EXECUTIVE SUMMARY

Introduction

This Integrated Receiving Water Impacts (IRWI) Report provides a comprehensive analysis of the monitoring results conducted by Los Angeles County Department of Public Works (LACDPW) to fulfill the requirements of the Monitoring and Reporting Program (MRP) under Order No. 01-182, National Pollutant Discharge Elimination System (NPDES) No. CAS-004001, for the period from 2001 to 2005. This report also includes an overall analysis of the available data from the past 10 years of stormwater quality monitoring. In addition, the IRWI report also serves as the fourth year monitoring report. This report fulfills the reporting requirements (Item D) of the current NPDES permit Order No. 01-182, Monitoring and Reporting Program.

The purpose of the IRWI report is to present a comprehensive analysis of the results of the data from each element of the Monitoring Program, and other pertinent available studies. The primary objectives of the 2001 MRP include:

1) assessing compliance with the NPDES Permit granted to Los Angeles County;
2) measuring and improving the effectiveness of the Stormwater Quality Management Plans (SQMPs);
3) assessing the chemical, physical, and biological impacts from urban runoff on receiving waters from the Municipal Separate Storm Sewer System (MS4);
4) characterizing stormwater discharges;
5) identifying sources of pollutants; and
6) assessing the overall health and evaluating long-term trends in receiving water quality.

The findings of this analysis of the data are used to develop conclusions and recommendations for future monitoring under the new NPDES permit. This report also provides a budget summary for each monitoring requirement. The main objectives of the IRWI report are to:

1) Document status and trends of stormwater quality since 1994;
2) Assess whether the six primary objectives of the 2001 monitoring program, as stated in the MRP, were realized;
3) Suggest refinement of the 2001 MS4 Permit Stormwater Quality Management Plan, if necessary; and

Current Monitoring Programs

The MRP under the current NPDES Permit consists of three monitoring elements with defined objectives and specific sampling and analysis requirements. These monitoring elements are designed to meet the stated objectives of the 2001 MRP. The three monitoring elements that are being conducted as part of the 2001-2005 monitoring program consist of Core Monitoring, Regional Monitoring, and Special Studies. The six watershed management areas (WMA) within Los Angeles County that are a part of the NPDES permit include San Gabriel River, Los Angeles River, Dominguez Channel, Ballona Creek, Malibu Creek and Santa Clara River.
Core Monitoring Element

Core monitoring involves stormwater sampling at established, representative stations throughout the Los Angeles Basin. It also includes routine water quality sampling at established stations in receiving waters along the adjoining coast. The regular monitoring generates a long-term record of stormwater quality, pollutant loading, or water quality at these stations, which is used to evaluate the effectiveness of stormwater management in Los Angeles County. This element of the MRP also identifies pollutants that may pose risks to biota in receiving waters and helps track the source of toxic or excess pollutants. Core monitoring meets the following objectives of the MRP including: 1) stormwater characterization; 2) compliance with NPDES permit conditions; 3) measurement or improvement of SQMPs; 4) assessing impacts of urban runoff on receiving waters; 5) identification of pollutant sources; and 6) evaluating long-term trends in receiving water quality. Core monitoring involves Mass Emission Monitoring, Water Column Toxicity Monitoring, Tributary Monitoring, Shoreline Monitoring, and Trash Monitoring.

Mass Emission Monitoring

The objectives of mass emission monitoring are to estimate the mass emissions from the MS4, assess trends in the mass emissions over time, and determine if the MS4 is contributing to exceedances of water quality standards by comparing results to applicable standards in the Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan), the California Ocean Plan (Ocean Plan), or the California Toxics Rule (CTR), and with emissions from other discharges. Los Angeles County monitors mass emissions from the following seven stations: Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and the Santa Clara River. These stations characterize stormwater quality in one of the six watersheds that comprise Los Angeles County and together monitor stormwater runoff from 2060 square miles.

Water Column Toxicity Monitoring

The objectives of water column toxicity monitoring are to analyze mass emission samples for toxicity to help identify the source of toxic conditions in receiving waters. Once the mass emission station causing the toxic condition is identified, the SQMP will be modified to implement additional practices that eliminate or reduce the delivery of toxic substances from that watershed management area.

Tributary Monitoring

The objectives of tributary monitoring are to identify sub-watersheds where stormwater discharges are causing or contributing to exceedances of water quality standards, and to prioritize drainage and sub-drainage areas that need management actions. Monitoring during the 2002-2003 and 2003-2004 storm seasons focused solely on six tributaries within the Los Angeles River Watershed, namely Aliso Creek, Bull Creek, Burbank Western System Channel, Verdugo Wash, Arroyo Seco Channel, and Rio Hondo Channel. During the 2004-2005 storm season, sampling was conducted on six tributaries in the Ballona Creek Watershed Management Area, including Centinela, Sepulveda, Benedict, Adams, Fairfax, and Cochran sampling sites.
Shoreline Monitoring

The Municipal Stormwater Permit requires the City of Los Angeles to routinely monitor shoreline stations to evaluate the impacts to coastal receiving water quality and the loss of recreational beneficial uses resulting from stormwater/urban runoff in Santa Monica Bay. Eighteen stations along the shoreline within Santa Monica Bay were monitored and analyzed for total coliform, fecal coliform and enterococcus from 2001-2004.

Trash Monitoring

The objectives of trash monitoring are to assess the quantities of trash in receiving waters after storm events and to identify areas that may require trash total maximum daily loads (TMDLs). In March 2002, Los Angeles County began conducting a Trash Baseline Study within the Ballona Creek and Los Angeles River watersheds. The study aims to quantify the amount and type of debris flowing into the storm drain system from these watersheds and link this information to the dominant land use type that exists upstream of each studied catch basin.

Regional Monitoring

LACDPW is required to participate in regional monitoring programs that address public health concerns, monitor trends in natural resources and near shore habitats, and assess regional impacts from stormwater pollutant sources. The regional monitoring programs include stream bioassessment and Bight ’03 estuary monitoring.

Stream Bioassessment Monitoring

The objectives of stream bioassessment are to assess biological integrity and to detect biological trends and responses to pollution in receiving waters throughout the region. Bioassessment includes the collection and identification of stream benthic macroinvertebrates, and also assesses the quality and condition of the in-stream physical habitat and adjacent riparian zone. This information may complement monitoring programs that test water quality parameters which provide a measure of habitat conditions only at the moment sampling occurs. The twenty monitoring reaches assessed in this study were located in six major watersheds throughout Los Angeles County, including Santa Clara River Watershed, Ballona Creek Watershed, Malibu Creek Watershed, Dominguez Channel Watershed, Los Angeles River Watershed, and San Gabriel River Watershed.

Estuary Monitoring

The estuary monitoring program is a component of the coastal ecology committee of the Southern California Bight 2003 project coordinated by the Southern California Coastal Water Research Project (SCCWRP). The two primary objectives of Bight ‘03 are to estimate the extent and magnitude of ecological change in the Southern California Bight (SCB) and to determine the mass balance of pollutants that currently reside within the SCB. The goal of the estuary monitoring program is to sample estuaries for sediment chemistry, sediment toxicity, and benthic macroinvertebrate diversity to determine the spatial extent of sediment fate from stormwater, and the magnitudes of its effects. Malibu Creek, Ballona Creek, Los Angeles River, San Gabriel River, and Dominguez Channel are the estuaries in Los Angeles County that are being monitored.
Special Studies

As required by the 2001 Municipal Stormwater Permit, LACDPW is conducting special monitoring programs, including the New Development Impacts Study in the Santa Clara River Watershed, Peak Flow Discharge Impact Study, and Evaluation of Stormwater Best Management Practices (BMP) Effectiveness.

New Development Impacts Study in the Santa Clara River Watershed

The objective of the New Development Impacts Study in the Santa Clara Watershed is to evaluate the effectiveness of the Standard Urban Stormwater Mitigation Plan (SUSMP) Best Management Practices at reducing pollutants in stormwater runoff. This evaluation will be accomplished by a computer model.

Peak Flow Discharge Impact Study

The goal of the Peak Flow Discharge Impact Study was to assess the potential connection between urbanization and stream erosion in natural drainage systems. The main objective was to evaluate peak flow impacts and, ultimately, use this relationship to determine numeric criteria to prevent or minimize erosion of natural stream channels and banks caused by urbanization. Eleven sites in eight watersheds in southern California were monitored from 2003-2005. The study approach was to evaluate the changes in stream channel configuration over time, and compare them to the changes in total basin impervious cover (TIMP) over the same time period.

Stormwater BMP Effectiveness

The goal of this project is to assess the effectiveness of BMPs for reducing the concentration of pollutants in stormwater. Samples of stormwater from upstream and downstream of the BMP are analyzed for the concentration of contaminants associated with stormwater. A key product expected from this project will be a matrix describing the effectiveness of various BMPs. These data will be of high value to agencies statewide in their effort to develop and implement watershed management plans. The objective of the monitoring protocols will be to obtain data on BMP removal efficiency for toxicity and toxicologically important constituents, such as pesticides and biologically available forms of trace metals.
REPORT ORGANIZATION

This report has been reorganized from previous reports to represent a watershed approach to reviewing the results rather than a program specific approach. This approach provides for integration of water quality data, toxicity, bioassessment and other data to support the development of a watershed management strategy of resource protection, enhancement, and restoration while balancing economic and environmental impacts within the drainage basin.

MONITORING RESULTS

Core Monitoring

Mass Emission Stations

Constituents of Concern. Constituents of concern (COCs) were determined for each watershed based on the mass emission monitoring data. A constituent is considered a COC if its frequency ratio exceeds 0.5 and mean exceedance ratio exceeds 1.0. The frequency at which the mean value exceeded the WQO was determined by dividing the total number of years a constituent was analyzed into the number of times the mean value of a constituent exceeded the WQO for a given year. The mean magnitude of exceedance was determined by dividing the WQO for a constituent into the constituents mean value for each year, then calculating the average magnitude of exceedance. COC’s as they are designated in this report serve as flags for water quality managers and should not be used for other purposes such as regulatory compliance. Table 1 presents the COCs identified for each watershed. (An x indicates constituents that were identified as COCs in each watershed).

Table 1. Constituents of Concern Identified for Each Watershed Based on Mass Emission Monitoring Results.

<table>
<thead>
<tr>
<th>Constituents of Concern</th>
<th>San Gabriel River</th>
<th>Coyote Creek</th>
<th>Los Angeles River</th>
<th>Dominguez Channel</th>
<th>Ballona Creek</th>
<th>Malibu Creek</th>
<th>Santa Clara River</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterococcus</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Total Coliform</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Total Aluminum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Total Copper</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Lead</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Zinc</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Copper</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Dissolved Lead</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Zinc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Diazinon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Cyanide</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
Increasing/Decreasing Trends. Constituents for which the data indicated statistically significant increasing or decreasing trends in their concentrations throughout the monitoring period for each watershed are presented in Table 2.

Table 2. Constituents Indicating an Increasing or Decreasing Trend for Each Watershed Based on Mass Emission Monitoring Results.

<table>
<thead>
<tr>
<th>Constituents Indicating Increasing/Decreasing Trends</th>
<th>Watershed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>San Gabriel River</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>I</td>
</tr>
<tr>
<td>Boron</td>
<td>I</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>I</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>I</td>
</tr>
<tr>
<td>Total Lead</td>
<td>I</td>
</tr>
<tr>
<td>MBAS</td>
<td>I</td>
</tr>
<tr>
<td>Potassium</td>
<td>I</td>
</tr>
<tr>
<td>Sulfate</td>
<td>I</td>
</tr>
<tr>
<td>Total Selenium</td>
<td>I</td>
</tr>
<tr>
<td>Dissolved Copper</td>
<td>I</td>
</tr>
<tr>
<td>BOD</td>
<td>D</td>
</tr>
<tr>
<td>Total Coliform</td>
<td>D</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>D</td>
</tr>
<tr>
<td>TPH</td>
<td>D</td>
</tr>
<tr>
<td>Turbidity</td>
<td>D</td>
</tr>
</tbody>
</table>

I - Increasing Trend  
D - Decreasing Trend

Cross Watershed Comparison. A regional assessment was conducted in order to analyze interrelationships across watersheds and identify overall trends based on the mass emission monitoring results. The overall conclusions that were made from the regional assessment include:

Bacterial Indicators. The highest concentrations for the bacterial indicators generally occurred at the Los Angeles River and Ballona Creek mass emission stations. The lowest mean concentrations were indicated for Dominguez Channel and Santa Clara River. The regression analysis did not indicate any significant trends with regard to the bacterial indicators. Regionally, these indicators remained well above the WQO throughout the watersheds and the monitoring period from 1994-2005. The regional evaluation of the ratios of the mean concentrations to the WQO, indicated that the highest WQO ratios were observed for the Los Angeles River, Ballona Creek and Coyote Creek Watersheds. The lowest ratios were observed for the Santa Clara River and Malibu Creek Watersheds. The magnitude of the WQO ratios for the bacterial indicators corresponded to the percentage of land use that relates to urbanization (use other than vacant lands or recreational uses) of the watersheds. A lower percentage of urbanization resulted in a lower WQO ratio.

The mean total loadings for the bacteriological indicators on a per acre basis indicate that the Los Angeles River, Coyote Creek, Dominguez Channel and Ballona Creek had the highest loadings per acre, and correspond to more urbanized watersheds. The lowest loadings per acre were
determined for Malibu Creek, Santa Clara River and San Gabriel River watersheds that are characterized by a greater percentage of vacant land of the total drainage area. The results of the loading estimates on a per acre basis indicate a correlation between higher loadings per acre for more urbanized watersheds compared to watersheds with higher percentages of total drainage area that remains undeveloped (vacant). The conclusions for the loading estimates are consistent with those summarized above regarding a relationship with the magnitude of exceedances with percent urbanization.

**Metals.** The highest mean concentrations for total and dissolved copper, lead and zinc on a regional basis were observed in the Los Angeles River. The lowest concentrations were generally observed for the Santa Clara River and Malibu Creek Watersheds. These two watersheds are the least urbanized of the watersheds. Exceedances of the WQO for total and dissolved lead, copper and zinc were observed regionally in all the watersheds monitored with the exception of the Santa Clara River and Malibu Creek Watersheds. The highest WQO ratios were observed for the Los Angeles River, followed by the Dominguez Channel, Ballona Creek and Coyote Creek Watersheds. The Santa Clara River and Malibu Creek Watersheds had the lowest WQO ratios. The ranking of the magnitude of these WQO ratios for lead, copper and zinc generally corresponded to a greater percentage of urbanization of the watersheds.

**Nutrients.** Malibu Creek, San Gabriel River and Coyote Creek displayed higher mean values for nitrate and nitrate-N. The means for Malibu Creek MES were the highest of all the watersheds. Higher nitrate concentrations could be the result of greater use of fertilizers in agricultural, golf courses or nursery activities, and seepage from in-ground septic systems near and up-stream of the MES. Malibu Creek also had higher mean values of ammonia, sulfate, total dissolved solids, specific conductance, hardness and chloride than the other watersheds.

**Other Water Quality Parameters.** The means of several constituents, including alkalinity, calcium, chloride, hardness, magnesium, sodium, specific conductance, and sulfate, measured at the Malibu Creek MES were significantly different compared to the other MES. This comparison indicated a greater mean concentration in mineral salts and ions in wet and dry weather runoff at the Malibu Creek MES.

**Solids (TDS, TSS, TOC).** The highest mean total loadings for TDS were determined for the Los Angeles River, Ballona Creek, Coyote Creek, Malibu Creek and San Gabriel River Watersheds. The highest TDS loadings per acre were calculated for Ballona Creek, Malibu Creek, and Coyote Creek. The lowest TDS per acre was indicated for Santa Clara River, which is one of the least urbanized watersheds.

TSS total mean loads were highest for the Santa Clara River and lowest for Malibu Creek. The higher TSS for Santa Clara may indicate greater suspended sediment loads due to erosion of stream banks and disturbed areas. The mean loading of TSS per acre was highest for Ballona Creek, Los Angeles River, Coyote Creek and Santa Clara River and lowest for Malibu Creek.

The TOC mean loadings for 2004-2005 were highest in the Los Angeles River, followed by Coyote Creek and Ballona Creek. The lowest was for Malibu Creek. The highest mean loadings per acre were determined for Coyote Creek, followed by Ballona Creek, Dominguez Channel,
and Los Angeles River. The lowest was for Santa Clara River. The higher TOC loadings appear to correspond to greater urbanization.

**Pesticides.** The only pesticide that was detected above its WQO was diazinon. The WQO was exceeded in the Dominguez Channel, Coyote Creek and Santa Clara River Watersheds.

**TPH.** Other notable trends that were observed in mean annual concentrations included a decreasing concentration in total petroleum hydrocarbons (TPH) for Ballona Creek and Santa Clara River Watersheds.

**Toxicity.** No strong patterns in toxicity were observed. The fewest toxic responses for all three tests performed were at San Gabriel River, Malibu Creek, and Santa Clara River. *Ceriodaphnia dubia* survival may have decreased due to high concentrations of dissolved copper and zinc in the wet weather runoff.

**Peak and High Intensity Storm Events.** The potentially greater impact of high intensity storm events on water quality was observed for all watersheds, with the exception of Malibu Creek Watershed, for the 2004-2005 and 1997-1998 annual wet weather sampling. The greatest monthly precipitation occurred during these same years. High numbers of exceedances were observed across watersheds during these years for BOD, COD, turbidity, total volatile suspended solids, total iron, bacterial indicators, total and dissolved phosphorus, total copper, and total zinc. This analysis indicated that the high intensity and long-duration storm events resulted in some of the greater overall impacts to water quality as measured at the MES.

**Water Column Toxicity Monitoring**

Toxicity monitoring determined that overall there were more toxic responses observed during wet weather than dry weather. Wet weather samples showed a toxic response for *Ceriodaphnia dubia* survival in samples collected from Dominguez Channel, Coyote Creek, Los Angeles River and Santa Clara River. Indications of thresholds that may have affected *Ceriodaphnia* survival were found only for dissolved copper and zinc. Fewer toxic responses were observed for *C. dubia* reproduction; those were found in Ballona Creek, Coyote Creek, Dominguez Channel, and Malibu Creek.

Sea urchin fertilization tests had toxic responses in both dry and wet weather in Los Angeles River, Dominguez Channel, Ballona Creek, and Coyote Creek. The results for Los Angeles River indicate a persistent toxic response for the dry weather samples. In accordance with the permit, a Toxicity Identification Evaluation (TIE) was performed.

The first dry weather sample collected in Los Angeles River in 2005 resulted in a Toxic Unit Chronic (TUc) which exceeded the Permit requirement for sea urchin fertilization. This indicated the presence of significant toxicity within the sample. Based on these results, a Toxicity Identification Evaluation (TIE) was conducted on the sample to investigate the sources of toxicity. The results of the Phase I TIE indicated that metal toxicity is likely to be responsible for the reduction in sea urchin fertilization.
**Tributary Stations**

Water quality monitoring at the Los Angeles River tributary stations identified constituents that consistently exceeded WQOs at some or all of the stations, including all indicator bacteria, total copper, total lead and total zinc. All exceedances at the tributary stations coincided with exceedances at the mass emission station. For bacteriological indicators, the magnitude of exceedance of the WQO is similar for all the tributaries and the mass emission station. No one or set of tributaries appear to be a primary source of bacterial indicator exceedances based on concentration.

The magnitude of exceedances of the WQO for total and dissolved copper, total zinc and total lead were relatively lower at the furthest upstream locations of Aliso Creek and Bull Creek stations compared to downstream tributaries. Exceedances of the WQO for the selected metals were greatest at the mass emissions station which is located well downstream of any of the tributary stations, and therefore receives the greatest amount of overall contributions. The tributary stations that had higher magnitude of exceedances were located at relatively larger subwatersheds with a significant proportion of the watershed urbanized.

Water quality monitoring at the Ballona Creek tributary stations determined that indicator bacteria, total copper, and total lead exceeded WQOs at the majority of the tributary stations. These exceedances coincided with exceedances at the mass emission station. For bacteriological indicators, the magnitude of exceedance of the WQO is similar for all the tributaries and the mass emission station. No one or set of tributaries appear to be a primary source of bacterial indicator exceedances.

Based on concentration, Sepulveda and the further upstream tributaries appear to exhibit greater exceedances of the WQO for the selected metals. For these metals, the magnitude of exceedance of the WQO is higher for total copper and lead at the Centinela station compared to further upstream tributary and channel locations that include Sepulveda, Benedict, and the MES. The farthest upstream tributary locations are characterized by greater exceedances than Centinela and the other downstream locations.

Based on constituent loadings, a similar pattern was observed for indicator bacteria and metals (total and dissolved copper and lead) at the Ballona Creek tributary stations. Loadings for each constituent were highest at the MES (S01), located at the bottom of the watershed, and at TS12 (Cochran), which is the uppermost station in the watershed. Based on these results, pollutant loadings were highest in the upper and lower reaches of the watershed, while the middle portion had the lowest pollutant loadings.

**Shoreline Monitoring**

Shoreline monitoring within the Ballona Creek and Malibu Creek Watersheds from 2001-2004 indicated that bacterial densities were higher during wet weather than dry weather. There were exceedances of all indicator bacteria during dry and wet weather in all three sampling years with more exceedances during wet weather. These exceedances corresponded with the bacteria exceedances that occurred at the mass emission stations.
Trash Monitoring

Trash monitoring was conducted in the Los Angeles River and Ballona Creek Watersheds during the 2002-2003 and 2003-2004 storm seasons. In Los Angeles River, the first storm event of the season produced the most amount of trash, particularly from commercial land use areas during both years. For both storm seasons, industrial land use was the largest contributor of trash, followed by commercial land use. Low density single family produced the least amount of trash during both storm seasons.

Trash monitoring in Ballona Creek in 2002-2003 determined that the first storm event of the season produced the most amount of trash, while the second storm event contributed the most amount of trash during the 2003-2004 storm season. Low Density Single Family Residential was the largest contributor of trash during the first storm of the 2002-2003 season and commercial land use was the largest contributor of trash during the second storm event of the 2003-2004 season. Based on the results for the entire storm seasons, low density single family residential and commercial produced the most amount of trash during 2002-2003 and commercial land use was the largest contributor during the 2003-2004 storm season.

Regional Monitoring

Stream Bioassessment Monitoring

Twenty bioassessment monitoring sites were located in six watersheds throughout Los Angeles County: Santa Clara River Watershed, Ballona Creek Watershed, Malibu Creek Watershed, Dominguez Channel Watershed, Los Angeles River Watershed, and San Gabriel River Watershed.

Based on total California Department of Fish and Game (CFG) IBI scores, there were essentially three categories of sites: The Cold Creek and San Gabriel reference sites that were rated Fair or Good, Station 18-Triunfo Creek, Station 1-Santa Clara River, and Station 9-Zone 1 Ditch which were rated Poor, and the remaining sites that were rated Very Poor. It is notable that CFG IBI scores were quite consistent for the two survey years, with most sites differing by only two or three points. It appears that there may be a correlation between high amounts of urbanization and low CFG IBI scores, in that the most urbanized sites had the lowest CFG IBI scores.

The sites scoring in the Very Poor range did not show a correlation between physical habitat quality and IBI score. An analysis of variance (ANOVA) between lined and non-lined channels did not show a trend between the two habitat factors and IBI scores. Station 12-Los Angeles River (concrete lined) was the highest rated of the Very Poor sites and Station 8-Compton Creek and Station 8-Medea Creek (soft bottom) were rated much lower than many of the lined channel sites.

Estuary Monitoring

The San Gabriel River, Los Angeles River, Dominguez Channel, Ballona Creek and Malibu Creek Estuaries were monitored to estimate the extent and magnitude of ecological change in the Southern California Bight (SCB) and to determine the mass balance of pollutants that currently...
reside within the SCB. Samples were analyzed for sediment chemistry, sediment toxicity and benthic macroinvertebrate diversity.

In summary, there were exceedances of sediment quality objectives at all five estuaries. Dominguez Channel Estuary had the most number of exceedances while San Gabriel River Estuary had the least. In general, the constituents that often exceeded the sediment objectives at the majority of the estuaries included four metals (cadmium, copper, nickel and zinc) and total detectable DDT and total detectable chlordane. Copper and zinc consistently exceeded WQOs in stormwater samples; however, cadmium and nickel were detected less frequently. In addition, even though total detectable DDT and chlordane exceeded objectives in the estuary sediments, they were not detected in any stormwater/urban runoff samples. Mean ERM-Q values were above the 0.10 threshold in at least two stations within each estuary except San Gabriel River Estuary, which had ERM-Q values all below the threshold. The sediments at all stations within San Gabriel River Estuary and Malibu Lagoon were identified as not toxic to the test organisms, while sediments in some stations within the other three estuaries were either identified as moderately toxic or highly toxic. It appeared that San Gabriel River Estuary was the least impacted as it had the least amount of exceedances, low ERM-Q values and high survival rate of *E. estuarius*. Dominguez Channel Estuary appeared to be the most impacted estuary due to the high number of exceedances, high ERM-Q values at all stations and toxic sediments.

**Special Studies**

*New Development Impacts Study in the Santa Clara River Watershed*

A water quality model has been selected to evaluate the possible changes that Standard Urban Stormwater Management Plan (SUSMP) implementation might have on stormwater quality. The drainage area of a specific development will be selected for modeling and monitoring. Regional data will be used to calibrate the water quality calculations. The model will be validated with site specific water quality monitoring data. The monitoring approach will involve monitoring the selected development site during three storms by collecting and analyzing flow-weighted composite samples. Work on the modeling plan is on going. Water quality monitoring is scheduled to occur during the 2005-2006 wet weather season.

*Peak Flow Discharge Impact Study*

The Peak Flow Discharge Impact Study was conducted to assess the potential connection between stream erosion and urbanization. The Peak Discharge Impact Study resulted in the following findings:

1. Channel width increases as the discharge rate increases.
2. Ephemeral streams in southern California appear to be more sensitive to changes in the percent of impervious cover than streams in other areas: enlargement of streams occurs at a lower value of impervious surface area.
3. There is a natural level of channel degradation occurring in all stream channels investigated, even in the absence of development within then drainage area.
(4) Streams appear to be sensitive to changes in flow rates associated with increased impervious cover and they appear to have a low resistance to erosion, which results in increased channel enlargement.

The relationships established in this investigation can be used to evaluate potential effects of development on the stability of natural streams. This investigation presents an important step in understanding the relationship between channel response and changes in impervious cover. The entire technical report is available at ftp://ftp.sccwrp.org/pub/download/pdfs/450_peak_flow.pdf.

Stormwater BMP Effectiveness Study
As part of the current National Pollution Discharge Elimination System (NPDES, 2001) permit and Special Studies, County of Los Angeles Public Works also conducted a Best Management Practice (BMP) effectiveness study to evaluate how well structural and treatment control BMPs affect the quality of stormwater run off. The study included monitoring, collection of stormwater runoff samples, and evaluation of six BMPs during 2004-05 storm season. The data obtained from water samples were analyzed by utilizing statistical methods to determine the removal effectiveness of several pollutants of concern.

In this study, the removal effectiveness of BMPs was found to vary for the constituents of concern. The statistical results showed that higher removal was achieved at higher inflow concentrations except for bacteria and nutrients. The removal efficiencies for the inflow and the outflow concentrations for metals, bacteria, and nutrients were negative or otherwise relatively low for catch basin inserts, a hydrodynamic separator, a wet vault and an enhanced manhole. The statistical analyses showed that the confidence intervals around the mean inflow and the mean outflow concentrations for all the constituents tested overlapped implying that the removal effectiveness for the constituents of concern were not statistically significant. The removal effectiveness for the infiltration trench and the bioswale are subject of further studies as more storm data needs to be collected and statistically analyzed.

RECOMMENDATIONS
The following recommendations are made based on the monitoring studies that have been conducted to fulfill the MRP requirements under the current NPDES municipal stormwater permit. The following recommendations include monitoring, research, and studies that should be considered or undertaken to better address the MRP objectives, advance the understanding of stormwater quality science and support TMDL programs. Because of their scope, such studies should be undertaken by various entities, such as the Regional Water Quality Board, NPDES permittees, or by collaborative efforts between private and public organizations. The recommendations presented consider the effective use of available resources by balancing costs through scientifically based recommended tradeoff options. Table 3 presents the objectives of the current monitoring program, a summary of the findings and conclusions for these programs, and recommendations for future modifications to the program to more effectively address the objectives with available resources.
Table 3. MRP Findings and Recommendations for Future Action.

<table>
<thead>
<tr>
<th>MRP Objective</th>
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<tr>
<td>1) Assessing compliance with the NPDES Permit granted to Los Angeles County</td>
<td>The Permit includes the monitoring program activities that are required by LACDPW.</td>
<td>• Objective has been successfully addressed by the monitoring program.</td>
<td>• Continue programs with modifications as recommended under the following objectives.</td>
</tr>
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<td></td>
<td></td>
<td>• The MRP requirements for Core Monitoring (Mass Emissions, Water Column Toxicity Monitoring, Tributary Monitoring, Shoreline Monitoring &amp; Trash Monitoring), Regional Monitoring (Estuary Sampling and Bioassessment) and Special Studies have been achieved. Compliance with the requirements for field and analytical methods has been met. Minor exceptions are noted and summarized in this report; however, primary permit requirements have been met. Permit requirements have been met with regard to the total number of events sampled from 2001 to the present.</td>
<td></td>
</tr>
<tr>
<td>2) Measuring and improving the effectiveness of the SQMPs</td>
<td>The SQMP contains programs in the areas of 1) Public Information; 2) Industrial/Commercial Control; 3) Development Planning; 4) Development Construction; 5) Public Agency Activities; 6) Illicit Connection/Illicit Discharge Elimination Program. Emphasis of the SQMP is pollution prevention through education, inspection, public outreach, planning, and implementation of BMPs.</td>
<td>• Measurement of the effectiveness of the SQMP is currently performed on a watershed management area basis through the Core Monitoring program. Overall long-term trends in water quality are presented for each watershed, and summarized on a regionally cross-watershed basis in this report. The conclusions of the integrated data set related to long-term reductions of constituents indicate isolated cases of overall reductions on a watershed basis. One significant trend is the decrease in TPH in the Ballona Creek, Santa Clara River, and Coyote Creek MES. Decreasing trends are also indicated for dissolved chromium and turbidity at the Malibu MES. No significant trends are indicated for the constituents that consistently exceed WQO in these urbanized watersheds. These constituents include bacteriological indicators and several metals including total copper, lead and zinc. This report provides a summary of the BMP effectiveness studies that assess goals of the MRP through BMP implementation. This BMP study is part of the Special Studies program of the MRP that focus on this objective of measuring effectiveness of the SQMP.</td>
<td>• In order to more efficiently meet this objective, it is recommended to re-design the monitoring program to reduce the frequency of base of watershed (MES) monitoring since no significant short-term trends are indicated for the primary COCs, and use resources on more focused sampling up into the watershed.</td>
</tr>
<tr>
<td>3) Assessing the</td>
<td>The Core Monitoring program</td>
<td>• The Monitoring Program has</td>
<td></td>
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<td>chemical, physical, and biological impacts from urban runoff on receiving waters</td>
<td>as required under the MRP includes water quality monitoring of the mass loading stations and tributaries for wet and dry weather. It also includes water quality toxicity monitoring at the mass emission stations. Bioassessments have also been conducted as part of the monitoring program to study the impact on the ecology of the receiving waters. Estuary sampling that includes toxicity analysis of sediments was conducted to assess the impacts to the estuary environment from the watersheds. The results from this program provide the basis for assessing the chemical, physical and biological impacts to the receiving waters.</td>
<td>successfully addressed this objective through the Core Monitoring Program, Regional Monitoring and Special Studies. • This report presents the wet and dry weather chemical analysis and compares the concentrations to the WQO. COCs based on frequency and magnitude of exceedance of the WQO are identified in this report for each of the WMA based on the sampling at the MES. The identification of these COCs provides an assessment of the impacts to the receiving waters. The biological impacts are assessed through the bioassessment and toxicity testing conducted of the receiving waters. Impacts to the estuary sediment and shoreline receiving waters are assessed by the Bight 03 program and shoreline sampling programs, respectively. • The results of these monitoring programs indicate continued impacts to the receiving creeks and rivers from urban runoff by bacteriological indicators and several metals (predominantly copper, lead and zinc). The greatest loadings on a per acre basis of these constituents are from more urbanized watersheds. Aluminum and Cyanide are also found to exceed WQO in most of the watersheds. The likely predominant sources of these metal constituents and cyanide are from non-point sources that include vehicle emissions and wear and tear of tires and brake pads. The results of the bioassessment using preliminary IBI scores indicate poor to very poor ratings for the sites in most of the watersheds with the exception of the reference sites. The results of the estuary sampling indicated exceedances of sediment quality objectives at all five estuaries. The constituents that often exceeded sediment quality objectives at most of the estuaries were cadmium, copper, nickel, and zinc; and, total detectable DDT and chlordane.</td>
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| 3) Assessing the chemical, physical, and biological impacts from urban runoff on receiving waters (continued) | • This report provides a regional assessment of water quality using the results of the Core monitoring program to assess regional chemical, physical and biological impacts on receiving waters.  
• Dry weather sampling results presented in this report provide a direct evaluation of the impact of urban runoff, because the dry weather flow is predominantly urban runoff for most urbanized watersheds with lined channelized receiving waters. The specific contribution of urban runoff to wet weather flows needs to be further studied to determine base flow characteristics. | • In order to better address this program objective, it is recommended to continue the dry weather program at the MES.                                                                                                                                                                                                                                                                     |                                                                 |
| 4) Characterization of stormwater discharges                                  | The Core Monitoring program as required under the MRP includes characterization of the stormwater at the mass loading stations and tributaries for wet and dry weather. It also includes water quality toxicity monitoring at the mass emission stations.                                                                 | • Wet weather sampling at the MES has been conducted in accordance with the permit over the last five years (wet weather data at some MES has been collected for the past 10 years). The characteristics of stormwater have been successfully addressed by this monitoring program.  
• This report provides water quality results summary for each watershed.  
• This report provides a regional assessment of water quality using the results of the core monitoring program.  
• Specific sampling of storm drains during wet weather events to assess the characterization of stormwater discharges to receiving waters has been conducted as part of the tributary sampling where the sampling location has been located at the storm drain outfalls. | • Further sampling of storm drains is needed to better assess stormwater contributions to loadings and exceedances of WQO.                                                                                                                                                                                                                                    |
Table 3. MRP Findings and Recommendations for Future Action.

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<td>5) Identifying sources of pollutants</td>
<td>The tributary monitoring program provides initial data to better define potential sources of higher constituent loading within the watersheds sampled. Tributary sampling has been conducted on Los Angeles River and Ballona Creek (Previous studies have only hypothesized about the potential sources of pollutants in the tributaries).</td>
<td>• This objective has begun to be addressed through the tributary sampling program conducted in the Los Angeles River and Ballona Creek. The tributary results have been used to better define the sub-watersheds that are contributing the greatest loads and contributions to exceedances of the WQO. These studies form the basis for more specific source identification studies that include sampling of storm drains within the sub-watershed that has been shown to contribute the greatest constituent loadings. As presented in this report, the tributary sampling at Ballona Creek identified the sections of the Creek and specific sub-watersheds that contribute the largest loads.</td>
<td>• Continued tributary sampling should be conducted on designated watersheds to first identify the sub-watersheds that are contributing the greatest loadings and contributions to exceedances of the WQO. The tributary sampling should be coordinated with any required TMDL studies and compliance monitoring to best use available resources. A trade-off of reduction of the frequency of sampling at the MES should be made with increased tributary monitoring.</td>
</tr>
<tr>
<td>6) Assessing the overall health and evaluating long-term trends in receiving water quality</td>
<td>The Core Monitoring program consisting of water quality monitoring at the mass emission stations at each of the seven watersheds and tributary monitoring provide for an assessment of overall health and long-term trends in the receiving water quality. Additional intra-regional and special studies including the bioassessment program and the estuary sampling also provide the basis for an overall assessment.</td>
<td>• The Monitoring Program has been successful in assessing the overall health of the receiving waters through the sampling and analysis of wet and dry samples at the MES, toxicity testing at the MES, estuary monitoring and bioassessment. The last 10 years of wet weather data has been compiled in this report and trend analysis performed to assess long-term term trends. Statistical trends are identified in this report for the combined data sets. • This report provides an assessment for each watershed on the long-term trends (1995-2005) related to quality of receiving waters. • This report provides an assessment of intra-regional monitoring and presents conclusions regarding overall health and long-term trends as applicable to the data and time-frame of the sampling program.</td>
<td>• Wet weather sampling at the MES does not indicate statistically significant short term trends at the MES. Until significant management actions and subsequent reductions in the loadings of the COC are implemented, the frequency of the wet weather MES sampling should be reduced. These reductions provide a tradeoff of resources to allow for continued dry weather monitoring at the MES (only 3-4 years of dry weather monitoring has been conducted), and continued monitoring up in the watershed on a sub-watershed basis.</td>
</tr>
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The overall goal of the MRP is to provide results that are to be used to refine the SQMP for the reduction of pollutant loadings and the protection and enhancement of the beneficial uses of the receiving waters in Los Angeles County. The results of the monitoring program that have been conducted in the Ballona WMA provide a model for the other watershed programs in further meeting this overall goal of the MRP. The Ballona “Model” consists of an already extensive
data base of wet weather monitoring at the MES that provides a basis for assessment of overall water quality in the watershed, and determination of trends in the concentrations and loadings from the drainage area monitored by the MES. A similar data set also exists for the Los Angeles River for which tributary monitoring has also been conducted. For both WMAs in which tributary monitoring has been conducted, results have identified drainage areas that contribute a greater magnitude of the exceedances of WQO and overall loadings. Based on the analysis of trends (presented in this section), the wet weather sampling frequency at the MES can be reduced and still meet the objectives of assessment of water quality with regard to meeting the WQO.

Core Monitoring

Based on the results and the subsequent conclusions from the Core Monitoring Program over the last 10 years, improvements/modifications to this program are presented below for each element of the program in order to better address the objectives of the MRP.

Mass Emission Stations

For nearly all the monitored watersheds, 10 years of wet weather data has been collected. Primary COCs have been identified and impacts to the receiving waters assessed. For the identified COCs that consistently exceed WQO, there have been no statistically significant trends in the concentrations of bacteriological indicators and total copper, lead and zinc. Therefore, the frequency of mass emission monitoring can be reduced and the objectives of the MRP can be better addressed through the expansion of monitoring up into the watershed. The reduction of wet weather monitoring at the MES provides a trade-off to re-allocate resources to better meet the overall goal of the Monitoring Program.

It has also been recommended to remove those constituents that have been detected in less than 25% of ten consecutive sampling events from the analytical suite. A review of the analytical results for the past five years indicates that no to very low frequency (less than 0.2%) of detections were reported under the following constituent groups: Semi-volatile organic compounds (SVOCs), pesticides as listed for EPA Method 625, and herbicides (glyphosate, 2,4-D, 2,4,5-TP-Silvex). For these constituents, it is recommended to discontinue analysis in wet and dry weather samples.

In addition, it has been recommended to modify the analytical methods for mercury, thallium, PCBs and DDT to achieve the lowest practical analytical reporting limit to confirm that the constituents are not present at concentrations that exceed the WQO. The exceedance values for these constituents were based on half the Practical Quantitation Limit (PQL), however these values were greater than the WQO.

Tributary Monitoring

In order to better address all the objectives of the Core Monitoring Element, the core element could expand the tributary monitoring program, where a trade-off of other components can allow re-allocation of available resources. The sites should also be coordinated with any TMDL compliance monitoring to best use available resources.
**TSS Monitoring**

It is recommended that the current TSS correlation study should be discontinued and the current state of the art for measuring sediment loads should be investigated by the Stormwater Monitoring Coalition, who should make recommendations on the sampling and analytical methods. Current research and published data on the success of different techniques should be assessed in developing these recommendations in order to fully capture the contribution of sediment loads to the measured water quality at the MES and to the receiving estuaries.

**Regional Monitoring**

Based on the results and conclusions presented in this Report the following recommendations are made for the Regional Monitoring Element:

**Stream Bioassessment Monitoring**

- Continue the Bioassessment Monitoring Program at 20 sites throughout the county to assess biological conditions and monitor long term trends of urban runoff impacts
- Replace sites that are typically dry in the fall with sites more likely to have water flow
- Focus the bioassessment surveys to determine which tributaries may be of greater concern
- Change the sampling protocol to the CSBP 2003 version, allowing for a more cost effective sampling regime that will yield comparable results
- Co-locate bioassessment stations with MES and tributary samples, where feasible, to allow for more effective assessment of the data to meet the MRP objectives of assessing chemical, physical and biological impacts from urban runoff on receiving waters.

**Bight ’03-Estuary Monitoring**

- Continue to support the Bight program where there is a research component strongly associated with the impacts due to stormwater.

**Special Studies**

Based on the results of the Monitoring Program as reported in this Report, Special Studies should be considered to identify sources of pollutants in stormwater.