

FINAL

IN-WATER HULL CLEANING PAUSE PILOT STUDY

SAMPLING AND ANALYSIS PLAN & QUALITY ASSURANCE PROJECT PLAN



**Prepared for:
Port of San Diego**



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ACRONYMS AND ABBREVIATIONS

AFP	antifouling paint
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
BMP	best management practice
CD	compact disk
CEDEN	California Environmental Data Exchange Network
City	City of San Diego
COC	chain-of-custody
CRM	certified reference material
CWA	Clean Water Act
DQO	data quality objective
ELAP	California State Environmental Laboratory Accreditation Program
ID	identifier
IWHC	in-water hull cleaning
LCS	laboratory control sample
LD	laboratory duplicate
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NELAP	National Environmental Laboratory Accreditation Program
NIST	National Institute of Standards and Technology
NIWC	Naval Information Warfare Systems Command
PDF	Portable Document Format
PM	Project Manager
Port	Port of San Diego
QA	quality assurance
QAM	Quality Assurance Manual
QAPP	Quality Assurance Project Plan
QC	quality control
Regional Board	San Diego Regional Water Quality Control Board
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SIYB	Shelter Island Yacht Basin
SIYB TMDL	Shelter Island Yacht Basin Dissolved Copper Total Maximum Daily Load
SOP	standard operating procedure
SPAWAR	Navy Space and Naval Warfare Systems Center Pacific
SRM	standard reference material
SWAMP	Surface Water Ambient Monitoring Program
Time Series Study	24-Hour Time Series Analysis of Dissolved Copper in SIYB
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
Weck	Weck Laboratories, Inc.
Wood	Wood Environment & Infrastructure Solutions, Inc.
WQO	water quality objective
YSI	YSI Incorporated

UNITS OF MEASURE

<	less than
±	plus or minus
%	percent
°C	degrees Celsius
µg/L	microgram(s) per liter
µm	micrometer(s) or micron(s)
dd/ddd.dddd°	decimal degrees
in.	inch(es)
kg/yr	kilogram(s) per year
ppt	part(s) per thousand

1.0 INTRODUCTION

Shelter Island Yacht Basin (SIYB) waters contain dissolved copper concentrations that have exceeded the dissolved copper numeric water quality objectives (WQOs) as well as the toxicity and pesticides narrative WQOs. These water quality conditions may threaten and impair the wildlife habitat and marine habitat beneficial uses in the basin (San Diego Regional Water Quality Control Board [Regional Board], 2005). Because of this exceedance, SIYB was placed on the list of impaired water bodies compiled pursuant to federal Clean Water Act (CWA) Section 303(d). To address this impairment, the SIYB Dissolved Copper Total Maximum Daily Load (SIYB TMDL) was adopted in 2005 under Resolution No. R9-2005-0019 (Regional Board, 2005). As part of the TMDL process, a conceptual model was developed to assign loading estimates to various copper sources in SIYB and resolve this impairment by requiring loading of dissolved copper into SIYB waters to be reduced. As stated in the TMDL, to achieve compliance by 2022, the copper load must be reduced to an annual load of 567 kilograms per year (kg/yr).

Recreational marine vessels moored in harbors and marinas are subject to biofouling that includes attachment and growth of aquatic organisms. Vessel hulls are commonly coated with copper-based paints that act as a toxicant by releasing copper and inhibiting growth of fouling organisms. Periodic hull cleaning occurs throughout the coating life cycle to maintain a smooth bottom surface. Environmental loading associated with passive leaching of antifouling paint and periodic cleaning activities to refresh the paint surface result in dissolved copper levels that exceed water quality regulatory criteria in SIYB.

The SIYB TMDL Conceptual Model identifies that copper antifouling paint sources contribute the majority of dissolved copper loading to SIYB. The greatest source of loading is the passive leaching of copper antifouling paint applied to the vessels moored in SIYB, accounting for approximately 93 percent (%; 2,000 kg/yr of copper) of total loading. The SIYB TMDL Conceptual Model identifies that the in-water hull cleaning (IWHC) of copper antifouling paints accounts for approximately 5% (100 kg/yr of copper) of loading (Regional Board, 2005). Other sources¹ were found to be nominal in the TMDL Conceptual Model.

A study conducted by the Navy Space and Naval Warfare Systems Center Pacific (SPAWAR) (now known as Naval Information Warfare Systems Command [NIWC]) evaluated leach rates resulting from both the act of IWHC and its residual effects following the active cleaning of the hull (i.e., the life cycle of a paint). This study entitled, *“Life Cycle Contributions of Copper from Vessel Painting and Maintenance Activities”* (Earley et al., 2013) utilized *in situ* data collection methods and best available science to evaluate copper loading and potential environmental impacts associated with IWHC. This study measured copper release rates following periodic IWHC events to better understand the relative contribution of passive leaching and IWHC to annual loading over an estimated three-year paint life cycle. Results of the study suggest that IWHC activities contribute greater than 5% of the annual copper load to SIYB. The study results

¹ As stated in the Regional Board Technical Report, dissolved copper loading from urban runoff is marginal compared with loading from the other anthropogenic sources, at approximately 1% (30 kg/year) of the total load. In addition, copper is found naturally in seawater, and background loading accounts for approximately 1% (30 kg/yr). Direct atmospheric deposition was also determined to be a relatively insignificant contributor of dissolved copper, accounting for less than 1% (3 kg/yr) of the total load. Lastly, sediment was found to act primarily as a sink, rather than a source, of dissolved copper under current loading conditions to SIYB. This finding is of concern because of the likelihood of long-term contamination of sediment by copper (Regional Board, 2005).

indicate increased volatility and dynamic copper release for 30-day periods following IWHC activity that can vary the contribution of IWHC-related loading from 5% to more than 40% of annual copper load per vessel, depending on the cleaning methods and frequency.

Findings presented in Earley et al., which represents the best available science to date, suggest that loading associated with IWHC may account for a greater percentage of loading to SIYB than previously modeled in the TMDL. However, the relationship between copper loading associated with IWHC and water quality (i.e., dissolved copper concentrations) is unclear.

The purpose of this IWHC Pause Pilot Study is to address data gaps associated with the impact of IWHC on water quality² in SIYB by evaluating how dissolved copper concentrations change throughout SIYB during an 8-week pause in IWHC.

This combined Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) has been prepared by Wood Environment & Infrastructure Solutions, Inc. (Wood) for the Port of San Diego (Port) to answer the following study question:

- How does a pause in IWHC affect dissolved copper concentrations in SIYB?

This SAP/QAPP provides detailed information on the design and implementation of the IWHC Pause Pilot Study. It is organized as follows:

- Section 1, **Introduction** to the IWHC Pause Pilot Study including background information and study purpose.
- Section 2, **Background Studies** briefly describing results of previous copper-related studies that have been performed in SIYB.
- Section 3, **Project Management** overview of the project personnel, roles and responsibilities of the key team members, and lines of communication.
- Section 4, **Sampling and Analysis Plan** with detailed information on the design of each of the components of the IWHC Pause Pilot Study, proposed monitoring station locations, timeline of sampling events, sample collection techniques, sample handling and chain of custody (COC) procedures, field measurements and analytical tests to be conducted, and data analysis techniques.
- Section 5, **Quality Assurance Project Plan** outlining the procedures to ensure that collection and handling of water samples, collection of field data, and analysis of water samples are conducted with a high degree of quality assurance (QA) and quality control (QC).
- Section 6, **Report Preparation** to list information that will be compiled and submitted to the Port at the conclusion of the IWHC Pause Pilot Study.
- Section 7, **References** for literature sources and reports cited in this document.

² A previous investigation (Amec Earth & Environmental, Inc., 2006) has shown that in-water hull cleaning is also a source of copper particulates that likely end up in the sediments. Since the SIYB TMDL is specific to dissolved copper in ambient waters of the basin, this investigation will only focus on the dissolved fraction of copper.

2.0 BACKGROUND STUDIES

The SIYB TMDL monitoring program was implemented in 2011 to evaluate progress towards compliance with the SIYB TMDL. Monitoring and progress reports are submitted to the Regional Board annually to provide updates on (1) best management practice (BMP) planning and implementation to reduce dissolved copper loading, (2) the tracking of vessel paint use to assess the number of vessel hulls converted from using copper-based antifouling paints (AFPs) to using non-copper or low-copper alternatives, and (3) water quality monitoring to measure dissolved copper concentrations and toxicity in the water column. In addition to the annual monitoring program, special studies are conducted periodically to address specific research questions. The special studies conducted to date are described below.

2.1 SIYB Enhanced Water Quality Special Study (Amec Foster Wheeler Environment & Infrastructure, Inc. [Amec Foster Wheeler], 2017)

The SIYB enhanced water quality special study was designed to develop a better understanding of basin-wide characteristics of dissolved copper in SIYB. The main goal of this special study was to determine whether existing TMDL monitoring stations provide an accurate assessment of basin-wide conditions. A total of twelve additional sites were sampled in SIYB in concurrence with the annual TMDL sampling event in August 2016. All sites were sampled at the surface, mid, and bottom depths to provide water quality data from the entire water column.

In general, the findings of this special study showed that dissolved copper concentrations increase from the mouth to the head of SIYB. This pattern is the same as that observed in the annual TMDL monitoring program. Additionally, the special study showed that dissolved copper concentrations in surface and mid water samples tended to be higher than in the bottom waters; however, WQO exceedances were observed at all depths.

Detailed study methods, findings, and conclusions can be found in the 2016 SIYB Enhanced Water Quality Special Study Monitoring Report (Amec Foster Wheeler, 2017)

2.2 24-Hour Time Series Analysis of Dissolved Copper in SIYB (Amec Foster Wheeler, 2018)

A special study examining the potential effect of tidal influence on dissolved copper concentrations of surface water over a full semidiurnal tidal cycle in SIYB (Time Series Study) was completed in January 2018. The Time Series Study involved collection of surface water samples at three stations located throughout SIYB at approximately two-hour intervals for the duration of a full tidal cycle (approximately 25 hours).

Overall, the results of this study indicated that tidal variations may affect the dissolved copper concentrations in surface waters of SIYB; however, much of what was observed appeared dependent on location within the basin. In particular, this variability was (1) the least prominent at the head of the basin; (2) more prominent at the locations closer to the mouth of the basin, and (3) not significantly different at each station between the high and low tidal phases captured during the Time Series Study.

Detailed study methods, findings, and conclusions can be found in the 24-Hour Time Series Analysis in SIYB Technical Memorandum (Amec Foster Wheeler, 2018)

2.3 Conceptual Model Review (Wood and Dudek, 2019)

The Port conducted a TMDL Conceptual Model Review in 2019 to compare the original 2005 SIYB TMDL Conceptual Model to the more recent best available science, the life cycle dynamic model developed by SPAWAR (Earley et al., 2013). The life cycle dynamic model suggests that hull cleaning activities contribute greater than 5% of the annual copper loads to SIYB. Increased copper release for the 30-day period following hulling cleaning activity can vary the contribution of hull cleaning-related loading from 5% to more than 40% of annual copper load per vessel depending on the number of times a vessel is cleaned and the cleaning methods. Therefore, the copper load to the water column attributable to in-water hull cleaning is likely considerably higher than the load identified in the TMDL.

Detailed findings of the review are included in the SIYB TMDL Conceptual Model Review Report (Wood and Dudek, 2019)

2.4 SIYB TMDL Winter Monitoring Event (2021)

Beginning in 2021, a winter monitoring event was added to supplement the annual SIYB TMDL compliance monitoring, which occurs in the summer. The purpose of the winter monitoring event was to provide a better understanding of the seasonal variability of dissolved copper levels in SIYB and at the reference locations during a period of cooler water temperatures and lower frequency of hull cleaning and vessel usage relative to the summer months. Monitoring for this winter event was conducted in February 2021, and results will be included in the 2021 SIYB TMDL monitoring and progress report.

3.0 PROJECT MANAGEMENT

This section presents project personnel, team organization, roles and responsibilities of key team members, and lines of communication for field and laboratory activities.

3.1 SAP/QAPP Distribution

Table 3-1 identifies those individuals who will receive one copy of the approved SAP/QAPP.

Table 3-1.
SAP/QAPP Distribution List

Title	Name (Affiliation)	Signature/Date
Project Manager	Kelly Tait (Port)	
Project Manager and Field QA Officer	Barry Snyder (Wood)	
Field Project Manager	Marisa Swiderski (Wood)	
Analytical QA Officer	Rolf Schottle (Wood)	
Analytical Laboratory Project Manager	Chris Samatmanakit (Weck)	

Notes: Port = Port of San Diego; QA = quality assurance; Weck = Weck Laboratories, Inc.; Wood = Wood Environment & Infrastructure Solutions, Inc.

3.2 Project Organization

Project Personnel and Roles

Wood will organize field sampling logistics and equipment, perform sample collection and oversight for laboratory analysis of samples, conduct data analysis, and prepare reports for the IWHC Pause Pilot Study. Individual roles and contact information for project personnel are outlined in Table 3-2.

Kelly Tait is the Project Manager (PM) for the Port. Ms. Tait will be responsible for project administration and will serve as the lead contact at the Port.

Barry Snyder is the PM and Field QA Officer for Wood. Mr. Snyder will be responsible for overall project management, organization, contracts, and oversight. In addition, he will serve as the Field QA Officer and will oversee field-related QA/QC procedures.

Marisa Swiderski is the Field PM for Wood. Ms. Swiderski will oversee coordination and execution of the field effort, including organization of field staff and scheduling of sampling days, and will be responsible for overseeing data analysis and finalizing the project report.

Rolf Schottle is the Analytical QA Officer for analytical chemistry for Wood. Mr. Schottle will be responsible for guaranteeing the validity of all QA/QC procedures and will ensure that analytical chemistry data reported by the laboratory and Wood has been generated in compliance with the appropriate protocols. Mr. Schottle will also be responsible for coordination with the analytical laboratory and will work with the Analytical Laboratory PM to ensure that proper QC procedures are followed.

Chris Samatmanakit is the Analytical Laboratory PM for Weck Laboratories, Inc. (Weck). Mr. Samatmanakit will be responsible for providing analytical chemistry data in an approved and quality-controlled format.

Table 3-2.
Project Personnel Roles and Contact Information

Name (Affiliation)	Project Role(s)	Contact Information
Kelly Tait (Port)	Project Manager	(619) 686-6372 (office) (619) 348-1690 (mobile) ktait@portofsandiego.org
Barry Snyder (Wood)	Project Manager and Field QA Officer	(858) 300-4320 (office) (858) 354-8340 (mobile) barry.snyder@woodplc.com
Marisa Swiderski (Wood)	Field Project Manager	(858) 300-4324 (office) (808) 772-8740 (mobile) marisa.swiderski@woodplc.com
Rolf Schottle (Wood)	Analytical QA Officer	(858) 300-4323 (office) (619) 985-2405 (mobile) rolf.schottle@woodplc.com
Chris Samatmanakit (Weck)	Analytical Laboratory Project Manager	(626) 336-2139 ext. 141 (office) chris.samatmanakit@wecklabs.com

Notes: QA = quality assurance; Port = Port of San Diego; Weck = Weck Laboratories, Inc.; Wood = Wood Environment & Infrastructure Solutions, Inc.

3.3 Quality Assurance Officers' Roles

The QA Officers are responsible for guaranteeing the overall quality of the data produced and reported throughout the project. Specific duties of the QA Officers include:

- Conducting audits of ongoing tests, data packages, and completed reports;
- Conducting audits of the routine QC documentation of field and laboratory procedures;
- Communicating potential QC problems to the staff; and
- Ensuring that all problems are resolved.

The QA Officers are also responsible for issuing QA reports to management, maintaining a current Quality Assurance Manual (QAM), and issuing QAPPs as required. The QA Officers also ensure that data reported have been generated in compliance with the QAM and the

appropriate protocols. The QA Officers are knowledgeable in the quality system standard defined under the California State Environmental Laboratory Accreditation Program (ELAP).

Barry Snyder and Rolf Schottle are the project QA Officers. Mr. Snyder, in the role of Field QA Officer, will oversee sample collection activities to ensure that proper sampling procedures are employed. As Analytical QA Officer, Mr. Schottle will work directly with the Analytical Laboratory PM, Mr. Samatmanakit, to ensure that proper QC procedures are followed.

The QA Officers will also review and assess procedures against plan requirements during the life of the project and will evaluate the need for any corrective actions. The QA Officers may stop actions conducted by the team if there are significant deviations from required practices or if there is evidence of a systematic failure. Mr. Samatmanakit will also have the same authority for laboratory-related operations.

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4.0 SAMPLING AND ANALYSIS PLAN

Sampling methodology, sample collection and handling, and analytical test methods to be employed by the field and laboratory teams are discussed in this section.

4.1 Water Quality Sampling and Analyses

The objective of this study is to answer the following study question: *How does a pause in IWHC affect dissolved copper concentrations in SIYB?* To address this question, water quality samples will be collected weekly for the duration of the study to evaluate concentrations of dissolved copper in SIYB before, during, and after an 8-week pause in IWHC.

In addition, the study will include a storm water sampling component to assess the effects of storm water on dissolved and total copper concentrations in SIYB. An attempt will be made to sample one storm event during the program. The purpose of this study component is to evaluate potential spikes in copper levels that may occur as a result of storm water discharges.

4.1.1 Sample Collection Locations

Samples will be collected weekly from 13 core monitoring stations in SIYB and two reference stations outside of SIYB. A subset of the core monitoring stations and both reference stations are co-located with the stations monitored annually for TMDL compliance (SIYB-1 through SIYB-6, SIYB-REF-1, and SIYB-REF-2). Additional core monitoring stations were selected at the ends of docks along the outer edges of marinas and main channel of SIYB to capture any changes in dissolved copper concentrations that may result from a pause in IWHC activities. Samples will be collected biweekly from an additional seven enhanced monitoring stations located in the inner portions of the marinas to provide supplemental data at a higher resolution and to allow for comparison between inner and outer marina/channel stations.

A majority of the monitoring stations are dock accessible for ease of access and to provide a conservative estimate of dissolved copper concentrations due to the proximity to vessels. In addition, selection of stations near vessels where IWHC occurs is expected to aid in the detection of changes in dissolved copper concentrations associated with the pause in IWHC. Due to the specificity of the study question, the knowledge of the SIYB site based on annual TMDL monitoring surveys, and multiple special studies³, the selected sample locations are targeted by design (United States Environmental Protection Agency [USEPA], 2002). Core and enhanced monitoring stations coordinates are outlined in Table 4-1 and depicted in Figure 4-1.

For storm event sampling, samples will be collected from two outfalls⁴ (if practicable) (Table 4-1; Figure 4-2) to assess the concentrations of dissolved and total copper in storm water prior to discharge into SIYB. Samples will also be collected from core monitoring and reference stations to assess the effects of storm water on dissolved and total copper concentrations in SIYB.

³ Descriptions of the annual SIYB TMDL monitoring program and other copper-related special studies are provided in Section 2.0.

⁴ These outfalls are monitored by the City of San Diego (City) for the SIYB TMDL, and results are reported separately to the Regional Board by the City. Note that the City's monitoring location for Outfall 2 (32.72080, -117.23217) is located upstream of the respective discharge points into SIYB.

Table 4-1.
Proposed Monitoring Station Coordinates

Station Type	Station ID	Target Sampling Coordinates	
		Latitude dd.ddddd°	Longitude -ddd.ddddd°
Core	C-1/SIYB-1	32.71821	-117.22601
Core	C-2	32.71783	-117.22538
Core	C-3	32.71699	-117.22635
Core	C-4	32.71623	-117.22729
Core	C-5	32.71632	-117.22906
Core	C-6/SIYB-2	32.71412	-117.22921
Core	C-7/SIYB-3	32.71550	-117.22989
Core	C-8/SIYB-4	32.71683	-117.23203
Core	C-9	32.71742	-117.23372
Core	C-10	32.71586	-117.23270
Core	C-11	32.71448	-117.23569
Core	C-12/SIYB-5	32.71217	-117.23297
Core	C-13/SIYB-6	32.70858	-117.23514
Reference	C-REF-1/ SIYB-REF-1	32.70406	-117.23232
Reference	C-REF-2/ SIYB-REF-2	32.70926	-117.22544
Enhanced	E-14	32.71739	-117.22452
Enhanced	E-15	32.71646	-117.22573
Enhanced	E-16	32.71557	-117.22658
Enhanced	E-17	32.71722	-117.22882
Enhanced	E-18	32.71434	-117.22819
Enhanced	E-19	32.71517	-117.23316
Enhanced	E-20	32.71154	-117.23218
Storm Water Outfall	OF-1	32.71603	-117.23550
Storm Water Outfall	OF-2	32.71892	-117.23144

Notes: ddd/dd.ddddd° = decimal degrees; ID = identifier



Figure 4-1. Proposed Monitoring Stations

Notes: BCM = Bay Club Marina; CN = Crow's Nest Yachts; GCA = Gold Coast Anchorage; HMM; Half Moon Marina; KKM = Kona Kai Marina; LPYC = La Playa Yacht Club; SDYC = San Diego Yacht Club; SGYC = Silver Gate Yacht Club; SIYB = Shelter Island Yacht Basin; SIM = Shelter Island Marina; SWYC = Southwestern Yacht Club; TL = Tonga Landing

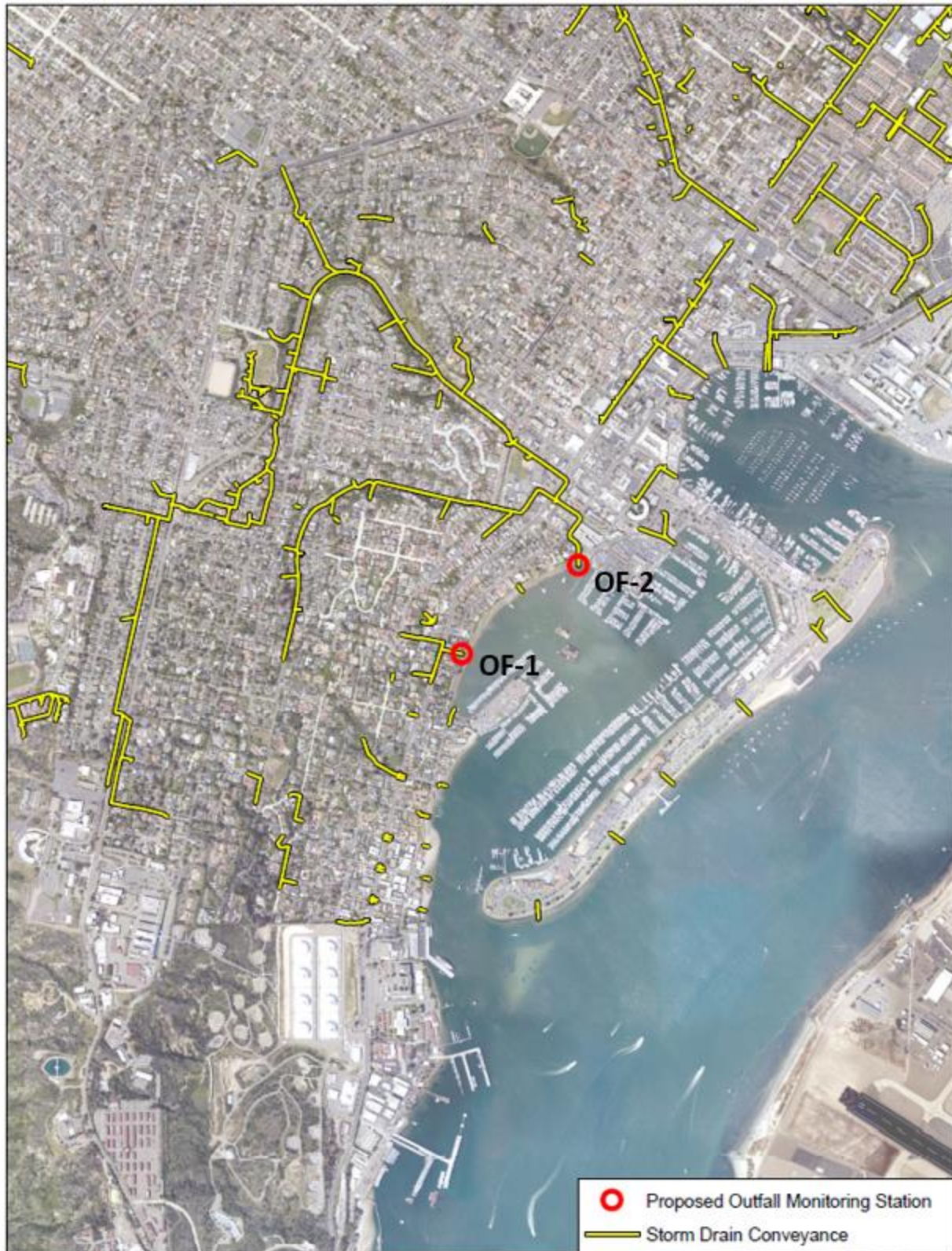


Figure 4-2. Proposed Outfall Monitoring Stations

4.1.2 Study Phasing and Timeline

The IWHC Pause Pilot Study will be divided into three phases spanning 16 weeks:

- **Phase 1 (Pre-IWHC Pause)** will include weekly sampling for four weeks prior to the IWHC pause. During each sampling event, surface water samples will be collected from the 13 core monitoring stations and two reference stations to evaluate dissolved copper concentrations leading up to the IWHC pause. In addition, samples will be collected from the seven enhanced monitoring stations biweekly (i.e., every other week).
- **Phase 2 (IWHC Pause)** will include weekly sampling for eight weeks during the IWHC pause. During each sampling event, surface water samples will be collected from the 13 core monitoring stations and two reference stations to evaluate dissolved copper concentrations during the IWHC pause. In addition, samples will be collected from the seven enhanced monitoring stations biweekly (i.e., every other week) to provide supplemental data at a higher resolution and allow for comparison between inner and outer marina/channel stations.
- **Phase 3 (Post-IWHC Pause)** will include weekly sampling for four weeks after the IWHC pause. During each sampling event, surface water samples will be collected from the 13 core monitoring stations and two reference stations to evaluate dissolved copper concentrations following the IWHC pause. In addition, samples will be collected from the seven enhanced monitoring stations biweekly (i.e., every other week).

If possible, one storm event will be sampled at some point during the 16-week monitoring program. During this event, samples will be collected from two outfalls (if practicable) to evaluate concentrations of dissolved and total copper in storm water prior to discharge into SIYB, as well as the 13 core monitoring stations and two reference stations to assess the effects of storm water on dissolved and total copper concentrations in SIYB.

Figure 4-3 shows a timeline of the IWHC Pause Pilot Study.

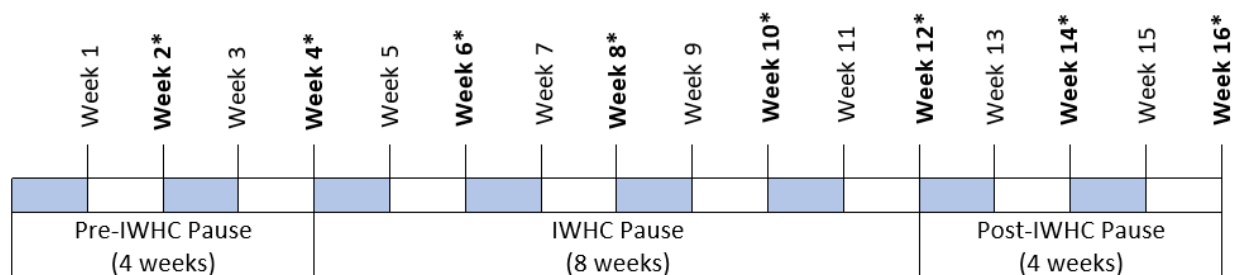


Figure 4-3. IWHC Pause Pilot Study Timeline

Notes: **Bold*** Indicates biweekly sampling of enhanced monitoring stations

4.1.3 Sample Collection

Samples will be collected starting at the reference stations (C-REF-2/SIYB-REF-2 and C-REF-1/SIYB-REF-1) and continuing from the mouth of the basin toward the head of the basin to minimize cross-contamination between samples. During each sampling event, samples will be collected in the same order to randomize the effects of tides over the course of the 16-week

study. Because samples will be collected weekly over a 16-week period, it will be infeasible to collect samples at each individual station at the same tidal stage. However, the SIYB Time Series Study performed in 2018 provided a general understanding of variation in dissolved copper concentrations in surface waters with tide in SIYB (see Section 2.0; Amec Foster Wheeler, 2018).

Samples will be collected using two teams; one team will sample directly from the docks, and one team will sample from a vessel⁵ using the same sampling techniques. During each sampling event and consistent with annual monitoring methods, discrete surface water samples (i.e., 1 meter below the surface) will be collected at each station according to the Surface Water Ambient Monitoring Program (SWAMP) “clean hands” techniques using a Niskin bottle deployed from the dock or from a vessel⁵. As described in Section 4.1.2, core monitoring stations will be sampled weekly and enhanced monitoring stations will be sampled biweekly for the duration of the study. Upon collection, water samples will be field-filtered through a 0.45-micrometer (µm) glass fiber filter using a bottle top vacuum filtration system and transferred to labeled containers for analysis of dissolved copper. Samples for dissolved copper analyses will be preserved immediately upon arrival to the analytical laboratory. In addition, field measurements of temperature and salinity of the surface water will be made at each station using a YSI, Inc. (YSI) meter according to manufacturer’s specifications. If a rain event occurs prior to routine weekly sampling, the sampling team may postpone sampling until a later day while still collecting samples every week to minimize the possible effects of storm water runoff on the sample results. Storm event sampling procedures are described below.

In addition, an attempt will be made to sample one storm event during the program. A storm event will be defined as one that produces greater than a quarter of an inch (0.25 in.) of rain. During a qualifying storm event, grab samples will be collected from two outfalls (if practicable) (Figure 4-2), and surface water samples will be collected from the core monitoring stations and reference stations according to procedures described above. Upon collection, water samples will be transferred to labeled containers for analysis of total and dissolved copper. Water samples collected for dissolved copper analyses will be filtered in the field through a 0.45-µm glass fiber filter using a bottle top vacuum filtration system, transferred to labeled containers, and preserved immediately upon arrival to the analytical laboratory.

All water samples will be logged on a COC form (Attachment C) and placed in a cooler on ice. Samples will be stored at 4 degrees Celsius (°C) in the dark until delivered to Weck for analysis.

4.1.4 Equipment Decontamination and Cleaning

Prior to each sampling event, the Niskin bottles (one per sampling team) will be cleaned using Alconox and thoroughly rinsed with deionized water. Upon deployment at each station, the Niskin bottles will also be rinsed thoroughly with site water and allowed to equilibrate at the sampling depth (1 meter below the water surface) for at least one minute prior to sample collection. After collection, water samples will be transferred from the Niskin bottle to laboratory-certified, contaminant-free bottles that are the appropriate type for the required analyses. In between sample collections, each Niskin bottle will be stored in a plastic-lined tub.

⁵ The vessel that will be used in this study is coated with a non-biocide hull paint (i.e., does not contain copper or other biocides).

4.1.5 Sample Processing, Handling, and Custody

Water samples will be uniquely identified by labeling laboratory-provided containers with sample labels in indelible ink. All labels will include the project title, appropriate identification number, date and time of sample collection, and preservation method. The field team will inspect the sample collection bottles before and after they are filled to ensure that each sample bottle is correctly labeled with station location and analysis type. After each sample collection, the field crew will confirm the accuracy of the station identifiers and test request information on the bottle labels, and verify the same information is logged on a COC form (Attachment C). The completed COC form will then be placed in the cooler for transport to the analytical laboratory. Samples will be kept on ice from the time of sample collection until delivery to the analytical laboratory. All samples will be transferred to the laboratory and analyzed within the method-specified holding time (Table 4-2). Additionally, appropriate volumes of each sample will be archived at Weck in case any analyses need to be repeated for confirmation. All analyses will be conducted by Weck, an ELAP-accredited laboratory⁶ for all the specific tests required for this program.

Table 4-2. Sample Holding Times

Analyte	Holding Time
Dissolved Copper	180 days ^a
Total Copper ^b	180 days ^a

Notes:

- The holding time for metals after preservation is 180 days. The dissolved fraction will be filtered in the field through a 0.45-micrometer (µm) glass fiber filter using a bottle top vacuum filtration system. Dissolved and total metals samples will be preserved at the laboratory immediately upon receipt from the courier.
- Only storm event samples will be analyzed for total copper.

4.1.6 Field Sampling Preservation, Packaging, and Shipment

During each sampling event, samples will be preserved by placing the sample bottles in wet-iced coolers immediately after collection. Field samples will be shipped via courier with appropriate COC forms within 24 hours of completion of the sampling event.

4.1.7 Chain-of-Custody Records

Proper COC procedures will be used throughout the sample collection, transport, and analytical process. The principal documents used to identify samples and to document possession are COC records, field logbooks, checklists, and field tracking forms. The COC process is initiated during sample collection. A COC record will be provided with each sample or group of samples. Each employee who has custody of the samples will sign the form and will ensure that the samples are not left unattended and are properly secured.

⁶ Weck is accredited by the National Environmental Laboratory Accreditation Program (NELAP) (Certificate #4047-008) through the State of Oregon, which is a NELAP-recognized accreditation body, for the analysis of metals using USEPA Method 1640 (Note that this ELAP Certificate is set to expire on 01/29/2022; the SAP/QAPP will be updated to include updated ELAP accreditation information when available). Weck is also accredited by the State of California ELAP (Certificate #1132) for the analysis of metals using USEPA 200.8.

Documentation of sample handling and COC includes the following:

- Client and project name,
- Sample identifier,
- Sample collection date and time,
- Any special notations on sample characteristics or analysis,
- Initials of the person collecting the sample,
- Date the sample was sent to the analytical laboratory, and
- Shipping company and waybill information or courier.

Completed COC forms will be placed into a plastic envelope and kept inside the cooler containing the samples. A courier will deliver the water samples from the Wood Office to the analytical laboratory within 24 hours of completion of the sampling event. Upon delivery of the samples to the analytical laboratory, the COC form will be signed by the person receiving the samples. Copies of the COC records will be included in the final reports prepared by the analytical laboratory.

4.1.8 Analytical Methods

Field measurements of temperature and salinity will be taken at each station. All water samples will be analyzed for dissolved copper (Table 4-3). For storm event sampling, samples will also be analyzed for total copper to account for particulate copper that may be present in storm water discharge. Dissolved and total copper analyses will follow USEPA methods. Analytical methods and target detection and reporting limits are presented in Table 4-3.

Table 4-3.
Laboratory Analytical Methods and Target Detection and Reporting Limits

Water Quality Measurement	Method	Method Detection Limit	Reporting Limit	Instrument Sensitivity
Salinity	YSI ProDSS	N/A	N/A	± 0.1 ppt
Temperature	YSI ProDSS	N/A	N/A	± 0.1 °C
Total Copper (seawater)	USEPA 1640	0.0038 µg/L	0.010 µg/L	N/A
Dissolved Copper (seawater)	USEPA 1640	0.0038 µg/L	0.010 µg/L	N/A
Total Copper (storm water)	USEPA 200.8	0.13 µg/L	0.50 µg/L	N/A
Dissolved Copper (storm water)	USEPA 200.8	0.13 µg/L	0.50 µg/L	N/A

Notes:

µg/L = microgram(s) per liter; °C = degrees Celsius; N/A = not applicable; ppt = part(s) per thousand; USEPA = United States Environmental Protection Agency; YSI = YSI Incorporated

4.2 Data Review

Following each field event, field data sheets will be checked for completeness and accuracy by the field crew and the Field PM (Ms. Swiderski). In addition, all sample COCs will be checked against sample labels prior to samples being transported to the laboratory. In the laboratory, technicians will document sample receipt and sample preparation activities in laboratory logbooks or on bench sheets.

In the laboratory, data validation will include use of dated and signed entries by technicians on the data sheets and logbooks used for samples, sample tracking and numbering systems to track the progress of samples through the laboratory, and QC criteria to reject or accept specific data. Data for laboratory analyses will be entered directly onto data sheets. Data sheets will be filled out in ink and signed by the technician, who is responsible for checking the sheet to ensure completeness and accuracy. The technician who generated the data will have the prime responsibility for the accuracy and completeness of the data.

Each technician will review the data to ensure the following:

- Sample description information is correct and complete,
- Analysis information is correct and complete,
- Results are correct and complete, and
- Documentation is complete.

All data will be reviewed and verified by the analytical laboratory to determine whether data quality objectives (DQOs) have been met and whether appropriate corrective actions have been taken, when necessary, as detailed in this SAP/QAPP.

4.3 Laboratory Quality Assurance and Quality Control

Analytical laboratories will provide a QA/QC narrative that describes the results of the standard QA/QC protocols that accompany analysis of field samples. All hard copies of results will be maintained in the project files. In addition, backup copies of results generated by the laboratory will be maintained at its facility. At a minimum, the laboratory reports will contain results of the laboratory analysis, QA/QC results, all protocols and any deviations from the project SAP/QAPP, and a case narrative of COC details. Laboratory QA/QC requirements are discussed in detail in Section 5.

4.4 Data Analysis

The IWHC Pause Pilot Study was designed to capture relative trends in water column dissolved copper concentrations over time. Data analysis will include a comparison of the relative concentration differences (e.g., relative percent difference or rate of change) during each phase of the study at different locations throughout SIYB. Summary data tables and figures will be created only after the raw data have passed through the QA/QC criteria.

4.4.1 Factors that May Affect Study Results

This section discusses some of the potential variables and factors that may affect the study results. Evaluation of these factors will need to be considered when interpreting study results.

- **Potential for considerable enhanced cleaning activities in the period leading up to and following the IWHC pause:** This additional cleaning effort could potentially result in a spike in copper load entering the basin compared to what would be observed during routine hull cleaning activities. To determine the pre-pause/post-pause site conditions,

samples will be collected weekly for four weeks leading up to/and following the IWHC pause.

- **Potential for rainfall and associated storm water runoff:** Because the study is taking place during the wet season, significant rainfall and associated storm water runoff could potentially impact study results. To account for potential impacts to copper levels in SIYB from storm water discharges, an attempt will be made to sample one storm event (i.e., >0.25 in. of rain) during the study period. This will include collecting samples from two outfalls (if practicable) to evaluate concentrations of dissolved and total copper in storm water prior to discharge into SIYB, as well as the 13 core monitoring stations and two reference stations to assess the effects of storm water on dissolved and total copper concentrations in the SIYB receiving water.
- **Seasonality:** Annual TMDL compliance monitoring is conducted in the summer. By sampling in the summer for compliance monitoring, dissolved copper concentrations are likely to be at their highest level in the water column because the release rates of copper from AFPs is higher at warmer sea surface temperatures, and a greater frequency of hull cleaning tends to occur due to higher fouling rates. To decrease the financial impact on hull cleaners during the IWHC pause, the IWHC Pause Pilot Study will be conducted during the winter, which tends to have cooler water temperatures, lower fouling rates, and lower hull cleaning frequency. The 2018 Time Series Study (Amec Foster Wheeler, 2018) and 2021 Winter Monitoring studies were also conducted in the winter and can provide additional information on seasonal variations in dissolved copper levels in SIYB.
- **Variation in surface water dissolved copper levels due to tides:** Because of the 16-week study design, it is not feasible to coordinate sample collection at a given station at the same tidal stage. However, sampling stations in the same order over 16 weeks will capture a broad range of tidal stages at each station. Further, based on the results of the 2018 Time Series Study conducted in SIYB, tides are not expected to have a substantial impact on surface water dissolved copper levels, particularly near the head of the basin (see Section 2.0; Amec Foster Wheeler, 2018).
- **Potential for non-compliance with IWHC pause:** Because there will be an ordinance in place to implement a pause in IWHC for 8 weeks, no hull cleaning of copper-based AFPs is expected to occur during this time. However, potential non-compliance with the ordinance could impact study results if spikes in copper load occur during and following each cleaning event.

4.5 Data Management

The analytical laboratory will supply analytical results in electronic Portable Document Format (PDF) and will be responsible for ensuring that results are accurate. After completion of the data review by the laboratory, hard copy results will be placed in the project files; results in electronic format will be imported into a database system. The database is discussed in further detail in Section 5.5.1. All data generated during the study will also be uploaded into the California Environmental Data Exchange Network (CEDEN).

5.0 QUALITY ASSURANCE PROJECT PLAN

5.1 Field and Analytical QA/QC Procedures

Strict QA/QC procedures will be employed throughout the entire study, from mobilization through delivery of samples to the analytical laboratory. Extra care will be taken to minimize the possibility of compromising sample integrity. The sample collection teams will be trained in and follow field sampling standard operating procedures (SOPs), as described in this document. A QA log (Attachment B) will be completed during the first sample collection event at a subset of stations, and periodically thereafter, to review each step of the sample and data collection process. These checks will ensure that collection procedures are consistent between sampling events and among stations, and that all field data are recorded correctly and completely.

Field team members will take care to avoid contamination of samples at all times by employing the SWAMP “clean hands” technique and will wear powder-free nitrile gloves during sample collection. All samples will be collected in laboratory-supplied, laboratory-certified, contaminant-free sample bottles.

The sampling team will be familiar with this SAP/QAPP and field sampling SOPs to ensure that all sampling personnel are trained accordingly. Additionally, the field team members will be made aware of the significance of the project’s method detection limits and the requirement to avoid contamination of samples at all times.

Field equipment will be checked and calibrated for operation in accordance with the manufacturer’s specifications (calibration records will be recorded and maintained) and will be inspected for damage prior to use and when returned from use. Observations of activities surrounding the sampling area will be recorded on field data sheets (Attachment A) at each station and during movement between stations (i.e., IWHC, topside maintenance, etc.). Photographs will also be taken, as necessary.

As required by SWAMP protocols, a co-located field duplicate (hereafter referred to as a field duplicate) will be collected at one randomly selected station during each sampling event. Each field duplicate sample will consist of a second sample collected for analysis to assess variability in sampling procedures, as well as ambient conditions. The field duplicate samples will be analyzed for the same suite of parameters as the primary test samples. In addition to the field duplicate samples, the study will also include one equipment rinse blank⁷ and one field blank for each sampling event.

The IWHC Pause Pilot Study will include the following QA/QC elements:

- | | |
|--|--|
| ✓ Verification of laboratory certifications | ✓ Field conditions and water quality data sheets |
| ✓ Field equipment calibrations records | ✓ Observations for IWHC or other water-quality- |
| ✓ Staff training on QAPP-required field procedures | impacting activities near sample collection stations |

⁷ Because two Niskin bottles will be required (one for each sampling team), the equipment rinse blanks will be collected from one Niskin bottle per week, alternating between bottles over the 16-week monitoring program.

For this study, the analytical laboratory chosen to conduct the analyses is required to (1) be certified to conduct the analyses for the constituents of concern, (2) be certified for the specific analysis methods required for this program, and (3) hold a valid ELAP certificate at the time the IWHC Pause Pilot Study is initiated and the samples are analyzed. The QA objectives for chemical analysis to be followed by the analytical laboratory are detailed in its laboratory QAM and this QAPP. The objectives for accuracy and precision involve all aspects of the testing process, including the following:

- Methods and SOPs
- Calibration methods and frequency
- Data analysis, validation, and reporting
- Internal QC
- Preventive maintenance
- Procedures to ensure data accuracy and completeness

Results of all laboratory QC analyses will be reported with the final data. Any QC samples that fail to meet the specified QC criteria in the methodology or QAPP will be identified and the corresponding data will be appropriately qualified in the final report. The final report will include a separate section that discusses any QA/QC issues encountered during the sampling activities, as well as the corrective actions taken to address any issues satisfactorily.

5.2 Special Training Needs/Certifications

All field personnel will be trained and will have experience in proper field sampling and sample handling techniques, including COC procedures, prior to sampling. These techniques will be reviewed prior to each sampling event and all field personnel will provide a signature to document the training.

Weck is accredited by the National Environmental Laboratory Accreditation Program (NELAP) (Certificate #4047-008) through the State of Oregon, which is a NELAP-recognized accreditation body, for the analysis of metals using USEPA Method 1640. Weck is also accredited by the State of California ELAP (Certificate #1132) for the analysis of metals using USEPA 200.8.

5.2.1 Training and Certification Documentation

All personnel are responsible for complying with the QA/QC requirements that pertain to their organizational/technical function. Technical staff members must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular functions and a general knowledge of laboratory operations, test methods, QA/QC procedures, and records management. A training sign-in sheet will document that field personnel are trained and experienced in all handling techniques and procedures.

5.2.1.1 Field Sampling

Field personnel will be trained in proper sampling techniques, sample handling, sample preservation and storage, sample transport, COC, and SOPs.

5.2.1.2 Analytical Laboratory

The training program for the analytical chemistry laboratory begins with reviewing the SOP for a new task. The Analytical Laboratory PM, Chris Samatmanakit, demonstrates the procedure to the trainee, shows the appropriate steps in the SOP, and explains the significance of each step. The trainee later performs the procedure under the supervision of Mr. Samatmanakit. At this time, questions are answered, and parts of the procedure may be demonstrated again to the trainee. The trainee continues to work under the direct supervision until he/she can demonstrate the procedure with competence and full understanding. This process may be short or long, depending on the procedure. Once the trainee has demonstrated competence, Mr. Samatmanakit completes a training form. At this time, the employee can work without supervision. This documentation is kept in files organized by individual with a separate form for each task. On an annual basis, the analyst is requalified, and this requalification is documented on the training form as well.

5.2.2 Training Personnel

Wood's Field PM, Marisa Swiderski, and/or Field QA Officer, Barry Snyder, will verify that training is provided for field personnel in proper field sampling techniques prior to work initiation to ensure that consistent and appropriate sampling, sample handling/storage, and COC procedures are followed.

5.3 Quality Objectives for Criteria for Measurement of Data

The laboratory will follow in-house QA/QC plans, and any deviations will be documented in the analytical reports. DQOs applicable to water samples collected for this project consist of accuracy, precision, representativeness, completeness, and comparability for field testing and chemistry analyses. Specific DQOs are presented in Table 5-1, along with acceptability criteria for each measurement.

Table 5-1. Data Quality Objectives for Laboratory and Field Measurements

Group	Parameter	Calibration	Accuracy	Precision		% Complete
Field Testing	Temperature, Salinity	NIST (temp), Salinity standard	± 0.1 °C, ± 0.1 ppt	FD		100
Laboratory Analyses	Dissolved Copper	SRM/CRM or MS/MSD, LCS	70–130%	LD, FD, and MS/MSD	<30%	100
	Total Copper	SRM/CRM or MS/MSD, LCS	70–130% (USEPA 200.8) 60–138% (USEPA 1640)	LD, FD, and MS/MSD	<30%	100

Notes:

°C = degrees Celsius; < = less than; % = percent; ± = plus or minus; CRM = certified reference material; FD = field duplicate; LCS = laboratory control sample; LD = laboratory duplicate; MS = matrix spike; MSD = matrix spike duplicate; ppt = part(s) per thousand; NIST = National Institute of Standards and Technology; SRM = standard reference material; USEPA = United States Environmental Protection Agency

Acceptance criteria will be based on the implementation of acceptable and recognized QA/QC procedures. Acceptable data requires proper sample collection and handling methods, sample preparation and analytical procedures, holding times, and QA protocols.

Accuracy is defined as the difference between the measured value of an indicator and its true or expected value, which is an estimate of systematic error or net bias (Kirchner, 1983; Hunt and Wilson, 1986; and Taylor, 1987). Accuracy will be ensured for trace metals through acceptable recoveries of laboratory control samples (LCS) and matrix spike (MS) samples using method-specific performance-based control limits.

Precision is defined as the measure of agreement among repeated measurements of the same property under identical or substantially similar conditions, calculated as either a range or as a standard deviation. The precision of chemistry laboratory measurements will be assessed by comparison of the sample result to that for a duplicate sample in addition to comparisons between the laboratory MS and matrix spike duplicate (MSD). Precision will be measured by the degree of agreement between the sample and the laboratory duplicate (LD) or the MS and MSD results. Samples within a $\pm 30\%$ relative percent difference (RPD) between the sample result and duplicate result will be accepted as unqualified results.

Representativeness is defined as how well a sample collected represents the population or area it was taken from. Representativeness will be measured by the ability of samplers to collect from each target location and within the given timeframes of the study. Data will be assessed for changes in dissolved copper concentrations over time (trend), comparing core, reference, and enhanced monitoring stations to address the study question. Core monitoring stations were targeted throughout SIYB, including each of the largest marinas.

Completeness is a measure of the proportion of the expected, valid data (i.e., data not associated with some criterion of potential unacceptability) that is actually collected during a measurement process. The objective for completeness is 100% for each measurement process.

Comparability is an expression of confidence with which one dataset can be compared with another. The objective of comparability is to ensure that data developed during each sampling event are comparable with data previously collected (i.e., that methods of analysis are comparable) and that the methods used adequately address applicable criteria or standards. Comparability is addressed by specifying laboratory methods that are consistent with the current standards of practice, as approved by the USEPA and/or the NELAP.

In addition, the analytical reporting limits for copper are below the relevant regulatory criteria for assessment of aquatic health, meeting this DQO, as presented in Table 4-3. The method detection limits are below the SWAMP reporting limits and preliminary benchmarks in accordance with the DQOs.

5.4 Assessments and Response Actions

The Analytical Laboratory PM at Weck, Chris Samatmanakit, will receive a copy of this SAP/QAPP prior to submission of samples and will be required to sign off that he has read and understands all of the expectations for Weck outlined in this SAP/QAPP. The Wood Analytical

QA Officer, Rolf Schottle, will be immediately notified by phone, with a follow-up in writing, of any incident that results in the need for corrective action as described in the following sections.

5.4.1 Corrective Action Plans

An out-of-control event is defined as any occurrence failing to meet pre-established criteria. A nonconformance is a deficiency in characteristic, documentation, or procedure sufficient to make the quality indeterminate or unacceptable. An out-of-control event is a subcategory of nonconformance. Any out-of-control events observed, whether in the field or in the laboratory, will be immediately communicated to the Wood PM and Analytical QA Officer to determine the appropriate course of action.

When either situation (out-of-control event or nonconformance) is identified, it will be categorized as follows:

- **Deficiency** – Recognition that a specific requirement (e.g., program, process, or procedure) has been violated.
- **Observation** – Recognition of an activity or action that might be improved but is not in violation of a specific requirement. Left unaddressed, the activity or action might develop into a deficiency.

5.4.2 Criteria Used for Determination of an Out-of-Control Event

Factors that affect data quality (e.g., failure to meet calibration criteria, inadequate recordkeeping, improper storage, or preservation of samples) require investigation and corrective action.

When a nonconformance is recognized, each individual involved with the analysis in question has an interactive role and responsibility. This process is described in the following two paragraphs:

- **Analytical Laboratory PM** – The Analytical Laboratory PM, Chris Samatmanakit, must review all analytical and QC data for reasonableness, accuracy, and clerical errors. In an out-of-control event, Mr. Samatmanakit will notify the Analytical QA Officer, Rolf Schottle, immediately (within 24-48 hours) by telephone and email. Mr. Samatmanakit and Mr. Schottle will work together to solve the problem. Mr. Schottle will notify Wood PM, Barry Snyder of the issue and the proposed remedy. This process will prevent the reporting of suspect data by stopping work on the analysis in question and ensuring that all results that are suspect are repeated, if possible, after the source of the error is determined and remedied.
- **Analytical QA Officer** – The Analytical QA Officer, Mr. Schottle, will report to Wood PM, Barry Snyder, on the status of the problem. Mr. Snyder will then notify the Port PM, Kelly Tait, immediately (24 to 48 hours) by phone with a follow-up in writing if the work is affected by an out-of-control event or results of an internal audit. In the event that a QC measure is out-of-control and the data are to be reported, qualifiers will be reported together with sample results. Mr. Schottle is responsible for reviewing nonconformance

report forms, recommending or approving proposed corrective actions, and verifying that corrective actions have been completed.

5.4.3 Procedures for Stopping Analyses

Whenever the analytical system is out of control, investigation and correction efforts are initiated by all concerned personnel. Best professional judgment will be used by the person(s) notified to rectify the problem in accordance with the QAPP.

If the problem is instrumental or specific only to preparation of a sample batch, samples will be reprocessed after the instrument is repaired and recalibrated.

5.4.4 Corrective Action

The need for corrective action may arise from various possible sources: equipment malfunction, failure of internal QA/QC checks, failure of follow-up on performance or system audit findings, or noncompliance with QA requirements.

When measurement equipment or analytical methods fail QA/QC requirements, the problem(s) will immediately be brought to the attention of the Analytical Laboratory PM, who will notify the Analytical QA Officer immediately. Corrective measures will depend entirely on the type of analysis, the extent of the error, and whether the error is determinant or not. The corrective action is determined by the Laboratory PM and the QA Officer. However, final approval is the responsibility of the Wood PM, Mr. Snyder.

If failure is due to equipment malfunction, the equipment will not be used until repaired. Precision and accuracy will be reassessed, and the analysis will be rerun. All attempts will be made to reanalyze all affected parts of the analysis so that at completion, the product is not affected by failure of QC requirements.

5.5 Data Validation and Usability

Data validation is the process whereby data are filtered and accepted or rejected on the basis of a set of criteria. It is a systematic procedure of reviewing a body of data against a set of criteria to provide assurance of its validity prior to its intended use. Data are checked for accuracy and completeness. The data validation process consists of data generation, reduction, and review. Requirements of the ELAP Good Automated Laboratory Practices (Document 2185) (USEPA, 1995) are followed for computer processing, manipulation, reporting, storage, and retrieval of data. Data reduction, validation, and reporting are ongoing processes that involve the Analytical Laboratory PM, QA Officers, and Wood PM.

5.5.1 Database Generation

Upon completion of each sampling event, the field data sheets will be removed from the field logbooks, and the sheets will be checked for completeness and accuracy by the Field PM, Ms. Swiderski, or Wood PM, Mr. Snyder. Appropriate field sheets must be present and filled out completely. If there are any questions, clarification from field personnel will be obtained as soon

as possible. Field data sheets and the field logbooks will be placed into folders by data type, labeled with the data type and survey name, and filed in the appropriate filing cabinet. Field sheets will also be scanned, and electronic copies stored in the project folder on Wood's San Diego server.

In the laboratory, technicians will document sample preparation activities in bound laboratory notebooks or on bench sheets. Data validation includes use of dated and signed entries by technicians on the data sheets and logbooks used for samples, sample tracking and numbering systems to track the progress of samples through the laboratory, and QC criteria to reject or accept specific data.

The data for laboratory analyses will be entered directly onto data sheets. Data sheets must be filled out in ink and signed by the technician, who is responsible for checking the sheet to ensure completeness and accuracy.

The technician who generates the data has the prime responsibility for the accuracy and completeness of the data. Each technician reviews the data to ensure the following:

- Sample description information is correct and complete.
- Analysis information is correct and complete.
- Results are correct and complete.
- Documentation is complete.

Data sheets are submitted to the Analytical Laboratory PM and Analytical QA Officer. A tracking sheet is initialed when the data are ready for transmittal to a data entry operator. Original data sheets are not allowed to leave laboratory facilities. If for any reason data entry is performed by an employee, but not at Wood's facilities, data sheets are copied, and the originals are kept with the Analytical Laboratory PM and Analytical QA Officer.

Data files are assigned a job number and are given a file name, which will be used when the file is put on compact disk (CD).

All data generated during the study will be uploaded into CEDEN.

5.5.2 Error Checking and Verification

The raw data entry file is checked 100% against the original laboratory reports by the Analytical QA Officer or designee. Any errors found are corrected in the raw data entry sheets. If no errors are found, the station checked is marked "OK." The process is continued until no errors are found in the check. After the raw data are checked, each spreadsheet is marked with the date the check was completed and the initials of the Analytical QA Officer or designee. The raw data files used for error checking are saved and filed.

Further data validation is performed by the Analytical Laboratory PM. Validation is accomplished by performing routine audits of the data collection and flow procedures and by monitoring QC sampling results.

Data validation includes use of dated and signed entries by the technicians and Analytical Laboratory PM on the bench sheets and notebooks used for samples, sample tracking and numbering systems to track the progress of samples through the laboratory, and QC criteria to reject or accept specific data.

In the data review process, the data are compared with information (e.g., sample history, sample preparation, and QC sample data) to evaluate the validity of the results. Corrective action is minimized by developing and implementing routine internal system controls. Analysts are provided specific criteria that must be met for each procedure, operation, or measurement system.

5.6 Reconciliation with User Requirements

The Wood QA Officers (Barry Snyder and Rolf Schottle) will review data after each survey to determine whether DQOs have been met. If data do not meet the project's specifications, the applicable QA Officer will review the errors, communicate verbally and in writing with laboratory QA Officers as appropriate, and determine whether the problem is a result of calibration/maintenance, sampling techniques, or other factors. They will suggest corrective action. It is expected that the problem would be corrected by retraining, revision of techniques, or replacement of supplies/equipment. If the problem is not corrected by these methods, then the DQOs will be reviewed for feasibility. If specific DQOs are not achievable, the Analytical QA Officer will recommend appropriate modifications. Any revisions need approval by the Wood PM, Barry Snyder, and the Port PM, Kelly Tait.

5.7 Documents and Records

Wood will document and track aspects of the sample collection process, including generating field logs (Attachment A) at each site and COC forms (Attachment C) for all samples collected. COC forms will accompany water samples to the analytical laboratory. The analytical laboratory will document and track all aspects of sample receipt and storage, analyses, and reporting.

Wood will maintain a database of information collected throughout this project. After verification and final database establishment, the raw data files and databases will be copied onto CD for storage onsite. All original data sheets, statistical worksheets, and reports produced will be accumulated into project-specific files maintained in file cabinets or on computer servers at the Wood office after the report has been submitted. Final report text and tables are also stored on a CD and provided to the Port. After data submissions, directories are archived for storage offsite. All records will be maintained for at least five years or transferred according to agreement between the company and the client, should the laboratory transfer ownership. All records and analyses pertaining to accreditation are kept for a minimum of five years. If there is a change in company ownership, accreditation records for at least the previous five years must be transferred to the new owner.

Analytical results gathered at Weck will be stored in a database system at their main office and will be provided to Wood's PM, Barry Snyder, and Analytical QA Officer, Rolf Schottle, electronically. Data received from outside contractors will be kept exactly as received (electronically); data are error checked and processed into Wood's database system.

Persons responsible for maintaining records for this project are as follows: Mr. Snyder, Wood's PM, will oversee the operations of the project, including field QA, and will arbitrate any issues relative to records retention and any decisions to discard records. The Analytical Laboratory PM, Mr. Samatmanakit, will maintain all chemistry records; and the Field PM, Ms. Swiderski, will maintain the data at Wood and will maintain all sample collection, sample transport, COC, and field analyses forms.

Copies of this SAP/QAPP will be distributed to the Port's PM, Kelly Tait. Updates to this SAP/QAPP will be distributed in like manner, and all previous versions will be discarded from the project file.

Copies of the final report, including laboratory results and field records, will be maintained for a minimum of five years after project completion.

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6.0 REPORT PREPARATION

Wood will provide a draft technical memorandum based on the parameters outlined in Section 1.0 within 60 days of receipt of the final analytical data package. At a minimum, the following information will be included in the memorandum:

1. *Introduction*. This section will include a presentation of the study objectives.
2. *Sample collection methods*. This section will provide detailed information on monitoring stations, number of samples, and sample collection methods.
3. *Sample analyses*. Laboratory analytical methods, sample handling and transport, lab QA/QC results, and other pertinent information will be described.
4. *Results*. An evaluation, interpretation, tabulation, and summary of the water quality data will be provided.
5. *QA/QC Summary*. This section will discuss adherence to project-specific QAPP requirements, QA/QC issues to be addressed, and any necessary corrective actions.

The Wood PM, Mr. Snyder, and Field PM, Marisa Swiderski, are responsible for preparation and submittal of all project reports. Draft and final reports will be prepared to summarize the data collected for this project. Tables, figures, and report write-up will be reviewed by at least two Wood staff, including, at a minimum, the PM and a QA Officer. The document will also be reviewed by a technical editor. The reports will be returned to the office staff for any corrections, and the final draft will then be reviewed again by the Wood PM. The Wood PM will sign the letter of transmittal for delivery of the report to the Port PM.

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7.0 REFERENCES

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ATTACHMENT A

FIELD DATA SHEET

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In-Water Hull Cleaning Pause Pilot Study

Sample Date:

☐ Pre-IWHC Pause (4 weeks) ☐ IWHC Pause (8 weeks) ☐ Post-IWHC Pause (4 weeks)

Weather Conditions:

Surface Water Conditions:

General Observations/Notes:

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ATTACHMENT B

FIELD SAMPLING QA CHECKLIST

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In-Water Hull Cleaning Pause Pilot Study

FIELD SAMPLING QA CHECKLIST

Station Location: _____

Date/Time: _____

Mark each box with Y, N, or NA

1. Station Occupation and Field Data Recording:

Station GPS coordinates (approx. \pm 3 m) and station identification verified	
Time of sampling recorded	
Temperature and salinity readings taken at 1 meter below surface	
Check for in-water hull cleaning operations in the area and record distance and direction from site if observed	
General site observations recorded	

2. Sampling Procedures:

Field staff wearing fresh, powder-free nitrile gloves	
SWAMP protocols utilized to avoid sample contamination (i.e., clean hands/dirty hands technique)	
Sampling instrument given site water rinse prior to deployment	
Sample bottle(s) are the correct type, lab-certified, and contaminant-free	
Sample bottle(s) correctly labeled and match the station identification	
Sample bottle(s) correctly labeled with the sample date and time	
Sample collected at 1 meter below surface	
Staff avoided contaminating samples at all times	
Equipment rinsate blank and field blank have been collected (if applicable)	
Field duplicate collected (if applicable)	
PPE properly removed and disposed of upon site completion	

4. Sample Storage and Transport:

Water samples properly stored on ice in a cooler	
Water samples properly logged on COC form	
Proper persons have signed the COC	
Cooler and samples hand delivered to labs with completed COC	

Additional Notes:

Signature of QA/QC Personnel: _____ Date/Time: _____

Print Name/Company: _____

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ATTACHMENT C

CHAIN-OF-CUSTODY FORM

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Weck Laboratories, Inc.

Analytical Laboratory Services - Since 1964

CHAIN OF CUSTODY RECORD

STANDARD

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SPECIAL REQUIREMENTS / BILLING INFORMATION

1) **LAB ACTION:** PRESERVE Cu/Zn IMMEDIATELY. HDPE Metals bottles have NO acid in bottle; 2) Diss. metals were field filtered using 0.45 um bottle top filt. system

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