3.0 METHODS

This section describes the field and laboratory methods used to implement the Monitoring Program, which includes Core Monitoring, Regional Monitoring and Special Studies from 2001-2005. The field and analytical methods for the Core Monitoring and the Regional Monitoring and Special Studies are presented separately. The method requirements under the Monitoring and Reporting Program (MRP) are listed and any modifications due to actual site conditions are highlighted. Methods used for the monitoring programs conducted prior to 2000 are presented in the Los Angeles County 1994-2000 Integrated Receiving Waters Impact Report (LACDPW, 2000).

3.1 Core Monitoring Methods

This section summarizes the field and analytical methods used for the core monitoring program. The core monitoring program consists of the Mass Emissions Monitoring, Water Column Toxicity Monitoring, Tributary Monitoring, Shoreline Monitoring and Trash Monitoring.

3.1.1 Mass Emissions Monitoring Methods

The methods for the Mass Emissions Monitoring Program were conducted in accordance with the *Evaluation of Analytes and QA/QC Specifications for Monitoring Program* (Woodward-Clyde 1996a) and *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (USEPA 1995). A summary of the MRP Requirements and confirmation of meeting these requirements are presented in Table 3-1.

3.1.1.1 Precipitation and Flow Measurement

For every monitoring station, a minimum of one automatic tipping bucket (intensity measuring) rain gauge is located nearby or within the tributary watershed. Large watersheds may require multiple rain gauges to accurately characterize the rainfall. The LACDPW operates various automatic rain gauges throughout the county. Existing gauges near the monitored watersheds are also utilized in calculating stormwater runoff and are essential to develop runoff characteristics for these watersheds.

Flow monitoring equipment is needed to trigger the automated samplers because the Monitoring Program requires flow-weighted composites for many constituents. Flows are determined from measurements of water elevation as described below.

The water elevation in a storm drain is measured by the stage monitoring equipment, and the flow rate is derived from a previously established rating table for the site or calculated with an equation such as Manning's. The LACDPW uses rating tables generated from analysis of storm drain cross sections and upstream/downstream flow characteristics. The rating tables are modified if it is demonstrated in the field through stream velocity measurements that calculated table values are incorrect. Previous stormwater flow measurement efforts indicate that all stations will require multiple storm events to gather the data necessary for calibration of the measurement devices.

Table 3-1. Summary of MRP Requirements and Modifications for Mass Emissions Monitoring Program.

Mass Emissions Monitoring		
MRP Requirements	**Methods Performed/Achieved from 2001-2005**	**Modifications due to site conditions/site procedures**
A.1. • Monitor 7 mass emission stations by 2002 • Monitor first storm event and 2 additional storms by 2002 • Monitor a minimum of two dry weather events each year by 2002	• Monitoring performed at all 7 stations from 2002-2005 • At least 3 storm events monitored at all stations during reporting period • 2 dry weather events monitored beginning 2002 at all 7 stations	• Monitoring of 6 stations conducted from 2000 (Santa Clara monitoring began in 2002)
A.2. • All storm events of at least 0.25 inches of rainfall shall be analyzed for TSS		• A small percentage of events were not analyzed for TSS due to problems with samplers. However, this did not result in inability to perform comparisons of TSS with COCs.
A.3. • Grab samples shall be collected for pathogen indicators and oil and grease • Monitor storms with 0.25 inches or greater of rainfall	• Grab samples collected at all stations and analyzed for bacteria, DO, total phenol, oil and grease, TPH and cyanide	
• Samples collected during first storm event shall be analyzed for constituents listed in Attachment U-1	See section 3.1.6, Table 3-7	• MTBE only analyzed for in 2004-2005 from one dry weather event
A.4. • Collect flow-weighted composite manual samples where it is not feasible to install automatic samplers • Collect a minimum of three sample aliquots each hour of discharge during first 3 hours or for duration of storm if less than 3 hours	• Manual sampling began in 2002 at the Santa Clara River station	
A.5. • Samples shall be analyzed for constituents listed in Attachment U-1	See section 3.1.6, Table 3-7	• Sample analysis did not include Benzo(g,h,i)perylene and 3,4 Benzofluoranthene
• Conduct annual confirmation sampling for non-detected constituents during the first storm		• Non-detected constituents continued to be monitored for the 2001-2005 permit period. However, bacteriological indicators were analyzed for all events. Benzo(b and k) fluoranthene, a carcinogenic PAH, was analyzed in samples in 2000-2001 and 2001-2002, and was not detected. Benzo(k) fluoranthene was included in the analyte list in 2002-2003 and 2003-2004, and also not detected.
A.6. • Perform annual analysis of correlation between pollutants of concern and TSS	• Analysis of correlation between TSS and COC presented in this report using all available data	

The automatic samplers utilize pressure transducers as the stage measurement device. However, pressure transducers are only accurate as flow measurement devices in open channel flow regimes. Therefore, for stations monitoring flows in underground storm drains, efforts were made to select drains that do not surcharge (flow under pressure) during events smaller than a 10-year storm event.

3.1.1.2 Wet Weather Sampling Methods

Sample Collection

- **Grab Sample** - a discrete, individual sample taken within a short period of time, usually less than 15 minutes. This method is used to collect samples for constituents that have very short holding times and specific collection or preservation needs, including bacteria, dissolved oxygen, total phenol, oil and grease, total petroleum hydrocarbons and cyanide. For example, samples for coliforms are taken directly into a sterile container to avoid non-resident bacterial contamination.
- **Composite Sample** - a mixed or combined sample created by combining a series of discrete samples (aliquots) of specific volume, collected at specific flow-volume intervals. Composite sampling is conducted over the duration of the storm event, ranging between 1.5 hours to 15 hours depending on the intensity of the storm.

During a storm event, grab samples were collected during the initial portion of the storm (on the rising limb of the hydrograph) and taken directly to the laboratory.

Flow composite storm samples were obtained using refrigerated American Sigma 800SL automated samplers to collect samples at flow-paced intervals. Samples collected at each station were combined in the laboratory to create a single flow-weighted sample for analysis.

During the storm season, the sampler was programmed to start automatically when the water level in the channel or storm drain exceeded a certain height, determined by experienced field staff, on the basis of current flow conditions and field experience. A sample was collected each time a set volume of water had passed the monitoring point (this volume is referred to as the pacing volume or trigger volume). The samples were stored in glass containers within the refrigerated sampler. A minimum of eight liters of sample was required to conduct the necessary laboratory analyses for all the constituents. The automated sampler was programmed with the intent of capturing the major portion of a runoff event. Depending upon rainfall and runoff conditions, the automated sampler will either completely fill up its sample bottles and discontinue sampling, or sample at a very slow rate should runoff become very light.

Samples were retrieved from the automated samplers as soon as possible to meet laboratory analysis holding time requirements. As samples were collected, rainfall and runoff data were logged and stored for transfer to the office.

3.1.1.3 Dry Weather Sampling Methods

Sample Collection

- **Grab Sample** - a discrete, individual sample taken within a short period of time, usually less than 15 minutes. This method is used to collect samples for constituents that have

very short holding times and specific collection or preservation needs, including bacteria, dissolved oxygen, total phenol, oil and grease, total petroleum hydrocarbons and cyanide. For example, samples for coliforms are taken directly into a sterile container to avoid non-resident bacterial contamination.

- **Composite Sample** - a mixed or combined sample created by combining a series of discrete samples (aliquots) of specific volume, collected at specific time intervals. Composite sampling is conducted over a 24-hour period.

Grab samples were collected at the beginning of the sampling event and taken directly to the laboratory.

Composite samples were obtained using refrigerated American Sigma 800SL automated samplers to collect samples at timed intervals. Samples collected at each station were combined in the laboratory to create a single sample for analysis.

A sample was collected approximately every 20 minutes and the approximate flow was recorded. The sample was stored in glass containers within the refrigerated sampler.

Four - 2.5 gallon bottles of sample were collected during the dry weather events. The four bottles were combined and sub sampled to create one - 2.5 gallon composite for testing purposes. The automated sampler was deactivated by field personnel at the end of the 24-hour period.

Samples were retrieved from the automated samplers as soon as possible to meet laboratory analysis holding time requirements.

3.1.1.4 Field Quality Assurance/Quality Control

Properly performed monitoring station set up, water sample collection, sample transport, and laboratory analyses are vital to the collection of accurate data. Quality Assurance/Quality Control (QA/QC) is an essential component of the monitoring program.

Evaluation of Analytes and QA/QC Specifications for Monitoring Program (Woodward-Clyde 1996a) and *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (USEPA 1995) describe the procedures used for bottle labeling, chain-of-custody tracking, sampler equipment checkout and setup, sample collection, field blanks to assess field contamination, field duplicate samples, and transportation to the laboratory.

An important part of the QA/QC Plan is the continued education of all field personnel. Field personnel were adequately trained from the onset and informed about new information on stormwater sampling techniques on a continuing basis. Field personnel also evaluate the field activities required by the QA/QC Plan, and the Plan is updated if necessary.

Bottle Preparation

For each monitoring station, a minimum of three sets of bottles was available so that up to two complete bottle change-outs could be made for each storm event. Bottle labels contained the following information:

- LACDPW Sample ID Number

- Station Number
- Station Name
- Sample Type (Grab or Composite)
- Laboratory Analysis Requested
- Date
- Time
- Preservative
- Temperature
- Sampler's Name

Bottles were cleaned at the laboratory prior to use, then they were labeled and stored in sets. Each station was provided with the same number, types, and volumes of bottles for each rotation unless special grab samples were required. Clean composite sample bottles were placed in the automated sampler when samples were collected. This practice ensured readiness for the next storm event. All bottles currently not in use were stored and later transported in plastic ice chests. Composite sample bottles were limited to a maximum of 2.5 gallons each, to ensure ease of handling.

Chain-of-Custody Procedure

Chain-of-custody forms were completed to ensure and document sample integrity. These procedures establish a written record which tracks sample possession from collection through analysis.

Field Setup Procedures

All field sampling locations were fixed sites, with the automated sampler placed on a public road or flood control right-of-way. After sample collection, field staff prepared the sampler for collection of the next set of samples. Inspection of visible hoses and cables was performed to ensure proper working conditions according to the site design. Inspection of the strainer, pressure transducer, and auxiliary pump was performed during daylight hours in non-storm conditions.

The automated sampler was checked at the beginning of the storm (during grab sample collection) to ensure proper working condition and to see if flow composite samples were being collected properly.

Bottles were collected after each event and packed with ice and foam insulation inside individually marked ice chests. Chain-of-custody forms were completed by field staff before transportation of the samples to the laboratory. Under no circumstance were samples removed from the ice chest during transport from the field to the laboratory.

Travel Blanks and Field Duplicates

Potential field contamination was assessed through analysis of travel blanks and duplicate grab samples. Field travel blanks were collected for each monitoring station during every sampling event to quantify post sampling contamination. The monitoring program also included field duplicates to assess the precision of laboratory results. A field duplicate, the origin of which was unknown to the laboratory, was collected for each sampling event. This methodology for

assessing post sampling contamination and laboratory testing procedures provided data to measure the precision and accuracy of the laboratory results.

3.1.2 Toxicity Water Column Monitoring

The methods for the Toxicity Water Column Monitoring Program were conducted in accordance with the *Evaluation of Analytes and QA/QC Specifications for Monitoring Program* (Woodward-Clyde 1996a) and *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (USEPA 1995). A summary of the MRP Requirements and confirmation of meeting these requirements are presented in Table 3-2.

Table 3-2. Summary of MRP Requirements and Modifications for Toxicity Water Column Monitoring Program.

Toxicity Water Column Monitoring		
MRP Requirements	**Methods Performed/Achieved from 2000-2005**	**Modifications due to site conditions/site procedures**
B.1. • Analyze samples from 7 mass emission stations • Monitor first storm event and one additional storm • Monitor two dry weather events each year • Use one freshwater and one marine species for testing	• Monitoring performed at all 7 stations from 2002-2005 • 2 storm events monitored since 2002 at all 7 stations • 2 dry weather events monitored since 2002 at all 7 stations • *C. dubia* (freshwater) and sea urchins (marine) were used for toxicity testing	• Program became effective in December 2001. Therefore, first storm event not captured in 2000-2001 and 2001-2002 season.
B.2. • Begin Phase I TIE on all toxic samples		• There was insufficient flow to collect water required to conduct TIEs for first monitoring period of 2001-2002. TIEs have been conducted on all samples starting in 2002-2003 season.
B.3. • Perform TRE for toxic pollutant if pollutant causes 50% of toxic responses in TIE evaluation	• No toxic results of 50% or greater in samples collected.	
• Identify source of toxicity • Recommend BMP's to reduce toxicity		• Relationship of toxicity to COC presented in this report. Potential sources of COC discussed in this report.
• Develop two TRE's per year	• Not required based on actual results	• Potential BMPs and effectiveness being performed as part of special studies – see conclusions of these studies.

3.1.2.1 Wet Weather Sampling Methods

Sample Collection

Flow composite storm samples were obtained using refrigerated American Sigma 800SL automated samplers at the mass emission stations to collect samples at flow-paced intervals. Composite sampling is conducted over the duration of the storm event, ranging between 1.5 hours to 15 hours depending on the intensity of the storm. Samples collected at each station were combined in the laboratory to create a single flow-weighted sample for analysis.

During the storm season, the sampler was programmed to start automatically when the water level in the channel or storm drain exceeded a certain height, determined by experienced field staff, on the basis of current flow conditions and field experience. A sample was collected each time a set volume of water had passed the monitoring point (this volume is referred to as the pacing volume or trigger volume). The sample was stored in glass containers within the refrigerated sampler. A minimum of eight liters of sample was required to conduct the necessary laboratory analyses for all the constituents. The automated sampler was programmed with the intent of capturing the major portion of a runoff event. Depending upon rainfall and runoff conditions, the automated sampler will either completely fill up its sample bottles and discontinue sampling, or sample at a very slow rate should runoff become very light.

Samples were retrieved from the automated samplers as soon as possible to meet laboratory analysis holding time requirements. As samples were collected, rainfall and runoff data were logged and stored for transfer to the office.

3.1.2.2 Dry Weather Sampling Methods

Sample Collection

Composite samples were obtained using refrigerated American Sigma 800SL automated samplers at the mass emission stations to collect samples at timed intervals. Composite sampling is conducted over a 24-hour period. Samples collected at each station were combined in the laboratory to create a single sample for analysis.

A sample was collected approximately every 20 minutes and the approximate flow was recorded. The sample was stored in glass containers within the refrigerated sampler. The automated sampler was deactivated by field personnel at the end of the 24-hour period.

Samples were retrieved from the automated samplers as soon as possible to meet laboratory analysis holding time requirements.

3.1.2.3 Field Quality Assurance/Quality Control

Properly performed monitoring station set up, water sample collection, sample transport, and laboratory analyses are vital to the collection of accurate data. Quality Assurance/Quality Control (QA/QC) is an essential component of the monitoring program.

Evaluation of Analytes and QA/QC Specifications for Monitoring Program (Woodward-Clyde 1996a) and *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (USEPA 1995) describe the procedures used for bottle labeling, chain-of-custody tracking, sampler equipment checkout and setup, sample collection, field blanks to assess field contamination, field duplicate samples, and transportation to the laboratory.

An important part of the QA/QC Plan is the continued education of all field personnel. Field personnel were adequately trained from the onset and informed about new information on stormwater sampling techniques on a continuing basis. Field personnel also evaluate the field activities required by the QA/QC Plan, and the Plan is updated if necessary.

Bottle Preparation

For each monitoring station, a minimum of three sets of bottles was available so that up to two complete bottle change-outs could be made for each storm event. Bottle labels contained the following information:

- LACDPW Sample ID Number
- Station Number
- Station Name
- Sample Type (Grab or Composite)
- Laboratory Analysis Requested
- Date
- Time
- Preservative
- Temperature
- Sampler's Name

Bottles were cleaned at the laboratory prior to use, then they were labeled and stored in sets. Each station was provided with the same number, types, and volumes of bottles for each rotation unless special grab samples were required. Clean composite sample bottles were placed in the automated sampler when samples were collected. This practice ensured readiness for the next storm event. All bottles currently not in use were stored and later transported in plastic ice chests. Composite sample bottles were limited to a maximum of 2 ½ gallons each, to ensure ease of handling.

Chain-of-Custody Procedure

Chain-of-custody forms were completed to ensure and document sample integrity. These procedures establish a written record which tracks sample possession from collection through analysis.

Field Setup Procedures

All field sampling locations were fixed sites, with the automated sampler placed on a public road or flood control right-of-way. After sample collection, field staff prepared the sampler for collection of the next set of samples. Inspection of visible hoses and cables was performed to ensure proper working conditions according to the site design. Inspection of the strainer, pressure transducer, and auxiliary pump was performed during daylight hours in non-storm conditions.

The automated sampler was checked at the beginning of the storm (during grab sample collection) to ensure proper working condition and to see if flow composite samples were being collected properly.

Bottles were collected after each event and packed with ice and foam insulation inside individually marked ice chests. Chain-of-custody forms were completed by field staff before transportation of the samples to the laboratory. Under no circumstance were samples removed from the ice chest during transport from the field to the laboratory.

Travel Blanks and Field Duplicates

Potential field contamination was assessed through analysis of travel blanks and duplicate grab samples. Field travel blanks were collected for each monitoring station during every sampling event to quantify post sampling contamination. The monitoring program also included field duplicates to assess the precision of laboratory results. A field duplicate, the origin of which was unknown to the laboratory, was collected for each sampling event. This methodology for assessing post sampling contamination and laboratory testing procedures provided data to measure the precision and accuracy of the laboratory results.

3.1.2.4 Laboratory Analysis

The samples were subjected to the *Ceriodaphnia dubia* 7-day survival and reproduction tests in addition to the *Strongylocentrotus purpuratus* (sea urchin) fertilization test as a measure of toxicity. Performed as multi-concentration tests, sample concentrations of 100%, 56%, 32%, 18%, 10% and 0% (N-control) were used to determine the level of toxicity. These tests were conducted under guidelines prescribed in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (USEPA 1995).

Water quality measurements (temperature, pH, dissolved oxygen, hardness, conductivity, and alkalinity) were made for each sample at the beginning and throughout each test. These measurements were performed to ensure there were no large variations in water quality, which can affect the accuracy of the toxicity tests.

3.1.3 Tributary Monitoring

The methods for the Tributary Monitoring Program were conducted in accordance with the *Evaluation of Analytes and QA/QC Specifications for Monitoring Program* (Woodward-Clyde 1996a) and *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (USEPA 1995). A summary of the MRP Requirements and confirmation of meeting these requirements are presented in Table 3-3.

3.1.3.1 Precipitation and Flow Measurement

For every monitoring station, a minimum of one automatic tipping bucket (intensity measuring) rain gauge is located nearby or within the tributary watershed. Large watersheds may require multiple rain gauges to accurately characterize the rainfall. The LACDPW operates various automatic rain gauges throughout the county. Existing gauges near the monitored watersheds are also utilized in calculating stormwater runoff and are essential to develop runoff characteristics for these watersheds.

Flow monitoring equipment is needed to trigger the automated samplers because the Monitoring Program requires flow-weighted composites for many constituents. Flows are determined from measurements of water elevation as described below.

The water elevation in a storm drain is measured by the stage monitoring equipment, and the flow rate is derived from a previously established rating table for the site or calculated with an equation such as Manning's. The LACDPW uses rating tables generated from analysis of storm drain cross sections and upstream/downstream flow characteristics. The rating tables are

modified if it is demonstrated in the field through stream velocity measurements that calculated table values are incorrect. Previous stormwater flow measurement efforts indicate that all stations will require multiple storm events to gather the data necessary for calibration of the measurement devices.

The automatic samplers utilize pressure transducers as the stage measurement device. However, pressure transducers are only accurate as flow measurement devices in open channel flow regimes. Therefore, for stations monitoring flows in underground storm drains, efforts were made to select drains that do not surcharge (flow under pressure) during events smaller than a 10-year storm event.

Table 3-3. Summary of MRP Requirements and Modifications for Tributary Monitoring Program.

Tributary Monitoring		
MRP Requirements	**Methods Performed/Achieved from 2000-2005**	**Modifications due to site conditions/site procedures**
C.1. • Monitor 6 tributaries per year • Monitor each tributary for a minimum of one year • Rotate stations among watersheds as monitoring is complete	• 6 tributaries monitored in Los Angeles River Watershed in 2002-2003 and 2003-2004 • 6 tributaries monitored in the Santa Monica Bay Watershed in 2004-2005	
C.2. • Begin monitoring October 15, 2002	• Sampling began in 2002	
C.3. • Monitor first storm event and three additional storms each year • Monitor one dry weather event	• At least 4 storm events monitored at each station • At least l dry weather event monitored at each station	• First storm event monitored for each season
C.4. • Collect flow-weighted composite samples during first three hours of storm • Collect three sample aliquots within each hour of discharge • Analyze for required constituents listed in Attachment U-1	• Automated samplers were used and programmed to sample until after peak of the storm • Method requirement achieved • See section 3.1.6, Table 3-7	• True actual duration depended on the storm event • Sample analysis did not include *B*enzo(g,h,i)perylene and 3,4 Benzoflouranthene. However, biological indicators were analyzed and PAH benzo(b and k) fluoranthene was analyzed in 2000-2001, and benzo(k) fluoranthene in 2002-2003 and 2003-2004. Neither was detected.

3.1.3.2 Wet Weather Sampling Methods

Sample Collection

- **Grab Sample** - a discrete, individual sample taken within a short period of time, usually less than 15 minutes. This method is used to collect samples for constituents that have very short holding times and specific collection or preservation needs, including bacteria,

dissolved oxygen, total phenol, oil and grease, total petroleum hydrocarbons and cyanide. For example, samples for coliforms are taken directly into a sterile container to avoid non-resident bacterial contamination.

- **Composite Sample** - a mixed or combined sample created by combining a series of discrete samples (aliquots) of specific volume, collected at specific time intervals. Composite sampling is conducted over the duration of the storm event, ranging between 1.5 hours to 15 hours depending on the intensity of the storm.

During a storm event, grab samples were collected during the initial portion of the storm (on the rising limb of the hydrograph) and taken directly to the laboratory.

Flow composite storm samples were obtained using Isco portable samplers to collect samples at flow-paced intervals. Composite sampling was conducted, at the least, during the first three hours of the storm event. A single flow-weighted sample was collected at each station and taken to the laboratory for analysis.

During the storm season, the sampler was programmed to start automatically when the water level in the channel or storm drain exceeded a certain height, determined by experienced field staff, on the basis of current flow conditions and field experience. A sample was collected each time a set volume of water had passed the monitoring point (this volume is referred to as the pacing volume or trigger volume). The samples were stored in glass containers. The automated sampler was programmed with the intent of capturing the major portion of a runoff event. Depending upon rainfall and runoff conditions, the automated sampler will either completely fill up it sample bottles and discontinue sampling, or sample at a very slow rate should runoff become very light.

Samples were retrieved from the automated samplers as soon as possible to meet laboratory analysis holding time requirements. As samples were collected, rainfall and runoff data were logged and stored for transfer to the office.

3.1.3.3 Dry Weather Sampling Methods

Sample Collection

- **Grab Sample** - a discrete, individual sample taken within a short period of time, usually less than 15 minutes. This method is used to collect samples for constituents that have very short holding times and specific collection or preservation needs, including bacteria, dissolved oxygen, total phenol, oil and grease, total petroleum hydrocarbons and cyanide. For example, samples for coliforms are taken directly into a sterile container to avoid non-resident bacterial contamination.
- **Composite Sample** - a mixed or combined sample created by combining a series of discrete samples (aliquots) of specific volume, collected at specific time intervals. Composite sampling is conducted over a 24-hour period.

Grab samples were collected at the beginning of the sampling event and taken directly to the laboratory. Composite samples were obtained using Isco 6712 portable samplers to collect samples at timed intervals. Samples collected at each station were combined in the laboratory to create a single sample for analysis.

A sample was collected approximately every 20 minutes and the approximate flow was recorded. The sample was stored in glass containers. 2.5 gallons (9.4 liters) of sample was collected during the dry weather events. The automated sampler was deactivated by field personnel at the end of the 24-hour period.

Samples were retrieved from the automated samplers as soon as possible to meet laboratory analysis holding time requirements.

3.1.3.4 Field Quality Assurance/Quality Control

Properly performed monitoring station set up, water sample collection, sample transport, and laboratory analyses are vital to the collection of accurate data. Quality Assurance/Quality Control (QA/QC) is an essential component of the monitoring program.

Evaluation of Analytes and QA/QC Specifications for Monitoring Program (Woodward-Clyde 1996a) and *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (USEPA 1995) describe the procedures used for bottle labeling, chain-of-custody tracking, sampler equipment checkout and setup, sample collection, field blanks to assess field contamination, field duplicate samples, and transport to the laboratory.

An important part of the QA/QC Plan is the continued education of all field personnel. Field personnel were adequately trained from the onset and informed about new information on stormwater sampling techniques on a continuing basis. Field personnel also evaluate the field activities required by the QA/QC Plan, and the Plan is updated if necessary.

Bottle Preparation

For each monitoring station, a minimum of three sets of bottles was available so that up to two complete bottle change-outs could be made for each storm event. Bottle labels contained the following information:

- LACDPW Sample ID Number
- Station Number
- Station Name
- Sample Type (Grab or Composite)
- Laboratory Analysis Requested
- Date
- Time
- Preservative
- Temperature
- Sampler's Name

Bottles were cleaned at the laboratory prior to use, then they were labeled and stored in sets. Each station was provided with the same number, types, and volumes of bottles for each rotation unless special grab samples were required. Clean composite sample bottles were placed in the automated sampler when samples were collected. This practice ensured readiness for the next storm event. All bottles currently not in use were stored and later transported in plastic ice chests. Composite sample bottles were limited to a maximum of 2 ½ gallons each, to ensure ease of handling.

Chain-of-Custody Procedure

Chain-of-custody forms were completed to ensure and document sample integrity. These procedures establish a written record which tracks sample possession from collection through analysis.

Field Setup Procedures

All field sampling locations were fixed sites, with the automated sampler placed on a public road or flood control right-of-way. After sample collection, field staff prepared the sampler for collection of the next set of samples. Inspection of visible hoses and cables was performed to ensure proper working conditions according to the site design. Inspection of the strainer, pressure transducer, and auxiliary pump was performed during daylight hours in non-storm conditions.

The automated sampler was checked at the beginning of the storm (during grab sample collection) to ensure proper working condition and to see if flow composite samples were being collected properly.

Bottles were collected after each event and packed with ice and foam insulation inside individually marked ice chests. Chain-of-custody forms were completed by field staff before transportation of the samples to the laboratory. Under no circumstance were samples removed from the ice chest during transport from the field to the laboratory.

Travel Blanks and Field Duplicates

Potential field contamination was assessed through analysis of travel blanks and duplicate grab samples. Field travel blanks were collected for each monitoring station during every sampling event to quantify post sampling contamination. The monitoring program also included field duplicates to assess the precision of laboratory results. A field duplicate, the origin of which was unknown to the laboratory, was collected for each sampling event. This methodology for assessing post sampling contamination and laboratory testing procedures provided data to measure the precision and accuracy of the laboratory results.

3.1.4 Shoreline Monitoring

The methods for the Shoreline Monitoring Program were conducted in accordance with the *Evaluation of Analytes and QA/QC Specifications for Monitoring Program* (Woodward-Clyde 1996a). Monitoring was conducted by the Los Angeles Bureau of Sanitation. A summary of the MRP Requirements and confirmation of meeting these requirements are presented in Table 3-4.

Table 3-4. Summary of MRP Requirements and Modifications for Shoreline Monitoring Program.

Shoreline Monitoring		
MRP Requirements	**Methods Performed/Achieved from 2000-2005**	**Modifications due to site conditions/site procedures**
D.1. • Monitor 18 stations along shoreline within Santa Monica Bay • Analyze samples for total coliforms, fecal coliforms and enterococcus • Monitoring shall occur during daylight hours • Transmit data daily to LA County DHS	• All stations were monitored during 2001-2002, 2002-2003 and 2003-2004 • All samples analyzed for total coliforms, fecal coliforms and enterococcus • All stations monitored during daylight hours • Data has been transmitted to LA County DHS since inception of program	None reported

Sample Collection

Water samples from eighteen Santa Monica Bay shoreline stations were collected daily. Shoreline stations ranged from Surfrider Beach in Malibu to Malaga Cove in Palos Verdes. All samples were collected 50 yards away from where the storm drain flow meets the shoreline, if applicable, or 50 yards away from a pier or jetty. All samples were collected at ankle-depth water level during daylight hours.

Sample Analysis

Water samples were collected and analyzed according to Standard Methods (APHA 1992). Total coliform, fecal coliform, and enterococcus bacterial densities were determined by membrane filtration as recommended in sections 9222B, 9222D, and 9230C from July 1, 2002 through December 1, 2002. Beginning December 2, 2002 the chromogenic method was employed to analyze samples for total coliform and E. coli following Standard Methods sections 9223 (APHA 1992) but the membrane filtration method was maintained for analyzing samples for enterococcus. Samples were tested daily for total and fecal coliforms/*E. coli* and five times a month for enterococcus bacteria.

Quality Assurance/Quality Control

Quality assurance and quality control procedures were conducted to confirm the validity of the analytical data collected. All areas impacting reported data were subjected to standard microbiological quality control procedures in accordance with Standard Methods (APHA 1992). These areas included sampling techniques, sample storage and holding, facilities, personnel, equipment, supplies, media, and analytical test procedures. Duplicate analyses were also performed on ten percent of all samples. When quality control results were not within acceptable limits, corrective action was initiated. This quality assurance program helped ensure the production of uniformly high quality and defensible data. In addition, EMD participates annually in the performance evaluation program managed by the California State Department of Health Services (CSDHS). As part of their Environmental Laboratory Accreditation Program, (ELAP), CSDHS biennially certifies EMD.

Data Analysis

The results obtained from microbiological samples are generally not normally distributed. To compensate for a skewed distribution and to obtain a nearly normal distribution, data must be log-normalized prior to analysis. Geometric means are the best estimate of central tendency for log-normalized data and were calculated for each bacterial indicator group. Annual geometric means were calculated for all shoreline sampling sites and compared to AB411 Bacteriological Standards presented below.

AB411 Bacteriological Standards

	Single Sample Limit
Total Coliform	1,000 MPN/ 100 ml if Fecal > 10% of Total, or 10,000 MPN/100 ml
Fecal Coliform	400 MPN/ 100 ml
Enterococcus	104 MPN/ 100 ml

Shoreline data were divided into periods of wet and dry weather to examine the effects of storm drain runoff on indicator bacterial concentrations. Regulatory agencies have defined wet weather as the day of rain plus two days following the rain event. Rain data were obtained from the National Weather Service's Los Angeles Civic Center monitoring station.

3.1.5 Trash Monitoring

The methods for the Trash Monitoring Program were conducted in accordance with the *Evaluation of Analytes and QA/QC Specifications for Monitoring Program* (Woodward-Clyde 1996a). A summary of the MRP requirements and confirmation of meeting these requirements are presented in Table 3-5.

Table 3-5. Summary of MRP Requirements and Modifications for Trash Monitoring Program.

Trash Monitoring		
MRP Requirements	**Methods Performed/Achieved from 2000-2005**	**Modifications due to site conditions/site procedures**
E.1. • Conduct visual observations of trash at each station after first storm event and 3 additional storms per year beginning 2002 • Take a minimum of one photograph at each station • Capture and quantify trash from 10% of total land area, or • Sample a minimum of ten representative sites for each land use monitored • Conduct compliance monitoring after first two years • Dispose all trash in compliance with all regulations	• All observations were conducted after four storm events, including the first storm, in 2002-2003, 2003-2004 and 2004-2005 • All photographs were taken at each station in 2002-2003, 2003-2004 and 2004-2005 • 10 sites for each land use monitored were sampled in 2002-2003 and 2003-2004 • Compliance monitoring conducted • Trash disposed of in accordance with regulations	None Reported

Monitoring Activities

Visual observations of trash were made and a minimum of one photograph at each mass emission station was taken after four storm events including the first storm event.

In addition, a minimum of ten representative sites for each land use monitored were sampled. On average, each sampling site contained a minimum of five catch basins fitted with inserts with a total of 256 inserts within the Los Angeles Watershed Management Area (WMA) and 309 inserts within the Ballona Creek WMA. A total of five structural full capture devices or Continuous Deflective System (CDS) units were installed. However, one of the CDS units was decommissioned at the end of the 2003-2004 season due to operating issues. All of the upstream catch basins were fitted with inserts. Each insert and CDS unit were emptied within 72 hours of every rain event of 0.25 inches or greater, additionally being emptied every three months during dry weather.

3.1.6 Laboratory Analyses for Core Monitoring Program

The Department of Agricultural Commissioner/Weights and Measures (ACWM) Environmental Toxicology Laboratory provides water quality laboratory and related services to the LACDPW. The ACWM lab is state certified to perform the water quality analyses contracted by LACDPW. The ACWM Lab maintains a laboratory analysis program that includes Quality Assurance and Quality Control protocols consistent with the objectives of the monitoring program required by the Permit.

3.1.6.1 Analytical Requirements – Monitoring and Reporting Program

The requirements for the analytical program for the Core Monitoring Program, specifically, are provided in the Standard Monitoring Provisions of the MRP. These requirements are summarized below in Table 3-6 for each of the Core Monitoring programs. The confirmation of the meeting these requirements are also provided.

Table 3-6. Summary of Analytical Requirements per MRP for the Core Monitoring Program.

MRP Requirements	Confirmation of Meeting Requirements	Modifications to Analytical Requirements
General Core Monitoring Program – Item K • No. 6 – All chemical, bacteriological, and toxicity analyses shall be conducted at certified laboratory • No. 7 - Priority Toxic Pollutants (CTR – Fed Reg 31682) – MLs per Appendix 4 of SIP shall be used – per Attachment U-1 of MPR • No. 9 - If ML is not attainable per 40 CFR 136, lowest quantifiable concentrations of the lowest calibration standard analyzed can be used if documentation submitted	• Analysis of Core Monitoring Program samples conducted at the State certified ACWM Lab • See Table 3-7 for MLs for Analytes Tested – MLs are in conformance with Attachment U-1 • Concentrations below the PQL but above the ML were reported as estimated concentrations	None Reported
Mass Emissions Stations – Item A. • No. 5 – Samples shall be analyzed for all constituents in Attachment U-1	• See Table 3-7 for Analytes Tested –Constituents tested are in conformance with Attachment U-1	See Table 3-1
Water Column Toxicity Monitoring – Item B. • No. 1 - A min of one freshwater and one marine marine species – tests shall include dilution series – range from undiluted to 6% sample	• *C. dubia* (freshwater) and sea urchins (marine) were used for toxicity testing	None Reported
Tributary Monitoring – Item C. • No. 4 – Constituents to be analyzed shall include – a) pH, DO, Temp. Cond., TSS b) Indicator Bacteria c) Priority Pollutants – Attachment U-1 for first storm d) All constituents for which water body is impaired downstream e) All constituents that caused toxicity or exceeded WQO at MES f) flow	• Tributary samples analyzed for same constituents as MES samples, per Attachment U-1	See Table 3-3 Temperature not recorded. Conductivity was measured as specific conductance.
Shoreline Monitoring – Item D. • No. 1b – 3 Indicator groups shall be tested – total coliform, fecal coliform and enterococcus	• Samples analyzed for all indicator bacteria	None Reported

3.1.6.2 Analytical Suite and Analytical Methods

The suite of analytes and associated detection limits for samples collected at the mass emission and tributary stations are specified in the MRP, and summarized in Table 3-7. Constituents of

concern for derivation of event mean concentrations are specified by the Permit. All the laboratory methods used for analysis of the samples are approved by the California Department of Health Services and are in conformance with U.S. Environmental Protection Agency (USEPA) approved methods. Table 3-7 also provides the analytical method, the type of sample (grab or composite), and the years sampled for each constituent.

The laboratory made an effort to provide the lowest detection limits attainable without compromising the reliability of the data. "Detection limit" (DL) is defined by the USEPA as "the concentration above which we are 99% confident that the analyte is present at a concentration greater than zero" (40 CFR Part 136, Appendix B). For this project the laboratory made some allowance for interference in the analysis due to the complex nature of the sample matrix by performing a DL study using a water sample collected from a channel during dry weather. These 'matrix specific' DLs are the reported DLs in the data tables. Data below the DL are reported as zero. The Practical Quantitation Limit (PQL) is the concentration above which the analyte can be accurately quantified. Reported PQLs were developed by the laboratory during the analysis of stormwater runoff samples using professional judgment to account for matrix interferences. Data that fall between the DL and PQL are reported by the laboratory at the apparent concentrations. When reviewing these data it should be noted that the concentrations below the PQL are estimated.

The Municipal Stormwater Permit defines MDL and ML (i.e., PQL) as follows:

MDL means the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. ML means the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed. Table 3-7 provides the ML (identified as PQL) for each of the constituents analyzed.

Table 3-7. Analytical method, sample type, detection level, and years sampled for each constituent monitored at the Mass Emissions and Tributary Stations.

CONSTITUENT	Sample Type	EPA Method	PQL*	Units	00-01	01-02	02-03	03-04	04-05
General									
Oil and Grease	Grab	EPA413.1	1	mg/L	X	X	X	X	X
Total Phenols	Grab	EPA420.1	0.10	mg/L	X	X	X	X	X
Cyanide	Grab	EPA335.2	0.01	mg/L	X	X	X	X	X
pH	Comp	SM4500H B	0-14		X	X	X	X	X
Dissolved Oxygen	Grab	SM4500O G	1.00	mg/L			X	X	X
Indicator Bacteria									
Total Coliform	Grab	SM9230B	20.00	MPN/100ml	X	X	X	X	X
Fecal Coliform	Grab	SM9230B	20.00	MPN/100ml	X	X	X	X	X
Fecal Enterococcus	Grab	SM9230B	20.00	MPN/100ml	X	X	X	X	X
General Mineral									
Dissolved Phosphorus	Comp	EPA365.3	0.05	mg/L	X	X	X	X	X
Total Phosphorus	Comp	EPA365.3	0.05	mg/L	X	X	X	X	X
Turbidity	Comp	EPA180.1	0.10	NTU	X	X	X	X	X
Total Suspended Solids	Comp	EPA160.2	2.00	mg/L	X	X	X	X	X
Total Dissolved Solids	Comp	EPA160.1	2.00	mg/L	X	X	X	X	X
Volatile Suspended Solids	Comp	EPA160.4	1.00	mg/L	X	X	X	X	X

Table 3-7. Analytical method, sample type, detection level, and years sampled for each constituent monitored at the Mass Emissions and Tributary Stations.

CONSTITUENT	Sample Type	EPA Method	PQL*	Units	00-01	01-02	02-03	03-04	04-05
Total Organic Carbon	Comp	EPA415.1	1.00	mg/L	X	X	X	X	X
Total Petroleum Hydrocarbon	Grab	EPA418.1	1.00	mg/L	X	X	X	X	X
Biochemical Oxygen Demand	Comp	SM5210B	2.00	mg/L	X	X	X	X	X
Chemical Oxygen Demand	Comp	EPA410.4	10.00	mg/L	X	X	X	X	X
Total Ammonia	Comp	EPA350.3	0.1	mg/L	X	X	X	X	X
Kjeldahl-N	Comp	EPA351.4	0.10	mg/L	X	X	X	X	X
Nitrate-N	Comp	SM4110B	0.50	mg/L	X	X	X	X	X
Nitrite-N	Comp	SM4110B	0.03	mg/L	X	X	X	X	X
Alkalinity	Comp	EPA310.1	4.00	mg/L	X	X	X	X	X
Specific Conductance	Comp	EPA120.1	1.00	umhos/cm	X	X	X	X	X
Hardness	Comp	EPA130.2	2.00	mg/L	X	X	X	X	X
MBAS	Comp	EPA425.1	0.05	mg/L	X	X	X	X	X
Chloride	Comp	EPA300.0	2.00	mg/L	X	X	X	X	X
Fluoride	Comp	EPA300.0	0.10	mg/L	X	X	X	X	X
Methyl tertiary butyl ether (MTBE)	Grab	EPA524.2	1.00	µg/L					X
Metals									
Dissolved Aluminum	Comp	EPA200.8	100.00	µg/L	X	X	X	X	X
Total Aluminum	Comp	EPA200.8	100.00	µg/L	X	X	X	X	X
Dissolved Antimony	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Total Antimony	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Dissolved Arsenic	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Total Arsenic	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Dissolved Berylium	Comp	EPA200.8	1.00	µg/L	X	X	X	X	X
Total Beryllium	Comp	EPA200.8	1.00	µg/L	X	X	X	X	X
Dissolved Cadmium	Comp	EPA200.8	1.00	µg/L	X	X	X	X	X
Total Cadmium	Comp	EPA200.8	1.00	µg/L	X	X	X	X	X
Dissolved Chromium	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Total Chromium	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Dissolved Copper	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Total Copper	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Dissolved Chromium +6	Comp	EPA200.8	10.00	µg/L	X	X	X	X	X
Total Chromium +6	Comp	EPA200.8	10.00	µg/L	X	X	X	X	X
Dissolved Iron	Comp	EPA200.8	100.00	µg/L	X	X	X	X	X
Total Iron	Comp	EPA200.8	100.00	µg/L	X	X	X	X	X
Dissolved Lead	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Total Lead	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Dissolved Mercury	Comp	EPA200.8	1.00	µg/L	X	X	X	X	X
Total Mercury	Comp	EPA200.8	1.00	µg/L	X	X	X	X	X
Dissolved Nickel	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Total Nickel	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Dissolved Selenium	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Total Selenium	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Dissolved Silver	Comp	EPA200.8	1.00	µg/L	X	X	X	X	X
Total Silver	Comp	EPA200.8	1.00	µg/L	X	X	X	X	X
Dissolved Thallium	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Total Thallium	Comp	EPA200.8	5.00	µg/L	X	X	X	X	X
Dissolved Zinc	Comp	EPA200.8	50.00	µg/L	X	X	X	X	X
Total Zinc	Comp	EPA200.8	50.00	µg/L	X	X	X	X	X
Semi-Volatiles									
2- Chlorophenol	Comp	EPA625	2.00	µg/L			X	X	X
2,4-dichlorophenol	Comp	EPA625	2.00	µg/L			X	X	X
2,4-dimethylphenol	Comp	EPA625	2.00	µg/L			X	X	X
2,4-dinitrophenol	Comp	EPA625	3.00	µg/L			X	X	X

Table 3-7. Analytical method, sample type, detection level, and years sampled for each constituent monitored at the Mass Emissions and Tributary Stations.

CONSTITUENT	Sample Type	EPA Method	PQL*	Units	00-01	01-02	02-03	03-04	04-05
2-nitrophenol	Comp	EPA625	3.00	µg/L			X	X	X
4-nitrophenol	Comp	EPA625	3.00	µg/L			X	X	X
4-chloro_3_methylphenol	Comp	EPA625	3.00	µg/L			X	X	X
Pentachlorophenol	Comp	EPA625	2.00	µg/L			X	X	X
Phenol	Comp	EPA625	1.00	µg/L			X	X	X
2,4,6-trichlophenol	Comp	EPA625	1.00	µg/L			X	X	X
Acenaphthene	Comp	EPA625	0.05	µg/L	X	X	X	X	X
Acenaphthylene	Comp	EPA625	0.05	µg/L		X	X	X	X
Anthracene	Comp	EPA625	0.05	µg/L			X	X	
Benzidine	Comp	EPA625	3	µg/L			X	X	X
1,2 Benzanthracene	Comp	EPA625	0.10	µg/L			X	X	X
Benzo(a)pyrene	Comp	EPA625	0.10	µg/L			X	X	
Benzo(g,h,i)perylene	Comp	EPA625	0.50	µg/L					
3,4 Benzoflouranthene	Comp	EPA625	1.0	µg/L					
Benzo(k)flouranthene	Comp	EPA625	0.10	µg/L			X	X	
Bis(2-Chloroethoxy) methane	Comp	EPA625	0.10	µg/L			X	X	X
Bis(2-Chloroisopropyl) ether	Comp	EPA625	1.00	µg/L			X	X	X
Bis(2-Chloroethyl) ether	Comp	EPA625	0.10	µg/L			X	X	X
Bis(2-Ethylhexl) phthalate	Comp	EPA625	1.00	µg/L	X	X	X	X	X
4-Bromophenyl phenyl ether	Comp	EPA625	1.00	µg/L			X	X	X
Butyl benzyl phthalate	Comp	EPA625	0.30	µg/L			X	X	X
2-Chloroethyl vinyl ether	Comp	EPA625	2.50	µg/L					X
2-Chloronaphthalene	Comp	EPA625	0.10	µg/L			X	X	
4-Chlorophenyl phenyl ether	Comp	EPA625	0.10	µg/L			X	X	X
Chrysene	Comp	EPA625	0.10	µg/L		X	X	X	X
Dibenzo(a,h)anthracene	Comp	EPA625	0.10	µg/L		X	X	X	X
1,3-Dichlorobenzene	Comp	EPA625	0.05	µg/L			X	X	X
1,4-Dichlorobenzene	Comp	EPA625	0.05	µg/L			X	X	X
1,2-Dichlorobenzene	Comp	EPA625	0.05	µg/L			X	X	X
3,3-Dichlorobenzidine	Comp	EPA625	3.00	µg/L			X	X	X
Diethyl phthalate	Comp	EPA625	0.50	µg/L			X	X	X
Dimethyl phthalate	Comp	EPA625	0.50	µg/L			X	X	X
di-n-Butyl phthalate	Comp	EPA625	1.00	µg/L			X	X	X
2,4-Dinitrotoluene	Comp	EPA625	0.05	µg/L			X	X	X
2,6-Dinitrotoluene	Comp	EPA625	0.05	µg/L			X	X	X
4,6 Dinitro-2-methylphenol	Comp	EPA625	3.00	µg/L			X	X	X
1,2-Diphenylhydrazine	Comp	EPA625	3.00	µg/L			X	X	X
di-n-Octyl phthalate	Comp	EPA625	1.00	µg/L			X	X	X
Fluoranthene	Comp	EPA625	0.10	µg/L		X	X	X	X
Fluorene	Comp	EPA625	0.10	µg/L		X	X	X	X
Hexachlorobenzene	Comp	EPA625	0.50	µg/L			X	X	X
Hexachlorobutadiene	Comp	EPA625	1.00	µg/L			X	X	X
Hexachloro-cyclopentadiene	Comp	EPA625	3.00	µg/L			X	X	X
Hexachloroethane	Comp	EPA625	1.00	µg/L			X	X	X
Indeno(1,2,3-cd)pyrene	Comp	EPA625	0.10	µg/L		X	X	X	X
Isophorone	Comp	EPA625	0.05	µg/L			X	X	X
Naphthalene	Comp	EPA625	0.05	µg/L		X	X	X	X
Nitrobenzene	Comp	EPA625	0.05	µg/L			X	X	X
N-Nitroso-dimethyl amine	Comp	EPA625	0.30	µg/L			X	X	X
N-Nitroso-diphenyl amine	Comp	EPA625	0.30	µg/L			X	X	X
N-Nitroso-di-n-propyl amine	Comp	EPA625	0.30	µg/L			X	X	X
Phenanthrene	Comp	EPA625	0.05	µg/L		X	X	X	X
Pyrene	Comp	EPA625	0.05	µg/L		X	X	X	X

Table 3-7. Analytical method, sample type, detection level, and years sampled for each constituent monitored at the Mass Emissions and Tributary Stations.

CONSTITUENT	Sample Type	EPA Method	PQL*	Units	00-01	01-02	02-03	03-04	04-05
1,2,4-Trichlorobenzene	Comp	EPA625	0.50	µg/L			X	X	X
Pesticides									
Aldrin	Comp	EPA625	0.05	µg/L			X	X	X
alpha-BHC	Comp	EPA625	0.05	µg/L			X	X	X
beta-BHC	Comp	EPA625	0.05	µg/L			X	X	X
delta-BHC	Comp	EPA625	0.05	µg/L			X	X	X
gamma-BHC (lindane)	Comp	EPA625	0.05	µg/L			X	X	X
alpha-chlordane	Comp	EPA625	0.05	µg/L			X	X	X
gamma-chlordane	Comp	EPA625	0.05	µg/L			X	X	X
4,4'-DDD	Comp	EPA625	0.10	µg/L			X	X	X
4,4'-DDE	Comp	EPA625	0.10	µg/L			X	X	X
4,4'-DDT	Comp	EPA625	0.10	µg/L			X	X	X
Dieldrin	Comp	EPA625	0.10	µg/L			X	X	X
alpha-Endosulfan	Comp	EPA625	0.10	µg/L			X	X	X
beta-Endosulfan	Comp	EPA625	0.10	µg/L			X	X	X
Endosulfan sulfate	Comp	EPA625	0.10	µg/L			X	X	X
Endrin	Comp	EPA625	0.10	µg/L			X	X	X
Endrin aldehyde	Comp	EPA625	0.10	µg/L			X	X	X
Heptachlor	Comp	EPA625	0.05	µg/L			X	X	X
Heptachlor Epoxide	Comp	EPA625	0.05	µg/L			X	X	X
Toxaphene	Comp	EPA625	1.00	µg/L			X	X	X
Polychlorinated Biphenyls									
Aroclor-1016	Comp	EPA608	0.50	µg/L			X	X	X
Aroclor-1221	Comp	EPA608	0.50	µg/L			X	X	X
Aroclor-1232	Comp	EPA608	0.50	µg/L			X	X	X
Aroclor-1242	Comp	EPA608	0.50	µg/L			X	X	X
Aroclor-1248	Comp	EPA608	0.50	µg/L			X	X	X
Aroclor-1254	Comp	EPA608	0.50	µg/L			X	X	X
Aroclor-1260	Comp	EPA608	0.50	µg/L			X	X	X
Organophosphate Pesticides									
Chlorpyrifos	Comp	EPA507	0.05	µg/L	X	X	X	X	X
Diazinon	Comp	EPA507	0.01	µg/L	X	X	X	X	X
Prometryn	Comp	EPA507	2.00	µg/L			X	X	X
Atrazine	Comp	EPA507	2.00	µg/L			X	X	X
Simazine	Comp	EPA507	2.00	µg/L			X	X	X
Cyanazine	Comp	EPA507	2.00	µg/L			X	X	X
Malathion	Comp	EPA507	2.00	µg/L			X	X	X
Herbicides									
Glyphosate	Comp	EPA547	25.00	µg/L	X	X	X	X	X
2,4-D	Comp	EPA515.3	10.00	µg/L	X	X	X	X	X
2,4,5-TP-SILVEX	Comp	EPA515.3	1.00	µg/L	X	X	X	X	X

* PQL's from 2003-2004

3.1.6.3 Comparison of Water Quality Objectives to Practical Quantitation Limit

The applicable WQO are compared to the results from the mass emissions stations and tributary locations in Section 4. In accordance with the Monitoring and Reporting Program, Item K, no. 8, for the purpose of reporting compliance with numerical limitations, performance goals, and receiving water limitations, analytical data will be reported using one of the approved methods as appropriate. The method used for this report is method (a), which reports an actual numerical value for sample results greater than or equal to the ML.

3.1.6.4 Quality Assurance and Quality Control

The primary objective of the laboratory quality assurance/quality control program is to ensure that the analyses are scientifically valid, defensible, and of known precision and accuracy. The ACWM laboratory maintains QA/QC procedures (as described in their Quality Assurance Manual) in accordance with requirements of the California Department of Health Services. The ACWM laboratory standard operation procedures include method validation, equipment calibration, preventive maintenance, data validation procedures, assessment of accuracy and precision, corrective actions, and performance and system audits. ACWM Lab conducted the QA/QC review and data validation for all monitoring data and the QA/QC documentation is available within the ACWM Lab files. The validated data as provided by the ACWM Lab were used for data analysis and interpretation with no further QA/QC review.

3.1.7 Statistical Methods

Comparison to Water Quality Objectives

The data collected in the 2004-2005 Core Stormwater Monitoring were compiled by station into tables with the appropriate Water Quality Objectives (WQO). Each observation was compared to the lowest applicable WQO from the Basin Plan, Ocean Plan, or the California Toxic Rule (CTR); those above the WQO were highlighted. The Criterion Continuous Concentrations (CCC) from the CTR were used for comparison; those for metals with established water effects ratios were adjusted for hardness as described in the CTR. For these metals the water quality objective changes for every storm event.

Determination of constituents of concern (COC), a list of constituents was developed by first evaluating all water quality data collected from a single mass emission station. At each location, a mean value for each monitoring year was calculated from all samples collected, wet and dry weather events inclusive. For those constituents that have an associated WQO, the mean value was then compared to the lowest established WQO. ***The term COC used in this report is therefore based on a comparison of mean annual concentrations to water quality objectives***. These WQO may represent conservative benchmarks that do not reflect an impact to actual receptors and beneficial use specific to a receiving water body. Therefore, 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.

Next, these results were used to calculate frequency and mean magnitude of exceedance ratios. 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. For example, if Constituent A has a WQO of 10 mg/L with mean concentrations in Years 1-3 of 5 mg/L, 17 mg/L and 23 mg/L, the magnitude of exceedance for each year would be 0.5, 1.7 and 2.3, respectively. The mean magnitude of exceedance would be 1.5. This indicates that on average, the Constituent A exceeds the WQO by 50%. Constituents having a frequency ratio greater than 0.5 and a mean exceedance ratio greater than 1.0 were considered COCs.

In addition to comparisons to WQO, trend analysis was also evaluated (see below). Constituents that had an increasing trend but were below the WQO are discussed in the presentation of COC to identify which constituents should continue to be monitored to assure the trend is not continuous and does not exceed the WQO. In addition, constituents currently on the 303(d) list are presented as a comparison to the COCs identified through the comparison to WQO as discussed above.

Trend Analysis

Data for each mass emission station were plotted through time for those constituents with sufficient values above detection levels. Data for each constituent were averaged by sampling year to determine trends; for those observations that were non-detectable one-half of the PQL was used in the calculation. For this analysis, wet and dry sampling events were evaluated separately. The data shown in the trend data plots were tested by regression analysis to determine significant trends. When an upward or downward trend was statistically significant ($p<0.05$) the trend line is shown on the data plot.

Cross-Watershed Comparisons

Multivariate cluster analysis was applied to the measured constituents for each mass emission station and averaged by sampling year with wet and dry events evaluated separately. This approach groups the station/times by the commonality of the constituent concentrations found at each one. Likewise, it groups the constituents according to similar loadings at stations. Prior to the analysis the bacteriological measures were $\log_{10}$ transformed and the data for each constituent was standardized by the overall mean value for each constituent.

Analysis of variance (ANOVA) was used to compare concentrations of the measured constituents at the mass emission stations. The term *analysis of variance* is sometimes a source of confusion. In spite of its name, ANOVA is concerned with differences between *means* of groups, not differences between *variances.* This analysis uses variances to detect whether the means are different. The way it works is simple: the program determines the variation (variance) *within* the groups that are being compared (e.g. monitoring stations), then compares that variation to the differences *between* the groups, taking into account how many subjects there are in the groups. If the observed differences between groups are larger than those expected by chance, a statistical significance ($p<0.05$) is achieved.

Relationships Between Toxicity and Constituents

The relationship between toxicity and constituents has been evaluated by comparisons to threshold values. Sometimes thresholds of chemical concentrations are involved with toxicity whereby the organisms do not respond negatively until a certain chemical level is reached. Concentrations of constituents above a specific threshold may no longer illicit a linear response in organism toxicity. The threshold analysis uses constituent levels reported to be toxic in the literature where available and compares them to constituent levels in the stormwater samples.

Threshold values from literature were assigned to constituents that are potentially causal to toxic response. Where threshold values were not available, “best-fit” values (those that gave the best match to the observed toxicity results) were selected. Values were available for diazinon, nickel, lead, zinc, nitrate, and conductivity.

The EPAs "Ecotox" database (www.epa.gov/ecotox) provides toxicity data by species and chemical, which is collected from a large number of independent studies. This resource also provides information on test duration, endpoints observed, as well as other parameters. Toxicity values for nitrate, metals, and the test species were collected from this resource.

The Handbook of Environmental Data on Organic Chemicals (Vershueren 1983) provides data on air and water pollution factors, bioconcentration and toxicity for a variety of organic chemicals, including pesticides. Toxicity data are provided by species and endpoint. Toxicity values for diazinon, chlorpyrifos, and malathion for species related to *Ceriodaphnia dubia* were collected from this resource.

Despite the usefulness of these resources, they have limitations. Toxicity values are not always provided for the test durations used in this stormwater toxicity study. When using a value from a longer test period (say a 21-day test), the value will likely be a conservative estimate of what level would actually cause toxicity in a 7-day test. Data are also not provided for all constituents or it is possible that the data provided is for a related species to the test species used in this study, which will most likely have a different sensitivity to the toxicants than the test species selected for this study.

These resources do not provide toxicity data of physical parameters (e.g., total dissolved solids, hardness, turbidity) to the test species. For the relationship between physical parameters and toxicity it is best to rely upon the regression analysis. These resources also do not provide information on possible interactions between chemicals or the interactions between chemicals and physical parameters.

3.2 Regional Monitoring

LACDPW is required to participate in regional monitoring programs that address environmental health concerns; monitor trends in natural resources and near shore habitats, and assess regional impacts from stormwater pollutant sources. The regional monitoring program consists of Estuary and Stream Bioassessment Monitoring.

3.2.1 Estuary Monitoring

In compliance with Section II.F of the stormwater monitoring requirements, LACDPW is participating in the coastal ecology committee of the Bight 2003 project coordinated by the Southern California Coastal Waters 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. Monitoring was done in each estuary in the summer of 2003.

The methods for estuary monitoring were followed in accordance with the Southern California Bight 2003 Field Operations Manual (SCCWRP 2003).

Samples were collected by various participants in the Bight '03 program. Benthic infauna and sediment toxicity samples were analyzed by Weston Solutions, Inc.; chemical analyses were performed by CRG Marine Laboratories, Inc. and the City of San Diego; particle size analysis was provided by the City of San Diego and the City of Los Angeles Environmental Monitoring Division; and total organic carbon analyses were done at SCCWRP and the City of San Diego. All data were submitted to SCCWRP; data used in this report were obtained from the SCCWRP database. Benthic infauna and sediment chemistry data are currently undergoing QA review; data presented in this report should therefore be considered preliminary.

3.2.2 Stream Bioassessment Monitoring

Section II.G of the stormwater monitoring requirements requires LACDPW to perform annual bioassessments on streams in Los Angeles County beginning in 2003 and continuing through 2005.

The twenty monitoring reaches assessed in this study were located in five watersheds throughout Los Angeles County, including the Santa Clara River Watershed, the Santa Monica Bay Watershed (Ballona Creek Watershed and Malibu Creek Watershed), the Dominguez Channel Watershed, the Los Angeles River Watershed, and the San Gabriel River Watershed. Sampling methods and sample analysis followed protocols described in the California Stream Bioassessment Procedure (Harrington 1999) established by the Surface Water Ambient Monitoring Program within the California Department of Fish and Game.

3.2.3 Data Analysis

Estuary Monitoring

Sediment Chemistry. Currently, there are no universally accepted criteria for assessing contaminated sediments. However, SCCWRP decided to utilize Effect Range-Low (ER-L) and Effect Range-Median (ER-M) values to evaluate the potential for sediment to cause adverse biological effects (Long et al. 1995) (Table 3-8). The guidelines were intended to provide informal (non-regulatory) effects-based benchmarks of sediment chemistry data (Long et al. 1998). Two effects categories have been identified:

ER-L – Effects Range-Low: concentrations below which adverse biological effects are rarely observed; and

ER-M – Effects Range-Median: concentrations above which adverse biological effects are more frequently, though not always observed.

Sediment chemistry data from samples collected from each of the estuaries were compared to the ER-L and or the ER-M data.

Table 3-8. Sediment Effects Guideline Values.

Parameter	Effects Range-Low (ER-L)	Effects Range-Median (ER-M)
Metals (mg/Kg)		
Arsenic	8.2	70
Cadmium	1.2	9.6
Chromium	81	370
Copper	34	270
Lead	46.7	218
Mercury	0.15	0.71
Nickel	20.9	51.6
Silver	1	3.7
Zinc	150	410
Organics (µg/Kg)		
Total Detectable DDT	1.58	46.1
Total Detectable Chlordane	0.6	6
Total Detectable PAHs	4,022	44,800
Total Detectable PCBs	22.7	180

Source: Long et al. 1995

ER-L = Concentration at lower tenth percentile at which adverse biological effects were observed or predicted.
ER-M = Concentration at which adverse biological effects were observed or predicted in 50% of test organisms.
mg/Kg = milligrams per kilogram.
µg /Kg = micrograms per kilogram.

In addition, for each estuary ER-M values were used to calculate a mean ER-M quotient (ERM-Q). The concentration of each constituent was divided by its ER-M to produce a quotient, or proportion of the ER-M equivalent to the magnitude by which the ER-M value is exceeded or not exceeded. The mean ERM-Q for each embayment was then calculated by summing the ERM-Qs for each constituent and then dividing by the total number of ERM-Qs assessed. ERM-Qs were not calculated for constituents below the detection limit and thus were not used in the generation of the mean ERM-Q. The mean ERM-Q thus represents an assessment for each embayment of the cumulative sediment chemistry relative to the threshold values. In this way, the cumulative risks of effect to the benthic community can provide a mechanism to compare embayments. This method has been used and evaluated by several researchers (Hyland et al. 1999, Carr et al. 1996, Chapman 1996, and Long et al. 1995) throughout the country.

The aggregate approach using an ERM-Q is a more reliable predictor of potential toxicity but should not be used to infer causality of specific contaminants. ER-L and ER-M values were originally derived to be broadly applicable and they cannot account for site-specific features that may affect their applicability on a more local or regional level. Local differences in geomorphology can result in chemicals being more or less available and therefore more or less toxic than an ER-L or ER-M value might indicate. Additionally, some regions of the country are naturally enriched in certain metals and local organisms have become adapted.

Sediment Toxicity. Sediment toxicity results were obtained from the exposure of the test species (*Eohaustorius estuarius*) to sediments collected from each of the estuaries. The percent survival of test organisms in sediments from the embayments was compared to percent survival in a control sample to assess benthic infaunal toxicity levels from each of the estuaries sampled.

Benthic Infauna. The benthic infauna data from each of the estuaries was assessed using a variety of indices common to ecological community structure evaluations. Some of the tools that are employed in the assessment include relative abundance, species richness, Shannon-Wiener Species Diversity Index, evenness and dominance.

Stream Bioassessment Monitoring

Taxonomic data was entered into an electronic file using Microsoft Word and converted into a SAS database for QA/QC and data reduction. Benthic macroinvertebrate community-based metric values were calculated from the database, based upon metrics recommended in the California stream bioassessment procedure (CSBP; Harrington 1999) (Appendix A). A taxonomic list of the macroinvertebrates present in each sample was created, including the designated tolerance value (TV) and functional feeding group (FFG) of each taxon. Functional feeding group designations were refined in 2003 (CAMLNet 2003), with the addition of macrophyte herbivores (MH), piercer herbivores (PH), omnivores (OM), and xylophages (XY, wood eater). These groups were previously included in the grazer FFG. CDFG recommends that for the FFG proportional bioassessment metric calculations, these four categories plus parasites are combined into a group designated "Other". Also note that for some organisms identified at the Family level or above, a single TV or FFG was not assigned. This is because the taxa within the group have a broad range of tolerances or feeding strategies and a single designation is not representative.

In addition to the individual metric values, a multi-metric Index of Biotic Integrity (IBI) was calculated for each monitoring reach and compared to CFG's Southern California IBI (Ode et al. In Press). The IBI is a quantitative scoring system for assessing the quality of benthic macroinvertebrate assemblages, and can be a useful tool in reducing a complex macroinvertebrate data set to a qualitative rating for each monitoring reach. The IBI score is derived from the cumulative value of seven biological metrics (Appendix A, asterisked metrics). The total scores were categorized into ratings of the benthic community, ranging from Very Poor to Very Good. It has been noted that the Southern California IBI was developed with very few sites located in low elevations in Los Angeles County, and development of a refined IBI has begun with the participation of LACDPW and other Southern California principle stormwater agencies.

3.3 Special Studies

As required by the 2001 Municipal Stormwater Permit, Los Angeles County Department of Public Works is conducting special monitoring programs, including the New Development Impacts Study in the Santa Clara Watershed, the Peak Flow Discharge Impact Study and the Stormwater BMP Effectiveness Study.

3.3.1 New Development Impacts Study in the Santa Clara Watershed

The objective of the New Development Impacts Study in the Santa Clara Watershed was to evaluate the effectiveness of the Standard Urban Stormwater Mitigation Plan (SUSMP) Best Management Practices at reducing pollutants in stormwater runoff. While the evaluation was

planned to be accomplished by comparing the water quality of runoff from a new development constructed in accordance with SUSMP requirements to a development similar in size and land use constructed prior to the adoption of SUSMP requirements, suitable developments could not be found. Instead, a water quality model will be developed to predict SUSMP BMP effectiveness. Model calibration and development will start in the 2005-2006 storm season.

3.3.2 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. In 2002-2003 and 2003-2004, approximately ten stream reaches in catchments with varying degrees of urbanization were selected for evaluation of their morphometric attributes. The reaches were selected to represent the various geomorphic channel types in the study area and were used to help classify stream and establish baseline conditions for each stream class.

In June 2005, the final report was forwarded to the RWQCB. The report can be viewed at ftp.sccwrp.org/pub/download/pdfs/450_peak_flow.pdf. The report's executive summary is included in Appendix B.

3.3.3 Stormwater BMP Effectiveness Study

The goal of this project is to assess the effectiveness of BMPs for reducing the concentration of pollutants in stormwater. Collaborative monitoring programs will be established with local research and stormwater management agencies that will be implementing BMPs in the southern California coastal area. Samples of stormwater from upstream and downstream of the BMP will be analyzed for pollutant concentrations from flow-weighted composites collected upstream and downstream (or down-gradient) from each BMP.

Five different types of BMP's are being analyzed at sites throughout Los Angeles County: catch basin inserts, hydrodynamic separator, enhanced manhole, vegetated swale and infiltration. The latter BMP is being analyzed through DPW's involvement in the Los Angeles/San Gabriel Rivers Watershed Council's Water Augmentation Study.

To date, LACDPW has monitored fifteen storm events. Sampling and analysis will continue through the 2005-2006 storm season.