Carlsbad Watershed Management Area (WMA)
Receiving Water Monitoring Program

Monitoring Plan

Prepared For:
County of San Diego Carlsbad WMA Principal Copermittees

Based Upon:
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LIST OF ACRONYMS AND ABBREVIATIONS

>	less than
<	greater than
AFDM	ash-free dry mass
APHA	American Public Health Association
AWWA	American Water Works Association
BMI	benthic macroinvertebrate
BOD	biochemical oxygen demand
BSA	bovine serum albumin
Caltrans	California Department of Transportation
CDFG	California Department of Fish and Game
CEDEN	California Environmental Data Exchange Network
COC	chain of custody
cm^2	square centimeter
CRAM	California Rapid Assessment Method
CSBP	California Stream Bioassessment
EDD	electronic data deliverable
EDTA	ethylenediaminetetraacetic acid
ELAP	Environmental Laboratory Accreditation Program
GIS	geographic information system
GPS	Global Positioning System
IBI	Index of Biological Integrity
ID	identification
m	meter
mL	milliliter
MLS	Mass Loading Station
mm	millimeter
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
PBO	piperonyl butoxide
Permit	San Diego Regional Water Quality Control Board Order Number R9-2013-0001, National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for Discharges from the Municipal Separate Storm Sewer Systems (MS4s) Draining the Watersheds Within the San Diego Region
pH	hydrogen ion concentration
PVC	polyvinyl chloride

O/E	observed to expected
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RWQCB	Regional Water Quality Control Board
SAFIT	Southwest Association of Freshwater Invertebrate Taxonomists
SCCWRP	Southern California's Coastal Water Research Project
SDCRC	San Diego County Regional Copermittees
EC-MLS	Escondido Creek Mass Loading Station
SDWQCB	San Diego Regional Water Quality Control Board
SMC	Stormwater Monitoring Coalition
SOP	standard operating procedure
SPE	solid phase extraction
STS	sodium thiosulfate
SWAMP	Surface Water Ambient Monitoring Program
TIE	toxicity identification evaluation
TMDL	total maximum daily load
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
WEF	Water Environment Federation

1 INTRODUCTION

The purpose of this Monitoring Plan is to describe the long-term receiving water monitoring, as required by the San Diego Regional Water Quality Control Board (RWQCB) Order No. R9-2013-0001, *National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for Discharges From the Municipal Separate Storm Sewer Systems (MS4s) Draining the Watersheds Within the San Diego Region*, hereafter referred to as the Permit. The goal of the Carlsbad Watershed Management Area (WMA) Receiving Water Monitoring Program is to characterize current conditions and assess progress in the receiving waters, and effectiveness of water quality improvement strategies implemented as part of the Carlsbad Watershed Management Area (WMA) Water Quality Improvement Plan.

1.1 PROGRAM OVERVIEW

The Receiving Water Monitoring Plan includes the following monitoring to satisfy the requirements of Provision D of the Permit:

- Long-term dry and wet weather receiving water monitoring at two mass loading stations (MLSs) in accordance with the Permit (Provisions D.1.b, c, and d)
- Rapid stream bioassessment and in accordance with the Permit (Provision D.1.c.(5)) which includes Regional monitoring participation in the Stormwater Monitoring Coalition (SMC) Regional Monitoring Program and Southern California Bight Regional Monitoring Program (Provision D.1.e.(1))
- Continue dry weather hydromodification monitoring in accordance with the Permit (Provision D.1.c.(6))

1.2 MONITORING LOCATIONS

The Responsible Agencies within the Carlsbad WMA include the following municipalities; City of Carlsbad, City of Encinitas, City of Escondido, City of Oceanside, City of San Marcos, City of Solana Beach, City of Vista and the County of San Diego. The Carlsbad WMA Responsible Agencies have selected the Escondido Creek Mass Loading Station (MLS) (EC-MLS) and Buena Vista Creek (BV-MLS) as the long-term receiving water monitoring locations. EC-MLS is a natural channel located in the City of Encinitas and BV-MLS is a concrete-lined channel in the City of Vista. . Location details are provided in Table 1-1. A map of the location is presented in Figure 1-1.

Table 1-1. Long-term Receiving Water Monitoring Location[1]

Watershed	Station ID	Latitude	Longitude	Cross Street Description	Channel Type	Jurisdiction
Carlsbad WMA	EC-MLS	33.048290	-117.22603	El Camino Del Norte Bridge	Natural Channel	City of Encinitas
Carlsbad WMA	BV-MLS	33.18263	-117.28394	At Buena Vista Creek, south of east terminus of Tiberon Dr.	Concrete-lined Channel	City of Vista

[1] As defined in the Transitional Receiving Water Monitoring Work Plan (San Diego County Regional Copermittees [SDCRC], 2014)

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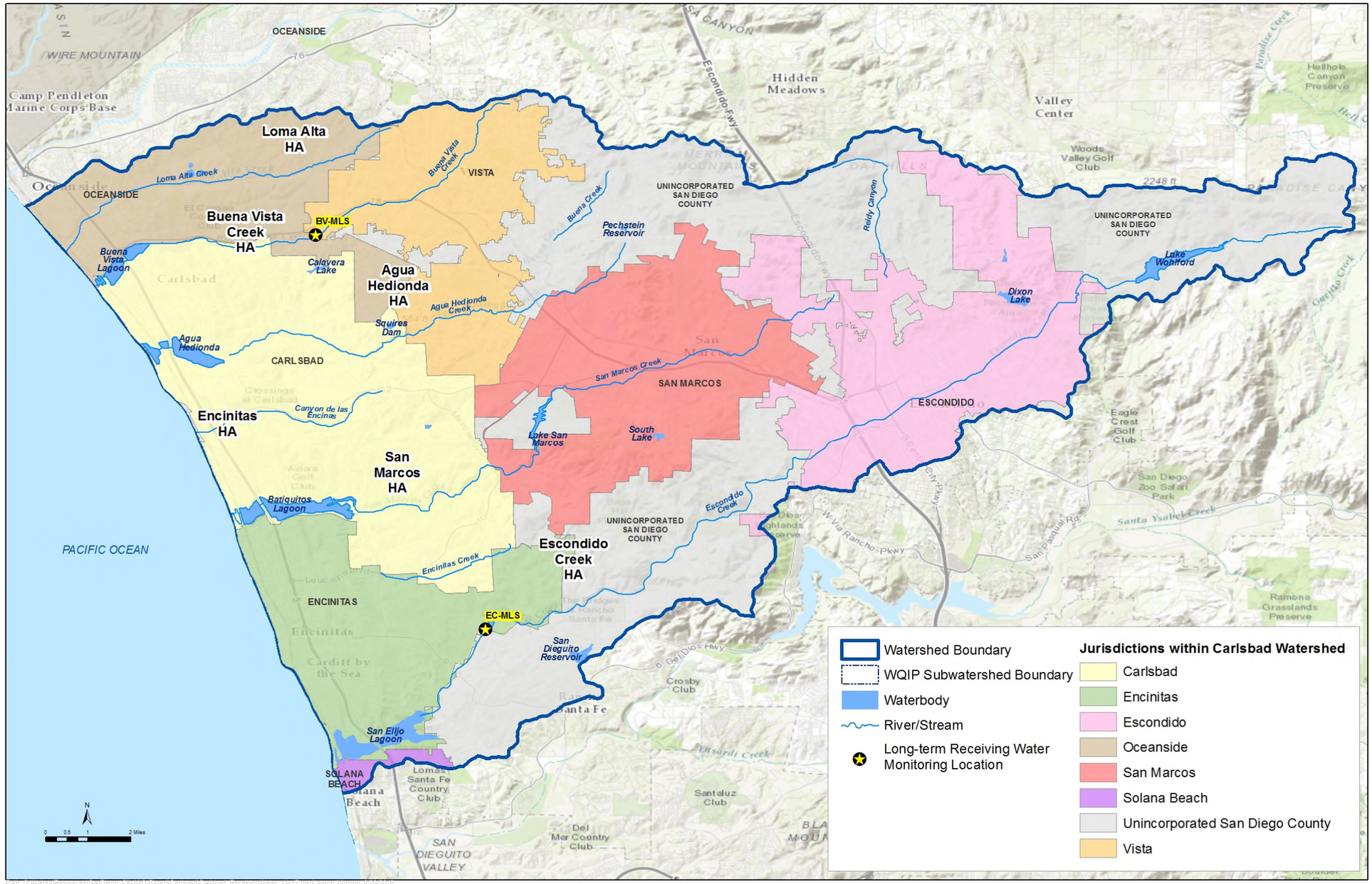

Figure 1-1. Long-term Receiving Water Monitoring Location

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2 MONITORING METHODS

This section describes monitoring methods and procedures used to implement the long-term receiving water monitoring program. Long-term receiving water monitoring will be conducted at the MLS for the Carlsbad WMA, in accordance with the Permit (Provisions D.1.b, c, and d).

2.1 WATER QUALITY SAMPLING

This section discusses the sampling procedures and analytical methods for water quality sampling. All sampling and analyses conducted for long-term receiving water monitoring locations will be in accordance with applicable United States Environmental Protection Agency (USEPA) regulations and guidance. Attachment A provides a complete list of constituents, potential methods, sample volumes, holding times, and target reporting limits for the Carlsbad WMA Receiving Water Monitoring Program.

2.1.1 DRY WEATHER

Each long-term monitoring location will be monitored during three dry weather events: once during September prior to the start of the wet season, once during a dry period in the wet season, and once in May or June after the end of the wet season. Dry weather monitoring will be conducted in days with less than 0.1 inches of rainfall and 72 hours of antecedent dry conditions.

In the event that dry weather flow is not observed at a station during the September monitoring event prior to the start of the wet season, the first dry weather sampling event will occur during a qualifying event (e.g., at least 72 hours after a storm event) if dry weather flow is observed during the wet season.

2.1.2 WET WEATHER

Each long-term station will be monitored during three wet weather events: during the first viable rainfall event of the wet season on or after October 1, during one event at least 30 days after the first rainfall event, and during one rainfall event after February 1. A flow- or time-weighted composite will be collected.

2.1.3 FLOW MONITORING

Flow rates may be monitored using American Sigma (or comparable) flowmeters with an ultrasonic sensor, bubbler, or submerged pressure transducer as the primary measuring device. The primary sensor will continuously measure stage (i.e., stream height) and relay that information to the flowmeter. The flowmeter will continually calculate flow rates by inserting the stage information into the preprogrammed discharge equation. Using this system, the flowmeter will be able to actuate the sampler to achieve a flow-weighted composite sample, if desired. Sampling and flow equipment will be monitored remotely, and data will be transferred to a permanent data system by cellular modem or manual download.

Equipment installed and used for monitoring during dry weather will remain in place for at least the duration of the monitoring event. The monitoring year is approximately October 1 through

September 30. If collected, continual flow data will be downloaded remotely from each station once every two weeks to verify equipment functionality and to reduce data gaps, ensure accuracy, and identify maintenance and calibration needs. Flow data will be entered into the data management system. Equipment will be maintained throughout this period to ensure that it is in proper working order. Additional flow monitoring details, including example methods used for stream rating and channel surveys, are provided in Attachment B.

2.1.4 GRAB SAMPLES

Grab samples will be collected for those constituents that are not amenable to composite sampling. Per the Permit, the constituents to be collected as grab samples are indicated in Attachment A and include:

- Temperature
- Hydrogen ion concentration (pH)
- Specific conductance
- Dissolved oxygen
- Turbidity
- Total coliform
- Fecal coliform
- *Enterococcus*

Samples will be collected from the horizontal and vertical center of the channel if possible and will be kept clear of uncharacteristic floating debris.

Microbiology samples will be collected using sterile techniques. Nitrile or latex-type gloves will be worn during sample handling. During the sample event, a 100-milliliter (mL) sterile bacteria bottle will be used to collect the sample directly from the receiving water. Care will be employed to not allow contact with area structures or bottom sediments. The container will be opened only for the time needed to collect the sample and will be closed immediately following sample collection. If it is suspected that the container was compromised at any time, the sample container will be discarded, and a new sample will be collected using a new sample bottle. The sample must be filled only to the 100-mL mark on the sample bottle (not over-topped or under-filled).

Field measurements will be performed for pH, specific conductance, temperature, dissolved oxygen, and turbidity using a water quality probe or similar device. Calibration of the instruments will be conducted prior to each sampling event in accordance with the manufacturer's specifications and calibrated following each sampling event. Calibration records will be kept on file.

A field observation data sheet will be completed for each sample collected to be representative of station conditions. Field observations include trash assessments, which will be performed at each station in accordance with the *Monitoring Workplan for the Assessment of Trash in San Diego County* (SDCRC, 2007a).

2.2 COMPOSITE SAMPLES

A flow- or time-weighted composite sample will be collected at each station during the dry weather and wet weather monitoring events. During the monitoring event, sample aliquots will be collected in proportion to the rate of flow (i.e., flow-weighted) using automated equipment and Teflon-lined tubing. Dry weather flow-weighted composite samples will be collected over a typical 24-hour period, with a minimum of three sample aliquots collected per hour. Wet weather flow-weighted composite samples will be collected by taking sample aliquots across the hydrograph of the storm event. Based on the anticipated size of the storm, a flow-proportioned pacing will be programmed into the automated sampling equipment. The first sample aliquot will be taken at or shortly after the time that stormwater runoff begins, and each subsequent aliquot of equal volume will be collected every time the pre-selected flow volume (flow-proportional pacing) discharges past the monitoring location. Some variation may occur depending on actual storm intensity and duration.

The flow-weighted composite samples will be analyzed for all the constituents not identified for grab sampling. The complete list of constituents for the Carlsbad WMA for dry weather and wet weather is provided in Attachment A.

2.3 SAMPLE ANALYSIS

Samples will be analyzed for the bacteria, chemistry, toxicity, and general field parameters provided in Attachment A. Attachment A includes the methods and target reporting limits for each constituent. Chemical, toxicity, and bacterial analysis of samples will be performed by a laboratory certified for the appropriate fields of testing by the California Environmental Laboratory Accreditation Program (ELAP). The laboratory(s) will also be a participant in the SMC Intercalibration Program.

General physical and chemical constituents will be analyzed by accredited laboratories, with the exception of field-measured constituents (i.e., pH, specific conductance, temperature, turbidity, and dissolved oxygen). Field measurements will be collected by field staff during sampling activities using an YSI 6600 series water quality probe or similar type device.

2.4 QUALITY ASSURANCE / QUALITY CONTROL

Quality assurance (QA) and quality control (QC) for sampling processes will include proper collection of the samples to minimize the possibility of contamination. All samples will be collected in laboratory-supplied, laboratory-certified, contaminant-free sample bottles. Field staff will wear powder-free nitrile or similar gloves at all times during sample collection.

QC samples will be collected to ensure that valid data are collected. Depending on the parameter, QC samples will consist of blanks and duplicate samples to remain compliant with Surface Water Ambient Monitoring Program (SWAMP) protocols. QC requirements will be reviewed and discussed with the appropriate staff to verify the proper working order of equipment, refresh monitoring personnel in monitoring techniques, and determine whether the data quality objectives are being met.

The QA objectives for analyses conducted by the participating analytical laboratories are detailed in their Laboratory QA Manuals. The objectives for accuracy and precision involve all aspects of the testing process, including the following:

- Methods and standard operating procedures (SOPs)
- Calibration methods and frequency
- Data analysis, validation, and reporting
- Internal QC
- Preventive maintenance
- Procedures to ensure data accuracy and completeness

The results of the laboratory QC analyses will be reported with the final data. Any QC samples that fail to meet the specified QC criteria in the methodology will be identified, and the corresponding data will be appropriately qualified in the final report. All QA/QC records for the various testing programs will be kept on file for review by regulatory agency personnel.

2.4.1 TRAINING AND CERTIFICATION

All field personnel will have current and relevant experience in all aspects of standard field monitoring, including use of relevant field equipment such as field instruments and monitoring equipment. Field personnel will be trained and will have experience in the sample collection and handling/storage, and chain-of-custody procedures. Proper field sampling and sample-handling techniques will be reviewed prior to sampling, and only those staff with proficiency will be permitted to conduct the field work. Training will be documented in the health and safety plan for each member of the field team.

All personnel are responsible for complying with the QA/QC requirements that pertain to their organizational/technical functions. Each technical staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of his or her particular function and a general knowledge of laboratory operations, test methods, QA/QC procedures, and records management.

2.4.2 CHAIN-OF-CUSTODY PROCEDURES

Samples will be considered to be in custody if they are (1) in the custodian's possession or view, (2) retained in a secured place (under lock) with restricted access, or (3) placed in a container and secured with an official seal such that the sample could not be reached without breaking the seal. The principal documents used to identify samples and to document possession will be chain-of-custody (COC) records, field logbooks, and field tracking forms. COC procedures will be used for samples throughout the collection, transport, and analytical process.

COC procedures will be initiated during sample collection. A COC record will be provided with each sample or group of samples. Each person who will have custody of the samples will sign the form and ensure that the samples will not be left unattended unless properly secured. Documentation of sample handling and custody includes the following:

- Sample identifier
- Sample collection date and time
- Any special notations on sample characteristics or analysis
- Initials of the person collecting the sample
- Date the sample was sent to the analytical laboratory
- Shipping company and waybill information

Completed COC forms will be placed in a plastic envelope and kept inside the cooler containing the samples. Once delivered to the analytical laboratory, the COC form will be signed by the person receiving the samples. The condition of the samples will be noted and recorded by the receiver. COC records will be included in the final reports prepared by the analytical laboratories and are considered an integral part of the report. An example chain of custody form is provided in Attachment C

2.4.3 FIELD QUALITY CONTROL

For all conventional water quality analyses except field measurements performed on grab samples, field blanks and field duplicates will be analyzed in accordance with SWAMP guidelines as described in Attachment B.2.i(1) of the Permit.

For toxicity testing, only field duplicates will be collected. The use of controls and reference toxicant testing are QA/QC measures that have been put in place to identify changes in test organism sensitivity due to stress or other factors.

2.4.4 EQUIPMENT CALIBRATION

All instruments used for field and laboratory analyses will be calibrated in accordance with the manufacturer's specifications. Calibration of the flow monitoring and sampling equipment will be conducted immediately prior to deployment or use and will be field verified during each data download or sampling event. The calibrations will be conducted in accordance with the manufacturer's specifications.

Field measurements for pH, specific conductance, dissolved oxygen, turbidity, and temperature will be made using a water quality probe in accordance with the manufacturer's specifications. The water quality probe will be calibrated with calibration solutions, and it will be verified that the expiration date has not been exceeded.

2.4.5 EQUIPMENT DECONTAMINATION AND CLEANING

QA/QC for sampling processes begins with proper collection of the samples to minimize the possibility of contamination. All water samples will be collected in laboratory-certified, contaminant-free bottles. Appropriate sample containers and field measurement and sampling gear

will be transported to the sampling location in clean storage containers. Field measurements will be taken and recorded using the appropriate decontaminated equipment. If sampling poles are used for collecting water samples, they will be decontaminated between sampling locations.

2.5 TOXICITY IDENTIFICATION EVALUATIONS

Provision D.1.c(4)(f) of the Permit requires that the Copermittees discuss the need for conducting a Toxicity Identification Evaluation (TIE)/Toxicity Reduction Evaluation (TRE) if chronic toxicity is detected in receiving waters. A TIE is a set of procedures to identify specific chemicals or conditions responsible for toxicity; a TRE is a study designed to identify causative agents of effluent or ambient toxicity, isolate its sources, evaluate effectiveness of toxicity control options, and confirm reduction of toxicity. A work plan that outlines the process to identify chronic toxicity and prioritize the need to implement a TIE/TRE based on the magnitude and persistence of chronic toxicity is included as Attachment D.

2.6 DRY WEATHER HYDROMODIFICATION MONITORING

This section describes the sampling and data collection methods for the dry weather receiving water hydromodification monitoring requirements as outlined in Provision D.1.c.(6) of the Permit.

In addition to the hydromodification monitoring conducted as part of the Responsible Agencies' Hydromodification Management Plans, hydromodification monitoring for EC-MLS is required at least once during the Permit term. The Responsible Agencies must collect the following hydromodification monitoring observations and measurements within an appropriate domain of analysis during at least one dry weather monitoring event for each long-term receiving water monitoring location:

- Channel conditions, including: Channel dimensions, hydrologic and geomorphic conditions, and presence and condition of vegetation and habitat
- Location of discharge points
- Habitat integrity
- Photo documentation of existing erosion and habitat impacts, with location (i.e., latitude and longitude coordinates) where photos were taken
- Measurement or estimate of dimensions of any existing channel bed or bank eroded areas, including length, width, and depth of any incisions
- Known or suspected cause(s) of existing downstream erosion or habitat impact, including flow, soil, slope, and vegetation conditions, as well as upstream land uses and contributing new and existing development

The monitoring will coincide with the spring receiving water dry weather monitoring event in May or June and the dry weather receiving water bioassessment monitoring. The domain of analysis at each long-term monitoring location for dry weather hydromodification monitoring will be within the same reach of the channel as that used for dry weather bioassessment monitoring.

Table 2-1 provides an outline of the hydromodification monitoring requirements and the methods for each assessment category. Detailed methods for each assessment category are described in the following sections.

Table 2-1. Hydromodification Monitoring Requirements

Assessment Requirement Category	Method
Channel Conditions	
Channel Dimensions	Channel survey (cross-sectional and thalweg survey)
Hydrologic and geomorphic conditions	Southern California Coastal Water Research Project (SCCWRP) channel assessment tool
Presence and condition of vegetation and habitat	California Rapid Assessment Method (CRAM)
Location of discharge points	Table of MS4 outfalls to stream segment
Habitat integrity	CRAM
Photo documentation of existing erosion and habitat impacts, with location (i.e., latitude and longitude coordinates) where photos were taken	Channel survey and photo documentation
Measurement of estimate of dimensions of any bed or bank eroded areas, including length, width, and depth of any incisions	Channel survey
Known or suspected cause(s) of existing downstream erosion or habitat impact, including flow, soil, slope, and vegetation conditions, as well as upstream land uses and contributing new and existing development	Geographic information system (GIS) desktop analysis and SCCWRP channel assessment tool

2.6.1 Channel Dimensions

Channel surveys will be conducted at each monitoring location to gather basic hydraulic measurements of the receiving water channels. Channel surveys will be conducted using a DeWalt self-leveling rotary laser. The cross-section survey involves placing endpoints at the highest point of the channel on each bank. A measuring tape will be stretched between the endpoints such that the zero end of the tape is attached to the endpoint on the left bank of the channel (looking downstream). Channel depth will be measured across the channel from a stadia rod that is vertical and level from the channel bottom. The channel surveys will be conducted for the reach upstream and downstream of the cross-section. The average channel slope will be calculated from the survey data.

2.6.2 Hydrologic and Geomorphic Conditions

The geomorphic assessment will be conducted to characterize the susceptibility of the channel and gather basic hydraulic measurements of the receiving water channels. The geomorphic assessment comprises the channel survey and the Southern California Coastal Water Research Project (SCCWRP) channel assessment tool. The SCCWRP Field Manual (Bledsoe et al., 2010) will be used to assess the vertical and lateral susceptibility of the receiving water channels. The domain of analysis for each monitoring location is derived from the desk and field components of the screening tool and will be within reach of the channel used for dry weather bioassessment monitoring. A suite of field measurements will also be made to characterize the channel bed and banks, and overall stability state. Sediment samples will be collected to characterize bed materials. Fixed-interval pebble counts will be performed for each reach where the channel bed is composed of gravel or

coarser material (Bunte and Abt, 2001), and channel beds composed of fine material will be noted as sand or cohesive materials (bed gradations are not required for channels with D50 less than (<) 2 millimeters [mm]).

2.6.3 Presence and Condition of Vegetation and Habitat Integrity

The presence and condition of vegetation and habitat integrity will be determined from the data collected during dry weather bioassessment monitoring. For dry weather bioassessment monitoring, the sampling will follow the protocols previously outlined in Section 2.5. Physical habitat quality assessments of the monitoring locations using the California Rapid Assessment Method (CRAM) will provide a numerical summary score of the physical conditions for each monitoring location. This method involves assessing the quality of the in-stream habitat features as well as the buffer zones (250 meters perpendicular to flow from each bank and 500 meters upstream and downstream of the monitoring reach), hydrologic source quality, and biotic structure quality. For each monitoring reach sampled, the physical habitat of the stream and its adjacent banks will be assessed to provide a record of the overall physical condition of the reach. Parameters such as substrate complexity, channel alteration and human influence, frequency of riffles, and width and quality of riparian zones will provide a more comprehensive understanding of the condition of the stream. Additionally, specific characteristics of the sampled riffles will be measured, including substrate size classes, stream depth, gradient, sinuosity, and flow volume. A final CRAM score will be calculated that can range from 25 to 100 points, with higher scores indicating higher quality conditions. CRAM ratings of good, fair, and poor are defined by the score (i.e., for the CRAM score range of 25-100, <50=low, 50-75=moderate, and >75=high).

2.6.4 Photo Documentation

A channel survey will be conducted and photographs will be used to document the conditions in the receiving water channels, including any existing erosion and habitat impacts. Photographs will be taken using a digital camera with a built-in Global Positioning System (GPS), altimeter, and compass. Photo documentation will be conducted using the general procedures outlined in San Diego Water Board Stream Photo Documentation Procedures for 401 Water Quality Certifications Standard Operating Procedure.

The following information will be recorded for each photograph:

- Project name
- General location
- Photographer and team members
- Photo number
- Date
- Time

At a minimum, photographs will be taken of the following:

- Long view up or down the stream (from stream level) showing changes in the stream bank and vegetation
- Long view and medium view of streambed changes (e.g., thalweg, gravel, meanders)
- Long views from a bridge or other elevated position
- Medium and close views of structures and plantings
- Medium views of bars and banks, with a person (preferably holding a stadia rod) in view for scale
- Close views of streambed with a ruler or other common object in the view for scale

2.6.5 Dimensions of Bed or Bank Eroded Areas

Measurements or estimates of dimensions of any bed or bank eroded areas, including length, width, and depth of any incisions, will be conducted during the channel survey. Bed or bank eroded areas will be documented with photographs as described in the channel survey section above.

2.6.6 Location of Discharge Points/Known or Suspected Causes of Erosion or Habitat Impact

Known or suspected cause(s) of existing downstream erosion or habitat impact, including flow, soil, slope, and vegetation conditions, as well as upstream land uses and contributing new and existing development, will be assessed during a GIS desktop exercise and the SCCWRP channel assessment tool.

2.7 Dry Weather Receiving Water Bioassessment Monitoring

Dry weather receiving water bioassessment monitoring will be conducted in accordance with the Permit (Provisions D.1.a.(1), D.1.a.(3)(a), D.1.c.(5), and D.1.e.(1)(a)). Dry weather receiving water bioassessment monitoring will include bioassessment at each long-term receiving water monitoring location and participation in the SMC Regional Monitoring Program. Bioassessment surveys will be conducted during the spring/summer dry season bioassessment index period, typically from May through July. Benthic macroinvertebrates (BMIs) and physical habitat data will be collected following the *SWAMP Bioassessment Procedures: Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California* (Ode, 2007) using the reach-wide benthos method. Benthic algae (i.e., periphyton) monitoring will be conducted in accordance with the *SWAMP Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Bioassessments in California* (Fetscher et al., 2009). Samples will be collected and processed for ash-free dry mass (AFDM), chlorophyll-a analysis, and periphyton taxonomy. Reach-wide algal cover will be quantified as part of the SWAMP physical habitat assessment. Physical habitat quality of the monitoring locations will be quantified using CRAM for riverine wetlands (Collins et al., 2012).

The SWAMP sampling protocol includes the collection of stream BMI and also assesses the physical quality and condition of the streambed and banks in detail. (Note: A physical habitat index based on

the SWAMP procedure has not been developed at the time of this report). CRAM assessments incorporate broader buffer zone and land use attributes than do SWAMP assessments, and also provide a numerical quality score for each monitoring location. BMIs reside in streams for periods ranging from a month to several years, and have varying sensitivities to the multiple stressors associated with urban runoff. Using species-specific tolerance values and community species composition, numerical biometric indices are calculated, allowing for comparison of relative habitat health among streams in a region. By assessing the invertebrate community structure of a stream, a cumulative measure of stream habitat health and ecological response is obtained.

The data include a taxonomic listing of all BMIs identified in the surveys, and calculation of the biological metrics listed in the California Stream Bioassessment Procedure (CSBP). Additionally, calculation of two indices that rate the overall BMI community quality will be performed. These include the Index of Biotic Integrity (IBI) (Ode et al., 2005) and the observed to expected (O/E) ratio of taxa (Hawkins, Western Center for Monitoring and Assessment, 2010).

2.7.1 2015 SMC Regional Monitoring Program

The 2015 SMC Regional Monitoring Program is currently being developed. The SMC Bioassessment Technical Workgroup is working to determine which components of the 2009-2013 SMC Regional Monitoring Program were effective tools for achieving the program's goals and what monitoring elements may be suspended or added for future assessments. Beginning in 2015, SMC will confirm the monitoring locations under this program.

2.7.2 Monitoring Reach Delineation

Using SWAMP methodology, every monitoring reach is 150 meters in length and will be sampled from downstream to upstream. If a portion of a reach is inaccessible, the reach length may be reduced to as little as 100 meters. The bioassessment reaches are placed as closely as possible to the water quality and flow monitoring locations.

2.7.3 Macroinvertebrate Sample Collection

BMI samples will be collected at evenly spaced 15-meter transects for a total of 11 transects in the 150-meter reach. The samples will be collected in an alternating margin-center-margin pattern. Collections will be made using a 1-foot-wide, 0.5-millimeter (mm)-mesh, D-frame kick-net. A 1-square-foot area upstream of the net will be sampled by disrupting the substrate and scrubbing the cobble and boulders, so that the organisms will be dislodged and swept into the net by the current. The duration of the sampling generally ranges from 1 to 3 minutes, depending on the substrate complexity. Every monitoring location will be sampled from downstream to upstream. The samples will be combined into a single composite sample for the reach, transferred to 1-quart jars, preserved with 95 percent ethanol, and returned to the laboratory for processing. Photographs will be taken of every monitoring location.

2.7.4 Multihabitat Periphyton Sample Collection

Periphyton (benthic algae) will be collected using the reach-wide procedure and within the same transects used for BMI collection, but offset 1 meter upstream to avoid disturbed substrate.

Depending on the substrate type and the stream habitat, one of three sampling devices will be used to collect the substrate sample: a 12.6-square centimeter (cm^2) rubber delimiter, a 4-centimeter (cm) diameter polyvinyl chloride (PVC) delimiter, or a syringe scrubber.

After all transects are sampled, the subsamples will be composited. The macroalgae will be gathered and separated from the composited liquid. A subsample of the macroalgae will be taken for the soft-bodied taxonomic identification sample. The composite liquid volume will be recorded, and the remaining macroalgae will be finely cut up and thoroughly mixed with the composite liquid. The homogenized sample will be used for the diatom taxonomic identification sample, as well as the two filtered biomass samples. The diatom and soft-bodied algae samples will be fixed accordingly before being delivered to the laboratory for taxonomic identification. Taxonomic identification will be performed by a qualified taxonomist. The remaining homogenized portion of the composite will be filtered in the field, and the filters will be placed on ice and/or frozen until delivery to the chemistry laboratory for chlorophyll-a and ash-free dry mass analysis.

A separate soft-bodied algae sample will be collected for qualitative taxonomic identification. The qualitative sample consists of a composite of all soft-bodied algae found within the reach. The sample will be left unpreserved and put on ice or refrigerated until delivery to the laboratory for taxonomic identification. Qualitative taxonomic identifications will be performed by a qualified taxonomist for the receiving water and SMC monitoring locations.

2.7.5 Physical Habitat Quality Assessment

For each monitoring reach sampled, the physical habitat of the stream and its adjacent banks will be assessed to provide a record of the overall physical condition of the reach. Parameters such as substrate complexity, channel alteration and human influence, frequency of riffles, and width and quality of riparian zones will provide a more comprehensive understanding of the condition of the stream. Additionally, specific characteristics of the sampled riffles will be measured, including substrate size classes, stream depth, gradient, sinuosity, and flow volume.

CRAM assessments of each monitoring location also will be performed. This method assesses the quality of the in-stream habitat features as well as the buffer zones (250 meters perpendicular to flow from each bank and 500 meters upstream and downstream of the monitoring reach), hydrologic source quality, and biotic structure quality. A final CRAM score will be calculated that can range from 25 to 100 points, with the higher scores indicating higher quality conditions.

Water quality measurements will be taken at each of the monitoring locations using a YSI Model 6600 (or comparable) data sonde. Measurements will include water temperature, specific conductance, pH, and dissolved oxygen. Samples will be collected for laboratory analysis following the protocols outlined in the SMC Regional Monitoring Program Workplan. Stream flow velocity will be measured with a Marsh-McBirney Model 2000 (or comparable) portable flowmeter, or will be visually estimated when the water is too shallow for the flowmeter.

2.7.6 Laboratory Processing and Analysis

Laboratory processing of BMI samples will follow the SWAMP Bioassessment Procedures: *Standard Operating Procedures for Laboratory Processing and Identification of Benthic Macroinvertebrates in*

California (Woodward et al., 2012). At the laboratory, samples are poured over a No. 35 standard testing sieve (0.5-mm stainless-steel mesh), and the ethanol is retained for reuse. The sample is gently rinsed with fresh water, and large debris such as wood, leaves, or rocks are removed. The sample is transferred to a tray marked with grids approximately 50 cm^2 in size. One grid is randomly selected, and the sample material contained within that grid is removed and processed. In cases where the test organisms appear extremely abundant, a fraction of the grid may be removed.

The material from the grid is examined under a stereomicroscope, and all the invertebrates are removed, sorted into major taxonomic groups, and placed in vials containing 70 percent ethanol. If there are less than 600 test organisms in the grid, another grid is selected and processed. This process is repeated until 600 organisms are removed from the sample, or until the entire sample is sorted. Organisms from a grid in excess of 600 are also removed, counted, and recorded as "remaining test organisms," so that estimated total organism abundance and density for the sample can be calculated. Terrestrial organisms, vertebrates, water-column associated organisms (e.g., copepods), and nematodes are not removed from the samples. Processed material from the sample is placed in a separate jar and labeled "sorted," and the unprocessed material is returned to the original sample container and archived. Sorted material is retained for QA purposes. All organisms are identified to Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) standard taxonomic effort Level II (SAFIT, 2006).

2.7.7 QUALITY ASSURANCE/QUALITY CONTROL

QA/QC procedures for the Bioassessment Monitoring and SMC Program will be consistent with those outlined in Section 2.2.4. In addition, QA of the benthic infauna sample sorting will be performed on all of the samples to ensure at least a 90 percent removal rate of organisms. Organisms removed during sorting QA also will be identified. Taxonomic QA will be performed on 10 percent of the samples.

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3 DATA MANAGEMENT, ASSESSMENT, AND REPORTING

The Monitoring and Assessment Annual Report, which will be submitted to the RWQCB on January 31 annually, will include descriptions of monitoring conducted during the applicable monitoring year.

3.1 DATA MANAGEMENT

Field Data Records and Analytical Data Reports will be sent to and kept by the Program Manager or specified contracted agency. Data will be submitted in a standardized California Environmental Data Exchange Network (CEDEN)-compatible format to the Lead Agency for their records.

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ATTACHMENT A
DRY WEATHER AND WET WEATHER CONSTITUENTS, POTENTIAL METHODS, VOLUMES, HOLDING TIMES, AND TARGET REPORTING LIMIT

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Table A-1. Analyte List for Long-Term Receiving Water Monitoring

Analyte	Volume Required	Potential Analytical Method*	Target Reporting Limit	Units	Max Holding Time	Dry Weather Monitoring	Wet Weather Monitoring
Conventional Parameters							
Dissolved Organic Carbon	250 mL	SM 5310 C	0.50	mg/L	28D	X[3,8]	X[8]
Dissolved Oxygen	In field	Meter	0.01	mg/L	NA	X[1,2,3,5C]	X[1,2,8]
MBAS	500 mL	SM 5540C	0.05	mg/L	48H	X[5C,6]	X[6]
pH	In field	Meter	0.01	pH	NA	X[1,2,3,5B,5C]	X[1,2,8]
Specific Conductivity	In field	Meter	1	µS/cm	NA	X[1,2]	X[1,2,8]
Sulfates	250 mL	USEPA 300.0	0.5	mg/L	28D	X[4,6]	X[4,6]
TDS	500 mL	SM 2540C	10	mg/L	7D	X[4,6]	X[4,6]
Temperature	In field	Meter	0.1	◦C	NA	X[1,2]	X[1,2,8]
Total Hardness	Calculation	SM 2340B	0.662	mg/L	NA	X[6]	X[6,8]
Total Organic Carbon	250 mL	SM 5310 C	0.30	mg/L	28D	X[3,6]	X[6]
TSS	1000 mL	SM 2540D	5	mg/L	7D	X[4,6]	X[4,6]
Turbidity	250 mL	Meter	0.1	NTU	NA or 48H	X[1,2,4,5B,5C,6]	X[1,2,4,6,7,8]

Table A-1. Analyte List for Long-Term Receiving Water Monitoring (Continued)

Analyte	Volume Required	Potential Analytical Method*	Target Reporting Limit	Units	Max Holding Time	Dry Weather Monitoring	Wet Weather Monitoring
Indicator Bacteria							
Enterococcus	100 mL	SM 9230C	20	MPN/100mL	8H	X[3,4,5A,5B,5C,6]	X[3,4,6,8]
Fecal Coliform	100 mL	SM 9221E	20	MPN/100mL	8H	X[3,4,5A,5B,5C,6]	X[3,4,6,8]
Total Coliform	100 mL	SM 9221B	20	MPN/100mL	8H	X[3,4,5A,8]	X[3,4,6,8]
Inorganic Analytes							
Arsenic (Dissolved)	250 mL	USEPA 200.8	0.0004	mg/L	6M	X[6]	X[6]
Arsenic (Total)	250 mL	USEPA 200.8	0.0004	mg/L	6M	X[6]	X[6]
Cadmium (Dissolved)	250 mL	USEPA 200.8	0.0001	mg/L	6M	X[5B,5C,6]	X[6]
Cadmium (Total)	250 mL	USEPA 200.8	0.0001	mg/L	6M	X[5B,5C,6]	X[6,7]
Chromium (Dissolved)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[5B,5C,6,10]	X[6]
Chromium (Total)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[5B,5C,6,10]	X[6]
Chromium III (Dissolved)	NA	Calculation	NA	NA	NA	X[5B,5C]	-
Chromium III (Total)	NA	Calculation	NA	NA	NA	X[5B,5C]	-
Chromium VI (Dissolved)	250 mL	USEPA 218.6	0.0003	mg/L	28D	X[5B,5C]	-

Table A-1. Analyte List for Long-Term Receiving Water Monitoring (Continued)

Analyte	Volume Required	Potential Analytical Method*	Target Reporting Limit	Units	Max Holding Time	Dry Weather Monitoring	Wet Weather Monitoring
Chromium VI (Total)	250 mL	USEPA 218.6	0.0003	mg/L	28D	X[5B,5C]	-
Copper (Dissolved)	250 mL	USEPA 200.8	0.0005	mg/L	6M	X[5B,5C,6]	X[6]
Copper (Total)	250 mL	USEPA 200.8	0.0005	mg/L	6M	X[5B,5C,6]	X[6,7]
Iron (Dissolved)	250 mL	USEPA 200.7	0.01	mg/L	6M	X[5C,6]	X[6]
Iron (Total)	250 mL	USEPA 200.7	0.01	mg/L	6M	X[5C,6]	X[6]
Lead (Dissolved)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[5B,5C,6]	X[6]
Lead (Total)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[5B,5C,6]	X[6]
Manganese (Dissolved)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[4,5C]	X[4]
Manganese (Total)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[4,5C]	X[4]
Mercury (Dissolved)	250 mL	USEPA 245.1	0.00005	mg/L	28D	X[6]	X[6]
Mercury (Total)	250 mL	USEPA 245.1	0.00005	mg/L	28D	X[6]	X[6]
Nickel (Dissolved)	250 mL	USEPA 200.8	0.0008	mg/L	6M	X[5B,5C,6]	X[6]
Nickel (Total)	250 mL	USEPA 200.8	0.0008	mg/L	6M	X[5B,5C,6]	X[6]
Selenium (Dissolved)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[4,6]	X[4,6]
Selenium (Total)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[4,6]	X[4,6]

Table A-1. Analyte List for Long-Term Receiving Water Monitoring (Continued)

Analyte	Volume Required	Potential Analytical Method*	Target Reporting Limit	Units	Max Holding Time	Dry Weather Monitoring	Wet Weather Monitoring
Silver (Dissolved)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[5B,5C]	-
Silver (Total)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[5B,5C]	-
Thallium (Dissolved)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[6]	X[6]
Thallium (Total)	250 mL	USEPA 200.8	0.0002	mg/L	6M	X[6]	X[6]
Zinc (Dissolved)	250 mL	USEPA 200.8	0.005	mg/L	6M	X[5B,5C,6]	X[6]
Zinc (Total)	250 mL	USEPA 200.8	0.005	mg/L	6M	X[5B,5C,6]	X[6,7]
Nutrients							
Ammonia	250 mL	USEPA 350.1	0.1	mg/L	28D	X[3,4,6]	X[6]
Dissolved Phosphorus	250 mL	USEPA 365.1	0.01	mg/L	48H	X[3,4]	-
Nitrate	250 mL	USEPA 353.2	0.1	mg/L	48H	X[3,6,9]	X[6,7,9]
Nitrite	250 mL	USEPA 353.2	0.1	mg/L	48H	X[3,6,9]	X[6,7,9]
Orthophosphate	250 mL	USEPA 365.1	0.002	mg/L	48H	X[3,6]	X[6]
TKN	250 mL	USEPA 351.2	0.1	mg/L	28D	X[3,6]	X[6]
Total Nitrogen	Calculation	Calculation	NA	NA	NA	X[3,4,5C]	X
Total Phosphorus	250 mL	USEPA 365.1	0.01	mg/L	28D	X[3,4,5C,6]	X[6,7]

Table A-1. Analyte List for Long-Term Receiving Water Monitoring (Continued)

Analyte	Volume Required	Potential Analytical Method*	Target Reporting Limit	Units	Max Holding Time	Dry Weather Monitoring	Wet Weather Monitoring
Synthetic Organic Compounds							
DDT	2 L	EPA 608 low level	5.0	ng/L	7D	X[4]	X[4]
Organophosphate Pesticides	2 L	USEPA 625M	0.01	µg/L	7/40D	X[6]	X[6]
Synthetic Pyrethroids	2 L	GC/MS NCI-SIM	2-10	ng/L	7/40D	X[6]	X[6]
Toxicity							
Larval Survival and Growth with *Pimephales promelas*	15 L	EPA-821-R-02-013	NA	Pass/Fail	36H	X[4,11]	X[4,11]
Survival and Reproduction with *Ceriodaphnia dubia*	4 L	EPA-821-R-02-013	NA	Pass/Fail	36H	X[4,11]	X[4,11]
Growth with *Selenastrum capricornutum*	4 L	EPA-821-R-02-013	NA	Pass/Fail	36H	X[4,11]	X[4,11]

NA = Not applicable; mL = milliliter; L = liter; D = day; H = hour; M = month

* Potential methods are presented and Other equivalent EPA-approved methods may be substituted as long as the target reporting limits are met.

1. Parameter listed in Table D-2 of the MS4 Permit.
2. Analytes that are field measured are not required to be analyzed by a laboratory.
3. Parameter contributes to a highest priority water quality condition identified in the Carlsbad WMA Water Quality Improvement Plan.
4. Parameter listed as a cause for impairment of receiving waters in Carlsbad WMA 303(d) list.

5A. Parameter listed in NALs for discharges from MS4s to Ocean Surf Zone (MS4 Permit Provision C.1.a(1))
5B. Parameter listed in NALs for discharges from MS4s to Bays, Harbors, and Lagoons/Estuaries (MS4 Permit Provision C.1.a(2))
5C. Parameter listed in NALs for discharges from MS4s to Inland Surface Waters (MS4 Permit Provision C.1.a(3))

6 Parameter listed in Table D-3 of the MS4 Permit.

7. Parameter listed in SALs for discharges from MS4s to receiving waters (Table C-5 of the MS4 Permit).
8. Grab samples may be collected for pH, temperature, specific conductivity, dissolved oxygen, turbidity, hardness, and indicator bacteria.
9. Nitrite and nitrate may be combined and reported as nitrite+nitrate.
10. Analysis of Chromium in MS4 discharges is not explicitly required in the MS4 permit. Chromium is analyzed to calculate Chromium III.
11. Parameter listed in Table D-4 of the MS4 Permit. Long-term monitoring locations are located in freshwater so only freshwater constituents are represented.

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ATTACHMENT B
STREAM RATING AND CHANNEL SURVEY DETAILS

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STREAM RATINGS

Per the San Diego County Regional Copermittees' (SDCRC) Transitional Receiving Water Monitoring Work Plan, stream ratings may be conducted as described herein (SDCRC, 2014).

The flow rate at each of the monitoring locations will be determined by stream stage (water level) sensors that are typically secured to the bottom of the channel. To quantify flow rates on the basis of stream stage, a relationship between flow and stage will be derived using the standardized stream rating protocols developed by the U.S. Geological Survey (USGS) (Rantz, 1982; Oberg et al., 2005). Instantaneous flow measurements will be taken at various stages at each of the monitoring locations. The measurements will be combined to produce and calibrate the rating curve for each monitoring location.

To accurately measure flow in streams, the following elements are needed to develop the rating curves:

- An accurate survey of the stream channel cross-section and longitudinal slope
- Accurate level measurements based on a fixed point
- Measurements of velocity and flows at several points throughout the rating curve, including low flow, mid flow, and peak flow conditions

To measure instantaneous flows during low flow and base flow conditions, two velocity measurement instruments are typically used—a Marsh-McBirney Model 2000 Portable Flowmeter connected by a cable to an electromagnetic open channel velocity sensor and the SonTek (YSI) FlowTracker Acoustic Doppler Velocimeter. The FlowTracker is a high-precision, shallow-water flowmeter that measures velocity in three dimensions and features an automatic discharge computation.

To make an instantaneous flow measurement, a tape measure is stretched across the stream, perpendicular to flow and secured on both banks of the stream. The tape is positioned so that it is suspended approximately 1 foot above the surface of the water. The distance on the tape directly above the waterline (i.e., where the water meets the bank) is recorded as the initial point. The first measurement is made at the first point where there is adequate water depth (i.e., at least 0.2 foot) and measurable velocity. At this point, three measurements are made, including water depth, velocity, and distance from the bank (the initial point). Subsequent depth, velocity, and distance measurements are made incrementally across the entire width of the channel. Data from the field measurements are entered into a computer model that calculates the stream's cross-sectional profile from the depth and distance from bank measurements. Total flow across the channel is determined by integrating the velocity measurements over the cross-sectional surface area of the stream channel. The result is an instantaneous flow measurement in cubic feet per second.

A StreamPro Acoustic Doppler Current Profiler (ADCP) is used to measure mid- and high-stage flow conditions. The StreamPro ADCP is the USGS instrument of choice for measuring flows nationwide (Oberg et al., 2005). The instrument is pulled across the stream either by walking across a bridge or attaching the unit to a tagline. Data are collected in real time and transmitted by a wireless data link to a PC. Data can be viewed in real time and are typically post-processed following the field event in the office.

Rating curves are extended to high stream stages not measured using site-specific survey information and the Chézy–Manning formula (Linsley et al., 1982). The Chézy–Manning formula is an empirical formula for open channel flow, or flow driven by gravity, as follows:

$$Q = (1.486 / n) A R^{2/3} S^{1/2}$$

where:

- Q = flow
- n = Manning Roughness coefficient
- A = cross-sectional area
- R = hydraulic radius
- S = hydraulic slope

The hydraulic radius is derived as follows:

$$R = A/P$$

where:

- A = cross-sectional area of flow (ft2)
- P = wetted perimeter (ft)

The Chézy–Manning formula was developed for conditions of uniform flow in which the water surface profile and energy gradient are parallel to the streambed and the area, hydraulic radius, and depth remain constant throughout the reach. Field surveys of the channel geometry of each MLS will be conducted to compute the channel characteristics for each station.

CHANNEL SURVEYS

Channel surveys will be conducted at each monitoring location to gather basic hydraulic measurements of the receiving water channels and to derive stream discharge using the Chézy–Manning formula. Channel surveys will be conducted using a DeWalt self-leveling rotary laser. The cross-section survey involves placing endpoints at the highest point of the channel on each bank. A measuring tape is stretched between the endpoints such that the zero end of the tape is attached to the endpoint on the left bank of the channel (looking downstream). Channel depth is measured across the channel from a stadia rod that is vertical and level from the channel bottom. The channel thalweg surveys are conducted for the reach upstream and downstream of the cross-section. The average channel slope is calculated from the survey data.

Channel survey data are used with the Chézy–Manning formula to produce a rating curve for each sampling location. Each rating curve is calibrated using instantaneous flow measurements by adjusting the formula roughness coefficient.

UNITED STATES GEOLOGICAL SURVEY WATERSHEDS

USGS flow monitoring gauges are located in the larger watersheds, specifically Santa Margarita, San Luis Rey, Los Peñasquitos Creek, San Diego River, and Tijuana River. The USGS gauging stations are used to estimate the annual flow volumes for the watersheds. If a USGS gauging station is within relative proximity to the EC-MLS, flow data will be compared with USGS data to validate flow monitoring data collected at EC-MLS.

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ATTACHMENT C
EXAMPLE CHAIN-OF-CUSTODY FORM

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ATTACHMENT D
DRAFT TIE/TRE IMPLEMENTATION WORK PLAN

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