SD Public Utilities

ANNUAL RECEIVING WATERS MONITORING & TOXICITY TESTING QUALITY ASSURANCE REPORT

2018

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CERTIFIED
Public Utilities Department
Continual Improvement, Prevention of Pollution, Regulatory Compliance
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Annual Receiving Waters Monitoring & Toxicity Testing Quality Assurance Report

2018

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City of San Diego
Public Utilities Department
Environmental Monitoring & Technical Services Division

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2018 Quality Assurance Report

Introduction

The Environmental Monitoring and Technical Services (EMTS) Division of the City of San Diego Public Utilities Department performs comprehensive Quality Assurance (QA)/Quality Control (QC) activities to ensure the accuracy and reliability of both 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 and consistency of field sampling, laboratory analysis, record keeping, data entry, and 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 permit requirements, sample collection methods, technology, and applicability of new analytical methods.

Details of the division's QA/QC program for receiving waters monitoring are 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. As a part of continuation in the ISO 14001 certification process, EMTS underwent and passed an external audit in 2018 conducted by a third-party auditor.

This report summarizes the QA/QC activities that were conducted during calendar year 2018 by City of San Diego 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 South Bay International Wastewater Treatment Plant owned and operated by the International Boundary and Water Commission, U.S. Section.

Facilities and Staff

The EMTS Division includes laboratories from three different sections that participate in the receiving waters monitoring and toxicity testing activities associated with the above NPDES permits: (1) the Marine Biology and Ocean Operations section (Marine Biology Laboratory); (2) the Microbiology section (Marine Microbiology Laboratory and Toxicology Laboratory); (3) Environmental Chemistry Services section (Environmental Chemistry Laboratory).

The Marine Biology, Marine Microbiology, and Toxicology Labs are located at the EMTS Division's laboratory facility at 2392 Kincaid Road, San Diego, CA 92101. Staff scientists from these three labs are responsible for conducting most field sampling operations and subsequent biological and oceanographic laboratory assessments associated with the City's Ocean Monitoring Program (e.g., water quality, benthic sediments and macrofauna, trawl-caught fishes and invertebrates, contaminant accumulation in marine fishes).

Laboratory personnel are organized into different work groups within the Marine Biology & Ocean Operations, and Microbiology sections based on main responsibilities and areas of

Table 1

NPDES permits and associated Orders issued by the San Diego Regional Water Quality Control Board for the City of San Diego's Point Loma Wastewater Treatment Plant (PLWTP) and South Bay Water Reclamation Plant (SBWRP), and the U.S. Section of the International Boundary and Water Commission's South Bay International Wastewater Treatment Plant (SBIWTP).

Facility	NPDES Permit	Order No.	Effective Dates
PLWTP	CA0107409	R9-2017-0007	October 1, 2017 – September 30, 2022
SBWRP	CA0109045	R9-2013-0006[a]	April 4, 2013 – April 3, 2018
SBIWTP	CA0108928	R9-2014-0009[b]	August 1, 2014 – July 31, 2019

[a]Amended by Order Nos. R9-2014-0071 and R9-2017-0023
[b]Amended by Order Nos. R9-2014-0094 and R9-2017-0024

expertise. Brief descriptions of each of these sections' work groups in the calendar year 2018 are presented below. Copies of organizational charts for each section during any given period are available upon request.

The Environmental Chemistry Services (ECS) section is comprised of work groups located at other City laboratory facilities and is responsible for performing chemical analyses of the various seawater, sediment, and fish tissue samples collected by Marine Biology staff. Descriptions of the ECS section and their QA procedures are presented in a separate QA report each year.

Marine Biology Laboratory

Project Coordination and Assessment (PCA): One of the primary responsibilities of the PCA work group is to oversee the analysis and reporting of 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. Personnel in this group work closely with the Information Management and Geographic Information System (GIS) group described below to perform QA of all receiving waters monitoring data that are entered into the laboratory's database. Various industry standard 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 Management and GIS (IM/GIS): The IM/GIS work group is primarily responsible for the administration of the laboratory'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 IM 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, and ocean outfall inspections. These

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

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

staff members maintain and calibrate all oceanographic instrumentation, including the lab'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 the processing of all benthic macrofauna and trawl invertebrate samples, maintains the taxonomic literature and voucher collections, and conducts taxonomic training. In addition, taxonomy staff produce in-house identification sheets and keys to various species and other higher-level taxa groups. Members of this work 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.

Marine Microbiology Laboratory

The Marine Microbiology Laboratory is accredited by the California State Water Resources Control Board Environmental Laboratory Accreditation Program (ELAP), which is renewed on a biennial basis (see Table 2). Microbiology personnel are responsible for the identification and quantification 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 laboratory analyses using approved and accredited methods to measure concentrations of fecal indicator bacteria (e.g., membrane filtration, multiple tube fermentation, Colilert-18, 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, calibration, and QA 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 QA protocols for special projects or studies involving microbiology.

Members of the Marine Microbiology Lab also provide for monitoring, surveillance, control, and prevention of insects and other pests that can transmit diseases or cause 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 of urban creeks and streams are also conducted to evaluate and analyze

short and long-term impacts of sewage spills into watersheds and receiving waters. In such cases, 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.

Toxicology Laboratory

The Toxicology Laboratory is also certified by ELAP with renewal on a biennial basis (see Table 2). Toxicology personnel are responsible for conducting or overseeing 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 to being summarized here, the Toxicology Lab maintains a separate, detailed Quality Assurance Manual that contains up-to-date revisions to reflect current laboratory practices and procedures, and ensures timely document version control in accordance with ELAP requirements and ISO 14001 standards.

Scope of Work

The City of San Diego Ocean Monitoring Program is responsible for monitoring the coastal San Diego area to document and analyze possible effects on the marine environment due to the discharge of treated municipal wastewater (i.e. effluent) to the Pacific Ocean via the Point Loma Ocean Outfall (PLOO) and the South Bay Ocean Outfall (SBOO). Treated effluent from the Point Loma Wastewater Treatment Plant (PLWTP) is discharged to the ocean through the PLOO, whereas commingled effluent from the South Bay Water Reclamation Plant (SBWRP) and South Bay International Wastewater Treatment Plant (SBIWTP) is discharged through the SBOO. The separate orders and permits associated with these treatment facilities (Table 1) define the requirements for receiving waters monitoring and toxicity testing including sampling plans, compliance criteria, laboratory and statistical analyses, and reporting guidelines.

The core receiving waters monitoring requirements for the Point Loma and South Bay monitoring programs that were in effect throughout calendar year 2018 are summarized in Tables 3 and 4, respectively. The permanent-fixed position sampling sites for each program are shown in Figure 1. These core monitoring activities include: (1) weekly sampling of ocean waters from recreational areas located along the shoreline and within the Point Loma and Imperial Beach kelp beds to assess nearshore water quality conditions; (2) quarterly sampling of ocean waters at offshore sites to document water quality conditions throughout the region; (3) semi-annual benthic sampling to monitor sediment conditions and the status of resident macrobenthic invertebrate communities; (4) semi-annual trawl surveys to monitor the ecological health of demersal fish and megabenthic invertebrate communities; (5) annual collection of fish tissue samples to monitor levels of chemical constituents that may have ecological or human health implications. In addition to the receiving waters monitoring activities described above, toxicity testing (acute and chronic bioassays) is required for influent, effluent, and groundwater samples as outlined in Table 5. The results of the above receiving waters monitoring activities and effluent toxicity tests are analyzed and presented in various regulatory reports that are submitted to the San Diego Regional Water Quality Control Board (SDRWQCB) and United States Environmental Protection Agency (USEPA) on an ongoing basis. Although not included in this report,

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 - FIB	1	1/Week	52	416	T, F, E [a]	1248	1 sample/station
&	kelp	8	Seawater - FIB	3	1/Week	52	1248	T, F, E [a]	3744	3 depths/station
Oceanographic Conditions		8	CTD	1	1/Week	52	416	CTD profile [c]	3744	1 cast/station (1-m batch avg samples)
	offshore	3	Seawater - FIB	3	1/Quarter	4	36	E [b]	36	3 depths/station (18-m stns)
	(n=36)	11	Seawater - FIB	3	1/Quarter	4	132	E [b]	132	3 depths/station (60-m stns)
		11	Seawater - FIB	4	1/Quarter	4	176	E [b]	176	4 depths/station (80-m stns)
		11	Seawater - FIB	5	1/Quarter	4	220	E [b]	220	5 depths/station (98-m stns)
		36	CTD	1	1/Quarter	4	144	CTD profile [c]	1296	1 cast/station (1-m batch avg samples)
Sediment Chemistry	offshore	22	Grab	1	2/Year	2	44	sed chem [d]	352	1° and 2° core stations (Jan, Jul)
	offshore	12	Grab	1	2/Year	2	24	sed chem [e]	24	1° core stations (Jan, Jul)
	offshore	40	Grab	1	1/Year	1	40	sed chem [d]	320	Randomized stations (Jul) [g]
Benthic Infauna	offshore	22	Grab	1	2/Year	2	44	community	44	1° and 2° core stations (Jan, Jul)
	offshore	40	Grab	1	1/Year	1	40	structure	40	Randomized stations (Jul) [g]
Sediment Toxicity	offshore	8-28	Grab	1	1/Year	1	8-28	acute toxicity	8-28	3 year Pilot Project (2016-2018) [h]
Demersal Fishes & Invertebrates	offshore	6	Trawl	1	2/Year	2	12	community structure	12	1 trawl/station (Jan, Jul)
Bioaccumulation in Fish Tissues	offshore	4	Trawl/ Hook & Line	3	1/Year	1	12	liver tissue [f]	60	3 composites/zone (Oct)
	offshore	2	Hook & Line	3	1/Year	1	6	muscle tissue [f]	30	3 composites/zone (Oct)
Totals							**3038**		**11,506**	

[a] Fecal Indicator Bacteria (FIB) parameters = total coliform (T), fecal coliform (F), *Enterococcus* bacteria (E); n=3 parameters required at shore and kelp water quality stations.
[b] *Enterococcus* = only FIB indicator required at offshore water quaility stations.
[c] CTD profile = temperature, depth, pH, salinity, dissolved oxygen, light transmittance (transmissivity), and chlorophyll *a* (n=7 required parameters), plus density and CDOM (n=9 parameters total)
[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] Sediment constituents = BODs at 12 primary core stations only (voluntary sampling per agreement with USEPA Region IX)
[f] Fish tissue constituents = lipids, metals, PCBs, chlorinated pesticides, and PAHs (n=5 parameter categories; see NPDES permit for complete list of constituents)
[g] Random (regional) benthic survey = joint requirement of Point Loma and South Bay outfall monitoring programs (i.e., 40 stations/year total)
[h] Sediment Toxicity Monitoring Plan for the South Bay Ocean Outfall and Point Loma Ocean Outfall Monitoring regions, San Diego, California

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	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	11	Seawater - FIB	1	1/Week	52	572	T, F, E [a]	1716	1 sample/station
&	kelp/	7	Seawater - FIB	3	1/Week	52	1092	T, F, E [a]	3276	3 depths/station
Oceanographic	nearshore	7	CTD	1	1/Week	52	364	CTD profile [b]	3276	1 cast/station (1-m batch avg samples)
Conditions										
	offshore	21	Seawater - FIB	3	1/Quarter	4	252	T, F, E [a]	756	3 depths/station
	(n=33)	33	CTD	1	1/Quarter	4	132	CTD profile [b]	1188	1 cast/station (1-m batch avg samples)
Sediment	offshore	27	Grab	1	2/Year	2	54	sed chem [c]	432	1° and 2° core stations (Jan, Jul)
Chemistry	offshore	40	Grab	1	1/Year	1	40	sed chem [c]	320	Randomized stations (Jul) [e]
Benthic Infauna	offshore	27	Grab	1	2/Year	2	54	community	54	1° and 2° core stations (Jan, Jul)
	offshore	40	Grab	1	1/Year	1	40	structure	40	Randomized stations (Jul) [e]
Sediment Toxicity	offshore	8-28	Grab	1	1/Year	1	8-28	acute toxicity	8-28	3 year Pilot Project (2016-2018) [f]
Demersal Fishes & Invertebrates	offshore	7	Trawl	1	1/Year	2	14	community structure	14	1 trawl/station (Jan, Jul)
Bioaccumulation in Fish Tissues	offshore	5	Trawl/Hook & Line	3	1/Year	1	15	liver tissue [d]	75	3 composites/zone (Oct)
	offshore	2	Hook & Line	3	1/Year	1	6	muscle tissue [d]	30	3 composites/zone (Oct)
Totals							**2663**		**11,205**	

[a] Fecal Indicator Bacteria (FIB) = total coliform (T), fecal coliform (F), and *Enterococcus* bacteria (E); n=3 parameters required at all shore, kelp nearshore and offshore water quality stations

[b] CTD profile = temperature, depth, pH, salinity, dissolved oxygen, light transmittance (transmissivity), chlorophyll *a* (n=7 required parameters), plus density and CDOM (n=9 parameters total)

[c] 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)

[d] Fish tissue constituents = lipids, metals, PCBs, chlorinated pesticides, and PAHs (n=5 parameter categories; see NPDES permit for complete list of constituents)

[e] Random (regional) benthic survey = joint requirement of Point Loma and South Bay outfall monitoring programs (i.e., 40 stations/year total)

[f] Sediment Toxicity Monitoring Plan for the South Bay Ocean Outfall and Point Loma Ocean Outfall Monitoring regions, San Diego, California

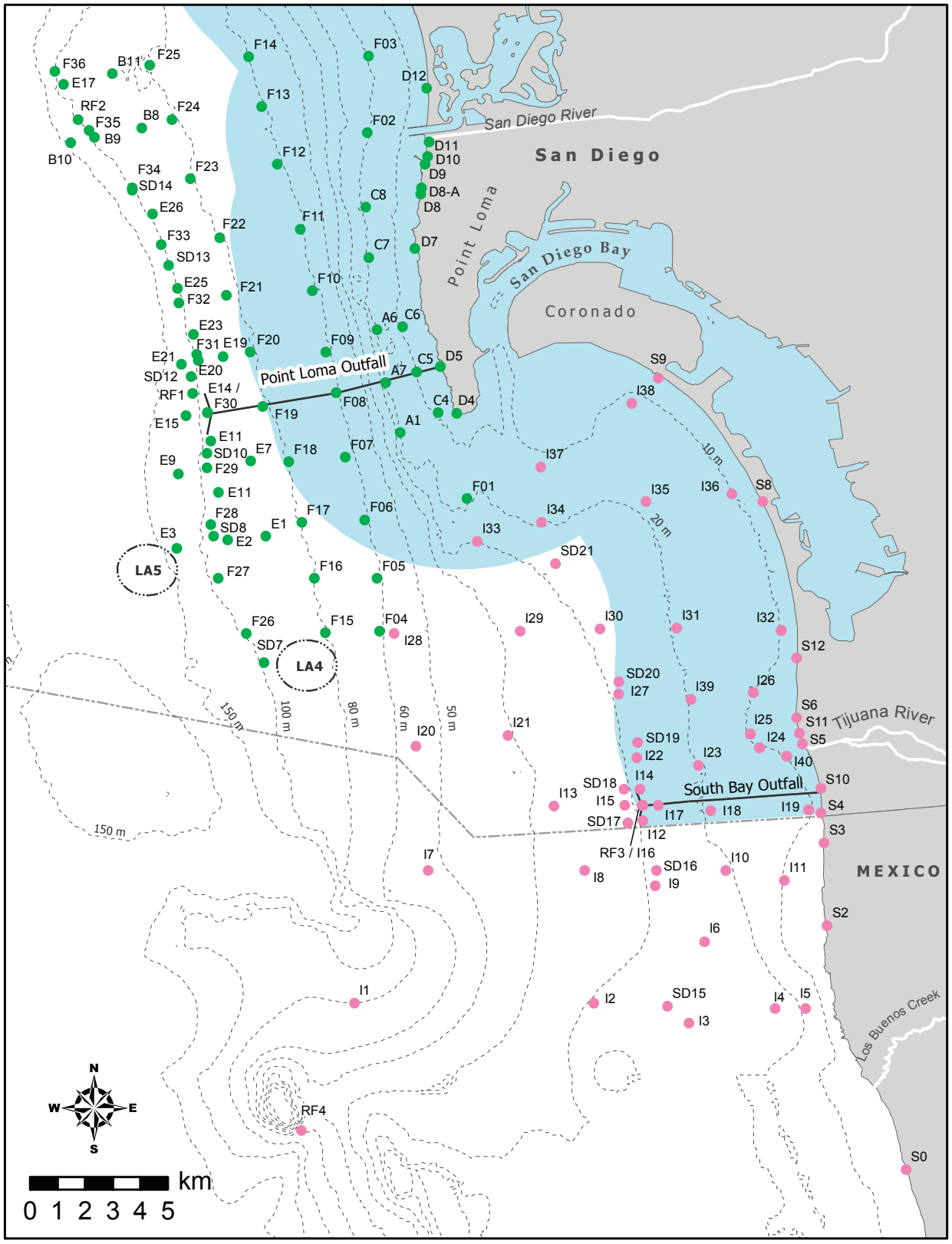

Figure 1

NPDES permit-mandated (fixed-grid) 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 required 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 Tests/Yr	Concurrent Ref Tox Tests/Yr	Total Tests/Yr	Endpoints	Dilutions per bioassay	Notes
Point Loma												
Chronic toxicity[a]	PLWTP	final effluent	1	1/Month	12	1	12	12	24	sensitive lifestage	1[a] + control	species = giant kelp
	(Biennial screening)	final effluent	1	3 x per 2 yrs	3 x per 2 yrs	3	9 per 2 yrs	9 per 2 yrs	18 per 2 yrs	sensitive lifestage	1[a] + control	screening spp: giant kelp, red abalone, and topsmelt
South Bay												
Chronic toxicity	SBWRP	final effluent	1	1/Quarter	4	1	4	4	8	sensitive lifestage	5 + control	species = giant kelp
	(Biennial screening)	final effluent	1	3 x per 2 yrs	3 x per 2 yrs	3	9 per 2 yrs	9 per 2 yrs	18 per 2 yrs	sensitive lifestage	5 + control	screening spp: giant kelp, red abalone, and topsmelt

[a]The In-stream Waste Concentration (IWC) of 0.49% effluent, using the of significant Toxicity (TST)
Ref Tox = Reference Toxicant Test
Sensitive lifestage endpoints: (1) red abalone = development; (2) giant kelp = germination and growth; (3) topsmelt = survival and growth

a Sediment Toxicity Monitoring Plan for the SBOO and PLOO monitoring regions was implemented in 2016 (City of San Diego, 2015). The results of this 3-year pilot study, including associated QA/QC activities, will be presented separately in a final project report that will be submitted to the SDRWQCB and USEPA by July 1, 2019.

In addition to the above core monitoring efforts, the City may conduct "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. 2002). These special studies are determined by the City in coordination with the SDRWQCB and USEPA, and are generally designed to address recommendations for enhanced environmental monitoring of the San Diego coastal region as put forth in a peer-reviewed report coordinated by scientists at the Scripps Institution of Oceanography (SIO 2004). Data for such studies are typically subject to the same QA/QC procedures as the routine monitoring data, although the analysis and reporting schedules will likely be customized to meet the targeted goals of the special study. Thus, details and results of ongoing QA/QC activities associated with these special studies are not included in this report unless otherwise indicated.

As a 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 these regional programs is to optimize the efforts of the various partner agencies (e.g., municipal dischargers, research agencies) and leverage their considerable scientific expertise and resources to survey the entire southern California coastal region using a cost-effective monitoring design. These bight-wide surveys have included the 1994 Southern California Bight Pilot Project (SCBPP) and subsequent Bight′98, Bight′03, Bight′08, Bight′13, and Bight′18 regional monitoring efforts that began in 1998, 2003, 2008, 2013, and 2018, respectively. During these programs, the City's regular sampling and analytical efforts may be reallocated as necessary with approval of the SDRWQCB and USEPA. As with special studies, the regional monitoring efforts are typically subject to QA/QC procedures like those for routine monitoring data, although the analysis and reporting schedules may vary. Thus, the details and results of the bight-wide monitoring efforts are not included in these annual QA reports unless otherwise indicated. However, the planning documents for the current Bight′18 project, including its Quality Assurance Plan, are available upon request or for download from SCCWRP's website (www.sccwrp.org).

Summary of Work Performed in 2018

During calendar year 2018, a total of 6651 discrete samples were collected by EMTS staff as part of the above scope of work and as part of permit-mandated special studies (Table 6). Of these, about 9% (n = 575) were QC samples such as field duplicates. In addition, a total of 1643 QA tests such as macrofauna sorting, microbiological analyses, and toxicity tests were conducted to validate the quality of specific analyses. The results of the QA/QC activities presented in the following sections support the precision and accuracy of the resultant data and validate their use in permit-mandated monitoring, 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 re-sorts and re-IDs; (4) results of toxicology QA procedures.

Table 6

Number of discrete samples collected and analyzed by EMTS staff for NPDES permit-related activities during 2018. NA = not applicable; ECS = Environmental Chemistry Services.

	Number of Samples Collected		Number of Analyses per Sample Type	
Sample Type	**Regular**	**QC**	**Regular**	**QA**
Sediment Grab				
Particle Size Subsample	117 [ab]	NA	(performed by ECS)	
Chemistry Subsample	493 [abc]	NA	(performed by ECS)	
Benthic Infauna Grab	117 [ab]	NA	74 [a]	32 [abd]
Otter Trawl	33 [b]	NA	33	NA
Fish Tissue	NA [e]	NA [e]	NA [e]	NA [e]
Water Quality				
CTD Cast	1055	NA	9492 [f]	NA
Microbiology	4216 [g]	575	11,448 [h]	1593 [h]
Toxicology				
Sediment Bioassay	29 [i]	NA	29 [i]	4 [i]
Chronic Bioassay	16	NA	16	14
Totals	**6076**	**575**	**21,092**	**1643**

[a] Includes 1° and 2° core stations in January (49) and 1° core stations + E-15 in July (25)

[b] Incudes Bight'18 stations sampled by City of San Diego

[c] PLOO stations had five subsamples per grab; BOD taken at PLOO core stations in January (12) and July (13); all other stations had four subsamples per grab

[d] Includes other agency Bight'18 samples, re-sorts (n=20), and re-IDs (n=12)

[e] Samples not collected as part of regulatory relief for participating in Bight'18

[f] Includes up to nine parameters per cast (depth, temperature, salinity, dissolved oxygen, light transmittance, chlorophyll *a*, pH, density, CDOM)

[g] Includes resamples

[h] Includes up to three types of fecal indicator bacteria (total coliform, fecal coliform, *Enterococcus*)

[i] Includes samples from the San Diego Ocean Outfall Sediment Toxicity Monitoring Plan (City of San Diego 2015)

CTD Calibration and Maintenance

The City of San Diego's Marine Biology Laboratory uses two Sea-Bird Scientific Electronics SBE-25plus CTDs. Both systems are configured with Sea-Bird's SBE-55 mini carousel package and outfitted with six four-liter Niskin bottles. Typically, laboratory staff carry out semiannual in-house CTD intercalibration exercises to ensure consistency between the two CTD instruments used to collect water column profiling data for the City's Ocean Monitoring Program. In 2018, intercalibration exercises were conducted during the months of January and November. However, the January 2018 intercalibrations were for comparing the probes in use during the second half of 2017 and so the results of those tests were reported previously in that year's report (i.e., City of San Diego 2018). Consequently, only the results of the November 2018 intercalibration exercise are reported herein as follows. Briefly, the two different CTDs were attached to each other, configured with similar probes,

Table 7

Summary of the CTD intercalibration casts: (A) casts conducted on November 18, 2018. Values are the mean difference (Mean∆) and maximum difference (Max∆) between Unit #5 and Unit #6, as well as the cast number (i.e., 1, 2, or 3) and depth (m) at which the maximum difference occurred; (B) results of CTD intercalibration exercises conducted from 2013 through 2018. Values are the differences between Unit #3 and Unit #4 (2013–2015) and Unit #5 and Unit #6 (2016–2018) averaged over all depths (0–100 m).

A

	November 2018			
Parameter	**Mean∆**	**Max∆**	**Cast**	**Depth (m)**
Temperature (°C)	0.029	0.217	3	17
Salinity (ppt)	0.020	0.084	1	27
DO (mg/L)	0.105	0.234	1	11
pH	0.057	0.064	3	94
Transmissivity (%)	2.390	3.156	3	69
Chlorophyll *a* (µg/L)	0.112	0.061	1	39

B

Parameter	**Jun 2013**	**Dec 2013**	**Jul 2014**	**Dec 2014**	**Sep 2015**	**Dec 2015**	**Dec 2016**	**Aug 2017**	**Jan 2018**	**Nov 2018**
Temperature (°C)	0.02	0.01	0.06	0.01	0.03	0.03	0.02	0.10	0.04	0.03
Salinity (ppt)	0.01	0.01	0.01	0.00	0.02	0.006	0.014	0.04	0.02	0.02
DO (mg/L)	0.06	0.05	0.08	0.07	0.20	0.12	0.122	0.14	0.03	0.11
pH	0.03	0.04	0.05	0.02	0.02	0.02	0.02	0.22	0.03	0.06
Transmissivity (%)[a]	2.92	1.44	4.43	4.27	4.57	4.59	2.41	1.84	—	2.39
Chlorophyll *a* (µg/L)[b]	0.76	0.07	0.04	0.03	0.26	0.07	—	—	0.11	0.11

[a] Transmissivity results not available from January 2018 intercalibration casts due to probe failure
[b] Chlorophyll *a* results not available from December 2016 and August 2017 intercalibration casts due to probe failure

aligned, and then deployed to a depth of 120 m and retrieved three separate times. For each of the three CTD casts, depths greater than 100 m were discarded to minimize bottom effects. After all three casts were completed, comparisons of the results for six key parameters, including water temperature, salinity, dissolved oxygen (DO), pH, transmissivity, and chlorophyll *a* were performed to assess whether deviations between the instruments and sensors were within acceptable limits. The results of these comparisons are summarized in Table 7A and Figure 2, and compared to results from previous years in Table 7B. The results of the November 2018 intercalibration exercise demonstrated acceptable variability between the City's two CTDs for the six water quality parameters described above.

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, DO probes, and pumps are inventoried in-house, each instrument is rotated out of service and sent back to the factory every six months for recalibration along with the system pump. 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

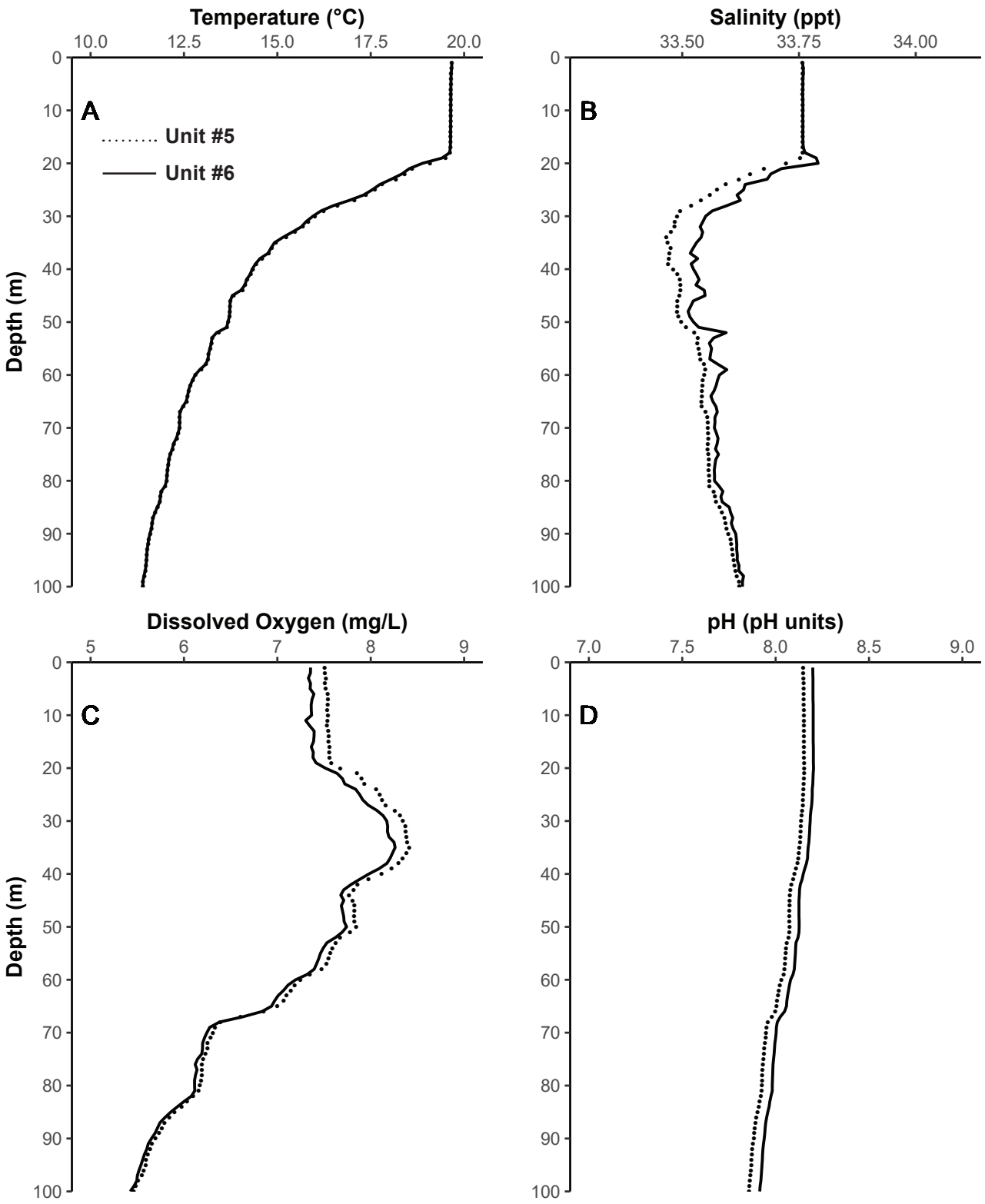

Figure 2

Comparison of results from CTD Unit #5 and Unit #6 from one representative cast made during the November 2018 CTD intercalibration exercise. Data include cast profiles for (A) temperature, (B) salinity, (C) dissolved oxygen, (D) pH, (E) transmissivity, and (F) chlorophyll *a*.

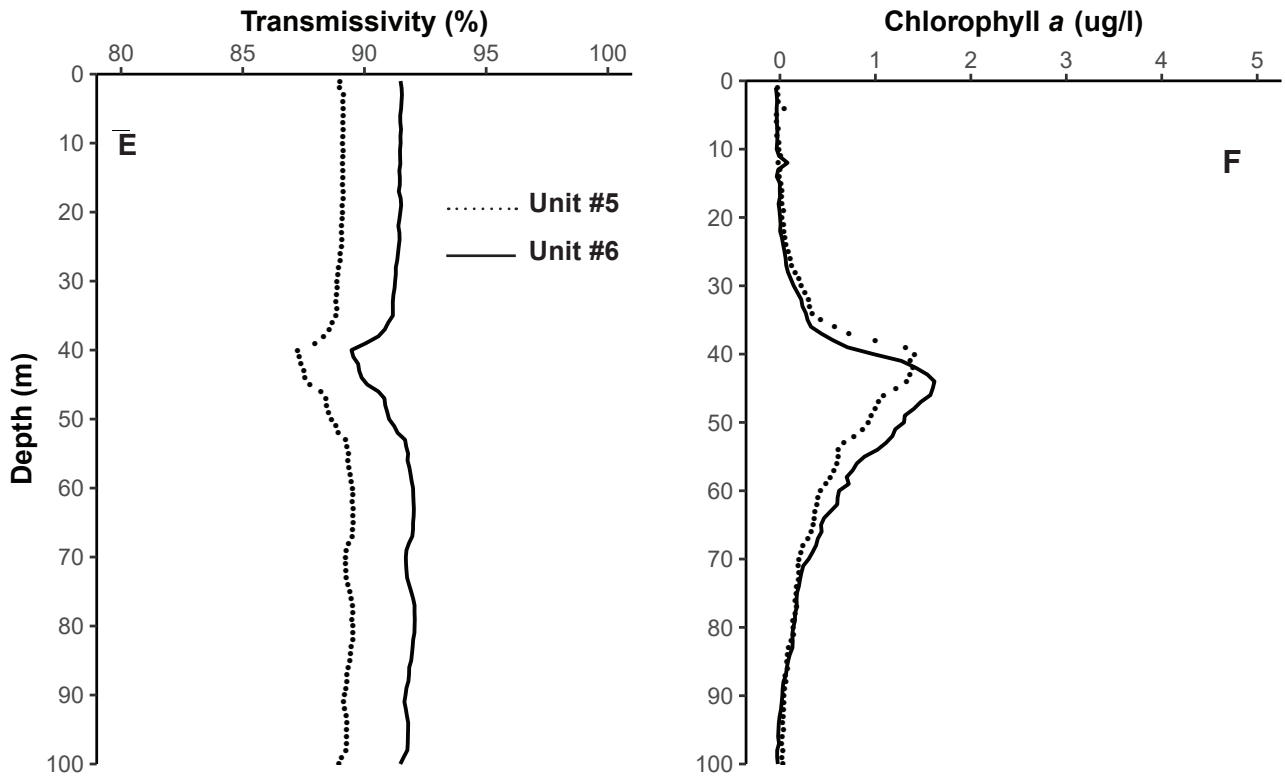

Figure 2 *continued*

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 field survey. The DO probe on each CTD is calibrated monthly to check for sensor drift. If the sensor drift is ≥ 5% from factory calibration, the DO sensor coefficients are changed. If the DO sensor drift reaches 10%, from factory calibration, it is removed from service, returned to manufacturer for servicing or repair, and replaced with a newly factory-calibrated probe. The pH and transmissivity probes are inspected in the morning prior to each sampling cruise to ensure proper function. For pH calibrations, three buffer solutions (pH = 7.0, 8.0, 9.0) are used to bracket the expected pH range. If the reading of any buffer solution deviates by more than 0.05 pH units, the probe is adjusted electronically using factory provided software and then recalibrated. The transmissometer on each CTD is checked by cleaning the windows of the LED light path, noting the zero reading by blocking the light path, and then noting the full range reading by removing the obstruction. If any specific probe fails to calibrate or has drifted out of its accepted range, it is removed from the CTD and replaced with a newly calibrated spare. Additionally, the results of each probe are evaluated by reviewing the data for each parameter 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.

Table 8

Summary of bacteriological QA analyses conducted during 2018 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 Duplicate	Total	49	25	0.1429	> 0.05	Fail to reject
	Fecal	31	18	0.8980	> 0.05	Fail to reject
	Entero	35	19	0.5071	> 0.05	Fail to reject
Lab Duplicate	Total	154	87	1.6116	> 0.05	Fail to reject
	Fecal	74	38	0.2325	> 0.05	Fail to reject
	Entero	93	52	1.1406	> 0.05	Fail to reject

Bacteriological Quality Assurance Analyses

Duplicate analyses are run throughout the year as QA checks on bacteriological data reported by the City. Field duplicates represent two separate samples collected simultaneously at the same station and then processed by a single analyst (microbiologist) using the same method to measure variability between samples collected in the field. Laboratory duplicates are designed to measure precision and accuracy of the test whether analysts can replicate their own results, and consist of two samples that are diluted, filtered, and plated from a single sample container by a single analyst to measure analyst precision. During calendar year 2018, a total of 575 QA/QC water samples were collected, of which 467 were laboratory duplicates and 108 were field duplicates (Table 6). The results of the analyses performed on these samples have been reported previously in the Point Loma and South Bay monthly receiving waters monitoring reports.

The sign test (Gilbert 1987) was used to compare the results from the paired field and laboratory duplicate analyses performed during 2018 (Table 8). When matched pairs of samples are compared, the sign test hypothesizes 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. Results from the duplicate field and laboratory samples compared in 2018 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 high repeatability of these 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. These counts are performed on a single plate by pairs of analysts with the acceptance requirement that counts by any two analysts must fall within 10% of each other. This calculation is known as the Relative Percent Difference (RPD). During 2018, 206 count comparisons were performed, and 100% of all comparisons for total coliforms, fecal coliforms, and *Enterococcus* consistently fell within the 10% RPD threshold.

Table 9

Results of benthic macrofauna sample re-sort analyses conducted during 2018 by the City of San Diego's (CSD) Ocean Monitoring Program, including those for Bight'18. Percent = (the # of animals found in the resorted sample/ the total sample abundance) X 100. Values with an asterisk (*) should be treated as preliminary and are based on estimates of total abundance received from the contract sorters.

PLOO			SBOO			Bight'18: CSD		
Survey	**Station**	**Percent**	**Survey**	**Station**	**Percent**	**Survey**	**Station**	**Percent**
Jan-18	B-9	0.0%	**Jan-18**	I-7	0.0%	**Jul-18**	10240 [8701]	0.0%
	E-20	0.0%		I-13	3.9%*		10376 [8729]	0.0%
	E-26	0.0%		I-14	<0.1%*		10232 [8732]	0.0%
				I-27	0.0%		10347 [8736]	1.4%*
							10317 [8738]	0.0%
							10875 [8748]	0.0%
Jul-18	E-5	0.0%	**Jul-18**	I-2	0.0%			
	E-15	0.0%		I-16	0.0%			

Bight'18: Other Agencies		
Survey	**Station**	**Percent**
Jul-18	10281	0.8%*
	10323	0.0%
	10392	0.0%

Macrofaunal Community Quality Assurance Analysis

Laboratory analyses of benthic macrofaunal samples involve three processes: (1) sample washing and preservation; (2) sample sorting; (3) identification and enumeration of all invertebrate organisms down to species level or the lowest taxon possible. Quality control of sorting is essential to assuring the validity of the subsequent steps in the sample analysis process. The sorting of benthic samples into major taxonomic groups is contracted to an outside laboratory, with the contract specifying an expected 95% removal efficiency. Ten percent of the sorted samples from each taxonomist at the contract lab are subjected to re-sorting as QA for the contract. The original sorting of a sample fails the QA criterion if the abundance in the re-sorted sample deviates more than five percent from the total abundance of all animals from that sample. If more than one failure occurs, the contract requires the re-sorting of all samples previously sorted by an individual contract sorter. The re-sort results for the January and July 2018 benthic samples, as well as Bight′18 samples, are shown in Table 9. All samples re-sorted from the 2018 surveys met the acceptance QA criteria for sorting.

Additionally, the laboratory performs internal and external re-identifications (re-IDs) as a QA measure to maintain consistency amongst taxonomists both within and outside the City. For 2018, these were performed on January PLOO and SBOO grabs only, and are included in the total count for Benthic Infauna Grab QA (Table 6). All re-identification sample analyses are conducted by taxonomists other than those who originally analyzed the samples, and are completed without access to original results. Two samples from each project in each taxa group were sent to an external consulting agency. All other re-IDs were performed by City marine biologists.

Toxicology Quality Assurance Analyses

All required whole effluent toxicity and sediment toxicity analyses in 2018 were performed by the City of San Diego Toxicology Laboratory (CSDTL), which is ELAP certified as indicated in Table 2.

The CSDTL 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 and test precision. Consistency among the reference toxicant test results enhances confidence in the toxicity data concurrently obtained from the test material (e.g., wastewater effluent). A specific reference toxicant is used for each combination of test material, test species, test conditions and endpoints, and the material is chosen from a list developed by the USEPA. The reference toxicant is purchased from an approved 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 reference toxicant test is performed at the same time the test material is evaluated. A control chart for each test method is maintained by the Division QA Manager and/or Laboratory Supervisor using results from no fewer than 20 of the most recent reference toxicant tests when available. The charted parameters that may be used include: effect concentrations (e.g., LC_{50}, EC_{50}), control performance, percent minimum significant difference, and coefficient of variability.

Using a nominal error rate of 5.0%, results from 19 of the most recent 20 reference toxicant tests are expected to fall within 2 standard deviations of the simple moving average (i.e., unweighted running mean), while 1 of these tests may fall outside the control chart limits by chance alone. Additionally, a series of USEPA-recommended quality control limits are also used to further evaluate test sensitivity.

Each run that is in violation of control limits would trigger an investigation of animal supply, reference toxicant stock quality, and laboratory practices. Additional testing may also be conducted to determine whether an exceedance is anomalous or if corrective actions are needed. All NPDES-mandated tests conducted with the affected animals are flagged, reviewed for anomalous responses, and in certain cases, tests are repeated with a new batch of animals. In 2018, all reference toxicant control charts for bioassays conducted by the CSDTL met the acceptability criteria as specified in Standard Operating Procedures and USEPA Methods.

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