SD Public Utilities

ANNUAL RECEIVING WATERS MONITORING & TOXICITY TESTING QUALITY ASSURANCE REPORT

2019

Environmental Monitoring and Technical Services
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Annual Receiving Waters Monitoring & Toxicity Testing Quality Assurance Report

2019

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

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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) procedures. These procedures ensure the accuracy and reliability of data collected from receiving waters monitoring and toxicity testing, which are provided to regulatory agencies in compliance with the reporting requirements specified in several National Pollutant Discharge Elimination System (NPDES) permits (Table 1). Furthermore, these QA/QC procedures ensure 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 EMTS division's QA/QC program for receiving waters monitoring are documented in a separate Quality Assurance Project Plan (QAPP) that is currently under revision and will be published by the end of 2020 (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. The next audit will take place in 2020.

This report summarizes the QA/QC activities that were conducted during calendar year 2019 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 (PLWTP) and South Bay Water Reclamation Plant (SBWRP), as well as similar ocean monitoring activities required for the South Bay International Wastewater Treatment Plant (SBIWTP) owned and operated by the International Boundary and Water Commission, U.S. Section.

Facilities and Staff

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

The MBOO section, and Marine Microbiology and Toxicology Labs are located at the EMTS Division's laboratory facility at 2392 Kincaid Road, San Diego, CA 92101. Functions of these labs are described below. The ECS section is composed of work groups located at other City laboratory facilities. Descriptions of the ECS laboratory functions and their QA procedures are presented in a separate QA report each year.

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, R9-2017-0024, and R9-2019-0012

Marine Biology and Ocean Operations

Staff scientists from the Marine Biology and Ocean Operations section are responsible for conducting most field sampling operations, some laboratory analyses, and 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 accumulation in marine fishes). Staff in this section are organized into different work groups based on main responsibilities and areas of expertise. Brief descriptions of the areas of emphasis for each work group are provided below.

Program Coordination, Assessment and Reporting: One of the primary responsibilities of this work group is to oversee the assessment 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. Staff on this team work closely with other staff to perform QA of all receiving waters monitoring data. 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.

Quality Assurance and Safety: This work group was created to define oversight and development of MBOO quality assurance policies and procedures including, but not limited to, the Quality Assurance Project Plan, Standard Operating Procedures, Work Instructions, ISO and hazardous material documentation, and to serve as the MBOO administrator of Qualtrax, a compliance software that is in the process of implementation for the division. Furthermore, this group oversees safety of operations both in the laboratory and aboard the ocean-going vessels through oversight of Cal/OSHA and US Coast Guard compliance, hazardous materials and universal waste management, and safety and training. Staff in this work group coordinate with members of other work groups to produce this annual report of quality assurance activities.

Ocean Operations: This work group comprises two subsections, Ocean Operations and Vessel Operations. Ocean Operations staff oversee and conduct water quality sampling, benthic sediment and macrofauna sampling, trawling and rig-fishing, and ocean outfall inspections. These staff members maintain and calibrate all oceanographic instrumentation, including the laboratory's remotely operated

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	619-758-2314	CA01393	2185
Toxicology	619-758-2345	CA01302	1989

vehicle (ROV), remotely operated towed vehicle (ROTV), and static and real-time moorings. Vessel operations staff (boat operators) 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 as appropriate.

Laboratory Operations: The Laboratory Operations work group coordinates processing of all benthic macrofauna and trawl-caught fish and invertebrates, rig fish samples (i.e., label preparation, sample login, data entry), maintains the taxonomic literature and voucher collections, and conducts taxonomic training. This group also oversees fish dissections as part of permit bioaccumulation requirements. In addition, these staff produce in-house identification/voucher sheets and keys to various invertebrate species and other higher-level taxa groups. Members of this and other work groups participate in and are members of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) and the Southern California Association of Ichthyological Taxonomists and Ecologists (SCAITE), regional taxonomic standardization programs, and perform all QA/QC procedures to ensure the accuracy of the taxonomic identifications made by laboratory staff.

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 staff 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 for 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 Laboratory 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. In addition to being summarized here, the Marine Microbiology 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.

Toxicology Laboratory

The Toxicology Laboratory is also certified by ELAP with renewal on a biennial basis (Table 2). Toxicology staff 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 PLWTP is discharged to the ocean through the PLOO, whereas commingled effluent from the SBWRP and SBIWTP is discharged through the SBOO. The separate orders and permits associated with these treatment facilities 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 2019 are summarized in Tables 3 and 4. The permanent fixed-position sampling sites for each program are shown in Figure 1. Core monitoring for the Point Loma region is conducted at 82 different stations located from the shore seaward to a depth of about 116 m, and includes 12 primary core stations along the 98-m discharge depth contour and 10 secondary core stations located along or adjacent to the 88 m and 116-m depth contours. South Bay region core monitoring is conducted at a total of 53 stations ranging from along the shore to offshore depths of about 61 m, including 12 primary core stations located along the 28-m discharge depth contour and 15 secondary core stations located along or adjacent the 19, 38, and 55-m depth contours.

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 (chronic bioassays) is required for effluent 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. 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 three year pilot study, including associated QA/QC activities, were presented separately in a final project report that was submitted to the SDRWQCB and USEPA on June 30, 2019 (City of San Diego 2019). As per recommendations in this final project report, the Toxicology lab collected and analyzed sediment toxicity samples in 2019, and will continue to do so until 2023.

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 study goals. 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 regional monitoring efforts that took place 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. Analyses for samples collected during these events are completed by external parties including, but not limited to, the Dr. Andrew Dickson's Marine Physical Laboratory at the Scripps Institution of Oceanography (Dickson Laboratory), UCLA researchers Ina Benner and Robert Eagle, and SCCWRP researchers. As with special studies, the regional monitoring efforts are typically subject to QA/QC

Table 3

Core receiving waters monitoring requirements for the Point Loma Ocean Outfall region. Sampling effort excludes FIB resamples, QA/QC activities, new plume tracking requirements, and/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	Rotating offshore stations[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 particle 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] Continued Sediment Toxicity Monitoring as recommended by the Final Project Report (City of San Diego, 2019) for the South Bay Ocean and Point Loma Ocean Outfall Monitoring regions, San Diego, California

Table 4

Core receiving waters monitoring requirements for the South Bay Ocean Outfall region. Sampling effort excludes FIB resamples, QA/QC activities, new plume tracking requirements, and/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 Conditions	nearshore	7	CTD	1	1/Week	52	364	CTD profile[b]	3276	1 cast/station (1-m batch avg samples)
	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	Rotating offshore stations[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 particle 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] Continued Sediment Toxicity Monitoring as recommended by the Final Project Report (City of San Diego, 2019) for the South Bay Ocean and Point Loma Ocean Outfall Monitoring regions, San Diego, California

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 + 12 Ref Tox	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 + 9 Ref Tox 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 + 4 Ref Tox	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 + 9 Ref Tox 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

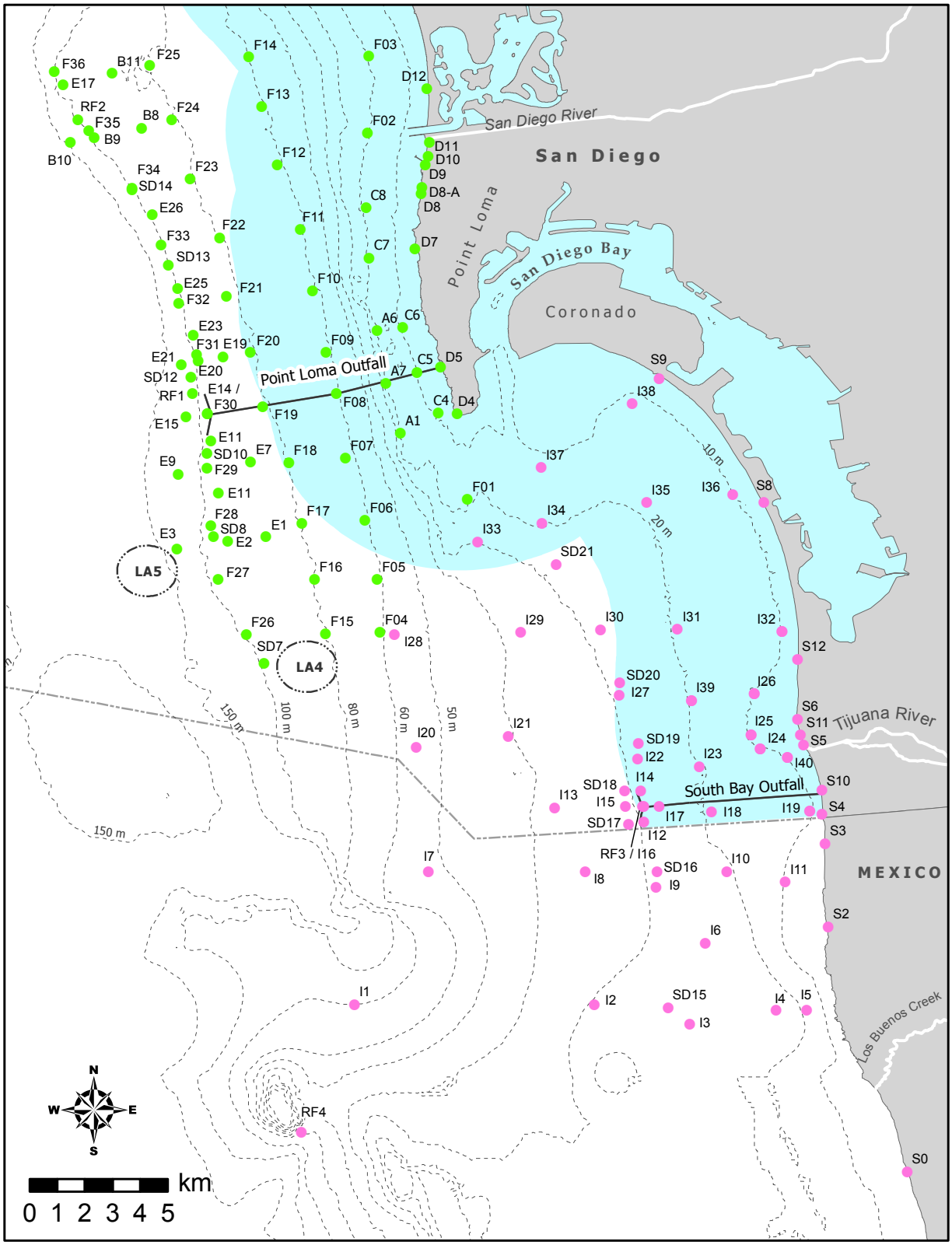

Figure 1
NPDES permit-mandated (fixed-grid) water quality, benthic, trawl, and rig fishing stations for the City of San Diego's Ocean Monitoring Program for the Point Loma (green dots) and South Bay (pink dots) ocean outfall regions.

Table 6

Number of discrete samples collected and analyzed by EMTS staff for NPDES permit-related activities during 2019. 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	138	NA	(performed by ECS)	
Chemistry Subsample	576 [a]	NA	(performed by ECS)	
Benthic Infauna Grab	138	NA	138	6
Otter Trawl	26	NA	26	NA
Fish Tissue	38 [b]	NA	(performed by ECS)	
Water Quality				
CTD Cast	1056	NA	9497 [d]	NA
Microbiology	4383 [c]	590	11,965 [e]	1624 [e]
Toxicology				
Sediment Toxicity	8 [f]	NA	8 [f]	1 [f]
Chronic Bioassay	16	NA	16	12
Bight '18 Ocean Acidification				
CTD Cast	12	NA	84 [d]	NA
Ocean Acidification	84	18	(performed by Dickson Lab)	
Coccolithophore	36	NA	(performed by UCLA)	
Pteropod RNA	12	NA	(performed by SCCWRP)	
Pteropod Shell Condition	12	NA	(performed by SCCWRP)	
Totals	**6536**	**608**	**21,734**	**1643**

[a] SBOO stations = 94; PLOO stations = 44

[b] Third replicate for Trawl Zone 9 not available due to insufficient number of fish collected

[c] Includes resamples

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

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

[f] Includes samples for continued Sediment Toxicity Monitoring following the Final Project Report (City of San Diego 2019)

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, planning documents for the current Bight′18 project, including its Quality Assurance Plan, are available on SCCWRP's website (www.sccwrp.org).

Summary of Work Performed in 2019

During calendar year 2019, a total of 7144 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

Table 7

Summary of the CTD intercalibration casts: (A) casts conducted during 2019. Values are the mean difference across casts and depths between Unit #5 and Unit #6 (MeanΔ) and maximum difference (MaxΔ) between units, as well as the cast number (i.e., 1, 2, 3) and depth (m) at which the maximum difference occurred; (B) results of CTD intercalibration exercises conducted from 2013 through 2019. Values are the differences between Unit #3 and Unit #4 (2013–2015) and Unit #5 and Unit #6 (2016–2019) averaged over all depths (0–100 m).

A

	July 2019				December 2019			
Parameter	**MeanΔ**	**MaxΔ**	**Cast**	**Depth (m)**	**MeanΔ**	**MaxΔ**	**Cast**	**Depth (m)**
Temperature (°C)	0.015	0.313	3	7	0.014	0.166	1	42
Salinity (ppt)	0.004	0.047	2	8	0.017	0.398	1	1
DO (mg/L)	0.305	0.555	1	7	0.388	1.926	1	8
pH	0.110	0.194	1	1	0.056	0.063	3	80
Transmissivity (%)	2.841	6.895	1	100	3.877	13.045	1	1
Chlorophyll *a* (µg/L)	0.222	0.602	1	1	0.742	2.899	1	2

B

Parameter	**Jul 2014**	**Dec 2014**	**Sep 2015**	**Dec 2015**	**Dec 2016**	**Aug 2017**	**Jan 2018**	**Nov 2018**	**Jul 2019**	**Dec 2019**
Temperature (°C)	0.06	0.01	0.03	0.03	0.02	0.10	0.04	0.03	0.02	0.01
Salinity (ppt)	0.01	0.00	0.02	0.006	0.01	0.04	0.02	0.02	0.004	0.02
DO (mg/L)	0.08	0.07	0.20	0.12	0.12	0.14	0.03	0.11	0.31	0.39
pH	0.05	0.02	0.02	0.02	0.02	0.22	0.03	0.06	0.11	0.06
Transmissivity (%)[a]	4.43	4.27	4.57	4.59	2.41	1.84	—	2.39	2.84	3.88
Chlorophyll *a* (µg/L)[b]	0.04	0.03	0.26	0.07	—	—	0.11	0.11	0.22	0.74

[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

9% (n = 608) were QC samples, such as lab 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.

CTD Calibration and Maintenance

The City of San Diego's MBOO section uses two Sea-Bird Scientific SBE-25plus CTDs. Both systems are configured with Sea-Bird's SBE-55 mini carousel package and outfitted with six 4-liter Niskin bottles. Typically, laboratory staff carry out semi-annual in-house CTD intercalibration exercises to ensure consistency between the two CTD instruments used to collect water column profiling data

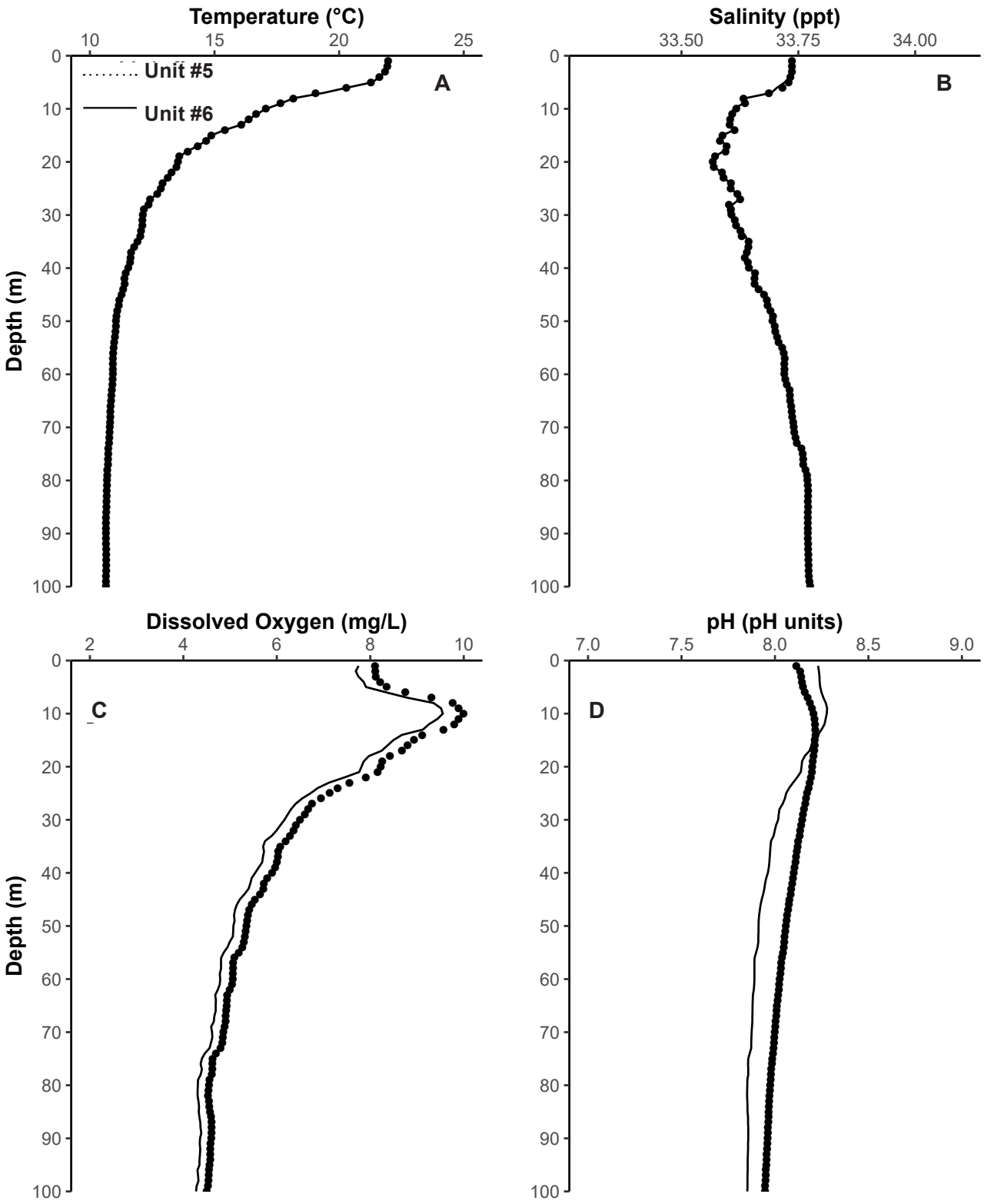

Figure 2

Comparison of results from CTD Unit #5 and Unit #6 from one representative cast made during the July 2019 CTD intercalibration exercise. Data include cast profiles for (A) temperature, (B) salinity, (C) dissolved oxygen, (D) pH, (E) transmissivity, and (F) chlorophyll *a*.

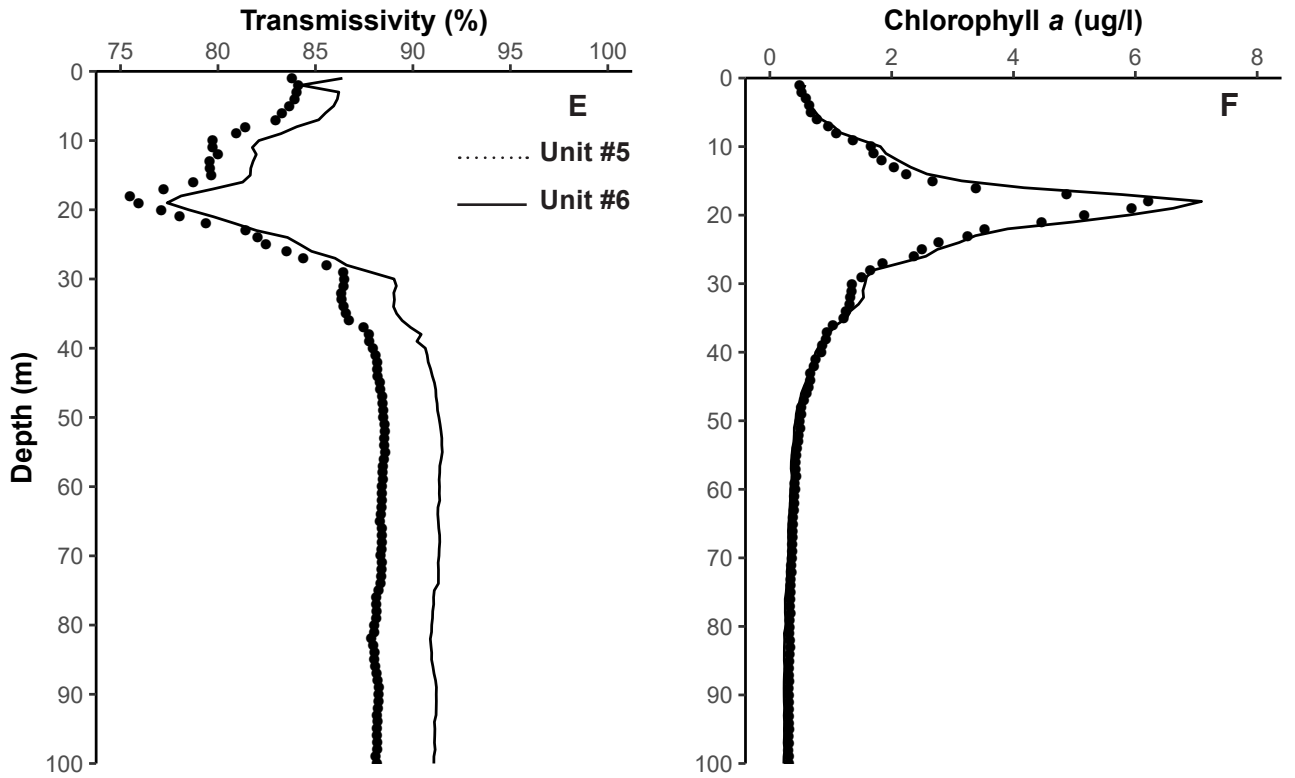

Figure 2 *continued*

for the City's Ocean Monitoring Program. For calendar year 2019, the intercalibration exercises were conducted in July and December. During these exercises, two CTDs configured with similar probes were attached to each other and deployed to a depth of 120 m and retrieved three separate times. For each cast, depths greater than 100 m were discarded to minimize bottom effects. After the three casts were completed, comparisons of the results for six different parameters (i.e., temperature, salinity, dissolved oxygen (DO), pH, transmissivity, chlorophyll *a*) were performed to assess whether deviations between the instruments and sensors were performing within acceptable limits. The results are summarized in Table 7A, and Figures 2 and 3, and compared to results from previous years in Table 7B. The intercalibration exercises conducted for instruments used in July 2019 demonstrated acceptable variability between CTDs for all measurable parameters: temperature, salinity, DO, pH, transmissivity, and chlorophyll *a* fluorescence (Table 7A).

In December 2019, cast 1 showed the greatest maximum differences in parameter readings between CTDs, with salinity, DO, transmissivity, and chlorophyll *a* showing large differences near the surface; this is likely due to interference from air bubbles. This issue during the December intercalibration event was resolved in subsequent casts when the greatest difference between CTDs for each parameter was more typical (i.e., 0.04 ppt for salinity, 0.5 mg/L for DO, 4.2% beam transmission; see Figure 3).

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

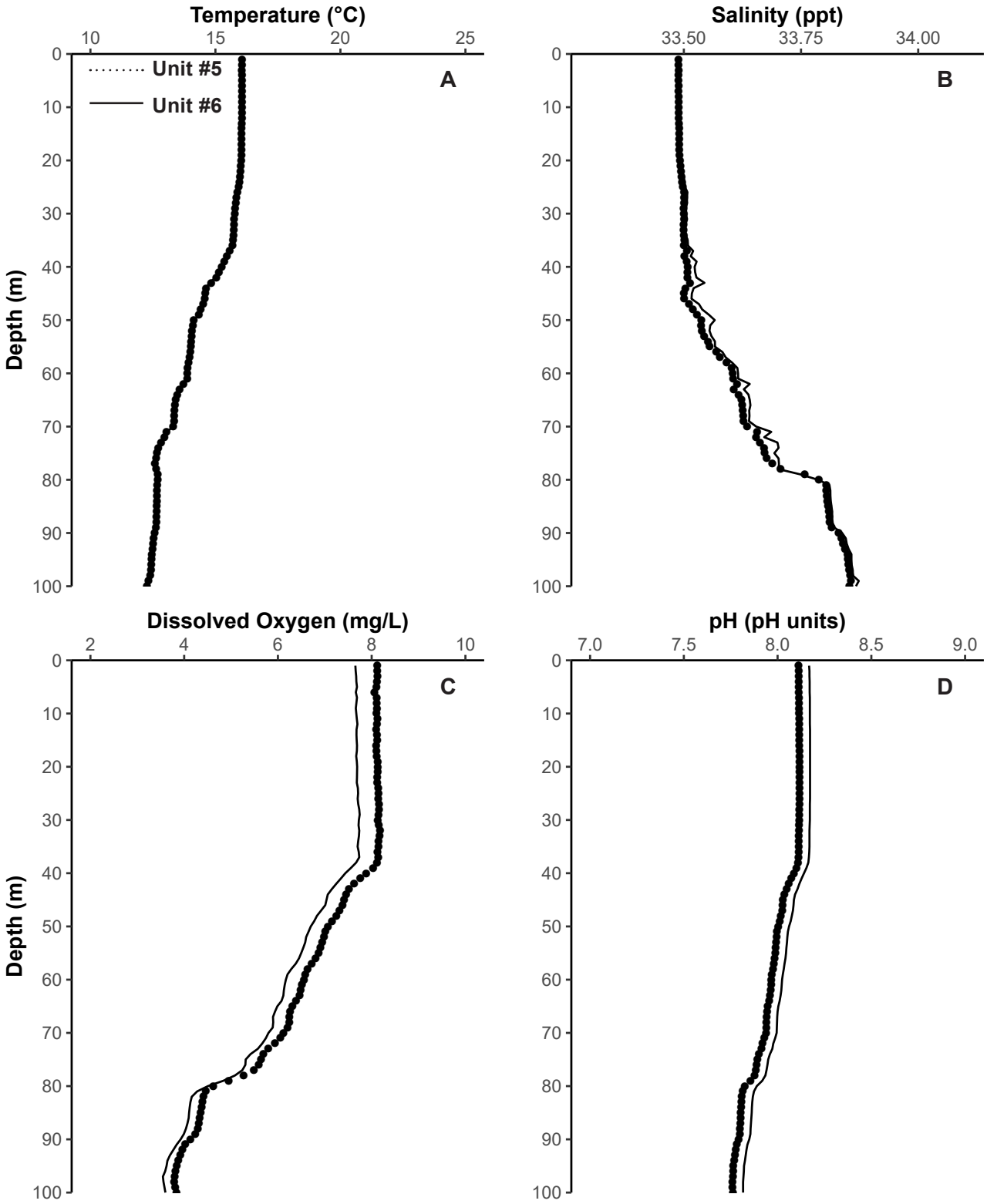

Figure 3

Comparison of results from CTD Unit #5 and Unit #6 from one representative cast made during the December 2019 CTD intercalibration exercise. Data include cast profiles for (A) temperature, (B) salinity, (C) dissolved oxygen, (D) pH, (E) transmissivity, and (F) chlorophyll *a*.

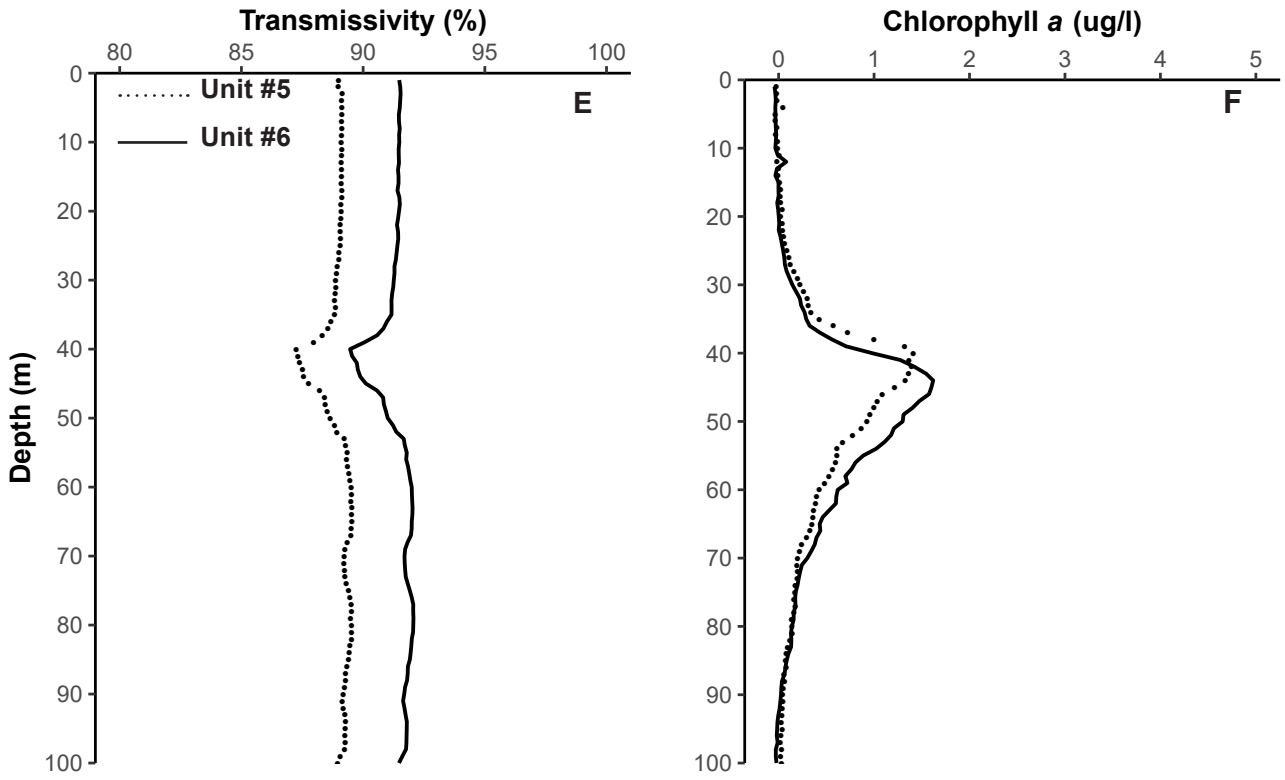

Figure 3 *continued*

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 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 the 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, then the probe is 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 maximum-value 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 2019 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
Lab Duplicate	Total	161	75	-0.8669	> 0.05	Fail to reject
	Fecal	119	54	-1.0084	> 0.05	Fail to reject
	Entero	107	57	0.6767	> 0.05	Fail to reject
Field Duplicate	Total	47	24	0.1459	> 0.05	Fail to reject
	Fecal	44	24	0.6030	> 0.05	Fail to reject
	Entero	34	12	-1.7150	> 0.05	Fail to reject

Bacteriological Quality Assurance Analyses

Duplicate samples are collected throughout the year as part of QA/QC procedures requred by bacteriological analyses. Field duplicates are two separate samples taken simultaneously from the same station and then processed by a single analyst to measure variability between samples. Laboratory duplicates consist of two samples that are diluted, filtered, and plated from a single sample container by a single analyst to measure analyst precision. During 2019, a total of 590 QA/QC water samples were collected, comprised of 475 laboratory duplicates and 115 field duplicates (Table 6). The results from 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 laboratory and field duplicate analyses performed in 2019 (Table 8). 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 2019, results from duplicate field and laboratory samples 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 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 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 2019, 228 count comparisons were performed. Seven out of 68 comparisons had a greater than 10% RPD for total coliform counts, eight out of 80 comparisons had a greater than 10% RPD for fecal coliform counts, and two out of 80 comparisons had a greater than 10% RPD for *Enterococcus* counts. In addition to these QA procedures, all analysts maintain their competency to perform certified methods through regular proficiency tests or demonstrations of capability.

Table 9

Results of benthic macrofauna sample re-sort analyses conducted during 2019 by the City of San Diego's Ocean Monitoring Program. Percent = (the # of animals found in the resorted sample/the total sample abundance) X 100.

PLOO			SBOO			REGIONAL		
Survey	**Station**	**Percent**	**Survey**	**Station**	**Percent**	**Survey**	**Station**	**Percent**
Jan-19	B9	0.0%	**Jan-19**	I4	0.0%	**Jul-19**	8801	0.2%
	E2	0.0%		I8	2.5%		8812	0.0%
	E11	0.0%		I13	0.0%		8818	0.0%
	E17	0.0%		I30	0.0%		8828	0.0%
	E21	0.0%		I33	1.2%		8837	0.0%
				I35	0.0%		8844	1.2%
Jul-19	B9	0.0%						
	B10	0.0%	**Jul-19**	I3	0.0%			
	E7	0.0%		I13	0.0%			
	E25	0.0%		I27	0.5%			
	E26	0.3%		I35	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 ensuring 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 2019 benthic samples are shown in Table 9. All samples re-sorted from the 2019 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 2019, 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. All re-IDs conducted in 2019 met acceptance criteria. Three samples from each project in each taxa group were sent to an external consulting agency.

Toxicology Quality Assurance Analyses

All required whole effluent toxicity and sediment toxicity analyses in 2019 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 two standard deviations of the simple moving average (i.e., unweighted running mean), while one 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 2019, 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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