THE CITY OF SAN DIEGO

Annual Receiving Waters Monitoring & Toxicity Testing Quality Assurance Report

2012

City of San Diego
Ocean Monitoring Program

Public Utilities Department
Environmental Monitoring and Technical Services Division

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Prepared by:

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2012 Quality Assurance Report

Introduction

The Environmental Monitoring and Technical Services (EMTS) Division of the City of San Diego's Public Utilities Department performs comprehensive Quality Assurance/Quality Control (QA/QC) activities to ensure the accuracy and reliability of receiving waters monitoring and toxicity testing data provided to regulatory agencies in compliance with the reporting requirements specified in several National Pollutant Discharge Elimination System (NPDES) permits (Table 1). These QA/QC procedures assure the quality of field sampling, laboratory analysis, record keeping, data entry, electronic data collection/transfer, as well as data analysis and reporting. The procedures are regularly reviewed and revised as necessary to reflect ongoing changes in NPDES permit requirements, sample collection, methods, technology, and applicability of new analytical methods.

Details of the division's QA/QC program for receiving waters monitoring and toxicity testing is documented in a separate Quality Assurance Plan that is currently under revision (City of San Diego, in prep). Additionally, the EMTS Division maintains certification through the International Organization for Standardization (ISO) 14001 Environmental Management Systems program (ISO 14001). As part of continuation in the ISO certification process, EMTS underwent and passed an external audit in 2012 conducted by a third-party auditor. This report summarizes the QA/QC activities that were conducted during calendar year 2012 by EMTS staff in support of NPDES permit requirements for receiving waters monitoring and toxicity testing for the City's Point Loma Wastewater Treatment Plant and South Bay Water Reclamation Plant, as well as similar ocean monitoring activities required for the International Wastewater Treatment Plant operated by the International Boundary and Water Commission.

Facilities and Staff

The EMTS Division includes three sections (laboratories) that participate in the receiving waters monitoring activities associated with the above NPDES permits: (1) Marine Biology and Ocean Operations; (2) Microbiology; (3) Wastewater Chemistry Services. The Marine Biology and Ocean Operations section (Marine Biology Lab) and the Marine Microbiology and Vector Management work group (Marine Microbiology Lab) of the Microbiology section are located at the EMTS Division's laboratory facilities located at 2392 Kincaid Road, San Diego, CA 92101. Staff scientists of these two labs are responsible for conducting most field operations and performing subsequent biological and oceanographic assessments associated with the City's Ocean Monitoring Program (e.g., water quality, benthic sediments and macrofauna, trawl-caught fishes and invertebrates, contaminant bioaccumulation in fishes). Lab personnel are organized into several different work groups based on their major work responsibilities and areas of expertise (see Appendices A.1, A.2). Brief descriptions of the areas of emphasis for each work group are given in the following sections.

The Wastewater Chemistry Services (WCS) section is located at other City facilities and is responsible for performing chemical analyses of the various seawater, sediment and fish tissue samples collected by the program. Descriptions of the WCS section and their QA procedures are presented in a separate QA report each year.

Table 1
NPDES permits that dictate receiving waters monitoring and toxicity testing by EMTS staff for CY 2012.

Facility	Owner/Operator	NPDES Permit No.	Effective Date
Point Loma Wastewater Treatment Plant	City of San Diego	CA0107409, Order No. R9-2009-0001	August 1, 2010
South Bay Water Reclamation Plant	City of San Diego	CA0109045, Order No. R9-2006-0067	January 1, 2007
International Wastewater Treatment Plant	International Boundary and Water Commission	CA0108928, Order No. 96-50	November 14, 1996

Marine Biology and Ocean Operations

***Data Management and Reporting (DM&R)*:** The primary responsibility of the DM&R work group is to analyze and report receiving waters monitoring data. This includes data QA, data analysis, and the interpretation of results from the receiving waters monitoring activities and other contract work. DM&R personnel work closely with the IT/GIS group (described below) to perform QA of all receiving waters monitoring data that are entered into the laboratory's database. Various software packages for data management, data manipulation, statistical analysis, and presentation are used to manage and analyze data from every aspect of receiving waters monitoring. The results and interpretation of these analyses are reported to regulatory and contract agencies in the form of monthly and annual reports.

***Information Technology and Geographic Information Systems (IT/GIS)*:** The IT/GIS work group is primarily responsible for the administration of the lab's database, performing geospatial data analysis, and generating all map products needed for the ocean monitoring program. Daily responsibilities include entry and archiving of ocean monitoring data, validation of data accuracy, maintenance of database structure and integrity, oversight of database access/security issues, and management of database enhancements. This group is also responsible for IT project planning, workflow automation programming, and website maintenance to support Marine Biology and other EMTS laboratory staff.

***Ocean Operations*:** This work group comprises two subsections, Ocean Operations and Vessel Operations. Ocean Operations personnel oversee and conduct water quality sampling, benthic sediment and macrofauna sampling, trawling and rig-fishing, diving operations, and ocean outfall inspections. These staff maintain and calibrate all oceanographic instrumentation, SCUBA equipment, and the laboratory's remotely operated vehicle (ROV). Vessel operations personnel are primarily responsible for the operation and maintenance of the City's two monitoring vessels (*Oceanus* and *Monitor III*). When in port, the group's boat operators schedule and oversee all regular vessel maintenance as well as any modifications that may become necessary. While at sea, they are responsible for ensuring the safety of the crew, locating and maintaining position at monitoring stations, and assisting with various deck activities during field operations.

***Taxonomy*:** The Taxonomy work group coordinates and manages the processing of all benthic macrofauna and trawl invertebrate samples, maintains the taxonomic literature and voucher collections,

Table 2
ELAP certifications for EMTS Division Marine Microbiology and Toxicology labs located at 2392 Kincaid Road, San Diego, CA. 92101.

Laboratory	Phone	ELAP Code	Cert.No.
Marine Microbiology	619-758-2360	CA01393	2185
Toxicology	619-758-2348	CA01302	1989

and conducts taxonomic training. In addition, taxonomy staff produce in-house identification sheets and keys to important species and other taxa. Members of this group participate in a regional taxonomic standardization program and perform all QA/QC procedures to ensure the accuracy of the taxonomic identifications made by laboratory personnel.

***Toxicology*:** The Toxicology Laboratory is certified by the State of California Department of Health Services, Environmental Laboratory Accreditation Program (ELAP), which is renewed on a biennial basis (see Table 2). Toxicology personnel are responsible for conducting all acute and chronic toxicity testing required by the City's NPDES permits and contractual obligations. Primary responsibilities include collection of wastewater effluent or other types of samples, maintaining test organisms and laboratory supplies, calibration of test instruments, conducting acute and chronic bioassays, record keeping, and the statistical evaluation, interpretation and reporting of all toxicology data. In addition, the Toxicology Lab maintains a separate Quality Assurance Manual in accordance with ELAP requirements, that contains up-to-date revisions to reflect current laboratory practices and procedures, and to ensure timely document version control.

Marine Microbiology and Vector Management

***Marine Microbiology*:** The Marine Microbiology Laboratory is also certified by ELAP (see Table 2). This lab is responsible for the quantification and identification of bacteria found in environmental samples. Responsibilities include the preparation of microbiological media, reagents, sample bottles, supplies and equipment, the collection of field samples along the shore, and a variety of laboratory analyses to measure concentrations of fecal indicator bacteria (e.g., membrane filtration, multiple tube fermentation, and Colilert-18 and Enterolert chromogenic substrate analyses) as appropriate to the sample type and as required by the NPDES permits. In addition, the group is responsible for the physical maintenance and quality assurance of large instruments such as autoclaves, incubators, water baths, ultra-freezers, a bacteriological safety cabinet, and three reagent-grade water point-of-use systems. Members are also responsible for developing sampling, analytical, and quality assurance protocols for special projects or studies involving microbiology.

***Vector Management*:** The Vector Management group provides for monitoring, surveillance, control and prevention of insects and other pests that are capable of transmitting diseases or causing harm to humans. The primary methods of control include environmental conservation measures, education, and water management techniques aided by appropriate chemical and biological control technology. The vector control program uses methods to census animal populations to determine control effectiveness and trends. Areas of responsibility include wastewater treatment plants, pump stations, buildings and office facilities. Biological assessments (bioassessments) of urban creeks and streams are conducted to evaluate and analyze short and long-term impacts of sewage spills into watersheds and receiving waters.

Field samples of aquatic communities are collected and field water quality indicators are measured. Physical habitat characteristics and anthropogenic changes are evaluated. Measures, evaluations, and comparisons are made to yield relative ratings of conditions within a specified community.

Scope of Work

Treated effluent from the Point Loma Wastewater Treatment Plant (PLWTP) is discharged to the Pacific Ocean through the Point Loma Ocean Outfall (PLOO), whereas the South Bay Ocean Outfall (SBOO) accepts commingled effluent from the South Bay Water Reclamation Plant (SBWRP) and International Wastewater Treatment Plant (IWTP). The separate NPDES permits associated with each of these treatment facilities define the requirements for toxicity testing and the monitoring of receiving waters for each discharge site. The permits define the sampling plans, compliance criteria, laboratory analyses, statistical analyses and reporting guidelines.

The core receiving waters monitoring efforts for both the Point Loma and South Bay monitoring programs are summarized in Tables 3 and 4, while the fixed-grid sampling sites for each program are shown in Figure 1. These core monitoring activities include weekly sampling of seawater from recreational areas along the shoreline and within the Point Loma and Imperial Beach kelp beds, as well as monthly or quarterly offshore sampling in order to document water quality conditions in the region. Benthic samples are collected semiannually or annually to monitor sediment conditions and macrofaunal communities. Trawl surveys are performed quarterly in the South Bay outfall region and semiannually off Point Loma to monitor the ecological health of demersal fish and megabenthic invertebrate communities. Additionally, fish tissue samples are collected and analyzed on either a semiannual or annual basis to monitor levels of chemical constituents that may have ecological or human health implications. Toxicity testing consists of acute and chronic bioassays of influent, effluent, and groundwater samples. The general toxicity testing required by the NPDES permits is outlined in Table 5. The results of these receiving waters monitoring activities and toxicity tests are analyzed and presented in various regulatory reports that are submitted to the San Diego Regional Water Quality Control Board (SDRWQCB).

In addition to the above core monitoring efforts, the City also conducts “strategic process studies” (i.e., special projects) as part of its regulatory requirements and as defined by the Model Monitoring Program developed for large ocean dischargers in southern California (Schiff et al. 2001). These special studies are determined by the City in coordination with the SDRWQCB and the United States Environmental Protection Agency (USEPA), and are generally designed to address recommendations for enhanced environmental monitoring of the San Diego coastal region put forth in a peer-reviewed report coordinated by scientists at the Scripps Institution of Oceanography (SIO 2004). Data for these directed studies are subject to similar QA/QC procedures as the routine monitoring data, although the projects themselves do not necessarily conform to the same analysis and reporting schedules. Thus, details and results of ongoing QA/QC activities associated with these special studies are not included in this report unless otherwise indicated.

As part of its regulatory requirements, the City also participates in regional monitoring activities for the entire Southern California Bight coordinated by the Southern California Coastal Water Research Project (SCCWRP). The intent of the regional programs is to maximize the efforts of the various partner agencies (e.g., municipal dischargers, research agencies) using a more cost-effective monitoring

Table 3

NPDES-permit mandated receiving waters sampling effort for the Point Loma ocean outfall region, excluding resamples, QA/QC analyses (e.g., field and laboratory duplicates), or special studies.

Monitoring Component	Location	No. of Stations/Zones	Sample Type	Discrete No. Samples/Site	Sampling Frequency	Sampling Times/Yr	Discrete No. Samples/Yr	Parameters	No. "Samples" Analyzed/Yr	Notes
Water Quality, Microbiology	shore	8	Seawater - Bacti	1	weekly	52	416	T, F, E [a]	1248	1 sample/station
&	kelp	8	Seawater - Bacti	3	5x/month	60	1440	T, F, E [a]	4320	3 depths/station
Oceanographic		8	Seawater - NH_4	3	quarterly	4	96	NH_4	96	3 depths/station/quarter
Conditions		8	CTD	1	5x/month	60	480	CTD profile [c]	3840	1 cast/station
	offshore	3	Seawater - Bacti	3	quarterly	4	36	E [b]	36	3 depths/station (18-m stns)
	(n=36)	11	Seawater - Bacti	3	quarterly	4	132	E [b]	132	3 depths/station (60-m stns)
		11	Seawater - Bacti	4	quarterly	4	176	E [b]	176	4 depths/station (80-m stns)
		11	Seawater - Bacti	5	quarterly	4	220	E [b]	220	5 depths/station (98-m stns)
		3	Seawater - NH_4	3	quarterly	4	36	NH_4	36	3 depths/stn (18-m stns, State Waters)
		9	Seawater - NH_4	3	quarterly	4	108	NH_4	108	3 depths/stn (60-m stns, State Waters)
		3	Seawater - NH_4	4	quarterly	4	48	NH_4	48	4 depths/stn (80-m stns, State Waters)
		36	CTD	1	quarterly	4	144	CTD profile [d]	1296	1 cast/station
Sediment Quality	offshore	22	Grab	1	semiannual	2	44	sediment constituents [e]	396	1 grab/station (Jan, Jul)
Benthic Macrofauna	offshore	22	Grab	2	semiannual	2	88	community structure	88	2 replicate grabs/station (Jan, Jul)
Demersal Fishes & Invertebrates	offshore	6	Trawl	1	semiannual	2	12	community structure	12	1 trawl/station (Jan, Jul)
Bioaccumulation in Fish Tissues	offshore	4	Trawl	3	annual	1	12	liver tissue contaminants [f]	48	3 composites/zone (Oct)
	offshore	2	Hook & Line/Trap	3	annual	1	6	muscle tissue contaminants [f]	24	3 composites/zone (Oct) (2 rig-fishing sites/zones)
Totals							3,494		12,124	

[a] T, F, E = total coliform, fecal coliform, and enterococcus bacteria (n = 3 parameters) required at shore and kelp stations
[b] E = enterococcus only required at offshore stations
[c] CTD profile = depth, temperature, salinity, dissolved oxygen, light transmittance (transmissivity), chlorophyll *a*, pH, density (n = 8 parameters)
[d] CTD profile = depth, temperature, salinity, dissolved oxygen, light transmittance (transmissivity), chlorophyll *a,* pH, density, and CDOM (n = 9 parameters)
[e] Sediment constituents = sediment grain size, total organic carbon, total nitrogen, sulfides, metals, PCBs, chlorinated pesticides, PAHs, BOD (n = 9 parameter categories; see NPDES permit for complete list of constituents; BOD = voluntary)
[f] Fish tissue contaminants = lipids, PCBs, chlorinated pesticides, metals (n = 4 parameter categories; see NPDES permit for complete list of constituents)

Table 4

NPDES-permit mandated receiving waters sampling effort for the South Bay ocean outfall region, excluding resamples, QA/QC analyses (e.g., field and laboratory duplicates), or special studies.

Monitoring Component	Location	Number of Stations	Sample Type	Discrete No. Samples/Site	Sampling Frequency	Sampling Times/Yr	Discrete No. Samples/Yr	Parameters	No. "Samples" Analyzed/Yr	Notes
Water Quality,	shore	11	Seawater - Bacti	1	weekly	52	572	T, F, E [a]	1716	1 sample/station
Microbiology										
&	kelp	3	Seawater - Bacti	3	5x/month	60	540	T, F, E [a]	1620	3 depths/station
Oceanographic		3	CTD	1	5x/month	60	180	CTD profile [b]	1440	1 cast/station (1-m batch avg samples)
Conditions										
	offshore	25	Seawater - Bacti	3	monthly	12	900	T, F, E [a]	2700	3 depths/station
	(n=37)	37	CTD	1	monthly	12	444	CTD profile [c]	3996	1 cast/station (1-m batch avg samples)
		28	TSS	3	monthly	12	1008	TSS	1008	3 depths/station
		28	Oil & Grease	1	monthly	12	336	O&G	336	1 depth/station
Sediment Quality	offshore	27	Grab	1	semiannual	2	54	sediment constituents [d]	432	1 grab/station (Jan, Jul)
Benthic Macrofauna	offshore	27	Grab	2	semiannual	2	108	community structure	108	2 replicate grabs/station (Jan, Jul)
Demersal Fishes & Invertebrates	offshore	7	Trawl	1	quarterly	4	28	community structure	28	1 trawl/station
Bioaccumulation Fish Tissues	offshore	7	Trawl	3	semiannual	2	42	liver tissue contaminants [e]	210	3 composites/station (Apr, Oct) (trawl sites)
	offshore	2	Hook & Line/Trap	3	semiannual	2	12	muscle tissue contaminants [e]	60	3 composites/station (Apr, Oct) (rig-fishing sites)
"Regional Survey"										
Sediment Quality	random array	40	Grab	1	annual	1	40	sediment constituents [d]	320	1 grab/station (Jul)
Benthic Macrofauna	random array	40	Grab	1	annual	1	40	community structure	40	1 grabs/station (Jul)
Totals							4,304		14,014	

[a] T, F, E = total coliform, fecal coliform, and enterococcus bacteria (n = 3 parameters)
[b] CTD profile = depth, temperature, salinity, dissolved oxygen, light transmittance (transmissivity), chlorophyll *a*, pH, density (n = 8 parameters)
[c] CTD profile = depth, temperature, salinity, dissolved oxygen, light transmittance (transmissivity), chlorophyll *a,* pH, density, CDOM (n = 9 parameters)
[d] Sediment constituents = sediment grain size, total organic carbon, total nitrogen, sulfides, metals, PCBs, chlorinated pesticides, PAHs (n = 8 parameter categories; see NPDES permit for complete list of constituents)
[e] Fish tissue contaminants = total lipids, metals, PCBs, chlorinated pesticides, PAHs (n = 5 parameter categories; see NPDES permit for complete list of constituents)

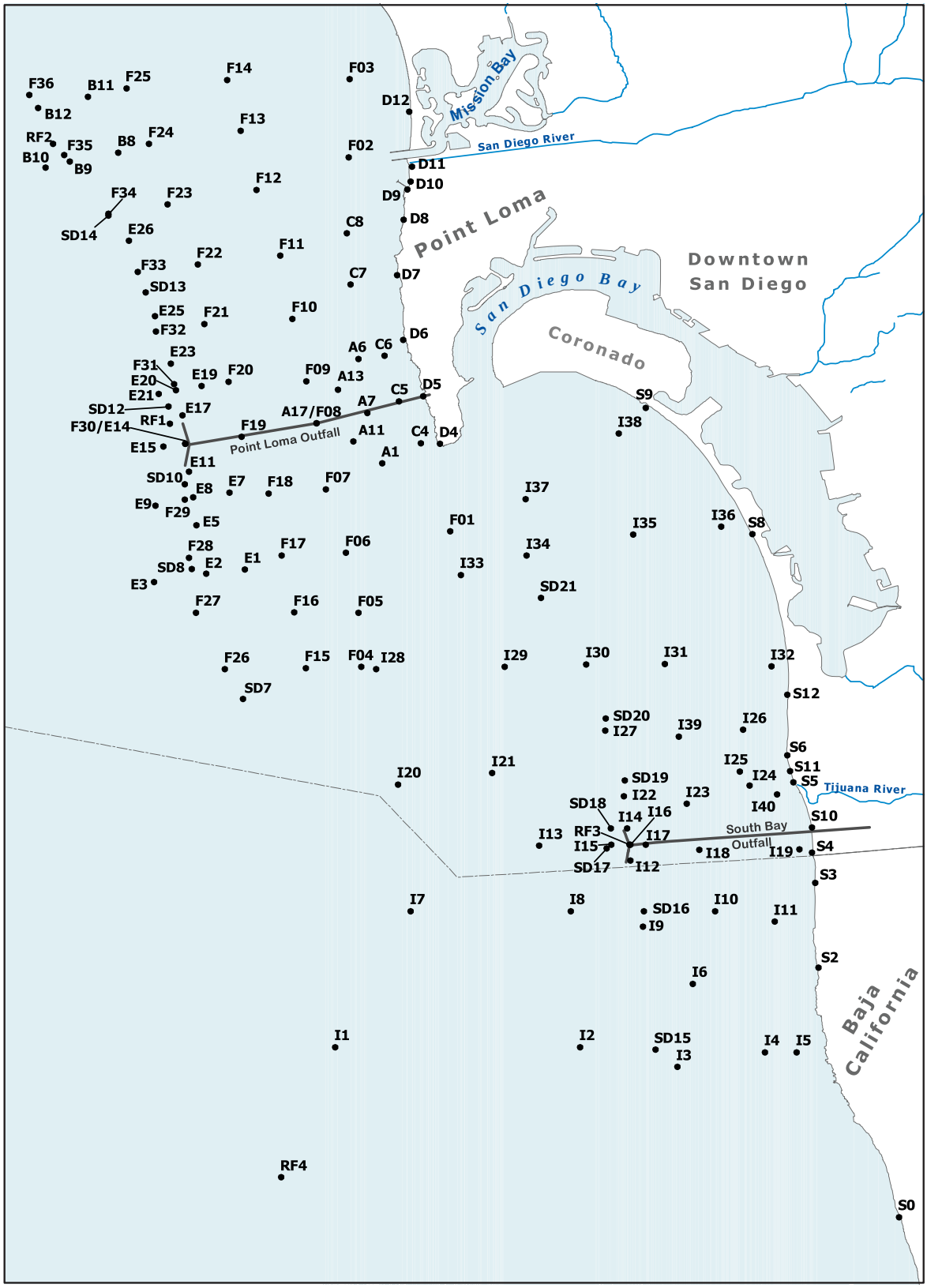

Figure 1

NPDES permit mandated (fixed) water quality, benthic, trawl and rig fishing stations for the City of San Diego's Ocean Monitoring Program for the Point Loma and South Bay ocean outfall regions.

Table 5

Toxicity testing conducted by EMTS staff in accordance with various NPDES permits. Listed effort excludes accelerated testing requirements (e.g., triggered by Notice of Violation), additional QA/QC procedures, or special studies.

Testing Component	Location/ Project	Sample Type	No. samples	Sampling Frequency	Sampling Times/Yr	No. test Species	Effluent/ Ref Tox Tests/Yr	Total Tests/Yr	Endpoints	Dilutions per bioassay	Notes
Point Loma											
Acute toxicity	PLWTP	final effluent	1	semi-annual	2	1	2 + 2 Ref Tox	4	survival	5 + control	species = topsmelt
	(Biennial screening)	final effluent	1	3 x per 2 yrs	3 x per 2 yrs	2	6+ 6 Ref Tox per 2 yrs	12 per 2 yrs	survival	5 + control	screening spp: mysid and topsmelt
Chronic toxicity	PLWTP	final effluent	1	monthly	12	2	24 + 24 Ref Tox	48	sensitive lifestage	5 + control	species = giant kelp, red abalone and purple sea urchin
	(Biennial screening)	final effluent	1	4 x per 2 yrs	4 x per 2 yrs	4	12 + 12 Ref Tox per 2 yrs	24 per 2 yrs	sensitive lifestage	5 + control	screening spp: giant kelp, red abalone, topsmelt, and purple sea urchin
South Bay											
Acute toxicity	SBWRP	final effluent	1	quarterly	12	1	4 + 4 Ref Tox	8	survival	5 + control	species = topsmelt
	(Biennial screening)	final effluent	1	3 x per 2 yrs	3 x per 2 yrs	2	6 + 6 Ref Tox per 2 yrs	12 per 2 yrs	survival	5 + control	screening spp: mysid and topsmelt
	SBWRP/ IWTP	comb. effluent	1	quarterly	4	1	4 + 4 Ref Tox	8	survival	5 + control	species = topsmelt
	(Biennial screening)	comb. effluent	1	3 x per 2 yrs	3 x per 2 yrs	2	6 + 6 Ref Tox per 2 yrs	12 per 2 yrs	survival	5 + control	screening spp: mysid and topsmelt
Chronic toxicity	SBWRP	final effluent	1	monthly	12	1	12 + 12 Ref Tox	24	sensitive lifestage	5 + control	species = red abalone and purple sea urchin
	(Biennial screening)	final effluent	1	4 x per 2 yrs	4 x per 2 yrs	4	12 + 12 Ref Tox per 2 yrs	24 per 2 yrs	sensitive lifestage	5 + control	screening spp: giant kelp, red abalone, topsmelt, and purple sea urchin
	SBWRP/ IWTP	comb. effluent	1	quarterly	4	1	4 + 4 Ref Tox	8	sensitive lifestage	5 + control	species = giant kelp
	(Biennial screening)	comb. effluent	1	4 x per 2 yrs	4 x per 2 yrs	4	12 + 12 Ref Tox per 2 yrs	24 per 2 yrs	sensitive lifestage	5 + control	screening spp: giant kelp, red abalone, topsmelt, and purple sea urchin

Comb. Effluent = combined SBWRP + IWTP effluent samples
Ref Tox = Reference Toxicant Test
Sensitive lifestage endpoints: (1) red abalone = development; (2) giant kelp = germination and growth; (3) topsmelt = survival and growth; (4) purple sea urchin = fertilization

Table 6

Number of discrete samples collected and analyzed by EMTS staff for NPDES permit-related activities during 2012. NA = not applicable; WCS = Wastewater Chemistry Services; FD = field duplicate; LD = laboratory duplicate.

	Number of Samples Collected		Number of Analyses per Sample Type	
Sample Type	**Regular**	**QC**	**Regular**	**QA**
Sediment Grabs				
Particle Size Subsample	269[ab]	NA	(performed by WCS)	
Chemistry Subsamples	977[abc]	NA	(performed by WCS)	
Benthic Infauna Grabs	270[a]	NA	262	4
Otter Trawl	40	NA	40	NA
Fish Tissue	67	NA	(performed by WCS)	
Water Quality				
CTD Casts	1248	NA	9360[e]	NA
Microbiology	4561[d]	348	12,511[f]	683 (FD)[f] 448 (LD)[f]
Suspended Solids	1008	96	(performed by WCS)	
Oil and Grease	336	72	(performed by WCS)	
$N\text{-}NH_3$	288	NA	288	NA
Toxicology				
Acute Bioassay	10	NA	15	12
Chronic Bioassay	44	NA	75	40

[a] includes Old Outfall special study stations; PLOO limited to primary core stations in July

[b] includes Sediment Mapping special study stations

[c] PLOO stations had five subsamples per grab; Sediment Mapping stations had three subsamples per grab; all other stations had four subsamples per grab

[d] includes resamples

[e] includes up to eight parameters per cast (temperature, salinity, dissolved oxygen, light transmittance, chlorophyll *a*, pH. density, CDOM)

[f] includes up to three types of analyses (total coliform, fecal coliform, enterococcus)

design and to best utilize the pooled scientific resources of the region. These bight-wide surveys have included the 1994 Southern California Bight Pilot Project (SCBPP) and subsequent Bight'98, Bight'03 and Bight'08 regional monitoring efforts in 1998, 2003 and 2008, respectively. Planning for the next Bight'13 effort is currently underway. During these programs, the City's regular sampling and analytical effort may be reallocated as necessary with approval of the SDRWQCB and USEPA. As with the special studies described above, the regional monitoring efforts are typically subject to QA/QC procedures similar to those for routine monitoring data, although these projects also do not conform to the same analysis and reporting schedules. Thus, the details and results of the bight-wide monitoring efforts are not included in this report unless otherwise indicated. However, all documents for the recently completed Bight'08 project, including its Quality Assurance Plan, are available for download at www.sccwrp.org/Documents/BightDocuments.

Summary of Work Performed in 2012

During calendar year (CY) 2012, a total of 9119 discrete samples and subsamples were collected by EMTS staff, including samples collected as part of permit-mandated special studies (Table 6). Of these,

Table 7

Summary of the CTD intercalibration casts conducted during 2012. Values are the mean difference (MeanΔ) and maximum difference (MaxΔ) between Unit #3 and Unit #4, as well as the cast number (i.e., 1, 2, or 3), and depth (m) at which the maximum difference occurred.

	August 2012				December 2012			
Parameter	**MeanΔ**	**MaxΔ**	**Cast**	**Depth (m)**	**MeanΔ**	**MaxΔ**	**Cast**	**Depth (m)**
Temperature (°C)	0.04	0.34	3	100	0.04	0.31	3	37
Salinity (psu)	0.01	0.06	3	100	0.01	0.03	3	1
DO (mg/L)	0.37	1.14	3	39	0.50	0.96	3	1
pH	0.03	0.05	2	100	0.31	0.55	2, 3	100
Transmissivity (%)	0.65	2.69	1	25	1.02	3.65	3	47
Chlorophyll *a* (µg/L)	1.63	10.64	2	20	2.55	3.00	1	11

about 6% ($n = 516$) were QC samples such as field duplicates. In addition, a total of 1183 QA tests were conducted to validate quality of specific analyses such as macrofauna sorting, microbiological analyses and toxicity tests. The results of the QA/QC activities presented in the following sections support the accuracy and precision of the resultant data and validate their use in permit-mandated monitoring or environmental testing and reporting. These include: (1) intercalibration of the Conductivity-Temperature-Depth (CTD) instruments used to sample water quality parameters; (2) results of the bacteriological QA procedures; (3) results of the macrofaunal community sample resorts; (4) results of toxicology QA procedures.

CTD Calibration and Maintenance

Ocean Operations personnel carry out semiannual in-house CTD intercalibration exercises to ensure consistency between the two Sea-Bird Electronics Model 25 CTD instruments used to collect water column profiling data for the City's ocean monitoring program. These exercises are typically carried out during the most extreme conditions of winter (November – January) and summer (June–August) months. For CY 2012, the intercalibration exercises were conducted in August and December. The instrument designated as Unit #3 is a combination CTD/carousel sampler, while Unit #4 is a standalone CTD unit. During each exercise, the two CTDs were attached to each other with similar probes aligned and then deployed to a depth of 110 m and retrieved three separate times. For each cast, the bottom 10 meters of data were discarded in an effort to minimize bottom effects. After all three casts were completed, comparisons of the results for six different parameters (i.e., temperature, salinity, dissolved oxygen (DO), pH, chlorophyll *a*, transmissivity) were performed to assess whether deviations between the instruments and sensors were within acceptable limits.

The results of the 2012 annual intercalibration exercises are summarized in Table 7 and Figure 2, and compared to results from previous years in Table 8. Comparisons of temperature, salinity, DO and transmissivity values demonstrated acceptable variability between CTDs. In contrast, the maximum difference recorded for chlorophyll *a* (as measured by fluorometer) was 10.64 µg/L in August, and results from both August and December were over 1 µg/L higher than preceding years. Additionally, pH probe variability was 10 times greater in December than previously reported. The latter was caused

Table 8

Results of CTD intercalibration exercises conducted between 2009 and 2012. Values are the differences between Unit #3 and Unit #4 averaged over all depths (0–100 m).

Parameter	2009	2010	Jun 2011	Jan 2012	Aug 2012	Dec 2012
Temperature (°C)	0.07	0.03	0.03	0.01	0.04	0.04
Salinity (psu)	0.02	0.01	0.01	0.01	0.01	0.01
DO (mg/L)	0.44	0.10	0.17	1.02	0.37	0.50
pH	0.02	0.01	0.02	0.02	0.03	0.31
Transmissivity (%)	0.47	1.61	1.74	0.76	0.65	1.02
Chlorophyll *a* (µg/L)	0.49	0.07	0.08	0.03	1.63	2.55

by a malfunctioning probe that has since been serviced, while the greater variability observed for chlorophyll *a* resulted from changes made by the manufacturer to the factory calibration process.

In addition to the semi-annual CTD intercalibration exercises, manufacturers of various probes recommend annual recalibrations at their factories. Since four sets of conductivity, temperature, pressure, pH and DO probes are inventoried in-house, each instrument is rotated out of service and sent back to the factory every six months for recalibration. Because there are only three sets of fluorometers and transmissometers, and two CDOM probes, these sensors are rotated out for external/factory recalibration service on an annual basis. However, if in-house calibration results indicate a problematic probe, it will be serviced earlier than scheduled. The overall rotation schedule of the probes between CTDs is staggered by six months to ensure that each instrument receives a replacement set within the annual calibration period.

The probes actively in use on each CTD undergo further in-house evaluations prior to and during each survey. The DO probe on each instrument is calibrated monthly to check for sensor drift. If the sensor drift $\geq$5% from factory calibration, the sensor coefficients are changed; if the sensor drift reaches 10%, it is removed from service and replaced with a freshly calibrated probe. The pH and transmissivity probes are checked in the morning prior to each sampling cruise to ensure proper function. For pH calibrations, three buffer solutions are used to bracket the expected pH range (i.e., pH7–pH9). If the reading of a particular buffer solution deviates by more than 0.05 pH units, the probe is adjusted electronically using a factory recommended procedure and then recalibrated. The transmissometer is checked by cleaning the windows of the LED light path and then noting the zero reading by blocking the light path and the full range reading by removing the obstruction. If any probe fails to calibrate or seems to have drifted out of range, it is removed from the instrument and replaced with a spare. Additionally, the results of each probe are evaluated by reviewing the data following each cast. If any probe is determined to be faulty and a field repair cannot be completed, sampling will be terminated immediately so that the needed repairs can be completed back at the laboratory.

Bacteriological Quality Assurance Analyses

Duplicate analyses are run throughout the year as QA checks on bacteriological data reported by the City. Field duplicates (referenced previously as “duplicate” analyses) are two separate samples taken

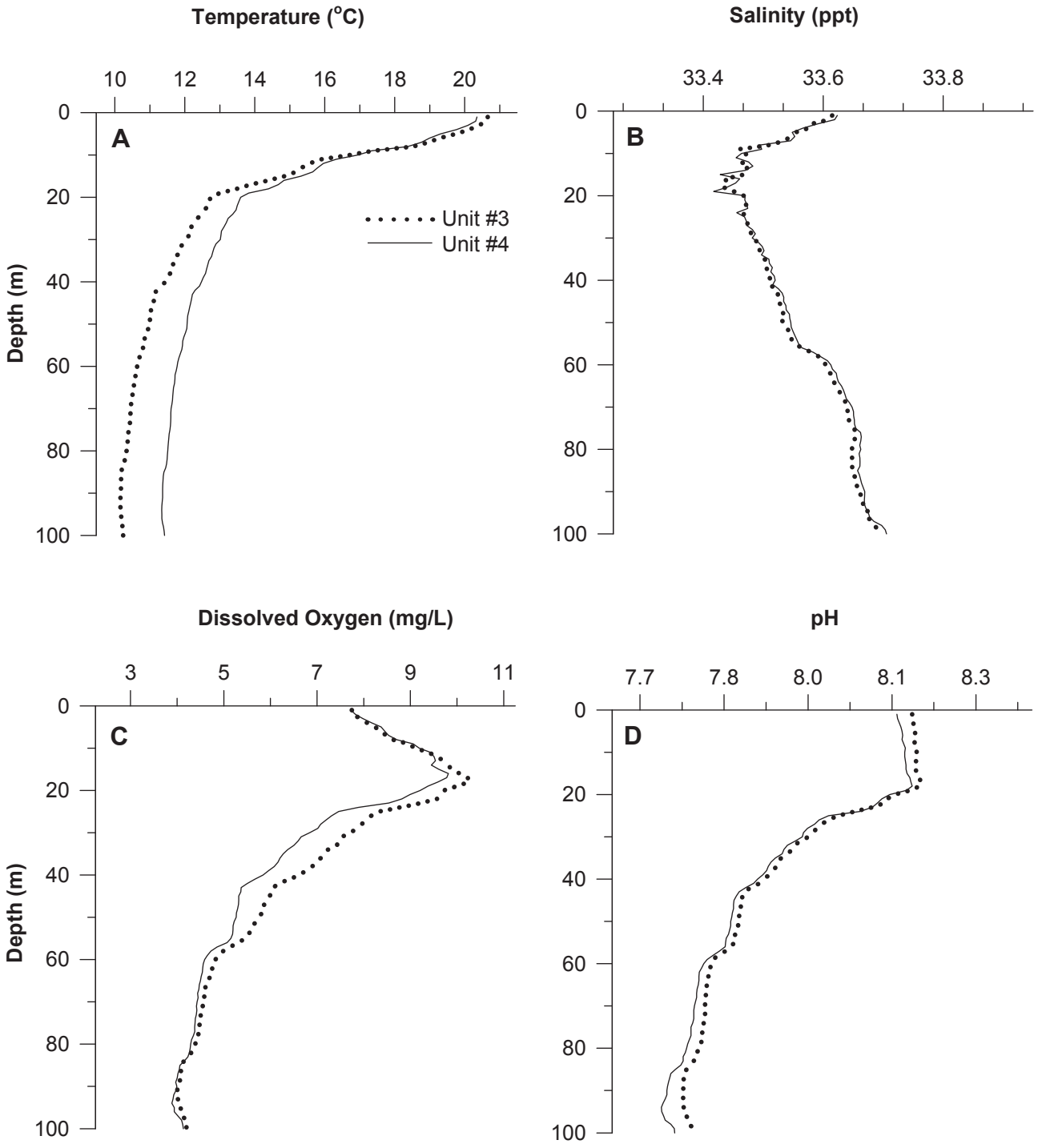

Figure 2

Comparison of results from CTD Units #3 and #4 from one representative cast made during the 2012 CTD intercalibration exercises. Data include cast profiles for (A) temperature, (B) salinity, (C) dissolved oxygen, (D) pH, (E) transmissivity, and (F) chlorophyll *a*.

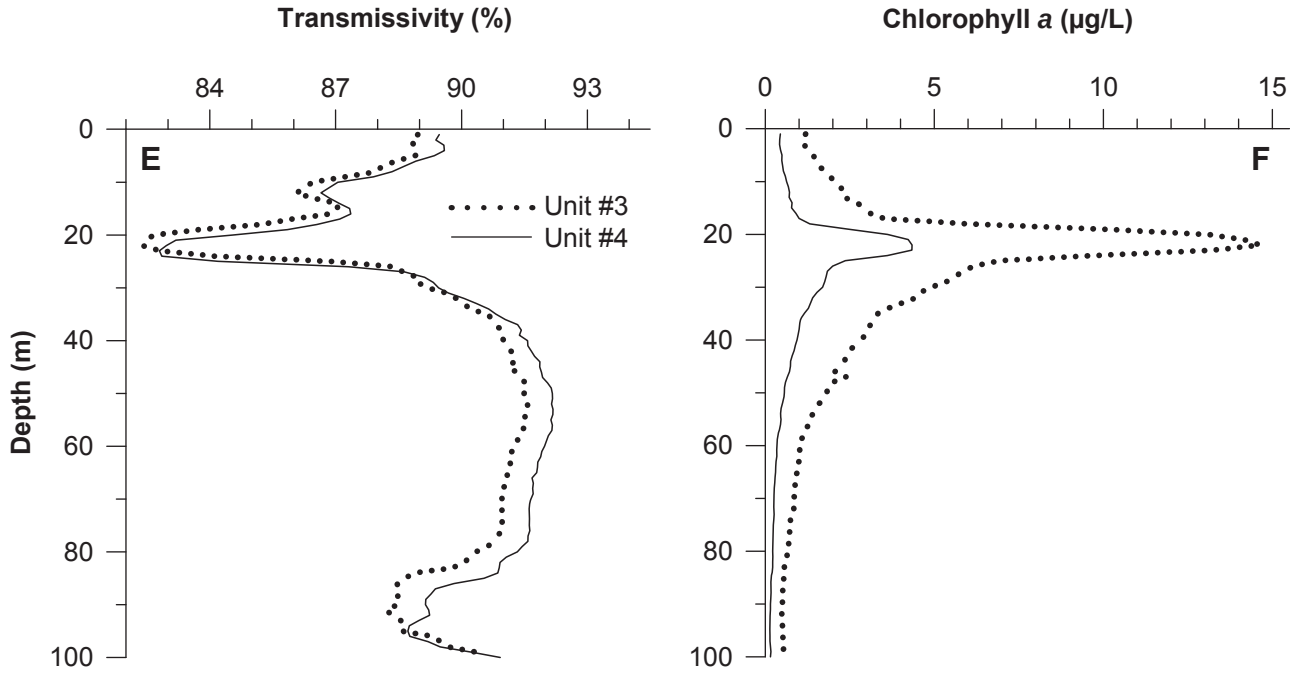

Figure 2 *continued*

from the same station at the same time and then processed by a single analyst to measure variability between samples. Laboratory duplicates (referenced previously as "split" analyses) are diluted, filtered, and plated from a single sample container by two different analysts to measure analyst precision. A total of 348 duplicate field samples were collected during CY 2012, while duplicate laboratory analyses were performed on approximately 5% of the water quality samples (i.e., $n=246$ samples). The raw data for these analyses have been reported previously in the Point Loma and South Bay monthly receiving waters monitoring reports.

The sign test (Gilbert, 1987) was used to statistically compare the results from the paired laboratory and field duplicate analyses performed in CY 2012 (Table 9). When matched pairs of samples are used, the sign test assumes that the probability of observing samples with differing plate counts is equally distributed among positive (sample A > sample B) and negative (sample A < sample B) results. Samples that do not differ (i.e., A - B = 0) are ignored. During 2012, results from duplicate field and laboratory analyses were not significantly different ($p>0.05$) for each of the three tested indicator bacteria (i.e., total coliforms, fecal coliforms, enterococcus), indicating low variability between samples and supporting the repeatability of laboratory measurements.

In addition to the above QA analyses, the Marine Microbiology Lab conducts monthly comparisons of bacterial colony counts to quantify the counting precision of each analyst. Counts are performed on a single plate by pairs of analysts, with the criterion being that counts by any two analysts must fall within 10% of each other. This calculation is known as the Relative Percent Difference (RPD). During 2012, 174 count comparisons were performed, and all results for fecal coliforms and enterococcus comparisons were within the required RPD. For total coliform counts, 4 out of 58 comparisons had an RPD greater than 10%. These exceedances were due to a single plate that contained colonies with an irregular, spreading morphology that was therefore difficult to read.

Table 9

Summary of bacteriological QA analyses conducted during 2012 for the City of San Diego's Ocean Monitoring Program. *n* = number of sample pairs with different colony counts (samples without differences are not considered); B = the number of positive differences between pairs; Z_b = sign test outcome; H_o = the probability of observing positive and negative differences in plate counts between paired samples is equal (see text). Paired samples were compared using the sign test (see Gilbert 1987) at a $p = 0.05$ level of significance.

Sample Type	Parameter	*n*	B	Z_b	*p*	H_o
Field Dup	Total	72	40	0.943	>0.05	Accept
	Fecal	45	22	-0.149	>0.05	Accept
	Entero	39	24	1.441	>0.05	Accept
Lab Dup	Total	60	30	0.000	>0.05	Accept
	Fecal	43	22	0.152	>0.05	Accept
	Entero	40	16	-1.265	>0.05	Accept

Macrofaunal Community – Resort Analysis

Laboratory analyses of benthic macrofaunal samples involve three processes: (1) sample washing and preservation; (2) sample sorting, and identification; (3) enumeration of all invertebrate organisms. Quality control of sorting is essential to assuring the value of the subsequent steps in the sample analysis process. The sorting of benthic samples to the major taxonomic groups is contracted to an outside laboratory, with a 95% removal efficiency expected. Ten percent of the sorted samples from each technician (sorter) at the contract lab are subject to resorting as QA for the contract. The original sorting of a sample fails the QA criterion if the resorted sample contains more than 5.0% of the total abundance of all animals from that sample. Failure requires the re-sorting of all samples previously sorted by that sorter. The resort results for the January 2012 and July 2012 benthic samples are shown in Table 10. The percentages of animals found in all re-analyzed samples were ≤ 5.0% of the total sample abundance, indicating that all sorters passed the QA process for the year.

Toxicology Quality Assurance Analyses

The Toxicology Laboratory conducts routine reference toxicant testing as a part of its quality assurance program. A reference toxicant is a standard chemical used to measure the sensitivity of the test organisms in order to establish confidence in the toxicity data obtained from the test material. A specific reference toxicant is used for each test method, and the material is chosen from a list developed by the USEPA. The reference toxicant is purchased from a supplier in aqueous form (stock solution), and the supplier must verify the concentration of the stock solution and provide written documentation of such analysis.

In most instances, a toxicity test with a reference toxicant is performed to assess the sensitivity of the test organisms at the same time the test material (e.g., effluent) is evaluated. A control chart containing no fewer than 20 of the most recent reference toxicant test results for each test method is maintained by

Table 10

Results of benthic macrofauna sample resort analyses conducted during 2012 for the City of San Diego's Ocean Monitoring Program. Percent = (the # of animals found in the resorted sample/the total sample abundance) X 100; ¹ and ² indicate sample replicate number; * final value not available but < 5.00%.

Quarter	Station	Percent	Station	Percent
	PLOO		SBOO	
Jan-12	B-10¹	0.00	I-18²	0.59
	E-8²	0.00	I-35¹	0.00
	E-19¹	0.86	I-8¹	0.00
	E-26¹	0.00	I-10²	0.00
	E-7¹	0.00	I-21¹	0.00
			I-30²	0.44
Jul-12	E-8²	0.58	I-9¹	0.00
	B-9²	0.00	I-35¹	4.03
	E-17¹	0.50	I-14²	2.67
	E-5²	0.86	I-23²	0.00
			I-2¹	0.00
			I-27²	0.28
			I-31¹	4.55
Jul-12	Regional 2012			
	8243	0.00		
	8203	0.00		
	8211	0.00		
	8225	0.00		
	8228	0.00		
	8251	0.61		

the QA officer and/or Laboratory Supervisor and is used to monitor test organism sensitivity. Results from a minimum of 19 of the most recent 20 reference toxicant tests must fall within the control chart boundaries (two standard deviations of the mean). Failure to do so triggers an investigation of animal supply, reference toxicant stock quality, and laboratory practices. Additional testing is also conducted to determine whether an exceedance is anomalous or if remedial measures are needed. All NPDES mandated tests conducted with the affected animals are to be flagged, reviewed for anomalous responses, and, in certain cases, repeated with a new batch of animals. In 2012, all reference toxicant control charts met the acceptability criteria.

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Schiff, K.C., J.S. Brown, and S.B. Weisberg. (2001). Model Monitoring Program for Large Ocean Discharges in Southern California. Technical Report No. 357. Southern California Coastal Water Research Project, Westminster, CA.

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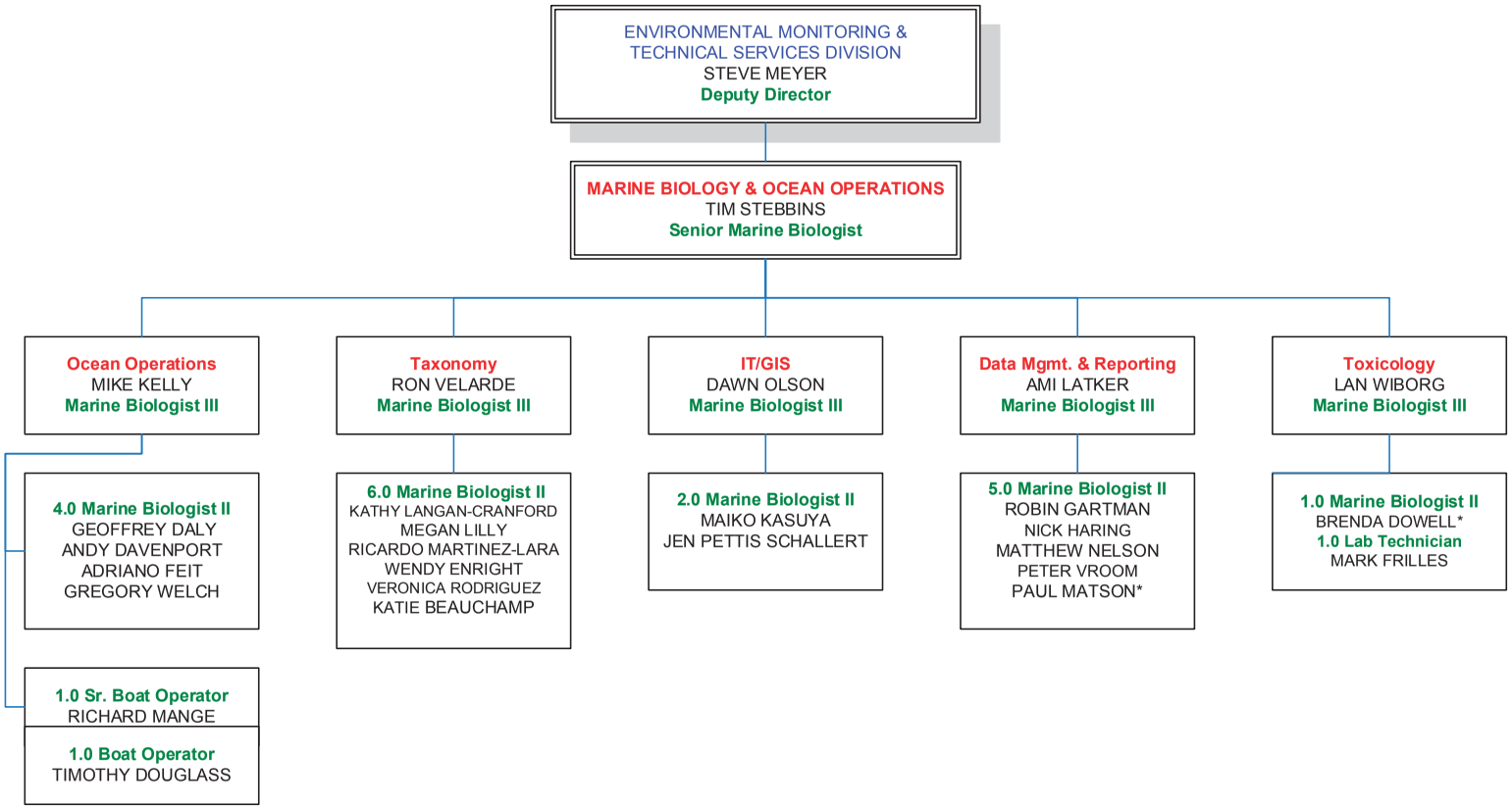
APPENDIX A

Organizational Charts

Appendix A.1

Organizational chart for the Marine Biology and Ocean Operations section of EMTS.



*Underfilled by MBI

City of San Diego - Public Utilities Dept.,Wastewater Branch
Environmental Monitoring & Technical Services Division
Marine Biology & Ocean Operations Section

Organization Chart – FY2013 | 03/12/2013

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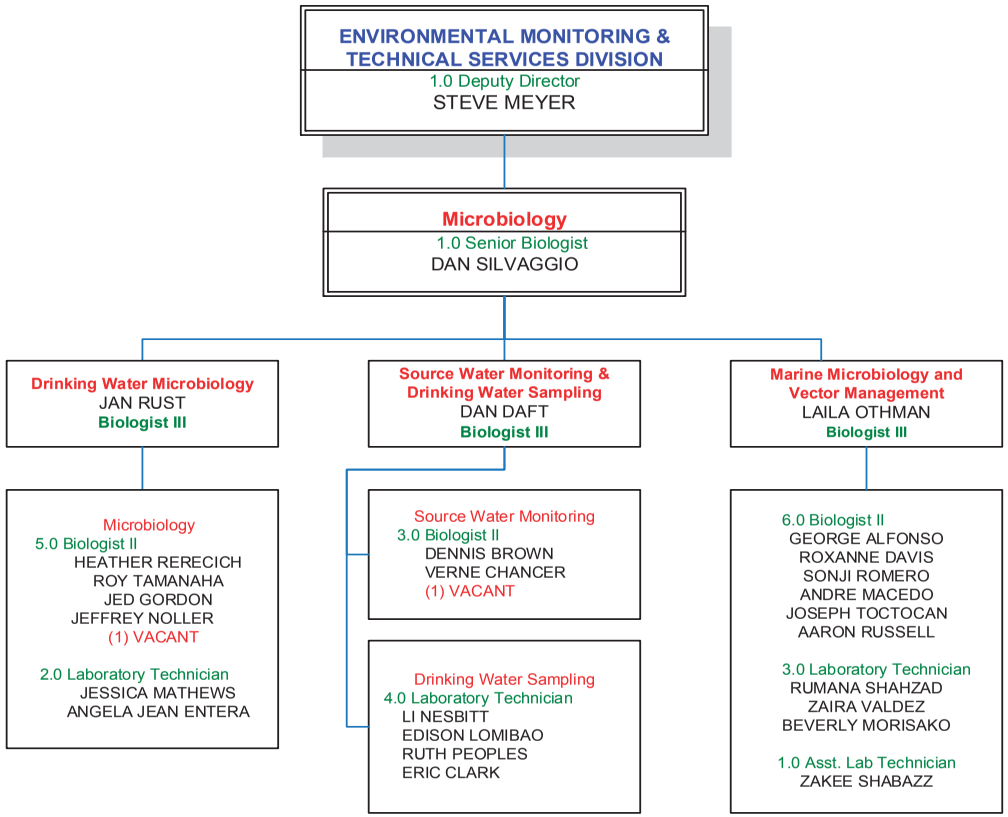
Appendix A.2

Organizational chart for the Microbiology section of EMTS.



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