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San Diego County Municipal Copermittees
Bight 2013 Workplan
FINAL

Prepared For:

County of San Diego Municipal Copermittees

July 25, 2013

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Bight 2013 Workplan

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July 25, 2013

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1.0 INTRODUCTION

The purpose of this workplan is to outline the activities that will be conducted by the San Diego Regional Copermittees (Copermittees) to contribute in-kind services to the Southern California Bight 2013 Regional Monitoring Program (Bight '13). This is a working document coinciding with the development of the Bight '13 Program.

Background

The aquatic health of the San Diego estuaries and lagoons have been assessed as part of the previous Bight Surveys in 2003 (Bight '03) and 2008 (Bight '08). It has also been assessed in the Copermittees' three-year Ambient Bay and Lagoon Monitoring (ABLM) Program from 2003-2005 and from 2010-2012. Additionally in 2008, the sediment conditions within San Diego estuaries were evaluated following the protocols of the State Water Resources Control Board's (SWRCB) *Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality* (referred to as Sediment Quality Objectives (SQOs)). This section provides an overview of the Bight '03, Bight '08, and ABLM study results relevant to San Diego estuaries.

2003 and 2008 Bight Surveys

The Bight program is a regional assessment of the Southern California Bight (Bight) organized every five years by the Southern California Coastal Water Research Project (SCCWRP), conducted from Point Conception to the Mexican border. Bight Surveys were initiated in 1994 based on recommendations received from marine monitoring program reviews by the National Academy of Sciences in 1989. SCCWRP is the lead coordinating agency for the Bight Surveys, bridging the regulated and regulatory communities. Previous surveys have been conducted in 1994, 1998, 2003, and 2008. Detailed information related to previous Bight surveys as well as information regarding the current Bight '13 survey can be found on the SCCWRP website at: http://www.sccwrp.org/Documents/BightDocuments.aspx.

In Bight '03, the ecological health of Southern California estuaries was assessed and compared to conditions found in coastal and offshore areas. As part of the Coastal Ecology Bight Study, sediment chemistry, toxicity, and benthic communities were measured at 60 stations in estuaries and embayments, with most of the sampling effort allocated to the Los Angeles region. Out of all surveyed marine habitats, embayments were found to have lower sediment quality in comparison to nearshore and offshore environments. Trace metals and total polyaromatic hydrocarbons (PAHs) had higher concentrations in sediments from embayments, especially within marinas and urban estuaries. Marinas and estuaries (particularly in Los Angeles) also contained the greatest incidence of sediment toxicity. Toxicity was present in 50% of the marina area and 41% of the estuarine area. Furthermore, assessments of benthic community condition indicated that most of the moderate and high disturbance of benthic infauna occurred in embayments.

The Bight '08 Survey represented the first effort to monitor and evaluate results in accordance with the SQO Policy across Southern California's embayments. The SQOs are based on a multiple lines of evidence (MLOE) approach in which the lines of evidence (LOE) are sediment toxicity, sediment chemistry, and benthic community condition. The MLOE results were integrated through the evaluation of the severity of biological effects and the potential for chemically mediated effects to provide a final station level assessment. In Bight '08, sediment chemistry, toxicity, and benthic communities were measured at 60 stations in estuaries and

embayments with 40 stations allocated to the San Diego region. Similar to Bight '03 results, embayments were again found to have lower sediment quality in comparison to nearshore and offshore environments. Approximately 27% of embayments within the Bight were considered contaminant impacted with at least half of the area in marinas and estuaries exhibiting contamination. Trace metals such as zinc, PAHs, and current use pesticide concentrations were observed in many estuaries as a result of urban runoff from adjacent watersheds. Marinas and estuaries also contained the greatest incidence of sediment toxicity with substantial toxicity present in 24% of marina sediments and 22% of estuary sediments. In addition, approximately 59% of southern California's estuaries and 37.4% of marinas had benthic communities in poor condition.

Ambient Bay and Lagoon Monitoring

The Copermittees conducted a three year ABLM to assess San Diego's lagoons from 2003 through 2005. The ABLM program applied a weight of evidence approach using a triad assessment of indicators which included chemistry, toxicity, and benthic infaunal communities to evaluate the sediment quality in the lagoons. The program design used a targeted approach to assess the finest grain size and highest total organic carbon. This approach was used to conservatively assess if the areas in the lagoons that were likely to be impacted exceeded published benchmarks or exhibited toxic effects. Three discreet samples were collected and composited into one composite sample for each lagoon per year. The three years of data were compiled to form a baseline of information, providing a worst case benchmark for comparison of future sampling results. Based on the ABLM study, San Diego County lagoon's sediment health was rated as fair based on the triad of indicators Sediment contamination was low during sampling years, as was toxicity. However, benthic infaunal communities were generally more disturbed than would have been expected based on the chemistry and toxicity data. Given that the ABLM study utilized composite sampling, future studies are needed to better understand the spatial distribution of conditions within San Diego estuaries.

The Copermittees also conducted a three year ABLM program from 2010 through 2012. By building on information gained through the 2003-2005 ABLM and the Bight '08 Survey, it was determined that special studies within each lagoon would provide more relevant information for addressing the permit management questions. Because the data collected previously were more indicative of stressors to the benthic community and did not suggest relationships to chemical influences, the 2010-2012 ABLM Program focused on benthic community assessments. Priority was given to those lagoons that had impacted benthos with associated toxicity or with the presence of chemistry exceedances. During the three year period, five lagoons/estuaries were monitored including Agua Hedionda Lagoon, Sweetwater River Estuary, San Elijo Lagoon, Batiquitos Lagoon, and Tijuana River Estuary. The sediment qualities of the five lagoons/estuaries were evaluated utilizing the SQO tool. Sampling consisted of water quality sampling for chemistry and physical parameters and sediment sampling for chemistry, toxicity, and benthic infaunal assessments. Each sampling site included three replicate samples to evaluate benthic conditions and one replicate water quality site. Data for this study were collected using methods consistent with previous data from this program, the Bight program, and SQOs to allow for comparisons to the past and likely data needs of the future. The majority of sites assessed exhibited minimal to low chemistry exposure, low to no toxicity, and low to high benthic disturbance. Comparisons to the benthic community from previous studies, as well as the analysis of the water quality, revealed that disturbances to the benthic community at the majority

of the sites were most likely associated with natural biological variation and physical disturbances rather than chemically mediated effects.

Regulatory Commitment
The San Diego Region Municipal NPDES Permit Order No. 2013-0001 (Permit) was adopted on May 8, 2013. Section D.1.e.(1).(b) of the Permit requires the Copermittees to participate in the Southern California Bight Regional Monitoring.

The Copermittees' Regional Monitoring Workgroup has indicated it will participate in the Bight '13 Survey by providing in-kind services. The Copermittees have agreed to contribute to the Bight '13 Survey by sampling up to 22 lagoon stations within the San Diego Region.

Participation by the Copermittees in the Bight '13 Survey will provide data useful in addressing the goals of the Monitoring and Assessment Sections of the Permit. Furthermore, the Copermittee's contribution to the Bight Survey will build on an existing dataset that provides a regional assessment of the coastal marine health, while simultaneously providing a local assessment of the San Diego Region Lagoons.

Technical Approach
This workplan is designed to provide data needed to answer questions related to the Southern California Bight, the San Diego Region, and the individual lagoons of study. Lagoons/estuaries selected for the Bight '13 program will be chosen based on whether or not they meet the requirements of the SQO tool (i.e. salinity, subtidal, open to ocean, etc.) and sampling stations will be located using a tessellated random sampling design consistent with Bight protocols.

The Copermittees data will be used to provide data needed to answer the following Bight '13 Contaminant Impact Assessment (CIA) (formerly Coastal Ecology) Program questions:

- *What is the extent and magnitude of direct impact from sediment contaminants?*
- *What is the trend in extent and magnitude of direct impacts from sediment contaminants?*

In addition, the Copermittees lagoon sampling effort will be used to satisfy the first iteration of sampling required for this Permit term in accordance with the Sediment Quality Monitoring requirements in Section D.1.e.(2) and the SQO Policy. Any stations with SQO results other than unimpacted or likely unimpacted will require follow-up evaluations in subsequent monitoring years within the Permit term in accordance with the SQO Policy.

2.0 SAN DIEGO REGIONAL COPERMITTEES BIGHT '13 WORKGROUP PARTICIPATION

The San Diego Regional Copermittees are participating in the CIA workgroup. This workgroup is the core of the Bight Program. This study will be used to assess sediment quality (chemistry, toxicity, and benthic community health) in nine of San Diego's lagoons. The CIA Workplan is included in Appendix B.

3.0 COASTAL ECOLOGY MAIN GROUP CURRENT PROGRAM DESIGN

The lagoons/estuaries selected for the Bight '13 program were chosen based on whether or not they meet the requirements of the SQO tool (e.g., salinity, subtidal, open to ocean, etc.). Sampling stations will be located using a tessellated random sampling design consistent with Bight protocols. Samples will be collected in areas considered to be in the lagoon or estuarine environments with salinities $\geq$ 25 ppt. Sampling will occur one time at each location during the summer of 2013 and is tentatively scheduled to occur from July through September 2013.

Nine lagoons/estuaries were selected in the San Diego Region for inclusion in the Bight '13 program and are presented as follows:

1. Santa Margarita Estuary
2. Agua Hedionda Lagoon
3. Batiquitos Lagoon
4. San Elijo Lagoon
5. San Dieguito Lagoon
6. Los Peñasquitos Lagoon
7. San Diego River Estuary
8. Sweetwater River Estuary
9. Tijuana River Estuary

Maps of the nine lagoons/estuaries are provided in Appendix A.

Lagoons/estuaries that were excluded from the Bight '13 Program, as well as the reasons for their exclusion, are presented below:

1. San Luis Rey River Estuary – not identified as suitable from National Wetlands Inventory due to depth/low salinity.
2. Loma Alta Slough– Too small, closed during summer months, low salinity.
3. Buena Vista Lagoon – Freshwater, closed lagoon.
4. Famosa Slough – Too small for program, somewhat disconnected from marine environment.

Several of the lagoons do require annual maintenance dredging at the ocean inlet to ensure that flows are not restricted. This dredging is typically restricted to the areas near the mouth and often occurs in late spring. Maintenance dredging is not expected to affect stations selected for the lagoon sample draw. In the event a sample location occurs in an area that was recently dredged, an alternate sample will be randomly selected outside of the area of influence.

3.1 Sediment Design and Program

Sediment samples will be collected in accordance with the Bight '13 sampling protocols. Weston's staff is attending all Bight '13 field technical sub-workgroup meetings to ensure that samples will be collected following all Bight protocols. Sediment samples will be collected using a Van Veen grab sampler and analyzed for chemistry, toxicity, and benthic community.

Chemistry

The Bight ’13 program core sediment chemistry list is presented in Table 3-1. Sediment samples will be analyzed according to Bight ’13 protocols. Additional chemistry analyses provided by the Bight Program from other participating agencies as special studies are included in Table 3-2.

Table 3-1. Bight ’13 Sediment Analytical List, Methods, and Detection Limits

Group/Analyte	Method	Units	RL*	Laboratory
General Parameters				
Total Solids	EPA 160.3	% Wet Weight	0.05	Physis
Particle Size Distribution	Laser Particle Size	µm	-	City of San Diego
Total Organic Carbon	EPA 9060A	% Dry Weight	0.1	Physis
Total Nitrogen	EPA 9060A	%	0.1	Physis
Total Phosphorus	SM 4500-P E	mg/g	0.05	Physis
Trace Metals				
Aluminum (Al)	EPA 6020	µg/dry g	5	Physis
Antimony (Sb)	EPA 6020	µg/dry g	10	
Arsenic (As)	EPA 6020	µg/dry g	1.6	
Barium (Ba)	EPA 6020	µg/dry g	0.05	
Beryllium (Be)	EPA 6020	µg/dry g	0.2	
Cadmium (Cd)	EPA 6020	µg/dry g	0.09	
Chromium (Cr)	EPA 6020	µg/dry g	16	
Copper (Cu)	EPA 6020	µg/dry g	7	
Iron (Fe)	EPA 6020	µg/dry g	5	
Lead (Pb)	EPA 6020	µg/dry g	9.3	
Mercury (Hg)	EPA 245.7	µg/dry g	0.03	
Nickel (Ni)	EPA 6020	µg/dry g	4.2	
Selenium (Se)	EPA 6020	µg/dry g	1	
Silver (Ag)	EPA 6020	µg/dry g	0.2	
Zinc (Zn)	EPA 6020	µg/dry g	30	
Synthetic Pyrethroids				
Allethrin	GCMS-NCI	ng/dry g	0.5	Physis
Bifenthrin	GCMS-NCI	ng/dry g	0.5	
Cyfluthrin	GCMS-NCI	ng/dry g	0.5	
Cypermethrin	GCMS-NCI	ng/dry g	0.5	
Danitol (Fenpropathrin)	GCMS-NCI	ng/dry g	0.5	
Deltamethrin	GCMS-NCI	ng/dry g	0.5	
Esfenvalerate	GCMS-NCI	ng/dry g	0.5	
Fenvalerate	GCMS-NCI	ng/dry g	0.5	
L-Cyhalothrin	GCMS-NCI	ng/dry g	0.5	

Group/Analyte	Method	Units	RL*	Laboratory
Permethrin	GCMS-NCI	ng/dry g	0.5	
Prallethrin	GCMS-NCI	ng/dry g	0.5	
Organochlorine Pesticides				
2,4'-DDT	EPA 8270	ng/dry g	0.5	Physis
4,4'-DDT	EPA 8270	ng/dry g	0.5	
2,4'-DDD	EPA 8270	ng/dry g	0.5	
4,4'-DDD	EPA 8270	ng/dry g	0.5	
2,4'-DDE	EPA 8270	ng/dry g	0.5	
4,4'-DDE	EPA 8270	ng/dry g	0.5	
4,4'-DDMU	EPA 8270	ng/dry g	0.5	
alpha-Chlordane	EPA 8270	ng/dry g	0.5	
gamma-Chlordane	EPA 8270	ng/dry g	0.5	
Oxychlordane	EPA 8270	ng/dry g	0.5	
cis-nonachlor	EPA 8270	ng/dry g	0.5	
trans-nonachlor	EPA 8270	ng/dry g	0.5	
Polychlorinated Biphenyls (PCBs) Congeners				
PCB-18	EPA 8270	ng/dry g	7.5	Physis
PCB-28	EPA 8270	ng/dry g	7.5	
PCB-37	EPA 8270	ng/dry g	7.5	
PCB-44	EPA 8270	ng/dry g	7.5	
PCB-49	EPA 8270	ng/dry g	7.5	
PCB-52	EPA 8270	ng/dry g	7.5	
PCB-66	EPA 8270	ng/dry g	7.5	
PCB-70	EPA 8270	ng/dry g	7.5	
PCB-74	EPA 8270	ng/dry g	7.5	
PCB-77	EPA 8270	ng/dry g	7.5	
PCB-81	EPA 8270	ng/dry g	7.5	
PCB-87	EPA 8270	ng/dry g	7.5	
PCB-99	EPA 8270	ng/dry g	7.5	
PCB-101	EPA 8270	ng/dry g	7.5	
PCB-105	EPA 8270	ng/dry g	7.5	
PCB-110	EPA 8270	ng/dry g	7.5	
PCB-114	EPA 8270	ng/dry g	7.5	
PCB-118	EPA 8270	ng/dry g	7.5	
PCB-119	EPA 8270	ng/dry g	7.5	
PCB-123	EPA 8270	ng/dry g	7.5	
PCB-126	EPA 8270	ng/dry g	7.5	
PCB-128	EPA 8270	ng/dry g	7.5	

Group/Analyte	Method	Units	RL*	Laboratory
PCB-138	EPA 8270	ng/dry g	7.5	
PCB-149	EPA 8270	ng/dry g	7.5	
PCB-151	EPA 8270	ng/dry g	7.5	
PCB-153	EPA 8270	ng/dry g	7.5	
PCB-156	EPA 8270	ng/dry g	7.5	
PCB-157	EPA 8270	ng/dry g	7.5	
PCB-158	EPA 8270	ng/dry g	7.5	
PCB-167	EPA 8270	ng/dry g	7.5	
PCB-168	EPA 8270	ng/dry g	7.5	
PCB-169	EPA 8270	ng/dry g	7.5	
PCB-170	EPA 8270	ng/dry g	7.5	
PCB-177	EPA 8270	ng/dry g	7.5	
PCB-180	EPA 8270	ng/dry g	7.5	
PCB-183	EPA 8270	ng/dry g	7.5	
PCB-187	EPA 8270	ng/dry g	7.5	
PCB-189	EPA 8270	ng/dry g	7.5	
PCB-194	EPA 8270	ng/dry g	7.5	
PCB-201	EPA 8270	ng/dry g	7.5	
PCB-206	EPA 8270	ng/dry g	7.5	
Polynuclear Aromatic Hydrocarbons				
1-Methylnaphthalene	EPA 8270	ng/dry g	50	
1-Methylphenanthrene	EPA 8270	ng/dry g	50	
1,6,7-Trimethylnaphthalene	EPA 8270	ng/dry g	50	
2,6-Dimethylnaphthalene	EPA 8270	ng/dry g	50	
2-Methylnaphthalene	EPA 8270	ng/dry g	50	
Acenaphthene	EPA 8270	ng/dry g	50	
Acenaphthylene	EPA 8270	ng/dry g	50	
Anthracene	EPA 8270	ng/dry g	50	
Benz[a]anthracene	EPA 8270	ng/dry g	50	
Benzo[a]pyrene	EPA 8270	ng/dry g	50	
Benzo[b]fluoranthene	EPA 8270	ng/dry g	50	
Benzo[e]pyrene	EPA 8270	ng/dry g	50	
Benzo[g,h,i]perylene	EPA 8270	ng/dry g	100	
Benzo[k]fluoranthene	EPA 8270	ng/dry g	50	
Biphenyl	EPA 8270	ng/dry g	50	
Chrysene	EPA 8270	ng/dry g	50	
Dibenz[a,h]anthracene	EPA 8270	ng/dry g	100	
Fluoranthene	EPA 8270	ng/dry g	50	

Group/Analyte	Method	Units	RL*	Laboratory
Fluorene	EPA 8270	ng/dry g	50	
Indeno[1,2,3-c,d]pyrene	EPA 8270	ng/dry g	100	
Naphthalene	EPA 8270	ng/dry g	50	
Perylene	EPA 8270	ng/dry g	50	
Phenanthrene	EPA 8270	ng/dry g	50	
Pyrene	EPA 8270	ng/dry g	50	
Polybrominated Diphenyl Ethers (PBDEs)				
BDE 17	GCMS-NCI	ng/dry g	0.1	Physis
BDE 28	GCMS-NCI	ng/dry g	0.1	
BDE 47	GCMS-NCI	ng/dry g	0.1	
BDE 49	GCMS-NCI	ng/dry g	0.1	
BDE 66	GCMS-NCI	ng/dry g	0.1	
BDE 85	GCMS-NCI	ng/dry g	0.1	
BDE 99	GCMS-NCI	ng/dry g	0.1	
BDE 100	GCMS-NCI	ng/dry g	0.1	
BDE 138	GCMS-NCI	ng/dry g	0.1	
BDE 153	GCMS-NCI	ng/dry g	0.1	
BDE 154	GCMS-NCI	ng/dry g	0.1	
BDE 183	GCMS-NCI	ng/dry g	0.1	

*Actual RLs provided by Physis may be lower than those required by the Bight '13 Monitoring Program.

Table 3-2. Additional Chemical Analyses Conducted as Special Studies in Sediments from San Diego Lagoons

Group/Analyte	Laboratory
Contaminants of Emerging Concern (CECs)	Physis/Calscience/Weck

Toxicity

Sediment toxicity samples will be collected and analyzed following the Bight '13 protocols. The Bight '13 program will use the following toxicity tests:

- *Eohaustorius estuarius* - 10 day amphipod test.
- *Mytilus galloprovincialis* - 48 hour sediment-pore water interface.

Additional toxicity analyses provided by the Bight Program from other participating agencies as special studies are included in Table 3-3.

Table 3-3. Additional Toxicity Analyses Conducted as Special Studies in Sediments from San Diego Lagoons

Special Study	Laboratory
Sediment Toxicity Identification Evaluation in Embayments	SCCWRP/ABC Labs/LACSD/Nautilus
Gene Microarray Analysis of Sediment Toxicity Samples	SCCWRP/Bight '13 toxicity testing laboratories
Alternative Toxicity Test Species Comparison	LACSD/Bight '13 toxicity testing laboratories

Benthic Community Assemblage

Benthic community assemblage samples will be collected and analyzed following Bight '13 protocols. Samples will be processed and preserved in the field. Samples initially will be sorted to five major phyletic groups for distribution to taxonomists who will identify organisms to species. Weston's taxonomists will utilize the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) Edition 8 for nomenclature and orthography. Additionally, Bight quality assurance/quality control (QA/QC) procedures will be followed both during sorting and during subsequent taxonomic identifications.

3.2 Water Quality Sampling

Water quality parameters will be measured at each sediment location prior to the sediment sample collection. Field parameters will be collected using a YSI 6600 data sonde at 6" below surface, mid depth, and 6" above the bottom. Data collected at each site include temperature, depth, salinity, dissolved oxygen, and pH. Salinity measurements must be above 25 ppt in order to meet the acceptability criteria for sampling.

Table 3-4. Water Quality Parameters

Analyte	Method/Instrument	Units	Reporting Limit	Laboratory
pH	Field/YSI 6600	pH Units	1-14	Field
Salinity	Field/YSI 6600	PPT	1-75	Field
Temperature	Field/YSI 6600	°C	0-100	Field
Dissolved oxygen	Field/YSI 6600	mg/l	0.2	Field

3.3 Prevention of the Spread of Aquatic Invasive Species

Southern California marine waters are known to have a number of aquatic invasive species. Weston field scientists are aware of and can identify the macro flora and fauna in the region (e.g., *Caulerpa taxifolia*, *Musculista senhousia*, and *Mytilus galloprovincialis*). Since the vessels to be used in the project are routinely stored on dry land, fouling organisms are not anticipated to be an issue. However, many invasive species are difficult to detect and may be entrained in muds, sediment, or the water column, additional measures are recommended.

In order to prevent the spread of aquatic invasive species from one lagoon or harbor to another, the following precautions will be taken:

- All boat surfaces will be inspected for mud/sediment and aquatic vegetation when initially hauled out from a given water body. Any observed sediment or vegetation will be cleaned off the boat at the site, including the trailer wheels and frame.
- All sampling equipment will be inspected for mud/sediment and aquatic vegetation and cleaned as necessary. Most equipment will be rinsed and decontaminated at the completion of each sampling station, and a final inspection will be conducted prior de-mobilizing and before leaving each water body.
- All personal gear, especially footwear, will be inspected and cleaned before leaving each water body.
- No site water will be transferred between water bodies or discharged from one to another.

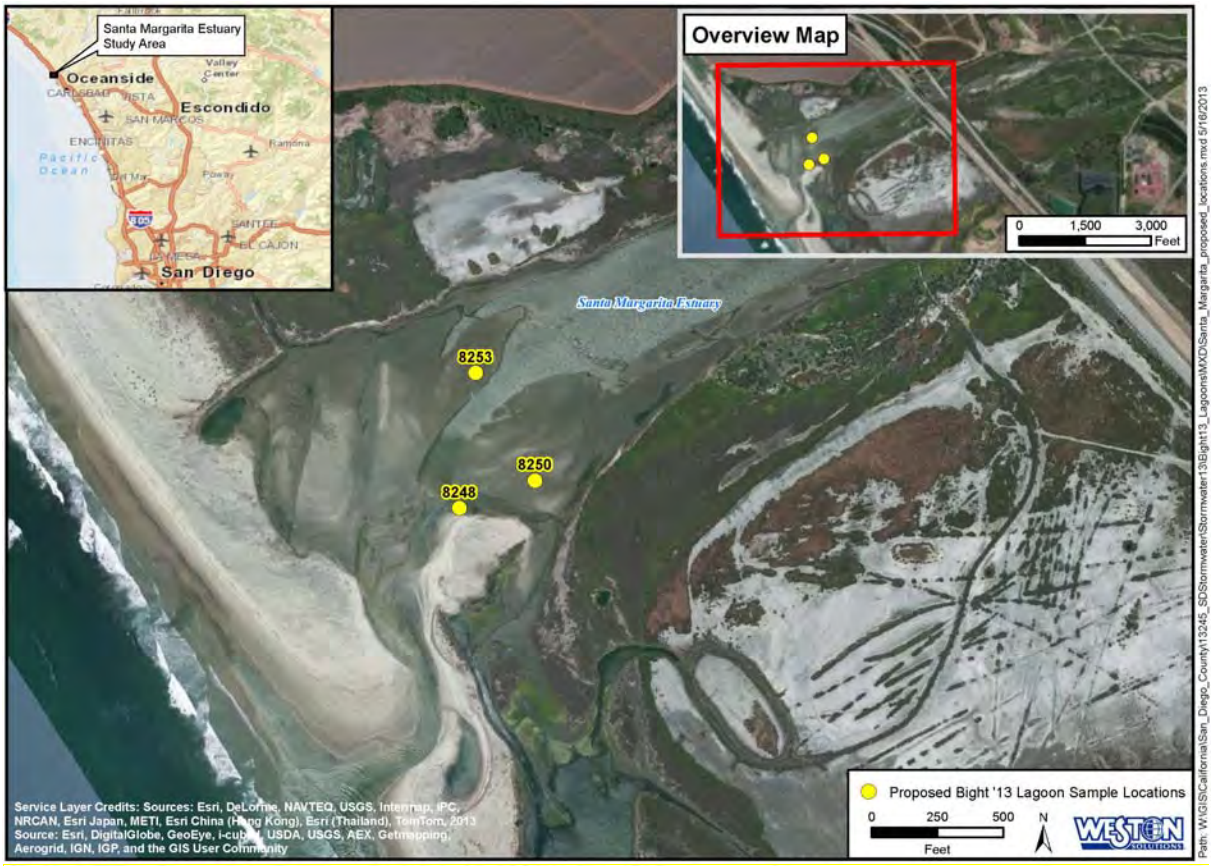
4.0 DATA MANAGEMENT AND REPORTING

The current workplan provides for data collection and submittal of electronic deliverables to SCCWRP. All sample results will be reviewed for adherence to the quality guidelines provided by the individual technical workgroups. Results will undergo thorough quality control review, will be entered into a data sharing template, and will be submitted to SCWWRP.

Data analysis and reporting will be included in the first Transitional Annual Monitoring Report due to the RWQCB in January 2015 prior to the release of the Bight '13 work product in approximately 2018.

APPENDIX A

Station Location Maps


Santa Margarita Estuary Study Area
Oceanside
Escondido
San Diego
Overview Map
0 1,500 3,000 Feet
Santa Margarita Estuary
8253
8250
8248
Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
Proposed Bight '13 Lagoon Sample Locations
0 250 500 N
Feet
WESTON SOLUTIONS


Oceanside
Escondido
Agua Hedionda Lagoon Study Area
San Diego
Chula Vista
Overview Map
0 0.5 1 Miles
Agua Hedionda Lagoon
8222
8218
8219
Proposed Bight '13 Lagoon Sample Locations
0 500 1,000 N
Feet
WESTON SOLUTIONS


Oceanside
Escondido
Batiquitos Lagoon Study Area
San Diego
Chula Vista
Overview Map
0 2,000 4,000 Feet
Batiquitos Lagoon
Batiquitos Lagoon
8205
8202
8200
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Proposed Bight '13 Lagoon Sample Locations
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WESTON SOLUTIONS
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8188
Overview Map
0 1,200 2,400 Feet
San Elijo Lagoon
8189
Oceanside
Escondido
San Elijo Lagoon Study Area
San Diego
Chula Vista
Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013 Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
Proposed Bight '13 Lagoon Sample Locations
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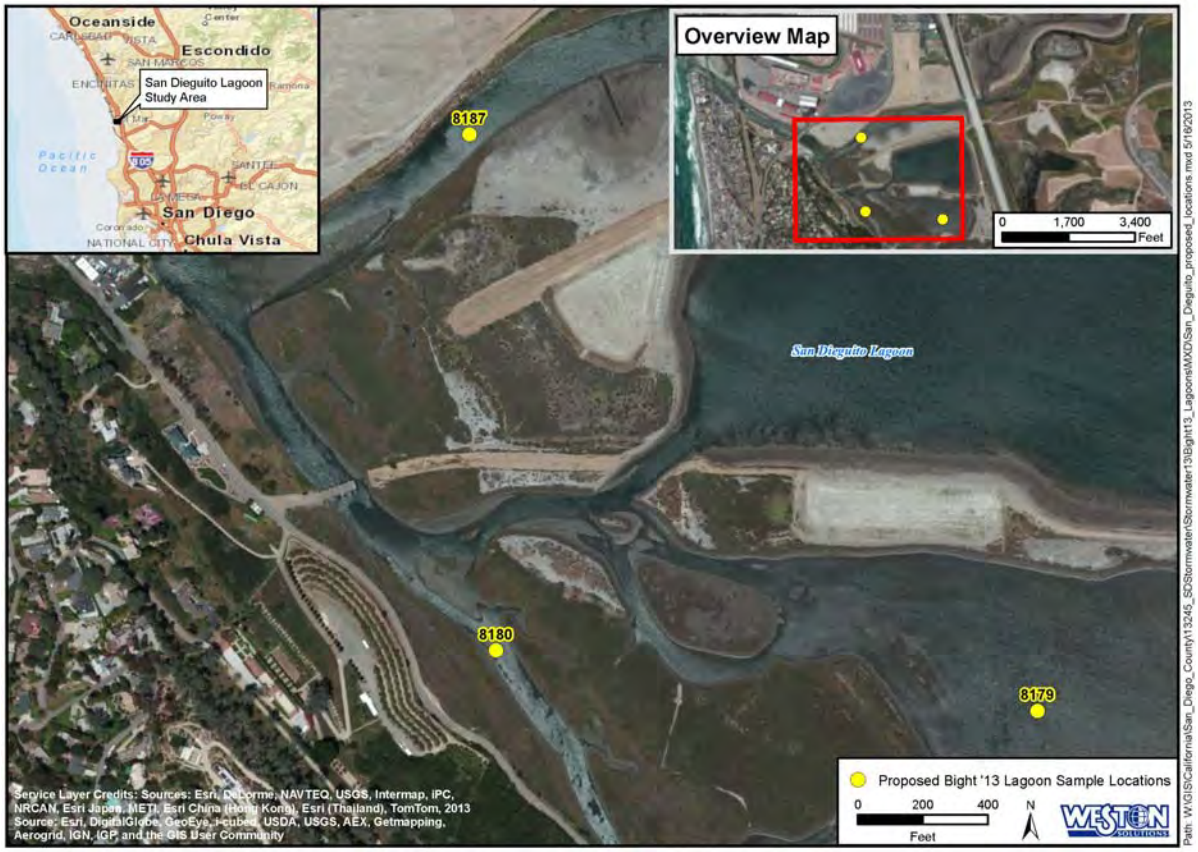
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Escondido
San Dieguito Lagoon Study Area
San Diego
Chula Vista
Pacific Ocean
Overview Map
0 1,700 3,400 Feet
8187
8180
8179
San Dieguito Lagoon
Proposed Bight '13 Lagoon Sample Locations
0 200 400 Feet
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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013 Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
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Oceanside
Escondido
Los Peñasquitos Lagoon Study Area
San Diego
Chula Vista
Pacific Ocean
Overview Map
0 1,500 3,000 Feet
8176
Los Peñasquitos Lagoon
8169
Proposed Bight '13 Lagoon Sample Locations
0 200 400 Feet
N
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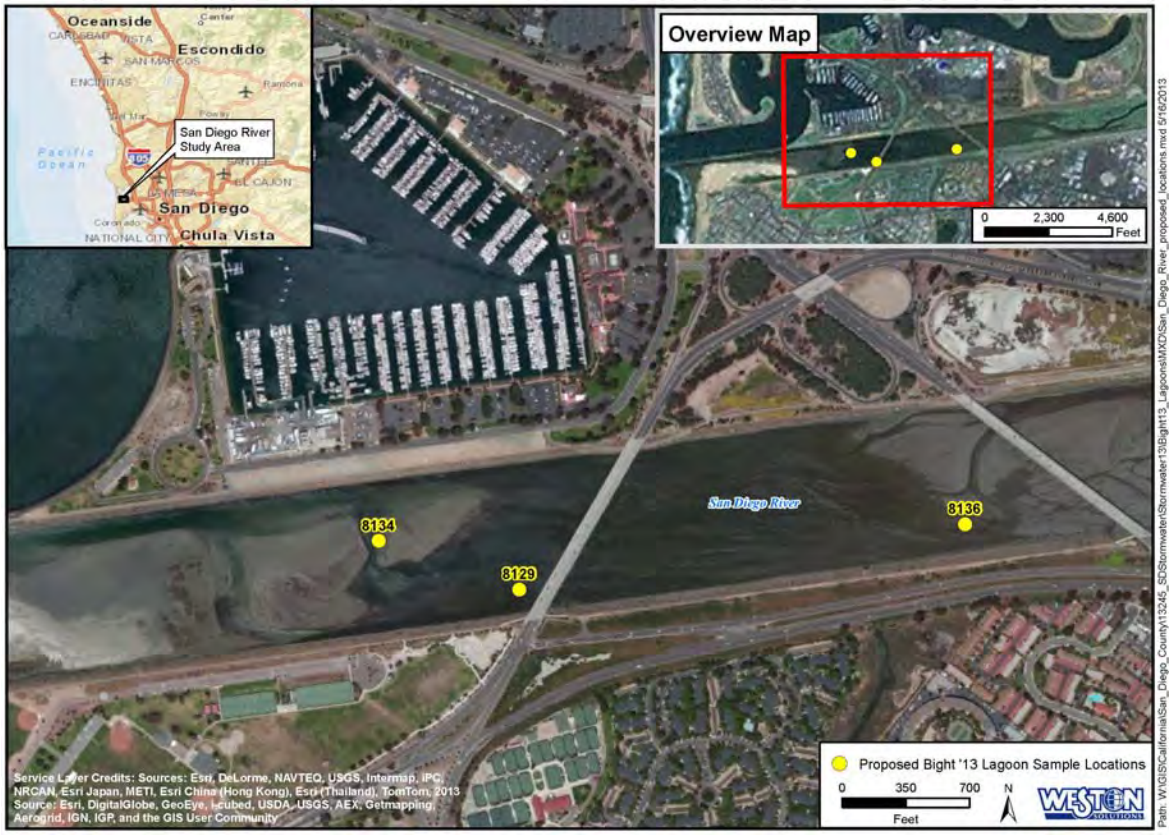
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Escondido
San Diego River Study Area
San Diego
Chula Vista
Overview Map
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San Diego River
8134
8136
8129
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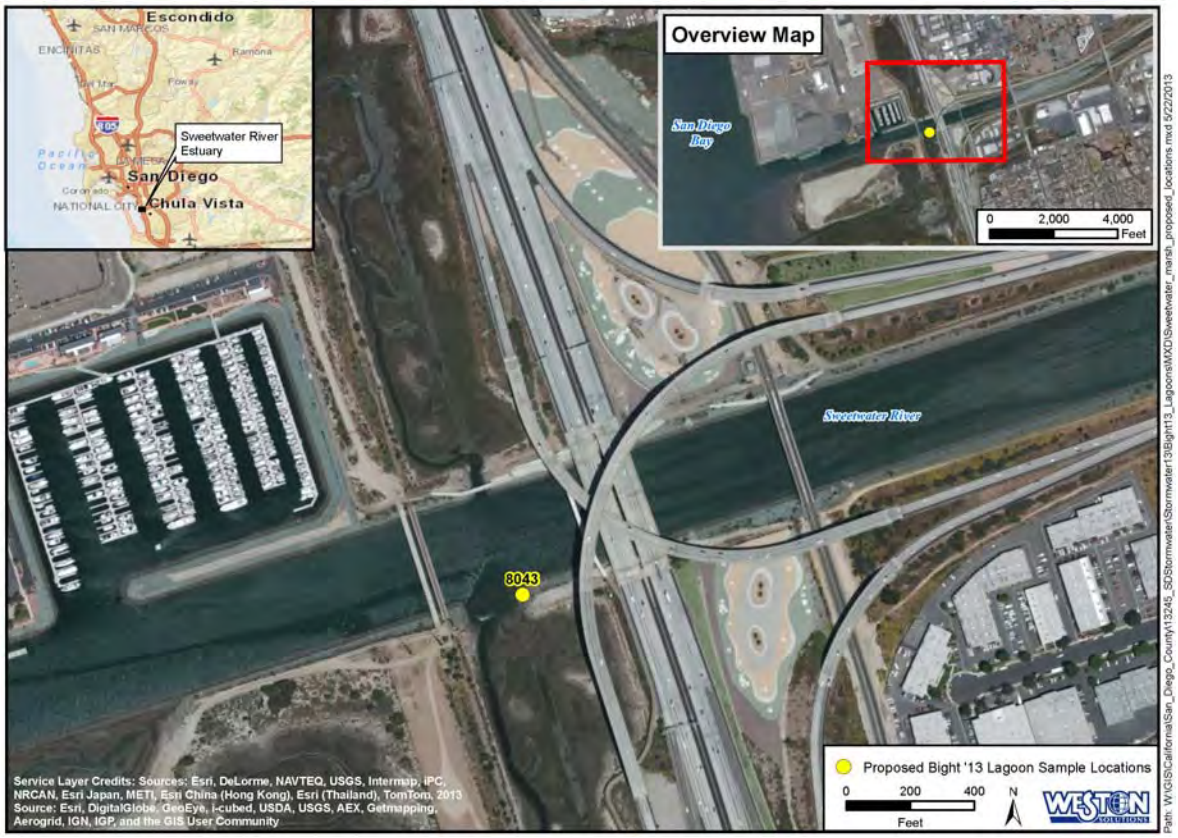
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San Diego
Chula Vista
Overview Map
San Diego Bay
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Sweetwater River
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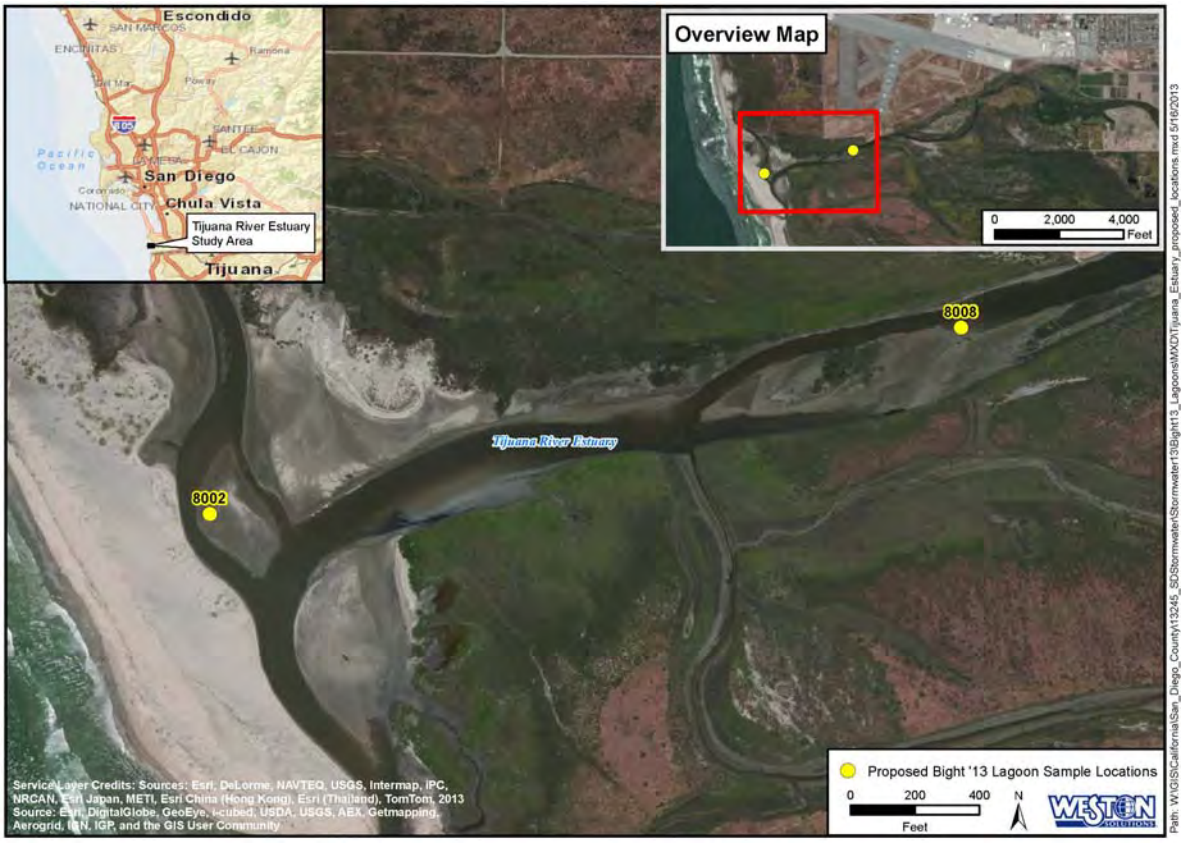
Escondido
SAN MARCOS
ENCINITAS
Ramona
Del Mar
Poway
SANTEE
EL CAJON
LA MESA
Pacific Ocean
San Diego
Coronado
NATIONAL CITY
Chula Vista
Tijuana River Estuary Study Area
Tijuana
Overview Map
0 2,000 4,000
Feet
8008
Tijuana River Estuary
8002
Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013
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Proposed Bight '13 Lagoon Sample Locations
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WESTON SOLUTIONS
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APPENDIX B

Bight '13 Contaminant Impact Assessment Workplan (Separate attachment)

APPENDIX C

Bight '13 Contaminant Impact Assessment Quality Assurance Manual (Separate attachment)

San Diego County Municipal Copermittees
2014 Sampling and Analysis Plan
for
Bight '13 Follow-Up Investigations
FINAL

Prepared For:

County of San Diego Municipal Copermittees

May 2014

San Diego County Municipal Copermittees
2014 Sampling and Analysis Plan
for
Bight '13 Follow-Up Investigations

FINAL

Prepared For:

County of San Diego Municipal Copermittees

Prepared By:

Weston Solutions, Inc.
5817 Dryden Place, Ste 101
Carlsbad, California 92008

May 2014

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ACRONYMS AND ABBREVIATIONS

ABLM	Ambient Bay and Lagoon Monitoring
ALS	ALS Environmental
ANOSIM	analysis of similarities
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
AVS-SEM	acid volatile sulfide – simultaneously extracted metals
Bight '03	Bight 2003 Regional Monitoring Program
Bight '08	Bight 2008 Regional Monitoring Program
Bight '13	Bight 2013 Regional Monitoring Program
BRI	Benthic Response Index
Cal EPA	California Environmental Protection Agency
CA LRM	California Logistic Regression Model
$CdCl_2$	cadmium chloride
COC	chain-of-custody
Copermittees	San Diego Regional Copermittees
CSI	Chemical Score Index
$CuCl_2$	copper chloride
CVAA	cold vapor atomic absorption
DD	decimal degrees
DGPS	Differential Global Positioning System
DO	dissolved oxygen
DOC	dissolved organic carbon
EC_{50}	median effective concentration
ER-L	effects range–low
ER-M	effects range–median
GC/MS	gas chromatography/mass spectrometry
HSD	honestly significant difference
IBI	Index of Biotic Integrity
ICP-AES	inductively coupled plasma-atomic emission spectrometry
ICP/MS	inductively coupled plasma/mass spectrometry
ID	inner diameter
LC_{50}	median lethal concentration
LOE	line of evidence
MDLs	method detection limits
MDS	multidimensional scales
$MgSO_4$	magnesium sulfate
MLOE	multiple lines of evidence
Nautilus	Nautilus Environmental
NCI	negative chemical ionization
NH_4	ammonium chloride
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
pH	hydrogen ion concentration

P_{MAX}	maximum probability model
PRIMER	Plymouth Routines in Multivariate Ecological Research
QA	quality assurance
QC	quality control
RBI	Relative Benthic Index
RIVPACS	River Invertebrate Prediction and Classification System
SAP	Sampling and Analysis Plan
SCAMIT	Southern California Association of Marine Invertebrate Taxonomists
SCCWRP	Southern California Coastal Water Research Project
SIM	selective ion monitoring
SIMPER	similarity percentages
SM	Standard Methods
SOPs	Standard Operating Procedures
SP	solid phase
SQOs	Sediment Quality Objectives
SVOCs	semi-volatile organic compounds
SWI	sediment-water interface
SWRCB	State Water Resources Control Board
TIE	toxicity identification evaluation
TOC	total organic carbon
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
Weck	Weck Laboratories, Inc.
WESTON	Weston Solutions, Inc.
WGS 84	World Geodetic System 1984

UNITS OF MEASURE

cm	centimeter
°C	degrees Celsius
L	liter
µg/kg	microgram per kilogram
µm	micrometer
m	meter
mg	milligram
mg/kg	milligram per kilogram
mg/L	milligram per liter
mL	milliliter
mm	millimeter
ppt	parts per thousand
%	percent

1.0 INTRODUCTION

The purpose of this Sampling and Analysis Plan (SAP) is to outline the activities that will be conducted by the San Diego Regional Copermittees (Copermittees) to satisfy the Sediment Quality Objective (SQO) requirement for possibly impacted sites identified as part of the Bight 2013 Lagoon Sediment Monitoring (Bight '13).

In 2003, the State Water Resources Control Board (SWRCB) initiated a program to develop SQOs for enclosed bays and estuaries. The primary objective is to protect benthic communities and aquatic life from exposure to contaminants in sediment. The Phase I SQOs are based on a multiple lines of evidence (MLOE) approach in which the lines of evidence (LOE) are sediment toxicity, sediment chemistry, and benthic community condition, as described in the *Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality* (SWRCB and California Environmental Protection Agency [Cal EPA], 2009) (Sediment Control Plan). Phase I SQOs have been approved by the SWRCB and Office of Administrative Law. Regional Water Quality Control Board Order R9-2013-0001 (Permit) requires the Copermittees to perform sediment monitoring to assess compliance with sediment quality receiving limits applicable to MS4 discharges to enclosed bays and estuaries in accordance with the Sediment Control Plan. The Permit also requires the Copermittees to participate in Bight Regional Monitoring. The Copermittees participated in the Bight '13 Contaminant Impact Assessment Program by conducting lagoon monitoring during summer 2013. A total of 22 sample stations were collected throughout the nine lagoons/estuaries within the San Diego Region. Of the 22 sample stations four were identified as possibly impacted with one site in each of the following lagoons: Agua Hedionda Lagoon, Batiquitos Lagoon, San Dieguito Lagoon, and San Diego Estuary. The four possibly impacted sites were recommended for follow-up activities. This SAP details the follow-up investigations to confirm and characterize the possibly impacted lagoon sites.

1.1 Background

The aquatic health of the San Diego estuaries and lagoons were assessed as part of the previous Bight Surveys in 2003 (Bight '03), 2008 (Bight '08), and most recently during 2013 (Bight '13). Lagoons and estuaries were also assessed in the Copermittees' three-year Ambient Bay and Lagoon Monitoring (ABLM) Program from 2003-2005 and from 2010-2012. Additionally in 2008-2013, the sediment conditions within San Diego estuaries were evaluated following the protocols of the Sediment Control Plan.

1.2 Regulatory Commitment

The San Diego Permit was adopted on May 8, 2013. Section D.1.e.(1).(b) of the Permit requires the Copermittees to participate in the Southern California Bight Regional Monitoring. The Copermittees' Regional Monitoring Workgroup participated in the Bight '13 Survey by providing in-kind services. The Copermittees contributed to the Bight '13 Survey by sampling up to 22 lagoon stations within the San Diego Region. This participation provides data useful in addressing the goals of the Monitoring and Assessment Sections of the Permit and satisfies the requirements of the Sediment Control Plan. Furthermore, the Copermittee's contribution to the Bight Survey will build on an existing dataset that provides a regional assessment of the coastal

marine health, while simultaneously providing a local assessment of the San Diego Region Lagoons.

In accordance with the Sediment Control Plan follow-up confirmation monitoring will be conducted for the results with possibly impacted SQO scores. One location in each of the following lagoons received a possibly impacted SQO score:

- Agua Hedionda Lagoon (Bight 13' Station 8222)
- Batiquitos Lagoon (Bight 13' Station 8202)
- San Dieguito Lagoon (Bight 13' Station 8179)
- San Diego River Estuary (Bight 13' Station 8136)

The remaining 18 stations were classified with unimpacted or likely unimpacted SQO scores. Based on the Bight '13 Lagoon Monitoring, the following lagoons do not require any follow-up actions at this time:

- Santa Margarita River Estuary
- San Elijo Lagoon
- Los Penasquitos Lagoon
- Sweetwater River Estuary
- Tijuana River Estuary

1.3 Technical Approach

This SAP is designed to provide data needed to answer questions related to characterizing the possibly impacted sites identified during the Bight '13 Monitoring Program. The goal is to characterize whether physical, chemical, or other potential stressors are contributing to the observed conditions in each follow-up lagoon location. The study follows a similar approach as during the previous follow-up studies conducted from 2010-2012 as part of the ABLM Program. However, special considerations will be needed and are discussed for each lagoon.

2.0 MATERIALS AND METHODS

2.1 Field Collection Program

Based on the results from the Bight '13 Lagoon Monitoring, sediment quality follow-up monitoring will be conducted in focused study areas in Agua Hedionda Lagoon, Batiquitos Lagoon, San Dieguito Lagoon, and San Diego River Estuary. One location in each of the lagoons/estuaries received a possibly impacted SQO score. To confirm the result at each location to determine response to changes in the physical environment, a sufficient number of samples must be collected to examine the patterns. Each sampling site will include three replicate samples of benthic condition (benthic community condition, sediment toxicity, sediment chemistry) on a relatively small spatial scale (10-15 meters [m]), and one replicate water quality station placed at the original location. The water quality characteristics are expected to be similar

on smaller spatial scales; therefore, only one water quality station will be used to describe the water quality within each of the sample sites.

To determine the physical and chemical factors that influence the distribution of organisms the following metrics will be used:

1. Sediment quality (3 samples per water quality station):
    a. Sediment physical and chemical analyses at the four lagoons/estuaries: grain size, total organic carbon (TOC), metals, synthetic pyrethroids, organochlorine pesticides, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs), ammonia, nutrients, total sulfides
    b. Additional sediment chemical analyses at San Diego River Estuary to determine bioavailability of metals to benthic organisms: acid volatile sulfide – simultaneously extracted metals (AVS-SEM)
    c. Sediment toxicity
        i. 10-day acute solid phase (SP) test with the amphipod *Eohaustorius estuarius*
        ii. 48-hr sediment-water interface (SWI) test with the mussel larvae *Mytilus galloprovincialis*
    d. Benthic community
        i. Traditional taxonomic techniques will be used to describe benthic communities
        ii. SQO benthic indices and marine indices will be calculated for comparison
    e. Stressor Identification Studies may be conducted based on a review of sediment quality objective results and data comparisons
2. Water quality measurements will be collected at one water quality station in each lagoon/estuary. A YSI 6600 Multiparameter Water Quality Sonde will be deployed for a minimum of two weeks at each water quality station. In addition, discrete water samples will be collected. Data to be collected will include:
    a. Temperature
    b. Salinity
    c. Dissolved oxygen (DO)
    d. Hydrogen ion concentration (pH)
    e. Dissolved organic carbon (DOC)
    f. Chlorophyll-a
    g. Nutrients (total nitrogen and total phosphorus)
    h. TSS

Prior to all field activities, encroachment permits will be obtained from the respective agency maintaining jurisdiction over the lagoon to be monitored (permits should be obtained within 2 months prior to the planned sampling). All sampling equipment will be deployed using inflatable Zodiac® type vessels or other applicable vessel.

Analytical chemistry for sediment and water will be provided by ALS Environmental (ALS) and Weck Laboratories, Inc. (Weck). Nautilus Environmental (Nautilus) will perform biological testing for SP and SWI analyses. Benthic infaunal and grain size analysis will be conducted by Weston Solutions, Inc (WESTON).

2.1.1 Sampling Locations

The proposed follow-up sampling locations for each of the four lagoons/estuaries are presented in Table 2-1. The Bight '13 station for which the follow-up monitoring is occurring is also provided for reference. Each of the four lagoons/estuaries consists of one sampling site. As described above, each sampling site includes three replicate samples of benthic condition (benthic community condition, sediment toxicity, sediment chemistry), and one replicate water quality station placed at the original Bight '13 location. Specific locations of each sampling site are presented in maps on the following pages (Figure 2-1 through Figure 2-4).

Table 2-1. Sample Locations and Analyses

Lagoon or Estuary	Bight '13 Site ID	ABLM 2014 Site ID	Latitude	Longitude	Analysis
Agua Hedionda Lagoon	8222	AH14	33.14010	-117.32430	Water Quality/Chemistry
		AH14-A	33.14020	-117.32421	Sediment Chemistry, Toxicity, and Benthic Infauna
		AH14-B	33.13998	-117.32423	
		AH14-C	33.14009	-117.32446	
Batiquitos Lagoon	8202	BL14	33.08810	-117.29130	Water Quality/Chemistry
		BL14-A	33.08823	-117.29128	Sediment Chemistry, Toxicity, and Benthic Infauna
		BL14-B	33.08804	-117.29117	
		BL14-C	33.08803	-117.29142	
San Dieguito Lagoon	8179	SDL14	32.96610	-117.25250	Water Quality/Chemistry
		SDL14-A	32.96621	-117.25240	Sediment Chemistry, Toxicity, and Benthic Infauna
		SDL14-B	32.96597	-117.25245	
		SDL14-C	32.96612	-117.25266	
San Diego River Estuary	8136	SDR14	32.75790	-117.22740	Water Quality/Chemistry
		SDR14-A	32.75801	-117.22731	Sediment Chemistry, AVS-SEM, Toxicity, and Benthic Infauna
		SDR14-B	32.75777	-117.22734	
		SDR14-C	32.75791	-117.22756	

Figure 2-1. Proposed Sampling Locations within Agua Hedionda Lagoon

Figure 2-2. Proposed Sampling Locations within Batiquitos Lagoon

Figure 2-3. Proposed Sampling Locations within San Dieguito Lagoon

Figure 2-4. Proposed Sampling Locations within San Diego River Estuary

2.1.2 Navigation

All station locations will be pre-plotted prior to sampling activities. Locations will be located using a Furuno GP 1650D Differential Global Positioning System (DGPS) or similar type GPS. The system uses U.S. Coast Guard differential correction data, and is accurate within 10 ft. All final station locations will be recorded in the field using positions from the DGPS.

2.1.3 Sediment Sampling and Handling

Benthic sediments will be collected using a stainless steel, 0.1-m^2 Van Veen grab sampler (Figure 2-5). A sample will be determined to be acceptable if the surface of the grab is even, there is minimal surface disturbance, and there is a penetration depth of at least five centimeters (cm). Rejected grabs will be discarded and re-sampled. Upon retrieval, if the grab is acceptable, the overlying water will be carefully drained, and the sediment will be processed depending on analysis and use. Data will be logged onto field data sheets (Appendix A). All Van Veen equipment will be cleaned prior to sampling. Between sampling locations, the Van Veen grab sampler and stainless steel scoop will be rinsed with site water. Sediment grabs will be collected for the following analyses: benthic infauna, chemistry, grain size, and toxicity.

Samples collected for benthic infaunal analysis will be rinsed through a 1.0 millimeter (mm) mesh screen. The material retained on the screen will be transferred to a labeled quart jar. A 7 percent (%) magnesium sulfate ($MgSO_4$) seawater solution will be added to relax the collected specimens. After 30 minutes, the samples will be fixed in a 10% buffered formalin solution.

Sediment chemistry and toxicity samples will be collected from the top 5 cm of the grab using a pre-cleaned stainless steel scoop. Sediment within 1 cm of the sides of the grab will be avoided to prevent interaction of any contaminants and the steel sampling device. Approximately 10 liters (L) of sediment will be collected for acute and chronic toxicity testing and placed in clean food-grade polyethylene bags. Sediment for chemical analyses will be placed in 250 milliliter (mL) certified clean glass jars with Teflon®-lined lids. Sediment collected for grain size will be placed in quart-sized Ziploc™ bags. All sediment samples will be logged on a chain-of-custody (COC) form (see Section 2.1.7) and placed in a cooler on ice until delivered to WESTON's Carlsbad Office. At WESTON, sediment samples will be stored at 4 degrees Celsius (°C) in the dark until delivered to the appropriate laboratory for analysis. ALS will analyze the sediment samples for metals, PCBs, PAHs, organochlorine pesticides, ammonia, total sulfides, AVS-SEM (only for San Diego River Estuary), total nitrogen, total phosphorus, percent solids, and TOC. Weck will analyze the sediment for synthetic pyrethroids. WESTON will conduct the grain size and benthic infaunal analysis. Nautilus will perform the acute and chronic toxicity testing.

Figure 2-5. Van Veen Grab Sampler

2.1.4 Water Quality Sampling and Handling

Water quality sampling will be conducted using YSI 6600 Multiparameter Water Quality Sondes. The YSI meter will be deployed for a minimum of two weeks at each water quality station to capture both the spring and neap tide. Water quality data collected will include depth, temperature, salinity, DO, and pH. YSI sondes will be attached to an anchored mounting support and placed horizontally approximately six inches above the SWI. A surface buoy will be used to mark the location of the sonde unless it poses a navigational hazard. The sondes will be set up to log data at 15 minute intervals. Recorded sonde data will be saved in the unit's internal memory until downloaded on a computer upon retrieval from the field.

In addition, discrete water samples will be collected 6 inches above the sediment water interface using a Niskin bottle. Water samples will be transferred to labeled containers for analysis of TSS, DOC, chlorophyll-a, total nitrogen, and total phosphorus.

All water samples will be logged on a COC form (see Section 2.1.7) and placed in a cooler on ice until delivered to WESTON's Carlsbad Office. At WESTON, water samples will be stored at 4°C in the dark until shipped or delivered to Weck for analysis. All water samples will be delivered within 24 hours of collection.

2.1.5 Prevention of the Spread of Aquatic Invasive Species

Southern California marine waters are known to have a number of aquatic invasive species. WESTON field scientists are aware of and can identify the macro flora and fauna in the region (e.g., *Caulerpa taxifolia*, *Musculista senhousia*, and *Mytilus galloprovincialis*). Since the vessels to be used in the project are routinely stored on dry land, fouling organisms are not anticipated to be an issue. However, many invasive species are difficult to detect and may be entrained in muds, sediment, or the water column, additional measures are recommended.

In order to prevent the spread of aquatic invasive species from one lagoon or harbor to another, the following precautions will be taken:

- All boat surfaces will be inspected for mud/sediment and aquatic vegetation when initially hauled out from a given water body. Any observed sediment or vegetation will be cleaned off the boat at the site, including the trailer wheels and frame.
- All sampling equipment will be inspected for mud/sediment and aquatic vegetation and cleaned as necessary. Most equipment will be rinsed and decontaminated at the completion of each sampling station, and a final inspection will be conducted prior to de-mobilizing and before leaving each water body.
- All personal gear, especially footwear, will be inspected and cleaned before leaving each water body.
- No site water will be transferred between water bodies or discharged from one to another.

2.1.6 Shipping

Prior to shipping, sample containers will be placed in sealable plastic bags and securely packed inside the cooler with ice. COC forms will be filled out (see Section 2.1.7), and the original signed COC forms will be inserted in a sealable plastic bag and placed inside the cooler. The cooler lids will be securely taped shut and then delivered to the analytical laboratories listed in Table 2-2.

Table 2-2. Analytical Laboratories and Shipping Information

Laboratory	Volume (per sample)	Analyses Performed	Shipping Information
Nautilus Environmental	5L sediment (SP toxicity testing), 5L (SWI toxicity testing),	Toxicity testing (SP and SWI)	Nautilus Environmental 4340 Vandever Avenue San Diego, CA 92120
ALS Environmental	500 mL sediment	Sediment chemistry	ALS Environmental 1317 South 13th Ave Kelso, WA 98626
Weck Laboratories, Inc	250 mL sediment, 2L water	Sediment (synthetic pyrethroids only) and water chemistry	Weck Laboratories 14859 E. Clark Ave City of Industry, CA 91745
Weston Solutions, Inc.	250 mL sediment, benthic infaunal samples (varies)	Grain size and benthic infaunal analysis	Weston Solutions, Inc. 5817 Dryden Place, Ste 101 Carlsbad, CA 92008

2.1.7 Documentation of Chain-of-Custody

This section describes the program requirements for sample handling and COC procedures. Samples are considered to be in custody if they are: (1) in the custodian's possession or view, (2) retained in a secured place (under lock) with restricted access, or (3) placed in a secured container. The principal documents used to identify samples and to document possession are COC records, field log books, and field tracking forms. COC procedures will be used for all samples throughout the collection, transport, and analytical process, and for all data and data documentation, whether in hard copy or electronic format.

COC procedures will be initiated during sample collection. A COC record will be provided with each sample or sample group (sample form provided in Appendix B). Each person who has custody of the samples will sign the form and ensure that the samples are not left unattended unless properly secured. Minimum documentation of sample handling and custody will include the following:

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

The completed COC form will be placed in a sealable plastic envelope that will travel inside the ice chest containing the listed samples. The COC form will be signed by the person transferring custody of the samples. The condition of the samples will be recorded by the receiver. COC records will be included in the final analytical report prepared by the laboratory, and will be considered an integral part of that report.

2.2 Physical and Chemical Analysis

Physical and chemical measurements of water and sediment in the Sediment Monitoring Program were selected to provide data on chemicals of potential concern in bays and estuaries located in San Diego County. All analytical methods used to obtain contaminant concentrations will follow United States Environmental Protection Agency (USEPA), Standard Methods (SM 21st Edition; American Public Health Association [APHA], 2005), or American Society for Testing and Materials (ASTM).

2.2.1 Sediment Samples

The specific physical and chemical analyses, analytical methods, target method detection limits (MDLs) and target reporting limits (RLs) for sediment samples are specified in Table 2-3. Physical analyses of sediment will include grain size and percent solids. Grain size is analyzed to determine the general size classes that make up the sediment (e.g., gravel, sand, silt, and clay). The frequency distribution of the size ranges (reported in mm) of the sediment will be reported in

the final data report. Percent solids will also be measured to convert concentrations of the chemical parameters from a wet-weight to a dry-weight basis. Chemical analyses of sediment will include ammonia, TOC, nutrients including total nitrogen and total phosphorus, total sulfides, metals, synthetic pyrethroids, chlorinated pesticides, PCBs, and PAHs. In addition, sediment samples at San Diego River Estuary will be analyzed for AVS-SEM to determine the bioavailability of metals to aquatic organisms.

Table 2-3. Chemical and Physical Parameters for Sediment Samples

Parameter	Method	Procedure	Target Method Detection Limit (dry weight)	Target Reporting Limit (dry weight)
Physical / Conventional Tests				
Ammonia	USEPA 350.1 M	ICP/MS	0.04 mg/wet kg	0.5 mg/wet kg
Grain Size	Plumb (1981)	Sieve/Pipette	1.0%	1.0%
Percent Total Solids	USEPA 160.3 M	Gravimetric	0.1%	0.1%
Total Organic Carbon	USEPA 9060A	Combustion IR	0.02%	0.1%
Total Nitrogen	USEPA353.2M/ASTM D1426-93B M	NH3/NO2/NO3/TKN	0.5 mg/kg	1 mg/kg
Total Phosphorus	USEPA 365.3M	Colorimetric	0.02 mg/kg	0.1 mg/kg
Total Sulfides	USEPA 9030M	Distillation	0.2 mg/kg	0.5 mg/kg
Sulfides, Acid Volatile	GEN-AVS	ICP-AES	0.004 µmol/g	0.016 µmol/g
Metals				
Aluminum (Al)	USEPA 6020A	ICP/MS	0.4 mg/kg	2 mg/kg
Antimony (Sb)	USEPA 6020A	ICP/MS	0.02 mg/kg	0.05 mg/kg
Arsenic (As)	USEPA 6020A	ICP/MS	0.2 mg/kg	0.5 mg/kg
Barium (Ba)	USEPA 6020A	ICP/MS	0.02 mg/kg	0.05 mg/kg
Beryllium (Be)	USEPA 6020A	ICP/MS	0.006 mg/kg	0.02 mg/kg
Cadmium (Cd)	USEPA 6020A	ICP/MS	0.008 mg/kg	0.02 mg/kg
Chromium (Cr)	USEPA 6020A	ICP/MS	0.05 mg/kg	0.2 mg/kg
Copper (Cu)	USEPA 6020A	ICP/MS	0.04 mg/kg	0.1 mg/kg
Iron (Fe)	USEPA 6020A	ICP/MS	2.0 mg/kg	4.0 mg/kg
Lead (Pb)	USEPA 6020A	ICP/MS	0.005 mg/kg	0.05 mg/kg
Mercury (Hg)	USEPA 7471B	CVAA	0.002 mg/kg	0.02 mg/kg
Nickel (Ni)	USEPA 6020A	ICP/MS	0.09 mg/kg	0.2 mg/kg
Selenium	USEPA 6020A	ICP/MS	0.5 mg/kg	1.0 mg/kg
Silver	USEPA 6020A	ICP/MS	0.005 mg/kg	0.02 mg/kg
Zinc (Zn)	USEPA 6020A	ICP/MS	0.2 mg/kg	0.5 mg/kg
AVS-SEM				
Antimony (Sb)	USEPA 6010C	ICP-AES	0.0003 µmol/g	0.008 µmol/g
Arsenic (As)	USEPA 6010C	ICP-AES	0.002 µmol/g	0.003 µmol/g
Cadmium (Cd)	USEPA 6010C	ICP-AES	0.0002 µmol/g	0.0004 µmol/g
Chromium (Cr)	USEPA 6010C	ICP-AES	0.0003 µmol/g	0.001 µmol/g
Copper (Cu)	USEPA 6010C	ICP-AES	0.0005 µmol/g	0.0013 µmol/g
Lead (Pb)	USEPA 6010C	ICP-AES	0.0005 µmol/g	0.001 µmol/g
Nickel (Ni)	USEPA 6010C	ICP-AES	0.0003 µmol/g	0.003 µmol/g
Zinc (Zn)	USEPA 6010C	ICP-AES	0.0003 µmol/g	0.0031 µmol/g
Synthetic Pyrethroids				
Allethrin	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*
Bifenthrin	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*
Cyfluthrin	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*
Cypermethrin	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*
Danitol (Fenpropathrin)	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*
Deltamethrin	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*
Esfenvalerate	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*
Fenvalerate	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*
L-Cyhalothrin	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*

Table 2-3. Chemical and Physical Parameters for Sediment Samples

Parameter	Method	Procedure	Target Method Detection Limit (dry weight)	Target Reporting Limit (dry weight)
Permethrin	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*
Prallethrin	GC/MS SIM	GC/MS NCI SIM	0.5 µg/kg *	0.5 µg/kg*
Organochlorine Pesticides				
2,4′-DDD	USEPA 8081B	GC/MS/MS	0.063 µg/kg	0.1 µg/kg
2,4′-DDE	USEPA 8081B	GC/MS/MS	0.079 µg/kg	0.1 µg/kg
2,4′-DDT	USEPA 8081B	GC/MS/MS	0.94 µg/kg	0.1 µg/kg
4,4′-DDD	USEPA 8081B	GC/MS/MS	0.035 µg/kg	0.1 µg/kg
4,4′-DDE	USEPA 8081B	GC/MS/MS	0.07 µg/kg	0.1 µg/kg
4,4′-DDT	USEPA 8081B	GC/MS/MS	0.047 µg/kg	0.1 µg/kg
Aldrin	USEPA 8081B	GC/MS/MS	0.079 µg/kg	0.1 µg/kg
BHC-alpha	USEPA 8081B	GC/MS/MS	0.061 µg/kg	0.1 µg/kg
BHC-beta	USEPA 8081B	GC/MS/MS	0.061 µg/kg	0.1 µg/kg
BHC-delta	USEPA 8081B	GC/MS/MS	0.097 µg/kg	0.1 µg/kg
BHC-gamma	USEPA 8081B	GC/MS/MS	0.031 µg/kg	0.1 µg/kg
Chlordane-alpha	USEPA 8081B	GC/MS/MS	0.062 µg/kg	0.1 µg/kg
Chlordane-gamma	USEPA 8081B	GC/MS/MS	0.064 µg/kg	0.1 µg/kg
cis-Nonachlor	USEPA 8081B	GC/MS/MS	0.038 µg/kg	0.1 µg/kg
Dieldrin	USEPA 8081B	GC/MS/MS	0.077 µg/kg	0.1 µg/kg
Endosulfan I	USEPA 8081B	GC/MS/MS	0.088 µg/kg	0.1 µg/kg
Endosulfan II	USEPA 8081B	GC/MS/MS	0.015 µg/kg	0.1 µg/kg
Endosulfan Sulfate	USEPA 8081B	GC/MS/MS	0.061 µg/kg	0.1 µg/kg
Endrin	USEPA 8081B	GC/MS/MS	0.072 µg/kg	0.1 µg/kg
Endrin Aldehyde	USEPA 8081B	GC/MS/MS	0.1 µg/kg	0.1 µg/kg
Endrin Ketone	USEPA 8081B	GC/MS/MS	0.071 µg/kg	0.1 µg/kg
Heptachlor	USEPA 8081B	GC/MS/MS	0.039 µg/kg	0.1 µg/kg
Heptachlor Epoxide	USEPA 8081B	GC/MS/MS	0.073 µg/kg	0.1 µg/kg
Methoxychlor	USEPA 8081B	GC/MS/MS	0.019 µg/kg	0.1 µg/kg
Mirex	USEPA 8081B	GC/MS/MS	0.045 µg/kg	0.1 µg/kg
Oxychlordane	USEPA 8081B	GC/MS/MS	0.1 µg/kg	0.1 µg/kg
Toxaphene	USEPA 8081B	GC/MS/MS	14 µg/kg	50 µg/kg
trans-Nonachlor	USEPA 8081B	GC/MS/MS	0.058 µg/kg	0.1 µg/kg
PCBs				
PCB Congeners	USEPA 8082A	GC/ECD	0.1 µg/kg	0.5 µg/kg
PAHs				
1-Methylnaphthalene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.1 µg/kg
1-Methylphenanthrene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
2,6-Dimethylnaphthalene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
2-Methylnaphthalene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Acenaphthene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Acenaphthylene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Anthracene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Benzo(a)anthracene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Benzo(a)pyrene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Benzo(b)fluoranthene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Benzo(e)pyrene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Benzo(g,h,i)perylene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Benzo(k)fluoranthene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Biphenyl	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Chrysene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Dibenzo(a,h)anthracene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Fluoranthene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Fluorene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg

Table 2-3. Chemical and Physical Parameters for Sediment Samples

Parameter	Method	Procedure	Target Method Detection Limit (dry weight)	Target Reporting Limit (dry weight)
Indeno(1,2,3-cd)pyrene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Naphthalene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Perylene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Phenanthrene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg
Pyrene	USEPA 8270D	GC/MS SIM	0.05 µg/kg	0.5 µg/kg

*Target MDLs and RLs for synthetic pyrethroids provided in wet weight.

2.2.2 Water Samples

The specific analyses, analytical methods, and target reporting limits for water samples are specified in Table 2-4. Water quality measurements will be taken in the field using YSI 6600 Multiparameter Water Quality Sondes as described in Section 2.1.4. Parameters will include DO, pH, salinity, and temperature. Laboratory chemical and physical analysis of water samples will include TSS, total nitrogen, total phosphorus, chlorophyll-a, and DOC.

Table 2-4. Chemical and Physical Parameters for Water Samples

Parameter	Method/Instrument	Units	Target Reporting Limit
Field Measurements			
Dissolved oxygen	YSI 6600	mg/L	0.2
pH	YSI 6600	pH units	1-14
Salinity	YSI 6600	ppt	1-75
Temperature	YSI 6600	°C	0-100
Physical / Conventional Laboratory Tests			
Chlorophyll-a	SM 10200 H	mg/m^3	10
Dissolved Organic Carbon	SM 5310 B	mg/L	0.1
Total Nitrogen	USEPA 353.2/USEPA 351.2	mg/L	0.1
Total Phosphorus	USEPA 365.3	mg/L	0.01
Total Suspended Solids	SM 2540 D	mg/L	5

2.2.3 Quality Assurance/Quality Control

The quality assurance (QA) objectives for chemical analysis conducted by the participating analytical laboratories are detailed in their Laboratory QA Manual(s). These objectives for accuracy and precision involve all aspects of the testing process, including the following:

- Methods and Standard Operating Procedures (SOPs)
- Calibration methods and frequency
- Data analysis, validation, and reporting
- Internal quality control (QC)
- Preventive maintenance
- Procedures to ensure data accuracy and completeness

Results of all laboratory QC analyses will be reported with the final data. Any QC samples that fail to meet the specified QC criteria in the methodology will be identified, and the corresponding data will be appropriately qualified in the final report.

All QA/QC records for the various testing programs will be kept on file for review by regulatory agency personnel.

2.3 Toxicity Testing

To evaluate the benthic condition of San Diego County's bays and lagoons, sediment toxicity testing will be conducted in accordance with the American Society for Testing and Materials (ASTM) and USEPA methods. The project plan is for analysis of three sediment samples per lagoon/estuary[1]. In addition, appropriate laboratory control samples will be run with each of the selected test species. Toxicity testing for this project will consist of a 10-day solid phase (SP) test using *Eohaustorius estuarius* and a 48-hour sediment-water interface (SWI) test using *Mytilus galloprovincialis*. The toxicity tests proposed for this project are summarized in Table 2-5. In addition, if significant toxicity is observed in the SP or SWI test, a toxicity identification evaluation (TIE) may be conducted as part of stressor identification studies described in Section 2.3.3.

Table 2-5. Toxicity Testing Proposed to Evaluate the Benthic Condition of San Diego County Bays and Lagoons

Test Type	Type of Organism	Taxon	Project Sediments	Control	Reference Toxicant	Ammonia Reference Toxicant
Solid Phase	Amphipod	*Eohaustorius estuarius*	X	Control Sediment	X	X
Sediment-Water Interface	Mussel	*Mytilus galloprovincialis*	X	Control Water	X	X

2.3.1 Solid Phase Testing

SP bioassays will be performed to estimate the potential toxicity of the collected sediments to benthic organisms. Ten-day SP tests using the marine amphipod *E. estuarius* will be conducted in accordance with procedures outlined in *Methods for Assessing Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods* (USEPA, 1994) and the ASTM method E1367-03 (ASTM, 2006). Test conditions are summarized in Table 2-6. On the day before test initiation, 2-cm aliquots of sample sediment will be placed in each of five replicate glass jars followed by approximately 800 mL of prepared seawater. Five replicate controls will be used to determine the health of the amphipods; this will be done by exposing the amphipods to clean sediment following the same protocols used for the test sediments. The test chambers will be left overnight to allow establishment of equilibrium between the sediment and overlying water. On day zero of the test, 20 amphipods will be randomly placed in each of the test chambers. Amphipods that do not bury in the sediment within an hour will be removed and replaced. Samples will be monitored daily for obvious mortality, sublethal effects, and abnormal

[1] Three replicate sediment samples will be collected per sampling site.

behavior. Water quality parameters, including DO, temperature, salinity, and pH, will be monitored daily. Overlying and interstitial ammonia will also be measured at test initiation and test termination. At the end of the test, organisms will be removed from the test chambers by sieving the sediment through a 0.5-mm mesh screen, and the numbers of live and dead amphipods in each test chamber will be recorded. Percent survival will be calculated for control and test sediments. Tests will be considered to be acceptable if there is more than 90% mean control survival.

Two 96-hour reference toxicity tests (cadmium chloride and ammonium chloride) will be conducted concurrently with each batch of sediment tests to establish the sensitivity of the test organisms used in the evaluation of the sediments and to evaluate the potential influence of ammonia toxicity on the test organisms. The cadmium reference toxicant test will be performed using the reference substance cadmium chloride ($CdCl_2$) with target concentrations of 1.25, 2.5, 5.0, 10.0, and 20.0 milligrams (mg) $CdCl_2$/L. Ten organisms will be added to each of four replicates for each concentration. The concentration of $CdCl_2$ that cause 50% mortality of the organisms (i.e., the median lethal concentration, or LC_{50}) will be calculated from the data. The LC_{50} values will then be compared to historical laboratory data for the test species with cadmium chloride. The ammonia reference toxicant test will be performed using the reference substance ammonium chloride (NH_4) with target concentrations of 20.0, 40.0, 80.0, 160.0, and 320.0 mg NH_4/L. Ten test organisms will be added to each of four replicates for each concentration. Subsamples will be obtained at test initiation to measure the actual ammonia concentrations and to calculate un-ionized ammonia concentrations. The LC_{50} values for total ammonia and un-ionized ammonia will be calculated from the data. The results of these reference toxicant tests will be used in combination with the control mortality to assess the health of the test organisms.

Table 2-6. Conditions for the 10-Day Solid Phase Bioassay with *E. estuarius*

Test Conditions 10-Day SP Bioassay		
	Test Species	***E. estuarius***
	Test Procedures	USEPA (1994); ASTM 1367-03 (2006)
	Age/Size Class	Mature, 3-5 mm
	Test Type/Duration	Static - Acute SP/10 days
	Sample Storage Conditions	4°C, dark, minimal head space
	Control Water Source	Scripps Pier seawater, 20 µm filtered, UV sterilized
Recommended Water Quality Parameters	Temperature	15 ± 2°C
	Salinity	20 ± 2 ppt
	Dissolved Oxygen	> 60% saturation (6.0 mg/L)
	pH	Monitor for pH drift
	Pore Water Total Ammonia	< 60 mg/L
	Pore Water Un-ionized Ammonia	< 0.8 mg/L
	Photoperiod	Continuous light
	Test Chamber	1 L glass jars

Table 2-6. Conditions for the 10-Day Solid Phase Bioassay with *E. estuarius*

Test Conditions 10-Day SP Bioassay	
Replicates/Sample	5
No. of Organisms/Replicate	20
Exposure Volume	2 cm sediment, 800 mL water
Aeration	Constant gentle aeration
Feeding	None
Water Renewal	None

2.3.2 Sediment-Water Interface Testing

SWI bioassays will be performed to estimate the potential chronic toxicity of contaminants fluxed from sediments to overlying water. Forty-eight-hour bivalve *M. galloprovincialis* SWI bioassays will be conducted in accordance with procedures outlined in *Short-term Methods for Measuring the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (USEPA 1995) and Anderson et al. (1996). Test conditions are summarized in Table 2-7. The day before test initiation, 5 cm aliquots of sample sediment will be placed in each of the five replicate glass chambers followed by approximately 300 mL of prepared seawater. Five replicate controls will be used to verify that the test system does not cause toxicity; this will be done by exposing the bivalve larvae to test chambers with screen tubes but no sediment. The test chambers will be left overnight to allow establishment of equilibrium between the sediment and overlying water. On day zero of the test, polycarbonate screen tubes will be lowered into each chamber so that larvae settled inside the screen tube will be in close proximity to the sediment surface. Approximately 250 bivalve larvae will be placed inside the screen tube in each of the test chambers. Water quality parameters, including DO, temperature, salinity, and pH, will be monitored daily. Overlying and interstitial ammonia will also be measured at test initiation and test termination. At the end of the test, organisms will be retrieved from the test chambers by removing the screen tubes and gently rinsing the larvae into glass shell vials with clean filtered seawater. The vials will be preserved with formalin to be analyzed by microscope. After microscope counts are performed, the percent normal-alive embryo development will be calculated for the control and test sediments. Tests will be considered to be acceptable if there is greater than 70% mean control normal-alive embryo development.

Two 48-hour reference toxicity tests (copper chloride and ammonium chloride) will be conducted concurrently with each batch of SWI tests to establish the sensitivity of the test organisms used in the evaluation of the sediments and to evaluate the potential influence of ammonia toxicity on the test organisms. The copper reference toxicant test will be performed using the reference substance copper chloride ($CuCl_2$) with target concentrations of 2.5, 5.0, 10.0, 20.0, and 40.0 micrograms (µg) $CuCl_2$/L. Approximately 250 larvae will be added to each of five replicates of these concentrations. The LC_{50} value will be calculated from the data and will then be compared to historical laboratory data for the test species with copper chloride. The

ammonia reference toxicant test will be performed using the reference substance ammonium chloride with target concentrations of 1.0, 2.0, 4.0, 8.0, and 16 mg NH_4/L. Approximately 250 larvae will be added to each of five replicates of these concentrations. Subsamples will be obtained at test initiation to measure the actual ammonia concentrations and to calculate un-ionized ammonia concentrations. The LC_{50} value for survival and the concentration causing a 50% reduction in normality (i.e., median effective concentration or EC_{50}) for total ammonia and un-ionized ammonia will be calculated from the data. The results of these reference toxicant tests will be used in combination with the percent control normal-alive embryo development to assess the health of the test organisms.

Table 2-7. Conditions for the 48-Hour Sediment-Water Interface Bioassay with *M. galloprovincialis*

Test Conditions 48-Hour SWI Bioassay		
	Test Species	***M. galloprovincialis***
	Test Procedures	USEPA (1995), Anderson et al. (1996)
	Age/Size Class	< 4 hour old larvae
	Test Type/Duration	Static - Acute SWI/48 hours
	Sample Storage Conditions	4°C, dark, minimal head space
	Control Water Source	Scripps Pier seawater, ≤ 1µm filtered, UV sterilized
Recommended Water Quality Parameters	Temperature	15 ± 2°C
	Salinity	32 ± 2 ppt
	Dissolved Oxygen	> 4.0 mg/L
	pH	Monitor for pH drift
	Photoperiod	16 hours light: 8 hours dark
	Test Chamber	Polycarbonate core tube 7.3 cm ID and 16 cm high, or similar
	Replicates/Sample	5
	No. of Organisms/Replicate	Approximately 250 larvae
	Exposure Volume	5 cm sediment, 300 mL water
	Aeration	Constant gentle aeration
	Feeding	None
	Water Renewal	None

2.3.3 Stressor Identification Studies

Biological testing is a useful tool for determining the presence of toxicity from sediment contamination; however, it does not indicate the cause of toxicity. The current SQO guidelines recommend assessing the multiple lines of evidence and conducting stressor identification investigations for sites identified as clearly impacted or likely impacted. Segments or reaches identified as possibly impacted are recommended for confirmation sampling prior to initiating stressor identification studies. However, by reviewing the available data sets, deductive reasoning can be used to narrow the focus of future actions.

The stressor identification investigations use a variety of tools that can be used to determine if the reason for the narrative objective not being met is due to generic stressors other than toxic pollutants, such as physical alterations or other pollutant related stressors. According to the SQO guidelines "If there is compelling evidence that the SQO exceedances contributing to a receiving water limit exceedance are not due to toxic pollutants, then the assessment area shall be designated as having achieved the receiving water limit." To determine if a site is impacted from toxic pollutants, one or more of the following tools may be applied:

- Evaluate the spatial extent of the area of concern in relation to anthropogenic sources
- Evaluate the body burden of the pollutants accumulated in the animals used for exposure testing
- Evaluate the chemical constituent results to mechanistic benchmarks
- Compare chemistry and biology data to determine if correlations exist
- Alternative biological assessment such as bioaccumulation experiments, pore water toxicity, or pore water chemistry analyses may be conducted.
- Phase I TIEs may also be conducted and are often useful for determining the causative agent or class of compounds causing toxicity.

Stressor identification investigations may be conducted using one or more of the following; statistical, biological, or chemical investigation data. Following a review of the investigation data, conclusions will be made based on the data available and/or recommendations will be developed for future studies to further characterize or identify the condition causing the narrative impairment.

2.4 Benthic Infauna Analysis

The benthic infaunal samples will be transported from the field to the laboratory and stored in a formalin solution for a minimum of 6 days. The samples will then be transferred from formalin to 70% ethanol for laboratory processing. The organisms will initially be sorted using a dissecting microscope into five major phyletic groups: polychaetes, crustaceans, molluscs, echinoderms, and miscellaneous minor phyla. While sorting, technicians will keep a count for quality control purposes, as described in the following paragraph. After initial sorting, samples will be distributed to qualified taxonomists who will identify each organism to species or to the lowest possible taxon. WESTON's taxonomists will utilize the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) Edition 9 for nomenclature and orthography.

A QA/QC procedure will be performed on each of the sorted samples to ensure a 95% sorting efficiency. A 10% aliquot of a sample will be re-sorted by a senior technician trained in the QA/QC procedure. The number of organisms found in the aliquot will be divided by 10% and added to the total number found in the sample. The original total will be divided by the new total to calculate the percent sorting efficiency. When the sorting efficiency of the sample is below 95%, the remainder of the sample (90%) will be re-sorted.

2.5 Data Review, Management and Analysis

2.5.1 Data Review

All data will be reviewed and verified by participating team laboratories to determine whether all data quality objectives have been met, and that appropriate corrective actions have been taken, when necessary.

2.5.2 Data Management

All laboratories will supply analytical results in both hard copy and electronic formats. Laboratories will have the responsibility of ensuring that both forms are accurate. After completion of the data review by participating team laboratories, hard copy results will be placed in the project file at WESTON and the results in electronic format will be imported into WESTON's database system.

2.5.3 Data Analysis

Data analysis will consist of tabulation and comparison with regulatory guidelines. Chemistry data for sediment will be compared to relevant Sediment Quality Guidelines. Toxicity results will be compared to appropriate laboratory controls. Sediment toxicity, chemistry, and benthic community condition will be assessed using California's SQOs as described in the *Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality* (SWRCB and Cal EPA, 2009).

2.5.3.1 Sediment Quality Guidelines

Results of chemical analyses of sediments will be compared to effects range-low (ER-L) and effects range-median (ER-M) values developed by Long et al. (1995). The effects range values (ER-L and ER-M) are helpful in assessing the potential significance of elevated sediment-associated contaminants of concern, in conjunction with biological analyses. Briefly, these values were developed from a large data set where results of both benthic organism effects (e.g., toxicity tests, benthic assessments) and chemical concentrations were available for individual samples. To derive these guidelines, the chemical values for paired data demonstrating benthic impairment were sorted in according to ascending chemical concentration. The 10^{th} percentile of this rank order distribution was identified as the ER-L and the 50^{th} percentile as the ER-M. While these values are useful for identifying elevated sediment-associated contaminants, they should not be used to infer causality because of the inherent variability and uncertainty of the approach. For certain pesticide compounds (i.e., chlordane and dieldrin) the ER-L and ER-M levels are so low as to make it largely impractical to detect them in typical estuarine sediments using routine analytical procedures. Accordingly, having non-detect results that are greater than the ER-L, ER-M, or MDLs would not require re-analysis.

2.5.3.2 Application of California Sediment Quality Objectives

Sediment quality from bays and lagoons in San Diego County will be assessed using California's SQOs. The goals of the SQOs are to determine if pollutants in sediments are present in quantities

that are toxic to benthic organisms and/or will bioaccumulate in marine organisms to levels that may be harmful to humans.

The SQOs are based on a MLOE approach in which sediment toxicity, sediment chemistry, and benthic community condition are the LOE. The MLOE approach evaluates the severity of biological effects and the potential for chemically-mediated effects to provide a final station level assessment. The specific methods associated with each LOE are described below.

Sediment Toxicity

Sediment toxicity will be assessed using two tests: a 10-day *E. estuarius* survival test and a sublethal test using the mussel *M. galloprovincialis*. Sediment toxicity test results from each station will be statistically compared to control test results, normalized to the control survival, and categorized as nontoxic, low, moderate, or high toxicity. The average of the test responses is calculated to determine the final toxicity LOE category (Table 2-8 and Table 2-9). If the average falls midway in between the two categories it is rounded up to the higher of the two.

Table 2-8. Sediment Toxicity Categorization Values for *E. estuarius*

% Survival of *E. estuarius* in Project Sediment		Category
If Significantly Different than Control Survival	If Not Significantly Different from Control	
90 – 100	82 – 100	**Nontoxic**
82 – 89[1]	59 – 81[1]	**Low Toxicity**
59 – 81[1]		**Moderate Toxicity**
< 59[1]	< 59[1]	**High Toxicity**

[1] These values are a percentage of the control

Table 2-9. Sediment Toxicity Categorization Values for *M. galloprovincialis*

% Normal of *M. galloprovincialis* in Project Sediment		Category
If Significantly Different than Control Survival	If Not Significantly Different from Control	
80 – 100	77 – 79	**Nontoxic**
77 – 79[1]	42 – 76[1]	**Low Toxicity**
42 – 76[1]		**Moderate Toxicity**
< 42[1]	< 42[1]	**High Toxicity**

[1] These values are a percentage of the control

Sediment Chemistry

Concentrations of chemicals detected in sediments will be compared to the California Logistic Regression Model (CA LRM) and the Chemical Score Index (CSI). The CA LRM is a maximum probability model (P_{MAX}) that uses logistic regression to predict the probability of sediment toxicity. The CSI is a predictive index that relates sediment chemical concentration to benthic community disturbance. Sediment chemistry results according to CA LRM and CSI are categorized as having minimal, low, moderate, and high exposure to pollutants (Table 2-10). The final sediment LOE category is the average of the two chemistry exposure categories. If the average falls midway in between the two categories it is rounded up to the higher of the two. For

example if the CA LRM is low exposure and the CSI is moderate exposure, then the final sediment LOE category is moderate exposure.

Table 2-10. Sediment Chemistry Guideline Categorization

Sediment Chemistry Guideline		Category
CA LRM	CSI	
<0.33	<1.69	**Minimal Exposure**
0.33 - 0.49	1.69 - 2.33	**Low Exposure**
0.50 - 0.66	2.34 - 2.99	**Moderate Exposure**
>0.66	>2.99	**High Exposure**

Benthic Community Condition

Benthic community condition will be assessed using a combination of four benthic indices: the Benthic Response Index (BRI), Relative Benthic Index (RBI), Index of Biotic Integrity (IBI), and a predictive model based on the River Invertebrate Prediction and Classification System (RIVPACS). The four indices will be calculated following the January 21, 2008 guidance provided by the Southern California Coastal Water Research Project (SCCWRP) entitled *Determining Benthic Invertebrate Community Condition in Embayments* for southern California marine bays. Each benthic index result is categorized according to four levels of disturbance, including reference, low, moderate, and high disturbance.

- Reference: Equivalent to a least affected or unaffected site
- Low Disturbance: Some indication of stress is present, but is within measurement error of unaffected condition
- Moderate Disturbance: Clear evidence of physical, chemical, natural, or anthropogenic stress
- High Disturbance: High magnitude of stress

Specific categorization values, which are specifically tailored to southern California marine bays, are assigned for each index (Table 2-11). The final step to determine the benthic community condition is to integrate the four indices into a single category. In doing so, the median of the four benthic index response categories are computed to determine the benthic condition. If the median fell between two categories, the value is rounded to the next higher category to provide the most conservative estimate of benthic community condition.

Table 2-11. Benthic Index Categorization Values for Southern California Marine Bays

Benthic Community Guideline				Index
BRI	IBI	RBI	RIVPACS	
< 39.96	0	> 0.27	> 0.90 to < 1.10	**Reference**
39.96 to 49.14	1	0.17 to 0.27	0.75 to 0.90 or 1.10 to 1.25	**Low Disturbance**
49.15 to 73.26	2	0.09 to 0.16	0.33 to 0.74 or > 1.25	**Moderate Disturbance**
> 73.26	3 or 4	< 0.09	< 0.33	**High Disturbance**

Station Level Assessment

The final station level assessment will be determined by the combination of the three LOE categories as presented in Attachment B of the *Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality* (SWRCB and Cal EPA, 2009). Attachment B presents every possible LOE combination which corresponds to one of six possible station level assessments as follows:

- unimpacted
- likely unimpacted
- possibly impacted
- likely impacted
- clearly impacted
- inconclusive

2.5.3.3 Statistical Analysis

The data used in the statistical analysis will include macrobenthic measures such as abundances of all taxonomic groups, total abundance, and total number of taxa. Environmental variables include the sediment contaminant concentrations, water column nutrients, physical factors such as sediment grain size, TOC, temperature, DO, salinity, and amphipod and mussel toxicity. The analysis methods detailed below may be modified if data do not pass normality testing, or if the results of the methods below are inconclusive.

Data will be tested for normality, and transformed as necessary prior to statistical analysis. Percent data (organic content, grain size, and amphipod and mussel survivorship) will likely be arcsin square root transformed. Comparisons of environmental variables and macrofaunal metrics between sites will be conducted with a Tukey honestly significant difference (HSD) test for multiple comparisons for normally distributed data and Kraskal Wallace for non-parametric data. Statistical analyses will be performed using the PRIMER 5.0 (Plymouth Routines in Multivariate Ecological Research) SAS 9.1 (SAS Institute) software packages.

Non-metric multidimensional scales (MDS) ordinations and hierarchical agglomerative cluster analysis will be conducted to describe the benthic community composition at each site. Ordinations are based on Bray-Curtis similarities (Bray and Curtis, 1957). Differences in benthic community composition within and between sites will be tested using an analysis of similarities (ANOSIM) randomization test, based on rank similarities of samples (Clark, 1993). The similarity percentages (SIMPER; Clark, 1993) routine will be used to identify the taxa or benthic metric that made the greatest contribution to defining differences among sites identified in the ANOSIM tests (Clark and Warwick, 1994).

2.6 Reporting

2.6.1 Draft and Final Reports

After all results are received, statistical analyses completed, and all evaluations made, the monitoring program results will be included in the Annual Monitoring Report. At a minimum, the following will be included in the final report:

- Summary of all field activities, including a description of any deviations from the SAP
- Descriptions of each sample and all original field logs
- Locations of sediment and water sampling stations, reported in latitude and longitude (DD) World Geodetic System 1984 (WGS 84)
- Plan view of the project showing the actual sampling locations
- QA/QC results and comparison of possible data quality impacts, as described in Section 2.6.2
- Data Results and interpretation using the sediment quality objectives.
- Recommendations for future stressor identification studies if warranted.

2.6.2 Quality Assurance/Quality Control and Laboratory Data Report

Analytical laboratories will provide a QA/QC narrative that describes the results of the standard QA/QC protocols that accompany analysis of field samples. All hard copies of results will be maintained in the project files. In addition, back-up copies of results generated by each laboratory will be maintained at their respective facilities. At a minimum, the laboratory reports will contain results of the laboratory analysis, QA/QC results, methodology, and a case narrative of COC details.

2.7 Schedule

Sampling and Reporting will occur as specified in Table 2-12 below.

Table 2-12. Schedule of Activities

Lagoon or Estuary	Permit Year	ABLM Sampling	Reporting
Agua Hedionda Lagoon	2014	July 2014	Copermittees Annual Monitoring Report Draft – November 2014 Final - January 2015
Batiquitos Lagoon			
San Dieguito Lagoon			
San Diego River Estuary			

3.0 REFERENCES

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APPENDIX A
Field Sediment Sampling Log

VAN VEEN TRACKING SHEET

Please Record All Drops (GOOD and BAD)

DATE	STATION	(Enter all Drops) GRAB NUMBER	TIME	WATER DEPTH (m)	Penetration Depth (cm)	Grade good(G) fair(F) poor(P)	Sample Type Infauna(I), Tox (T), and/or Chem(C)	Volume (L)	Color	Odor	Latitude	Longitude	Comments

APPENDIX B
Chain-of-Custody Form

☐ 5817 Dryden Place, Ste 101 • Carlsbad, CA 92008 • (760) 795-6900, FAX 931-1580
☐ 1340 Treat Blvd, Ste 210 • Walnut Creek, CA 94597 • (925) 948-2600, FAX 948-2601

CHAIN OF CUSTODY

35009

DATE_____ PAGE_____ OF_____

PROJECT NAME / SURVEY / PROJECT NUMBER

PROJECT MANAGER / CONTACT

CLIENT

ADDRESS

PHONE / FAX / EMAIL

SITE ID (Location)	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE / VOLUME	TOTAL NUMBER OF CONTAINER	ANALYSIS/TEST REQUESTED								PRESERVED HOW	FOR WESTON USE ONLY: SAMPLE TEMP. (°C) UPON RECEIPT	FOR WESTON USE ONLY: WESTON LAB ID

Sample Matrix Codes: FW=fresh water GW=ground water SLT=salt water SW=storm water WW=waste water SED=sediment A=air BIO=biologic SS=soil T=tissue O=other (specify) _____

Container Code: G=glass P=plastic B=bags ☐ O=other _____

Shipped By: ☐ Courier ☐ UPS ☐ FedEx ☐ USPS ☐ Client drop off ☐ Other _____

Turnaround Time: ☐ 2-day ☐ 5-day ☐ 7-day ☐ 10-day ☐ 14-day ☐ Standard ☐ Other _____

Reporting Requirements: ☐ PDF ☐ EDD ☐ Hard Copy ☐ Email ☐ Other _____

SAMPLED BY: PRINT **SIGNATURE**

COMMENTS / SPECIAL INSTRUCTIONS

RELINQUISHED BY				RECEIVED BY			
Print Name	Signature	Firm	Date/Time	Print Name	Signature	Firm	Date/Time
1.							
2.							
3.							
4.							
5.							
6.							

WHITE – return to originator • YELLOW – lab • PINK – retained by originator