COUNTY OF ORANGE

PUBLIC FACILITIES AND RESOURCES DEPARTMENT

ANALYSIS OF DATA REPORT

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11.0 WATER QUALITY MONITORING SUMMARY AND ANALYSES

11.1 Introduction

In response to the First Term Permits, the Permittees developed and implemented a water quality monitoring program (1993 DAMP Appendix K) to aid in the detection and control of illicit connections and illegal discharges to the municipal storm drain systems and to meet other program performance objectives. The monitoring program focused on estimating pollutant loads in urban stormwater runoff, tracked compliance with water quality objectives, searched for source of pollutants and addressed impacts on areas of special concern.

In response to the Second Term Permits, the Permittees conducted a two year re-evaluation and revision of the water quality monitoring program in order to re-focus the efforts to determine the role, if any, of urban stormwater discharges to the impairment of beneficial uses and to provide technical information to support an effective urban stormwater management program to reduce the beneficial use impairments determined to be associated with urban stormwater (2000 DAMP Appendix K).

The Permittees also initiated several water quality planning efforts, conducted additional water quality evaluations in response to technical requests from the Regional Boards and participated in various regional research and/or monitoring programs. The combination of these efforts will aid the Permittees in determining the extent and degree of the relationship between urban stormwater runoff and impairment of beneficial uses within the aquatic resources of Orange County.

11.2 PROGRAM DEVELOPMENT

11.2.1 Pre-NPDES Water Quality Monitoring

From 1973 to 1990, the Principal Permittee conducted routine water quality monitoring on drainage facilities which are tributary to water bodies identified as waters of the state by the Regional Boards. The receiving waters were also monitored routinely to assess the chronic effects on established beneficial uses.

When the monitoring program was initiated in 1973, monthly nutrient and trace element sampling was performed at several locations. Sediment samples were collected semiannually to assess the impact of contaminant deposition and adsorption. Additional constituents such as mercury, selenium, DDT, PCBs and radioactivity were also evaluated on a semiannual basis to address public concerns regarding the pollution threat from these constituents.

11.2.2 First Term Permit Water Quality Monitoring

In order to bring the pre-NPDES water quality monitoring program into conformance with the 1990 federal NPDES regulations and the First Term Permit objectives (Section 11.2), field screening to detect gross contamination was added to the program and the number of sampling sites in the channels and receiving waters were increased in order to better assess the amount and type of contamination in the storm drain system.

The First Term Permit water quality monitoring program consisted of field screening (channels only); dry-weather and storm sampling and a receiving water program

11.2.3 Second Term Permit Water Quality Monitoring

While the First Term Permit monitoring program produced useful information, the Permittees recognized (as has the rest of the nation) the high degree of uncertainty regarding the link between urban stormwater runoff and actual impairment of beneficial uses within the aquatic resources of Orange County.

Therefore, in response to the Second Term Permit objectives, the Co-Permittees conducted a systematic re-evaluation of the water quality monitoring program which led to a re-statement of the monitoring program's primary goals. The primary and parallel goals of the monitoring program were re-stated as:

- To determine the role, if any, of urban stormwater discharges in the impairment of beneficial uses; and
- To provide technical information to support effective urban stormwater management program actions to reduce the beneficial use impairment determined to be associated with urban stormwater.

In order to organize the vast array of monitoring activities needed to carry out the objectives and goals, the Permittees identified three separate key elements within the Final Monitoring Program (May 1999).

These three key elements are:

- A focus on known sites (or Warm Spots) where constituents are substantially above system-wide averages;
- A parallel (and somewhat overlapping) focus on areas of critical aquatic concern (herein referred to as critical aquatic resources or CARs); and
- A countywide reconnaissance program to identify specific sources of contamination from sub-watershed areas as well as specific land use investigations in order to evaluate the effectiveness of a variety of BMPs

The Final Monitoring Program includes an underlying rationale for each monitoring element, a discussion of how monitoring data will be used in decision-making, identification of potential links to other relevant monitoring programs being carried out by other agencies, a description of the basic monitoring design, identification of additional study design steps, and a description of anticipated monitoring activities.

These monitoring elements include many locations from the pre-NPDES and First Term Permit water quality monitoring programs that were of value because of the length of their historical record. Each key element of the Final Monitoring Program contains a description of the monitoring activities proposed to accomplish the objectives described above, as well as a description of the process for making decisions about how the monitoring program will respond to incoming data over time. This process can be used at any time throughout the life of the monitoring program to re-evaluate the direction of the program, or to reassess the appropriate allocation of resources within the program.

The Final Monitoring Program and subsequent elements utilize a five year timeline (1998/99 - 2002/03) for addressing the goals/objectives associated with each task. This timeline is reflective of the dynamic nature of the monitoring program and the fact that many of the objectives will require a substantial investment of resources before they are finalized.

The data presented in this section are the result of the water quality monitoring conducted from July 1, 2000 to July 1, 2001. More detailed information specific to data from prior years can be found in each of the prior annual reports and the two prior Reports of Waste Discharge.

11.2.4 Additional Local Water Quality Monitoring

Eight Permittees reported conducting water quality monitoring in addition to that which is conducted by the Principal Permittee on behalf of the Co-Permittees.

All of these Permittees reported conducting analyses for bacteriological components including total coliform, fecal coliform, enterococcus and E. Coli (**Table 11.1**) and three Permittees reported conducting monitoring in response to the Aliso Creek Watershed Directive. Newport Beach reported conducting analyses for specific viruses and Huntington Beach, San Clemente and Seal Beach reported conducting analyses for a number of additional constituents to help characterize the water quality of various waterbodies.

11.3 MONITORING APPROACH

Under the first term permit, water quality monitoring could be characterized as areawide rather than focused to any specific area or areas. Under the Final Monitoring Plan, monitoring has been conducted in waterbodies or watersheds which have been assessed as important aquatic resources or which have shown some elevated constituent levels which may be attributable to stormwater. Three processes were used in selecting the monitoring sites. They are summarized below:

- A list of the CARs, including inland streams, bays, harbors, estuaries, and coastal waters, was compiled and ranked according to several criteria including 303(d) listing, community interest, and beneficial uses (**Table 11.2**). A summary of the priority rankings is found in **Table 11.3**. The CARs receiving the highest ranking were prioritized for study during the term of the Final Monitoring Program. The monitoring parameters that were proposed for the CARs investigations arose from mining information from several studies conducted by the Principal Permittee and others. The available information at the time that the program was designed can be found in **Table 11.4. Table 11.5** is a summary of the information found in the sources from **Table 11.4**. The CARs monitoring program is an adaptive process driven by the the on-going analysis of data gathered from this and other programs.

  Figure 11.1 is the timeline that was developed for implementation of the studies of specific CARs. It should be noted that the Santa Ana Delhi and Costa Mesa Channels, although not CARs, are included in the timeline because information from these channels is an important component in the assessment of the impacts on the Upper Newport Bay.

  The CARs selected for intensive study during this reporting year were the San Diego Creek Watershed, the Upper Newport Bay, the Lower Newport Bay, and Aliso Creek. A baseline monitoring program is being maintained for the other CARs until they are selected for focused studies in the future.

- The NPDES water and sediment quality data from 1991-97 was statistically evaluated to identify areas which had mean concentrations of constituents of concern that were above countywide averages. These areas designated as Warm Spots were selected if their site mean concentration of a specific pollutant of concern was either (1) greater than two standard deviations above the systemwide mean (including all similar monitoring sites such as channels or harbor locations), or (2) three interquartile ranges above the third quartile. The database of each Warm Spot was further evaluated using power analyses to determine the frequency of annual monitoring that would be needed to detect statistically significant trends in the constituent of concern that led to the Warm Spot designation.

  The Warm Spots include Bonita Creek, Lane Channel, Agua Chinon Wash, Central Irvine Channel, Hicks Canyon Wash, Hines Channel, Sulphur Creek, Prima Deschecha Channel, Segunda Deschecha Channel, the Rhine Channel in the Lower Newport Bay, and Christiana Bay in Huntington Harbour. **Table 11.6** is a list of the Warm Spots and the frequencies of monitoring that were calculated to detect significant trends. **Figure 11.2** is a timeline that was developed for monitoring Warm Spots in order to identify the sources of constituents that resulted in their respective Warm Spot designations.

- The countywide Pollution, Notification, Investigation, and Response (PNIR) database maintained by Principal Permittee water pollution staff was interrogated to identify channels or drainage areas that had high incidences of water pollution activity during the period from 1991 through 1998. From these database evaluations was created a priority list for reconnaissance and source evaluation studies. Areas targeted for study during this reporting year included Construction Circle Drain which flows to Peters Canyon Wash and J01P05 (drainage for El Toro Auto Center) which flows to Aliso Creek.

Figure 11.3 is a timeline showing the implementation schedule of all three elements of the Final Monitoring Program.

11.3.1 Incorporation of the Nutrient Total Maximum Daily Load (TMDL) Regional Monitoring Program

At the direction of the Santa Ana Regional Board, a Regional Monitoring Program (RMP) for the San Diego Creek Nutrient TMDL was initiated in February of 2000. The chemical monitoring for this program includes many of the same sites in the Newport Bay and watershed as the Final Monitoring Program. Monitoring frequencies for some of the sites were increased as a result of the RMP and orthophosphate was been added to the suite of nutrient analyses. The Final Monitoring Program and the RMP are intended to complement each other. Therefore the chemical data from both programs will be included in this report.

Table 11.7 is compilation of the Warm Spots and CARs from the Final Monitoring Program and the RMP sites that were monitored during this reporting year. **Table 11.8** shows the monitoring frequencies of the Final Monitoring Program with the RMP additions in bold letters. If a monitoring location is within a designated "Water of the State" the beneficial uses for waterbody can be found **Table 11.9**. **Appendix J** contains the location maps of channels that were monitored with automatic samplers and continuously monitoring streamgages.

11.4 DESCRIPTION OF MONITORING PROCEDURES

The following are brief descriptions of the procedures used during this reporting period.

11.4.1 Time-composite Sampling

Time-composite sampling is the primary method of monitoring the concentration and load of constituents in streams, creeks, and drainage channels. This type of sampling is conducted with automatic samplers that consist of programmable pumps (peristaltic) which transport water from the channel to a collection reservoir in the autosampler base. The collection reservoir can be a single large composite bottle or a series of up to 24 bottles. The autosampler program can be modified to vary sample volumes and frequency of collection. In the Final Monitoring Program, 24 discrete sample bottles are used in each autosampler base.

For dry weather discharge evaluations, the automatic samplers are programmed to collect a discrete sample once an hour for a 24-hour period. During storms, sampling is initiated when the water level in the channel rises above a triggering device hardwired to the autosampler. The frequency of collection during the first hour of the storm is set at 1 sample/15 minutes. After the fifth sample is collected at the one-hour mark, the collection frequency is decreased to once every 2 hours. A storm event sampling spans approximately 96 hours to allow comparison of the data to 96-hour guidance criteria for chronic aquatic toxicity from the California Toxics Rule (CTR). Autosampler maintenance is performed periodically to change bottles, icepacks, and power supplies.

The first five samples collected during a storm are composited and represent the first flush. The concentrations of dissolved heavy metals in this sample can be compared to acute toxicity criteria. The remaining bi-hourly storm samples are used to prepare composite samples that are representative of the subsequent parts of the storm. The samples used to prepare each composite sample are selected using the stage hydrograph or by evaluating the electrical conductivities of the discrete samples. Using the hydrograph from the the Principal Permittee's Automated Local Evaluation in Real Time (ALERT) system, samples collected beyond the first flush and representing the storm peak and recession are composited into a single sample. In the absence of a streamgage hydrograph, the conductivity of each sample (in order of collection) is measured. Changes in conductivity usually denote the beginning or end of storm runoff. After the "first flush" of a storm, conductivities tend to immediately decrease during the rise of the storm hydrograph and slowly rise after the recession. Sample appearance (turbidity or fluvial sediment) can also be used in the compositing process. Storm samples tend to be more turbid and contain more fluvial sediment.

Composite samples are analyzed for pH, electrical conductivity, turbidity, nitrate, ammonia, total Kjehldahl Nitrogen (TKN), phosphate, total suspended and settleable solids, volatile suspended solids, and total recoverable and dissolved copper, chromium, lead, cadmium, zinc, silver and nickel (see **Appendix K**). The frequency of time composite monitoring is dependent on whether the waterbody is designated as a Water of the State. Waters of the State are monitored monthly and during storms. Other waterbodies are monitored during storms only.

Time composite monitoring is supported by the Principal Permittee's precipitation and streamgaging network which consists of recording and/or transmitting ALERT gages. Mechanical recording raingages are weighing bucket type. Accumulated rainfall is recorded in analog format on drum charts. The ALERT precipitation gages are tipping bucket type with dataloggers. Data are recorded and transmitted in digital format; sensitivity is 1 mm (0.04 inches) of accumulated rainfall.

The Principal Permittee uses several types of streamgages to monitor changes in water level. The oldest design is the stilling well with water level float; the newer types are manometer gages or pressure transducers. Data (water level versus time) are recorded on stripcharts. The ALERT interface to these gages consists of a connection from the recorder chart drive to an ALERT shaft encoder. ALERT information is recorded on a datalogger and transmitted to the Principal Permittee Katella yard base station in digital format. Sensitivity of the transmitted and recorded ALERT record is user-variable with the greatest sensitivity being a change in water level of 0.01 feet.

11.4.2 Harbor/Bay Monitoring

Harbor/bay monitoring is conducted semiannually and during storms (see **Appendix L**). Monthly sampling in the Upper Newport Bay is also conducted to evaluate nutrient loading from the San Diego Creek. Monthly monitoring of nitrogen and phosphorus in the sediments of the Upper Newport Bay was added in 1999/2000 reporting period to assist with the evaluation. The semiannual monitoring includes sampling for nutrients in the water column, and trace metals and organic contaminants in the sediments (See Section 11.4.3). Storm monitoring consists of surface water sampling for nutrient concentrations and depth-integrated sampling to evaluate the magnitude of heavy metal contamination in the water column.

11.4.3 Semiannual Sediment Sampling

On a semiannual schedule, sediment samples are collected from the channels and several locations in the harbors and bays (see **Table 11.8**) to evaluate concentrations of copper, chromium, cadmium, lead, zinc, silver, nickel, chlorinated hydrocarbon and organophosphate pesticides, herbicides, PCBs, and Polynuclear Aromatic Hydrocarbons (PAHs). The data from these samplings is contained in **Appendix M**.

11.5 METHODS OF DATA ANALYSIS

Acute and chronic aquatic toxicity criteria from the CTR were used as guidance to evaluate dissolved metals data collected from storm channels and harbors. Water quality criteria from the CTR and other sources are presented in **Table 11.10.**

Sediment quality criteria from the National Oceanographic and Atmospheric Administration's (NOAA) Effects Range database were used as guidance to evaluate the toxicity of sediments in the harbors and bays. The Southern California Coastal Water Research Project's (SCCWRP) iron normalization procedure was also used evaluate harbor sediment quality relative to statistically predicted anthropogenic amounts of trace metals. A summary of the sediment guidance criteria is found in **Table 11.11.**

11.5.1 Comparison to Water Quality Guidance

California Water Code Section 13170 authorizes the State Water Resources Control Board (SWRCB) to adopt water quality control plans for waters where standards are required by the Federal Clean Water Act (CWA) and its 1987 amendments, the Water Quality Act (WQA). According to Section 303(c)(2)(B) of the CWA, these plans must contain water quality objectives for priority pollutants that could be reasonably expected to affect the beneficial uses of the waters of the State.

On March 2, 2000, the State adopted the United States Environmental Protection Agency’s (USEPA) Rules establishing numeric water quality criteria for priority toxic pollutants (commonly referred to as the CTR) for the State of California. The CTR sets criteria for dissolved heavy metals in freshwater that are based on water hardness and separate criteria for saltwater. The dissolved metals data were compared to the acute and chronic criteria for guidance purposes. **Table 11.12** presents these guidance criteria for freshwater relative to water hardness.

According to the CTR, for waters with a hardness of 400 mg/l or less as calcium carbonate, the actual ambient hardness of the surface water shall be used in those equations. For waters with a hardness of over 400 mg/l as calcium carbonate, a hardness of 400 mg/l as calcium carbonate shall be used with a default Water-Effect Ratio (WER) of 1, or the actual hardness of the ambient surface water shall be used with a WER. For this reporting period the former method was used. The saltwater guidance criteria are found in **Table 11.10**.

In applying the CTR criteria to freshwater, if the time period to which the guidance applies is less than the length of the sampled period, a measured concentration greater than that guidance value will constitute an exceedance. For example, if the 1-hour guidance for lead (at a hardness of 100 mg/L as $CaCO_3$) is 65 μg/L, a concentration of 68 μg/L during a 24-hour period will be considered an exceedance of the guidance criterion. In computing the mean concentration during a sampled period with multiple composite samples, values below the detection limit were assumed to be zero. This assumption allows for a more consistent evaluation from year to year as detection limits are lowered with alternative methods of analysis or new technology. The assumption also gives greater confidence to a designation of an exceedance of a guidance criterion as it reduces the likelihood that the exceedance was caused by an erroneous estimation of a non-detected value. During this monitoring year the low detection limits achieved by the contract laboratory did not make this approach an issue except for a few instances where the calculated criterion for silver was lower than the detection limit of 2 μg/L.

With respect to the saltwater guidance from the CTR, the average concentrations of dissolved metals in depth-integrated samplings from each 4-day storm monitoring of the Harbors and Bays were compared to the 4-day guidance criteria. The dissolved metals concentrations in each grab sample were compared to the 1-hr acute toxicity guidance criteria. There is no chronic guidance criterion for silver so only the acute criterion was used. Since total chromium was analyzed only the Chromium III criteria were used.

11.5.2 Mass Load Calculations

Mass loads were calculated using chemical and hydrographic data. **Appendix J** contains watershed maps for all of the channels monitored to date, with automatic samplers. On each map, the watershed boundary upstream of the monitoring site, hydrographic (water level station) and representative precipitation station are shown. Water level records from streamgaging stations at or near the sampling site were processed using Western Hydrologic Software. Water levels from the station's continuous stripchart recorder were digitized and converted to discharge rates using stage-discharge relationships (channel ratings). The digitized streamflow record was converted to ASCII format and imported to a Microsoft Excel file. Graphs of time vs. water level stage are contained in **Appendix N**. The total discharge in acre-feet during each sampled period was computed. By multiplying the total water discharge per sampled period by the pollutant concentration of the composite sample from the period and applying the proper conversion factors (acre-feet to lbs. of water), a mass load in pounds or tons of contaminant was calculated. For data reported as ND (non-detected), one-half of reported laboratory detection limits were used in the calculations. **Appendix O** contains the mass load data from each monitored storm. **Table 11.13** is an annual summary.

11.5.3 Event Mean Concentrations (EMCs)

Event mean pollutant concentrations were calculated to produce a site mean EMC that could be used in the estimation of the mass loads from unsampled storms. To calculate the EMC of a monitored storm the sum of the mass load from each composite sampling during a storm was divided by the total sampled volume of water during the same period. After applying the appropriate conversion factors, an event mean concentration in mg/L or µg/L was calculated. The site mean EMCs were updated each year (**Appendix P**) with the EMC data from that year. **Table 11.14** contains the calculated EMCs of each monitored storm during the 2000-01 season.

11.5.4 Statistical Methods

Site mean EMCs were used to estimate mass loads from unsampled storms. To estimate these mass loads, the site mean EMC for a stormwater contaminant from a particular station was multiplied by the total annual volume of water discharged during unsampled storms, and the appropriate conversion factors. The site mean EMC was calculated from the set of calculated EMCs from each sampled storm from the beginning of the NPDES program. Only EMCs in which the 75-120% of the total storm runoff volume was sampled were used in the calculation. Each year the site means were updated with the data from that year.

The distribution of each EMC dataset was first evaluated for normality using the W Test developed by Shapiro and Wilk (1965). The W statistic was compared to a tabled value for a given value of α. To calculate W, the data from each station was first ordered from smallest to largest to obtain the sample order statistics $x_1 \leq x_2 \ldots \leq x_n$. k was then calculated from n where:

$$k = \frac{n}{2} \text{ if n is even or}$$

$$k = \frac{n-1}{2} \text{ if n is odd}$$

$$W = \frac{1}{d}\left[\sum_{i=1}^{k} a_i \left(x_{(n-i+1)} - x_i\right)\right]^2$$

where $$d = \sum_{i=1}^{n}(x_i - \bar{x})^2 = \sum_{i=1}^{n} x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)^2$$

Values of a_i were found in Table A6[1]. If the calculated W was less than the tabled value at the α (0.05) significance level, the null hypothesis was rejected and the distribution was considered normal. If the distribution was not normal at the α significance level the data was log-transformed and the W test was repeated to test for log-normality. If the distribution was not lognormal, the dataset was inspected for possible outliers. The Dixon test (for $n < 25$) was used to determine if the suspected points were outliers to a normal distribution. The procedure was performed as follows:

The dataset was ordered from smallest to largest that is $X_1 < X_2 < X_3 < \dots X_n$. The Dixon ratio r, which is a function of n was calculated.

Number of Points	**Ratio Calculated**
n = 3 to 7	r_{10}
n = 8 to 10	r_{11}
n = 11 to 13	r_{21}
n = 14 to 25	r_{22}

Depending on which point was suspected of being the outlier, the ratio was calculated in the following manner:

r	**If X_n is Suspect**	**If X_1 is Suspect**
r_{10}	$(X_n-X_{n-1})/(X_n-X_1)$	$(X_2-X_1)/(X_n-X_1)$
r_{11}	$(X_n-X_{n-1})/(X_n-X_2)$	$(X_2-X_1)/(X_{n-1}-X_1)$
r_{21}	$(X_n-X_{n-2})/(X_n-X_2)$	$(X_3-X_1)/(X_{n-1}-X_1)$
r_{22}	$(X_n-X_{n-2})/X_n-X_3)$	$(X3-X_1)/X_{n-2}-X_1)$

Using Table A.7[2], the calculated ratio was compared to the critical value at a confidence level of 95%. If the calculated value was greater than the tabled value the suspected point was rejected and the distribution was retested to confirm normality.

For normal distributions the mean is calculated as the arithmetic mean, that is

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

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[1]Gilbert, Richard O. Statistical Methods of Environmental Pollution Monitoring, 1987. Van Nostrand Reinhold, p259.
[2]Taylor, John Keenan. Statistical Techniques for Data Analysis, 1990. Lewis Publishers, Inc., p168.

the confidence limits for the mean of a normal distribution with unknown variance is given by

$$\bar{x} - t_{(1-\alpha/2,n-1)}\frac{s}{\sqrt{n}} \le \mu \le \bar{x} + t_{(1-\alpha/2,n-1)}\frac{s}{\sqrt{n}}$$

where s is the standard deviation of the dataset and $t_{(1-\alpha/2,n-1)}$ is from table A2[3]. Using $\alpha = 0.05$ the upper and lower limits are calculated. The true mean μ will occur outside of this range 5% of the time.

For lognormal distributions the arithmetic mean and standard deviation of the log-transformed data were first computed. The estimate of the mean is given by the minimum variance unbiased estimate μ_1 which is defined as

$$\mu_1 = [\exp(\bar{x})]\Psi_n\left(\frac{s^2}{2}\right)$$

where $\Psi_n(t)$ is the infinite series defined by

$$\Psi_n(t) = 1 + \frac{(n+1)t}{n} + \frac{(n+1)^3 t^2}{2!n^2(n+1)} + \frac{(n-1)^5 t^3}{3!n^3(n+1)(n+3)} + \frac{(n-1)^7 t^4}{4!n^4(n+1)(n+3)(n+5)} + \bullet\bullet\bullet$$

$\frac{s^2}{2}$ is substituted for t and values for Ψ_n are calculated using formulas in a Microsoft EXCEL 7.0 spreadsheet.

The lower confidence limit of the mean is given by

$$LL_\alpha = \exp\left(\bar{x} + 0.5s^2 + \frac{sH_\alpha}{\sqrt{n-1}}\right)$$

and the upper limit is given by

$$UL_{1-\alpha} = \exp\left(\bar{x} + 0.5s^2 + \frac{sH_{1-\alpha}}{\sqrt{n-1}}\right)$$

The values of H_α and $H_{1-\alpha}$ were found in Table A10 - A13[4]

The sample median of each normal distribution was calculated by first ordering the sample population from smallest to largest.

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[3]Gilbert, Richard O. Statistical Methods of Environmental Pollution Monitoring, 1987. Van Nostrand Reinhold, p255.
[4]Gilbert, Richard O. Statistical Methods of Environmental Pollution Monitoring, 1987. Van Nostrand Reinhold, pp264-265.

$$\text{sample median} = x_{(n-1)/2} \qquad \text{if n is odd}$$

$$= \frac{1}{2}\left(x_{(n/2)} + x_{(n+2)/2}\right) \text{ if n is even}$$

The true median of a lognormal distribution can be estimated by

$$M_2 = \exp(\bar{x})\Psi_n(t)$$

where $\Psi_n(t)$ is the infinite series described above. In this case the value of $t = -s^2/[2(n-1)]$.

11.5.5 Assessing Anthropogenic Influence in Harbor Sediments

The Southern California Coastal Water Research Project (SCCWRP) database for iron normalization[5] was used to determine the presence of anthropogenic enrichment in sediments collected from Orange County harbors. SCCWRP developed regression equations for the each relationship between a heavy metal and the percentage of iron in sediments collected from non-impacted sites in the Southern California Bight. 99% confidence limits (2 standard deviations) were calculated for each regression equation. Concentrations of heavy metals greater than the upper confidence limits are considered to be the result of anthropogenic enrichment.

11.6 ANALYSIS OF DATA

The Final Monitoring Program included a series of tables and figures outlining expected progress over the five-year term of the permit. These provide a framework for assessing the Program's current status and its progress toward completing the planned activities. The following sections briefly describe Program status with respect to each of the three major Program components, warm spots trend monitoring, critical aquatic resources monitoring and assessment, and reconnaissance and source identification.

Figure 11.4 shows the total annual rainfall at three sites in Orange County during the last six seasons. **Figure 11.5** shows the accumulated rainfall per season measured at the Principal Permittee gauge in Santa Ana. As can be seen by the 2000/01 season graph, more than 85% of this monitoring year's precipitation occurred during the period from January 9th to the end of February. With this relatively short rainy season, completion of all intended stormwater monitoring from **Table 11.8** was not accomplished. For example, although Newport Bay and Dana Point Harbor were sampled according to their intended frequency, Huntington Harbour was not monitored during any storms.

[5] Southern California Coastal Water Research Project. Annual Report,1996. Southern California Coastal Water Research Project Authority, pp68-76.

11.6.1 Warm Spot Monitoring

The Final Monitoring Program is generally on track with the categories of activities and the timelines listed in **Figure 11.3**. Stations were prioritized and sampling frequencies established as part of the monitoring program design. Long-term trends monitoring is ongoing and some source identification studies have been undertaken. Monitoring data are analyzed and evaluated each year, although a full trends analysis will not be repeated until the end of the five-year period. The power analyses indicated that trends would only be apparent after several additional years of monitoring data were available. The following paragraphs provide additional detail on the specifics of trend monitoring and source identification efforts.

Rattlesnake Canyon Wash – total suspended solids and metals in stormwater

Subsequent to the development of the Final Montoring Plan Rattlesnake Canyon Wash was rerouted to intersect with Peters Canyon Channel upstream of the Peters Canyon / Hicks Canyon Wash confluence. The site on Bryan Avenue to which the Warm Spot designation was assigned does not receive runoff from this channel in its present configuration.

Lane Channel – total dissolved solids

The summary of the initial phase of the investigation for sources of high total dissolved solids in Lane Channel can be found in **Appendix Q**.

Segunda Deshecha Channel – total dissolved solids

In the Segunda Deschecha Channel the initial source identification consisted of evaluating the hypothesis that the high total dissolved solids (TDS) in the water at the sampling point was a function of the tide. Data from the Field Screening Program (1991-97) was compared to the tidal stage at the time of sampling (**Figure 11.6**). It was determined that the high conductivity (a monitoring parameter proportional to TDS) in the channel was not a function of the tide.

The next phase in the investigation included hourly monitoring of the conductivity for 24-hour periods. From October 1999 through June 2001, the hourly conductivity of fourteen 24-hour periods was monitored in the Segunda Deschecha Channel. **Figure 11.7** is a plot of the hourly measurements from each sampling. The average of all hourly measurements is shown in **Figure 11.8**. It appears that the peak conductivity occurred in the evening about 10 PM.

Prima Deschecha Channel – total dissolved solids

The same hourly conductivity analysis was performed on the Prima Deschecha Channel with ten 24-hour samplings conducted from December 1999 to June 2001. **Figure 11.9** is a plot of the hourly conductivity measurements from each sampling. **Figure 11.10** is plot of the average conductivity during each hour from the ten samplings. **Figure 11.10** also contains the average hourly discharge rate measured in Prima Deschecha Channel between September 13 and October 3, 2001. **Figure 11.10** shows that the electrical conductivity and the flowrate are inversely proportional to each other suggesting that the high conductivity in Prima Deschecha Channel is a natural condition that is diluted by urban runoff. In the upcoming year, similar flow measurements will be conducted in Segunda Deschecha Channel to verifying that the same relationship exists for this channel.

<u>Bonita Canyon Channel – metals in stormwater</u>

At Bonita Canyon Channel, no source identification has been carried out, but this site has been added to the sediment TMDL program. A streamgage has been installed and is currently being maintained by the USGS under contract to the Principal Permittee. The annual average total suspended solids and total recoverable nickel, copper, and chromium concentrations were plotted in **Figure 11.11**. Even including data from the El Niño season (1997/98) it appears that the levels of these constituents have decreased from the high levels from during 1993/94 and 1995/95 seasons.

<u>Rhine Channel – copper in sediments</u>

At the Rhine Channel in Lower Newport Bay, the Co-Permittees assume that the source of copper in the bottom sediment is the product of past activities of the boatyards in the immediate area. The boatyards carry out maintenance activities and have related discharge permits, but samples have not been collected to confirm this supposition. The data from LNBRIN is plotted in **Figure 11.12**. The concentration of copper in the sediments during the last three seasons is much lower than during the period from 1992 to 1998.

<u>Agua Chinon and Hicks Canyon Wash – DDT in sediments</u>

The sources of the high concentrations of DDT metabolites in Agua Chinon and Hicks Canyon Wash have not been investigated. It is assumed that these legacy pesticides are in the soils of the agricultural areas in the watershed and enter the drainage system after large storms or development of these agricultural areas. From **Figure 11.13** it appears that the concentrations of these compounds in the sediments of Agua Chinon Wash have decreased since the 1996/97 season. In Hicks Canyon Wash however, the recent concentrations have not exhibited the same declining pattern.

<u>Central Irvine and Hines Nursery Channels – nitrates</u>

Efforts in the Central Irvine Channel are part of the last three intensive nutrient studies in Peters Canyon Wash and the nutrient TMDL program. The current emphasis has been on intensified monitoring, on a bi-weekly schedule, to better understand the temporal pattern of discharges. This information is intended, in part, to help focus subsequent source identification efforts on periods when discharge levels are highest. The situation is the same for Hines Channel, which is a tributary to Central Irvine Channel and also part of the TMDL monitoring program.

11.6.2 Critical Aquatic Resources (CARs) Monitoring

The CARs element is generally on track with the categories of activities and timelines listed in **Figure 11.3**. Baseline monitoring has been carried out as specified in **Table 11.8**, with the exception that Huntington Harbor was not sampled during this monitoring period because of the low number of storms. The 1997/98 annual status report included a summary of relevant studies performed by other agencies, but this has not been updated or extended to include a formal evaluation of the value of these studies. The next activity listed in **Figure 11.3**, Identify Data Gaps, has not been systematically addressed, although a number of new monitoring efforts have been initiated in response to immediate perceptions about the need for new information. In terms of the next activity in **Figure 11.3**, the Final Monitoring Program actively coordinates with other studies, participates in the SCCWRP's regional monitoring and research programs, and is directly involved with the Co-Permittees' monitoring efforts. The final two activities listed in **Figure 11.3** relate to activities at specific CARs, as described in **Figure 11.1**.

The Final Monitoring Program envisioned that the CARs would fulfill a broader impact assessment role that would involve filling important data gaps and collecting and integrating data from all sources to develop a more complete picture of impacts on aquatic resources. While data gaps are being filled as the result of monitoring activities, the larger impact assessment function has not been directly addressed. It is a challenge for the Program to carry out the collection and analysis of regular monitoring data and at the same time mount an aggressive data integration and assessment effort. In recognition of this, the recent workshop to develop a regional stormwater research strategy identified regional data integration and assessment as a high priority. Therefore, the Program's commitment in this area may be fulfilled by supporting and participating in a regional research project. This is analogous to the Program's participation in the periodic Southern California Bight Monitoring Program as a means of fulfilling its responsibilities to CARs in the coastal marine environment.

The following are summaries of the activities conducted in the CARs (from **Figure 11.1**) during the reporting period.

Santa Ana Delhi and Costa Mesa Channels

Figure 11.1 shows monitoring and assessment efforts at Santa Ana Delhi and Costa Mesa Channel extending throughout the permit period. Santa Ana Delhi was added to the sediment TMDL monitoring program, in order to help quantify the amount of sediment impacting Upper Newport Bay. It is also part of the nutrient TMDL program, and is therefore being monitored at levels above those proposed in the Final Monitoring Program. The Costa Mesa Channel was selected as a model urban runoff site because its watershed is approximately one square mile in area and has predominately urban land uses within it. It is sampled weekly for metals, nutrients, and bacteria and monthly for organophosphate pesticides. Both Santa Ana Delhi and Costa Mesa Channel are tributary to Upper Newport Bay and monitoring at these sites will be determined largely by requirements of the sediment, nutrient, pathogen, and toxics TMDLs. These two sites can be considered on schedule with respect to the timeline.

With respect to the monitoring results from this reporting year, all of the stormwater concentrations and 39 of 40 dry weather concentration of dissolved copper in Costa Mesa Channel would exceed the CTR acute toxicity criteria for saltwater at the interface of the channel and the Upper Newport Bay. Since the average dry-weather discharge rate of the Costa Mesa Channel is very low, the impact on the Bay due to copper would be negligible.

Figure 11.14 is plot of the fecal coliform concentration in Costa Mesa Channel throughout the year. As can be seen from the graph the fecal coliform concentration were extremely variable with a range of <2 to 240,000 MPN / 100 ml and a logmean of approximately 5,400 MPN / 100 ml. These results are similar to the 1999/00 reporting period.

Diazinon was found above the detection limit (0.05 μg/l) of the laboratory in nearly every sample collected from Costa Mesa Channel. Contrary to last year when over one third of the samples had concentrations greater than the LC_{50} for the freshwater toxicity testing organism *Ceriodaphnia dubia*[6] only about 10% were greater than the LC_{50} this year. **Figure 11.15** is a summary of the diazinon sampling. Chlorpyrifos was not detected (<0.05 μg/L) in any sample from this reporting period.

Upper Newport Bay / San Diego Creek and its tributaries

The Upper Newport Bay and its tributaries were assigned the top monitoring priority in the Final Monitoring Program. The monitoring of these areas included routine NPDES and TMDL sampling as described in **Table 11.8.**

Monitoring in the Upper Newport Bay and San Diego Creek is also related to efforts to evaluate the trapping efficiency of the basins in the Upper Bay, assess toxicity in the Upper Bay, and evaluate the efficiency of the Irvine Ranch Water District's nutrient removal ponds.

The mass loads of nutrients and total recoverable metals were calculated for each storm monitored for which there was water quality and flowrate information. In the Upper Newport Bay watershed loads were calculated for sampled stormwater runoff in Santa Ana Delhi Channel, El Modena Irvine Channel, Lane Channel, Peters Canyon Wash, San Diego Creek at Harvard Avenue, and San Diego Creek at Campus Drive. The mass load information for each sample from every storm is contained in **Appendix O**. The total annual stormwater discharge volumes from Santa Ana Delhi Channel, Peters Canyon Wash, San Diego Creek at Harvard, and San Diego Creek at Campus Drive were calculated from Principal Permittee's streamgaging records. Using these volumes and the updated site mean EMCs from **Appendix P** the unsampled stormwater loads from

[6] Lee, G. Fred, Evaluation Monitoring Report for San Diego Creek, 1998, Table 6-3.

each of these channels was estimated.   **Table 11.15** includes a summary of the sampled and unsampled loads from the Newport Watershed.

For channels discharging directly to the Newport Bay, dissolved metals concentrations were compared to the guidance criteria for saltwater from the CTR. Out of 47 stormwater samples, 46 exceeded the acute toxicity guidance criterion for copper and six exceeded the acute toxicity guidance criterion for zinc. Of the 10 composite storm periods that were evaluated against the chronic toxicity guidance criteria for the protection of saltwater aquatic life, all exceeded the guidance criterion for copper. **Table 11.16** is a summary of exceedances relative to the CTR that were found in the storm channels during this monitoring year.

In addition to the routine monitoring in the watershed, the Co-Permittees have carried out three annual intensive nutrient studies in tributaries to Peters Canyon Wash, which has been identified as a major source of nutrients. The purpose of these studies was to help develop a nutrients mass balance for this portion of the system.

During the 2000/2001 reporting year, the third intensive study was conducted. The first was conducted at the end of the summer season in 1999 (September 1999) and the second was conducted at the beginning (June 2000) of the 2000 summer season. In the 1999 and 2000 studies, the average daily total nitrogen loads measured in San Diego Creek at Campus Drive were used to estimate the TMDL summer season (April 1 – September 30) load. These two estimates were below the TMDL targets for December 31, 2002 and December 31, 2007.   Examination of the weekly monitoring data from Campus Drive during the 1999/00 season however, showed that the greatest load during the summer season occurred in April and May.

The objective of the 2001 study was to quantify the loads from the Peters Canyon Wash tributaries during the period of greatest load. The 2001 study spanned eight days from May 15-22, 2001. As in the previous two studies this study utilized automatic sampling and continuous flow monitoring equipment to quantify the nitrogen and phosphate loads contributed by tributaries of Peters Canyon Wash. Automatic samplers were also used to quantify the load from San Diego Creek at Harvard Avenue and Campus Drive. The findings of the 2001 study were:

- The average daily water discharge rate in San Diego Creek at Campus Drive was 8.94 cfs compared to 11.16 cfs in June 2000 and 7.81 cfs in September 1999. The sum of the average discharges from all measured upstream inputs in 2001 was 12.18 cfs, approximately 36% higher than measured at Campus Drive. During the May 2001 study, it appeared that water was by-passing the low-flow channel at Campus Drive. The area on the west side of the low-flow channel beneath Campus Drive was completely submerged. The amount of water bypassing the low-flow channel during this period however was not quantified.

- The average discharge rate at Peters Canyon Wash at Barranca Parkway was 6.73 cfs compared to 6.59 cfs in June 2000 and 5.61 cfs in September 1999. The sum of the average discharges from all upstream measured inputs to Peters Canyon Wash was 6.24 cfs, approximately 7% less than measured at Barranca Parkway.

- Of the Peters Canyon Wash tributaries, the Santa Ana – Santa Fe Channel showed the greatest change in average discharge rate from study to study. The rate increased from 0.89 cfs in September 1999 to 1.78 cfs in June 2000, and then decreased to 0.97 cfs in May 2001. The flowrate in San Diego Creek at Culver Drive increased from 0.73 cfs in June 2000 to 2.23 cfs in May 2001.

- Hicks Canyon Wash and Central Irvine Channel showed the greatest increase in the average nitrate nitrogen concentration from June 2000 study to the May 2001 study. The concentration Rattlesnake Canyon Wash increased from 2.2 to 48.5 mg/L while the average concentration in the Central Irvine Channel increased from 17.9 to 45.3 mg/L. In San Diego Creek at Campus Drive the average concentration in the June 2000 study was 2.8 mg/L and the average concentration in the May 2001 study was 7.6 mg/L. In the discharge from the Irvine Ranch Water District's treatment wetlands the average concentration increased from 0.62 in the June 2000 study to 5.7 mg/L in the May 2001 study.

- In the May 2001 study, the average nitrate nitrogen load transported by Peters Canyon Wash, measured at Barranca Parkway, was 571 lbs/day compared to the June 2000 study value of 328 lbs/day. The sum of the average loads from the monitoring points upstream of Barranca Parkway in the May 2001 study was 552 lbs/day. These findings are inconsistent with what was observed in the previous two studies where the sum of the loads upstream were approximately 20% higher than measured at Barranca Parkway. In the previous reports it was hypothesized that the reduction in load was probably due to assimilation by the higher order plants and attached algae in Peters Canyon Wash. Generally, the amount of algae observed in the channels during the May 2001 study was much less than in the previous two studies. Little or no rooted vegetation was observed in the reaches of Peters Canyon Wash where rooted plants were observed in the September 1999 and June 2000 study.

- The greatest contributors to the nitrate nitrogen load in Peters Canyon Wash were the Central Irvine Channel (139 lbs/day), Hicks Canyon Wash (99.8 lbs/day), Valencia Channel (74.3 lbs/day), Santa Ana – Santa Fe Channel (74.1 lbs/day), Como Storm Channel (62.3 lbs/day) and the Warner Drain (53.2 lbs/day). The load measured in Hicks Canyon Wash was approximately 92 lbs/day greater than measured in June 2000.

- The average daily nitrate nitrogen load measured in San Diego Creek at Campus Drive was 370 lbs/day compared to 169 lbs/day in June 2000 and 382 lbs/day in September 1999. The sum of the average daily nitrate loads measured at Peters Canyon Wash at Barranca Parkway, San Diego Creek at Harvard Avenue, the net load from the Irvine Ranch Water District's wetlands and the estimated loads for Lane, Barranca, San Joaquin, and Sand Canyon Channels was 794 lbs/day. Assuming that the flow rate of the water by-passing the low-flow channel at Campus Drive is equal to the difference between the sum of the upstream flowrates and the flowrate measured at Campus Drive the corrected nitrate nitrogen load for Campus Drive would be 504 lbs/day.

- As in the previous two studies, the Irvine Ranch Water District (IRWD) was diverting water from San Diego Creek through its constructed wetlands to reduce the nitrate load in the creek. The quality and volume of the water diverted from and returned to the Creek was monitored by IRWD. The average pumping rate from the Creek (May 15-22, 2001) was 6.70 cfs. The average return rate to the creek was 6.47 cfs yielding a net removal of 0.23 cfs.

  The mean nitrate nitrogen load pumped from the Creek was 393 lbs/day as NO_3. The mean nitrate nitrogen load returned to the Creek was 194 lbs/day. The IRWD Wetland Treatment Project removed on average, 199 lbs/day of nitrate nitrogen or about 51% of nitrate nitrogen pumped into the wetlands. The total nitrogen removal efficiency of the wetlands was about 41%. With respect to concentrations, the efficiencies for nitrate and total nitrogen reduction were 45% and 34% respectively. The efficiencies observed in the May 2001 study were lower than in the September 1999 and June 2000 studies. The efficiency of the wetlands is proportional to temperature. The first two studies were conducted during the summer when temperatures were higher and the removal efficiency of the wetlands was greater.

- The average daily Total Nitrogen (TN) loads from San Diego Creek at Campus Drive, Peters Canyon Wash at Barranca Pkwy and San Diego Creek at Harvard Avenue were 503, 647, and 224 lbs/day, respectively.

- The average daily total phosphate (as P) loads from San Diego Creek at Campus Drive, Peters Canyon Wash at Barranca Parkway and San Diego Creek at Harvard Avenue were 12.1, 14.3, and 1.16 lbs/day, respectively. The tributaries that contributed the greatest phosphate load to Peters Canyon Channel during the May 2001 study were Hicks Canyon Wash (7.28), El Modena Irvine (1.78) and the Central Irvine Channel (7.86). San Joaquin Channel (1.33 lbs/day) contributed the greatest phosphate load to reach 1 of San Diego Creek.

- Data from the UC Cooperative Extension indicate that no commercial agricultural fields were present in the watersheds of Como, Santa Ana–Santa Fe, Valencia, and Warner Storm Channels. These channels however continue to discharge high levels of nitrates, which are assumed to from groundwater.

- Using data from this study the projected total nitrogen load at Campus Drive between April 1st and September 30th would be 92,200 pounds. Using the adjusted flowrate for Campus Drive the load would be 125,000 pounds. Both of these estimates are well below the December 31, 2002 target of 200,000 pounds.

The complete reports for the 2001 study can be found in **Appendix R**.

The Newport Bay was sampled during three storms during the current monitoring year. The dissolved metals data from each storm were compared to water quality guidance criteria (acute and chronic toxicity) from the CTR. During the October 2000 storm the acute (instantaneous concentration >3.1 μg/L) and chronic (4-day average concentration >4.8 μg/L) guidance criteria for copper were exceeded at all locations in the Upper and Lower Bays. The chronic criterion for nickel (4-day average concentration > 8.2 μg/L) was exceeded at all locations in the Upper and Lower Bays. During storm in January 2001 the acute and chronic toxicity guidelines for copper were exceeded in both the Upper and Lower Bays. During the March 2001 storm there were no exceedances of the metals criteria in the Lower Bay. In the Upper Bay, at all stations, the chronic toxicity criterion for nickel, the acute criterion for copper, and the chronic criterion for copper were exceeded. In the next monitoring year a contract for toxicity testing will be established to determine if these metal concentrations cause toxicity to test organisms that would indicate an impact on bay organisms.

In addition to nutrient and heavy metal monitoring, bacteriological sampling was also conducted during the storm samplings in January and March 2001. **Figures 11.14** and **11.15** show the concentrations of total and fecal coliform bacteria at the water surface of each the monitoring locations during these storms. In the January storm, over three inches of rainfall occurred prior to the first day of sampling and prior to the second day of sampling. Generally, the bacterial concentrations were high for the first two samplings (**Figure 11.14)** and decreased in the third sampling. In the March event measureable rainfall occurred on or before each day of sampling. Because the total amount of rainfall was small (~0.4") the concentrations of fecal coliform bacteria generally decreased from sampling to sampling.

Dry weather monitoring of bacteriological quality was also conducted in the Upper Newport Bay. **Figure 11.16** shows the total and fecal coliform concentrations at four Upper Bay stations during the year. As in last years data the concentrations of bacteria are generally greatest near the mouth of San Diego Creek.

Time series plots of the tributary discharge, precipitation and tide stage during each monitored storm can be found in **Appendix S**.

In February of 2000, the Regional Monitoring Program (RMP) for the Nutrient TMDL was initiated. Chemical sampling for nutrients during storms and dry weather was conducted according to the frequencies outlined in RMP report. The data from the 2000/01 reporting period is contained in **Appendix T.**

The CARs evaluations for the Upper Bay and San Diego Creek can be considered on schedule.

<u>Lower Newport Bay</u>

There have been no efforts focused on Lower Newport Bay, and this site is therefore behind schedule.

Aliso Creek

With regard to Aliso Creek, the Co-Permittees are carrying out extensive studies to better characterize patterns of bacterial contamination, identify sources of this contamination, and assess options for source reduction and/or treatment. These studies were initiated as the result of a directive from the Regional Board and this site can be considered to be on schedule. The results of these studies can be found in the first and second quarterly progress reports.

Dana Point Harbor

Dana Point Harbor was monitored during two storms. During both of these storms the dissolved nickel concentration exceeded the chronic toxicity guidance criterion from the CTR. Focused studies in the Harbor are not slated to begin until the 2002/03 monitoring year.

San Juan Creek

The focused studies on San Juan Creek are slated to begin during the next monitoring year. The Orange County Health Care Agency with assistance from researchers from the University of South Florida are currently conducting a bacterial source tracking study in the San Juan Creek watershed. Antibiotic resistance analysis is being used to characterize the sources of bacteria from several stormdrains discharging to the Creek.

11.6.4 Reconnaissance

The Program is generally on track with the categories of activities and timelines listed in **Figure 11.3**. Stations were prioritized as part of the monitoring program design. Site-specific designs have been established and source identification conducted as each site is addressed.

The impact of the Construction Circle drain on Peters Canyon Wash was evaluated in a cooperative investigation with Region 8 (see Section 10 for details). The reconnaissance of the automotive repair complex on Orange Avenue in Lake Forest has also been completed (Section 10). The other four sites listed in the Final Monitoring Program have been slated for completion in the upcoming year. The full list of sites will therefore be completed ahead of schedule.

Figure 11.3 also included BMP evaluation as a part of the Reconnaissance Program. However, the workshop to develop a regional stormwater research program recognized that it is inefficient to conduct BMP evaluations on a program-by-program basis. The workshop therefore described a BMP evaluation project as a high priority. The Final Monitoring Program's commitment in this area may be fulfilled by supporting and participating in a regional research project. The Principal Permittee is working with SCCWRP on a BMP evaluation program with grant funding under Proposition 13.

11.6.5 Semiannual Sediment Sampling

Samples of bottom sediment from several watershed and harbor/bay locations were collected in the fall/winter of 2000 and the spring/summer of 2001. These samples were analyzed for trace metals, iron, chlorinated hydrocarbon pesticides, selected herbicides, and particle size distribution. One monitoring location in Dana Point Harbor was also monitored for polynuclear aromatic hydrocarbons (PAHs).

The database for harbor and bay sediments was evaluated using NOAA's guidance criteria for sediment toxicity. These criteria are used by SCCWRP in assessing toxicity of sediments collected from the Southern California Bight. Concentrations of metals and organic compounds from Newport Bay, Huntington Harbor, and Dana Point Harbor were compared to NOAA's Effects Range Median (ER-M). An ER-M is a predicted concentration at which half the test organisms in a toxicity test would show a toxic effect. No exceedances of the ER-Ms for metals or organic compounds were found in the samples collected during this reporting period.

SCCWRP's iron normalization procedure was again used to determine the presence of trace metal enrichment in the sediments from the bays and harbors. Using the regression equations and prediction intervals (**Table 11.11**) it was determined that every monitoring site in Newport Bay (Upper and Lower), Huntington Harbour, and Dana Point Harbor were anthropogenically (caused by the actions of man) enriched with zinc. All monitoring locations in Dana Point Harbor showed enrichment with copper and the locations near the outlets of the stormdrains showed enrichment with lead. Every location in Huntington Harbour and Bolsa Bay showed enrichment with lead. The monitoring locations near the outlets of Bolsa Chica Channel and the Sunset Channel also showed enrichment with copper. The Rhine Channel in the Lower Newport Bay showed enrichment with copper, lead, and zinc.   As in the previous reporting year, the furthest upstream sampling point in the Upper Newport Bay (UNBJAM) showed the least anthropogenic influence of any harbor/bay monitoring location.

11.7 QUALITY ASSURANCE / QUALITY CONTROL

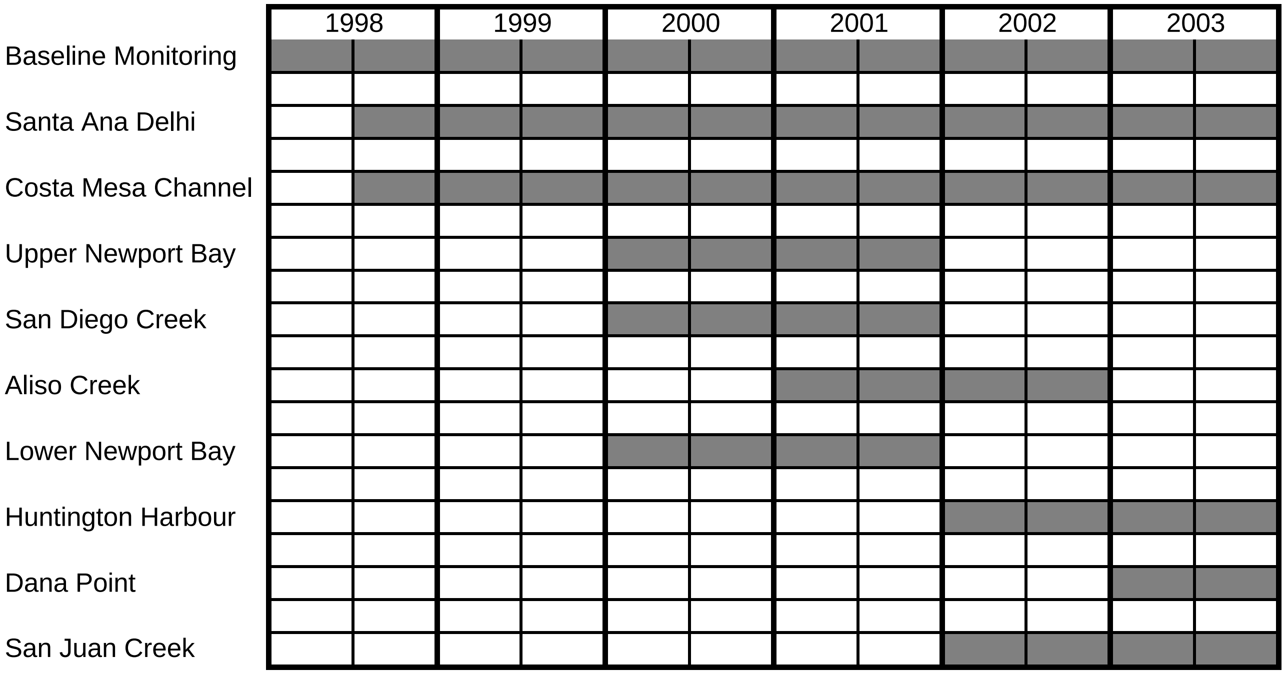
The quality of data produced by each of the three contractor laboratories was evaluated by submitting quality control samples with environmental samples. Most of the samples submitted were synthetic, comprised of aliquots of prepared standard solutions in nanopure water matrices. Quality Control sample conductivities were adjusted to levels similar to environmental samples with Ultrex grade sodium chloride. These synthetic samples were used to assess the accuracy of each laboratory. Replicate samples were also submitted to evaluate the precision of the laboratories.

The contractor laboratories conduct internal quality control programs utilizing certified reference materials (CRMs), spiked and replicate samples.

The results of the quality assurance program with the contract laboratory are summarized in **Appendix U.** The allowable range of percent recovery for synthetic and samples is set at 70 - 130 for concentrations above 5 times the detection limit. For replicate samples in which the highest reported value exceeded 5 times the detection limit, the allowable range was set at 75-125 percent. For blank sample analyses the allowable range was dl to 3(dl). Those results outside these ranges are boxed in the appendix.

Generally, the analytical performance of each laboratory was acceptable. Ten of the 70 analyses for TKN in synthetic samples produced results outside acceptable range of recovery. In nine of ten samples the reported recovery was lower than acceptable suggesting a systematic rather than random error.

Figure 11.1
Critical Aquatic Resources Monitoring Timeline



Monitoring year = July 1 of prior year - June 30 of reporting year

Figure 11.2
Warm Spot Monitoring Timeline

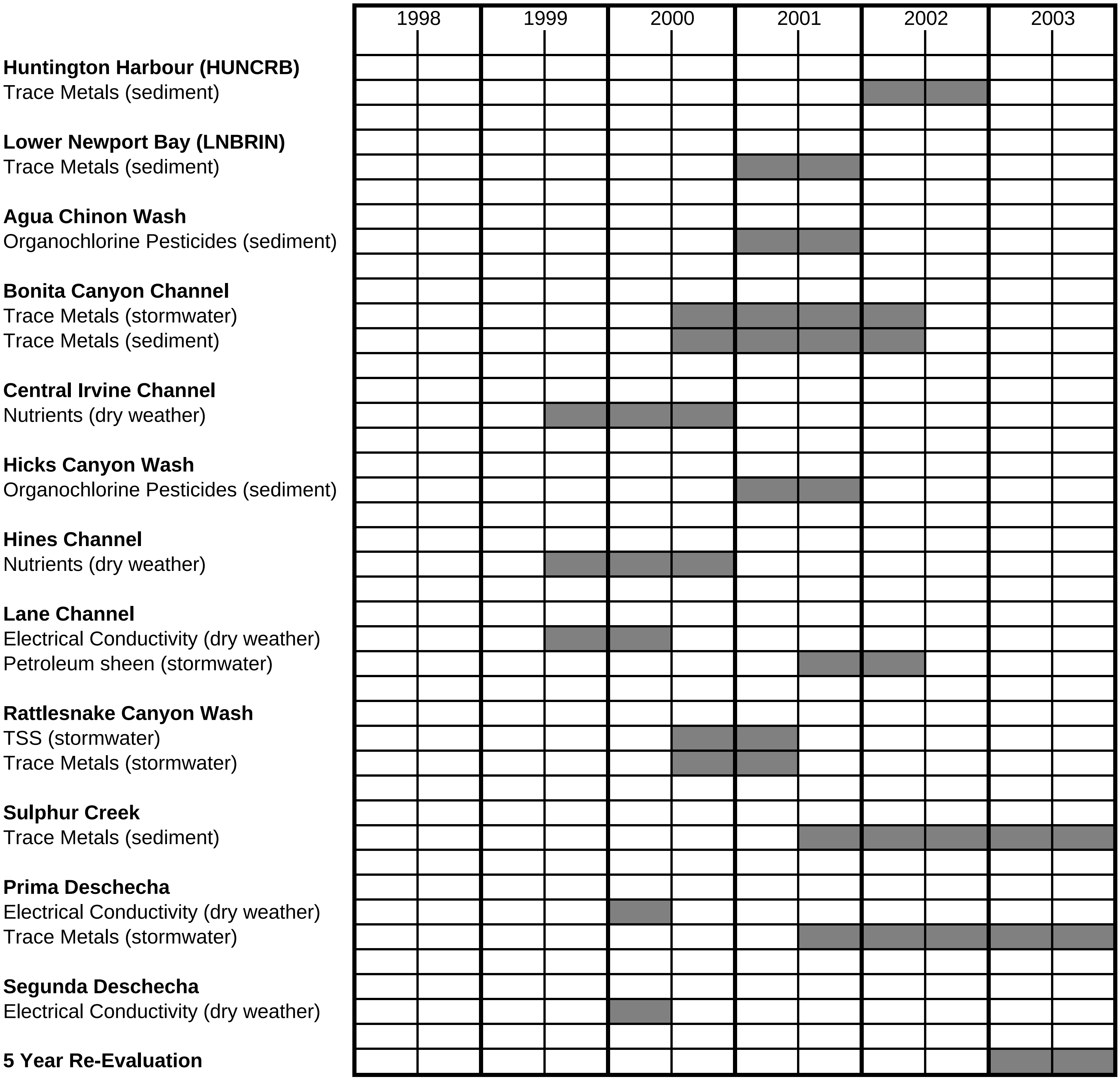


Figure 11.3
Water Quality Monitoring Program Timeline

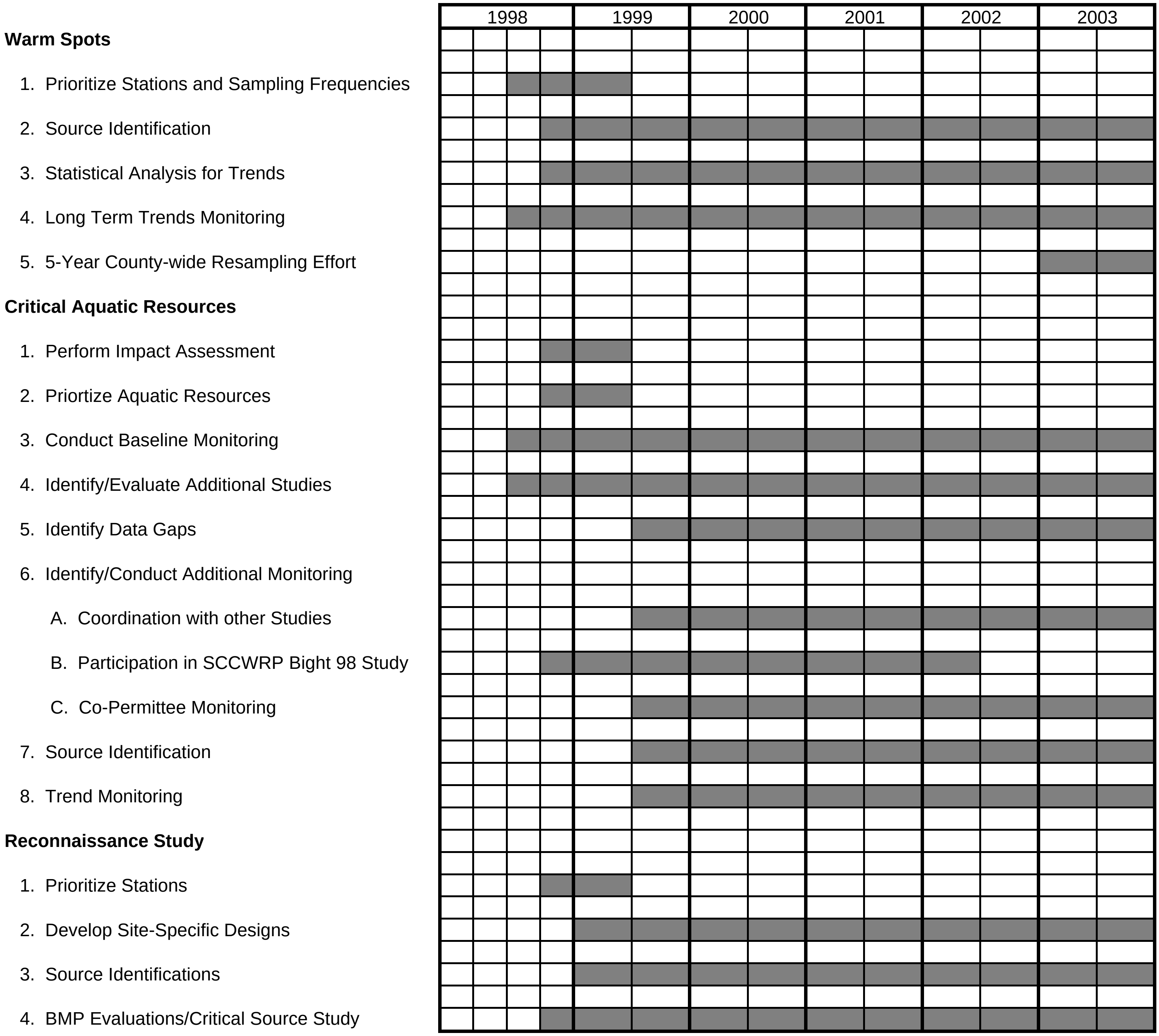
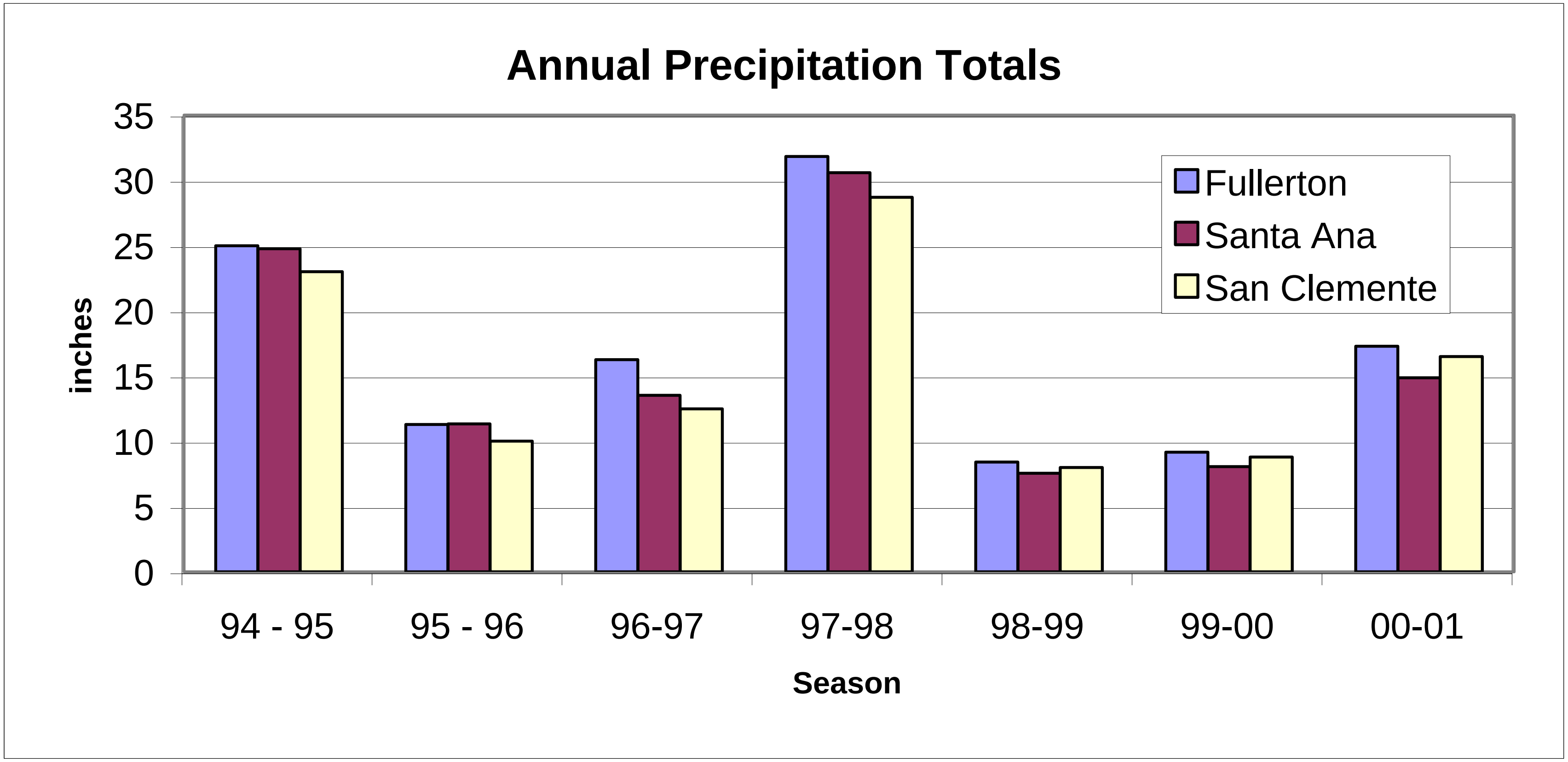
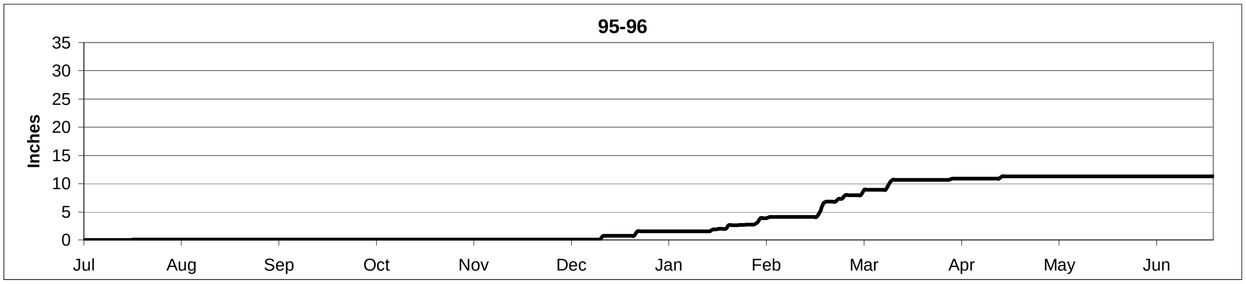


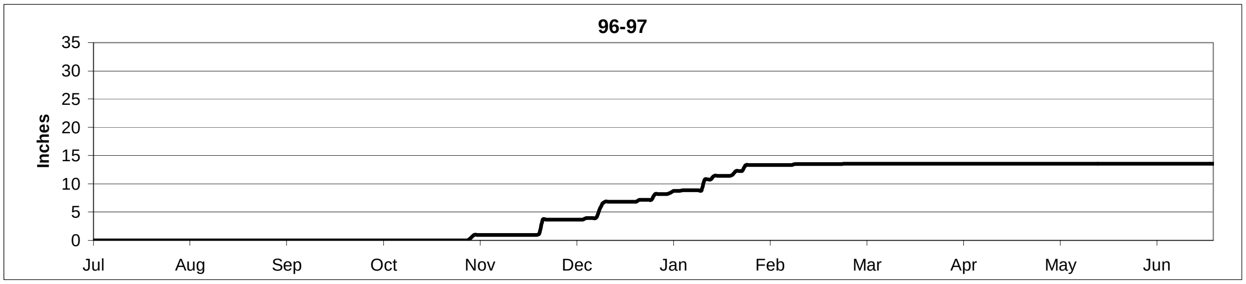
Figure 11.4

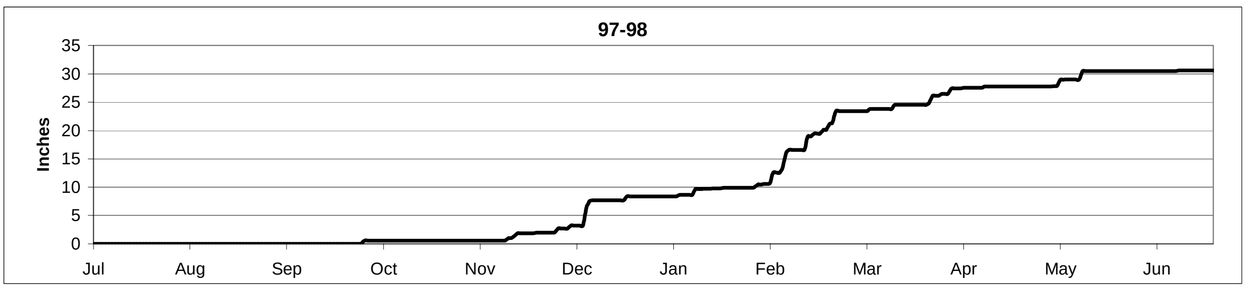


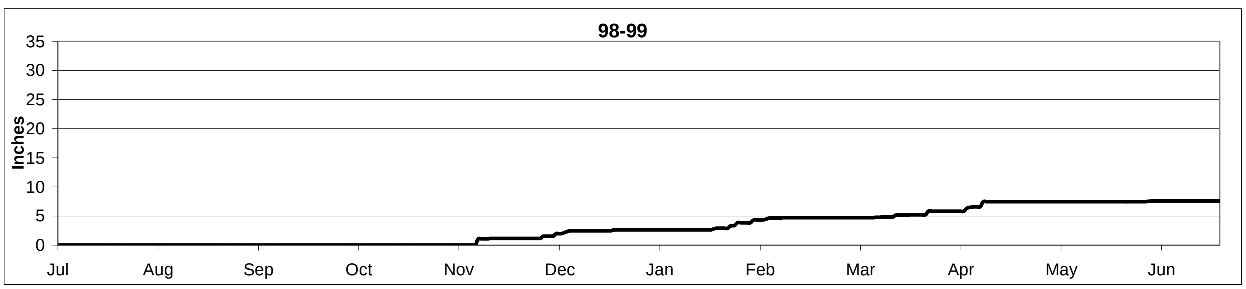
Season = July 1 - June 30

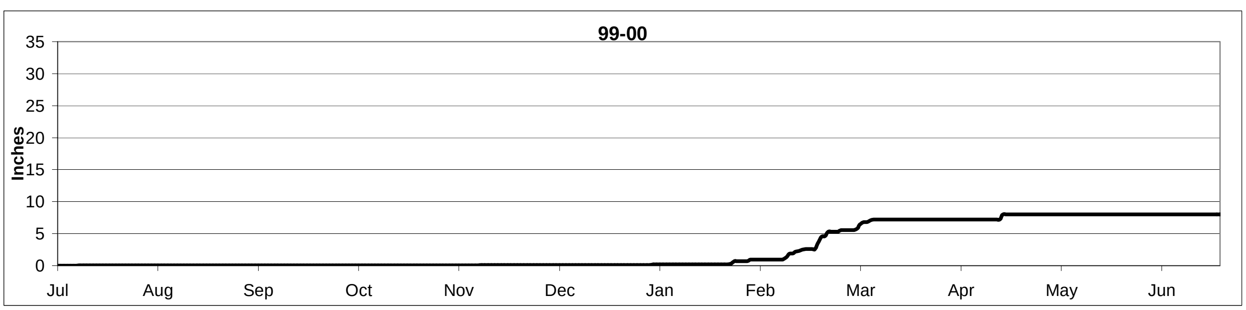
Figure 11.5
Annual Accumulated Rainfall in Santa Ana











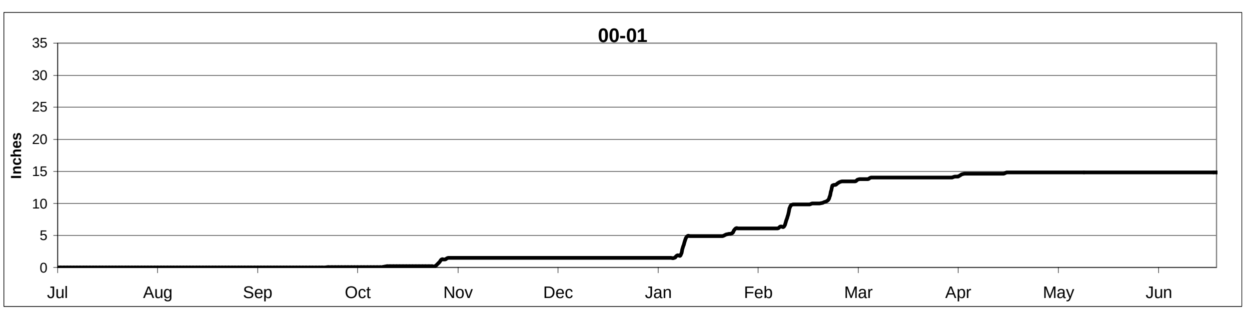
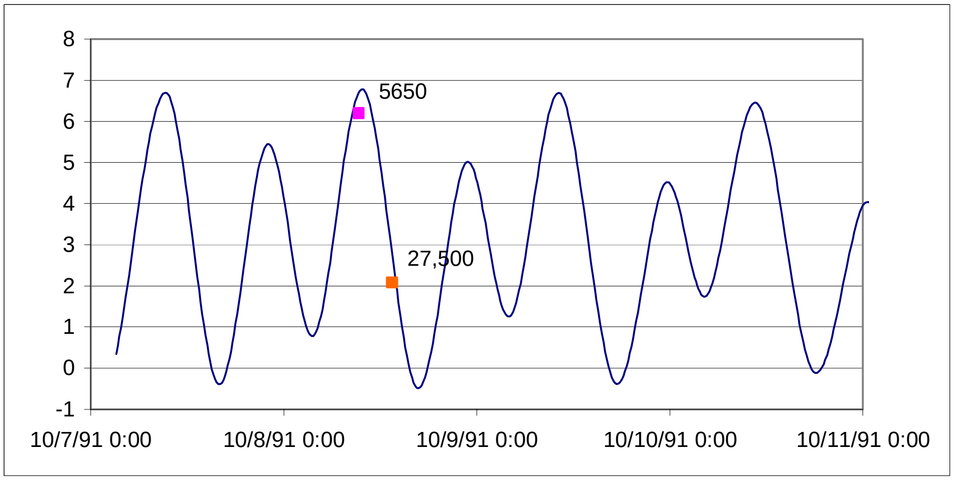
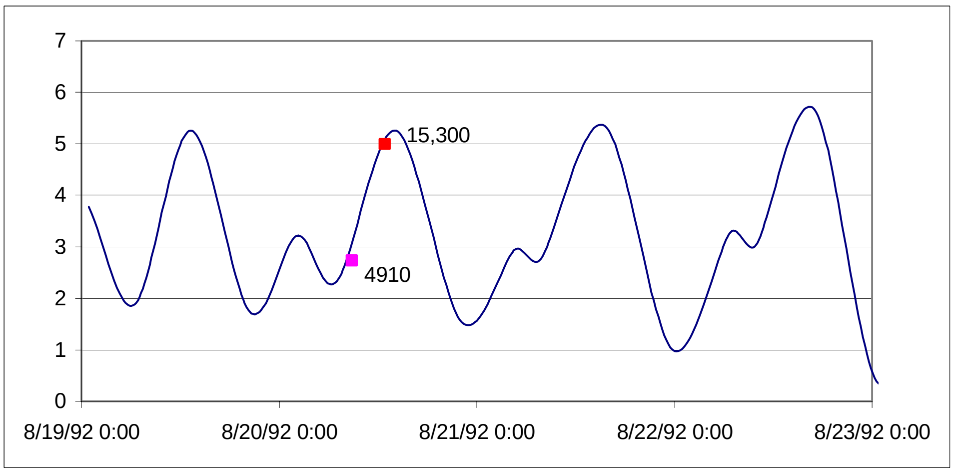


Figure 11.6
Tide Stage during Electrical Conductivity Measurements
in Segunda Deschecha Channel





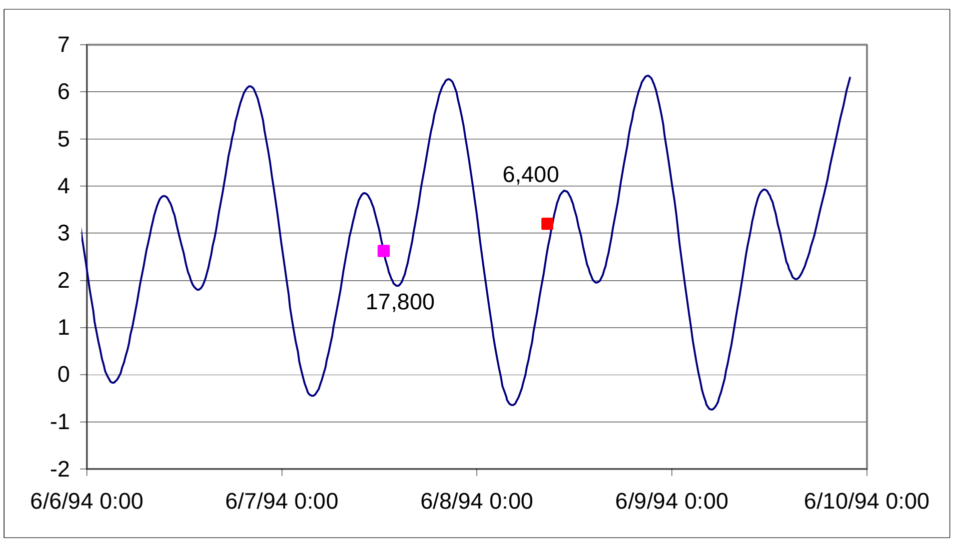
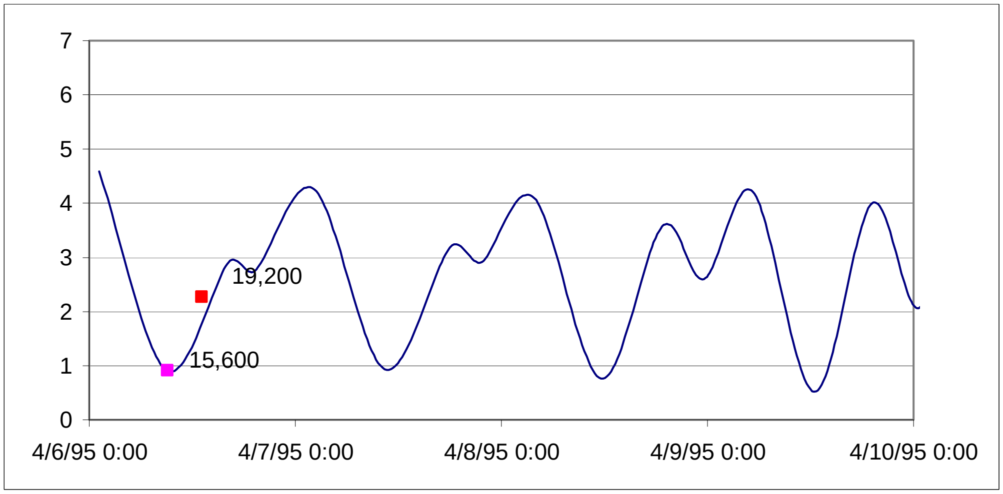
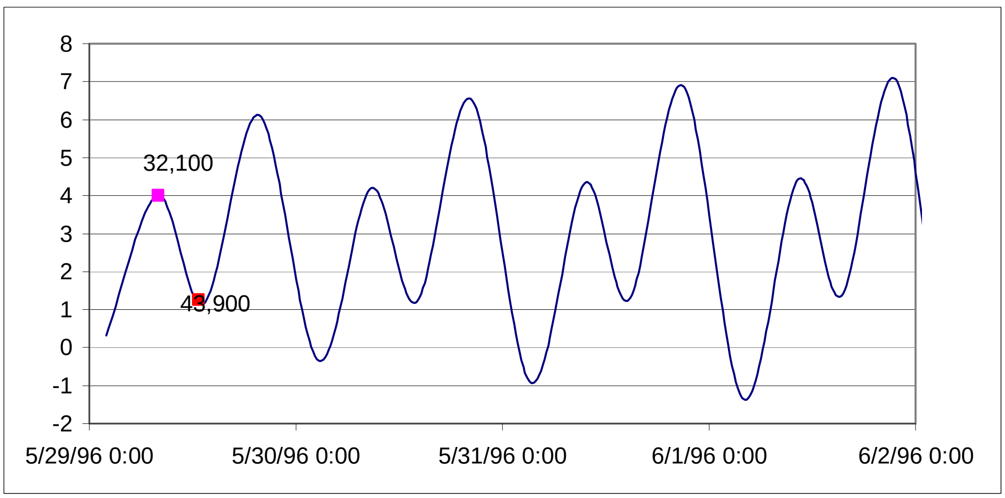


Figure 11.6
Tide Stage during Electrical Conductivity Measurements
in Segunda Deschecha Channel





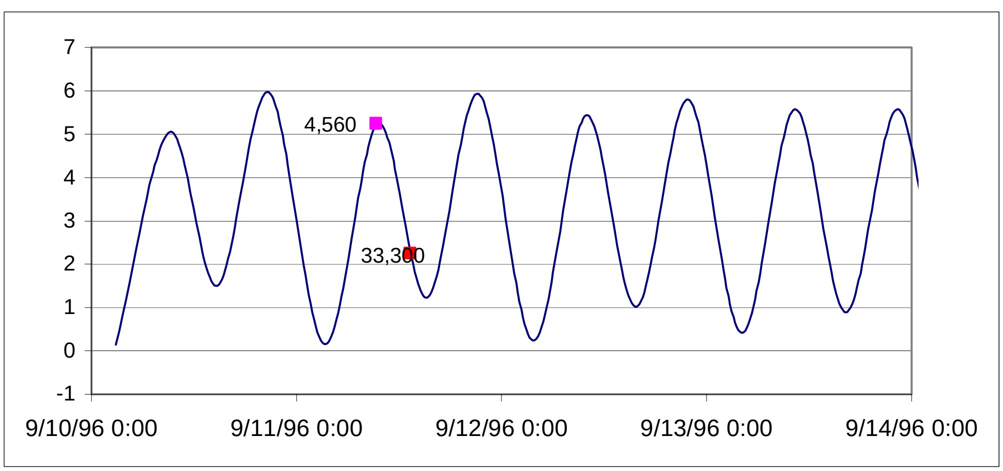


Figure 11.7 - Hourly Electrical Conductivity in Segunda Deschecha Channel

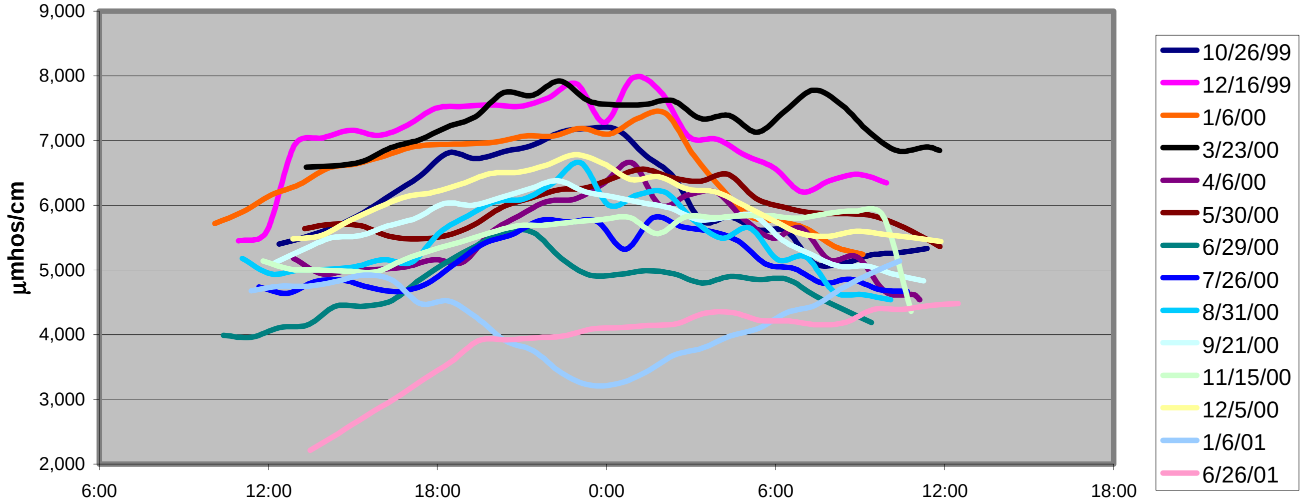


Figure 11.8 - Average Hourly Conductivity in Segunda Deschecha Channel

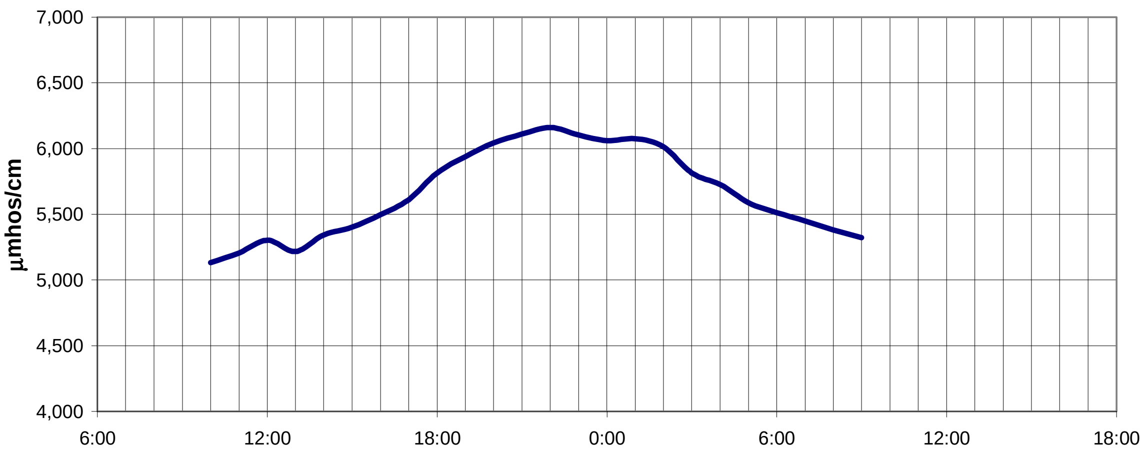


Figure 11.9 - Hourly Electrical Conductivity in Prima Deschecha Channel

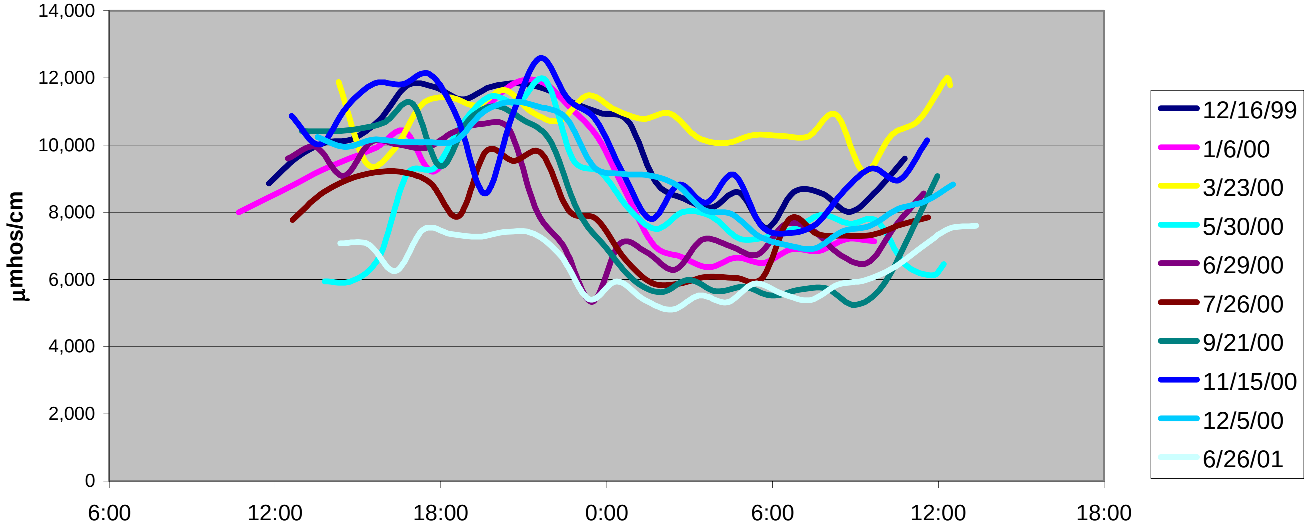


Figure 11.10 - Average Hourly Conductivity and Flowrate in Prima Deschecha Channel

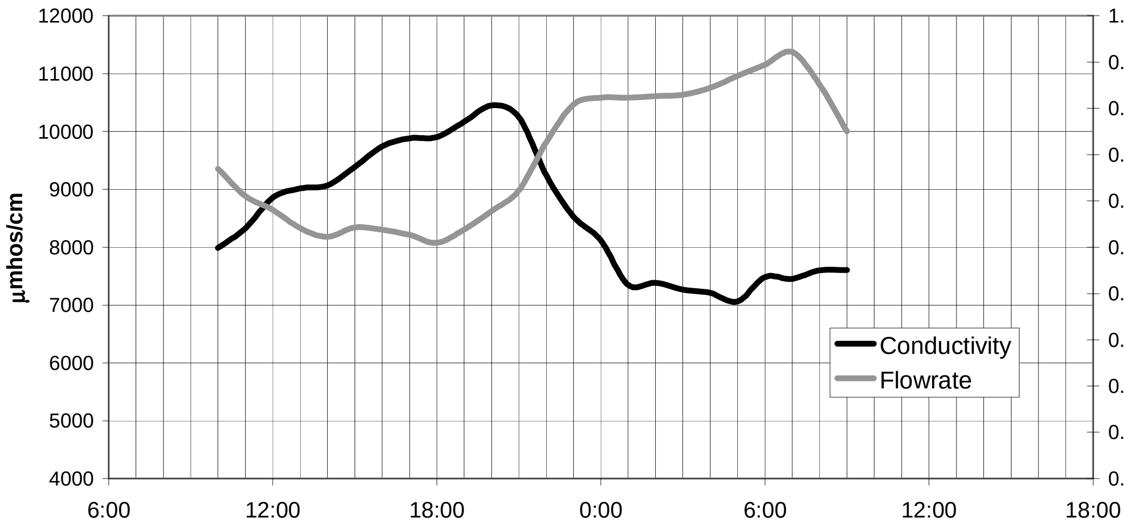
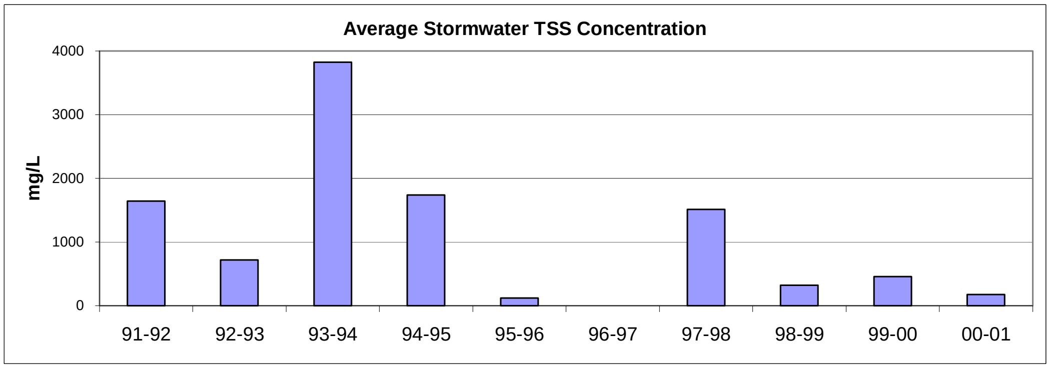
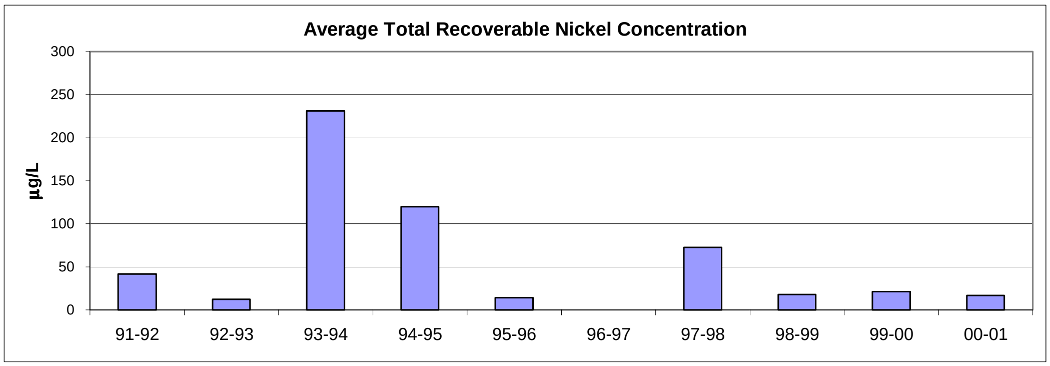
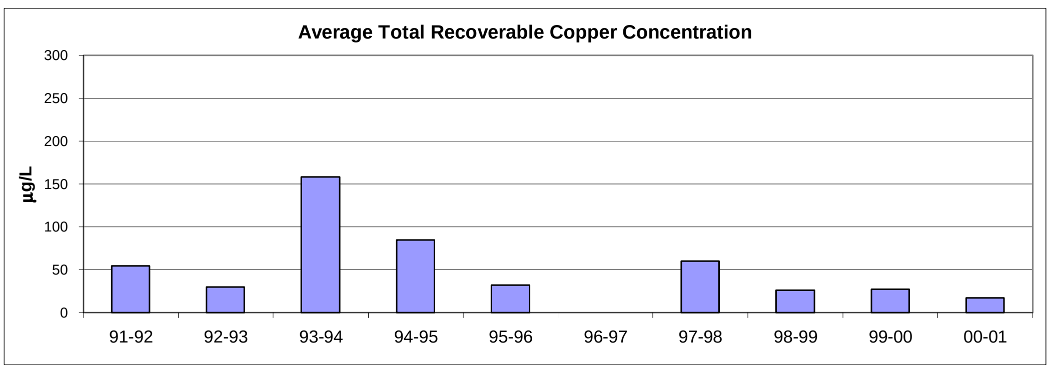
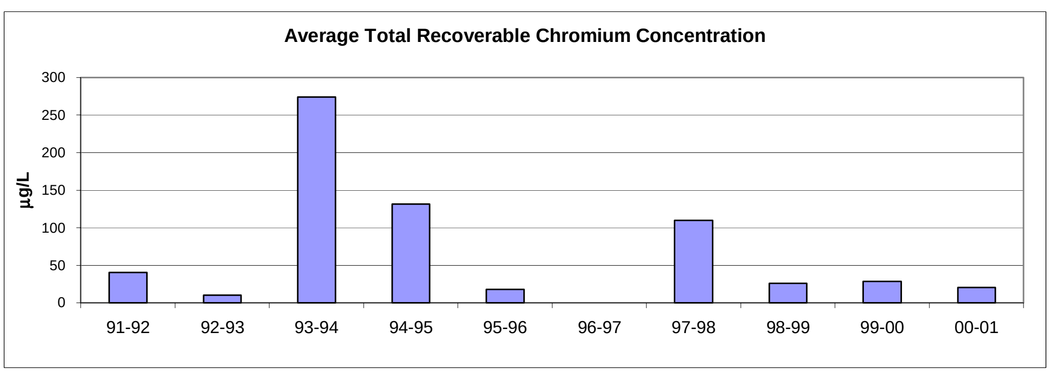


Figure 11.11
TSS and Total Recoverable Metals in Stormwater
at Bonita Canyon Channel



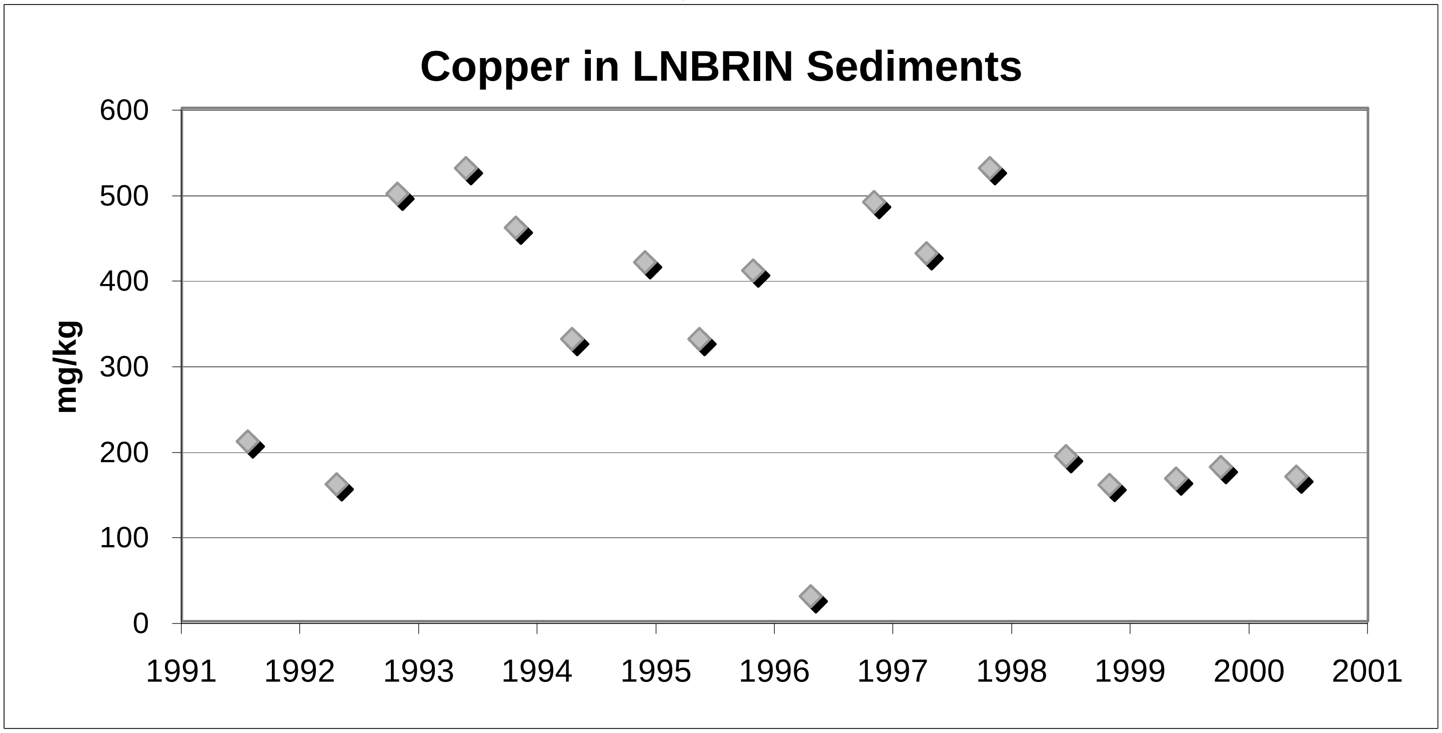






No samples collected in 1996/97 season

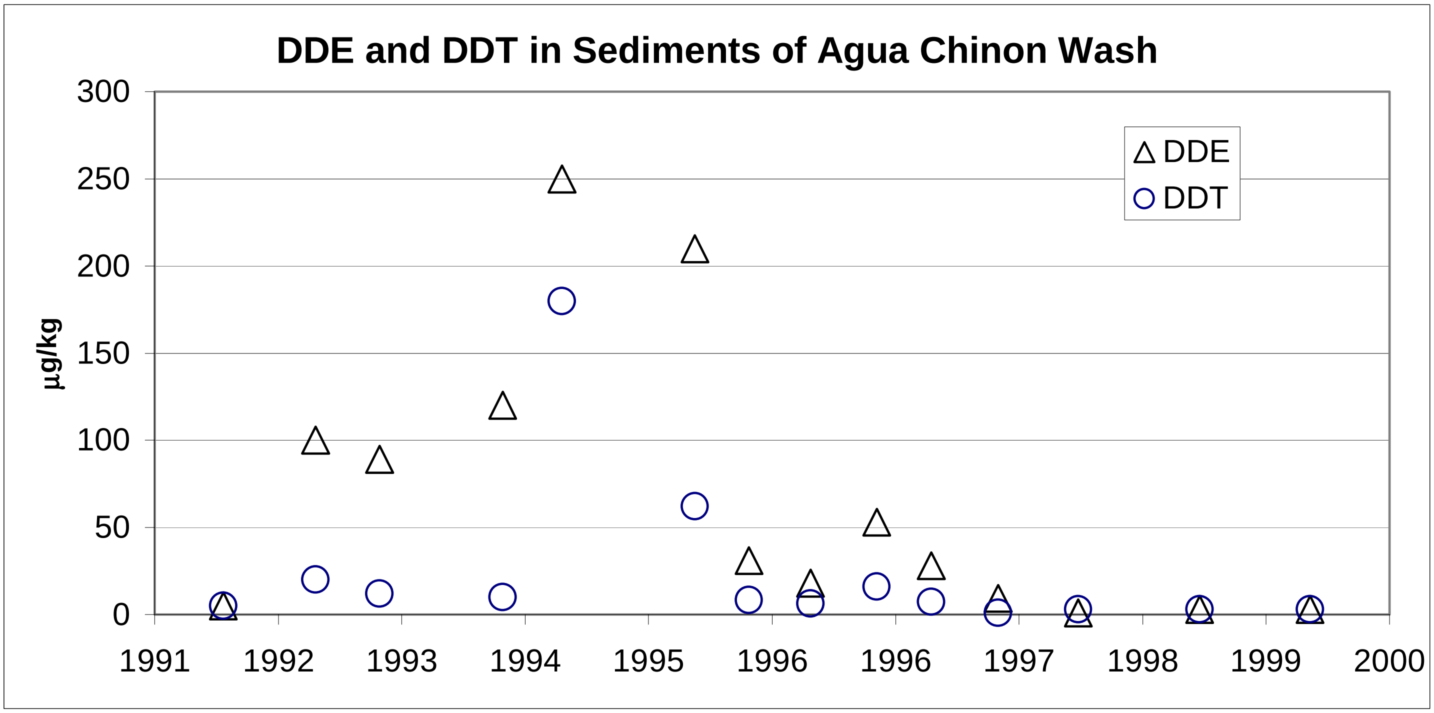
Figure 11.12



Copper in LNBRIN Sediments
mg/kg
600
500
400
300
200
100
0
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001

Figure 11.13

DDD and DDT in Sediments of Agua Chinon and Hicks Canyon Channels



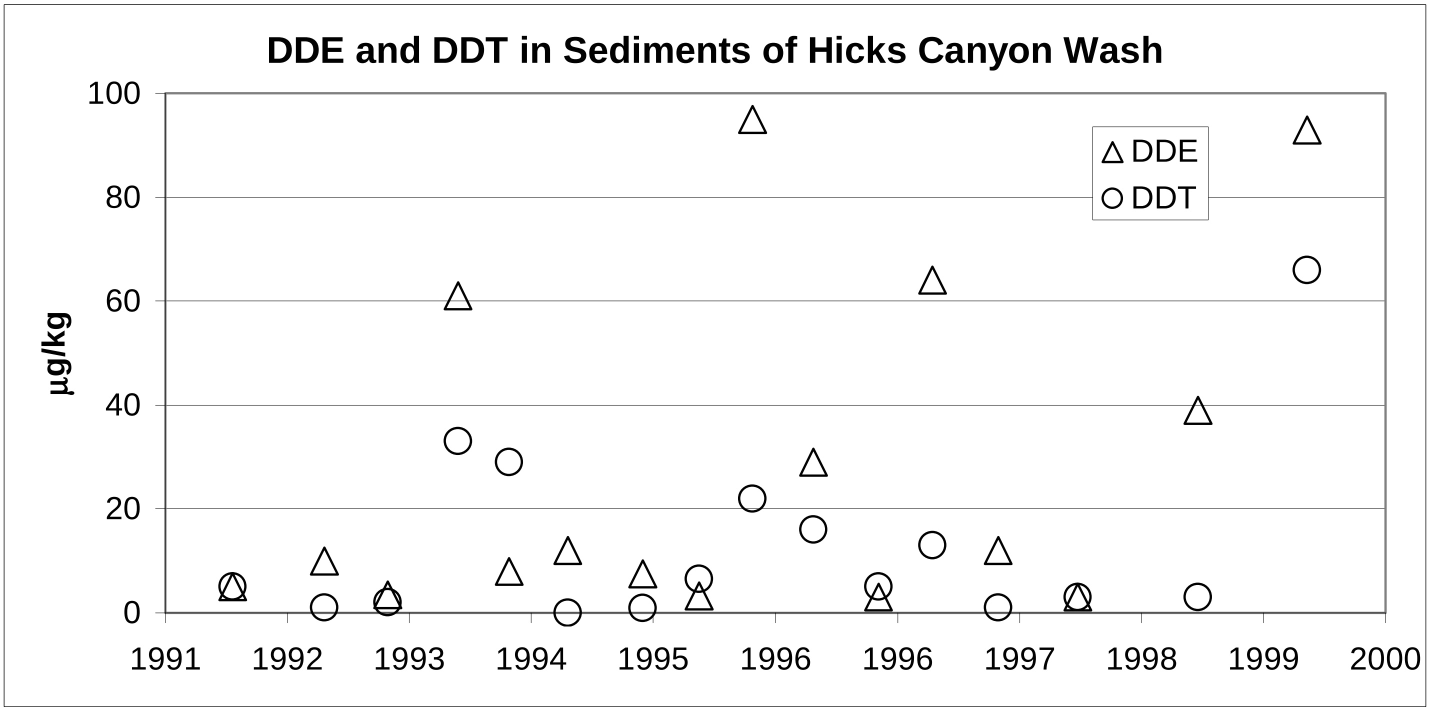


Figure 11.14
Fecal Coliform Concentration in Costa Mesa Channel

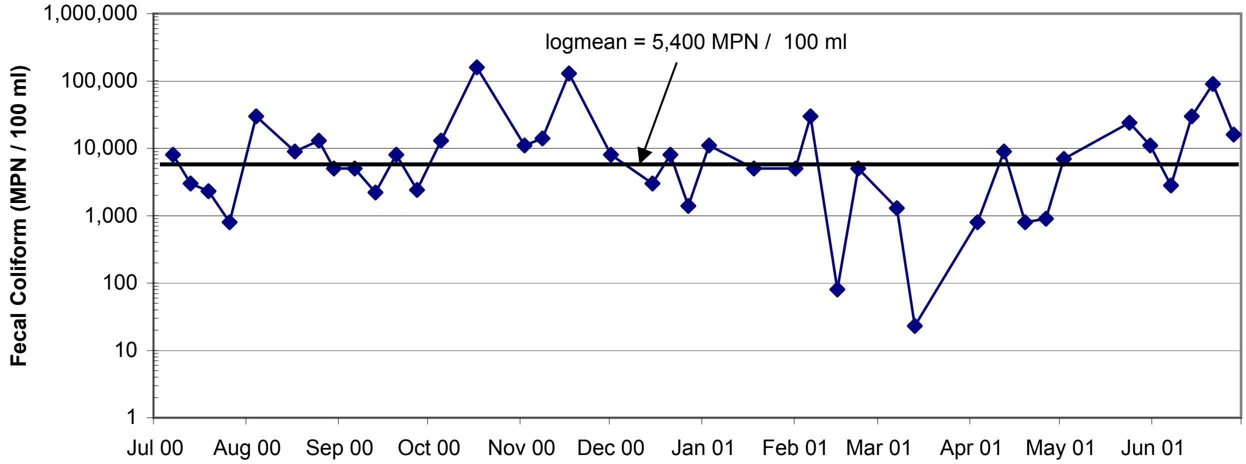


Figure 11.15
Diazinon Concentration in Costa Mesa Channel

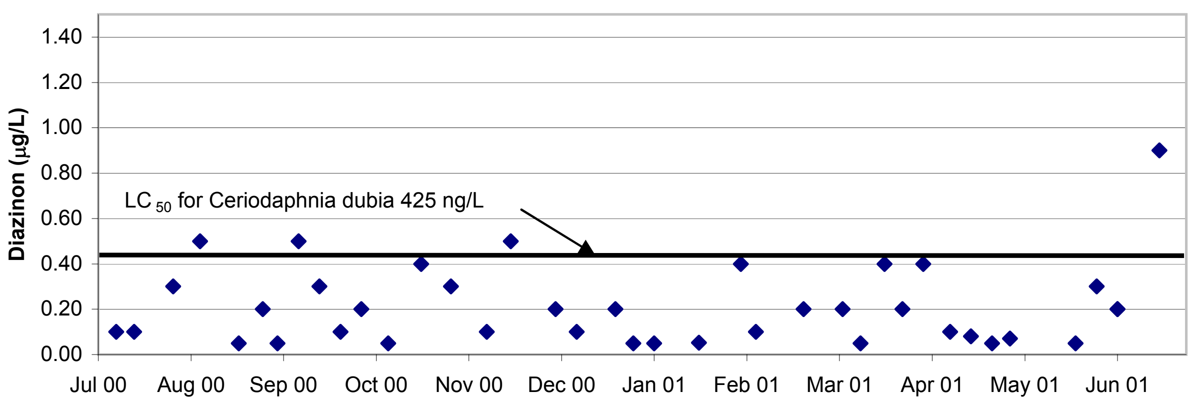
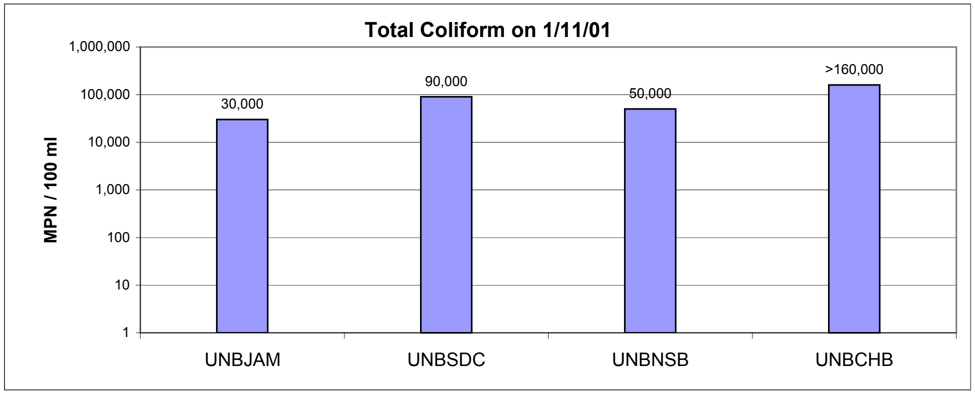
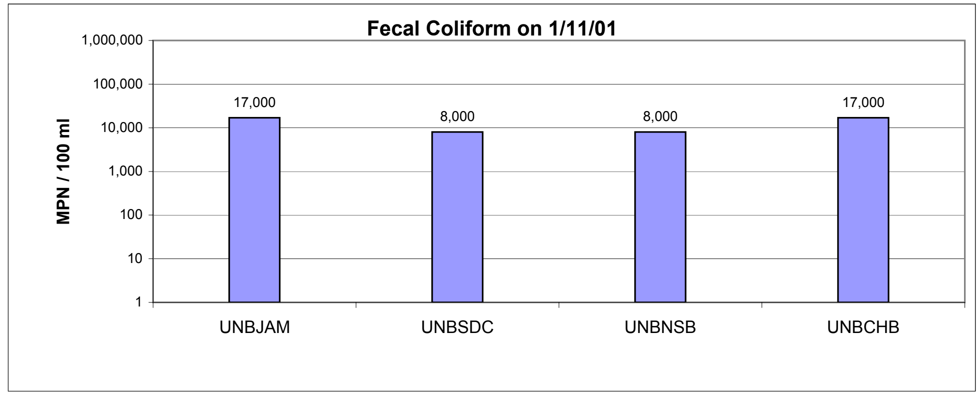
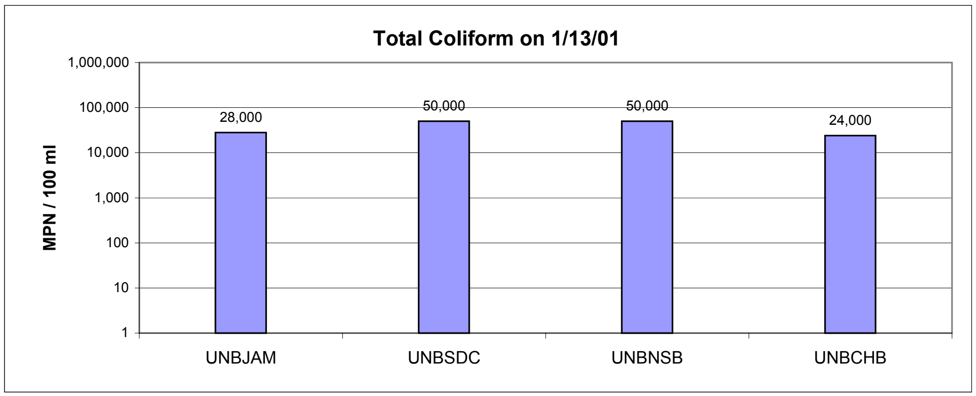
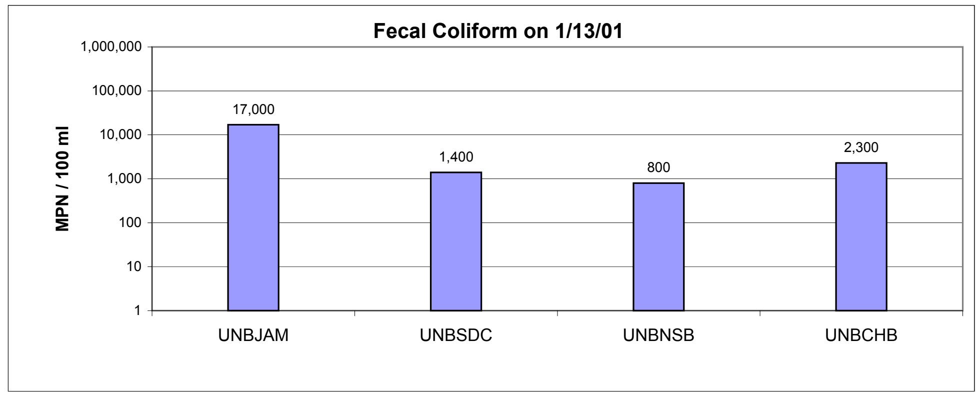


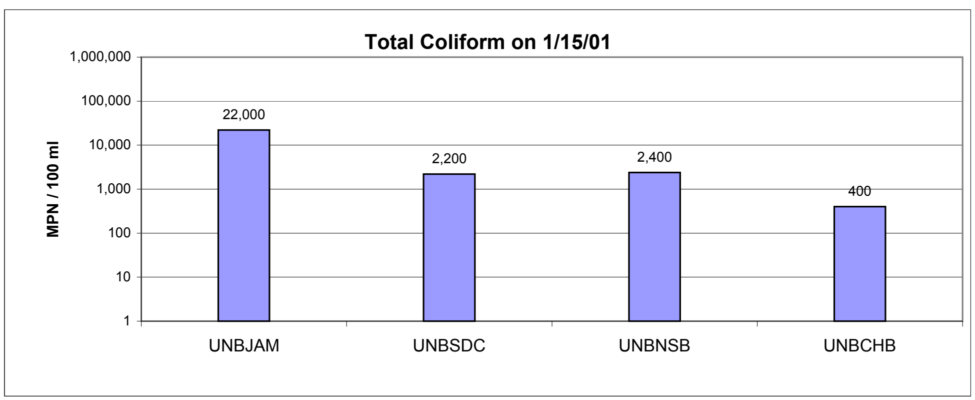
Figure 11.16
Bacteriological Sampling in Upper Newport Bay
Storm of 1/11/01 - 1/15/01

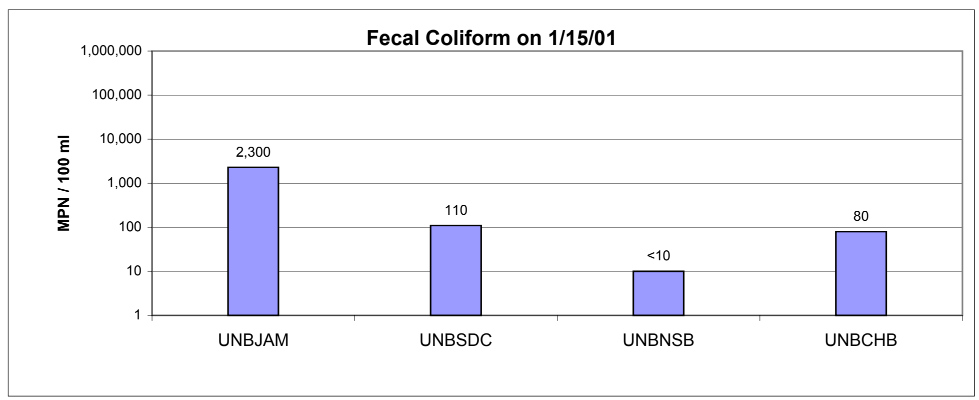






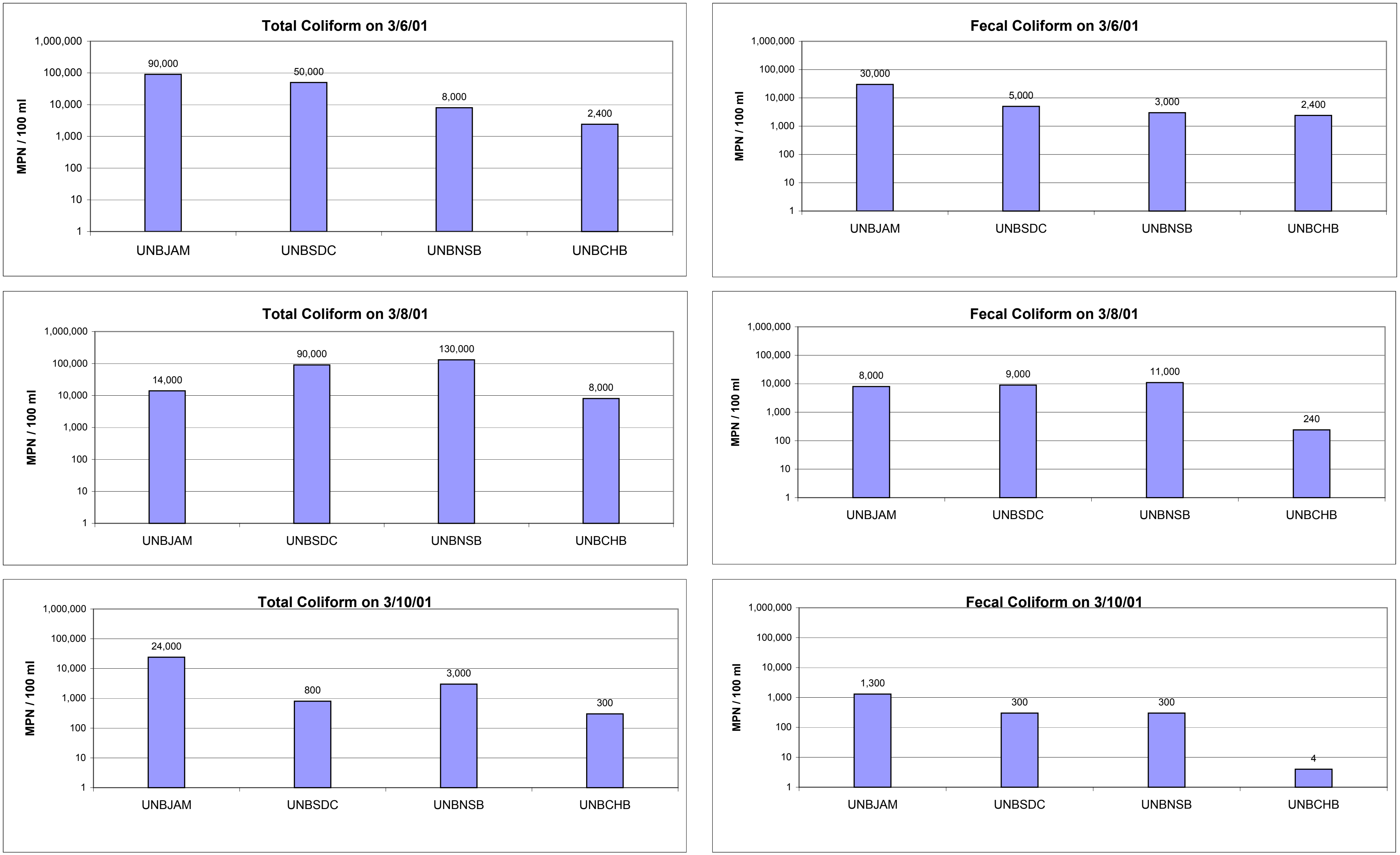






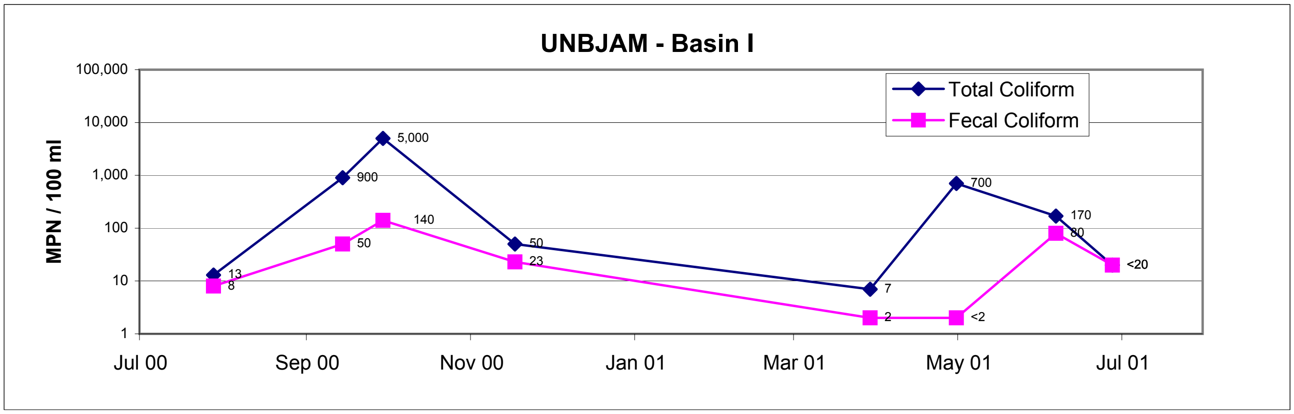
Sampled at surface

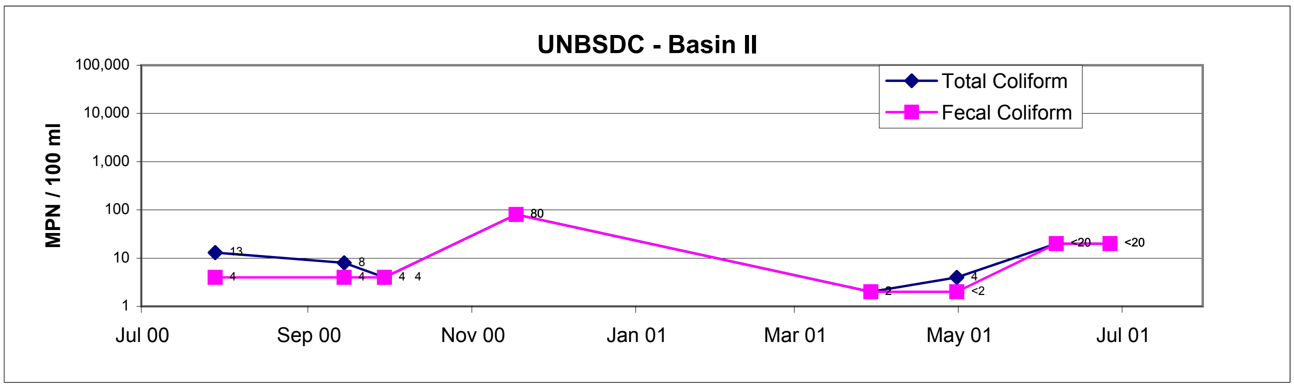
Figure 11.17
Bacteriological Sampling in Upper Newport Bay
Storm of 3/6/01 - 3/10/01

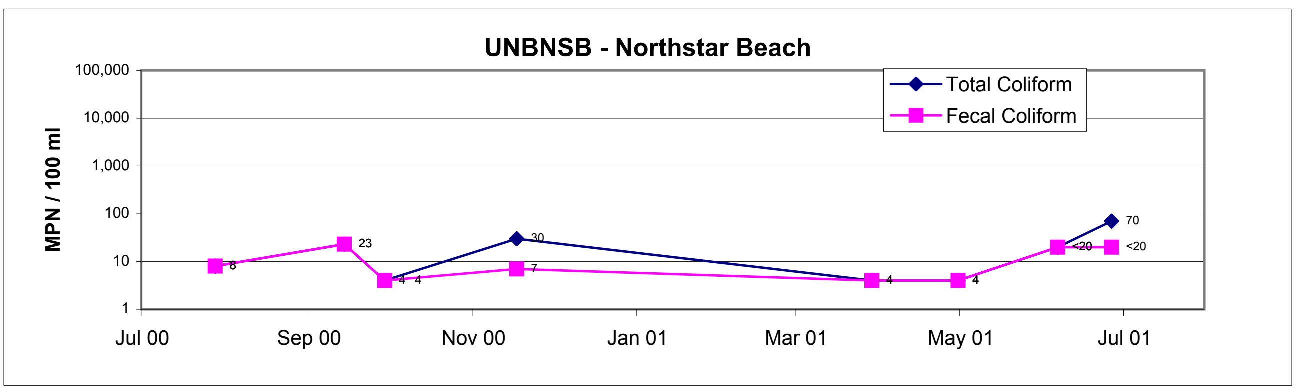


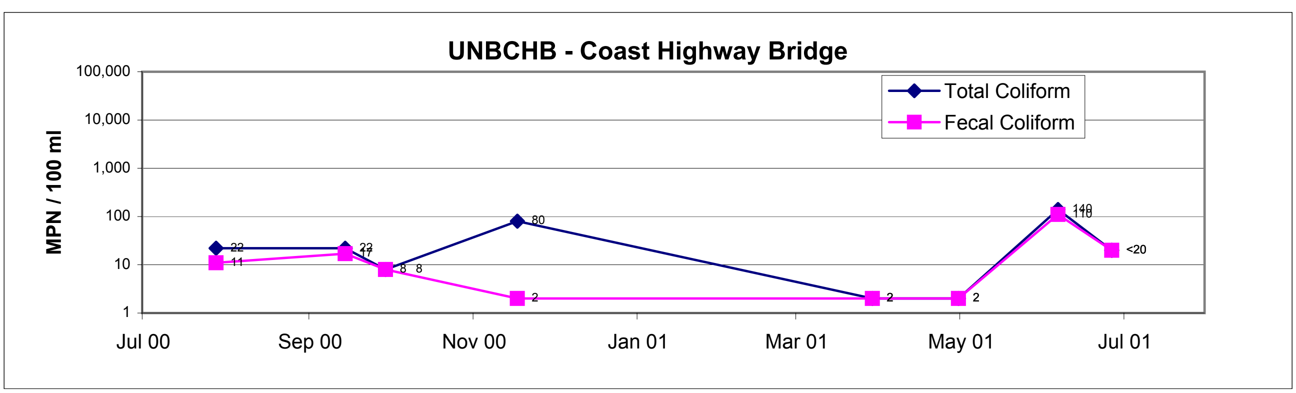
Sampled at surface

Figure 11.18
Dry Weather Bacteriological Concentrations in Upper Newport Bay









Sampled at surface

Table 11.2
Ranking of Critical Aquatic Resources

SITE	CRITERIA									
	303(d) listed	Community interest	Aquatic habitat	Wildlife habitat	Designated reserve	Contact recreation	Non-contact recreation	Utility resource	Urban impact	Total
Enclosed Bays and Estuaries										
Upper Newport Bay	XX	XX	X	X	X	X	X		X	10
Lower Newport Bay	XX	XX	X	X		X	X		X	9
Talbert Channel		XX	X	X	X	X	X		X	8
Bolsa Bay		XX	X	X	X	X	X		X	8
Sunset Aquatic/ Anaheim Bay / Huntington Harbour	XX	XX	X	X		X	X		X	9
Dana Point Harbor		XX	X	X		X	X		X	7
Coastal Resources										
Irvine Coast Marine Life Refuge		XX	X	X	X	X	X		X	8
Laguna Beach	XX	XX				X	X		X	7
Laguna Beach Marine Life Refuge		X	X		X	X	X		X	6
Newport Marine Life Refuge		X	X	X	X	X	X		X	7
Aliso Beach	XX	XX				X	X		X	7
Aliso Creek Mouth	XX	XX	X	X		X	X		X	9
Niguel Marine Life Refuge		X	X		X	X	X		X	6
Doheny Beach	XX	XX				X	X		X	7
Doheny Beach Marine Life Refuge		X	X		X	X	X		X	6
Inland Surface Waters										
Aliso Creek	XX	XX	X	X		X	X		X	9
Laguna Canyon Channel		XX		X		X	X	X	X	7
Oso Creek			X	X		X	X	X	X	6
Prima Desheca			X	X		X	X	X	X	6
San Diego Creek, Reach 1	XX	XX	X	X		X	X		X	9
San Diego Creek, Reach 2	XX	XX	X	X		X	X	X	X	10
San Juan Creek	XX	XX	X	X		X	X	X	X	10
San Juan Creek, Lower	XX	XX	X	X		X	X		X	9
Santa Ana River								X	X	2
Santiago Creek, Reach 4	XX		X	X		X	X	X		7
Segunda Desheca			X	X		X	X			4
Serrano Creek		XX	X	X		X	X		X	7
Silverado Creek	XX		X	X		X	X	X		7
Trabuco Creek			X	X		X	X	X	X	6

Scoring of candidate monitoring sites on each of several subjective criteria and Basin Plan beneficial uses that reflect habitat value and human us. Cells with more than one "X" indicate heavier weighting for that site on that criterion.

Table 11.3
Summary of Ranking Critical Aquatic Resources

Number of "X"s	Candidate sites
	First priority
9 - 10	San Diego Creek, Reach 1& Reach 2
10	San Juan Creek
10	Upper Newport Bay
9	Aliso Creek
9	Aliso Creek Mouth
9	Lower Newport Bay
9	San Juan Creek, Lower
9	Sunset Aquatic/Anaheim Bay/Huntington Harbour
7	*Dana Point Harbor (DPH)
	Second priority
8	Bolsa Bay
8	Irvine Coast Marine Life Refuge
8	Talbert Channel
7	Aliso Beach
7	Doheny Beach
7	Laguna Beach
7	Laguna Canyon Channel
7	Newport Marine Life Reserve
7	Santiago Creek, Reach 4
7	Serrano Creek
7	Silverado Creek
	Third priority
6	Doheny Beach Marine Life Refuge
6	Laguna Beach Marine Life Refuge
6	Niguel Marine Life Reserve
6	Oso Creek
6	Prima Desheca
6	Trabuco Creek
4	Segunda Desheca
2	Santa Ana River, Reach 2

Results of the ranking exercise for candidate monitoring sites. Overall ranking was based simply on the number of "X"s in each row of Table 11.1. * Dana Point Harbor is included as a first priority site because of the extensive amount of human use and community interest.

Table 11.4
Sources of Information Used for Critical Aquatic Resource Impact Assesment

	Study/Location	Agency	Funded by	Duration	Data
1	UNB Algal Studies	UCLA	IRWD	1996-	Salinity, nutrients, algal biomass
2	Newport Marine Life Reserve W'shed Studies	RiverTech	The Irvine Company		Nutrients
3	Newport Marine Life Reserve Offshore Studies	Dr. Ford, Cal State U. San Diego	The Irvine Company		Growth rate of kelp
4	Santa Ana River, Reach 1	SCCWRP	CSDOC	10/97-10/98	TSS, priority pollutants (organics, etc.)
5	Southern California Bight Pilot Project	SCCWRP	POTWs	1994, 1998	Chemical, biological, and toxicity samples
6	Basin Study, Santa Ana River (Imp. Hwy)	OC Water District & USGS	OCWD & USGS	10/95 - 9/99	Nitrates, organics
7	State Mussel Watch (UNB, DP, Huntington Harbor)	Ca. Dept. of Fish & Game	Reg'l Board	1977-	Toxics (trace metals, synthetic organics)
8	Toxic Substances Monitoring Program	Ca. Dept. of Fish & Game	Reg'l Board	1989	Toxics (trace metals, synthetic organics)
9	TMDL studies	Reg'l Board	Reg'l Board	1997	TMDLs on nutrients
10	TMDL studies	Reg'l Board	Reg'l Board		TMDLs on sediments
11	NB Plant Survey	Dr. Alex Horne, UC Berkeley	IRWD	1996	Plants
12	Coastal bacteria (coast)	County Environmental Health	County	1977-	Bacteria
13	Coastal bacteria (Aliso Creek, Laguna Beach)	Aliso Water Management Agency (AWMA)	AWMA	NPDES permit term	Bacteria
14	Coastal bacteria (San Juan Creek)	Southeast Regional Reclamation Authority (SERRA)	SERRA	NPDES permit term	Bacteria
15	Coastal bacteria (Santa Ana River)	County Sanitation Districts of Orange County (CSDOC)	CSDOC	NPDES permit term	Bacteria
16	Talbert Channel Conservancy	Cal State Long Beach			Polychaete taxonomy
17	Evaluation Monitoring Program (UNB w'shed)	Dr. Fred Lee, Transportation Corridor Agencies (TCA)		1997-2000	Toxicity
18	SD Creek Sediment Monitoring Program	Orange County Environmental Resources Section	County, Cities of Irvine, Tustin, & Newport Beach, Irvine Company	1987-	Transported sediment, channel profiling, bathymetric survey of NB
19	San Diego Creek/NB model	Resource Management Associates	County, City of Newport Beach, Army Corps of Engineers	1997-	Sediment transport model with potential for expansion into water quality model
20	Orange County Municipal NPDES Stormwater Program	Orange County Environmental Resources Section	County, Flood Control District, Cities	1991 -	Water and sediment quality data
21	Chemistry, Toxicity and Benthic Community Conditions in Sediments of Selected Southern California Bays and Estuaries	NOAA, SWRCB, USEPA, DFG, UCSC, CSUSJ	NOAA, SWRCB, USEPA, DFG	1997	Sediment quality data
22	Maintenance of trash/debris booms in Orange County flood control channels	Orange County PFRD/PW/OPS	County	Ongoing	Debris boom maintenance, debris disposal costs
23	Maintenance of Newport Dunes Aquatic Park	Newport Dunes Aquatic Park	Newport Dunes Aquatic Park	Ongoing	Algae removal costs
24	Debris removal in Huntington Harbour	G.H. Boston Company	City of Huntington Beach	Ongoing	Debris volumes
25	Debris removal in Newport Bay	City of Newport Beach Public Works	City of Newport Beach	Ongoing	Algae and debris volumes
26	Maintenance dredging in County facilites	Contractor administration by County Coastal Facilities	County	Ongoing	Sediment testing results, biological resources
27	Fish trawling in Newport Bay	Orange Coast College	Orange Coast College	Ongoing	Population distribution of fish
28	Army Corps of Engineers Reconnaissance Study - Aliso Creek	Army Corps of Engineers	Army Corps of Engineers, Cities, County, Water Districts	1998 - 2001	Create integrated watershed management plan.

Table 11.5
Critical Aquatic Resources Preliminary Impact Assessment

Resource	Beneficial use(s)	Available Indicators of probable impact	Source of Indicator From Table 10	Constituents of concern	Possible Sources
San Diego Creek, Reach 1 & 2	Aquatic habitat	Elevated toxics in fish tissue	8	Toxaphene, Dacthal, Diazinon, Oxidizon, Total DDT, Group A, Cd, Se, Zn	Urban runoff, agriculture
		Bioaccumulation	7	Chlorpyrifos, Oxidizon, Toxaphene, Total Chlordane, Total DDT, Dieldrin, Total PCB, Total PAH, Cd	Urban runoff, agriculture
	Wildlife habitat	Water quality	17,20	Diazinon, Chlorpyrifos, nutrients	Urban runoff, agriculture
		Sedimentation	18,19,26	Sediment	Channel erosion, construction, agriculture
		Wildlife changes			Urbanization, urban runoff
		Vegetation changes			Urban runoff, channel erosion, flowrate
	Recreation/ aesthetics	Algal blooms	20	Nutrients	Urban runoff, agriculture
		Elevated levels of bacteria	12		Urban runoff, wildlife, sewer overflows / line breaks
San Juan Creek & Lower	Recreation/ aesthetics	Beach closures	12, 14	Bacteria	Urban runoff, wildlife, sewer overflows / line breaks
	Groundwater Recharge	Water quality	14,20	Total Dissolved Solids	Urban runoff
Upper Newport Bay	Aquatic habitat	Elevated toxics in fish tissue	8	Cu, Hg, Pb, Total DDT	Urban runoff, recreational boating
		Water quality	17,20	Diazinon, Chlorpyrifos, nutrients	Urban runoff, agriculture, open space
		Sediment contamination	5,20,21,26	Total DDT	Urban runoff, agriculture, boatyards
		Bioaccumulation	7	Chlorpyrifos, Toxaphene, Total Chlordane, Total DDT, Dichlorobenzophenone, Dicofol, Dieldrin, Total PCB, Total PAH, Cu, Hg	Urban runoff, agriculture
	Wildlife habitat	Sedimentation	18,19,26	Sediment	Channel erosion, construction, agriculture
		Loss/change of species diversity	26,27	Toxics, DO, nutrients, sediment, species composition	Urban runoff, agriculture, open space
		Sediment contamination	20,21,26	Total Chlordane, Total DDT, DDE	Urban runoff, agriculture, boatyards
	Recreation/ aesthetics	Algal blooms	11,23,25	Nutrients	Urban runoff, agriculture
		Trash and debris	22	Trash and debris	Urban, natural
		Beach closures	12	Bacteria	Urban runoff, POTW discharge/line breaks
Aliso Creek & Mouth	Aquatic/ riparian habitat	Bank erosion	28	Flowrate	Urban development
		Loss of riparian vegetation	28	Flowrate	Urban development
	Recreation/ aesthetics	Beach closures	12,13,33	Bacteria	Urban runoff, sewer overflows / line breaks
Lower Newport Bay	Aquatic habitat	Bioaccumulation	7	Chlorpyrifos, Dacthal, Heptachlor Epoxide, Toxaphene, Total Chlordane, Total DDT, Dieldrin, Total PCB, Total PAH, Al, As, Cd, Cu, Cr, Hg, Mn, Pb, Se, Zn	Urban runoff, agriculture,boatyards, recreational boating
		Sediment contamination	5,20,21,26	Total Chlordane, Total DDT, Cu, Hg	Urban runoff, agriculture
	Recreation/ aesthetics	Algal blooms	11,25	Nutrients	Urban runoff, agriculture
		Trash and debris	25	Trash and debris	Urban, natural
		Complaints	12,20,25	Trash and debris, nutrients, bacteria	Urban, natural, agriculture, open space
Sunset Aquatic/Anaheim Bay/Huntington Harbour	Aquatic habitat	Bioaccumulation	7	Chlorpyrifos, Dacthal, Heptachlor Epoxide,Oxidizon, Toxaphene, Total Chlordane, Total DDT, Dieldrin, Total PCB, Total PAH, Al, As, Cd, Cu, Cr, Mn, Pb, Se, Zn	Urban runoff, agriculture
		Elevated toxics in fish tissue	8	Total Chlordane, Total DDT, Total PCB, Total PAH	Urban runoff, agriculture
		Sedimentation	26	Sediment	Agricultural runoff
		Loss/change of species diversity	5,26	Sediment, disturbance	Agricultural runoff, dredging
		Sediment contamination	5,20,26	DDE	Urban runoff, agriculture
		Water quality	20	Metals, nutrients	Urban runoff, agriculture
	Recreation/ aesthetics	Trash and debris	22,24	Trash and debris	Urban runoff
		Beach closures	12	Bacteria	Urban runoff, wildlife, sewer overflows / line breaks
Dana Point Harbor	Recreation/ aesthetics	Beach closures	12	Bacteria	Urban runoff, wildlife, sewer overflows / line breaks
	Aquatic habitat	Bioaccumulation	7	Total Chlordane, Total PCB, Al, Cd, Cu, Zn	Urban runoff, recreational boating
		Sediment contamination	5,20,21,26	Total Chlordane, Cu	Urban runoff, recreational boating

Bioaccumulation - toxics found in filter feeding invertibrates such as mussels
bacteria - pathogenic indicator organisms
Group A chemicals - includes aldrin,dieldrin, endrin, heptachlor, heptachlor epoxide, chlordane (total), hexachlorocyclohexane (total), endosulfan, toxaphene

Table 11.6
Warm Spot Constituents of Concern and Trend Monitoring Frequencies

				from Power Analyses			
Warm Spot	**Location**	**STORET Code**	**Constituent(s) of Concern**	**Trend Detectable**	**Monitoring Frequency samples/yr**	**term (years)**	**min. reduction to show signifcant trend**
Bonita Creek	u/s F05 conf.	BCF04	Ni Ni(s)	N N	(12) (2)		
Lane Channel	u/s Jamboree	LANF08	EC(d)	Y	10	5,10	28,13
Agua Chinon Wash	@ Irvine Ctr. Dr.	ACWF18	DDE(s), DDT(s)	N	(2)		
Central Irvine Channel	@ East Yale Loop	CICF25	NO_3(d)	?	20	20	78
Rattlesnake Canyon Wash	@ Bryan Ave.	RCWF26	TSS Pb	 Y	 20	 20	 70
Hicks Canyon Wash	@ Culver Dr.	HCWF27	DDE(s)	N	(2)		
Hines Channel	@ Bryan / Jeffrey	HINF28	NO_3(d)	Y	20	10,20	50,35
Sulphur Creek	d/s Sulphur Cr. Reservoir	SCDAM	Cd(s)	N	(2)		
Prima Deshecha Channel	@ Calle Vista Grande	PDCM01	EC(d) Cd Ni	Y Y Y	10 20 20	10,20 10,20 10,20	42,29 50,33 53,37
Segunda Deshecha Channel	@ El Camino Real	SDCM02	EC(d)	?	10	20	75
Lower Newport Bay	@ the Rhine Channel	LNBRIN	Cu(s)	?	5	20	85
Huntington Harbour	@ Christiana Bay	HUNCRB	Pb(s)	?	5	20	68

(s) sediment concentrations; (d) dry weather measurements; all others stormwater concentrations
(#) - frequency not based on power analyses

Table 11.7
NPDES and TMDL Monitoring Locations

	Warm Spot	CAR	TMDL	Waterbody	Location of Site	Station Code
			X	El Modena Irvine Channel	at Michelle Dr.	MIRF07
			X	Lane Channel	at Jamboree Blvd.	LANF08
	X		X	Agua Chinon Wash	at Pacifica	ACWF18
Upper Newport Bay Watershed	X			Central Irvine Channel	at I-5 Fwy.	CICF25
	X			Hines Nursery Channel	at Trabuco / Jefferey	HINF28
				Hicks Canyon Wash	at Culver Dr.	HCWF27
			X	Bonita Canyon Wash	u/s University Ave.	BCF04
		X	X	San Diego Creek	at Campus Dr.	SDMF05
		X	X	San Diego Creek	at Harvard Ave.	WYLSED
			X	Peters Canyon Wash	at Barranca Pkwy.	BARSED
			X	Costa Mesa Channel	at Westcliff Dr.	CMCG02
			X	Santa Ana Delhi Channel	u/s Irvine Ave.	SADF01
		X		San Juan Creek	at Ortega Hwy. In Caspers Park	SJOL01
		X			at La Novia	SJNL01
		X		Aliso Creek	in Laguna / Wood Canyon Wilderness Park	ACJ01
	X			Prima Deschecha Channel	at Calle Vista Grande	PDCM01
	X			Segunda Deschecha Channel	at El Camino Real	SDCM02
	X			Sulphur Creek	d/s Sulphur Creek dam	SCDAM
Upper Newport Bay		X	X		Unit I in-bay basin	UNBJAM
		X	X	Narrows	d/s Unit II In-bay basin	UNBSDC
		X	X	North Star Beach		UNBNSB
		X	X		at PCH bridge	UNBCHB
Lower Newport Bay		X	X	Turning Basin		LNBTUB
	X	X	X	Rhine Channel		LNBRIN
		X	X	Harbor Island Reach		LNBHIR
Sunset Aquatic Park / Anaheim Bay / Huntington Harbour		X		Sunset Aquatic Park	Near U.S. Navy bouys	HUNSUN
		X		Huntington Harbour	approx. 1/4 mi. d/s Bolsa Chica Ch. Mouth	HUNBCC
		X		Huntington Harbour	d/s Warner Ave. near HH Yacht Club dock	HUNWAR
	X	X		Christiana Bay	near outlet of Sunset Channel	HUNCRB
		X		Anaheim Bay	between two breakwaters	HUNHAR
		X		Bolsa Bay	off pier	BBOLR
Dana Point Harbor		X		East Basin	near outlet of 60" RCP	DAPTEB
		X		West Basin	near outlet of 51" RCP	DAPTWB
		X		Launch Ramp	near outlet of 18" RCP	DAPTLB
		X			near boatyard	DAPTLR
		X		Harbor Entrance	between two breakwaters	DAPTHE

Table 11.8
NPDES and TMDL Monitoring Frequencies

Station Code	Nutrients (aq)	Nutrients (sed)	Trace (aq)	Trace (sed)	PHP (s)	PAH (s)	Other Interest
MIRF07	**m/st**						
LANF08	**m/st**						EC(m)
ACWF18	**m/st**				semi		
CICF25	biweekly						
HINF28	biweekly						
HCWF27					semi		
BCF04	**m/st**		st(12)	semi			
SDMF05	w/st		st	semi	semi		op pest (m)
WYLSED	**biweekly**/st		st	semi	semi		
BARSED	**biweekly/st**						
CMCG02	w/st		w/st				bacteria (w/st), op pest (m)
SADF01	**biweekly/st**		st				
SJOL01	m/st		st	semi	semi		
SJNL01	m/st		st	semi	semi		
ACJ01	m/st		st	semi	semi		
PDCM01			st(20)				EC(m)
SDCM02							EC(m)
SCDAM				semi			
UNBJAM	m(s**,m,b**)/st	m	st	semi	semi		bacteria (m/st), debris (st)
UNBSDC	m(s**,m,b**)/st	m	st	semi	semi		bacteria (m/st), debris (st)
UNBNSB	m(s**,m,b**)/st	m	st				bacteria (m/st), debris (st)
UNBCHB	m(s,**m,b**)	m	st				bacteria (m/st), debris (st)
LNBTUB	st		st	semi	semi		
LNBRIN	st		st	5	semi		
LNBHIR	**m(s,m,b**)/st		st	semi	semi		
HUNSUN	semi/st		st				
HUNBCC	semi/st		st	semi	semi		
HUNWAR	semi/st		st	semi	semi		
HUNCRB	semi/st		st	5	semi		
HUNHAR	st		st				
BBOLR	semi/st		st	semi	semi		
DAPTEB	semi/st		st	semi	semi	semi	
DAPTWB	semi/st		st	semi	semi		
DAPTLB	semi/st		st	semi	semi		
DAPTLR	st		st	semi	semi		
DAPTHE	st		st				

(s,m,b) surface, middepth, bottom
s(12) storm sampling - 12 total composite samples per year
bold - nutrient TMDL additions including orthophosphate

Table 11.9
Beneficial Uses of Monitored Waterbodies

Bay/Harbor	Station Codes		MUN	AGR	IND	PROC	GWR	NAV	POW	REC1	REC2	COMM	WARM	LWARM	COLD	BIOL	WILD	RARE	SPWN	MAR	SHEL	EST
Anaheim Bay - Outer	HUNHAR		+					X		X	X					X	X	X	X	X		
Anaheim Bay - Seal Beach Nat'l Wildlife Refuge	HUNSUN		+							X[1]	X					X	X	X	X	X		X
Sunset Bay - Huntington Harbor	HUNBCC, HUNCRB HUNWAR		+					X		X	X	X					X	X	X	X		
Bolsa Chica Ecological Reserve	BBOLR		+							X	X					X	X	X	X	X		X
Upper Newport Bay	UNBJAM, UNBSDC UNBBCW, UNBNSB UNBNDB, UNBCHB		+							X	X	X				X	X	X	X	X	X	X
Lower Newport Bay	LNBTUB, LNBTRI, LNBRIN, LNBHIR LNBHAR		+					X		X	X	X					X	X	X	X	X	
Dana Point Harbor	DAPTLB, DAPTLR DAPTEB, DAPTWB DAPTHE				X			X		X	X	X					X	X	X	X	X	

Channel	Station Code	Watershed	MUN	AGR	IND	PROC	GWR	NAV	POW	REC1	REC2	COMM	WARM	LWARM	COLD	BIOL	WILD	RARE	SPWN	MAR	SHEL	EST
Santa Ana Delhi	SADF01	Upper Newport Bay																				
Bonita Canyon Channel	BCF04	Upper Newport Bay	+				I			I	I		I									
San Diego Creek - Harvard	WYLSED	Upper Newport Bay	+				I			I	I		I				I					
San Diego Creek - Campus	SDMF05	Upper Newport Bay	+							X[2]	X		X				X					
Peters Canyon Wash	BARSED	Upper Newport Bay	+				I			I	I		I									
Sand Canyon Wash	SCCF15	Upper Newport Bay	+				I			I	I		I									
Bee Canyon Channel	BEEF17	Upper Newport Bay	+				I			I	I		I									
Agua Chinon Wash	ACWF18	Upper Newport Bay	+				I			I	I		I									
Serrano Creek	SERF19	Upper Newport Bay	+				I			I	I		I									
Rattlesnake Canyon Wash	RCWF26	Upper Newport Bay	+				I			I	I		I									
Hicks Canyon Wash	HCWF27	Upper Newport Bay	+				I			I	I		I									
E. Costa Mesa Channel	CMCG02	Upper Newport Bay																				
Santa Isabella Channel	SICG03	Upper Newport Bay																				
Big Canyon Wash	BCWG04	Upper Newport Bay																				
Laguna Canyon	LCW102	South County	+	X						O	X		X				X					
Aliso Creek Channel	ACJ01	South County	+	X						O	X		X				X					
Sulphur Creek Channel	SCDAM	South County	+	X						O	X		X				X					
San Juan Creek - La Novia Ave	SJNL01	South County	+	X	X					X	X		X		X		X					
San Juan Creek - Ortega	SJOL01	South County	+	X	X					X	X		X		X		X					
Trabuco Creek	TCOL02	South County	+	X	X					X	X		X		X		X					
Oso Creek	OSOL03	South County	+	X	X					X	X		X		X		X					
Prima Deschecha	PDCM01	South County	+	X						O	X		X				X					
Segunda Deschecha	SDCM02	South County	+	X						O	X		X				X					
Santa Ana River - Imperial	SARIMP	Santa Ana River	+				X			X	X		X				X	X				
Santa Ana River - 5th Street	SARE01	Santa Ana River	+							X[2]	X		I				I					
Santiago Creek	SANE08	Santa Ana River	X				X			X[3]	X		X				X					
Silverado Creek	SILE17	Santa Ana River	X				X			I	I		I				I	I				

X - Present or Potential Beneficial Use
1 - No access per agency with jurisdiction (U.S. Navy)
2 - Access Prohibited in all or part by PFRD
I - Intermittent Beneficial Use
* - Excepted from MUN
o - Potential Beneficial Use
This information was taken from the 1994 update of the beneficial uses & water quality objectives for the San Diego Region and the 1995 Santa Ana River Basin Plan update.

Table 11.10
Applicable Water Quality Guidance for the Protection of Aquatic Life

Water Quality Measurement	**California Toxics Rule (CTR) Freshwater dissolved metals (Guidance only) H=ln(water hardness in mg/L as $CaCO_3$)**	**CTR Saltwater Dissolved metals**	**Ocean Plan Toxic Mat. Limits Total metals**	**Region 8/9 Basin Plans**
Lead ug/L H=ln Hardness	4 day =[1.462-0.146H][exp(1.273H-4.705)] 1 hour =[1.462-0.146H][exp(1.273H-1.460)]	4day = 8.1 1hr = 210	Daily max = 8 Inst. max = 20	
Cadmium ug/L	4 day = [1.107-0.042H][exp(0.7852H-2.715)] 1 hour = [1.137-0.042H][exp(1.128H-3.6867)]	4day = 9.3 1hr =42	Daily max = 4 Inst. max = 10	
Hexavalent Chromium ug/L		4day = 50 1hr = 1100	Daily max = 8 Inst. max = 20	
Nickel ug/L	4 day = 0.997[exp(0.846H+0.0584)] 1 hour = 0.998[exp(0.846H + 2.255)]	4day = 8.2 1hr = 74	Daily max = 60 Inst. max = 150	
Copper ug/L	4 day = 0.96[exp(0.8545H-1.702)] 1 hour = 0.96[exp(0.9422H-1.70)]	4day = 3.1 1hr = 4.8	Daily max = 12 Inst. max = 30	
Silver ug/L	1 hour = 0.85[exp(1.72H-6.52)]	1hr = 1.9	Daily max = 2.8 Inst. max = 7	
Zinc ug/L	4 day = 0.986[exp(0.8473H+0.884)] 1 hour = 0.978[exp(0.8473H+0.884)]	4 day = 81 1 hr = 90	Daily max = 80 Inst. max = 200	
Turbidity				Natural / Max. increase 0-50 NTU / 20% over natural 50-100 NTU / 10 NTU >100 NTU / 10% over natural
pH				6.5 - 8.5 freshwater 7.0 - 8.5 saltwater
Dissolved Oxygen				>5.0 mg/L MAR & WARM >6.0 mg/L COLD
Unionized Ammonia*				0.025 in receiving waters

$$* \text{ [Unionized Ammonia]} = \frac{[NH3\text{-}N]}{10^{(pka-pH)} + 1}$$

$$\text{where } pka = 0.09018 + \frac{2729.92}{T}$$

NH3-N = Total Ammonia as N
T = water temperature in Kelvin (C + 273.16)
pH = water pH

For example : at 20 C and pH 8.0 divide the ammonia nitrogen value by 26.25 to obtain unionized ammonia.
at 25 C and pH 9.0 divide by 2.76.

Table 11.11
Guidance Criteria for Harbor Sediment Evaluation

NOAA's Screening Concentrations

Metals (ppm)	**ER-L**	**ER-M**
Cadmium	1.2	9.6
Chromium	81	370
Copper	34	270
Lead	46.7	218
Nickel	20.9	51.6
Silver	1.0	3.7
Zinc	150	410
Organics (ppb)		
Acenaphthene	16	500
Acenaphthylene	44	640
Anthracene	85.3	1100
Fluorene	19	540
2-Methyl naphthalene	70	670
Naphthalene	160	2100
Phenanthrene	240	1500
Low molecular weight PAH	552	3160
Benzo(a)anthracene	261	1600
Benzo(a)pyrene	430	1600
Chrysene	384	2800
Dibenzo(a,h)anthracene	63.4	260
Fluoranthene	600	5100
Pyrene	665	2600
High molecular weight PAH	1700	9600
Total PAH	4022	44792
p,p' -DDE	2.2	27
Total DDT	1.58	46.1
Total PCBs	22.7	180

ER-L - Effects Range Low

The ERL represents the concentration corresponding to the 10th percentile in toxicity testing. No effects are likely below the ER-L.

ER-M - Effects Range Median

The ERM represents the concentration corresponding to the 50th percentile or median value. Effects are likely above the ER-M.

SCCWRP Iron Normalization Regression Coefficients

Iron (% dry) versus	Sample Size	r^2	Slope (m)	Intercept (b)	$\pm$ 99% Prediction Interval
Cadmium (µg/dry g)	83	0.734	0.0978	0.0055	0.1274
Chromium (µg/dry g)	88	0.882	16.50	-0.021	11.56
Copper (µg/dry g)	96	0.833	7.40	-2.01	6.50
Lead (µg/dry g)	103	0.738	4.350	0.0836	5.199
Nickel (µg/dry g)	110	0.533	9.850	-0.407	19.596
Silver (µg/dry g)	99	0.581	0.0795	-0.0183	0.1426
Zinc (µg/dry g)	88	0.967	31.50	-1.95	15.45

Table 11.12 California Toxics Rule for Dissolved Metals in Freshwater

		Lead		Cadmium		Chromium III		Nickel		Copper		Silver	Zinc	
HARDNESS	ln	1 hr	4 day	1 hr	4 day	1 hr	4 day	1 hr	4 day	1 hr	4 day	inst	1 hr	4 day
mg/L as CaCO3	Hardness	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10	2.30	4.91	0.19	0.35	0.41	83.25	27.00	67	7	1.54	1.25	0.07	17	17
20	3.00	10.79	0.42	0.74	0.68	146.86	47.64	120	13	2.95	2.26	0.22	30	30
30	3.40	17.04	0.66	1.16	0.92	204.70	66.40	169	19	4.32	3.20	0.43	42	43
40	3.69	23.51	0.92	1.58	1.14	259.09	84.05	216	24	5.67	4.09	0.71	54	54
50	3.91	30.14	1.17	2.01	1.34	311.04	100.90	260	29	6.99	4.95	1.05	65	66
60	4.09	36.88	1.44	2.45	1.53	361.14	117.15	304	34	8.31	5.79	1.43	76	77
70	4.25	43.71	1.70	2.90	1.72	409.73	132.91	346	38	9.60	6.60	1.87	87	87
80	4.38	50.61	1.97	3.35	1.90	457.08	148.27	388	43	10.89	7.40	2.35	97	98
90	4.50	57.57	2.24	3.80	2.07	503.37	163.29	428	48	12.17	8.18	2.88	107	108
100	4.61	64.58	2.52	4.26	2.24	548.74	178.00	468	52	13.44	8.96	3.45	117	118
110	4.70	71.63	2.79	4.73	2.40	593.29	192.46	508	56	14.70	9.72	4.06	127	128
120	4.79	78.72	3.07	5.20	2.56	637.11	206.67	546	61	15.96	10.47	4.72	137	138
130	4.87	85.83	3.34	5.67	2.72	680.28	220.67	585	65	17.21	11.21	5.42	146	148
140	4.94	92.97	3.62	6.14	2.87	722.84	234.48	622	69	18.45	11.94	6.15	156	157
150	5.01	100.13	3.90	6.62	3.02	764.86	248.11	660	73	19.69	12.66	6.93	165	167
160	5.08	107.31	4.18	7.10	3.17	806.38	261.58	697	77	20.93	13.38	7.74	175	176
170	5.14	114.50	4.46	7.58	3.31	847.43	274.90	734	81	22.16	14.09	8.59	184	185
180	5.19	121.70	4.74	8.06	3.45	888.04	288.07	770	86	23.38	14.80	9.48	193	194
190	5.25	128.92	5.02	8.55	3.60	928.25	301.11	806	90	24.60	15.50	10.41	202	204
200	5.30	136.14	5.31	9.03	3.73	968.07	314.03	842	93	25.82	16.19	11.37	211	213
210	5.35	143.37	5.59	9.52	3.87	1007.54	326.84	877	97	27.04	16.88	12.36	220	222
220	5.39	150.61	5.87	10.02	4.01	1046.67	339.53	912	101	28.25	17.57	13.39	229	230
230	5.44	157.85	6.15	10.51	4.14	1085.48	352.12	947	105	29.46	18.25	14.45	237	239
240	5.48	165.10	6.43	11.00	4.27	1123.98	364.61	982	109	30.66	18.92	15.55	246	248
250	5.52	172.34	6.72	11.50	4.40	1162.19	377.00	1017	113	31.86	19.59	16.68	255	257
260	5.56	179.59	7.00	12.00	4.53	1200.13	389.31	1051	117	33.06	20.26	17.85	263	265
270	5.60	186.84	7.28	12.50	4.66	1237.80	401.53	1085	121	34.26	20.93	19.04	272	274
280	5.63	194.09	7.56	13.00	4.78	1275.23	413.67	1119	124	35.46	21.59	20.27	280	283
290	5.67	201.34	7.85	13.50	4.91	1312.41	425.73	1153	128	36.65	22.24	21.53	289	291
300	5.70	208.58	8.13	14.01	5.03	1349.36	437.72	1186	132	37.84	22.90	22.83	297	300
310	5.74	215.83	8.41	14.51	5.16	1386.09	449.63	1219	135	39.02	23.55	24.15	306	308
320	5.77	223.07	8.69	15.02	5.28	1422.60	461.48	1253	139	40.21	24.20	25.51	314	317
330	5.80	230.31	8.97	15.53	5.40	1458.91	473.25	1286	143	41.39	24.84	26.89	322	325
340	5.83	237.54	9.26	16.04	5.52	1495.02	484.97	1319	146	42.57	25.48	28.31	331	333
350	5.86	244.77	9.54	16.55	5.64	1530.94	496.62	1351	150	43.75	26.12	29.76	339	341

For Hardness > 400 use Water Effects Ratio

Table 11.12 California Toxics Rule for Dissolved Metals in Freshwater

HARDNESS mg/L as CaCO3	ln Hardness	Lead 1 hr µg/L	Lead 4 day µg/L	Cadmium 1 hr µg/L	Cadmium 4 day µg/L	Chromium III 1 hr µg/L	Chromium III 4 day µg/L	Nickel 1 hr µg/L	Nickel 4 day µg/L	Copper 1 hr µg/L	Copper 4 day µg/L	Silver inst µg/L	Zinc 1 hr µg/L	Zinc 4 day µg/L
360	5.89	252.00	9.82	17.06	5.76	1566.67	508.21	1384	154	44.93	26.76	31.24	347	350
370	5.91	259.22	10.10	17.57	5.88	1602.22	519.74	1416	157	46.10	27.39	32.74	355	358
380	5.94	266.43	10.38	18.09	5.99	1637.60	531.22	1449	161	47.28	28.02	34.28	363	366
390	5.97	273.64	10.66	18.60	6.11	1672.81	542.64	1481	164	48.45	28.65	35.85	371	374
400	5.99	280.85	10.94	19.12	6.22	1707.86	554.01	1513	168	49.62	29.28	37.44	379	382
410	6.02	288.04	11.22	19.64	6.34	1742.75	565.33	1545	172	50.79	29.90	39.07	387	390
420	6.04	295.24	11.50	20.15	6.45	1777.49	576.60	1577	175	51.95	30.53	40.72	395	399
430	6.06	302.42	11.78	20.67	6.56	1812.07	587.82	1608	179	53.12	31.15	42.40	403	407
440	6.09	309.60	12.06	21.19	6.67	1846.52	598.99	1640	182	54.28	31.76	44.11	411	415
450	6.11	316.77	12.34	21.71	6.79	1880.82	610.12	1671	186	55.44	32.38	45.85	419	423
460	6.13	323.93	12.62	22.23	6.90	1914.98	621.20	1703	189	56.60	32.99	47.62	427	430
470	6.15	331.09	12.90	22.76	7.01	1949.01	632.24	1734	193	57.76	33.61	49.41	435	438
480	6.17	338.24	13.18	23.28	7.12	1982.90	643.23	1765	196	58.92	34.22	51.23	443	446
490	6.19	345.38	13.46	23.81	7.22	2016.67	654.19	1796	200	60.07	34.82	53.08	450	454
500	6.21	352.51	13.74	24.33	7.33	2050.32	665.10	1827	203	61.23	35.43	54.96	458	462
510	6.23	359.64	14.01	24.86	7.44	2083.84	675.98	1858	206	62.38	36.03	56.86	466	470
520	6.25	366.75	14.29	25.38	7.55	2117.25	686.81	1889	210	63.53	36.64	58.80	474	478
530	6.27	373.86	14.57	25.91	7.65	2150.54	697.61	1920	213	64.68	37.24	60.75	481	485
540	6.29	380.96	14.85	26.44	7.76	2183.71	708.37	1950	217	65.83	37.84	62.74	489	493
550	6.31	388.05	15.12	26.97	7.87	2216.78	719.10	1981	220	66.98	38.44	64.75	497	501
560	6.33	395.14	15.40	27.50	7.97	2249.73	729.79	2011	223	68.13	39.03	66.79	504	509
570	6.35	402.21	15.67	28.03	8.07	2282.58	740.45	2041	227	69.27	39.63	68.85	512	516
580	6.36	409.27	15.95	28.56	8.18	2315.33	751.07	2072	230	70.42	40.22	70.94	520	524
590	6.38	416.33	16.22	29.09	8.28	2347.97	761.66	2102	233	71.56	40.81	73.06	527	532
600	6.40	423.38	16.50	29.63	8.38	2380.52	772.21	2132	237	72.70	41.40	75.20	535	539
610	6.41	430.41	16.77	30.16	8.49	2412.96	782.74	2162	240	73.84	41.99	77.37	542	547
620	6.43	437.44	17.05	30.69	8.59	2445.31	793.23	2192	243	74.98	42.58	79.57	550	554
630	6.45	444.46	17.32	31.23	8.69	2477.56	803.70	2222	247	76.12	43.17	81.79	557	562
640	6.46	451.47	17.59	31.76	8.79	2509.73	814.13	2252	250	77.26	43.75	84.03	565	569
650	6.48	458.47	17.87	32.30	8.89	2541.80	824.53	2281	253	78.40	44.33	86.30	572	577
660	6.49	465.46	18.14	32.84	8.99	2573.78	834.91	2311	257	79.53	44.92	88.60	580	585
670	6.51	472.45	18.41	33.38	9.09	2605.68	845.25	2341	260	80.67	45.50	90.92	587	592
680	6.52	479.42	18.68	33.91	9.19	2637.48	855.57	2370	263	81.80	46.08	93.27	595	599
690	6.54	486.38	18.95	34.45	9.29	2669.21	865.86	2400	267	82.93	46.66	95.64	602	607
700	6.55	493.33	19.22	34.99	9.39	2700.85	876.13	2429	270	84.07	47.23	98.04	609	614
710	6.57	500.28	19.50	35.53	9.49	2732.41	886.37	2458	273	85.20	47.81	100.46	617	622

For Hardness > 400 use Water Effects Ratio

Table 11.12 California Toxics Rule for Dissolved Metals in Freshwater

		Lead		Cadmium		Chromium III		Nickel		Copper		Silver	Zinc	
HARDNESS mg/L as CaCO3	ln Hardness	1 hr μg/L	4 day μg/L	1 hr μg/L	4 day μg/L	1 hr μg/L	4 day μg/L	1 hr μg/L	4 day μg/L	1 hr μg/L	4 day μg/L	inst μg/L	1 hr μg/L	4 day μg/L
720	6.58	507.21	19.77	36.07	9.59	2763.89	896.58	2488	276	86.33	48.38	102.90	624	629
730	6.59	514.13	20.04	36.61	9.68	2795.29	906.76	2517	280	87.46	48.96	105.37	631	637
740	6.61	521.05	20.30	37.15	9.78	2826.61	916.92	2546	283	88.59	49.53	107.87	639	644
750	6.62	527.95	20.57	37.70	9.88	2857.86	927.06	2575	286	89.71	50.10	110.39	646	651
760	6.63	534.85	20.84	38.24	9.97	2889.03	937.17	2604	289	90.84	50.67	112.93	653	659
770	6.65	541.73	21.11	38.78	10.07	2920.12	947.26	2633	292	91.96	51.24	115.50	661	666
780	6.66	548.60	21.38	39.33	10.17	2951.15	957.32	2662	296	93.09	51.81	118.09	668	673
790	6.67	555.47	21.65	39.87	10.26	2982.10	967.36	2691	299	94.21	52.38	120.71	675	681
800	6.68	562.32	21.91	40.42	10.36	3012.98	977.38	2719	302	95.34	52.94	123.35	682	688
810	6.70	569.17	22.18	40.96	10.45	3043.79	987.37	2748	305	96.46	53.51	126.01	690	695
820	6.71	576.00	22.45	41.51	10.55	3074.53	997.35	2777	308	97.58	54.07	128.70	697	703
830	6.72	582.82	22.71	42.05	10.64	3105.20	1007.30	2805	312	98.70	54.63	131.41	704	710
840	6.73	589.64	22.98	42.60	10.74	3135.81	1017.22	2834	315	99.82	55.19	134.15	711	717
850	6.75	596.44	23.24	43.15	10.83	3166.35	1027.13	2863	318	100.94	55.76	136.91	718	724
860	6.76	603.24	23.51	43.70	10.92	3196.83	1037.02	2891	321	102.06	56.32	139.69	726	731
870	6.77	610.02	23.77	44.24	11.02	3227.24	1046.88	2919	324	103.18	56.87	142.49	733	739
880	6.78	616.79	24.04	44.79	11.11	3257.59	1056.73	2948	327	104.29	57.43	145.32	740	746
890	6.79	623.56	24.30	45.34	11.20	3287.88	1066.55	2976	331	105.41	57.99	148.17	747	753
900	6.80	630.31	24.56	45.89	11.29	3318.10	1076.36	3004	334	106.53	58.55	151.05	754	760
910	6.81	637.05	24.83	46.44	11.39	3348.27	1086.14	3033	337	107.64	59.10	153.95	761	767
920	6.82	643.78	25.09	46.99	11.48	3378.37	1095.91	3061	340	108.76	59.66	156.87	768	774
930	6.84	650.51	25.35	47.55	11.57	3408.42	1105.66	3089	343	109.87	60.21	159.81	775	782
940	6.85	657.22	25.61	48.10	11.66	3438.40	1115.38	3117	346	110.98	60.76	162.78	782	789
950	6.86	663.92	25.87	48.65	11.75	3468.33	1125.09	3145	349	112.09	61.32	165.77	789	796
960	6.87	670.61	26.13	49.20	11.84	3498.21	1134.78	3173	352	113.21	61.87	168.78	796	803
970	6.88	677.30	26.39	49.76	11.93	3528.02	1144.45	3201	356	114.32	62.42	171.82	803	810
980	6.89	683.97	26.65	50.31	12.02	3557.78	1154.11	3229	359	115.43	62.97	174.88	810	817
990	6.90	690.63	26.91	50.86	12.11	3587.49	1163.74	3257	362	116.54	63.51	177.96	817	824
1000	6.91	697.28	27.17	51.42	12.20	3617.14	1173.36	3284	365	117.64	64.06	181.06	824	831

For Hardness > 400 use Water Effects Ratio

Table 11.13
Massloads for Sampled Storms: 2000-2001 Season

STATION	Samples	Volume ac-ft	Storm Volume	NO3 tons	NH3 tons	TKN tons	PO4 tons	oP tons	TSS tons	VSS tons	Cd lbs	Cr lbs	Cu lbs	Pb lbs	Ni lbs	Ag lbs	Zn lbs
Anaheim Barber City Channel																	
Oct 11-14, 2000	45	36.1	30.0	0.13	0.00077	0.029	0.0125	0.00084	0.67	0.36	0.052	0.90	3.95	1.1	0.81	0.098	19.9
Peters Canyon Wash at Barranca Parkway																	
Oct 11-14, 2000	55	46.0	25.0	2.58	0.017	0.19	0.084	0.0119	2.43	2.11	0.064	0.68	2.52	0.26	0.39	0.13	4.9
Oct 27-31, 2000	53	271.9	266.1	12.50	0.13	1.06	1.30	0.19	131.55	18.57	0.70	13.0	50.2	6.9	8.1	0.72	87.8
Jan 8-9, 2001	13	13.8	16.9	0.39	0.021	0.12	0.080	0.0059	10.86	1.99	0.09	0.78	3.15	1.39	1.00	0.038	14.6
Jan 10-12, 2001	23	1757	1768	38.22	0.63	4.78	7.30	1.05	715.83	95.48	7.2	76.4	152.7	57.3	71.6	4.8	524.9
Jan 24-28, 2001	53	372.7	366.9	27.92	0.18	0.62	0.84	0.15	86.01	11.64	0.54	4.3	15.9	7.3	8.7	1.0	73.4
Mar 6-10, 2001	53	139.6	164.3	13.20	0.016	0.28	0.28	0.040	31.09	3.87	0.35	2.9	5.6	2.3	2.3	0.38	26.5
Costa Mesa Channel																	
Oct 10-15, 2000	61	0.17	0.10	0.00208	0.000081	0.00152	0.00068	0.00017	0.007	0.005	0.000	0.002	0.027	0.004	0.007	0.000	0.11
Oct 26-30, 2000	26	406.1	414.4	2.899	0.100	1.084	0.864	0.192	23.8	11.5	0.54	10.3	33.4	10.7	6.3	2.6	187.7
Jan 8-12, 2001	43	954	1195	4.454	0.398	1.821	2.577	0.522	45.6	19.4	1.4	10.8	55.9	19.0	6.0	2.7	249.7
Jan 24-28, 2001	42	214	215	9.249	0.147	0.537	0.422	0.089	12.041	3.798	0.26	2.1	13.6	5.8	3.1	0.5	64.8
Lane Channel																	
Oct 27-31, 2000	53	4.9	4.8	0.089	0.0014	0.0119	0.0078	0.00101	0.66	0.12	0.026	0.12	0.40	0.15	0.10	0.012	2.0
Jan 8-12, 2001	52	9.5	9.8	0.092	0.0055	0.020	0.015		1.82	0.32	0.018	0.14	0.96	0.32	0.24	0.026	3.5
Jan 24-27, 2001	37	3.2	3.6	0.046	0.0019	0.0087	0.0036	0.00058	0.26	0.05	0.005	0.04	0.23	0.08	0.073	0.009	0.91
El Modena-Irvine Channel																	
Feb 13-15, 2001	28	26.2	748.9	0.43	0.0021	0.088	0.040	0.0094	0.73	0.178	0.036	0.28	1.02	0.15	0.17	0.071	2.15
Feb 20-22, 2001	23	9.23	297.8	0.0046	1.25E-05	0.00085	0.000306	0.000076	0.0025	0.0025							
Feb 23-26, 2001	36	292.3	297.8	1.15	0.04	0.34	0.44	0.0029	22.39	2.30	0.40	3.2	10.7	3.2	1.6	0.79	36.4
Santa Ana Delhi Channel																	
Oct 27-31, 2000	54	354.7	356.2	5.61	0.08	0.74	0.57	0.079	28.33	7.55	0.5	9.6	26.0	11.1	2.7	0.96	98.5
Jan 8-12, 2001	51	1390	1421	12.16	0.67	3.53	2.36	0.44	235.14	54.98	2.2	19.4	118.9	74.2	21.7	3.8	502.4
Jan 24-28, 2001	53	306	302	5.09	0.16	0.73	0.29	0.043	31.48	7.72	0.41	3.3	17.3	12.2	5.0	0.81	78.8
Mar 6-10, 2001	53	104.7	125.0	1.82	0.0050	0.16	0.052	0.006	2.79	0.74	0.14	1.1	3.4	0.71	0.61	0.28	10.5
San Diego Creek at Campus																	
Oct 10-14, 2000	56	118.2	113.8	5.55	0.046	0.41	0.200	0.017	18.4	2.64	0.16	1.3	5.9	0.85	1.3	0.32	29.6
Oct 26-30, 2000	44	1624	1648	51.76	0.47	5.93	6.12	0.69	986	123	4.38	77.5	112.2	46.8	55.9	4.41	454.2
Jan 8-12, 2001	29	5490	5663	109.38	2.56	23.99	29.09	2.90	6,366	630	37.5	319.4	611.0	263.8	291.6	13.9	2,360.8
Jan 24-28, 2001	43	1105	1107	34.82	0.71	3.94	2.52	0.46	208	27.6	1.5	12.0	43.4	14.6	24.1	3.00	149.7
Mar 6-10, 2001	37	207.5	581.6	9.51	0.008	0.41	0.034	0.009	12.4	1.46	0.27	2.2	3.5	0.6	1.08	0.54	11.7
San Diego Creek at Harvard																	
Oct 26-31, 2000	56	450.1	826.4	16.61	0.05	1.49	1.41	0.14	297	35	1.9	22.1	35.2	11.2	13.9	1.1	108.3
Jan 8-12, 2001	45	2098	2192	50.44	0.90	5.93	9.80	1.13	2,170	234	15.3	120.0	196.5	76.3	114.5	5.5	763.7
Jan 24-28, 2001	53	286.0	295.1	13.15	0.22	0.99	0.85		115	14.9	0.94	7.1	15.2	5.4	8.76	0.78	60.0
Mar 6-7, 2001	18	187.3	193.8	4.61	0.019	0.38	0.56	0.077	73	10.1	0.61	5.0	10.7	3.0	6.58	0.51	35.5

Table 11.14
EMCs of Sampled Storms : 2000-2001 Season

STATION	Samples	Volume ac-ft	Storm Volume	NO3 mg/L	NH3 mg/L	TKN mg/L	PO4 mg/L	TSS mg/L	VSS mg/L	Cd µg/L	Cr µg/L	Cu µg/L	Pb µg/L	Ni µg/L	Ag µg/L	Zn µg/L
Anaheim Barber City Channel																
Oct 11-14, 2000	45	36.1	30.0							0.53	9.20	40.35	11.43	8.22	1.00	203.12
Peters Canyon Wash at Barranca Parkway																
Oct 11-14, 2000	55	46.0	25.0	41.22	0.28	3.10	1.35	38.83	33.80	0.51	5.47	20.11	2.08	3.14	1.00	39.06
Oct 27-31, 2000	53	271.9	266.1	33.84	0.36	2.88	3.52	356.07	50.26	0.95	17.59	67.90	9.33	10.92	0.98	118.80
Jan 8-9, 2001	13	13.8	16.9	20.87	1.14	6.45	4.26	578.49	106.20	2.38	20.71	84.01	36.98	26.57	1.00	390.24
Jan 10-12, 2001	23	1757	1768	16.01	0.27	2.00	3.06	299.89	40.00	1.50	15.99	31.99	12.00	14.99	1.00	109.96
Jan 24-28, 2001	53	372.7	366.9	55.13	0.36	1.23	1.65	169.86	23.00	0.53	4.22	15.70	7.17	8.55	1.00	72.50
Mar 6-10, 2001	53	139.6	164.3	69.59	0.08	1.46	1.48	163.93	20.42	0.93	7.56	14.87	6.08	5.95	1.00	69.98
Costa Mesa Channel																
Oct 10-15, 2000	61	0.17	0.10	9.20	0.36	6.71	2.99	31.74	23.01	0.55	4.37	59.83	7.94	15.76	1.00	239.60
Oct 26-30, 2000	26	406.1	414.4	5.25	0.18	1.97	1.57	43.22	20.92	0.49	9.37	30.30	9.72	5.70	2.31	170.11
Jan 8-12, 2001	43	954	1195	3.44	0.31	1.41	1.99	35.20	14.97	0.53	4.17	21.55	7.31	2.31	1.05	96.34
Jan 24-28, 2001	42	214	215	31.75	0.50	1.84	1.45	41.34	13.04	0.45	3.61	23.43	9.89	5.24	0.90	111.30
Lane Channel																
Oct 27-31, 2000	53	4.9	4.8	13.45	0.21	1.79	1.18	99.79	18.12	1.96	9.27	30.52	11.26	7.87	0.94	147.69
Jan 8-12, 2001	52	9.5	9.8	7.13	0.43	1.54	1.17	141.11	24.93	0.69	5.37	37.14	12.55	9.22	1.00	136.14
Jan 24-27, 2001	37	3.2	3.6	10.47	0.44	2.00	0.82	60.48	12.40	0.52	4.08	26.42	8.83	8.44	1.00	105.10
El Modena-Irvine Channel																
Feb 13-15, 2001	28	26.2	748.9	12.08	0.06	2.47	1.13	20.38	5.00	0.50	4.00	14.38	2.10	2.36	1.00	30.14
Feb 20-22, 2001	23	9.23	297.8	0.36	0.00	0.07	0.02	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb 23-26, 2001	36	292.3	297.8	2.90	0.09	0.85	1.10	56.37	5.78	0.50	4.00	13.51	4.08	2.04	1.00	45.81
Santa Ana Delhi Channel																
Oct 27-31, 2000	54	354.7	356.2	11.64	0.16	1.54	1.18	58.79	15.67	0.51	9.99	26.93	11.57	2.85	1.00	102.18
Jan 8-12, 2001	51	1390	1421	6.44	0.36	1.87	1.25	124.55	29.12	0.59	5.14	31.49	19.66	5.75	1.00	133.07
Jan 24-28, 2001	53	306	302	12.26	0.39	1.75	0.71	75.80	18.60	0.49	3.92	20.80	14.64	6.00	0.98	94.87
Mar 6-10, 2001	53	104.7	125.0	12.83	0.03	1.15	0.36	19.63	5.21	0.50	4.00	11.80	2.49	2.14	1.00	36.75
San Diego Creek at Campus																
Oct 10-14, 2000	56	118.2	113.8	34.58	0.29	2.58	1.24	114.80	16.45	0.50	4.00	18.50	2.66	4.12	1.00	92.13
Oct 26-30, 2000	44	1624	1648	23.46	0.21	2.69	2.77	447.11	55.70	0.99	17.55	25.42	10.59	12.67	1.00	102.92
Jan 8-12, 2001	29	5490	5663	14.67	0.34	3.22	3.90	853.48	84.42	2.51	21.41	40.96	17.69	19.55	0.93	158.26
Jan 24-28, 2001	43	1105	1107	23.19	0.48	2.63	1.68	138.62	18.40	0.50	4.00	14.46	4.87	8.04	1.00	49.85
Mar 6-10, 2001	37	207.5	581.6	33.72	0.03	1.46	0.12	44.00	5.16	0.48	3.84	6.28	1.13	1.92	0.96	20.82
San Diego Creek at Harvard																
Oct 26-31, 2000	56	450.1	826.4	27.17	0.09	2.43	2.31	484.95	57.88	1.56	18.10	28.80	9.19	11.40	0.87	88.57
Jan 8-12, 2001	45	2098	2192	17.70	0.32	2.08	3.44	761.36	82.26	2.68	21.06	34.48	13.39	20.09	0.96	133.98
Jan 24-28, 2001	53	286.0	295.1	33.85	0.58	2.56	2.18	296.86	38.24	1.21	9.13	19.57	6.96	11.28	1.00	77.21
Mar 6-7, 2001	18	187.3	193.8	18.11	0.08	1.49	2.18	287.89	39.75	1.19	9.84	20.93	5.97	12.93	1.00	69.82

Table 11.15
Total Stormwater Loads from the Newport Bay Watershed

PERIOD	Vol. Storm ac-ft	Vol. Sampled ac-ft	NO3 tons	PO4 tons	TSS tons	Cu lbs	Pb lbs	Zn lbs
Santa Ana Delhi Channel								
Oct 27-31, 2000	356.2	354.7	5.61	0.568	28.33	26.0	11.15	98.5
Jan 8-12, 2001	1420.9	1389.5	12.16	2.365	235.14	118.9	74.23	502.4
Jan 24-28, 2001	301.8	305.6	5.09	0.294	31.48	17.3	12.16	78.8
Mar 6-10, 2001	125.0	104.7	1.82	0.052	2.79	3.4	0.71	10.5
Total Sampled Load		2154.6	24.69	3.28	297.7	165.5	98.25	690.1
Annual Stormwater Volume	4,980	**Site Mean EMC**	**7.8**	**2.3**	**232.4**	**42.5**	**35.2**	**193.3**
Calc. Unsampled Load	2,826		29.8	8.6	892.6	327	271	1485
Sampled+Unsampled Load			54.5	11.9	1,190.4	492	369	2,175
Peters Canyon Wash								
Oct 11-14, 2000	25.0	46.0	2.58	0.084	2.43	2.5	0.26	4.9
Oct 27-31, 2000	266.1	271.9	12.50	1.302	131.55	50.2	6.89	87.8
Jan 8-9, 2001	16.9	13.8	0.39	0.080	10.86	3.2	1.39	14.6
Jan 10-12, 2001	1768.0	1756.9	38.22	7.303	715.83	152.7	57.27	524.9
Jan 24-28, 2001	366.9	372.7	27.92	0.836	86.01	15.9	7.26	73.4
Mar 6-10, 2001	164.3	139.6	13.20	0.281	31.09	5.6	2.31	26.5
Total Sampled Load		2600.9	94.8	9.9	977.8	230.1	75.4	732.2
Annual Stormwater Volume	7,546	**Site Mean EMC**	**29.4**	**2.9**	**668.6**	**47.0**	**20.9**	**166.1**
Calc. Unsampled Load	4,945		197.9	19.7	4,494	632	281	2232
Sampled+Unsampled Load			292.7	29.5	5,472	862	356	2,964
San Diego Creek at Campus Drive								
Oct 10-14, 2000	113.8	118.2	5.55	0.20	18.43	5.9	0.85	29.6
Oct 26-30, 2000	1647.7	1624.0	51.76	6.12	986.48	112.2	46.75	454.2
Jan 8-12, 2001	5663.2	5489.6	109.38	29.09	6,366	611.0	263.85	2,360.8
Jan 24-28, 2001	1107.5	1105.1	34.82	2.52	208	43.4	14.61	149.7
Mar 6-10, 2001	581.6	207.5	9.51	0.03	12.41	3.5	0.64	11.7
Total Sampled Load		8544.4	211.02	37.95	7,591	776.1	326.7	3,006.0
Annual Stormwater Volume	19,797	**Site Mean EMC**	**17.5**	**4.3**	**1,003.6**	**40.7**	**28.2**	**160.7**
Calc. Unsampled Load	11,253		268.2	66.1	15,349	1244	861	4914
Sampled+Unsampled Load			479.2	104.1	22,940	2,020	1,188.0	7,920
San Diego Creek at Harvard Avenue								
Oct 26-31, 2000	826.4	450.1	16.61	1.41	296.56	35.2	11.24	108.3
Jan 8-12, 2001	2192.2	2097.7	50.44	9.80	2,170	196.5	76.33	763.7
Jan 24-28, 2001	295.1	286.0	13.15	0.85	115.35	15.2	5.41	60.0
Mar 6-7, 2001	193.8	187.3	4.61	0.56	73.27	10.7	3.04	35.5
Total Sampled Load		3021.1	84.8	12.6	2655.1	257.6	96.0	967.6
Annual Stormwater Volume	8,918	**Site Mean EMC**	**17.9**	**5.4**	**1353.5**	**43.6**	**19.4**	**185.2**
Calc. Unsampled Load	5,897		143.1	43.3	10,846	698	311	2,969
Sampled+Unsampled Load			227.9	55.9	13,502	956	407	3,937
Bolsa Chica Channel								
Annual Stormwater Volume	5,173	**Site Mean EMC**	**8.6**	**2.1**	**247.7**	**33.4**	**25.0**	**171.7**
Annual Load			60.5	14.5	1,741	470	351	2,414
Westminster Channel								
Annual Stormwater Volume	1,881	**Site Mean EMC**	**7.1**	**1.6**	**176.7**	**47.9**	**28.3**	**170.0**
Annual Load			18.2	4.2	452	245	145	869
Anaheim Barber City Channel (w/o Mar - Jun, 2001)								
Annual Stormwater Volume	4,551	**Site Mean EMC**	**6.7**	**1.3**	**74.7**	**41.0**	**18.9**	**179.1**
Annual Load			41.4	8.1	462	507	233	2,216
Oso Creek								
Annual Stormwater Volume	8,965	**Site Mean EMC**	**4.7**	**2.8**	**450.0**	**23.7**	**6.9**	**87.6**
Annual Load			56.8	34.6	5,482	577	169	2,136

Table 11.16
Evaluation of Dissolved Metals in Channels to CTR

													At point of discharge to receiving water									
			Freshwater										Saltwater									San Diego Creek
			n		> Criteria								> Criteria									> Criteria*
			Acute	Chronic	Acute				Chronic				Acute					Chronic				Acute or Chronic
Station Code	**Channel**				**Cd**	**Cu**	**Ag**	**Zn**	**Cd**	**Pb**	**Ni**	**Cu**	**Cd**	**Cu**	**Ni**	**Ag**	**Zn**	**Cd**	**Cu**	**Ni**	**Zn**	
ABCC03	Anaheim Barber City	**S**	4	0										4			1					
ACJ01	Aliso Creek	**S**	26	5										17		1			5	5		
ACWF18	Agua Chinon Wash	**S**	1	0																		
BARSED	Peters Canyon Wash	**S**	16	4																		None
BCF04	Bonita Canyon	**S**	11	2																		None
CMCG02	Costa Mesa	**S**	15	2		7	1	5				1		15		1	4		2			
	Costa Mesa	**D**	40	0										39		2						
LANF08	Lane	**S**	12	1																		None
MIRF07	El Modena Irvine	**S**	7	1	1	2						1										None
PDCM01	Prima Deschecha	**S**	21	3	8				3		2		2	14	13		4	3	2	3	1	
RCWF26	Rattlesnake Canyon Wash	**S**	1	0																		
SADF01	Santa Ana Delhi	**S**	15	4		2						1		15			2		4			
SDMF05	San Diego Creek @ Campus	**S**	16	4		1								15					4			None
SJNL01	San Juan Creek @ La Novia	**S**	14	3										8					3	1		None
SJOL01	San Juan Creek @ Ortega	**S**	3	0										1								None
WYLSED	San Diego Creek @ Harvard	**S**	14	3																		
	Totals	**S**	**176**	**32**	**9**	**12**	**1**	**5**	**3**	**0**	**2**	**3**	**2**	**89**	**13**	**2**	**11**	**3**	**20**	**9**	**1**	**0**
		D	**40**	**0**	**0**	**0**	**0**	**0**					**0**	**39**	**0**	**2**	**0**					

(shaded) Not Applicable

n = Number of observations

S = Stormwater sampling

D = Dry weather sampling

Freshwater evaluation included comparison to CTR criteria for Cd, Cu, Cr III, Pb, Ni, Ag, Zn

Evaluation of discharges to saltwater included comparison to CTR criteria for Cd, Cu, Pb, Ni, Ag, Zn

*Using freshwater criteria and average hardness of 421 mg/L for San Diego Creek