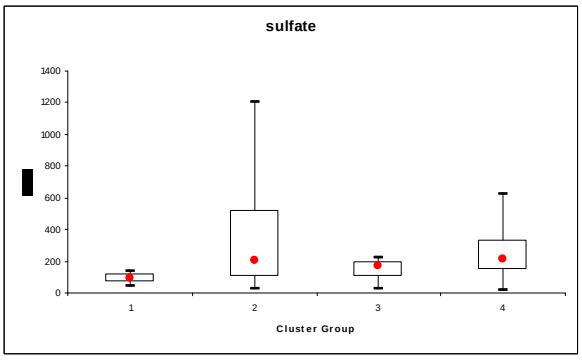


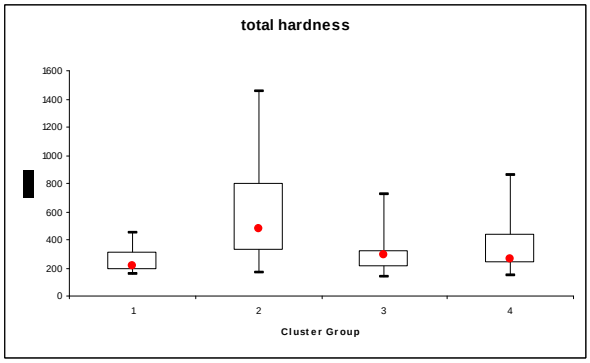


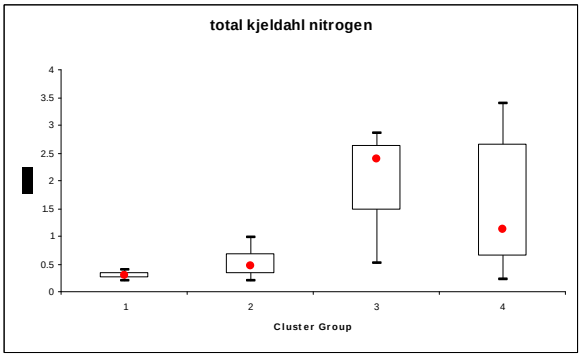

organic nitrogen
Cluster Group

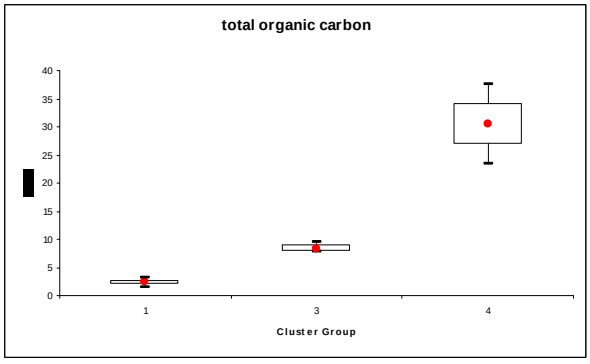

phosphorous (ortho)
Cluster Group

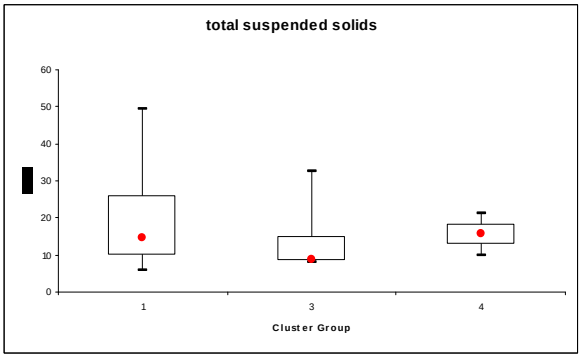

phosphorous (total)
Cluster Group


sulfate
Cluster Group


total hardness
Cluster Group

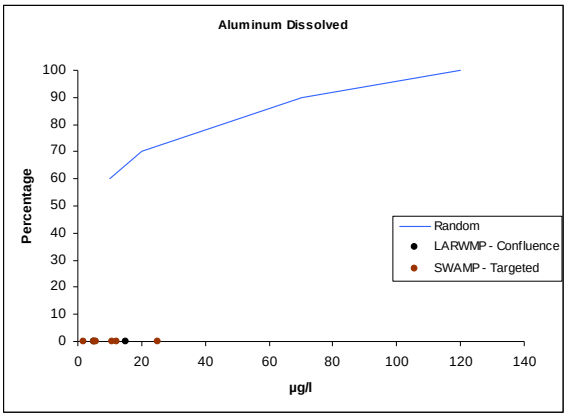

total kjeldahl nitrogen
Cluster Group

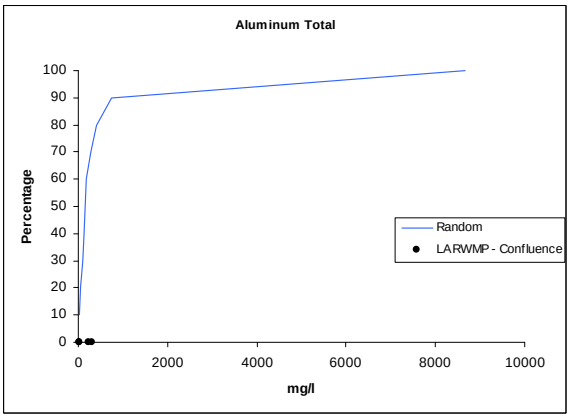

total organic carbon
Cluster Group

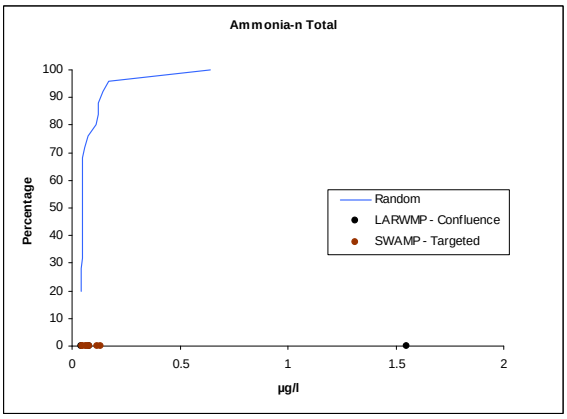

total suspended solids
Cluster Group

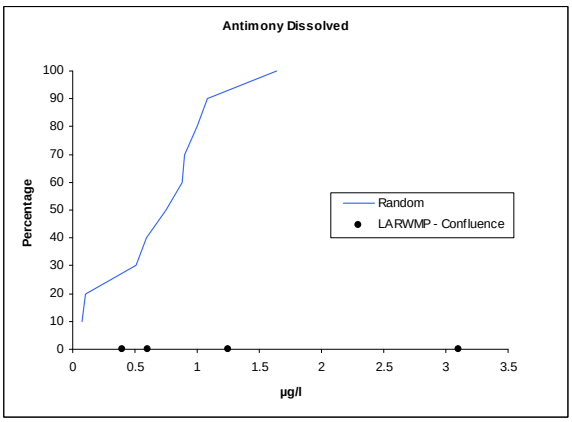
Appendix 5: Cumulative Frequency Distributions

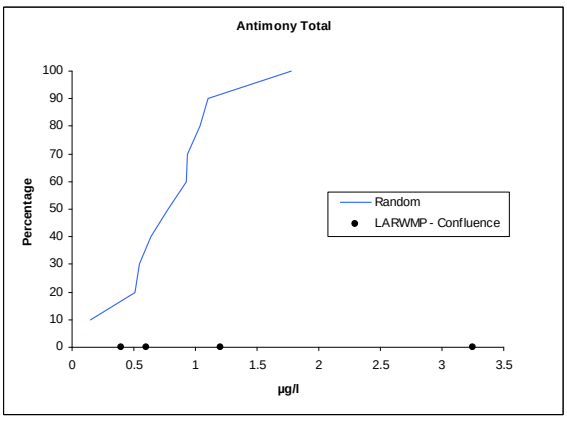
Cumulative frequency distributions illustrating the relationship of the values of all measured parameters measured at targeted and permit-mandated monitoring stations to the ambient background represented by the random watershed sites.

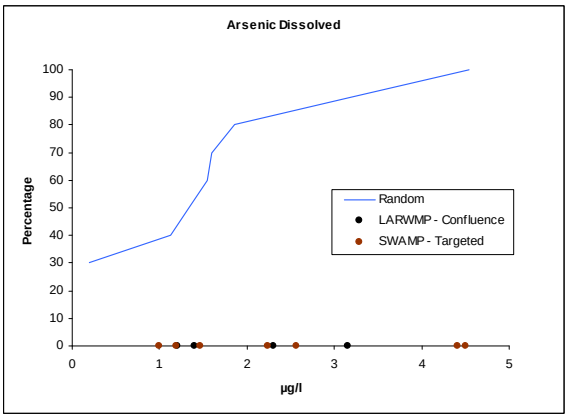


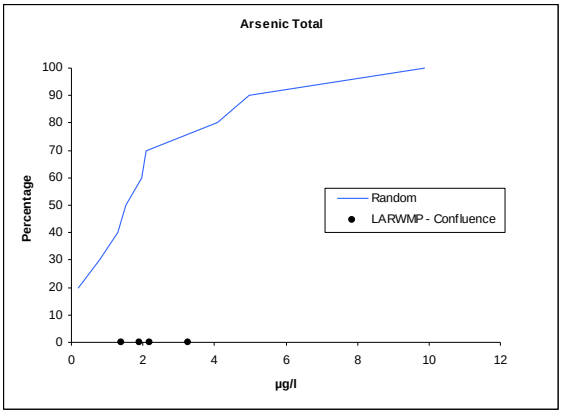


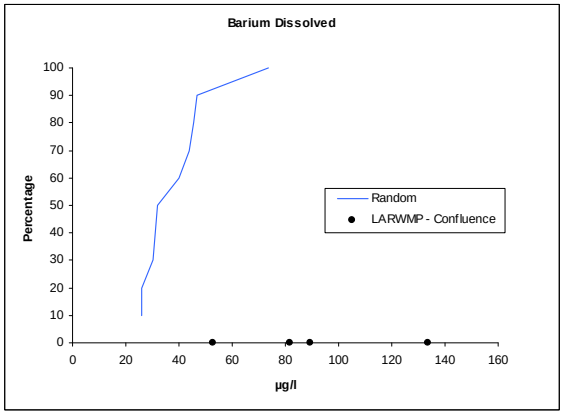


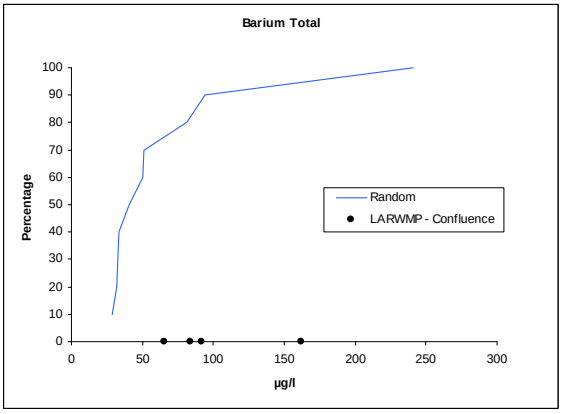


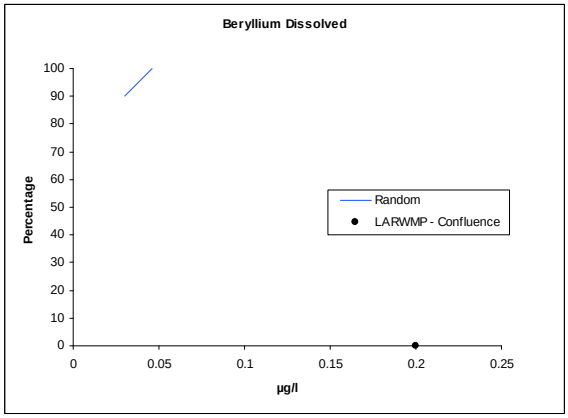


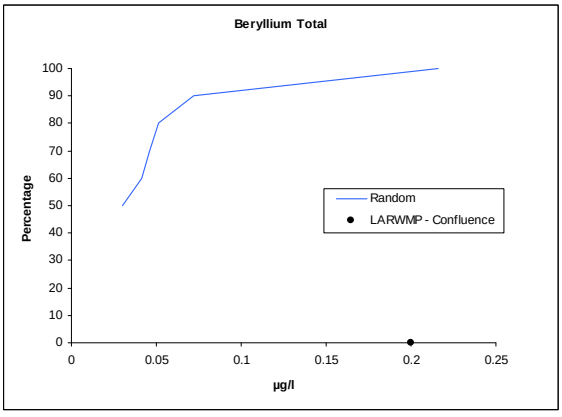


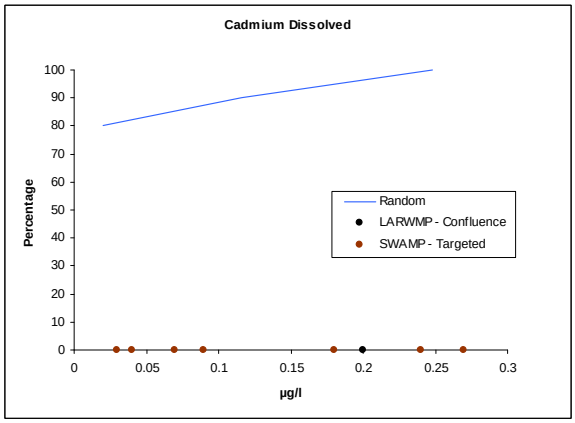

Arsenic Total
Percentage
µg/l
Random
LARWMP - Confluence

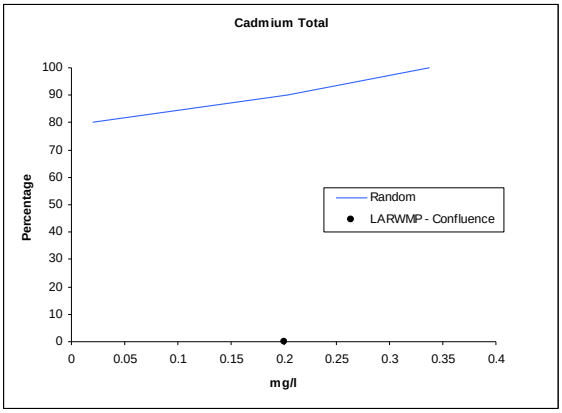

Barium Dissolved
Percentage
µg/l
Random
LARWMP - Confluence

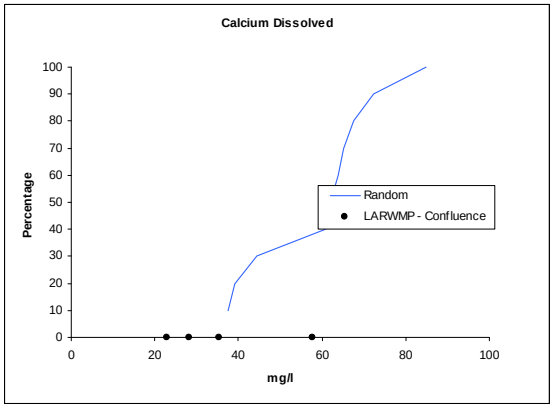

Barium Total
Percentage
µg/l
Random
LARWMP - Confluence

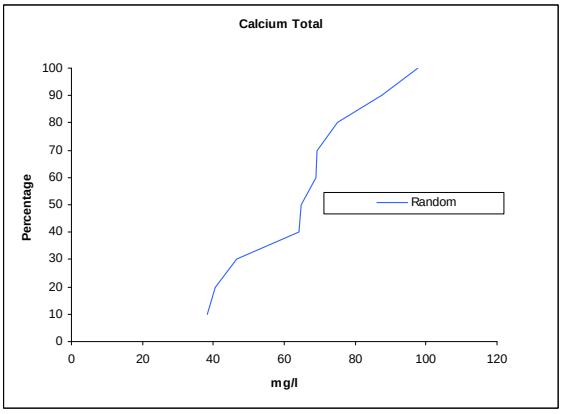

Beryllium Dissolved
Percentage
µg/l
Random
LARWMP - Confluence

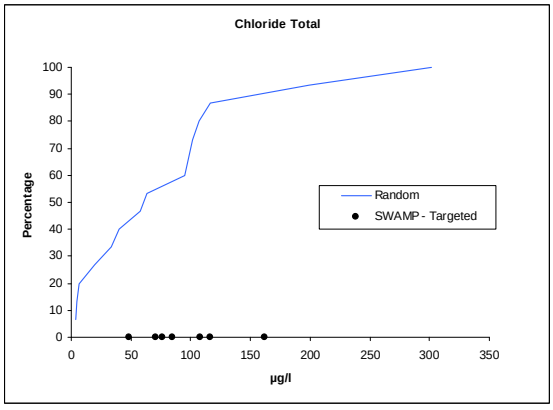

Beryllium Total
Percentage
µg/l
Random
LARWMP - Confluence

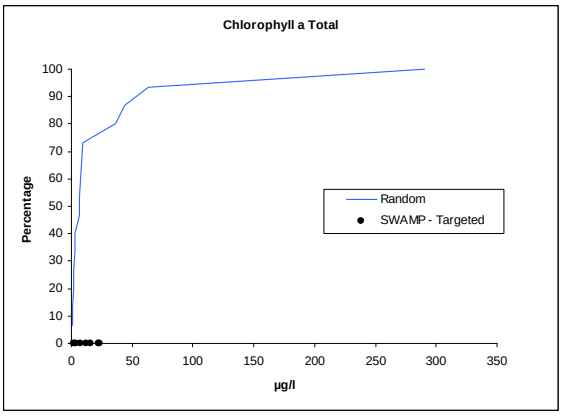

Cadmium Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
SWAMP - Targeted

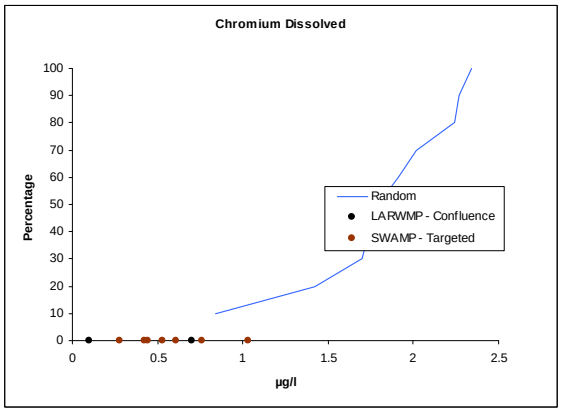

Cadmium Total
Percentage
mg/l
Random
LARWMP - Confluence

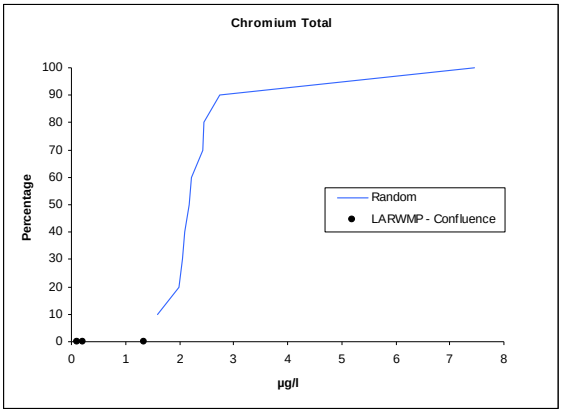

Calcium Dissolved
Percentage
mg/l
Random
LARWMP - Confluence

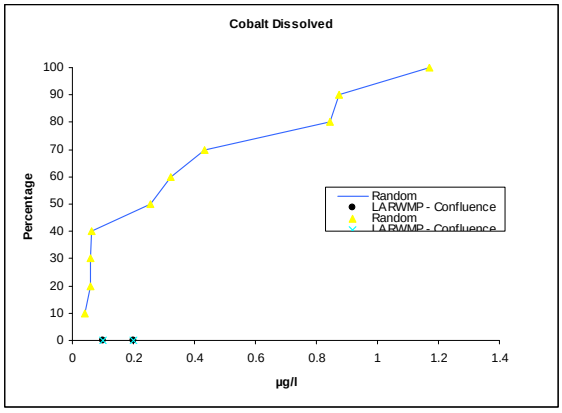

Calcium Total
Percentage
mg/l
Random

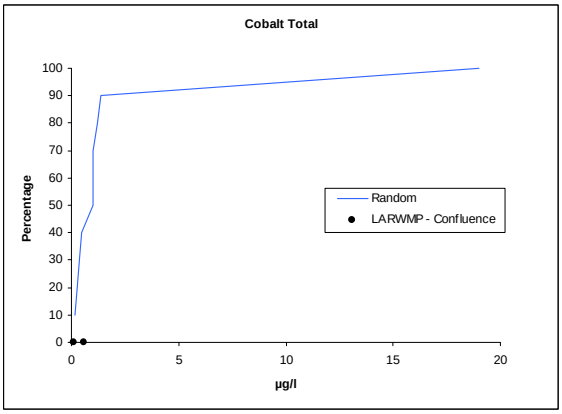

Chloride Total
Percentage
µg/l
Random
SWAMP - Targeted

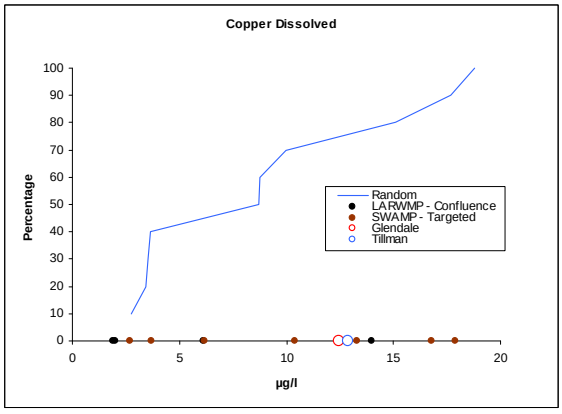

Chlorophyll a Total
Percentage
µg/l
Random
SWAMP - Targeted

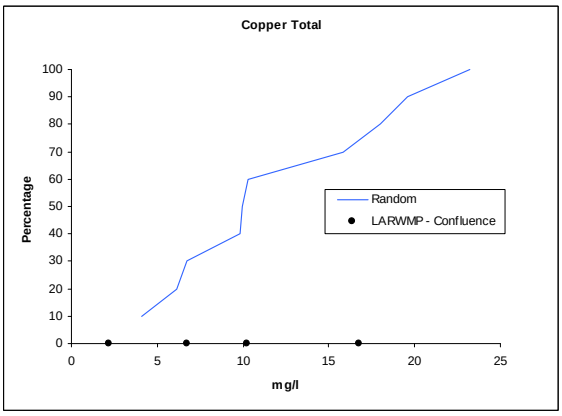

Chromium Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
SWAMP - Targeted

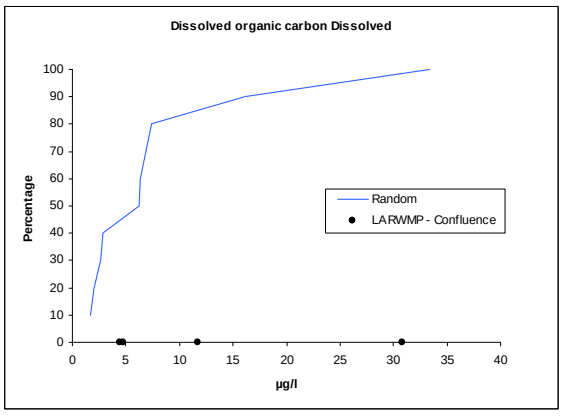

Chromium Total
Percentage
µg/l
Random
LARWMP - Confluence

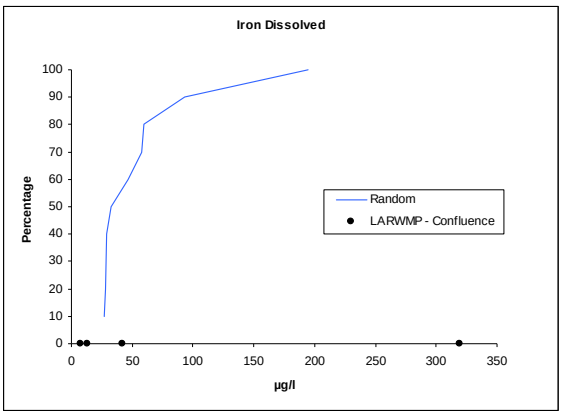

Cobalt Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
Random

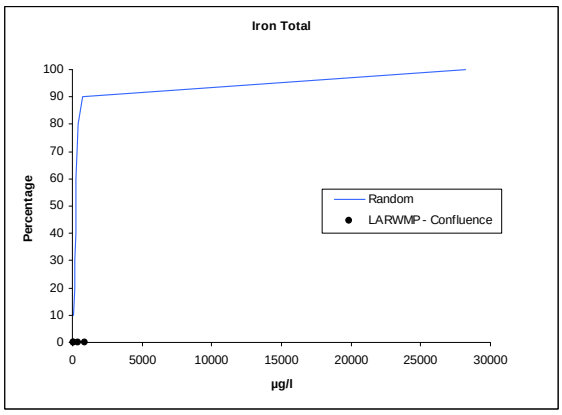

Cobalt Total
Percentage
µg/l
Random
LARWMP - Confluence

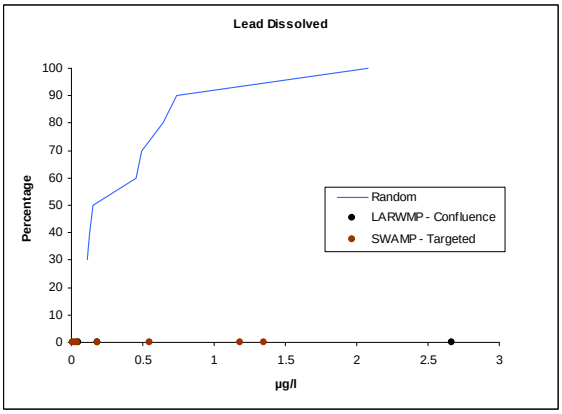

Copper Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
SWAMP - Targeted
Glendale
Tillman

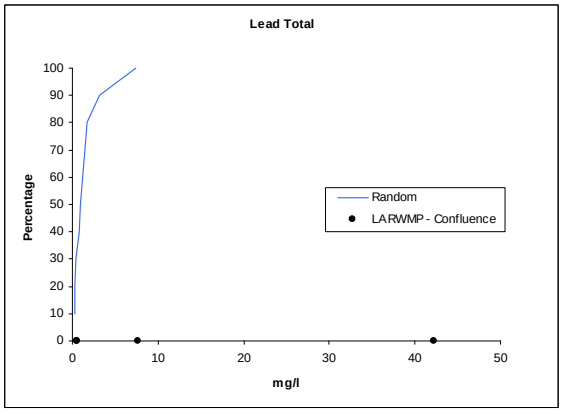

Copper Total
Percentage
mg/l
Random
LARWMP - Confluence

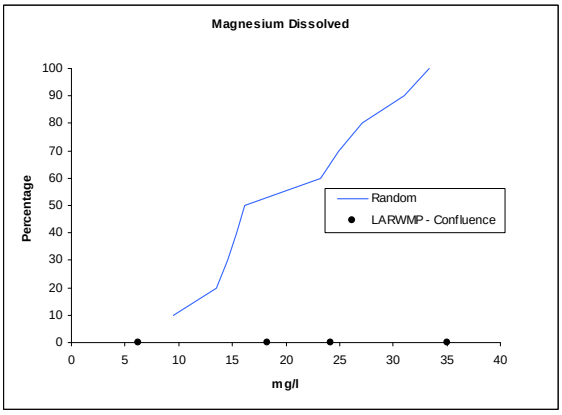

Dissolved organic carbon Dissolved
Percentage
µg/l
Random
LARWMP - Confluence

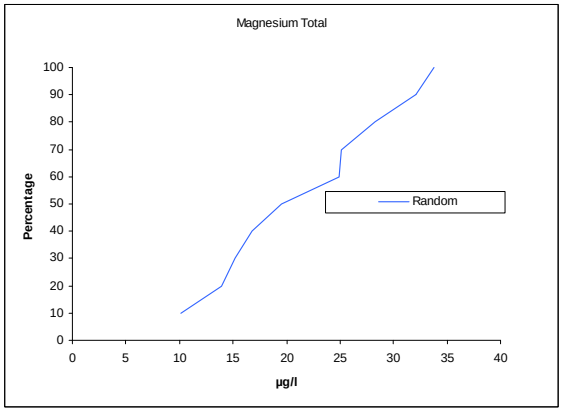

Iron Dissolved
Percentage
µg/l
Random
LARWMP - Confluence

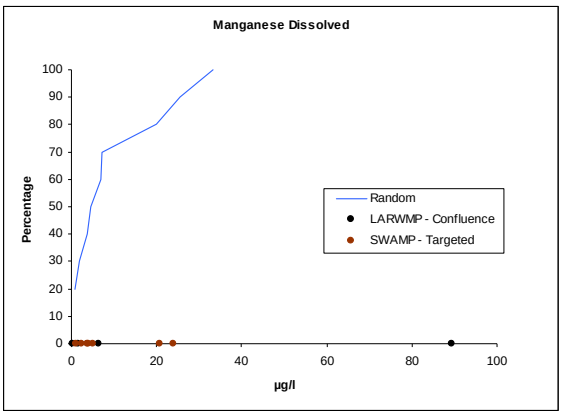

Iron Total
Percentage
µg/l
Random
LARWMP - Confluence

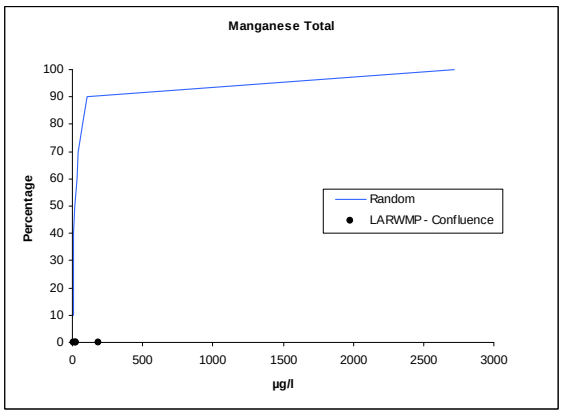

Lead Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
SWAMP - Targeted

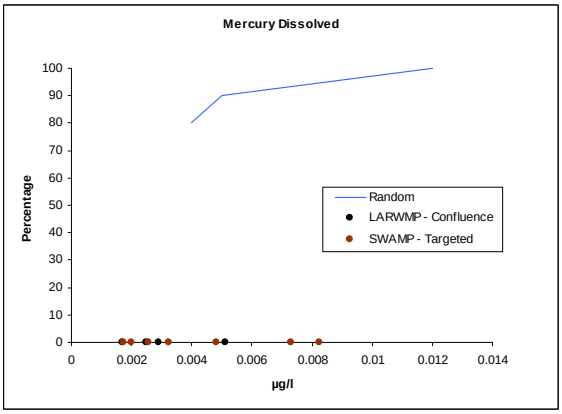

Lead Total
Percentage
mg/l
Random
LARWMP - Confluence

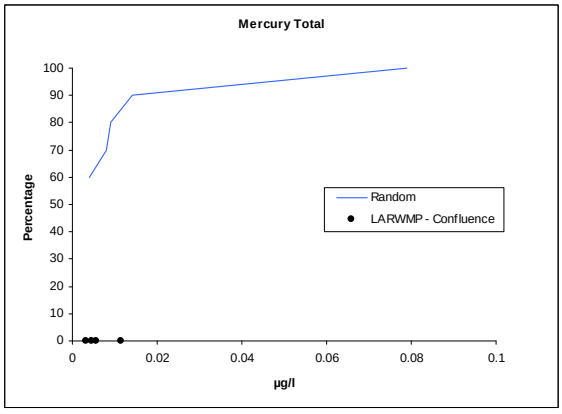

Magnesium Dissolved
Percentage
mg/l
Random
LARWMP - Confluence

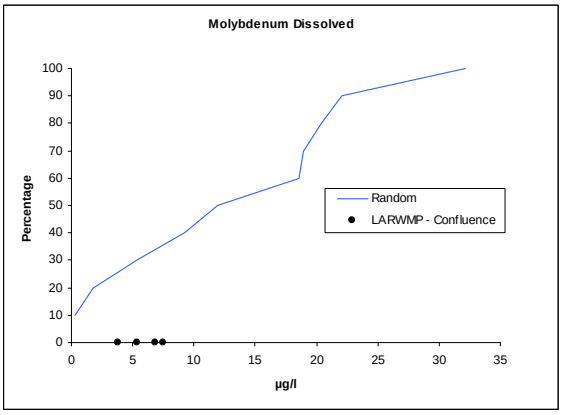

Magnesium Total
Percentage
µg/l
Random

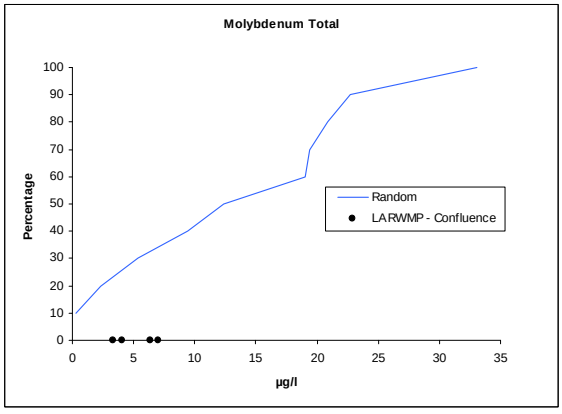

Manganese Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
SWAMP - Targeted

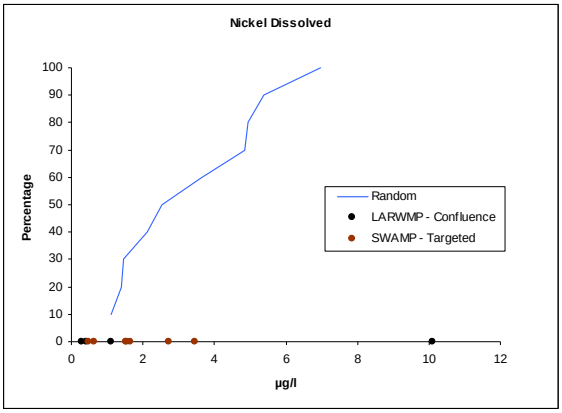

Manganese Total
Percentage
µg/l
Random
LARWMP - Confluence

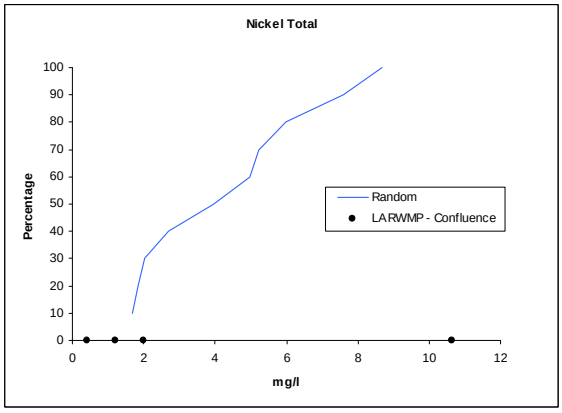

Mercury Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
SWAMP - Targeted

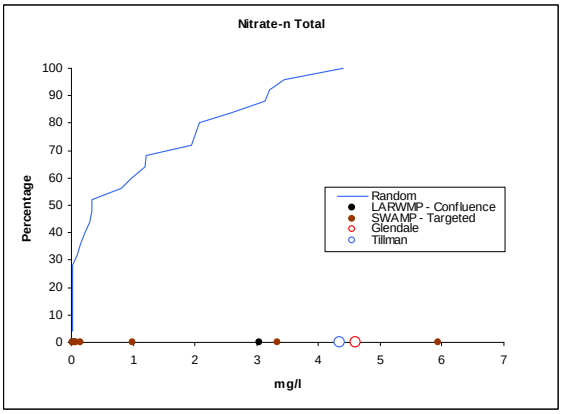

Mercury Total
Percentage
µg/l
Random
LARWMP - Confluence

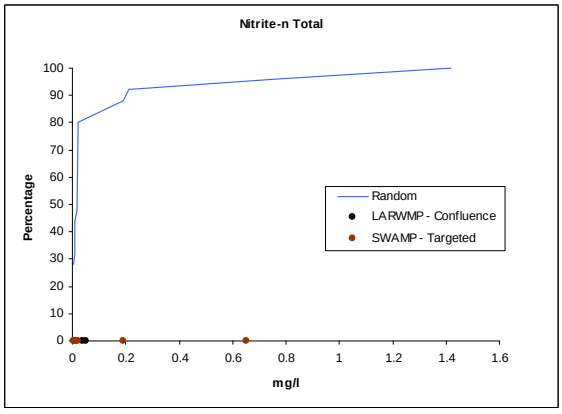

Molybdenum Dissolved
Percentage
µg/l
Random
LARWMP - Confluence

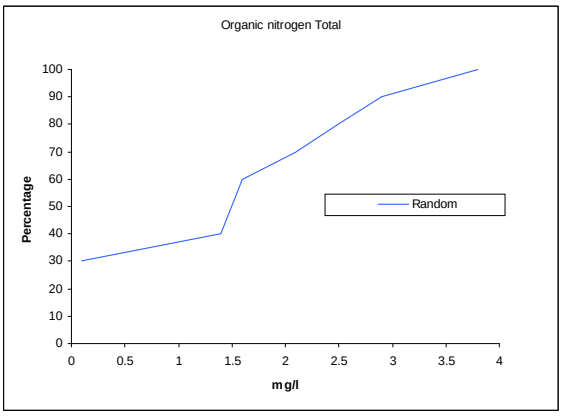

Molybdenum Total
Percentage
µg/l
Random
LARWMP - Confluence

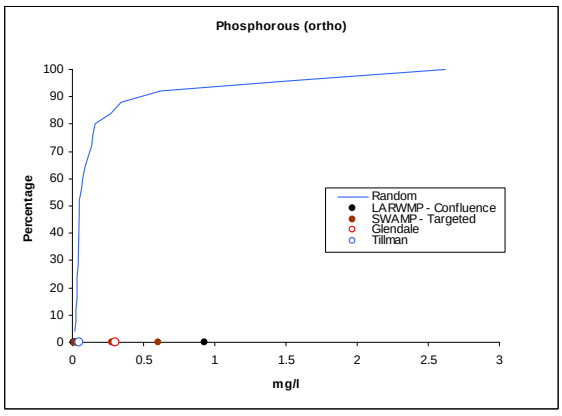

Nickel Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
SWAMP - Targeted

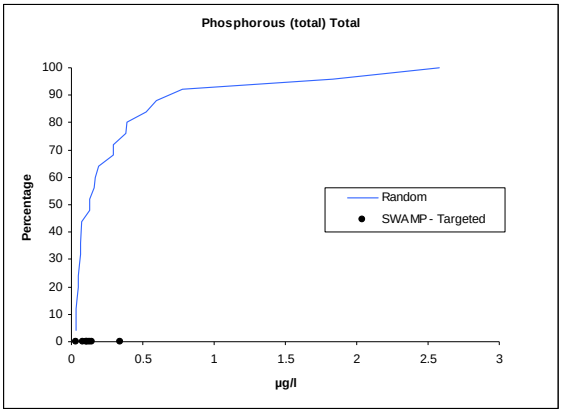

Nickel Total
Percentage
mg/l
Random
LARWMP - Confluence

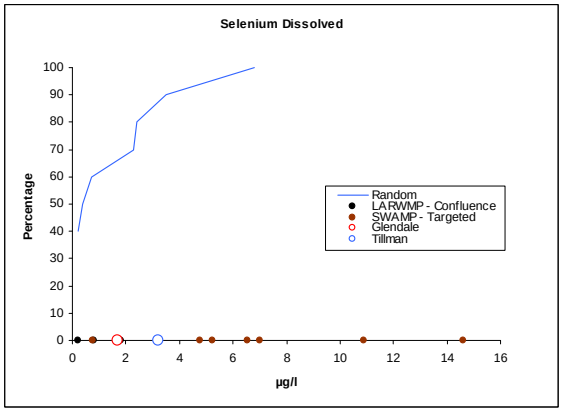

Nitrate-n Total
Percentage
mg/l
Random
LARWMP - Confluence
SWAMP - Targeted
Glendale
Tillman

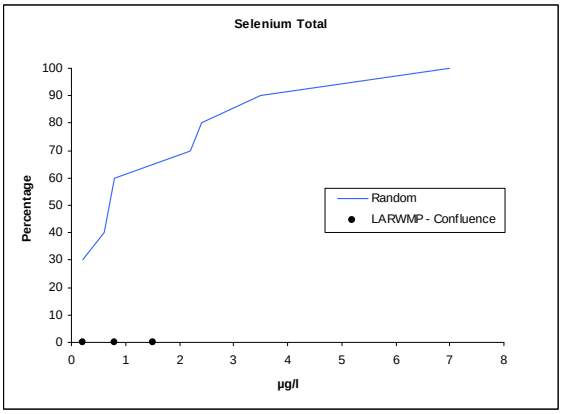

Nitrite-n Total
Percentage
mg/l
Random
LARWMP - Confluence
SWAMP - Targeted

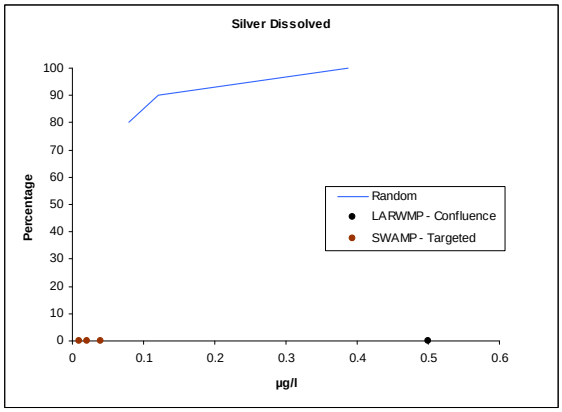

Organic nitrogen Total
Percentage
mg/l
Random

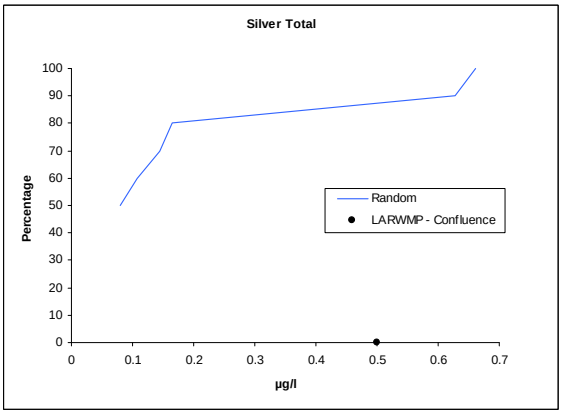

Phosphorous (ortho)
Percentage
mg/l
Random
LARWMP - Confluence
SWAMP - Targeted
Glendale
Tillman

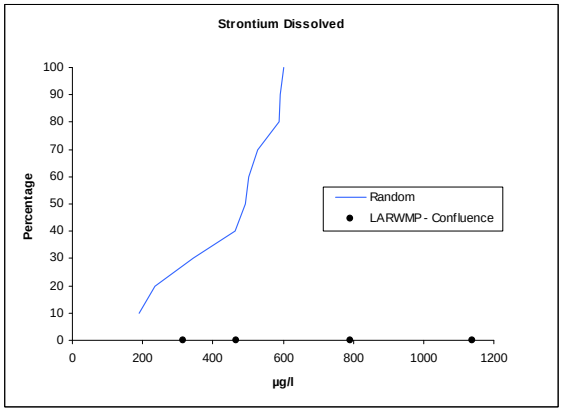

Phosphorous (total) Total
Percentage
µg/l
Random
SWAMP - Targeted

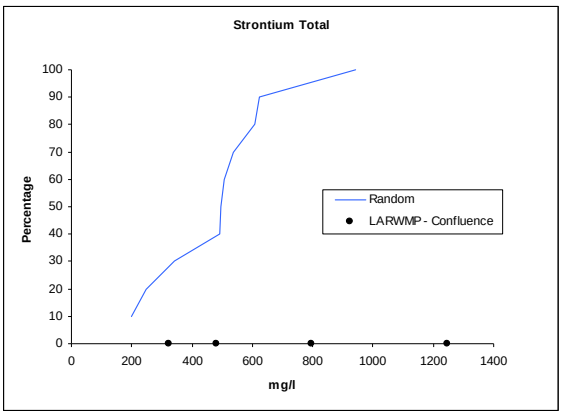

Selenium Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
SWAMP - Targeted
Glendale
Tillman

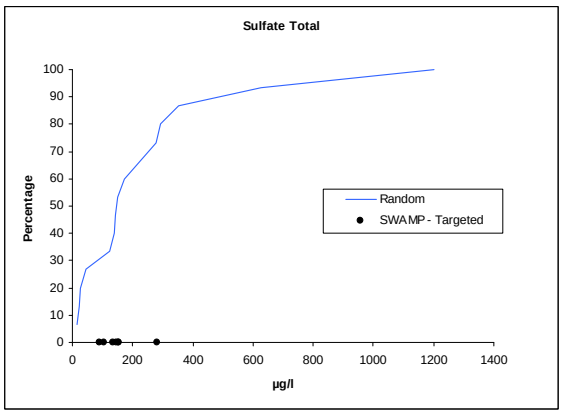

Selenium Total
Percentage
µg/l
Random
LARWMP - Confluence

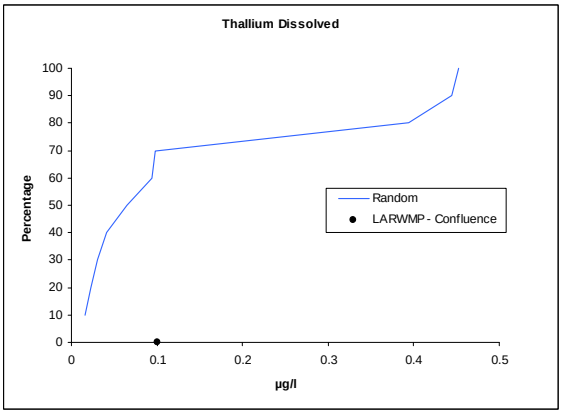

Silver Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
SWAMP - Targeted

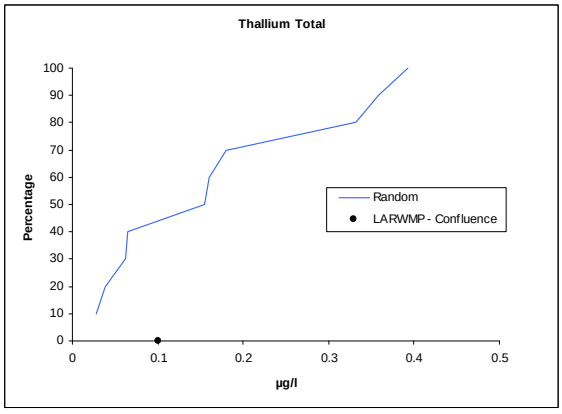

Silver Total
Percentage
µg/l
Random
LARWMP - Confluence

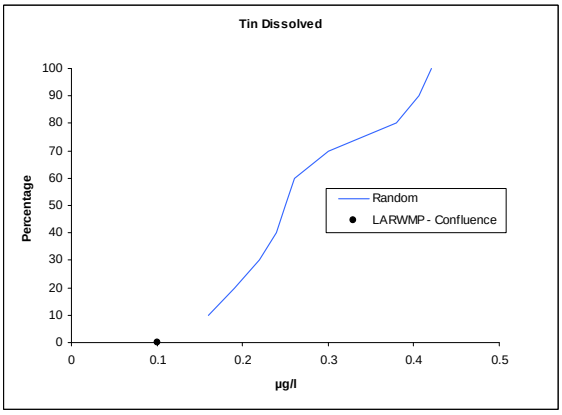

Strontium Dissolved
Percentage
µg/l
Random
LARWMP - Confluence

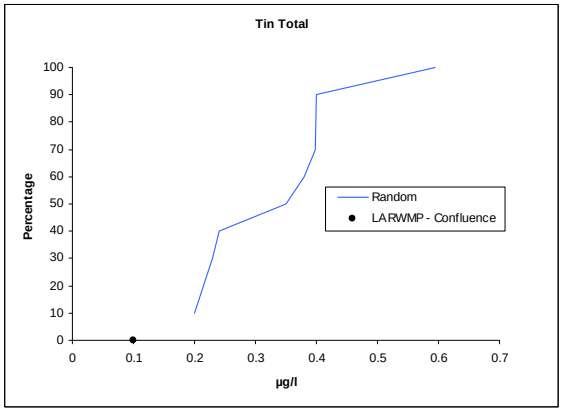

Strontium Total
Percentage
mg/l
Random
LARWMP - Confluence

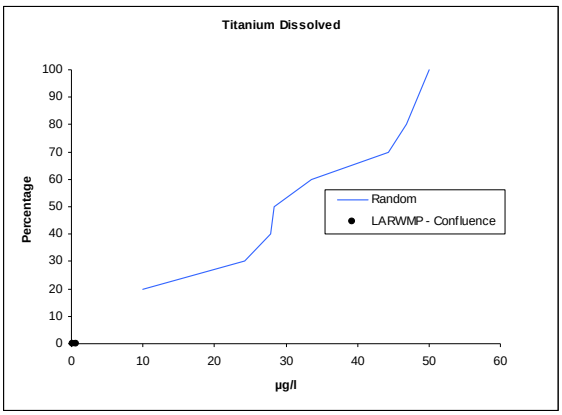

Sulfate Total
Percentage
µg/l
Random
SWAMP - Targeted

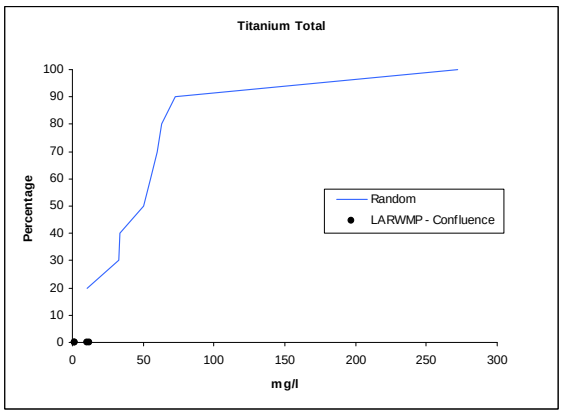

Thallium Dissolved
Percentage
µg/l
Random
LARWMP - Confluence

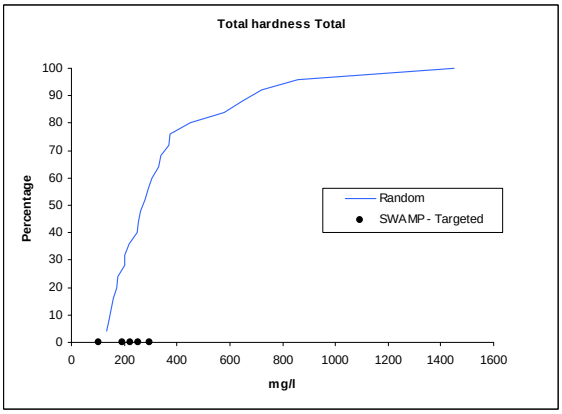

Thallium Total
Percentage
µg/l
Random
LARWMP - Confluence

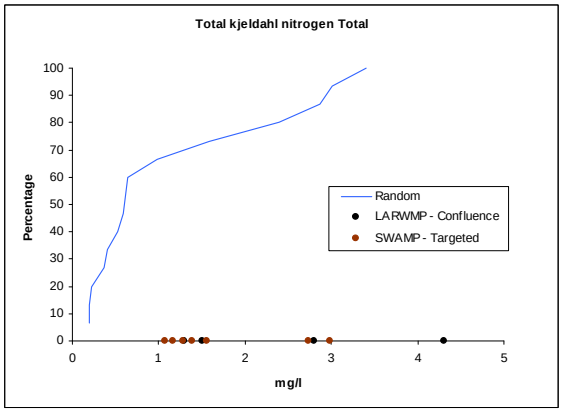

Tin Dissolved
Percentage
µg/l
Random
LARWMP - Confluence

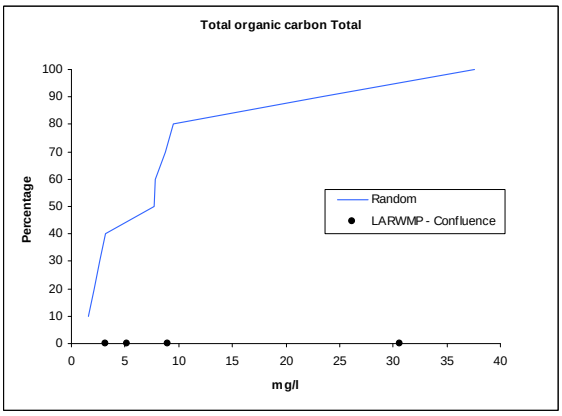

Tin Total
Percentage
µg/l
Random
LARWMP - Confluence

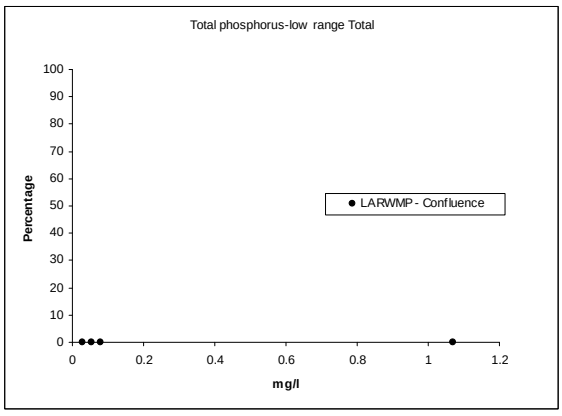

Titanium Dissolved
Percentage
µg/l
Random
LARWMP - Confluence

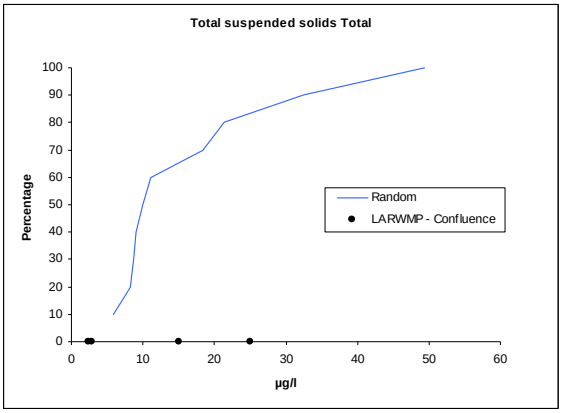

Titanium Total
Percentage
mg/l
Random
LARWMP - Confluence

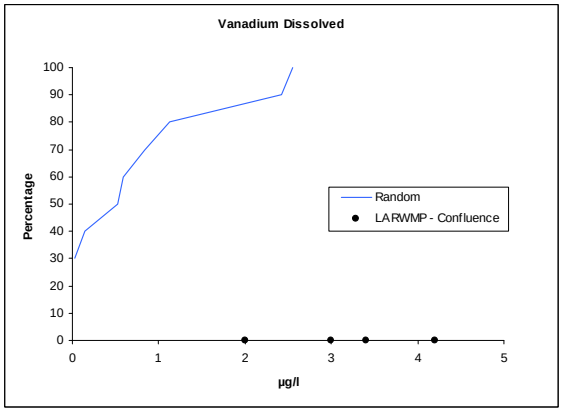

Total hardness Total
Percentage
mg/l
Random
SWAMP - Targeted

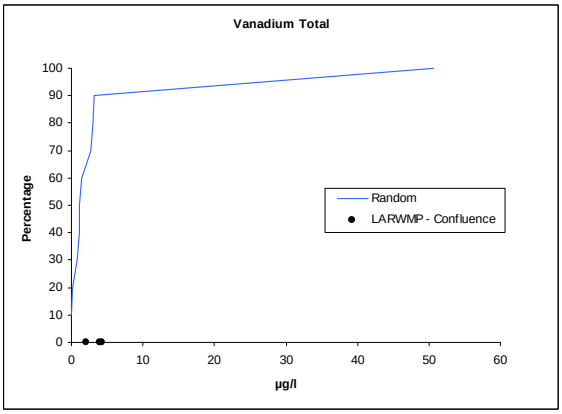

Total kjeldahl nitrogen Total
Percentage
mg/l
Random
LARWMP - Confluence
SWAMP - Targeted

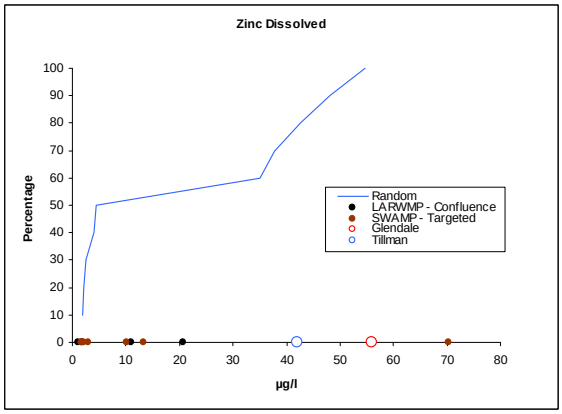

Total organic carbon Total
Percentage
mg/l
Random
LARWMP - Confluence

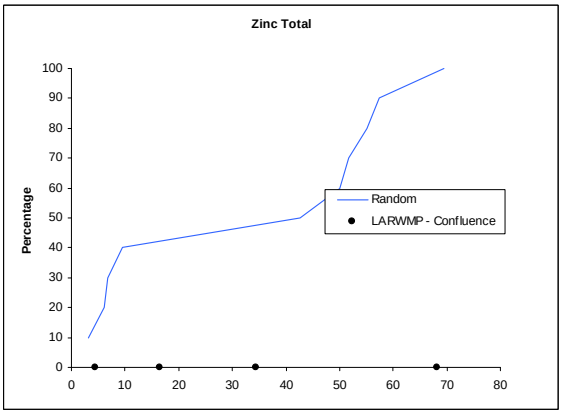

Total phosphorus-low range Total
Percentage
mg/l
LARWMP - Confluence


Total suspended solids Total
Percentage
µg/l
Random
LARWMP - Confluence


Vanadium Dissolved
Percentage
µg/l
Random
LARWMP - Confluence


Vanadium Total
Percentage
µg/l
Random
LARWMP - Confluence


Zinc Dissolved
Percentage
µg/l
Random
LARWMP - Confluence
SWAMP - Targeted
Glendale
Tillman


Zinc Total
Percentage
Random
LARWMP - Confluence

Appendix 6: Los Angeles River Estuary Chemistry Data

Table A6.1. Summary chemistry data for aquatic samples from station 412LARETY in the Los Angeles River estuary. DNQ refers to detected but not quantifiable.

	Fraction	Qualifier	Result	Unit	MDL	RL
Trace metals						
Aluminum	Dissolved	DNQ	2.27	µg/l	1.4	4.2
Arsenic	Dissolved	ND		µg/l	0.3	0.9
Cadmium	Dissolved		0.11	µg/l	0.03	0.09
Chromium	Dissolved	ND		µg/l	0.04	0.12
Copper	Dissolved		0.98	µg/l	0.3	0.9
Lead	Dissolved	DNQ	0.1	µg/l	0.1	0.3
Manganese	Dissolved		37	µg/l	0.1	0.3
Mercury	Dissolved		0.0004	µg/l	2E-04	0.0002
Nickel	Dissolved		0.9	µg/l	0.3	0.9
Selenium	Dissolved		1.62	µg/l	0.1	0.3
Silver	Dissolved	ND		µg/l	0.3	0.9
Zinc	Dissolved		2.51	µg/l	0.2	1
General chemistry						
Ammonia as N	Total		0.28	mg/l	0.04	0.1
Chloride	Total		17200	mg/l	0.2	0.35
Chlorophyll a	Total		1.62	µg/l	0.045	0.045
Nitrate as N	Total		0.244	mg/l	0.01	0.02
Nitrite as N	Total		0.145	mg/l	0.005	0.01
Phosphorous (ortho)	Total		0.116	mg/l	0.005	0.01
Phosphorous (total)	Total		0.177	mg/l	0.03	0.05
Sulfate	Total		2380	mg/l	0.5	0.7
Total kjeldahl nitrogen	Total		0.87	mg/l	0.12	0.25
Pesticides						
Benzene	Total	ND		µg/l	0.044	0.2
Bromobenzene	Total	ND		µg/l	0.041	0.2
Bromochloromethane	Total	ND		µg/l	0.07	0.4
Bromodichloromethane	Total	ND		µg/l	0.035	0.2
Bromoform	Total	ND		µg/l	0.071	0.4
Butylbenzene, n-	Total	ND		µg/l	0.057	0.3
Butylbenzene, sec-	Total	ND		µg/l	0.053	0.3
Butylbenzene, tert-	Total	ND		µg/l	0.062	0.3
Carbon tetrachloride	Total	ND		µg/l	0.041	0.2
Chlorobenzene	Total	ND		µg/l	0.042	0.2
Chloroform	Total	ND		µg/l	0.043	0.2
Chlorotoluene, 2-	Total	ND		µg/l	0.026	0.1
Chlorotoluene, 4-	Total	ND		µg/l	0.033	0.2
Dibromo-3-chloropropane, 1,2-(dbcp)	Total	ND		µg/l	0.106	0.5
Dibromochloromethane	Total	ND		µg/l	0.071	0.4
Dibromoethane, 1,2-	Total	ND		µg/l	0.09	0.5

	Fraction	Qualifier	Result	Unit	MDL	RL
Dibromomethane	Total	ND		µg/l	0.075	0.4
Dichlorobenzene, 1,2-	Total	ND		µg/l	0.064	0.3
Dichlorobenzene, 1,3-	Total	ND		µg/l	0.051	0.3
Dichlorobenzene, 1,4-	Total	ND		µg/l	0.051	0.3
Dichloroethane, 1,1-	Total	ND		µg/l	0.023	0.1
Dichloroethane, 1,2-	Total	ND		µg/l	0.05	0.3
Dichloroethylene, 1,1-	Total	ND		µg/l	0.048	0.2
Dichloroethylene, cis 1,2-	Total	ND		µg/l	0.063	0.3
Dichloroethylene, trans 1,2-	Total	ND		µg/l	0.043	0.2
Dichloropropane, 1,2-	Total	ND		µg/l	0.064	0.3
Dichloropropane, 1,3-	Total	ND		µg/l	0.036	0.2
Dichloropropane, 2,2-	Total	ND		µg/l	0.067	0.3
Dichloropropene, 1,1-	Total	ND		µg/l	0.027	0.1
Ethylbenzene	Total	ND		µg/l	0.038	0.2
Hexachlorobutadiene	Total	ND		µg/l	0.088	0.4
Isopropylbenzene	Total	ND		µg/l	0.017	0.1
Isopropyltoluene, p-	Total	ND		µg/l	0.053	0.3
MTBE	Total	ND		µg/l	0.077	0.4
Naphthalene	Total	ND		µg/l	0.087	0.4
Propylbenzene, n-	Total	ND		µg/l	0.031	0.2
Tetrachloroethane, 1,1,1,2-	Total	ND		µg/l	0.043	0.2
Tetrachloroethane, 1,1,2,2-	Total	ND		µg/l	0.059	0.3
Tetrachloroethylene	Total	ND		µg/l	0.052	0.3
Toluene	Total		0.38	µg/l	0.036	0.2
Trichlorobenzene, 1,2,3-	Total	ND		µg/l	0.087	0.4
Trichlorobenzene, 1,2,4-	Total	ND		µg/l	0.092	0.5
Trichloroethane, 1,1,1-	Total	ND		µg/l	0.04	0.2
Trichloroethane, 1,1,2-	Total	ND		µg/l	0.089	0.4
Trichloroethylene	Total	ND		µg/l	0.062	0.3
Trichloropropane, 1,2,3-	Total	ND		µg/l	0.05	0.2
Trimethylbenzene, 1,2,4-	Total	ND		µg/l	0.049	0.2
Trimethylbenzene, 1,3,5-	Total	ND		µg/l	0.024	0.1
Xylene, m/p-	Total	ND		µg/l	0.065	0.3
Xylene, o-	Total	ND		µg/l	0.054	0.3

Table A6.2. Summary chemistry data for sediment samples from station 412LARETY in the Los Angeles River estuary. DNQ refers to detected but not quantifiable.

	Fraction	Qualifier	Result	Unit	MDL	RL
Trace metals						
Aluminum	Total		62210	mg/kg	125	400
Arsenic	Total		7.13	mg/kg	1.8	5
Cadmium	Total		1.9	mg/kg	0.02	0.05
Chromium	Total		54.5	mg/kg	0.7	2
Copper	Total		76.2	mg/kg	1.5	5
Lead	Total		78.8	mg/kg	0.4	1
Manganese	Total		544	mg/kg	0.5	2
Mercury	Total		0.147	mg/kg	0.004	0.013
Nickel	Total		30.1	mg/kg	0.4	1
Silver	Total		1.08	mg/kg	0.07	0.2
Zinc	Total		353	mg/kg	2	6
General chemistry						
Moisture	Total		51.691	%	-88	-88
Total organic carbon	Total		4.97	%	0.01	0.01
Pesticides						
Aldrin	Total	ND		ng/g	0.505	1.94
Chlordane, cis-	Total		9.48	ng/g	1.39	1.94
Chlordane, trans-	Total		9.67	ng/g	0.785	1.94
Chlordene, alpha-	Total		1.38	ng/g	0.536	0.971
Chlordene, gamma-	Total	DNQ	0.64	ng/g	0.497	0.971
Chlorpyrifos	Total	ND		ng/g	1.62	1.94
Dacthal	Total	ND		ng/g	1.23	1.94
DDD(o,p')	Total		2.02	ng/g	1.49	1.94
DDD(p,p')	Total		8.96	ng/g	1.75	1.94
DDE(o,p')	Total	ND		ng/g	1.31	3.89
DDE(p,p')	Total		19.2	ng/g	1.12	3.89
DDMu(p,p')	Total	ND		ng/g	2.34	5.83
DDT(o,p')	Total	ND		ng/g	1.97	5.83
DDT(p,p')	Total	ND		ng/g	4.8	9.71
Diazinon	Total	ND		ng/g	13.1	38.9
Dieldrin	Total		6.26	ng/g	0.816	0.971
Endosulfan i	Total	ND		ng/g	2.1	3.89
Endosulfan ii	Total	ND		ng/g	5.28	9.71
Endosulfan sulfate	Total	ND		ng/g	5.28	9.71
Endrin	Total	ND		ng/g	1.83	3.89
Fine-astm,passing no. 200 sieve	Total		76.81	%	0.01	0.01
Hch, alpha	Total	ND		ng/g	0.925	0.971
Hch, beta	Total	ND		ng/g	1.2	1.94
Hch, delta	Total	ND		ng/g	0.699	3.89
Hch, gamma	Total	ND		ng/g	0.66	0.971
Heptachlor	Total	ND		ng/g	1	1.94

	Fraction	Qualifier	Result	Unit	MDL	RL
Heptachlor epoxide	Total		3.48	ng/g	0.979	1.94
Hexachlorobenzene	Total	DNQ	0.533	ng/g	0.21	0.583
Methoxychlor	Total	ND		ng/g	2.87	5.83
Mirex	Total	ND		ng/g	1.83	2.91
Nonachlor, cis-	Total		3.38	ng/g	1.9	1.94
Nonachlor, trans-	Total		9.1	ng/g	0.754	1.94
Oxadiazon	Total		7.73	ng/g	1.82	1.94
Oxychlordane	Total	ND		ng/g	0.715	1.94
Parathion, ethyl	Total	ND		ng/g	1.63	3.89
Parathion, methyl	Total	ND		ng/g	2.95	7.77
PCB 008	Total	ND		ng/g	0.194	0.389
PCB 018	Total		1.35	ng/g	0.194	0.389
PCB 027	Total	ND		ng/g	0.194	0.389
PCB 028	Total		3.03	ng/g	0.194	0.389
PCB 029	Total	ND		ng/g	0.194	0.389
PCB 031	Total		3.91	ng/g	0.194	0.389
PCB 033	Total		0.805	ng/g	0.194	0.389
PCB 044	Total		3.45	ng/g	0.194	0.389
PCB 049	Total		3.55	ng/g	0.194	0.389
PCB 052	Total		5.03	ng/g	0.194	0.389
PCB 056	Total		1.44	ng/g	0.194	0.389
PCB 060	Total		0.774	ng/g	0.194	0.389
PCB 066	Total		5.43	ng/g	0.194	0.389
PCB 070	Total		4.46	ng/g	0.194	0.389
PCB 074	Total		2.09	ng/g	0.194	0.389
PCB 087	Total		2.55	ng/g	0.194	0.389
PCB 095	Total		3.69	ng/g	0.194	0.389
PCB 097	Total		1.97	ng/g	0.194	0.389
PCB 099	Total		2.9	ng/g	0.194	0.389
PCB 101	Total		5.22	ng/g	0.194	0.389
PCB 105	Total		2.68	ng/g	0.194	0.389
PCB 110	Total		6.19	ng/g	0.194	0.389
PCB 114	Total	ND		ng/g	0.194	0.389
PCB 118	Total		5.97	ng/g	0.194	0.389
PCB 128	Total		1.2	ng/g	0.194	0.389
PCB 137	Total		0.43	ng/g	0.194	0.389
PCB 138	Total		8.11	ng/g	0.194	0.389
PCB 141	Total		1.46	ng/g	0.194	0.389
PCB 149	Total		5.49	ng/g	0.194	0.389
PCB 151	Total		1.56	ng/g	0.194	0.389
PCB 153	Total		5.74	ng/g	0.194	0.389
PCB 156	Total		0.622	ng/g	0.194	0.389
PCB 157	Total	DNQ	0.34	ng/g	0.194	0.389
PCB 158	Total		0.945	ng/g	0.194	0.389
PCB 170	Total		2.52	ng/g	0.194	0.389
PCB 174	Total		2.05	ng/g	0.194	0.389
PCB 177	Total		1.09	ng/g	0.194	0.389

	Fraction	Qualifier	Result	Unit	MDL	RL
PCB 180	Total		4.74	ng/g	0.194	0.389
PCB 183	Total		1.22	ng/g	0.194	0.389
PCB 187	Total		2.31	ng/g	0.194	0.389
PCB 189	Total	ND		ng/g	0.194	0.389
PCB 194	Total		1.4	ng/g	0.194	0.389
PCB 195	Total		0.5	ng/g	0.194	0.389
PCB 200	Total	ND		ng/g	0.194	0.389
PCB 201	Total		1.51	ng/g	0.194	0.389
PCB 203	Total		1.23	ng/g	0.194	0.389
PCB 206	Total		1.15	ng/g	0.194	0.389
PCB 209	Total		1.12	ng/g	0.194	0.389
PCB aroclor 1248	Total		86	ng/g	0.194	0.389
PCB aroclor 1254	Total		55	ng/g	19.4	48.6
PCB aroclor 1260	Total		52	ng/g	7.77	19.4
Tedion	Total	ND		ng/g	1.43	3.89
Toxaphene	Total	ND		ng/g	15.5	38.9

Appendix 7: Los Angeles River Estuary Benthic Infaunal Data

Raw benthic infaunal species abundance data for the station sampled in the Los Angeles River estuary.

Species	412LARETY
Armandia brevis	16
Capitella capitata Cmplx	1966
Grandidierella japonica	33
Lineidae	1
Macoma sp	2
Mediomastus sp	11
Monocorophium acherusicum	36
Monocorophium insidiosum	4
Monocorophium sp	10
Neotrypaea gigas	1
Notomastus hemipodus	1
Oligochaeta	2
Paranemertes californica	3
Platynereis bicanaliculata	1
Polydora cornuta	523
Prionospio lighti	1
Pseudopolydora paucibranchiata	60
Scolelepis sp SD1	5
Streblospio benedicti	2
Theora lubrica	4
Venerupis phillipinarium	2