Carlsbad Hydrologic Unit
SDRWQCB Investigative Order R9-2006-076
Lagoon TMDL Monitoring

Quality Assurance Project Plan

City of Encinitas
505S. Vulcan Avenue
Encinitas, CA 92024

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Quality Assurance Project Plan

City of Encinitas

PROJECT: Carlsbad Hydrologic Unit, SDRWQCB Investigative Order R9-2006-076, Lagoon TMDL Monitoring

PREPARED BY: MACTEC, Inc.
9177 Sky Park Court, Suite A
San Diego, CA 92123

1. APPROVED BY:

Cynthia Gorham-Test — Date
SDRWQCB Contract Officer

Linda Pardy — Date
SDRWQCB QA Officer

Erik Steenblock, Project Manager — Date: 8/29/07
City of Encinitas

Nathan Schaedler, PE, Project Manager — Date: 8/31/07
MACTEC, Inc.

Jerome Welch, PhD, QA Officer — Date: 8/30/07
MACTEC, Inc.

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3. DISTRIBUTION LIST

The final QAPP will be kept on file at MACTEC, Inc. The following individuals will receive copies of the approved QAPP and any subsequent revisions:

Rich Gossett
CRG Marine Laboratories
2020 Del Amo Blvd. Suite 200
Torrance, CA 90501
crglabs@sbcglobal.net
310/533-5190

Jay Shrake
MACTEC, Inc.
9177 Sky Park Court, Suite A
San Diego, CA 92123
jjshrake@mactec.com
858/278-3600

Nathan Schaedler
MACTEC, Inc.
9177 Sky Park Court, Suite A
San Diego, CA 92123
NSCHAEDLER@mactec.com
858/278-3600

Lisa Dean
Analytical Chemistry Lab, Rm154
Institute of Ecology, Green Street
University of Georgia
Athens, Georgia 30602
lisadean@uga.edu
706/542-6023

Georges L. Paradis
Marine Science Institute Lab,
University of California
Santa Barbara, CA
paradis@msi.ucsb.edu
805-893-3802

Martha Sutula
SCCWRP
7171 Fenwick Lane
Westminster, CA 92683
marthas@sccwrp.org
714/755-3222

Dario Deihl
SCCWRP
7171 Fenwick Lane
Westminster, CA 92683
dariod@sccwrp.org
714/755-3212

Cynthia Gorham-Test
SDRWQCB
9174 Sky Park Ct, Suite 100
San Diego, CA 92123
CTest@waterboards.ca.gov
858/467-2957

Linda Pardy
SDRWQCB
Quality Assurance Officer
9174 Sky Park Ct, Suite 100
San Diego, CA 92123
lpardee@waterboards.ca.gov
858/627-3932

Lawrence Homna
Merkel and Associates
5434 Ruffin Road
San Diego, CA 92123
LHonma@merkelinc.com

George Wilkins
Pacific REMS
San Diego, CA
619/871-2464
gwilkins@pacific-rems.com

4. PROJECT/TASK ORGANIZATION

4.1 Involved Parties and Roles

The California Regional Water Quality Control Board, San Diego Region (SDRWQCB) has issued Investigation Order No. R9-2006-076 (IO) to the dischargers to the creeks and lagoons in San Diego County that are 303(d) listed for sediment, nutrients, TDS and bacteria. This IO requires collection of monitoring data for the development of Total Maximum Daily Loads (TMDLs) as authorized by the Clean Water Act (CWA).

A total of seven lagoons are included in the IO, however, this project includes only those in the Carlsbad Hydrologic Unit (CHU). The City of Encinitas is acting as the Lead Agency among the Responsible Parties within the CHU who are working together on a watershed basis to implement the IO for four lagoons; Loma Alta Slough, Buena Vista Lagoon, Agua Hedionda Lagoon, and San Elijo Lagoon. The IO Responsible Parties within the CHU include the cities of Carlsbad, Encinitas, Escondido, Oceanside, San Marcos, Solana Beach and Vista, the County of San Diego, Caltrans, and the City of Escondido Hale Avenue Resource Recovery Facility (HARRF).

MACTEC Engineering and Consulting (MACTEC) is located in San Diego, California. MACTEC has been engaged by the City of Encinitas for the overall organization and successful completion of the IO. MACTEC will coordinate the sample collection, laboratory analysis, data management, data analysis, and reporting, as well as field sampling and logistics.

Merkel and Associates, Inc. (M&A) of San Diego, California with assist MACTEC with the sampling program. Brown and Caldwell and Science Applications International Corporation (SAIC) will provide support for sampling design, quality assurance, and field staff. Pacific REMS and Everest International will provide support for sampling design and quality assurance in advisory roles. Nautilus Environmental will provide advisory support and analytical support, as needed

The Southern California Coastal Water Research Project (SCCWRP) is located in Costa Mesa, California. SCCWRP is a joint powers agency that was formed by several government agencies with a common mission to gather the necessary scientific information to effectively, and cost-efficiently, protect the Southern California aquatic environment. SCCWRP received a grant from the State of California to prepare a study on nutrient loading in the San Diego Region. This work will be performed by SCCWRP simultaneously with this project and will satisfy the requirements for Special Studies in the IO. SCCWRP will be providing TSS and sediment analysis as described in the Workplan.

CRG Marine Laboratories is located in Torrance, California. CRG is responsible for processing, shipping and some laboratory analysis of samples.

The Responsible Parties intend to reduce sample analysis costs by working with SCCWRP, and several university and Public Agency laboratories. The laboratories include: Encina Wastewater Authority (EWA) laboratory located in Carlsbad, California; Analytical Chemistry

Lab, Institute of Ecology, at the University of Georgia (UGA); and the Marine Science Institute Lab, at the University of California, Santa Barbara (UCSB).

The SDRWQCB is located in San Diego, California. The SDRWQCB is the end user of the data from this study. They will interpret the results and apply them for the development of a TMDL for San Diego coastal lagoons, including those in the CHU; San Elijo Lagoon, Agua Hedionda Lagoon, Buena Vista Lagoon, and Loma Alta Slough.

Table 1. (Element 4) Personnel responsibilities.

Name	Organizational Affiliation	Title	Contact Information (Telephone number, fax number, email address)
Nathan Schaedler	MACTEC	Project Manager	Tel: 858-278-3600 Fax: 858-278-5300 nschaedler@mactec.com
Jerome Welch	MACTEC	QA Officer	Tel: 858-278-3600 Fax: 858-278-5300 jewelch@mactec.com
Jay Shrake	MACTEC	Monitoring Leader	Tel: 858-278-3600 Fax: (858) 278-5300 jjshrake@mactec.com
Sean Porter	MACTEC	Wet & Dry Weather Source Monitoring Leader	Tel: 858-278-3600 Fax: 858-278-5300 saporter@mactec.com
Lawrence Honma	Merkel and Associates, Inc.	Longitudinal Transect Sampling Leader/Sediment Sampling Leader	Tel:858-560-5465 Fax: 858-560-7779 LHonma@merkelinc.com
George Wilkens	Pacific REMs	Continuous Monitoring Leader	Tel: 619-871-2464 gwilkins@pacific-rems.com
Matha Sutula	SCCWRP	Senior Scientist: Special Studies	Tel: 714-755-3222 Fax: 714-755-3299 marthas@sccwrp.org
Dario Diehl	SCCWRP	QA Officer	Tel: 714-372-9212 Fax: 714-894-9699 Dariod@sccwrp.org

Table 1. (Element 4) Personnel responsibilities (continued).

Name	**Organizational Affiliation**	**Title**	**Contact Information (Telephone number, fax number, email address)**
Richard Gossett	CRG Marine Laboratory	Laboratory Manager	Tel 310-533-5190 Fax: 310-533-5003 crglabs@sbcglobal.net
Georges L. Paradis	Marine Science Institute University of California, Santa Barbara	Analytical Lab Manager	Tel 805-893-7182 (ICPMS lab) Tel 805-893-3802 (MSI lab) paradis@msi.ucsb.edu
Lisa Dean	Analytical Chemistry Lab, Institute of Ecology, University of Georgia	Research Technician III	Tel (310-533-5190 Fax: (310) 533- lisadean@uga.edu
Cynthia Gorham-Test	SDRWQCB	SDRWQCB Officer	Tel: 858-467-2957 Fax: 858-571-6972 Ctest@waterboards.ca.gov
Linda Pardy	SDRWQCB	SDRWQCB QA Officer	Tel: 858-627-3932 Fax: 858-571-6972 Lpardy@waterboards.ca.gov

4.2 Quality Assurance Officer Role

Dr. Jerome Welch is MACTEC's Quality Assurance (QA) Officer and the QA Officer for this project. The QA Officer's role is to establish the quality assurance and quality control procedures found in this QAPP as part of the sampling, field analysis, and data management and analysis procedures. Dr. Welch will also work with CRG, EWA, UCSD, SCCWRP, and UGA's laboratories by communicating all quality assurance and quality control issues contained in this QAPP.

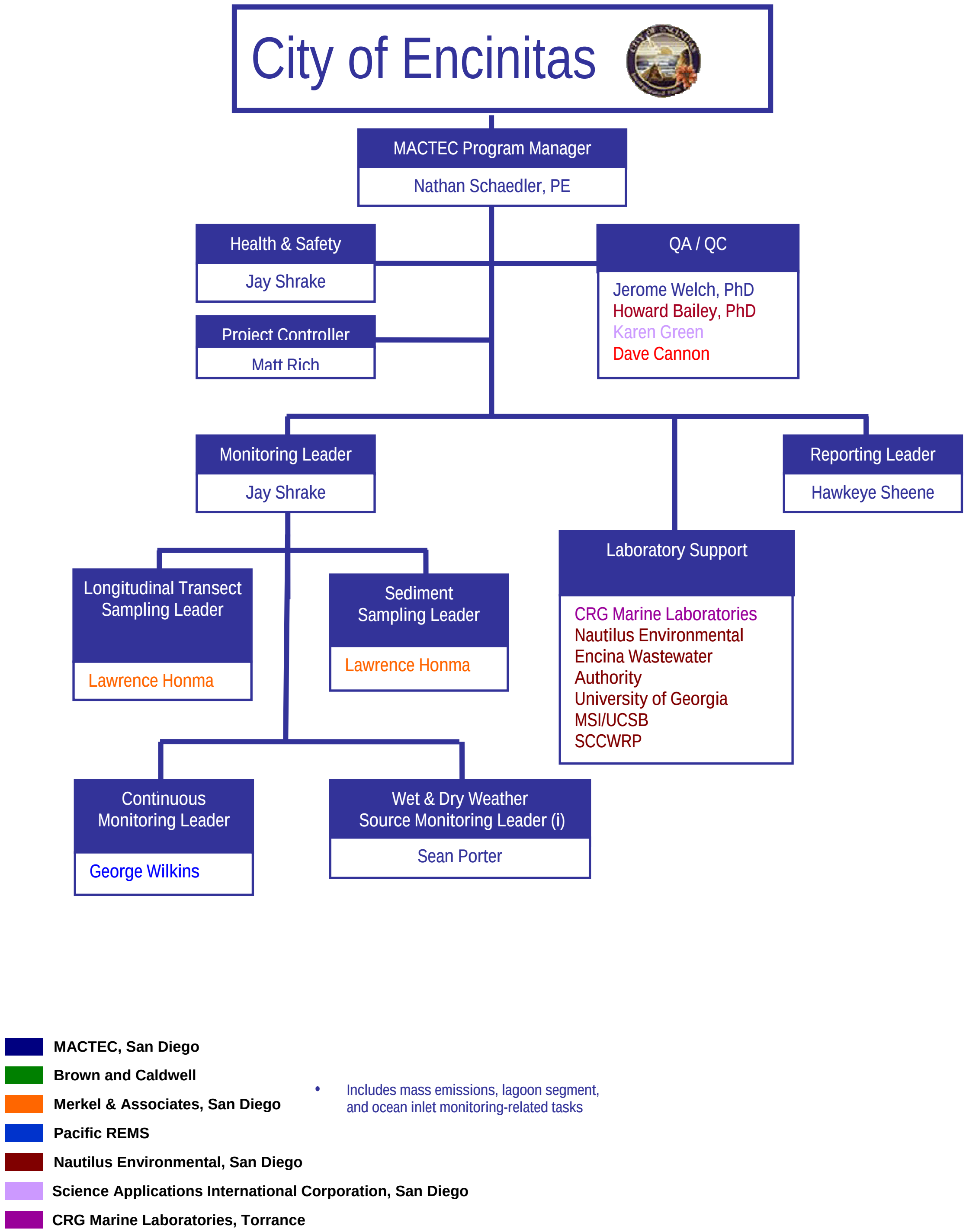
The QA officer will also review and assess all procedures during the life of the contract against QAPP requirements. The QA officer will report all findings to the Project Manager, including all requests for corrective action. The QA officer may stop all actions, including those conducted by any laboratory if there are significant deviations from required practices or if there is evidence of a systematic failure.

4.3 Persons Responsible for QAPP Update and Maintenance.

MACTEC's Project Manager and QA Officer are responsible for creating and maintaining this QAPP. Changes and updates to this QAPP may be made by MACTEC's Project Manager and QA Officer. The Project Manager will be responsible for making the changes and ensuring these updates are provided to each of the participating agencies and the SDRWQCB. Previous versions of the QAPP should be removed so as to avoid any confusion as to current versions of the QAPP.

4.4 Organizational Chart and Responsibilities

Figure 1. Organization chart



5. PROBLEM DEFINITION / BACKGROUND

5.1 Problem Statement

The coastal lagoons of the Carlsbad Hydrologic Unit (CHU) are heavily influenced by their urbanized watersheds. Watershed runoff, coupled with reduced tidal influence from restricted inlets, has resulted in beneficial use impairments in many systems, including low dissolved oxygen, excessive algal growth, eutrophication, presence of pathogens, excessive sedimentation and suspended sediment. Loma Alta Slough, Agua Hedionda Lagoon, Buena Vista Lagoon, and San Elijo Lagoon have been added to the State's list of impaired waterbodies (303d list) for at least one of the following constituents: indicator bacteria, nutrients, sediment/siltation, total dissolved solids (TDS), and/or eutrophic conditions. Table 2 summarizes the 303 (d) listings by lagoon. As a consequence of this listing, TMDLs must be developed for the critical constituents in each of the lagoons.

Setting the appropriate TMDLs must be based on an understanding the hydrodynamics, sources, loading, transport and cycling of constituents of interest. Dynamic simulation models are the best tools for determining load allocations. These models must simulate loads from the watersheds as well as fate and transport in the estuaries or lagoons. Complete data required to develop these models are not currently available for Southern California coastal lagoons. Partial data exist for some lagoons and will be included where applicable. Thus, the purpose of the monitoring program is to address the principal data needs required to develop watershed loading and lagoon water quality models for the targeted contaminants of interest in the lagoons. These models will then be used for TMDL development and implementation in each of the lagoons.

The objective of this monitoring program, as outlined in the San Diego Coastal Lagoons TMDL Monitoring Workplan, Appendix A, is to support the development of watershed loading and lagoon water quality models by:

1. Quantifying the loading of contaminants to the lagoons (e.g. watershed sources, storm drains, and others) during wet and dry weather
2. Collecting data to calibrate and validate lagoon hydrodynamic and water quality models for each of the targeted contaminants (sediment, total dissolved solids, indicator bacteria, and nutrients).

Table 2. Summary of 303(d) listings by lagoon.

Lagoon	Tidal Regime	303(d) Listing			
		Sediments	Total Dissolved Solids	Bacteria	Nutrients/ Eutrophication
Loma Alta Slough	Tidal[1]			X	X
Agua Hedionda Lagoon	Tidal	X		X	
Agua Hedionda Creek	N/A		X		
Buena Vista Lagoon	Nontidal	X		X	X
San Elijo Lagoon	Tidal[1]	X		X	X

1Subject to periodic closure due to build up of sand at the mouth of the lagoon

5.2 Decisions or Outcomes

The general approach and specific design elements of the monitoring program are driven by a series of management questions. These questions were drafted by the San Diego Regional Water Quality Control Board and revised by the group of watershed stakeholders for the seven lagoons (Appendix A). The management questions can be organized by three general categories:

1. Questions that characterize sources of targeted contaminants to the lagoons or to Agua Hedionda Creek
2. Questions that characterize within-lagoon hydrodynamics and water quality
3. Questions that relate to the implementation of models to set load allocations

Table 3 presents these management questions by major category.

Table 3. List of major management questions that frame approach and design elements of the monitoring plan.

Type	Question
Sources	What are the relative contributions for targeted contaminants from each land use type or from regulated facilities?
	What are the concentrations of targeted contaminants at the base of each watershed before it enters an impaired lagoon?
	What is the daily rainfall in the watershed?
	What is the total annual (and daily) flow and mass loads of targeted contaminants from each watershed to each impaired lagoon?
	What is the total annual (and daily) flow and mass load of total dissolved solids to Agua Hedionda Creek?
	What are the concentrations of targeted contaminants at the ocean inlet before it enters an impaired lagoon?
	What is the net annual flux of the targeted contaminants from the impaired lagoon to the coastal ocean?
Within Lagoon or Creek Hydrodynamics or Water Quality	What is the concentration of total dissolved solids in Agua Hedionda Creek? Do they exceed Water Quality Objectives?
	What are the concentrations of targeted contaminants within each impaired lagoon? Do they exceed Water Quality Objectives?
	What are the dissolved oxygen concentrations in lagoons impaired for nutrients or eutrophication?
	What are the physical factors that control lagoon hydrodynamics and sediment transport?
	What are the sediment flux rates for nutrients in these water bodies?
	What is the sediment oxygen demand in these water bodies?
	What are the standing crop totals and primary productivity rates for plant/macroalgae biomass in these water bodies?

Table 3. List of major management questions that frame approach and design elements of the monitoring plan. (continued)

Type	Question
Implementation Questions	What is the total annual load reduction of nutrients needed so that beneficial uses and water quality objectives are met?
	What is the total annual load reduction of bacteria needed so that recreational beneficial uses and water quality objectives are met?
	What is the total annual load reduction of sediment needed so that sedimentation is reduced to meet water quality, physical and biological habitat objectives?
	What is the total annual load reduction of total dissolved solids needed in Agua Hedionda Creek so that water quality objectives that support the MUN beneficial uses are met?

6. PROJECT/TASK DESCRIPTION

6.1 Work Statement and Produced Products

6.1.1 General Approach

The general approach to this project is to calibrate and validate the watershed loading and water quality models with a targeted set of monitoring data. Model parameters can either be developed from measured data or estimated from literature values. Where necessary, site-specific sources, losses, and key rates of transformation within the lagoons will be measured to assure that models for each specific lagoon reflect its unique hydrology and water quality. The monitoring program adopted will characterize the site-to-site variations within each lagoon as well as seasonal variability in loads and fluxes.

The three principal types of monitoring included are as follows:

1. Continuous monitoring of hydrodynamic and core water quality parameters (salinity, temperature, etc.);
2. Wet weather monitoring, which will be conducted during and immediately following a specified number of storm events at a mass emission (ME) site in the main tributary, targeted locations in the lagoon, and at the ocean inlet; and
3. Dry weather monitoring, which will be conducted during “index” periods that are meant to capture representative seasonal cycles of physical forcing and biological activity in the lagoon. During each index period, sampling will be conducted at the ME and ocean inlet sites, as well as key locations within the lagoon.

The actual sampling effort within each lagoon is a function of the number of segments agreed upon between the San Diego Regional Board and the stakeholders. The number of segments depended upon the number of unique environments within a specific lagoon and does not include the ocean inlet site and the mass emission site. Table 4 gives the number of segments by lagoon. Table 5 shows proposed GPS coordinates for mass emission, lagoon segment, and ocean inlet sampling sites. Figures 2 through 5 show locations of sampling sites in each lagoon. The actual location may change if necessary due to logistics, accessibility, etc.

Table 4. Number of segments by lagoon.

Lagoon Description	Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Number of Segments*	1	1	2	2

Table 5. (Element 6) Description of monitoring sites

Type	GPS Points	Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Mass Emission Station	Latitude	33.18836	33.14954	33.18078	33.04822
	Longitude	-117.36169	-117.29698	-117.32632	-117.22650
Segment 1	Latitude	33.17829	33.14166	33.17644	33.01016
	Longitude	-117.36802	-117.32476	-117.34636	-117.26428
Segment 2	Latitude	NA	NA	33.16975	33.01123
	Longitude	NA	NA	-117.26931	-117.27407
Ocean Inlet 1	Latitude	33.177713	33.14568	NA	33.01291
	Longitude	-117.36884	-117.34345	NA	-117.27835
Ocean Inlet 2	Latitude	NA	33.14434	NA	NA
	Longitude	NA	-117.33324	NA	NA

Note Actual locations may vary based on stakeholders needs and logistical issues.

Figure 2. Sampling sites at San Elijo Lagoon.

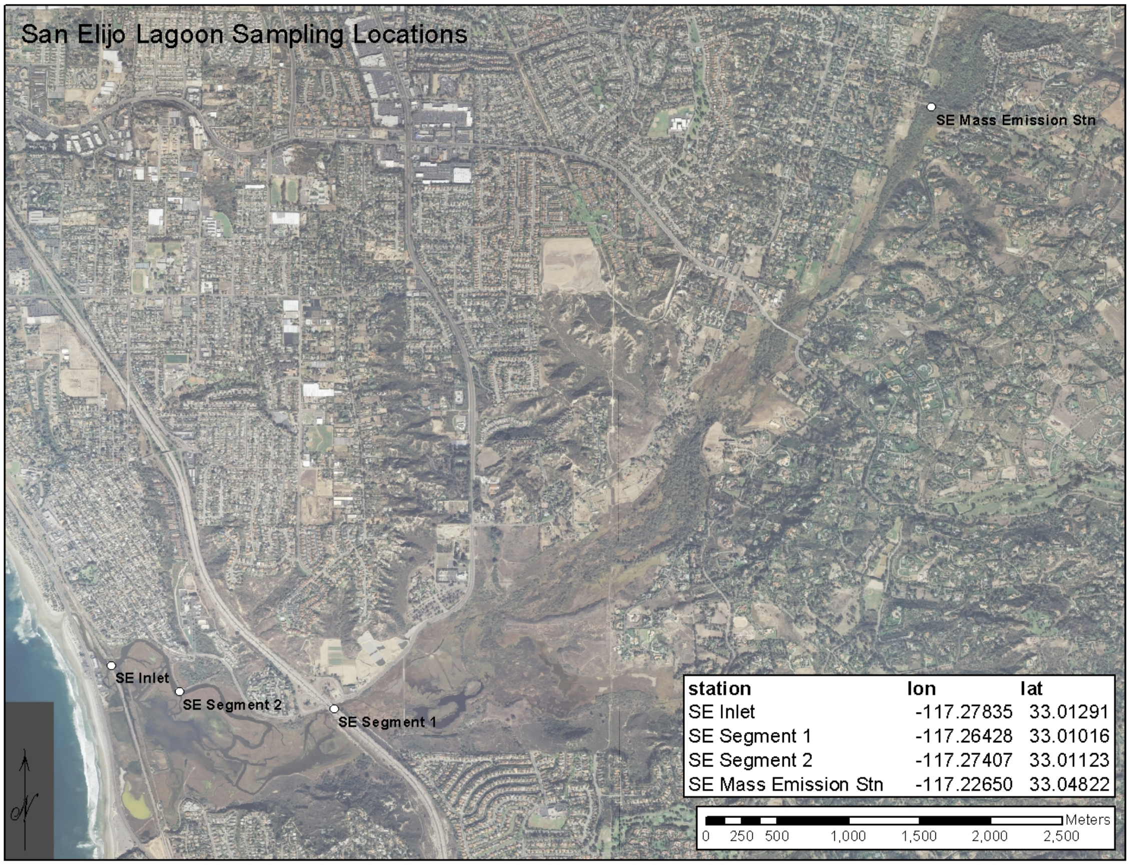


Figure 3. Sampling sites at Agua Hedionda Lagoon

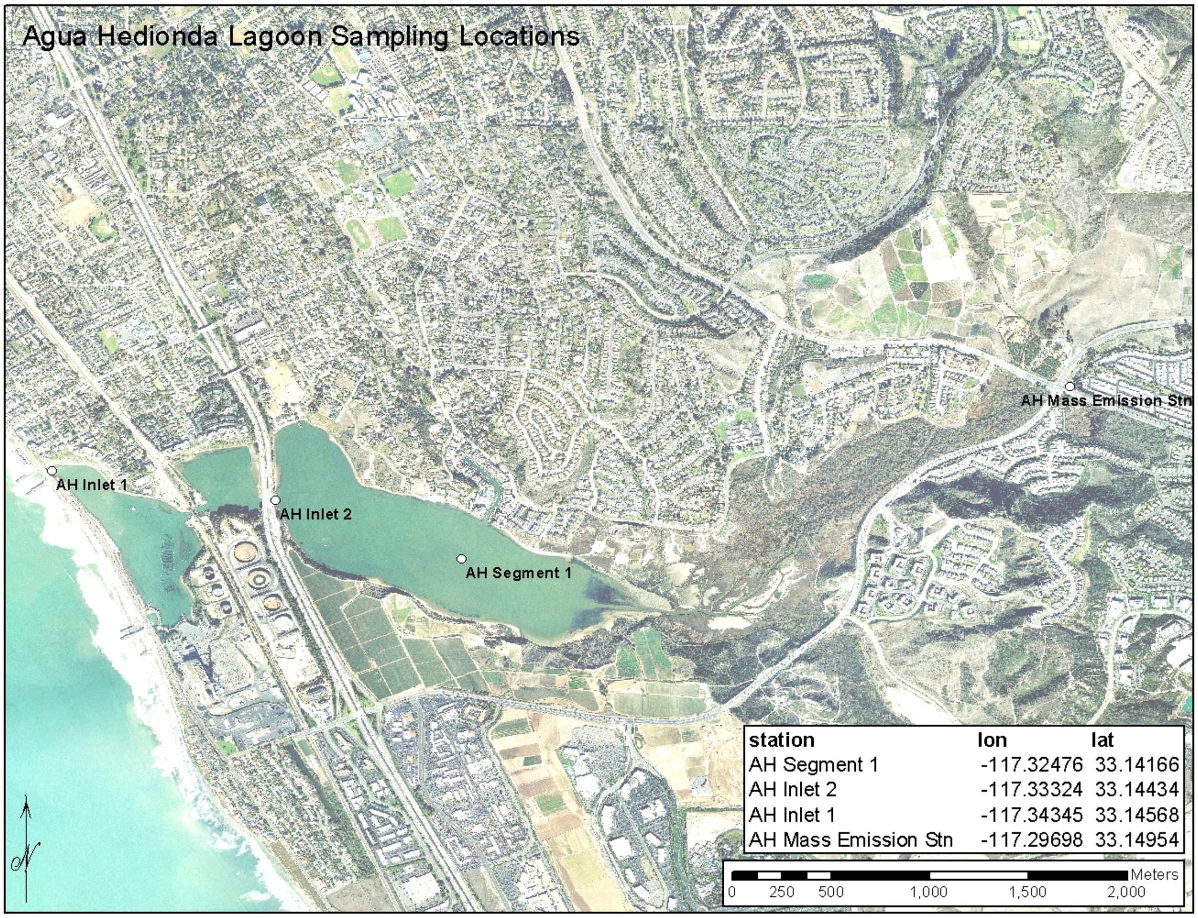


Figure 4. Sampling sites at Buena Vista Lagoon

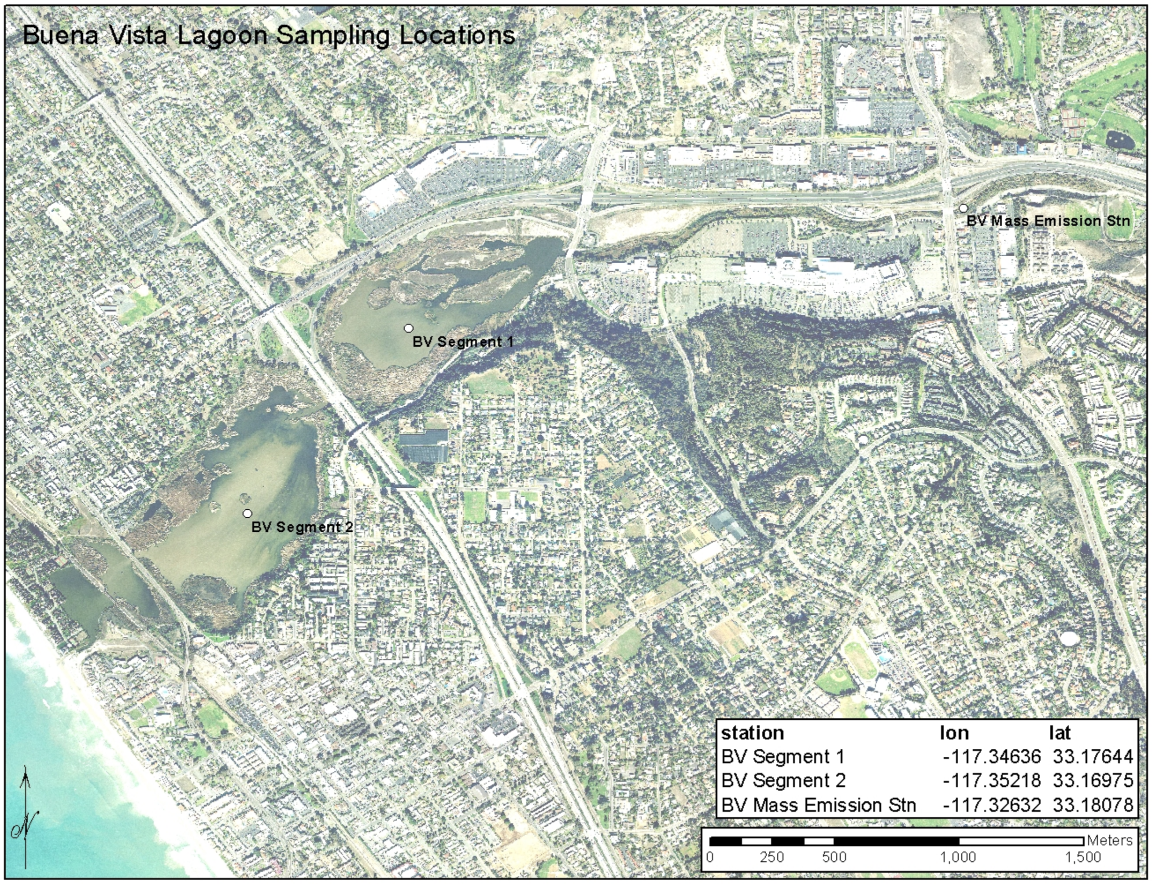


Figure 5. Sampling sites at Loma Alta Slough

6.1.2 Specific Approach

6.1.2.1 Continuous Monitoring for Hydrology and Chemical Parameters

In order to calibrate and validate the watershed hydrology and lagoon hydrodynamic models, monitoring of hydrology and core chemical parameters (salinity, temperature, turbidity, and water-level and flow) will be measured via *in-situ* probes (data sondes) installed at the mass emission site, within each segment, and at the ocean outlet at discrete depths.

Water level will be measured at the segment and ocean inlet sites, and flow will be measured at the mass emission site. As these lagoons are listed for eutrophication, pH and dissolved oxygen will be measured during index period sampling. Buena Vista Lagoon is never open to tidal exchange and, consequently, no ocean inlet site will be monitored. In each of the watersheds, data from a minimum of one rainfall station must be acquired.

Continuous monitoring will occur during two periods in all lagoons. The first period will be wet weather monitoring for three months from January to March, the second will be dry weather monitoring for 4 months from mid-June to mid-October, with the exception of

Agua Hedionda lagoon where dry weather monitoring will take place for three months from July through September. Wet weather continuous monitoring will coincide with storm sampling in each of the lagoons when possible.

The mass emission site will be placed at a location above the upstream boundary of the estuary (tidal influence). The location of segment sites is driven by the number of distinct regions of the lagoon (Table 4). Proposed locations for segment sites have been defined in Table 5 and shown on Figures 2 through 6, though these locations are subject to change given logistical considerations.

The ocean inlet is generally defined as the lagoon mouth. For all lagoons except Buena Vista, ocean inlet continuous monitoring will occur within the lagoon mouth when the lagoon mouth is open. Agua Hedionda Lagoon will have an additional "boundary" condition station at the I-5 bridge for all sampling in order to enhance data collection. This site will serve as a second ocean inlet site. For Buena Vista, which has no surface water tidal influence, no ocean inlet monitoring is required.

6.1.2.2 Wet Weather Sources and Within Lagoon Sampling

Wet weather sources consist of three major types: 1) watershed loading, 2) direct runoff to the lagoon from storm drains within the lagoon's local catchment, and 3) atmospheric deposition. Watershed loading of the targeted contaminants will be estimated through a wet weather watershed model. Data collection will include pollutagraph sampling (flow and concentration) at a mass emission site in the main tributary, sampling within the lagoons and at the ocean inlet to capture impacts of the storms on lagoon water quality. Post-storm sediment sampling will be conducted to assess how the storm impacts sediment bulk characteristics after one storm. Atmospheric deposition will be estimated from existing data in the literature.

Wet weather sampling is sub-divided into four sections each of which is detailed on the following pages:

1. Collection of pollutagraph data during storm events
2. Storm event sampling within the lagoons
3. Storm event sampling at the ocean inlet
4. Sediment sampling within the lagoons after a storm event

6.1.2.2.1 Watershed Hydrology and Pollutagraph Sampling

Watershed loading during wet weather will be estimated from pollutagraphs generated during storm events. Pollutagraphs estimate the contaminant discharge as a function of time and will be used to determine the loading of contaminants from the watershed to the lagoons over the course of a storm event. Pre-storm weather forecasts will be utilized to sample storms with rainfall ranging from 0.2 inch to 1 inch or greater.

Pollutagraph sampling at mass emission sites will occur during two storm events in Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon, and Agua Hedionda Lagoon, with eight discrete samples taken throughout the pollutagraph per storm. Five discrete pollutagraph samples will be collected per storm for bacteria analysis.

In addition to the chemical constituents required for a given impairment, all lagoons will be monitored for particle size distribution at the mass emission site during a minimum of one storm event.

6.1.2.2.2 Lagoon Storm Sampling

The purpose of storm event sampling within the lagoons is to calibrate the lagoon water quality model with respect to its response over the course of a storm event. Storm event sampling within the lagoon will be conducted simultaneously with pollutagraph sampling and ocean inlet sampling during storm events. Because Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon and Agua Hedionda Lagoon are only required to sample two pollutagraphs, as compared to other lagoon in this region (part of this CHU monitoring program), the third within lagoon storm event sampling will correspond to one of the two storms monitored in the San Diego County Regional Monitoring Program, Order No. 2007-01. The influence of a storm on the lagoon may lag the onset of the storm and that lag period will vary with each lagoon. The anticipated lag time (i.e., the amount of time after a storm's onset before the lagoon is affected) as well as readings recorded by the submerged salinity probe will be used to initialize a sampling program. An autosampler will be used, therefore many samples will be collected over the storm, and a subset of samples will be selected based on the salinity of the sample, the turbidity of the sample, and the targeted period (slack high and low tide). Refer to Section 15 for details on the equipment proposed.

Time-weighted samples will be collected for a three-hour duration, at slack high tide and at slack low tide. The autosampler will be programmed to collect aliquots every 15 minutes into a composite jar. However, the sampling program will not begin until the lagoon water drops in salinity below a pre-determined amount, representing the freshwater plume, and the time conditions are met (i.e., slack high tide and slack low tide). During the two tidal regulated sampling events, microbiology samples will be collected simultaneously with the composite samples. QA/QC samples will also be collected per Surface Water Ambient Monitoring Program (SWAMP) requirements and in accordance with the Workplan (Appendix A).

This sampling protocol allows for the selection of samples that best represent the freshwater plume as it moves through the lagoon. Suggested locations of autosamplers within lagoon segments are listed below. Final locations will depend on logistics and safety of staff and/or consultants:

- San Elijo Lagoon: segment samplers at I-5 bridge and at Segment 1 site
- Agua Hedionda Lagoon: segment sampler at I-5 bridge
- Buena Vista Lagoon: segment samplers at I-5 and Carlsbad Boulevard bridges
- Loma Alta Slough: segment sampler at railroad trestle

6.1.2.2.3 Ocean Inlet Sampling

The purpose of the ocean inlet sampling is to calibrate the lagoon water quality model with respect to the net transport of the targeted contaminants to the ocean from the lagoons during a storm event. The four ocean inlet sampling locations will be sampled using an autosampler and an in-situ salinity probe. It is assumed that one depth will be sampled at each ocean inlet.

As with the lagoon sampling, time-weighted samples will be collected simultaneously with mass emission pollutagraph sampling and will consider expected lag time from the onset of the storm. Samples will be collected for a three-hour duration, at slack high tide and at slack low tide. The autosampler will be programmed to collect aliquots every 15 minutes into a composite jar. However, the sampling program will not begin until the lagoon water drops in salinity, representing the freshwater plume, and the time conditions are met (i.e., slack high tide and slack low tide). During the two tidal regulated sampling events, microbiology samples will be collected simultaneously. QA/QC samples will also be collected per SWAMP requirements and in accordance with the Workplan (Appendix A).

Potential locations for ocean inlet autosampler locations are:

- San Elijo Lagoon: Pacific Coast Highway bridge
- Agua Hedionda Lagoon: Pacific Coast Highway bridge
- Buena Vista Lagoon: no ocean inlet sampling optional during storm event
- Loma Alta Slough: Pacific Street bridge

6.1.2.2.4 Post-Storm Event Sediment Sampling

The purpose of this sampling element is to calibrate the lagoon sediment transport and water quality models with respect to the impact of a storm event on the spatial characteristics of sediment within the lagoon. These data will be used to determine where sediments settle in the lagoon. Post-storm event sediment sampling at all lagoons will occur within two weeks after one of the three storm events sampled. In order to trigger the sampling, the storm should be generally ±50 % of the median storm. Sediment samples will be collected from a small vessel (or on foot at Loma Alta Slough) using a ponar or similar grab sampler, with only the top 2 cm retained. Each grab will be observed to determine acceptability, which is defined as an intact sample with no blow out or other indications that the top layer has been disturbed.

6.1.2.3 Monitoring of Dry Weather Sources and Within Lagoon Hydrodynamics and Water Quality

As with the wet weather monitoring, data collected for the dry weather program is designed to support the watershed model development through the estimation of loading and fluxes of target constituents into and out of each lagoon. Dry weather monitoring consists of storm drains, each mass emission site, ocean inlet, and within lagoon sampling sites during key “index” periods. These index periods are intended to capture representative seasonal cycles of physical forcing and biological activity in the lagoon.

Dry weather sampling is sub-divided into two sections, each of which is detailed below:

- Storm drain and other point source sampling

- Index period monitoring of lagoon segments, the ocean inlet, mass emission site and lagoon longitudinal transects

6.1.2.3.1. Storm Drain and Other Point Source Sampling

Storm drains are not expected to be a significant source of constituents to each lagoon during dry weather due to low flows. Thus, flow rates and analyte concentration will be measured once per index period at those drains that represent 80% of the target constituent loading into each lagoon. Point sources specific to individual lagoons (e.g., a large tributary that flows into the lagoon downstream of the mass emission site) should also be sampled once per index period in addition to the storm drain sampling.

6.1.2.3.2. Index Period Monitoring

Sampling during index periods is intended to calibrate and validate the hydrodynamic and water quality models with data capturing seasonal cycles of physical forcing and biological activity within the lagoons. Spacing of index periods is particularly important for lagoons with eutrophication and bacteria impairments due to seasonality in algae blooms and associated variations in nutrient cycling.

The following section covers sampling of all constituents during the index periods in the following locations:

- Within lagoon segments
- At ocean inlet
- At mass emission site
- Along longitudinal transects

These index periods are intended to capture representative seasonal cycles of physical forcing and biological activity in the lagoon.

Four index periods will be sampled. Each index period will span two weeks. During those two weeks, the first three days of each week will be sampled (for a total of six days sampled). Designated field teams will perform the sampling in all four lagoons. The team will setup the autosamplers and, if needed, flowmeters at the mass emission sites, at the lagoon sites, and at the ocean inlet sites, and start the sampling program during ebb tide or during the flood tide, where applicable.

<u>Lagoon Segment Sampling</u>:

Sampling at each segment site constrains intra-lagoon variability in target constituents, as well as daily variations at each individual segment. Per the Workplan, two samples per day per segment will be collected for tidal lagoons (Loma Alta, San Elijo, and Agua Hedionda) and one sample per segment per day will be collected at non-tidal lagoons (Buena Vista Lagoon). For tidal lagoons, one composite sample will be collected during ebb tide and one sample will be collected during flood tide. Samples will be collected using an autosampler. Table 4 gives the number of segments per lagoon.

Ocean Inlet Sampling

The ocean inlet will be monitored over each index period in order to constrain the tidal exchange across the inlet over each of the index periods. During the index periods, dry weather ocean inlet sampling will be performed for all lagoons except Buena Vista, which has no tidal exchange. Ocean inlet sampling should correspond with index period sampling of lagoon segments and mass emission sites. Daily sampling will be conducted only if the mouth of the lagoon is open. Time-weighted composite samples will be collected twice per day, as per the Workplan. During the composite sample collection periods, microbiology samples will be collected simultaneously. Samples will be collected using an autosampler. QA/QC samples will also be collected per SWAMP requirements and in accordance with the Workplan.

Mass Emission Site Sampling:

Loading from the watershed will be estimated by monitoring the mass emission site over each of the index periods, conducted simultaneously with sampling of the lagoon segments and ocean inlet sites. Mass Emission site sampling will be conducted once daily during the same index periods as the Lagoon segment sampling and the ocean inlet sampling. Daily composite samples will be collected. MACTEC will use a flowmeter to record and log the flows in the Mass Emission channels during the index period sampling events. QA/QC samples will also be collected per SWAMP requirements and in accordance with the Workplan.

Transect Sampling

The purpose of measuring a longitudinal transect is to provide spatial data by which the water quality will be calibrated and then validated within the lagoon. Sampling conducted at moored sites within segments provides data on only one site within each segment, albeit for 6 days. Data from a longitudinal transect will show the mean and range of values for targeted contaminants for each segment. Measuring values over the transect twice provides data for both calibration and validation of the models.

Longitudinal transect sampling will be conducted along a salinity gradient in each lagoon from a small vessel (or on foot at Loma Alta Slough) at designated locations using GPS during flood and ebb tide (morning and evening for Buena Vista) on the fourth day of week 1 of each index period. At each sampling location, discrete water samples will be collected just below the water surface, and salinity, temperature, turbidity, dissolved oxygen, and pH will be measured with a hand-held probe. QA/QC samples will also be collected per SWAMP requirements and in accordance with the Workplan.

6.1.2.4 Analytes to be Monitored

A “core” set of analytes will be monitored in each lagoon to establish the lagoon hydrodynamic model. Other analytes will depend on specific lagoons’ listing (bacteria, total dissolved solids, sediment, or eutrophication). Table 6 provides a list of analytes by TMDL type, the analytical method for analysis, and the target reporting limits for each analyte. Each analytical method and target reporting limit are compatible with the SWAMP.

Table 6. (Element 6) Constituents to be measured by TMDL type, analytical methods, and target reporting limits. Under "type", "Core" refers to parameters that apply across the board to all TMDLs of interest

Type	Analyte	Analytical Method	Target Reporting Limit
Core	Temperature	Data Sonde	0.1 °C
	Conductivity	Data Sonde	2.5 µS/cm
	Turbidity	Data Sonde	0.5 NTU
	Total Suspended Solids (TSS)	SM 2540-D[6]	0.5 mg/L
Total Dissolved Solids	Total Dissolved Solids (TDS)	SM2450C	0.2 mg/L
Bacteria	Total Coliform*	SM 9222B	2 MPN/ 100 mL
	Fecal Coliform*	SM 9222D	2 MPN/ 100 mL
	Enterococcus	SM 9230C[6], EPA1600[5]	1 colonies/ 100 mL
Eutrophication	pH	Data Sonde	0.2
	Dissolved Oxygen (DO)	Data Sonde	1.00 mg/L
	Total Nitrogen (TN)	USGS I-4650-03	0.1 mg/L
	Total Phosphorus (TP)	USGS I-4650-03	0.05 mg/L
	Total Dissolved Nitrogen (TDN)	USGS I-2650-03	0.1 mg/L
	Total Dissolved Phosphorus (TDP)	USGS I-2650-03	0.05 mg/L
	Nitrate+Nitrite-N	SM 4500-NO3+NO2 F	0.05 mg/L
	Ammonium-N	SM 4500-NH3 G SM 4500-NH3 F	0.05 mg/L 0.05 mg/L
	Soluble Reactive Phosphorus (SRP)	SM4500P C	0.05 mg/L
	Chlorophyll a	EPA 445.0 SM 10200H	2 µg/L 0.01 mg/m^3
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	EPA 405.1 SM 5210B	2 mg/L
Suspended Sediment or Sediment	% Fines or % Sand/Silt/Clay	ASTM D-422 (1963)[1] EPA (1995)[2] Plumb (1981)[3]	1 %
	% Organic Carbon (%OC)	EPA 9060	0.01 %
	% Organic Nitrogen (%ON)	EPA 9060	0.01 %
	% Total Phosphorus (%TP)	Nelson (1987)[4]	0.01 %

*Suggested analytical methods from SWAMP, using membrane filtration technique.

1. ASTM D-2216, 1980. Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures. American Society for Testing and Materials.

2. U.S. EPA, 1995. Environmental Monitoring and Assessment Program (EMAP): Laboratory Methods Manual – Estuaries, Volume 1: Biological and Physical Analyses. United States Environmental Protection Agency, Office of Research and Development, Narragansett, RI. EPA/620/R-95/008.

3. Plumb, R. H., 1981. Procedure for Handling and Chemical Analysis of Sediment and Water Samples. Technical Report EPA/CE 81-1, prepared for Great Lakes Laboratory, State University College at Buffalo, NY, for the U.S. EPA/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material. U.S. Army Engineers Waterways Experiment Station, CE, Vicksburg, MS.
4. Nelson, N. S. 1987. An acid-persulfate digestion procedure for determination of phosphorus in sediments. Commun. in Soil Sci. Plant Anal. v.18 no.4 p.359-69.
[5] This method is proposed to be used optionally in addition to SM9230C per authorization from SDRWQCB.
[6] American Public Health Association, et al. Standard Methods for the Examination of Water and Wastewater. 19th Edition, 1997.

The SDRWQCB has determined that the Stakeholders are not required to use laboratories with state certification for this IO, as long as it meets the SWAMP-comparable Measurement Quality Objectives (MQOs) for the target analytes Stakeholders and SCCWRP are allowed to filter and freeze nutrient samples to increase the holding times to 28 days (not applicable to SWAMP holding times for other constituents). Samples collected must be immediately put on ice until processed. The filtering must be done within 6 hours of sample collection and prior to freezing.

The Responsible Parties of the IO intend to reduce sample analysis costs by working with SCCWRP, and several university and public agency laboratories. Therefore MACTEC will utilize CRG Marine Laboratories as a processing lab and clearing house for all samples, except those bacteria samples submitted to the public agency laboratory. MACTEC will lead the sampling effort and submit samples to CRG. Depending on the analyte and the monitoring program, CRG will either analyze the sample or process and ship the sample to a university or public agency laboratory.

Please refer to Section 12 for flow charts depicting sample handling to the appropriate laboratories for all monitoring programs.

6.1.3 Project Planning

The sampling program will take approximately one year to complete. Wet Weather sampling is targeted to take place between January 2008 and March 2008. Storm event sampling will take place between October 2007 and April 2008. Dry weather sampling will take place during periods between February and October 2008. Continuous Monitoring will take place between October 2007 and October 2008. A final report on watershed sampling will be prepared by June 2008.

Table 7 lists the activities and deliverable dates.

Table 7. Activities, deliverables, and due dates for the current study

Activity	Dates		Deliverable	Deliverable due date
	Anticipated Date of Initiation	Anticipated date of completion		
Prepare QAPP	08/01/2007	09/01/2007	QAPP	9/01/2007
Task 3.1 Continuous Monitoring (Wet)	10/01/2007	03/31/2008	Quarterly Data Submittal	see below

Task 3.1 Continuous Monitoring (Dry)	6/15/2008-7/1/2008	10/15/2008	Quarterly Data Submittal	see below
Task 3.1 Mass Emission Monitoring	10/01/2007	09/30/2008	Quarterly Data Submittal	see below
Task 3.2 Wet Weather Pollutograph	1/1/2008*	03/31/2008	Quarterly Data Submittal	see below
Task 3.2 Wet Weather Storm Event Lagoon Sampling	1/1/2008*	03/31/2008	Quarterly Data Submittal	see below
Task 3.2 Wet Weather Storm Event Ocean Inlet Sampling	1/1/2008*	03/31/2008	Quarterly Data Submittal	see below
Task 3.2 Wet Weather Sediment Sampling Post-Storm	1/1/2008*	03/31/2008	Quarterly Data Submittal	see below
Task 3.3 Dry Weather Sources (Storm Drain Sampling – cities to implement)	2/1/2008	09/30/2008	Quarterly Data Submittal	see below
Task 3.3 Dry Weather Index Period	2/1/2008	09/30/2008	Quarterly Data Submittal	see below
Data Reporting	10/1/2007	01/01/2008	Quarterly Data Submittal	01/01/2008
Data Reporting	1/1/2008	04/01/2008	Quarterly Data Submittal	04/01/2008
Data Reporting	4/1/2008	07/01/2008	Quarterly Data Submittal	07/01/2008
Data Reporting	7/1/2008	10/01/2008	Quarterly Data Submittal	10/01/2008
Reporting	1/1/2009	06/01/2009	Final Report	06/01/2009

* Wet weather storm event sampling is recommended to occur between January – March 2008. However, wet weather storm event sampling may be implemented prior to January 1, 2008 (after October 1, 2007) if a storm event occurs that meets sampling criteria and field and laboratory staff and equipment are in place.

7. QUALITY OBJECTIVES AND CRITERIA

Data Quality Objectives (DQOs) are quantitative and qualitative statements that clarify study objectives, and specify the tolerable levels of potential errors in the data (U. S. EPA, 2000). DQOs specify the quantity and quality of data required to support the study objectives. DQOs are generally used to determine the level of error considered to be acceptable in the data produced by the sampling or monitoring program. They are used to specify acceptable ranges of field sampling and laboratory performance. Each data quality category is described below. Numeric DQOs for the constituents being sampled are listed in Table 8.

7.1 Precision

Precision describes how well repeated measurements agree. The precision objectives in this study apply to duplicate analysis of samples in the laboratory. Precision is quantified as relative percent difference (RPD) and is listed in Table 8

Precision measurements will be determined on both field and laboratory replicates. The water quality instrumentation will be maintained per the manufacturer's specifications. Calibration will be conducted per the guidelines in the Operating Manual, on file at MACTEC and M&A. A record of the calibration procedure will be kept for each calibration event. Two fully operational Quanta instruments will be available and calibrated at all times. Should the unit in use exhibit inaccuracies during either calibration or use, the backup unit will be deployed in its place. The switch will be clearly indicated on the field reporting form. The Quanta will be used to collect water quality parameter data, per the operational instructions in the Operating Manual. The number of replicates for field measurements will be ten duplicate quadrats at each study site.

7.2 Accuracy

Accuracy describes how close the measurement is to its true value. Accuracy is the measurement of a sample of known concentration and comparing the known value against the measured value. The accuracy of chemical measurements in this study will be checked by performing tests on standardized or certified reference materials (SRRM or CRM) during each batch of sample analysis at the laboratory. Accuracy is quantified as percent recovery of the measured value relative to the true value (Table 8)

The accuracy of laboratory measurements will be checked by performing weekly performance testing of test standards. A standard is a known concentration of a specific solution. Standards will be purchased from chemical or scientific supply companies. Standards may also be prepared by a commercial or research laboratory. The concentration of the standards, known to the Task Manager, will be unknown to sampling personnel until after measurements are determined. A Data Quality Form: Accuracy, found in Appendix B will be used to record accuracy, and results will be maintained by the QA Officer.

7.3 Completeness

Completeness describes the fraction of collected data that are successfully analyzed in the laboratory. Completeness DQOs are often a function statistical criteria associated with the statistical design of the project. While no specific statistical criteria have been generated as part of this project, it is expected that 90% of all analyses should be completed when sampled. Completeness will be quantified by comparing the number of measurements we actually collected to the number of measurements we planned to collect.

7.4 Bias

Bias describes the the tendency for under or overprediction of sampled or measured values relative to the true value. Bias will be assessed through the use of matrix spikes and reference materials. Bias is quantified by assessing if percent recovery is consistently negative or positive relative to the true value. No DQOs are established for bias so long as the precision and accuracy DQOs are met.

7.5 Representativeness

Representativeness describes the degree to which the results of analyses represent the samples collected, and the samples in turn represent the environment from which they were taken. Achieving representativeness in conducting scientific studies or monitoring is important, because without adequate representativeness, it is not valid to extrapolate results of the study to generate conclusions about the system at large. A way to achieve representativeness is by sampling from several locations within the area of interest, and by choosing sampling locations at random, so as to remove the personal bias of the sample collector, which would skew the results.

In this project, we strive to achieve representativeness of samples so that the data can then be used to formulate conclusions about the study systems at large. Sites were chosen to best represent distinctive processes or sections of the estuaries: mass emission site above the upstream boundary of the estuary, lagoon segment sites based on distinct regions within each, and ocean inlet or lagoon mouth sites defining the boundary condition. All sites were chosen to be representative of the lagoon processes of interest.

Since no Water Quality Criteria will be applied as part of this project, target reporting limits or project-specific action levels are dealt with by the inclusion of the required SWAMP Target Reporting Limits (or lower), where such values exist.

Table 8. (Element 7) Measurement Quality Objectives.

Group	Parameter	Target Reporting Limit	Accuracy	Precision	Recovery	Completeness
Conventional Constituents in Stormwater and Estuary Waters	TSS	0.5 mg/L	Standard Reference Materials (SRM, CRM) within 95% CI stated by provider of material. If not available then with 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	90%
	TN	0.1 mg/L				
	TDN	0.1 mg/L				
	TP	0.05 mg/L				
	TDP	0.05 mg/L				
	SRP	0.05 mg/L				
	Nitrate	0.05 mg/L				
	Nitrite	0.05 mg/L				
	Ammonium	0.05 mg/L				
	Chlorophyll a	2 µg/L 0.01 mg/m^3				
	CBOD5	2 mg/L				
	TDS	0.2 mg/L				

Group	Parameter	Target Reporting Limit	Accuracy	Precision	Recovery	Completeness
In Situ Sampling	Temperature	0.1 °C	Calibration Standard (3-5 standards over the expected range of sample target analyte concentrations with the lowest concentration standard at or near the MDL.	Field replicate	N/A	90%
	Conductivity	2.5 µS/cm				
	Turbidity	0.5 NTU				
	pH	0.2				
	DO	1.00 mg/L				
Bacteria	Total Coliform	2 MPN/ 100 mL	Field and Laboratory blanks>TRL	Laboratory duplicate, Blind Field duplicate, $R_{log} \leq$ 3.27•mean R_{log} (*	N/A	90%
	Fecal Coliform	2 MPN/ 100 mL				
	Enterecoccus	1 colonies/ 100 mL				
Sediment and suspended solids	% Fines or %Sand/Silt/Clay	1 %	Standard Reference Materials (SRM, CRM) within 95% CI stated by provider of material.	Laboratory duplicate, blind field duplicate, <20% relative standard deviation	N/A	90%
	% OC	0.01 %				
	% ON	0.01 %				

Note Na = Not Applicable

8. SPECIAL TRAINING NEEDS/CERTIFICATION

8.1 Specialized Training or Certifications

MACTEC's QA Officer is responsible for overseeing training. MACTEC and M&A staff have completed all applicable certification and training to conduct. CRG Laboratory holds certification for analysis of all the constituents. The CRG Laboratory's QA officer provides training to CRG personnel. The Laboratory Supervisors of EWA, SCCWRP, UCSB, and UGA provide training to their respective staff. Details of the training are available from each group. MACTEC holds copies of each agency's QA Manuals for review.

Standard Operating Procedures (SOPs) for field, laboratory, and data management tasks have been developed and updated on a regular basis in order to maintain procedural consistency. The maintenance of SOP Manuals will provide project personnel with a reference guide for training new personnel as well as a standardized information source that personnel can access.

8.1.1 Recommended Training for Continuous Monitoring Field Personnel

Proper training of field personnel represents a critical aspect of quality control. Field technicians are trained to conduct a wide variety of activities using standardized protocols to ensure comparability in data collection among crews and across geographic areas. At a minimum, it is recommended that each field crew should consist of a Chief Scientist and a minimum of one technician. Minimum recommended qualifications for Chief Scientists should include an M.S. degree in biological/ecological sciences or similar related field, and at least three years of experience in field sampling/field data collection activities, or a B.S. degree and at least five years experience. The remaining crew members generally are recommended to hold B.S. degrees in the appropriate disciplines as just described, and preferably, at least one year's experience in field sampling/field data collection activities.

When a boat is required for sample collection activities, the vessel operator should be an experienced boat handler or should be certified as having completed at least minimal U.S. Coast Guard boating safety training for the appropriate respective vessel. The vessel operator should also be well versed in the safe and correct operation of on-board sample collection equipment and processes, including navigation skills and the use of GPS equipment. The vessel itself shall contain all proper U.S. Coast Guard-required personal floatation devices and other safety gear, have current state registration, and be in good operation and maintenance condition.

When SCUBA diving is required, all personnel will be required to meet the requirements set forth in the M&A Diving Safety Program, as specified in the M&A Diving Safety Manual (Appendix C).

8.1.2 Safety Guidelines for Field Activities

Personnel conducting any field activities will be well versed in standard safety procedures for such activities, in accordance with the project-specific Health and Safety Plan (HASP) provided in Appendix D. It is the responsibility of the QA officer or Safety

Officer or Supervisor, or designee, to ensure that safety training is mandatory for all field personnel, and that such training is documented in training certifications/records maintained and updated for all participating field staff.

8.2 Training and Certification Documentation

CRG Laboratory, SCCWRP, EWA, MACTEC, and M&A maintain records of their training. Those records can be obtained if needed through the QA Officer at each office.

In addition to in-field training and certification/documentation of such training, all crews will be evaluated on their field performance during field QA audits conducted by M&A QA Manager. It is recommended that the conducting of such field performance audits be conducted for at least 10% if the anticipated effort. If any deficiencies within a crew are noted during this QA audit, they will be documented and remedied prior to continued field sampling. This can be accomplished by additional training or by changing crew composition, but verification of correction of any deficiencies must be documented in writing prior to the resumption of further sample collection activities. It is the responsibility of any and all SWAMP entities conducting field sample collection and field data measurements to develop and implement internal training and QA audit "checklists". Copies must be maintained in a central file by each SWAMP entity of all internal training and QA audit reports completed, as well as documentation of any deficiencies and corrective actions necessary to remedy such deficiencies. When requested, these records must be accessible to, or copies provided to, the SWAMP QA Program.

8.3 Training Personnel

Personnel training involves the use of SOPs, hands-on instruction by the field or laboratory manager, and the use of QA samples to ensure adequate accuracy, precision, and noncontamination. Ongoing QA samples help to document the success of the initial training. The QA Officers for CRG, SCCWRP, and EWA provide training to laboratory personnel. University laboratories' supervisors provide training to personnel. MACTEC's Project Scientist provides training to field personnel. M&A's Project Scientist provides training to their field personnel.

For training of field staff, all sampling equipment (e.g., boats, field instruments and field data equipment, grabs, etc.), and all pertinent sample collection protocols will be used extensively during "hands-on" training sessions (actual field sample collection trips). By the end of the sampling training trip(s), all crew members must demonstrate proficiency in all the required sampling activities, as certified by the Chief Scientist for the training session(s), as documented in training records developed and maintained for all SWAMP field and lab personnel.

9. DOCUMENTS AND RECORDS

Records generated by this project will be stored at MACTEC. Internal records from CRG, SCCWRP, EWA, UCSB, and UGA that are pertinent to this study will be maintained at their respective offices. Copies of all internal records held by CRG, SCCWRP, EWA, UCSB, and UGA will be provided to MACTEC upon request of the Project Manager or QA officer.

Persons responsible for maintaining records for this project are as follows. The Project Manager will maintain all sample collection, sample transport, chain of custody, field analyses forms, all records associated with the receipt and analysis of samples analyzed for all parameters, and all records submitted by the analytical laboratories. CRG's QA officer will maintain CRG's records. The laboratory director/manager/supervisors at the public agency/university laboratories will maintain their respective analytical laboratory records. The Project Manager will oversee the actions of these persons and will arbitrate any issues relative to records retention and any decisions to discard records.

All data will be entered into an electronic database using a set of standardized data protocols for data entry and sharing. Database tables will include information on the location and character of each sampling site, physical and or biological features, hydrographs and results of the chemistry analyses.

All field results will be recorded at the time of completion, using standard field data sheets similar to those in Appendix E. Data sheets will be reviewed for outliers and omissions before leaving the sample site. Chain of custody forms will be completed for all water samples before leaving each sampling site. Data sheets and chains of custody will be stored by MACTEC in hard copy form for three years from the time the study is completed. The directory where the files are stored are backed up nightly on a second hard drive, and backed up monthly off-site.

Copies of this QAPP will be distributed to all parties involved with the project, including field collectors and laboratory analysts by Project Manager. Copies will be sent to CRG, SCCWRP, EWA, UCSB, and UGA for distribution within these labs. Any future amended QAPPs will be distributed in the same fashion. All originals of this and subsequent amended QAPPs will be held at MACTEC. Copies of versions, other than the most current, will be discarded so as not to create confusion.

9.1 Quarterly Reports

This work shall be performed in accordance with Section A10 of the adopted (and amended) IO and Section III of the Workplan. Data will be provided in electronically submitted quarterly reports containing monitoring results collected from 90 to 120 days (or sooner) prior to the reporting due date. The data reports shall consist of electronic copies of laboratory results, including quality assurance/quality control data, in either WORD or PDF format and data compilations is EXCEL spreadsheet format. The reports will identify the analytical methods used, detection limits obtained for each reported constituent, and a map showing the location of the monitoring stations. The data will be SWAMP compatible and in the standardized format developed in conjunction with SCCWRP.

Data will be submitted via email to the SDRWQCB on a quarterly basis per the schedule provided in Section 6, Table 7. SCCWRP, TetraTech and the Responsible Parties will be carbon-copied (cc:) on each of these emails.

MACTEC will perform quality assurance and quality control measures to ensure that the Data Reports are accurate. Data shall be reported quarterly as promptly after it is collected and analyzed as possible.

9.2 Final Report

A Final Data Report, inclusive of all project data, will be provided. The report shall include monitoring data sets, data analysis, and quality assurance reports for all project data. Data analysis shall also include graphical and tabular formats, an analysis and presentation of appropriate data (such as pollutagraphs, pollutant concentration maps, etc.), and tables showing basic statistical analysis and basic conclusions that can be drawn from the data. The level of data analysis required in for the project in the final fiscal year of implementation (2008-2009) will be determined and coordinated with the Responsible Parties prior to the start of that fiscal year.

All laboratory data will be compiled in a relational database format including metadata. Electronic data from field instruments (i.e., flow data) will be downloaded in the field and appended to this database following the guidelines established in the field sampling SOP (Appendix F). Raw data, statistical data reports, and reports will also be stored at MACTEC for not less than 5 years. Written reports will be provided to the SDRWQCB.

GROUP B DATA GENERATION AND ACQUISITION

10. SAMPLING PROCESS DESIGN

A complete description of the sampling process design can be found in Sections 6.1.1 and 6.1.2 of this QAPP, as well as this project's Work Plan (Appendix A).

10.1 General Sampling Design

The samples to be collected for the present project include dry weather flows, wet weather runoff, estuary waters and sediment. The sampling locations are indicated in Figures 2 through 5. For each lagoon there is one mass emission site to collect wet and dry weather flows, one to two lagoon segments to collect estuary samples, one to two ocean inlet sites to collect estuary samples, and a lagoon site to collect post-storm event sediment. Table 24 (Section 13) provides an inventory of sampling effort by matrix.

10.2 Sampling Period

Sampling will take place during the wet weather season of 2007-2008 during three or more storms, and during the dry season in 2008. Continuous monitoring will take place for primary parameters for 12 months between October 2007 and 2008 and during periods which occur during wet and dry weather. Please refer to Table 9 for the monitoring program schedules

Table 9. Schedule of Monitoring Programs.

Monitoring Program	Target Sampling Period
Continuous Monitoring at Mass Emission, Lagoon Segment, and Ocean Inlets[1]	Mass Emission Site: October 2007-October 2008 Lagoon Segments/Ocean Inlets: Wet Weather (3 months: January –March 2008) Dry Weather (4 months: Mid-June-Mid-October 2008) (Agua Hedionda: July-September 2008)
Wet Weather Pollutagraph (2 storm events)	January – March 2008[2]
Wet Weather Lagoon Storm Sampling (3 storm events)	January – March 2008
Wet Weather Ocean Inlet* (3 storm events)	January – March 2008
Post Storm Event Sediment Sampling (3 storm events)	January – March 2008
Dry Weather Storm Drain Sampling	February 2008, April 2008, July 2008, September 2008
Dry Weather Index Lagoon Segment (4 periods, 7 days each, over 2 weeks)	February 2008, April 2008, July 2008, September 2008
Dry Weather Index Ocean Inlet* (4 periods, 7 days each, over 2 weeks)	February 2008, April 2008 July 2008, September 2008
Dry Weather Index Mass Emission (4 periods, 7 days each, over 2 weeks)	February 2008, April 2008 July 2008, September 2008
Dry Weather Index Transect Sampling (4 periods, 7 days each, over 2 weeks)	February 2008, April 2008 July 2008, September 2008

[1]Buena Vista Lagoon has no open ocean inlet.
[2] *Wet weather storm event sampling may be implemented prior to 1/01/08 (after 10/01/2007) if a storm event occurs that meets sampling criteria and field/laboratory staff/equipment are in place.

10.3 Sampling

10.3.1 Continuous Monitoring for Hydrology and Chemical Parameters

Monitoring of hydrology and core chemical parameters (salinity, temperature, turbidity, and water-level and flow) will be measured via in-situ probes installed at the mass emission site, within each segment, and at the ocean outlet at discrete depths.

Water level will be measured at the segment and ocean inlet sites, and flow will be measured at the mass emission site. For the lagoons listed for eutrophication (San Elijo Lagoon, Loma Alta Slough, and Buena Vista Lagoon), pH and dissolved oxygen will be measured during index sampling periods. Buena Vista Lagoon is never open to tidal exchange and, consequently, no ocean inlet site will be monitored. In each of the watersheds, data from a minimum of one rainfall station must be acquired.

Table 10 is a list of the number of stations for moored continuous monitoring of hydrodynamics and water quality for each lagoon. Tables in subsequent sections indicate specifically which chemical parameters will be measured continuously and the minimum frequency and/or duration during index periods and outside of index periods.

Table 10. Number of monitoring stations for continuous monitoring of hydrodynamics and water quality

<table>
<tr><th rowspan="2">Type</th><th rowspan="2">Analyte</th><th colspan="4">Lagoon</th></tr>
<tr><th>Loma Alta</th><th>Agua Hedionda</th><th>Buena Vista</th><th>San Elijo</th></tr>
<tr><td>Lagoon Bathymetry</td><td>Bathymetry</td><td colspan="4">Assumed all lagoons have bathymetry data</td></tr>
<tr><td>Weather Station</td><td>Rainfall, wind speed and direction, air temperature, % humidity</td><td colspan="4">Minimum of one site per watershed measured daily over one year</td></tr>
<tr><td rowspan="6">Mass Emission Site</td><td>Temperature</td><td rowspan="6">1 site/ lagoon</td><td rowspan="4">1 site/ lagoon</td><td rowspan="6">1 site/ lagoon</td><td rowspan="6">1 site/ lagoon</td></tr>
<tr><td>Conductivity</td></tr>
<tr><td>Turbidity[1]</td></tr>
<tr><td>Flow</td></tr>
<tr><td>Dissolved Oxygen[2]</td><td rowspan="2">N/A</td></tr>
<tr><td>pH[3]</td></tr>
</table>

[1] To be measured during index periods only
[2] To be measured during index periods only
[3] To be measured during index periods only

Table 10. Number of monitoring stations for continuous monitoring of hydrodynamics and water quality (continued)

Type	Analyte	Lagoon			
		Loma Alta	**Agua Hedionda**	**Buena Vista**	**San Elijo**
Lagoon Segment	Temperature	1 site	1 site	2 sites	2 sites
	Conductivity				
	Turbidity				
	Water Level				
	Dissolved Oxygen[3]		N/A		
	pH[4]				
Ocean Inlet[4]	Temperature	1 site/ lagoon	2 sites (1 at tidal inlet and at I-5 bridge)	No ocean inlet	1 site/ lagoon
	Conductivity				
	Turbidity				
	Water Level				
	Dissolved Oxygen[3]		N/A		
	pH[4]				

10.3.2. Watershed Hydrology and Pollutagraph Sampling

10.3.2.1 Pollutagraph Sampling

Watershed loading during wet weather will be estimated from pollutagraphs generated during storm events. Though prediction of the amount of rainfall in each storm prior to the event is not possible, a best effort should be made using pre-storm weather forecasts to sample storms with rainfall spanning a range from 0.2 inch to 1 inch or greater and spanning a range of sizes.

Pollutagraph sampling at mass emission sites will occur during two storm events in Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon, and Agua Hedionda Lagoon, with eight samples taken throughout the pollutagraph per storm. Five pollutagraph samples will be collected per storm for bacteria analysis. In addition to the chemical constituents required for a given impairment, all lagoons will monitor particle size distribution at the mass emission sites.

Table 11 lists the total number of samples required for pollutagraph sampling for each lagoon.

[4] To be measured only when lagoon mouth is open.

Table 11. Minimum number of samples for pollutagraph sampling by lagoon and targeted analytes.

Type	Analyte	Lagoon			
		Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Core	Temperature	Fixed site at ME			
	Conductivity	Fixed site at ME			
	Turbidity	Fixed site at ME			
	Total Suspended Solids (TSS)	16	16	16	16
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	16	--	--
Bacteria	Total Coliform	10	10	10	10
	Fecal Coliform	10	10	10	10
	Enterococcus	10	10	10	10
Eutrophication	pH	--			
	Dissolved Oxygen (DO)	--			
	Total Nitrogen (TN)	16	--	16	16
	Total Phosphorus (TP)	16	--	16	16
	Total Dissolved Nitrogen (TDN)	16	--	16	16
	Total Dissolved Phosphorus (TDP)	16	--	16	16
	Nitrate+Nitrite-N	16	--	16	16
	Ammonium	16	--	16	16
	Soluble Reactive Phosphorus (SRP)	16	--	16	16
	Chlorophyll a	--	--	--	--
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	16	--	16	16
Particle size of Suspended Sediment or Sediment	% Fines or %Sand/Silt/Clay	16	16	16	16
	% Organic Carbon (%OC)	--	--	--	--
	% Organic Nitrogen (%ON)	--	--	--	--
	% Total Phosphorus (%TP)	--	--	--	--

Note Fixed site refers to instrumentation continuously measuring water quality parameters at the ME site.
[1]To be measured only when lagoon mouth is open.

10.3.2.2 Lagoon Storm Sampling

Storm event sampling within the lagoon will be conducted simultaneously with pollutagraph sampling and ocean inlet sampling during storm events. Because Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon and Agua Hedionda Lagoon are only required to sample two pollutagraphs, as compared to other lagoons in this region but not part of this monitoring program, the third within lagoon storm event sampling should correspond to one of the two EMC storms monitored through the San Diego Regional Monitoring Program. The influence of a storm on the lagoon may lag the onset of the storm and that lag period will vary with each lagoon. The anticipated lag time (i.e., the amount of time after a storm's onset before the lagoon is affected) as well as readings recorded by the submerged salinity probe will be used to initialize a sampling program. An autosampler will be used, therefore many samples will be collected over the storm, and a subset of samples could be selected based on the salinity of the sample, the turbidity of the sample, and the targeted period (slack high and low tide). The sampling protocol allows the selection of samples that best represent the freshwater plume as it moves through the lagoon. Locations of autosamplers within lagoon segments are listed in Table 5 and shown in Figures 2 through 5. Table 12 gives the number of samples associated with this effort.

Sample numbers for in-situ monitoring of hydrology, core chemical parameters, and discrete water quality samples for all analytes are described in the workplan assuming a 2-meter depth at each site. The actual number of vertical depths at which probes and samplers will be deployed will be based on the total depth at a given site, based on the following rule set:

- One depth (mid-depth) will be monitored for sites less than 2 meters deep
- 2 vertical depths (surface and bottom) will be monitored for sites between 2 and 4 meters deep
- 3 vertical depths (surface, mid-depth, and bottom) will be monitored for sites greater than 4 meters deep

Based on these criteria, all lagoons with the exception of Agua Hedionda Lagoon will deploy probes and samplers for a single depth. Agua Hedionda Lagoon, Segment 1, will require probes and samplers deployed at 2 vertical depths. The sampling numbers in Table 12 reflect the additional samples required at Agua Hedionda Lagoon.

Table 12. Wet weather lagoon storm sampling.

Type	Analyte	Lagoon			
		Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Core	Temperature	Moored Site			
	Conductivity	Moored Site			
	Turbidity	Moored Site			
	Total Suspended Solids (TSS)	6	12*	12	12
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	--	--
Bacteria	Total Coliform	6	12*	12	12
	Fecal Coliform	6	12*	12	12
	Enterococcus	6	12*	12	12
Eutrophication	pH	--	--	--	--
	Dissolved Oxygen (DO)	--	--	--	--
	Total Nitrogen (TN)	6	--	12	12

Table 12. Wet weather lagoon storm sampling. (continued)

	Total Phosphorus (TP)	6	--	12	12
	Total Dissolved Nitrogen (TDN)	6	--	12	12
	Total Dissolved Phosphorus (TDP)	6	--	12	12
	Nitrate+Nitrite-N	6	--	12	12
	Ammonium	6	--	12	12
	Soluble Reactive Phosphorus (SRP)	6	--	12	12
	Chlorophyll a	6	--	12	12
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	6	--	12	12
Suspended Sediment or Sediment	% Fines or %Sand/Silt/Clay	--	--	--	--
	% Organic Carbon (%OC)	--	--	--	--
	% Organic Nitrogen (%ON)	--	--	--	--
	% Total Phosphorus (%TP)	--	--	--	--

Moored site refers to instrumentation to continuously measure water quality parameters within each segment.
* Sampling numbers reflect two discrete vertical depths to be sampled at Segment 1 in Agua Hedionda Lagoon

10.3.2.3 Ocean Inlet Sampling

Sampling at the ocean inlet will be conducted simultaneously with pollutagraph and within lagoon sampling during each of the three storm events. As with lagoon segment sampling, ocean inlet sampling during storm events will be conducted using an autosampler deployed at a fixed location in each lagoon and the storm lag will be considered. Ocean inlet autosampler locations are listed in Table 5 and shown in Figures 2 through 5.

Table 13 gives the number of samples associated with this effort.

Table 13. Wet weather ocean inlet sampling.

Type	**Analyte**	**Lagoon**			
		Loma Alta	**Agua Hedionda**	**Buena Vista**	**San Elijo**
Core	Temperature	Moored Site			
	Conductivity	Moored Site			
	Turbidity	Moored Site			
	Total Suspended Solids (TSS)	6	6		6
Total Dissolved	Total Dissolved Solids	--	--	--	--

Table 13. Wet weather ocean inlet sampling. (continued)

Type	Analyte	Lagoon			
		Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Solids	(TDS)				
Bacteria	Total Coliform	6	6	--	6
	Fecal Coliform	6	6	--	6
	Enterococcus	6	6	--	6
Eutrophication	pH	--	--	--	--
	Dissolved Oxygen (DO)	--	--	--	--
	Total Nitrogen (TN)	6	--	--	6
	Total Phosphorus (TP)	6	--	--	6
	Total Dissolved Nitrogen (TDN)	6	--	--	6
	Total Dissolved Phosphorus (TDP)	6	--	--	6
	Nitrate+Nitrite-N	6	--	--	6
	Ammonium	6	--	--	6
	Soluble Reactive Phosphorus (SRP)	6	--	--	6
	Chlorophyll a	6	--	--	6
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	6	--	--	6
Particle Size in Suspended Sediment or Sediment	% Fines or %Sand/Silt/Clay	--	--	--	--
	% Organic Carbon (%OC)	--	--	--	--
	% Organic Nitrogen (%ON)	--	--	--	--
	% Total Phosphorus (%TP)	--	--	--	--

Moored site refers to instrumentation to continuously measure water quality parameters within each segment.

10.3.2.4 Post-storm Event Sediment Sampling

Post-storm event sediment sampling at all lagoons will occur within two weeks after one of the storm events sampled and will be coordinated with SCCWRP. In order to trigger the sampling, the storm should be generally ±50 % of the median storm. Sediment samples will be collected from a small vessel or on foot using a ponar or grab sampler, with only the top 2 cm deep retained. Table 14 gives the number of samples associated with this effort. Each grab will be observed to determine acceptability, which is defined as an intact sample with no blow out or other indications that the top layer has been disturbed. Sampling locations will be recorded by GPS, and a field log will be maintained noting the sampling location, sample ID, GPS location, time, number of grabs, water depth, climatic conditions, and any additional comments. A composite sample from each site will be collected in pre-cleaned containers that have been triple rinsed with water from the sample site and will be analyzed for the parameters listed in Table 14. All equipment will be rinsed prior to deployment to maintain sample integrity and avoid any contamination.

Table 14. Post-storm event sediment sampling.

Type	Analyte	Lagoon			
		Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Suspended Sediment or Sediment	% Fines or %Sand/Silt/Clay	5	30	20	35
	% Organic Carbon (%OC)	5	--	20	35
	% Organic Nitrogen (%ON)	5	--	20	35
	% Total Phosphorus (%TP)	5	--	20	35

10.3.3. Monitoring of Dry Weather Sources and Within Lagoon Hydrodynamics and Water Quality

Dry weather monitoring consists of storm drains, each mass emission site, ocean inlet, and within lagoon sampling sites during key “index” periods. These index periods are intended to capture representative seasonal cycles of physical forcing and biological activity in the lagoon.

Dry weather sampling is sub-divided into two sections, each of which is detailed below:

- Storm drain and other point source sampling
- Index period monitoring of lagoon segments, the ocean inlet, mass emission site and lagoon longitudinal transects

10.3.3.1 Storm Drain and Other Point Source Sampling

Flow rates and analyte concentration will be measured once per index period at those drains that represent 80% of the target constituent loading into each lagoon. Point sources specific to individual lagoons (e.g., a large tributary that flows into the lagoon downstream of the mass emission site) will also be sampled once per index period in addition to the storm drain sampling. Table 15 lists the storm drain sampling sites for each lagoon. Table 16 gives the number of samples associated with this effort.

Table 15. Storm drain and point source sampling sites for each lagoon.

Lagoons	Storm Drain and Point Source/Tributary Sites			
	Description	ID	Latitude	Longitude
Loma Alta	Storm Drain	L054	33.18350	-117.36476
	Tributary	LA Trib	33.18248	-117.36512
Buena Vista	Storm Drain	BV Lag 1	33.18063	-117.34251
	Storm Drain	BV Lag 2	33.18058	-117.34250
Agua Hedionda	Storm Drain	AH-006	33.14627	-117.33790
	Storm Drain	AH-25	33.13816	-117.33578
San Elijo	Tributary- La Orilla Creek	LOR	33.01056	-117.24000
	Storm Drain	CBS-2	33.01667	-117.28139

Table 16. Storm drain sampling.

Type	Analyte	Lagoon			
		Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Core	Temperature	Hand held			
	Conductivity	Hand held			
	Turbidity	Hand held			
	Total Suspended Solids (TSS)	8	12	8	8
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	--	--
Bacteria	Total Coliform	8	12	8	8
	Fecal Coliform	8	12	8	8
	Enterococcus	8	12	8	8
Eutrophication	pH	Hand held	--	Hand held	Hand held
	Dissolved Oxygen (DO)	Hand held	--	Hand held	Hand held
	Total Nitrogen (TN)	8	--	8	8
	Total Phosphorus (TP)	8	--	8	8
	Total Dissolved Nitrogen (TDN)	8	--	8	8
	Total Dissolved Phosphorus (TDP)	8	--	8	8
	Nitrate+Nitrite-N	8	--	8	8
	Ammonium	8	--	8	8
	Soluble Reactive Phosphorus (SRP)	8	--	8	8
	Chlorophyll a	8	--	8	8
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	8	--	8	8

Note: Hand held refers to parameters measured over specified period with hand held device.

10.3.3.2 Index Period Monitoring

The following section covers sampling of all constituents during the index periods within lagoon segments, at ocean inlets, at mass emission sites, and along longitudinal transects. Index periods are intended to capture representative seasonal cycles of physical forcing and biological activity in the lagoon.

There will be four index periods for each lagoon. Each index period will be seven days in length and will be split over a two week time period.

10.3.3.2.1 Lagoon Segment Sampling

Sampling at each segment site constrains intra-lagoon variability in target constituents, as well as daily variations at each individual segment. Sample numbers for in-situ monitoring of hydrology, core chemical parameters, and discrete water quality samples for all analytes are described in the workplan assuming a 2-meter depth at each site. The actual number of vertical depths at which probes and samplers will be deployed will be based on the total depth at a given site, based on the following rule set:

- One depth (mid-depth) will be monitored for sites less than 2 meters deep
- 2 vertical depths (surface and bottom) will be monitored for sites between 2 and 4 meters deep
- 3 vertical depths (surface, mid-depth, and bottom) will be monitored for sites greater than 4 meters deep

Based on these criteria, all lagoons with the exception of Agua Hedionda Lagoon will deploy probes and samplers for a single depth. Agua Hedionda Lagoon, Segment 1, will require that probes and samplers deployed at 2 vertical depths. The sampling numbers in Table 17 reflect the additional samples required at Agua Hedionda Lagoon. Table 4 lists the number of segments per lagoon.

Table 17. Lagoon water quality sampling within segments during index periods.

Type	Analyte	Lagoon			
		Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Core	Temperature	Moored Site			
	Conductivity	Moored Site			
	Turbidity	Moored Site			
	Total Suspended Solids (TSS)	48	96*	48	96
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	--	--
Bacteria	Total Coliform	48	96*	48	96
	Fecal Coliform	48	96*	48	96
	Enterococcus	48	96*	48	96
Eutrophication	pH	Moored	--	Moored	Moored
	Dissolved Oxygen (DO)	Moored	--	Moored	Moored
	Total Nitrogen (TN)	48	--	48	96
	Total Phosphorus (TP)	48	--	48	96
	Total Dissolved Nitrogen (TDN)	48	--	48	96
	Total Dissolved Phosphorus (TDP)	48	--	48	96
	Nitrate+Nitrite-N	48	--	48	96
	Ammonium	48	--	48	96
	Soluble Reactive Phosphorus (SRP)	48	--	48	96
	Chlorophyll a	48	--	48	96
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	48	--	48	96

Note Moored site refers to instrumentation to continuously measure water quality parameters within each segment.
* Sampling numbers reflect two discrete vertical depths to be sampled at Segment 1 in Agua Hedionda Lagoon

10.3.3.2.2 Ocean Inlet Sampling

The ocean inlet will be monitored over each index period in order to constrain the tidal exchange across the inlet over each of the index periods. This sampling will be conducted at all lagoons except Buena Vista, which has no tidal exchange. For all other lagoons, if the mouth of the lagoon is closed during the index period, then ocean inlet sampling is not required. Ocean inlet sampling should correspond with index period sampling of lagoon segments and mass emission sites Table 18 indicates the sampling effort at the ocean inlet during all index periods.

Table 18. Ocean inlet sampling during index periods.

Type	Analyte	Lagoon			
		Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Core	Temperature	Moored Site			
	Conductivity	Moored Site			
	Turbidity	Moored Site			
	Total Suspended Solids (TSS)	48	48	--	48
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	--	--
Bacteria	Total Coliform	48	48	--	48
	Fecal Coliform	48	48	--	48
	Enterococcus	48	48	--	48
Eutrophication	pH	Moored	--	--	Moored
	Dissolved Oxygen (DO)	Moored	--	--	Moored
	Total Nitrogen (TN)	48	--	--	48
	Total Phosphorus (TP)	48	--	--	48
	Total Dissolved Nitrogen (TDN)	48	--	--	48
	Total Dissolved Phosphorus (TDP)	48	--	--	48
	Nitrate+Nitrite-N	48	--	--	48
	Ammonium	48	--	--	48
	Soluble Reactive Phosphorus (SRP)	48	--	--	48
	Chlorophyll a	48	--	--	48
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	48	--	--	48

Note Moored site refers to instrumentation to continuously measure water quality parameters within each segment. The site will be fixed to a structure or moored to bottom.

10.3.3.2.3 Mass Emission Site Sampling

Loading from the watershed will be estimated by monitoring the mass emission site over each of the index periods, conducted simultaneously with sampling of the lagoon segments and ocean inlet sites. Table 19 indicates the sampling effort at the mass emission site during all index periods.

Table 19. Mass emission site sampling during index periods.

Type	Analyte	Lagoons			
		Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Core	Temperature	Fixed Site			
	Conductivity	Fixed Site			
	Turbidity	Fixed Site			
	Total Suspended Solids (TSS)	24	24	24	24
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	24	--	--
Bacteria	Total Coliform	24	24	24	24
	Fecal Coliform	24	24	24	24
	Enterococcus	24	24	24	24
Eutrophication	pH	Fixed	--	Fixed	Fixed
	Dissolved Oxygen (DO)	Fixed	--	Fixed	Fixed
	Total Nitrogen (TN)	24	--	24	24
	Total Phosphorus (TP)	24	--	24	24
	Total Dissolved Nitrogen (TDN)	24	--	24	24
	Total Dissolved Phosphorus (TDP)	24	--	24	24
	Nitrate+Nitrite-N	24	--	24	24
	Ammonium	24	--	24	24
	Soluble Reactive Phosphorus (SRP)	24	--	24	24
	Chlorophyll a	24	--	24	24
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	24	--	24	24

Note Fixed site refers to instrumentation to continuously measure water quality parameters at the mass emission site.

10.3.3.2.4 Transect Sampling

Longitudinal transect sampling will be conducted along a salinity gradient in each lagoon. Samples will be collected either from a small vessel or on foot at designated locations using GPS during flood and ebb tide (morning and evening for Buena Vista) on the fourth day of week 1 of each index period (see Table 22). The number of transect locations in each lagoon is scaled to the size of each lagoon. The number transect locations per lagoon for the first and second transects as well as the locations for transect sampling are given in Table 20. Table 21 shows the transect sampling level of effort for each lagoon. At each sampling location, discrete water samples will be collected in sample bottles that have been cleaned according to specifications and triple rinsed with sample water before filling. Water samples should be collected just below the water surface (0.1m) for parameters listed in Table 21. Salinity, temperature, turbidity, dissolved oxygen, turbidity, and pH will be measured at each site in triplicate with a hand-held probe and recorded in field log book with the GPS coordinates for each sampling site. A simple map should be sketched into the log book indicating the approximate location of each transect site. If a lagoon does not have a salinity gradient, transect sampling will take place every 30 to 50 feet mid-channel initiating from the ocean inlet. QA/QC samples will also be collected per SWAMP requirements and in accordance with the Workplan.

Table 20. Number of transect samples by lagoon.

Lagoon	Transect 1: 1st of index period	Transect 2: 2nd of index period	Location
Loma Alta	8	8	Along salinity gradient
Agua Hedionda	3	3	In eastern-most basin only[1]
Buena Vista	10	10	5 in eastern most basin, 5 in central basin
San Elijo	18	18	3 in eastern most basin and 15 in western-most basin (along salinity gradient and with spatial coverage of whole basin)

[1] Note:Workplan incorrectly stated this to be the western-most basin.

Table 21. Transect sampling during index periods.

Type	Analyte	Lagoons			
		Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Core	Temperature	Hand held			
	Conductivity	Hand held			
	Turbidity	Hand held			
	Total Suspended Solids (TSS)	64	24[1]	80	144
Total Dissolved	Total Dissolved Solids (TDS)	--	--	--	--

Type	Analyte	Lagoons			
		Loma Alta	Agua Hedionda	Buena Vista	San Elijo
Solids					
Bacteria	Total Coliform[2]	40	24	24	24
	Fecal Coliform[2]	40	24	24	24
	Enterococcus[2]	40	24	24	24
Eutrophication	pH	Hand held	--	Hand held	Hand held
	Dissolved Oxygen (DO)	Hand held	--	Hand held	Hand held
	Total Nitrogen (TN)	64	--	80	144
	Total Phosphorus (TP)	64	--	80	144
	Total Dissolved Nitrogen (TDN)	64	--	80	144
	Total Dissolved Phosphorus (TDP)	64	--	80	144
	Nitrate+Nitrite-N	64	--	80	144
	Ammonium	64	--	80	144
	Soluble Reactive Phosphorus (SRP)	64	--	80	144
	Chlorophyll a	64	--	80	144
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	24	--	24	24

Note Hand held refers to water quality parameters measured over vertical profile in the water column with hand held device.
[1] Transect samples will only be collected in eastern most basin.
[2] Bacterial indicators will be analyzed for up to 5 samples/transect/index period for each lagoon. All samples/transect/index period will be analyzed for Agua Hedionda Lagoon.

10.4 Accessibility

Sampling will take place at the mass emission stations, lagoon segments, longitudinal transects, and ocean inlets. Permits will be acquired from the City of Oceanside, City of Carlsbad, City of Encinitas, CalTrans, North County Transit District, County of San Diego, and California Department of Fish and Game for the sampling and access to the sampling sites. The appropriate sampling permits will be obtained before each sampling phase begins.

10.5 Schedule

10.5.1 Continuous Monitoring for Hydrology and Chemical Parameters

Continuous monitoring will occur during two periods in all lagoons. The first period will be wet weather monitoring for three months from January to March, the second will be dry weather monitoring for 4 months from mid-June to mid-October, with the exception of Agua Hedionda lagoon where dry weather monitoring will take place for three months from July through September. Wet weather continuous monitoring will coincide with storm sampling in each of the lagoons when possible. For more information, please refer to Table 10, in Section 10.2.

10.5.2 . Watershed Hydrology and Pollutagraph Sampling

Pollutagraph sampling at mass emission sites will occur during two storm events in Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon, and Agua Hedionda Lagoon. Eight samples will be taken throughout the pollutagraph per storm. Five pollutagraph samples per storm will be analyzed for bacteria. For more information, please refer to Table 10, in Section 10.2.

Storm event sampling within the lagoon will be conducted simultaneously with pollutagraph sampling and ocean inlet sampling during storm events. Because CHU lagoons are only required to sample two pollutagraphs, the third within lagoon storm event sampling should correspond to one of the two storms monitored in the San Diego County Regional Monitoring Program, Order No. 2007-01.

Post-storm event sediment sampling will occur within two weeks after one of the three storm events. In order to trigger this sampling, the storm should be generally ±50 % of the median storm.

10.5.3. Monitoring of Dry Weather Sources and Within Lagoon Hydrodynamics and Water Quality

Flow rates and analyte concentrations in storm drains will be measured once per index period at those drains that represent 80% of the target constituent loading into each lagoon. Point sources specific to individual lagoons (e.g., a large tributary that flows into the lagoon downstream of the mass emission site) should also be sampled once per index period in addition to the storm drain sampling.

Index period sampling is intended to capture representative seasonal cycles of physical forcing and biological activity in the lagoon. There will be four index periods for each lagoon. Each index period will be seven days in length and will be split over a two week time period.

Table 22 provides an example of a sampling schedule for a typical 7-day index period. Within lagoon segment sampling is spread over 6 days during 2 weeks. Transect sampling is conducted on the 4th day of the first week (Table 13). For the six lagoons with four, 7-day index periods, the last two index periods will be sampled in the next fiscal year of the local agencies (i.e., sampling for 3rd and 4th index period will occur in July and September respectively). This applies to mass emission site sampling, lagoon segments, ocean inlet sampling, storm drain sampling, and lagoon transects.

Table 22. Mock up of sampling schedule for a typical index period for all lagoons.

Day	Week 1	Week 2
Mon	Mass Emission Site – 1 x per day Segments & ocean inlet – 2 X per day (1/day for Buena Vista	Mass Emission Site – 1 X per day Segments & ocean inlet – 2 X/day (1/day for Buena Vista Lagoon)

Day	Week 1	Week 2
	Lagoon)	
Tues	Mass Emission Site – 1 x per day Segments & ocean inlet – 2 X per day (1/day for Buena Vista Lagoon)	Mass Emission Site – 1 X per day Segments & ocean inlet – 2 X/day (1/day for Buena Vista Lagoon)
Wed	Mass Emission Site – 1 x per day Segments & ocean inlet – 2 X per day (1/day for Buena Vista Lagoon)	Mass Emission Site – 1 X per day Segments & ocean inlet – 2 X/day (1/day for Buena Vista Lagoon)
Thurs	Transect sampling (ebb and flood tide or AM & PM for Buena Vista Lagoon)	No sampling
Fri	No sampling	
Sat	No sampling	
Sun	No sampling	

10.6 Action plan for changes to site accessibility

Over the course of the project, issues such as flooding or drought, channel migration, and changes in ownership of land or permission to access sites could result in an inability to resample at previously sampled sites. If this occurs, new sites fulfilling the criteria of the old sites will be identified, and changes will be reported to the Grant Manager.

10.7 Reconciliation of natural variation with project information

It must be anticipated that natural variation will play a part in any study that takes place in the natural world, as opposed to a controlled laboratory environment. Such variation can be problematic, as it can result in “noise” in the dataset, which makes it more difficult to pick up the true signals under investigation, and establish relationships between stated predictor and response variables of interest. As part of this study, continuous monitoring will record variations in water quality for periods over a full year. This will allow for a statistical evaluation of natural variation and to normalize for parameters, as necessary, and minimize noise in the dataset.

10.8 Reduction of bias

Bias could affect the results of the work undertaken in this study. A potential source of bias relates to the selection of locations and time of sampling. For example, always sampling at high tide could bias the results. This potential source of bias will be reduced by having field data collectors sample over a range of tidal regimes, and thereby eliminates the potential for bias, and the non-representative data that would result from this bias.

11. SAMPLING METHODS

11.1 Sampling Containers and Equipment

Appropriate pre-cleaned sample containers will be used. Sample bottles and bottle caps will be protected from contact with solvents, dust, or other contaminants. Sample bottles for this project will not be reused until the laboratory has cleaned and blanked the containers.

Sampling requires the manual grab samples or automated collection of composite samples at each of the monitoring and sampling locations. MACTEC has provided the complete sampling SOP which appears in Appendix F. The following sample handling protocols will be followed when collecting samples to minimize the possibility of contamination:

- Manual grab samples will be collected by inserting the sample container under or down current of the storm water discharge, with the container opening facing upstream.

- Automated samples will be collected using a peristaltic pump as part of an autosampler unit. These samples will be composited based on time or flow.

- The sample bottles will be filled to below the neck and just above the shoulder.

- Samples will be packed in ice and will be delivered to the laboratory by field crews in order meet analytical holding times.

Automated samplers used for time weighted composite sampling composite or flow-weighted composite sampling utilize peristaltic tubing draw water through Teflon tubing, and into the sample container. Both the Teflon intake tubing and the silicone peristaltic tubing will be laboratory cleaned and blanked before deployment to the monitoring locations. For the lagoon segment sampling new, blanked tubing will be used for each sampling event. Any equipment which may come in contact with the sample will be cleaned and blanked.

A two-person team will conduct all sampling during storm events, and the sampling team will have access to a cellular phone in order to alert rescue agencies should an accident occur. Sampling will be postponed if the sampling team determines that the conditions are unsafe.

Failure to collect a sample due to safety concerns or technical issues will be promptly reported to the Project Manager, who will determine if any corrective action is needed and make arrangements to collect a replacement sample (if possible). The QA Officer will document sampling failures and the effectiveness of corrective action.

11.2 Continuous Monitoring for Hydrology and Chemical Parameters

Continuous monitoring of water quality parameters will be conducted at each sampling location (mass emission sites, ocean inlet sites, and lagoon segment sites) via a data collection device known as a sonde, which for this study will be a YSI 6920v2. Sondes will be equipped with similar sensors (temperature, conductivity, turbidity, dissolved oxygen, and pH) that meet the reporting limit requirements of Table 5 in the Work Plan, and maintained and calibrated following manufacturer's specifications. The sonde's computer controls data collection and is programmed to collect data at a set time interval, in this case every 15 minutes, to meet the modeling requirements. The sonde is powered by batteries, which will be changed out every two weeks during regular maintenance by field personnel.

Given the possible lagoon sampling locations, which lack any fixed structures to attach the sondes, mooring structures will be fabricated and deployed from a small vessel. The mooring structures will be sufficiently weighted and have secondary back-up measures in place to ensure that it will not move, and the location recorded by a Global Position System (GPS) unit. The number of vertical depths at which sondes will be deployed will be based on the total depth at a given site. In accordance with the requirements of the Work Plan, this will be based on the following:

- One depth (mid-depth) will be monitored for sites less than 2 meters deep
- 2 vertical depths (surface and bottom) will be monitored for sites between 2 and 4 meters deep
- 3 vertical depths (surface, mid-depth, and bottom) will be monitored for sites greater than 4 meters deep.

Table 23 summarizes the required durations and analytical parameters required for monitoring for each lagoon and lagoon segment.

Table 23. Continuous monitoring locations, parameters measured, and duration.

Lagoon	Location/ Segment	Duration	Salinity	Temp	Turbidity	Level	pH	DO	Flow
Loma Alta Slough	**Mass Emission**	Annual	X	X	X[1]		X	X[1]	X
	1	Wet/Dry	X	X	X	X	X[1]	X[1]	
	Inlet[2]	Wet/Dry	X	X	X	X	X[1]	X[1]	
Buena Vista Lagoon	**Mass Emission**	Annual	X	X	X[1]		X	X[1]	X
	1	Wet/Dry	X	X	X	X	X[1]	X[1]	
	2	Wet/Dry	X	X	X	X	X[1]	X[1]	
Agua Hedionda Lagoon	**Mass Emission**	Annual	X	X	X[1]				X
	1	Wet/Dry	X	X	X	X			
	Inlet 1[2]	Wet/Dry	X	X	X	X			
	Inlet 2[2]	Wet/Dry	X	X	X	X			

Table 23. Continuous monitoring locations, parameters measured, and duration. (continued)

Lagoon	Location/ Segment	Duration	Salinity	Temp	Turbidity	Level	pH	DO	Flow
San Elijo Lagoon	**Mass Emission**	Annual	X	X	X[1]		X	X[1]	X
	1	Wet/Dry	X	X	X	X	X[1]	X[1]	
	2	Wet/Dry	X	X	X	X	X[1]	X[1]	
	Inlet[2]	Wet/Dry	X	X	X	X	X[1]	X[1]	

[1]only during index periods
[2]only when mouth open

Wet Season 3 months (Jan to March)
Dry Season 4 months (June to Oct)
Mass Emission 1 year (Oct-Sept)

Data downloads and sonde maintenance will be performed at bi-weekly intervals. During maintenance, a hand held water quality meter (Hydrolab Quanta) will also be deployed and values compared to values from the sonde for Quality Assurance purposes.

11.3. Watershed Hydrology and Pollutagraph Sampling

11.3.1 Pollutagraph Sampling

Pollutagraph sampling consists of collecting discrete grab samples at specified intervals during the storm event. In general, samples should be collected every 30min during increasing stages within the conveyance and every 60min during the decreasing stages portion of the storm event. Field crews will evaluate the stage and flow rates and collect the pollutagraph samples at the appropriate intervals. In most cases, more samples are collected than needed for analysis. MACTEC will evaluate the sample spacing throughout the hydrograph and notify the laboratory of the samples to be analyzed.

11.3.2 Lagoon Storm Sampling

The during-storm lagoon samples will be collected using autosamplers. The samplers will be positioned on the lagoon banks or on floating platforms and collect time-weighted composite samples. Each sample will consist of a 3-hour composite sample; with sample aliquots collected every 15 minutes, during slack high tide and during slack low tide. Therefore, for a storm event, two composite lagoon samples will be collected at each lagoon sampling location. In addition, bacteria grab sample will be collected during the composite sampling routine.

11.3.3 Ocean Inlet Storm Sampling

The during-storm ocean inlet samples will be collected using autosamplers. The samplers will be positioned on the lagoon banks or on floating platforms and collect time-weighted composite samples. Each sample will consist of a 3-hour composite sample; with sample aliquots collected every 15 minutes, during slack high tide and during slack low tide. Therefore, for a storm event, two composite ocean inlet samples will be collected at each sampling location. Samples collected for bacteria will be grab samples taken during the composite sampling routine.

11.3.4 Post-storm Event Sediment Sampling

Sediment samples will be collected from a small vessel (or on foot at Loma Alta Slough) using a ponar or grab sampler, with only the top 2 cm retained. Each grab will be observed to determine acceptability, which is defined as an intact sample with no blow out or other indications that the top layer has been disturbed. Sampling locations will be recorded by GPS, and a field log will be maintained noting the sampling location, sample ID, GPS location, time, number of grabs, water depth, climatic conditions, dominant primary producer communities (macroalgae, benthic algae, SAV) and any additional comments. A picture of each sample will also be recorded. All sediment will be placed in a stainless steel mixing bowl, and homogenized using a stainless steel spoon. If multiple grabs are required to meet volume requirements, sediments from all acceptable attempts will be placed in a stainless steel bowl and homogenized to provide a site composite sample. Composite sample will be collected in pre-cleaned containers that have been triple rinsed with water from the sample site. Samples will be stored on ice until they can be processed for analysis. Sample containers will be labeled and placed into cool ice chests, chain-of-custody forms completed, and shipped or hand delivered to SCCWRP for analysis. Splits from the composite sample will be analyzed for percent fines, percent organic carbon, percent total nitrogen, and percent total phosphorus

11.4. Monitoring of Dry Weather Sources and Within Lagoon Hydrodynamics and Water Quality

11.4.1 Storm Drain and Other Point Source Sampling

The storm drain flow rates and analyte concentrations will be measured once per index period at those drains that represent 80% of the target constituent loading into each lagoon. Point sources specific to individual lagoons (e.g., a large tributary that flows into the lagoon downstream of the mass emission site) will also be sampled once per index period in addition to the storm drain sampling.

Each site visit will include sampling and analysis. Field samples will be collected by grab sample, standing downstream and submerging the sample container immediately below the water surface in the upstream direction, disturbing as little of the bottom material as possible. If practical, the sample will be collected at about 60% of the stream depth (from the surface) in an area of maximum turbulence. If the water level is very low, the water sample will be collected using a clean syringe to fill sample container. Sampling the slowly flowing water near the edge of stream will be avoided. The Horiba 6-parameter probe or comparable instrumentation will be used to measure pH, conductivity, turbidity, dissolved oxygen (DO) and water temperature at each selected location where water exists.

Samples for analytical laboratory analysis will be collected in the appropriate containers (see Table 24 for container type, holding time and necessary preservative for each analyte). The contracting laboratory will provide the appropriate pre-cleaned sample containers with preservative added. Samples will be collected by standing downstream (with the container opening facing upstream) and at the horizontal and vertical center of the stream/creek flow for a more representative sample of the whole stream. For shallow water (less than 6-inches deep), the bottle may be filled from the surface of the stream rather than sample mid-depth. For deeper water, mid-depth will be sampled by leaving the lid on the sample bottle and lowering the bottle to the mid-depth position, then removing the lid and allowing the container to fill. All samples will be stored in an ice chest with ice at approximately 4˚ C until custody is transferred to the analytical laboratory directly or via contracted courier. For site locations, refer to Table 15. for more information on dry weather storm drain sampling procedures and equipment, refer to the Dry Weather Analytical and Field Screening Monitoring Procedures Manual (County of San Diego, 2006), Appendix G

11.4.2 Index Period Monitoring

11.4.2.1 Lagoon Segment Sampling

The index period dry weather lagoon segment samples will be collected using autosamplers. The samplers will be positioned on the lagoon banks or on floating platforms and collect time-weighted composite samples. Each sample will consist of a 3-hour composite sample, with sample aliquots collected every 15-minutes, during slack high tide and during ebb and flood tides. Therefore, for an index period event, two composite lagoon segment samples will be collected at each sampling location. Microbiology samples will be collected as a grab sample during the composite sampling routine.

11.4.2.2 Ocean Inlet Sampling

The index period dry weather ocean inlet samples will be collected using autosamplers. The samplers will be positioned on the lagoon banks or on floating platforms and collect time-weighted composite samples. Each sample will consist of a 3-hour composite sample, with sample aliquots collected every 15-minutes, during ebb and flood tides. Therefore, for an index period event, two composite ocean inlet samples will be collected at each sampling location. Microbiology samples will be collected as a grab sample during the composite sampling routine.

114.2.3 Mass Emission Site Sampling

The index period dry weather mass emissions samples will be collected using autosamplers. The samplers will be positioned at the mass emissions monitoring location and collect time-weighted composite samples. Each sample will consist of a 3-hour composite sample; with sample aliquots collected every 15 minutes, during ebb and flood tides. Therefore, for an index period event, two composite ocean inlet samples will be collected at each sampling location. Microbiology samples will be collected as a grab sample during the composite sampling routine.

11.4.2.4 Transect Sampling

Longitudinal transect sampling will be conducted from a small vessel or on foot at designated locations using GPS during flood and ebb tide (morning and evening for Buena Vista) on the fourth day of week 1 of each index period.

Surface water samples will be collected at each transect site (0.1 m below air/water interface) as grab samples directly into specific sample containers (Table 25), which will be rinsed 3-times with sample water prior to being filled. Sample containers should be placed into the water with the lids secured and opened beneath the water to avoid sampling biofilms on the water surface. Samples collected for nitrate, nitrite, SRP, ammonia, TDN, TDP, and DOC will be syringe filtered immediately through a 0.45 μm filter and stored on ice until they can be frozen for subsequent analysis. Water samples designated for chlorophyll a and TSS will be filtered through a 0.7 μm filter and the filters frozen immediately until analysis. Water samples collected TN, TP, and CBOD will be collected and stored on ice until analysis. Salinity, temperature, turbidity, dissolved oxygen, and pH will be measured with a hand-held probe (Hydrolab Quanta and/or YSI 6929v2).

Sample containers will be labeled with permanent markers and clear tape used to ensure the label remains intact prior to sampling. Disposal gloves will also be used at each location to avoid contamination. A field log will be maintained noting the sampling location, sample ID, GPS location, time, water depth, climatic conditions, and any additional comments. QA/QC samples will also be collected per SWAMP requirements and in accordance with Tables 24 and 25 of the Work Plan. Sample containers will be placed into cool ice chests, chain-of-custody forms completed, and shipped to SCCWRP or other labs for analysis.

Table 24. (Element 11) Sampling locations and sampling methods

Sampling Location	Matrix	Depth (units)	Analytical Parameter	# Samples (include field duplicates)	Sampling SOP #	Sample Volume	Containers #, size, type	Preservation (chemical, temperature, light protected)	Maximum Holding Time: Preparation/ analysis
All surface transect sites	Water	0.1 m below surface,	dissolved oxygen, pH, temperature, salinity, turbidity,	3 (triplicate) per site	Field SOPs	N/A	N/A	N/A	N/A
All surface transect sites	Water	0.1 m below surface,	water column chlorophyll a	1 per site (duplicate 5%)	Field SOPs	500 mL	1, 0. 7 µm filter Whatman GF/F glass fiber filter	Cool to 4°C, dark; freeze	6 h to filter,freeze 30d to analysis
All surface transect sites	Water	0.1 m below surface,	nitrate + nitrite, nitrite, SRP, ammonium	1 of each per site (duplicate 5%)	Field SOPs	120 mL	1, 120 mL polyethylene bottle	Cool to 4°C, dark; filter within 6h, Freeze	30d
All surface transect sites	Water	0.1 m below surface,	TDN and TDP	1 of each per site (duplicate 5%)	Field SOPs	120 mL	1, 120 mL polyethylene bottle	Cool to 4°C, dark; filter within 6h, Freeze	30d
All surface transect sites	Water	0.1 m below surface,	TN and TP	1 of each per site (duplicate 5%)	Field SOPs	120 mL	1, 120 mL polyethylene bottle	4°C, dark, Freeze	30d
All surface transect sites	Water	0.1 m below surface,	TSS	1 per site (duplicate at 5% of sites)	Field SOPs	1000 mL	1, 0. 7 µm filter Whatman GF/F glass fiber filter	4°C, dark	7d to filter,freeze 7d to analysis

Table 24. (Continued)

Sampling Location	Matrix	Depth (units)	Analytical Parameter	# Samples (include field duplicates)	Sampling SOP #	Sample Volume	Containers #, size, type	Preservation (chemical, temperature, light protected)	Maximum Holding Time: Preparation/ analysis
All surface transect sites	Water	0.1 m below surface,	$CBOD_5$	1 per site (duplicate at 5% of sites)	Field SOPs	4 L	1, 4L cubitainer	4°C, dark	48 hours
All surface transect sites	Water	0.1 m below surface,	Total Coliform, Fecal Coliform	1 per site (duplicate at 5% of sites)	Field SOPs	100 mL	1, sterile 120 mL HDPE bottle	Cool to 4°C, dark	6 hours
All surface transect sites	Water	0.1 m below surface,	Enterococcus	1 per site (duplicate at 5% of sites)	Field SOPs	100 mL	1, sterile 120 mL HDPE bottle	Cool to 4°C, dark	6 hours
Post storm event sampling sites	Sedime nt	Top 2cm of surface sediment	Percent Fines	1 per site (duplicate at 5% of sites)	Field SOPs	~500 g wet weight	1, 500 mL amber jar	Cool to 4°C, dark; Oven dry 50°C for 48 h, room temp.	30d
Post storm event sampling sites	Sedime nt	Top 2cm of surface sediment	%OC/ %ON/ %TP	1 per site (duplicate at 5% of sites)	Field SOPs	~500 g wet weight	1, 500 mL amber jar	Cool to 4°C, dark; Oven dry 50°C for 48 h, room temp.	30d

12. SAMPLE HANDLING AND CUSTODY

All sample bottles will be pre-labeled. The labels will contain the sample identification number, the project name, the location the sample was collected, the laboratory the sample is being sent to and the analyses to be performed, and blank spaces for the date, time, and sampler's initials to be completed in the field.

Chains-of-Custody (COCs) will be pre-printed along with the bottle labels. COCs will contain the same data as the labels, in some cases with greater detail. COCs will be completed in the field with dates, times, and sample team names, and will be cross-checked with the bottles to ensure the proper samples have been collected.

When the complete sample has been collected, the sample bottles will be removed from the automated equipment, the label will be filled-out, and the bottles will be immediately placed on ice in a cooler for transportation to the laboratory.

Field personnel will gather coolers from the various sampling locations and meet couriers from the laboratory at pre-determined rendezvous points. Field personnel will coordinate with other team members and the laboratory to make sure deliveries occur frequently enough to meet all holding times specified in Table 24. When custody of the samples is transferred to the courier, the COC will be signed and dated, and a copy made from a portable copy machine for each party. An example of the Chain-of-Custody form is located in Appendix E.

All observations recorded in the field as well as information recorded in processing all field samples in the laboratory will be entered into an Access database. Hard copies of the field and laboratory data sheets will be maintained in a project notebook by the Project Manager, and by laboratory personnel, respectively.

Water samples may be filtered in the field (where appropriate) through 0.45 μm filters. Once sample containers are filled, they will be placed on ice, in a cooler, in the dark and transported to the laboratory for processing within specified holding times. As needed and appropriate, filtration and/or acidification will take place at the sampling sites or in the laboratory. Chlorophyll samples will be filtered immediately using 0. 7 μm Whatman GF/F glass fiber filters following collection. Filters will be kept in the dark (wrapped in aluminum foil) to minimize photodegradation and will be kept frozen until analysis, with a maximum holding time of 30 days. TSS samples will be filtered using 0. 7 μm Whatman GF/F glass fiber filters following collection. Filtrate will be discarded.

Sediment samples will be oven dried at 50oC for 48 hours and homogenized. Sub-samples of each section will be set aside for grain size analysis. The remaining sample will be ground with a Frisch Planetary Micro Mill (Pulverisette 7) to approximately 5 μm in size. Samples destined for % total phosphorus, % organic carbon and % total nitrogen samples will be placed in separate scintillation vials, capped, and shipped for analysis.

All sample containers and preservation methods are provided in Table 24. Transport of the samples to the analytical laboratory will be coordinated by the Project Manager to ensure that all samples are handled and analyzed within the proper holding time. COCs will be reviewed by personnel at the receiving laboratories to ensure that no samples have been lost in transport, and the laboratories will also verify that each sample has been received within necessary holding times.

Custody of all samples will be transferred from the field personnel to CRG Laboratories. CRG will split the samples as appropriate for delivery to remaining team laboratories, and retain a portion of the sample to analyze. Flowcharts diagramming the portioning and ultimate destinations of samples for the various programs are shown in Figures 6 and 7.

Figure 6. Wet Weather Monitoring Lab Analysis/Sample Handling Flow Charts

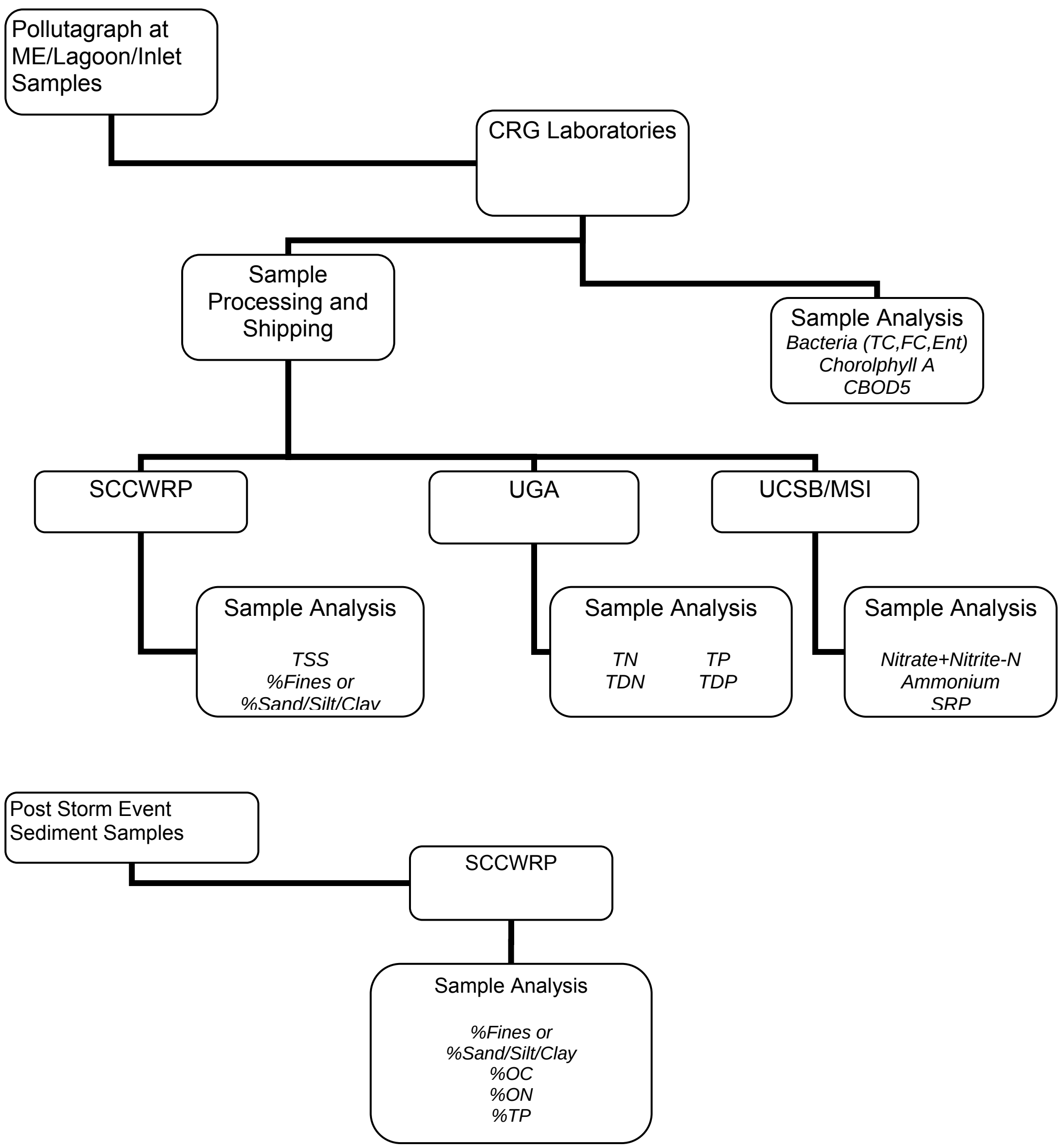
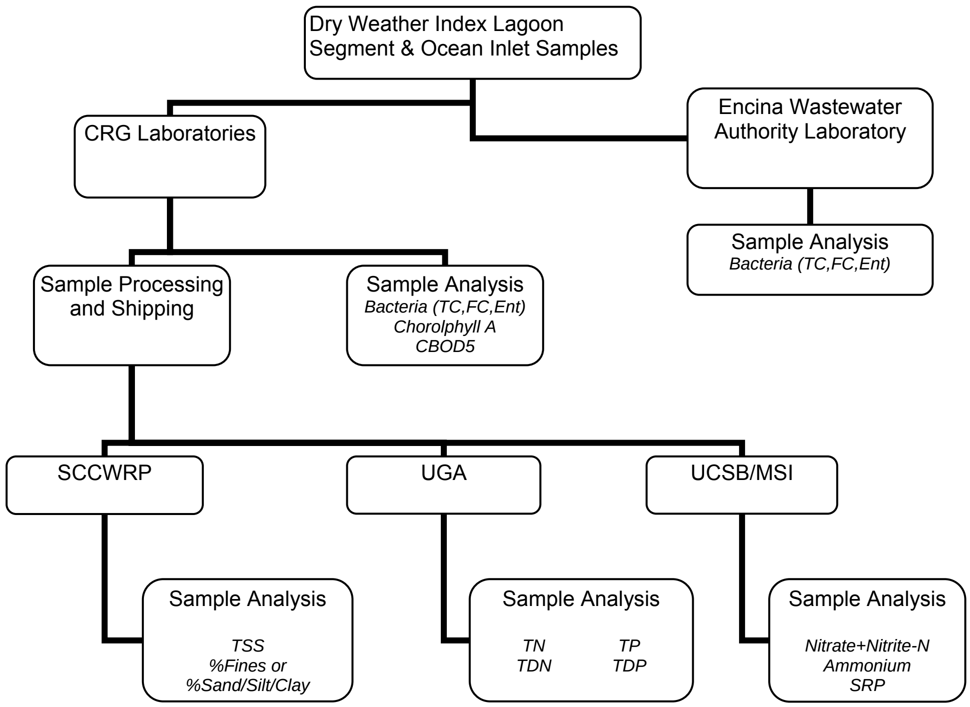
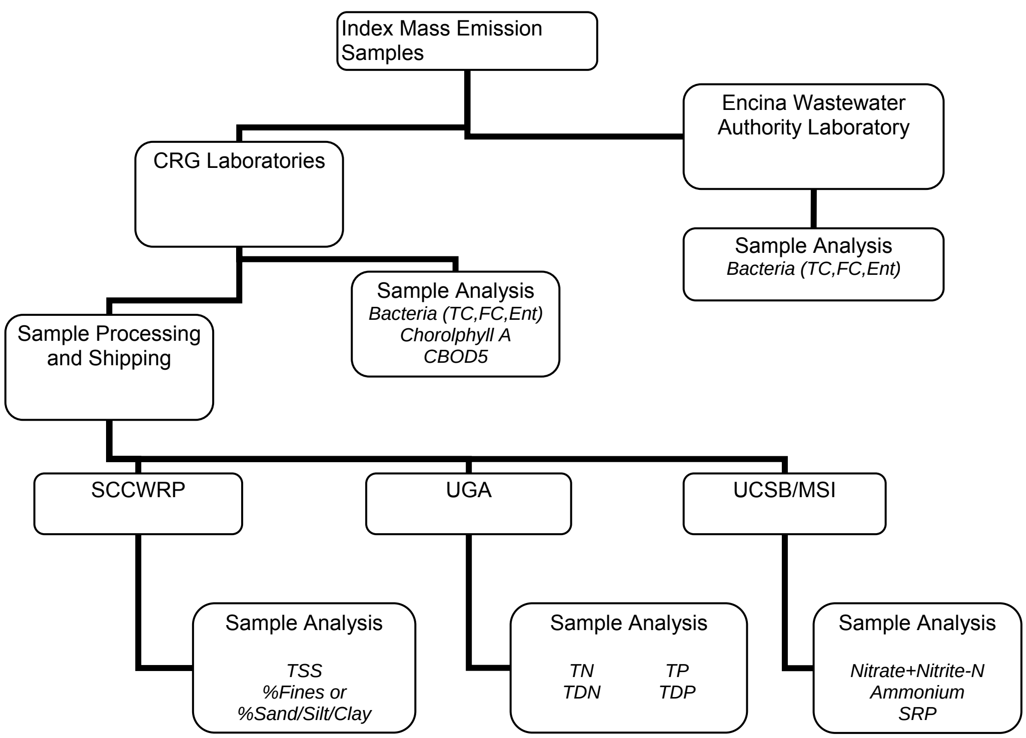
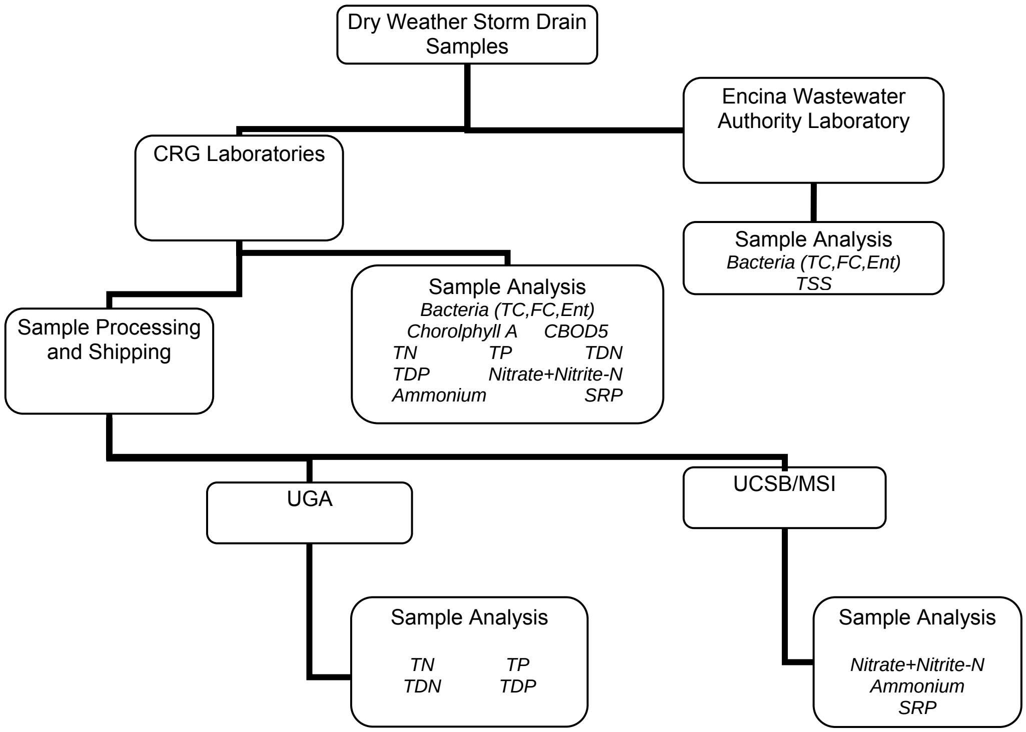


Figure 7. Dry Weather Monitoring Lab Analysis/Sample Handling Flow Charts






Dry Weather Storm Drain Samples
Encina Wastewater Authority Laboratory
CRG Laboratories
Sample Analysis
Bacteria (TC,FC,Ent)
TSS
Sample Analysis
Bacteria (TC,FC,Ent)
Chorolphyll A CBOD5
TN TP TDN
TDP Nitrate+Nitrite-N
Ammonium SRP
Sample Processing and Shipping
UGA
UCSB/MSI
Sample Analysis
TN TP
TDN TDP
Sample Analysis
Nitrate+Nitrite-N
Ammonium
SRP

13. ANALYTICAL METHODS

13.1 Analysis Methods

The samples will be analyzed for chemistry as indicated below.

13.1.1 Temperature, Conductivity, Turbidity, pH and Dissolved Oxygen (DO), and Total Suspended Solids (TSS)

Data sondes deployed at the outlined sampling locations will collect temperature, conductivity, turbidity, pH, DO, and TSS data. The sonde probes will log these parameters and be downloaded at the specified intervals. During the download activities, the probes will be cleaned and calibrated as per the manufactures recommendations.

13.1.2 Total Dissolved Solids (TDS)

Total dissolved solids in the water samples will be analyzed by the laboratory using EPA Approved Method SM 2450-C. The samples will be maintained at 4 degrees Celsius to ensure sample handing protocols are met. Total suspended solids will be analyzed using the gravimetric technique (SM 2540-D).

13.1.3 Microbiology

Samples collected for bacteria analysis will be delivered to the laboratory with 6 hours to meet the microbiological holding times. Samples analyzed for Total Coliform Bacteria will use analytical method SM 9222B. Fecal Coliform will be analyzed using method SM 9222D and Enterococcus will be analyzed using method SM 9230C and/or method EPA 1600.

13.1.4 Eutrophication

Total Nitrogen (TN) and Total Phosphorous (TP) will be analyzed using USGS Method I-4650-03. Total Dissolved Nitrogen (TDN) and Total Dissolved Phosphorus (TDP) will be analyzed using USGS Method I-2650-03. Nitrate+Nitrite-N will be analyzed using Method SM 4500- NO3+NO2 F. Refer to Table 8 for additional details of analytical methods for eutrophication analysis.

Nitrate + nitrite will be analyzed using the cadmium reduction method (SM 4500-NO3 F), nitrite will be analyzed using the colorimetric method (SM 4500-NO2 B), and ammonium will be analyzed using distillation and the automated phenate method (SM 4500-NH3 G) using a Lachat Instruments (division of Zelweger Analytics) Model QuikChem 8000 Flow Injection Analyzer.

For TN/TP (USGS I-4650-03) and TDN/TDP (USGS I-2650-03; Patton, C.J. and J.R. Kryskalla (2003)), persulfate will be used to digest unfiltered and filtered water samples to convert the nitrogen from all N compartments into nitrate and the phosphorus from all P compartments into orthophosphate for the simultaneous determination of TN and TP.

The resulting digests will be analyzed by automated colorimetry for nitrate-N and orthophosphate using an Alpkem Colorimeter.

SRP will be analyzed using the automated ascorbic acid reduction method (SM 4500-P F), using a Lachat Instruments Model QuikChem 8000 Flow Injection Analyzer.

Dissolved organic carbon (DOC) will be determined for filtered sample water via the combustion infrared method (SM 5310-B) using a Shimadzu 5000 Total Organic Carbon Analyzer with an ASI-5000A Auto Sampler.

Chlorophyll a in water samples, will be concentrated by filtering at low vacuum through a Whatman glass fiber filter (GF/F). Photosynthetic pigments will be extracted from the algae in 90% acetone and allowed to steep overnight, but not to exceed 24 hrs, to ensure thorough extraction of chlorophyll *a* (EPA 445). Using a self-calibrating Turner Designs Trilogy Laboratory fluorometer, the fluorescence of the sample will then be measured before and after acidification with 0.1M HCl to determine the concentration of phaeophytin-corrected chlorophyll a.

13.1.5 Suspended Sediment or Sediment Analysis

Sediment grain size (% sand only) will be determined by wet sieving the sample through a 62 micron sieve to separate the course and fine fractions (EPA, 1995). Sediment % organic carbon, % organic nitrogen will be determined on a CHN elemental analyzer (Exeter Analytical model CEC 440HA) by means of high temperature (1000ºC) combustion (Dumas method) in an oxygen- enriched helium atmosphere (EPA 9060).

Total sediment phosphorus will be determined by persulfate digestion, which will convert all organic P to orthophosphate. Digests will then be analyzed by automated colorimetry for nitrate-N and orthophosphate using an Alpkem Colorimeter (Nelson 1987).

Sediment grain size (% sand only) will be determined by wet sieving the sample through a 62 micron sieve to separate the course and fine fractions (EPA, 1995).

Sediment % organic carbon, % total nitrogen will be determined on a CHN elemental analyzer (Exeter Analytical model CEC 440HA) by means of high temperature (1000ºC) combustion (Dumas method) in an oxygen- enriched helium atmosphere (EPA 9060).

Total sediment phosphorus will be determined by persulfate digestion, which will convert all organic P to orthophosphate. Digests will then be analyzed by automated colorimetry for nitrate-N and orthophosphate using an Alpkem Colorimeter (Nelson 1987).

13.1.6 Flow Data

Flow data will be measured using doppler velocity sensors in combination with level sensors to estimate stage and calculate flow. The product of velocity and wetted cross sectional area provides an estimate of total flow. The equipment, site and sampling requirements are described in Appendix F. All raw data will be downloaded on a regular basis. Raw data will be uploaded to the project database for storage and retrieval. Original raw data files will also be archived at MACTEC. Velocity and stage data will be collected approximately once per month when not sampling. This will help calculate changes in flow conditions and calibrate the ratings table. During sampling, flow measurements will be collected at 15 minute intervals.

For dry weather storm drain and point source flow measurements conducted by field staff for the Responsible Parties, alternative methods may be employed to estimate flow rates for different flow types such as an open channel, outfall, or drainage pipe. Potential methods are described below.

Velocity-area method - This method requires the physical measurement of the velocity (V), depth (D), and width (W) of flowing water. Discharge is determined as follows:

Eq. (1). Discharge (ft^3/sec) = Velocity (ft/sec) x Depth (ft) x Width (ft)

The average velocity in foot per second of water flow will be measured using the Global Flow Probe FP101 (Global Water, Gold River, CA). For calibration and measurement procedures, refer to the Dry Weather Analytical and Field Screening Monitoring Procedures Manual (County of San Diego, 2006), Appendix G. Measure the flow velocity at three locations across a creek/stream (left, center, and right). Stream depth and width, both in feet, will be determined using the measurement marks on the probe pole. Note that the probe pole markings are in tenths of a foot, therefore read directly from the markings and do not need to make any conversions. Record measurement results on the Field Data Sheet and calculate the discharge in cubic feet per second (cfs) using Eq. (1).

When a water flow is too slow or the water is too shallow to measure the velocity using the probe, which occurs frequently during dry weather monitoring, the velocity may be estimated by timing the travel of a piece of floating debris (e.g., a leaf). The “apparent” velocity is calculated by dividing the travel distance (feet) by the recorded travel time (second). The “actual” velocity can be calculated by multiplying a correction constant – 0.8 for rough bottom and 0.9 for smooth bottom.

Fill a bottle method - If flowing water is an outfall and relatively slow, the fill-a-bottle method will be appropriate. Record the time that is taken to fill a bottle or a bucket, the volume of which is known. The discharge can be calculated by dividing the volume by the time. For example, it takes 20 seconds for an outfall to fill a 1-gallon bottle. Since 1 gal = 0.1337 cubic feet, the discharge is: 0.1337/20 = 0.007 cubic feet per second (cfs).

Partially filled pipe method - This method is useful when substantial water flows through a drainage pipe. The method is similar to the velocity-area methods except that the determination of cross sectional area is different. The procedures are described in detail in Appendix G.

Table 25. (Element 13) Analytical methods.

Analyte	Laboratory Organization	Target Reporting Limit	Analytical Method	Modified for Method yes/no
Temperature	Field Monitoring	0.1 °C	Data Sonde	no
Conductivity	Field Monitoring	2.5 µS/cm	Data Sonde	no
Turbidity	Field Monitoring	0.5 NTU	Data Sonde	no
Total Suspended Solids (TSS)	SCCWRP	0.5 mg/L	SM 2540-D	no
Total Dissolved Solids (TDS)	Field Monitoring	0.2 mg/L	SM2450C	no
Total Coliform*	CRG/EWA	2 MPN/ 100 mL	SM 9222B	no
Fecal Coliform*	CRG/EWA	2 MPN/ 100 mL	SM 9222D	no
Enterococcus	CRG/EWA	1 colonies/ 100 mL	EPA 1600*/SM 9230C	no
pH	Field Monitoring	0.2	Data Sonde	no
Dissolved Oxygen (DO)	Field Monitoring	1.00 mg/L	Data Sonde	no
Total Nitrogen (TN)	UGA	0.1 mg/L	USGS I-4650-03	no
Total Phosphorus (TP)	UGA	0.05 mg/L	USGS I-4650-03	no
Total Dissolved Nitrogen (TDN)	UGA	0.1 mg/L	USGS I-2650-03	no
Total Dissolved Phosphorus (TDP)	UGA	0.05 mg/L	USGS I-2650-03	no
Nitrate+Nitrite-N	UCSB	0.05 mg/L	SM 4500-NO3+NO2 F	no
Ammonium-N	UCSB	0.05 mg/L 0.05 mg/L	SM 4500-NH3 G SM 4500-NH3 F	no
Soluble Reactive Phosphorus (SRP)	UCSB	0.05 mg/L	SM4500P C	no
Chlorophyll a	CRG	2 µg/L 0.01 mg/m^3	EPA 445.0 SM 10200H	no
Carbonaceous Biological Oxygen Demand ($CBOD_5$)	CRG	2 mg/L	EPA 405.1 SM 5210B	no
% Fines or % Sand/Silt/Clay	SCCWRP	1 %	ASTM D-422 (1963)[1] EPA (1995)[2] Plumb (1981)[3]	no
% Organic Carbon (%OC)	SCCWRP	0.01 %	EPA 9060	no
% Organic Nitrogen (%ON)	SCCWRP	0.01 %	EPA 9060	no
% Total Phosphorus (%TP)	SCCWRP	0.01 %	Nelson (1987)[4]	no

Note NA = not applicable

* This method is proposed to be used optionally in addition to SM9230C per authorization from SDRWQCB.

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Sample inventory by media and sample type is provided in Table 26.

Table 26. Sampling inventory.

Type	Analyte	Matrix	Total Number of Samples
Core	Temperature	Water	Field Monitoring
	Conductivity	Water	Field Monitoring
	Turbidity	Water	Field Monitoring
	Total Suspended Solids (TSS)	Water	1048
Total Dissolved Solids	Total Dissolved Solids (TDS)	Water	40
Bacteria	Total Coliform*	Water	872
	Fecal Coliform*	Water	872
	Enterococcus	Water	872
Eutrophication	pH	Water	Field Monitoring
	Dissolved Oxygen (DO)	Water	Field Monitoring
	Total Nitrogen (TN)	Water	758
	Total Phosphorus (TP)	Water	758
	Total Dissolved Nitrogen (TDN)	Water	758
	Total Dissolved Phosphorus (TDP)	Water	758
	Nitrate+Nitrite-N	Water	758
	Ammonium-N	Water	758
	Soluble Reactive Phosphorus (SRP)	Water	758
	Chlorophyll a	Sediment	714
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	Water	546
Suspended Sediment or Sediment	% Fines or % Sand/Silt/Clay	Sediment	154
	% Organic Carbon (%OC)	Sediment	60
	% Organic Nitrogen (%ON)	Sediment	60
	% Total Phosphorus (%TP)	Sediment	60

13.2 Sample Disposal

After analysis, including QA/QC procedures, any excess sample will be disposed of by the analytical laboratories.

13.3 Corrective Action

Corrective action is taken when an analysis is deemed suspect for some reason. The corrective action varies somewhat from analysis to analysis, but typically involves the following:

- A check of procedures.
- A review of documents and calculations to identify possible errors.

- Correction of errors.
- A re-analysis of the sample extract, if sufficient volume is available, to determine if results can be improved.
- A complete reprocessing and re-analysis of additional sample material, if sufficient volume is available and if the holding time has not been exceeded.

The QA Officer at CRG has systems in place to document problems and make corrective actions as noted in Appendix H.

Laboratories will be required to provide a four-week turnaround on all deliverables. The deliverable package will include hard copy and Electronic Data Deliverable (EDD). The hard copy will include standard narratives identifying any analytical or QA/QC problems and corrective actions, if any. The following QA/QC elements will be included in the data package: sample collection, extraction, and analysis dates and times, results of method blanks, summary of analytical accuracy, summary of analytical precision, and reporting limits. The electronic data files will contain all information found in the hard copy reports submitted by the laboratories. Individual data sets will be submitted as either Microsoft Excel® workbook files or as Microsoft Access® database files.

For excerpts of QA procedures for the analytical labs, please refer to Appendix H through L. Full QA Manuals are available for review from MACTEC or through the QA officer or Laboratory Supervisor at each agency.

14. QUALITY CONTROL

Samples for QA/QC will be collected both in the field and in the lab. Field QA/QC samples are used to evaluate potential contamination and sampling error occurring prior to sample delivery to the analytical laboratory. Field QA/QC samples include field blanks. Lab QA/QC samples are used to evaluate the analytical process for contamination, accuracy, and reproducibility. Internal laboratory quality control checks will include method blanks, matrix spike/matrix spike duplicate (MS/MSDs), and duplicates. These QA/QC activities are discussed below.

14.1 Blanks

Blanks help verify that the equipment, sample containers, and reagents are not a source of contamination, and that the sampling techniques used are non-contaminating. Both field and laboratory blanks are included in the program.

Field blanks are used to determine if field sampling activities are a potential source for contamination. These blanks are collected by pouring "blank water" (contaminant-free deionized water) into sampling containers in the field during a sampling event. The same equipment used for collection of the grab samples will be used to transfer the blank water into the blank sample containers.

Method blanks will be run by the analytical laboratory to determine the level of contamination associated with laboratory reagents and equipment. A method blank is a sample of a known matrix that has been subjected to the same complete analytical procedure as the submitted samples to determine if contamination has been introduced into the samples during processing. Results of method blank analysis should be less than the reporting limits for each analyte.

14.2 Duplicates

Duplicates are part of the QA/QC program to assess precision. Field duplicates are used to assess variability attributable to collection, handling, shipment, and storage. Procedures for collecting field duplicates should be the same as that used for collecting the field samples. Duplicates of manual grab samples will be collected by filling two grab sample containers at the same time or in rapid sequence. Duplicates from an autosampler will be made by splitting a sample into two containers. Sample containers will be labeled separately, but will not be identified as a "duplicate" to the laboratory.

14.3 Spikes

Spikes are used to assess precision and accuracy of the laboratory analytical method, and to evaluate matrix interference. The matrix spike/matrix spike duplicates (MS/MSD) approach will be used with the field samples. A MS sample is an aliquot of a field sample into which the laboratory adds a known quantity of a compound. Reported percent recovery of the known compound in the sample indicates matrix effect on the analysis. A MSD sample is a duplicate aliquot of the matrix spike sample that is analyzed separately. The MSD results are compared to the matrix spike results to assess the precision of the laboratory analytical method. Duplicate results are evaluated by calculating the relative percent difference (RPD) between the two sets of results. This serves as a measure of the reproducibility (precision) of the sample results. The acceptable RPD limits are shown in Table 6. The RPD is calculated as:

Relative percent difference = 100 x (sample 1 - sample 2) / ((sample 1 + sample 2)/2)

14.4 In-Situ Measurements

Quality assurance and quality control activities for the continuous monitoring of water quality parameters via data sonde include collection of water quality data will a calibrated Hydrolab Quanta during biweekly maintenance events. The acceptance limit is 20% and will be calculated as follows:

Acceptance Limit = [(Value from Quanta – Value from Sonde)/ Value from Quanta] x 100; note: value may be negative number.

When values exceed 20%, calibrate equipment according to manufacturer's specifics and retest. Repeat until measurements fall within acceptance limit or replace unit.

Data Sonde QC	Frequency	Acceptance Limits
Water Quality Parameters	Bi-weekly comparison with additional probe or as required	Within 20%

14.5 Sampling and Analytical Quality Control Practices

All data collected as a part of this monitoring program must be compatible with the Surface Water Ambient Monitoring Program (SWAMP) quality assurance standards. Thus, an additional 10-15% will be added to the total number of samples estimated in Table 26. This 10-15% should cover analysis of field, laboratory, and equipment blanks, as well as blind field duplicates and laboratory duplicates.

Table 27 summarizes sampling and analytical quality control practices.

Table 27. (Element 14) Sampling (Field) and Analytical QC for water samples.

Group	Parameter	Element 14 Quality Control
Field testing (in-situ sampling)	Dissolved Oxygen	No SWAMP requirement – suggest replicate (3) measurements plus maintenance practices.
	Temperature	No SWAMP requirement – suggest replicate (3) measurements plus maintenance and calibration practices.
	Conductivity	No SWAMP requirement – suggest replicate (3) measurements plus maintenance and calibration practices
	pH by meter	No SWAMP requirement – suggest replicate (3) measurements, check against second pH buffer, plus maintenance and calibration practices
	Turbidity	No SWAMP requirement – suggest replicate (3) measurements plus maintenance and calibration practices
Field Test Kit	All inorganic chemical tests	No SWAMP requirement – suggest replicate (3) measurements, comparison against a known standard, and 10% check against laboratory measurement each sample run.
Mobile Laboratory	ALL	Same as stationary laboratory
Laboratory analyses	Conventional Constituents in water (including *TSS,* TN, TDN, TP, TDP SRP, Nitrate, Nitrite, Ammoni Chlorophyll a $CBOD_5$, TDS)	Blanks – Laboratory and field blanks. No detectable amount of substance in blanks. Frequencies – Accuracy, precision, recovery, and blanks at 1 in 20 (5%) with at least one in every batch. All quality assurance and quality control procedures and criteria specified by selected method.
	Bacteria – pathogen indicators	Field and sterility checks (laboratory blanks) no detectable amounts or less than 1/5 of sample amounts for field blanks. Frequency – accuracy at 1 per culture medium or reagent lot. Precision at 1 in 10 (10%) with at least one per batch. All quality assurance and quality control procedures found in *Standard Methods* (18th, 19th, or 20th editions) section 9020 and in the selected analytical method including confirmation practices.
	Volatile organics (including VOCs, MTBE, and BTEX) in water	Blanks – Laboratory and field blanks. No detectable amount of substance in blanks. Frequencies – Accuracy, precision, recovery, and blanks at 1 in 20 (5%) with at least one in every batch. All quality assurance and quality control procedures and criteria specified by selected method.
	Toxicity testing	Field duplicates at 5% of samples collected per event with a minimum of 1. Positive and negative controls with each test. General water quality measurements – dissolved oxygen, pH, conductivity, and ammonia. All performance criteria outlined in method SOP.
	Sediment and suspended solids (including % Fines or %Sand/Silt/Clay % OC% ON)	Laboratory duplicate, blind field duplicate, <20% relative standard deviation Standard Reference Materials (SRM, CRM) within 95% CI stated by provider of material.

15. Instrument/Equipment Testing, Inspection, and Maintenance

15.1 Sampling Equipment

MACTEC staff has established standard operating procedures for each piece of field equipment in use. Flowmeters, rain gauges, autosamplers, and communication devices are tested and calibrated prior to deployment in the field. Sampling equipment receives regular maintenance based on a combination of manufacturer requirements and the duration of equipment deployment. Maintenance of the flowmeters includes replacing the internal desiccant and memory batteries. Maintenance of the autosamplers includes replacing the internal desiccant, replacing the peristaltic pump tubing and calibrating the aliquot volume. Spare or replacement parts are available from the manufacturer within 2-days. Sampling or monitoring equipment which is defective or malfunctioning will be documented, repaired and/or replaced. . Documentation of any such actions will take place on an equipment/instrument log kept at MACTEC .

Laboratory and field measurement equipment will be checked for operation in accordance with the manufacturer's specifications, on file at MACTEC and M&A. This includes battery checks, routine replacement of membranes, checking cables and connections, and cleaning of conductivity electrodes. All equipment will be inspected prior to use and upon return from use for damage. Spare parts for all instruments are located either in the M&A office or in dedicated boxes that are to accompany the piece of equipment. If equipment appears compromised to the point where accurate data collection may be suspect, the Task Manager will determine the extent of damage and repair, if possible, or return to manufacturer for repair. Documentation of any such actions will take place on an equipment/instrument log kept at MACTEC.

Table 28. Equipment Maintenance Activity.

Equipment / Instrument	Maintenance Activity, Testing Activity or Inspection Activity	Responsible Person	Frequency
Hydrolab Quanta	Calibration, inspection/replacement of probe/membrane and cables.	Task Manager	Daily or as necessary.
YSI 6920v2	Calibration, inspection/replacement of probe/membrane and cables.	Task Manager	Daily or as necessary.
Horibu U-10	Calibration, inspection/replacement of probe/membrane and cables.	Responsible Parties Technical Staff*	Daily or as necessary.

*Responsible Parties may use alternative comparable instrumentation while maintaining QA/QC standards

Table 29. Parameter Calibration.

Parameter	Calibration Frequency	Standard or Calibration Instrument Used
Temperature	Bi-Weekly or as necessary	NIST calibrated or certified thermometer
Dissolved Oxygen	Bi-Weekly or as necessary	Water saturated air, according to manufacturer's instructions
pH	Bi-Weekly or as necessary	pH 7.0 buffer and one other standard (4 or 10)
Conductivity	Bi-Weekly or as necessary	Conductivity standard and distilled water
Turbidity	Bi-Weekly or as necessary	Standard and/or distilled water

15.2 Analytical Instruments

The CRG Laboratory maintains its equipment in accordance with its SOPs, which include those specified by the manufacturer and those specified by the method. These SOPs have been reviewed by MACTEC's QA Officer and found to be suitable for this study.

Table 30. (Element 15) Testing, inspection, maintenance of sampling equipment and analytical instruments.

Equipment	Maintenance/ Calibration/ Inspection Activity	Responsible Person	Frequency	SOP Reference
Hydrolab Quanta, YSI 6920V2, pH, Conductivity, Temp. Meter	Calibration	MACTEC Technical Staff	Daily, before use	Hydrolab Quanta series Instruments SOP
Horiba U-10	Calibration	Responsible Parties Technical Staff*	Daily, before use	Horiba U-10 Instrument Manual
American Sigma 950 AVB Flowmeter	Inspection, calibration, and maintenance	MACTEC Technical Staff	Semi-annually	American Sigma 950 O&M Manual AS009
American Sigma 900MAX Autosampler	Inspection, calibration, and maintenance	MACTEC Technical Staff	Semi-annually	American Sigma 900MAX Sampler O&M Manual AS005
American Sigma Rain Gauge	Inspection, calibration, and maintenance	MACTEC Technical Staff	Semi-annually	NA
American Sigma S1000 Stingray	Inspection, calibration, and maintenance	MACTEC Technical Staff	Semi-annually	Sigma 1000 Instrument Manual 52287-89

*Responsible Parties may use alternative comparable instrumentation while maintaining QA/QC standards

16. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

All laboratory equipment is calibrated based on manufacturer recommendations and accepted laboratory protocol. The laboratories maintain calibration practices as part of the method SOPs and details are described in the attached laboratory QA plan documents.

All laboratory equipment (pH, meters) are calibrated based on manufacturer recommendations and accepted laboratory protocol.

Calibration procedures for field monitoring equipment are performed before installation and twice during the wet-season. To calibrate the flowmeters, the recorded water level is checked by comparing the level to actual levels while the bubbler is submersed in water of a known level. Computational calibrations cannot be performed but deviations from known values are documented and the equipment is replaced or repaired. Autosampler calibration consists of calibrating the aliquot volume using a graduated flask or beaker. Rain gauges are not adjustable and cannot be calibrated. If a rain gauge fails to record simulated rainfall, the instrument is repaired or replaced.

See Section 15 and manufacturer's specifications/user's manuals (on file at MACTEC and M&A.

Table 31. Instrument/ Equipment Calibration and Frequency.

Equipment	Calibration Description	Responsible Person	Frequency	SOP Reference
YSI pH, Conductivity, Temp. Meter	Calibration using standard solutions	Merkel Technical Staff	Daily, before use	Hydrolab Quanta, YSI series Instruments SOP
Horiba U-10	Calibration using standard solutions	Responsible Parties Technical Staff*	Daily, before use	Horiba U-10 Instrument Manual
American Sigma 950 AVB Flowmeter	Water level check against known levels	MACTEC Technical Staff	Semi-annually	American Sigma 950 O&M Manual AS009
American Sigma 900MAX Autosampler	Aliquot calibration	MACTEC Technical Staff	Semi-annually	American Sigma 900MAX Sampler O&M Manual AS005
American Sigma Rain Gauge	N/A	MACTEC Technical Staff	Semi-annually	NA
American Sigma S1000 Stingray	Test voltage and signal strength	MACTEC Technical Staff	Semi-annually	Sigma 1000 Instrument Manual 52287-89

*Responsible Parties may use alternative comparable instrumentation while maintaining QA/QC standards

17. INSPECTION/ACCEPTANCE FOR SUPPLIES AND CONSUMABLES

Glassware, sample bottles, and collection equipment will all be inspected prior to their use. Supplies will be obtained from participating laboratories, by VWR (vwr.com, 800-932-2500) or similar vendor. The Task Managers will be in charge of ordering sampling containers. Supplies will be examined for damage as they are received.

CRG Laboratories maintains logbooks for all consumables that are checked against all materials received.

Bottles and caps will be inspected for damage prior to sampling, and only sound bottles with intact threads will be used. Caps will be tested for tightness prior to transport of samples.

The Project Manager will make sure sufficient field supplies are on hand prior to the start of sampling for each period. Field supplies will be stored at MACTEC and M&A. Laboratory supplies will be stored at the laboratories conducting the work.

Table 32. (Element 17) Inspection/acceptance testing requirements for consumables and supplies.

Project-Related Supplies/ Consumables	Inspection / Testing Specifications/ Source	Acceptance Criteria	Frequency	Responsible Individual
Pre-cleaned sample bottles	Open bottle	Lids on bottles screwed on	100%	MACTEC
Lab glassware	Dirty	Clean	100%	CRG Labs
Lab solvents and acids	Leaks	No cracks or chips	Prior to use	CRG Labs
Composite Sample Bottles	Laboratory cleaned and blanked	Factory-sealed, pre-sterilized plastic container	Yearly (batch) New bottles each storm	CRG/MACTEC
Microbiology grab bottles	Laboratory sterilized	Pass blanking analysis	Yearly (batch) New bottles each storm	CRG
Autosampler peristaltic pump tubing	Laboratory cleaned and blanked	Pass blanking analysis	Yearly (batch) New tubing each season	CRG/MACTEC
Autosampler intake tubing	Laboratory cleaned and blanked	Pass blanking analysis	Yearly (batch) New tubing each season	CRG/MACTEC
Gloves	New box (Cole Parmer)	New box	Monthly	MACTEC

18. NON-DIRECT MEASUREMENTS

There are no non-direct measures that will be fundamental to the success of this project.

19. DATA MANAGEMENT

A custom Lagoon Monitoring database will be created, which will be a central relational database including hydrology data, sampling equipment data, event data, and toxicity and chemistry data. The database will be stored on MACTEC's network, which is backed up daily. The original data files will also be maintain on the network project files and on compact disk. Hard copies of field and lab data will be stored at MACTEC for three years from project completion.

Field data will be entered into a database using a portable computer in the field. When the portable computers are brought back from the field, the data will be uploaded to the central database. Sample data and rain and flow data will be collected by the automated sampling equipment. These data will be downloaded from the equipment and saved to the central database.

CRG Laboratories will deliver all analytical data in both hard copy and electronic format. Electronic Data Deliverables (EDDs) will be in a SWAMP compatible format. CRG and the other team laboratories will perform quality checks on the EDDs to ensure they meet SWAMP standards before delivery. The required form of the EDDs will be provided to the laboratories. The SWAMP compatible analytical data will upload directly into the central database.

Data reviews will be conducted under the supervision of the QA Officer. Field data will be checked for anomalies and for completeness, and will be matched to the analytical data in the central database. Flow data will be evaluated by comparisons to field estimates at the time of sampling, and will be analyzed with rain and sample information to ensure sample representativeness.

Hard copy laboratory data will be initially screened for the following items when it is received:

- The laboratory reports must be complete and must be signed.
- The analyses performed must match the analyses requested on the COCs.
- The methods and reporting limits used must match those in listed in Table 24.
- The reports must contain all required information, such as reporting limits, for each analysis, and must include laboratory QA/QC information.
- The reports will be reviewed for typographical errors and suspect values.

Any discrepancies found will be immediately addressed with the laboratory. Data with issues that cannot be resolved will be marked as suspect or removed from the dataset.
Following the initial screening, a more complete QA/QC review process will be performed, which will include an evaluation of holding times, method and equipment blank contamination, and analytical accuracy and precision. Accuracy will be evaluated

by reviewing MS/MSD and LCS recoveries; precision will be evaluated by reviewing MSD and laboratory sample duplicate RPDs. Discrepancies will be noted in the report, and may cause the data to be marked as suspect. Finally, all reports and tables produced will be checked against the original hard copy reports.

GROUP C ASSESSMENT AND OVERSIGHT

20. ASSESSMENTS AND RESPONSE ACTIONS

The MACTEC Project Manager will be responsible for the day-to-day oversight of the project. The Project Manager will communicate quarterly with the Contract Manager, at a minimum, to discuss progress and issues related to sample collection, laboratory analysis, data management, and the overall status of the project. The Field and Laboratory Task Managers will review data as it is produced (i.e., after each storm). The MACTEC QA Officer will conduct periodic reviews of the data and relay any problems to the Project Manager on a quarterly basis. The MACTEC QA Officer has the power to halt all sampling and analytical work by MACTEC, SCCWRP, CRG, or any university or public agency laboratory if the deviation(s) noted are considered detrimental to data quality.

21. REPORTS TO MANAGEMENT

The status of data collection during this project will be reported by the Project Manager.

Table 33. (Element 21) QA Management Report.

Report	Due by	Person Filing Report	Report Recipient
Quarterly Data Submittal	01/01/2008	Project Manager	SDRWQCB, Tetra Tech, and SCCWRP
Quarterly Data Submittal	04/01/2008	Project Manager	SDRWQCB, Tetra Tech, and SCCWRP
Quarterly Data Submittal	07/01/2008	Project Manager	SDRWQCB, Tetra Tech, and SCCWRP
Quarterly Data Submittal	10/01/2008	Project Manager	SDRWQCB, Tetra Tech, and SCCWRP
Final Report	06/01/2009	Project Manager	SDRWQCB

GROUP D DATA VALIDATION AND USABLILITY

22. DATA REVIEW, VERIFICATION, AND VALIDATION

The specifics of data review, validation, and verification are detailed in the Quality Objectives section (Element 7) of this document. Project personnel will perform evaluation on the QA/QC samples as described in that section to maintain quality assurance and control of the data collected. At the same time, the data review, verification, and validation will also be carried during the data processing/management stage, as described in Element 19.

Data generated by project activities will be reviewed against the data quality objectives cited in Section 7 and the quality assurance/quality control practices cited in Sections 14, 15, 16, and 17. Data will be separated into three categories: data meeting all data quality objectives, data meeting failing precision or recovery criteria, and data failing to meet accuracy criteria. Data meeting all data quality objectives, but with failures of quality assurance/quality control practices will be set aside until the impact of the failure on data quality is determined. Once determined, the data will be moved into either the first category or the last category.

Data falling in the first category is considered usable by the project. Data falling in the last category is considered not usable. Data falling in the second category will have all aspects assessed. If sufficient evidence is found supporting data quality for use in this project, the data will be moved to the first category, but will be flagged with a “J” as per EPA specifications.

23. VERIFICATION AND VALIDATION METHODS

23.1 Data Verification and Validation Overview

Data verification is the process of evaluating the completeness, correctness, and conformance of the dataset against the method, procedural, or contractual requirements. The goal of data validation is to evaluate whether the data quality goals established during the planning phase have been achieved (USEPA 2002). Data quality indicators will be continuously monitored by the analyst producing the data (i.e., field and lab personnel), as well as the Project Manager, with assistance from the QA Officer, throughout the project to ensure that corrective actions are taken in a timely manner. Data validation is an analyte- and sample-specific process that extends verification to determine the analytical quality of the dataset (USEPA 2002). Laboratory and field personnel responsible for conducting QA analysis will be responsible for documenting when data do not meet measurement quality objectives as determined by data quality indicators.

23.2 Process for Data Verification and Validation

Data verification and validation for sample collection and handling activities will consist of the following tasks:

- Verification that the sampling activities, sample locations, number of samples collected, and type of analysis performed is in accordance with QAPP requirements;
- Documentation of any field changes or discrepancies;
- Verification that the field activities (including sample location, sample type, sample date and time, name of field personnel. etc) were properly documented.
- Verification of proper completion of sample labels and Chain of Custody forms, and secure storage of samples.
- Verification that all samples recorded on Chain of Custody forms were received by the laboratory.

Data verification and validation for the sample analysis activities will include of the following tasks:

- Appropriate methodology has been followed;
- Instrument calibrations have been adequately conducted;
- QC samples meet performance criteria;
- Analytical results are complete;
- Documentation is complete.

Verification and validation of data entry includes:

- Sorting data to identify missing or mistyped (too large or too small) values;
- Double-checking all typed values.
- Correct data types correspond to database fields (i.e., text for text, integers for integers, number for numbers, dates for dates, times for times, etc.)

23.3 Parties Responsible for Data Verification and Validation

Laboratory validation and verification of the data generated is the responsibility of each laboratory. Each laboratory supervisor maintains analytical reports in a database format as well as all QA/QC documentation for the laboratory. The laboratories also maintain all chain of custody and sample manifests.

The Project Manager is responsible for oversight of data collection and the initial analysis of the raw data obtained from the field and the contracted laboratory. His responsibilities also include the generation of rough drafts of quarterly and final reports.

23.4 Issue Resolution Process

Whenever possible, individual samples not meeting data quality objectives will be re-run or re-collected, unless evidence suggests that DQOs were not met due to natural variation outside the control of field or laboratory personnel (USEPA 2002). Instances where DQOs are not met will be documented and appropriate corrective actions taken. At the completion of data collection for each seasonal sampling, the Project Manager will gather the data, DQI records, and other appropriate records, to evaluate whether criteria described in the QAPP were met, overall. If any of the criteria are not met, whenever possible, corrective actions will be taken by the Project Manager after consultation with the RWQCB QA Program Manager. Software for data verification will aid database entry and submittal.

The final outputs of the data verification process will be verified data and data verification records that narrate any non-compliance issues or shortcomings of the data produced in field and laboratory activities and a certification statement that the data have been verified by the Program Manager. This certification should be made available to data users to inform them that the data have been verified.

Records in the database for which data do not meet data quality objectives will be flagged with a coded or narrative note. These flags will be carried through to the final data to ensure that data users are aware of any validation issues. Following data verification at the completion of data collection, data will also be validated (USEPA 2002) by the Program Manager, with assistance from the QA Officer. Field activities will be validated by 1) evaluating the field records for consistency, 2) reviewing QC information, 3) summarizing deviations and determining the impact on data quality, and 4) assign data validation qualifiers as necessary. Laboratory data will be validated by 1) assembling planning documents and data; 2) reviewing verified, reported sample results collectively for the dataset as a whole, including laboratory qualifiers; 3) summarizing data and QC deficiencies and evaluating the impact on overall data quality; and 4) assigning data validation qualifiers as necessary. Data verification and data validation issues will be summarized in the final report if deficiencies in the data exist.

24. RECONCILIATION WITH USER REQUIREMENTS

The goal of the present study is to support the development of watershed loading and lagoon water quality models by quantifying the loading of contaminants to the lagoons (e.g., watershed sources, storm drains, atmospheric deposition, and others) during wet and dry weather and by collecting data to calibrate and validate lagoon hydrodynamic and water quality models for each of the targeted contaminants (sediment, total dissolved solids, enteric bacteria, and nutrients).

Regulatory agencies will use this information in their assessment of source profiles for calculating waste load allocations. Stakeholders can use this information for baseline loading and providing data to support initiation of management actions.

The reports produced by this project will describe some of the limitations of the data. The samples collected will only describe observed conditions on a limited time scale. Only a few storms will be sampled. The reports describing the data will detail these limitations and assumptions to allow the user to determine their usefulness in other applications.

All data will be provided to SDRWQCB in SWAMP compatible electronic format.