SHELTER ISLAND YACHT BASIN DISSOLVED COPPER TOTAL MAXIMUM DAILY LOAD IMPLEMENTATION PLAN

Prepared for:

California Regional Water Quality Control Board, San Diego Region

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ACRONYMS AND ABBREVIATIONS

Basin Plan	*Water Quality Control Plan for the San Diego Basin – Region 9*
BLM	Biotic Ligand Modeling
BMP	best management practice
City	City of San Diego
CTR	California Toxics Rule
CWA	Clean Water Act
DOC	dissolved organic carbon
EC_{50}	median effective concentration
Implementation Plan	SIYB Dissolved Copper TMDL Implementation Plan
Investigative Order	Investigative Order No. R9-2011-0036
LC_{50}	median lethal concentration
MAR	marine habitat
MS4	Municipal Separate Storm Sewer System
OAL	Office of Administrative Law
pH	hydrogen ion concentration
Port	San Diego Unified Port District
RHMP	Regional Harbor Monitoring Program
Regional Board	San Diego Regional Water Quality Control Board
SIYB	Shelter Island Yacht Basin
SSO	site specific objective
SUSMP	Standard Urban Stormwater Mitigation Plan
TIE	Toxicity Identification Evaluation
TMDL	Total Maximum Daily Load
USEPA	U.S. Environmental Protection Agency
WER	Water Effects Ratio
WILD	wildlife habitat
WQO	water quality objectives

UNITS OF MEASURE

cm^2	square centimeter
kg/yr	kilogram per year
$\mu g/cm^2/day$	microgram per square centimeter per day
µg/L	microgram per liter
%	percent

1.0 INTRODUCTION

The Shelter Island Yacht Basin (SIYB) Dissolved Copper Total Maximum Daily Load (TMDL) Implementation Plan (Implementation Plan) describes the collective approach to achieving reductions in copper loading into SIYB in order to preserve and restore beneficial uses. The Implementation Plan takes a solutions-oriented approach of establishing and implementing Best Management Practices (BMPs) that directly and indirectly facilitate reductions in copper loading into the basin to meet the SIYB TMDL interim and final dissolved copper loading compliance thresholds. The Implementation Plan was prepared in response to Resolution No. R9-2005-0019 in which the San Diego Regional Water Quality Control Board (Regional Board) incorporated the dissolved copper TMDL into the *Water Quality Control Plan for the San Diego Basin – Region 9* (Basin Plan) (Regional Board, 2005). The Office of Administrative Law (OAL) reviewed and approved the dissolved copper TMDL on December 2, 2005.

This plan incorporates an adaptive management model of planning, implementation, and assessment. The first step in the planning phase is to develop a BMP implementation strategy by which the Named Parties (i.e., Dischargers) will work independently and collectively to reduce copper loading into SIYB. The implementation phase will involve the enactment of a phased program comprised of education, incentives, and policies that reduce copper loading. In recognition that the primary source of dissolved copper to the water column originates from copper-based antifouling paints, the main focus of implementation is to effect the conversion of hull paints from copper to non-copper and low-copper antifouling paint products to improve water quality. Therefore, assessment of compliance with the TMDL loading reductions will be determined through a basin-wide tracking program that quantifies the transition of vessels moored within SIYB from copper to non-copper and low-copper paints (less than 40% copper). Additionally, annual water quality monitoring will be used to track progress towards achieving long-term improvements in water quality. The results of tracking and monitoring assessments will be incorporated into technical reports that will be submitted annually to the Regional Board in compliance with the requirements of Investigative Order No. R9-2011-0036 (Investigative Order). A summary of the roles and responsibilities of the Named Parties in implementing the TMDL is provided in Appendix A.

1.1 TMDL Summary & Background

In 1996, SIYB was placed on the Clean Water Act (CWA) Section 303(d) list of impaired waters due to elevated levels of dissolved copper in the water column. The CWA requires that the Regional Board implement a TMDL for 303(d)-listed waters of SIYB since the existing water quality did not meet numeric water quality standards for dissolved copper or narrative water quality objectives (WQOs) for toxicity and pesticides. As a result, the Regional Board developed a TMDL for SIYB, with the purpose of achieving applicable WQOs as well as the restoration of marine habitat (MAR) and wildlife habitat (WILD) beneficial uses within the basin.

1.1.1 Source Analysis

The Regional Board's source analysis determined the total mass loading of dissolved copper to SIYB to be 2,163 kilograms per year (kg/yr). The TMDL stated that 98% of inputs are attributable to copper-based antifouling paints of recreational vessels (Regional Board, 2005). Copper is released from vessels to the water column through two sources: passive leaching and underwater hull cleaning. Passive leaching is the single largest source of dissolved copper to SIYB and was estimated to contribute a mass loading of 2,000 kg/yr of dissolved copper, which represents 93% of the total contribution (Table 1-1). The TMDL identified underwater hull cleaning as the second largest source of dissolved copper, resulting in the mass loading of 100 kg/yr, which represents 5% of the total contribution.

Table 1-1. Sources of Dissolved Copper to Shelter Island Yacht Basin

Source	Mass Load (kg/yr)	Contribution (% Dissolved Copper)
Passive Leaching	2,000	93
Hull Cleaning	100	5
Urban Runoff	30	1
Background	30	1
Direct Atmospheric Deposition	3	<1
Sediment	0	0
Total	**2,163**	**100**

Inputs of dissolved copper from upland sources appear to be much less pronounced according to the Regional Board's source analysis. Approximately 846 acres drain into SIYB, contributing 1% (30 kg/yr) of dissolved copper loading to SIYB via urban runoff, which consists of wet weather and dry weather flows (Regional Board, 2005). Other sources of dissolved copper to the SIYB include natural background sources in ambient seawater and aerial deposition. Water from San Diego Bay flushes SIYB and contributes to the loading of dissolved copper. Average copper concentrations in San Diego Bay were used to characterize background conditions and a box model was used to estimate loading. Background contributions of dissolved copper to SIYB are 1% (30 kg/yr). Direct atmospheric deposition contributes less than 1% (3 kg/yr) of dissolved copper loading to SIYB (Regional Board, 2005). This includes wet and dry deposition directly into SIYB. Indirect deposition is not included here, because it is a component of urban runoff.

1.1.2 Water Quality Objectives

The numeric WQOs in SIYB are equal to the California Toxics Rule (CTR) water quality values for dissolved copper within seawater (U.S. Environmental Protection Agency [USEPA], 2000). Continuous or chronic exposures may not exceed 3.1 micrograms per liter (µg/L) over a 4-day average, while acute exposures may not exceed 4.8 µg/L over a 1-hour average. In addition, numeric WQOs must not be exceeded more than once every three years. In addition to numeric WQOs, the Basin Plan establishes narrative WQOs for toxicity and pesticides (Regional Board, 1994):

> ***Toxicity Objective**: All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Board.*
>
> ***Pesticide Objective**: No individual pesticide or combination of pesticides shall be present in the water column, sediments, or biota at concentration(s) that adversely affect beneficial uses. Pesticides shall not be present at levels which will bioaccumulate in aquatic organisms to levels which are harmful to human health, wildlife or aquatic organisms.*

The Regional Board indicated that if numeric WQOs are met for dissolved copper, then narrative WQOs will also be met. However, since numeric WQOs are not site specific, SIYB-specific assessments of toxicity and biota may provide a more direct indication of basin-wide attainment of beneficial uses and narrative WQOs than assessments of dissolved copper concentrations alone.

1.1.3 Loading Allocations

Dissolved copper loading allocations were established by the Regional Board to reduce inputs of dissolved copper into the water column to levels that will meet WQOs (i.e., 3.1 µg/L for dissolved copper). Allocations were based on the known sources of dissolved copper into the water column, as well as the environmental conditions of SIYB that affect the fate and transport of dissolved copper in the basin. A linkage analysis was performed by the Regional Board to determine the maximum amount of copper loading that SIYB can support and still meet the numeric target (i.e., loading capacity). Final loading allocations for known sources of copper to SIYB were based on the known sources of copper, the loading capacity of the basin, and a 10% margin of safety that accounted for the uncertainty of the analysis.

In order to meet the numeric targets for dissolved copper (Section 1.1.2), loading must be equal to or less than the TMDL loading allocation of 567 kg/yr, requiring a 76% reduction from current loading. Reductions were assigned to sources based on current loading (Table 1-2)). Loading from passive leaching must be reduced by 81% from current loading, resulting in an allocation of 375 kg/yr. This equates to a 75% reduction in the total loading of dissolved copper to SIYB. Loading from hull cleaning must be reduced by 27% from current loading, resulting in an allocation of 72 kg/yr. This equates to a 1% reduction in the total loading of dissolved copper to SIYB. The remaining sources of copper are relatively insignificant to the total loading and were not assigned reductions.

Table 1-2. Dissolved Copper Loading Allocations for Shelter Island Yacht Basin

Source	Current Load (kg/yr)	Allocation (kg/yr)	Percent Reduction from Current Loading (%)	Percent Reduction from Total Loading (%)
Passive Leaching	2,000	375	81	75
Hull Cleaning	100	72	27	1
Urban Runoff	30	30	0	0
Background	30	30	0	0
Direct Atmospheric Deposition	3	3	0	0
Sediment	0	0	0	0
Margin of Safety		57		
Total	**2,163**	**567**		**76**

1.1.4 Total Maximum Daily Load Compliance Schedule

Under Resolution R9-2005-0019, the SIYB dissolved copper TMDL identified a phased load reduction schedule that will achieve the final 76% reduction over 17 years (Regional Board, 2005). Based on the official TMDL approval date[1], this time period is set to end in 2022. No reductions in dissolved copper loading were required during the initial two-year orientation period (2005-2007). The subsequent 15-year period requires incremental load reductions, including a 10% reduction in dissolved copper loading within 7 years, a 40% reduction within 12 years, and a 76% reduction within 17 years (Table 1-3).

Table 1-3. Interim and Final Loading Targets for TMDL Attainment

Stage	Time Period	Percent Reduction from Current Estimated Loading	Reduction to be Attained by end of Year	Estimated Interim Target Loading (kg/yr of Dissolved Copper)
1	2005-2007	0%	N/A	N/A
2	2007-2012	10%	7	1,900
3	2012-2017	40%	12	1,300
4	2017-2022	76%	17	567

[1] For a TMDL to be incorporated into the Basin Plan, it must be approved by the Regional Board, State Water Resources Control Board (SWRCB), OAL, and USEPA Region 9. The official TMDL approval date is when the OAL approves the document.

1.2 Named Parties and Stakeholders

The Named Parties (i.e., Dischargers) under the SIYB TMDL responsible for copper load and wasteload reductions include:

- San Diego Unified Port District (Port)
- SIYB marina and yacht club owners/operators
- Persons owning boats moored in SIYB
- SIYB underwater hull cleaners
- (City) of San Diego

The Port, marina and yacht club owners/operators, boat owners, and hull cleaners are responsible for copper discharges from boat hulls, while the City is responsible for discharges to the basin via its Municipal Separate Storm Sewer Systems (MS4s).

The Named Parties began coordinating and preparing this Implementation Plan in June 2009. The Implementation Plan provides a roadmap for coordinating BMP implementation as well as loading reduction assessments and water quality monitoring (Section 4.2). The Named Parties are committed to open communication and an open public advisory process with a focus on stakeholder input.

Regional stakeholders included residents, non-government organizations, community groups, dischargers that were not named in the SIYB TMDL, and other interested members of the public. Stakeholder input was sought during stakeholder meetings and comment periods. Stakeholders invited to participate in the public advisory process included the following (listed alphabetically):

- Department of Pesticide Regulation
- Department of Toxic Substances Control
- Non-SIYB marinas
- Paint manufacturers
- Port Tenants Association
- Regional Board
- San Diego Bay boaters
- San Diego Bay boatyards
- San Diego Coastkeeper
- San Diego Bay hull cleaners
- Scripps Institute of Oceanography
- U.S. Navy

1.3 Plan Objective

The objective of the Implementation Plan is to achieve a reduction in copper loading into SIYB, resulting in a water-column concentration that is protective of MAR and WILD beneficial uses, as directed by the SIYB TMDL. Loading reductions will be achieved through conversion of vessels to non-copper and low-copper hull paints, reductions of inputs via hull cleaning, and

control of watershed inputs. Key measures to achieve compliance with TMDL interim and final loading objectives include:

- Implementing an adaptive approach to reducing copper loading into SIYB.
- Identifying antifouling hull coatings that substantially reduce or eliminate copper release into the water column.
- Establishing a basin-wide vessel hull paint conversion tracking program to assess loading reductions.
- Establishing a basin-wide water quality monitoring program to assess trends in dissolved copper concentrations and toxicity.
- Defining application procedures and certification standards for boatyards to properly apply non-copper antifouling coatings.
- Identifying in-water hull cleaning standards.
- Implementing boater education and outreach programs.
- Creating incentive programs for boaters and/or boatyards to apply and properly maintain non-copper hull paints.

1.4 Implementation Approach

The Implementation Plan takes a solutions-oriented strategy of establishing BMPs that directly and indirectly reduce copper loading into SIYB to comply with interim and final dissolved copper loading thresholds. This plan was designed to be consistent with the findings of the SIYB TMDL[2], and has integrated the loading allocations and assumptions of the TMDL into the implementation and assessment approaches. Additionally, this plan incorporates an adaptive management model of planning, implementation, and assessment (Figure 1-1).

[2] Special studies will be implemented to further refine and assess findings and assumptions of the TMDL.

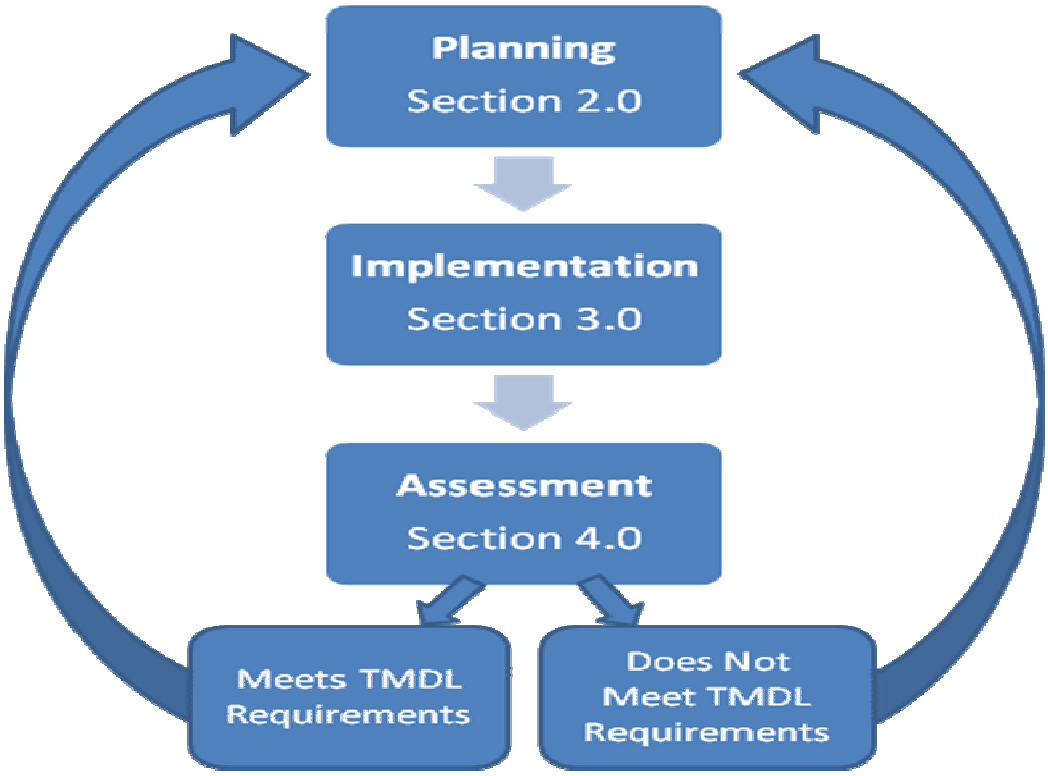

Figure 1-1. SIYB TMDL Implementation Plan Adaptive Management Approach

Planning includes the development of the Implementation Plan, which specifies the individual and coordinated efforts Named Parties will employ to reduce copper loading, track loading reductions, and monitor water quality improvements. Implementation consists of a flexible program that allows Named Parties to select BMPs that range from voluntary (e.g., education and incentives) to policy-driven measures (e.g., lease agreements, policies, and regulations). Assessment includes evaluations of compliance with the TMDL interim and final loading reduction targets through a basin-wide tracking program that quantifies the transition of vessels moored within SIYB from copper to non-copper and low-copper hull paints. Assessment also includes annual water quality monitoring and toxicity testing to track long-term trends in water quality and eventual attainment of final water quality numeric and narrative objectives.

2.0 PLANNING

This section describes the process the Named Parties used to develop the implementation strategy, inclusive of individual and coordinated efforts. The initial planning effort consisted of developing an approach to identify, prioritize, and plan the implementation of BMPs to meet dissolved copper loading reduction requirements of the SIYB TMDL. As such, it was determined that establishing a suite of individual and joint efforts would increase the likelihood that TMDL compliance will be achieved basin wide. As required in the Investigative Order, Named Parties are responsible for annually reporting the BMPs or other actions that have been implemented to reduce dissolved copper loads to the basin. Named Parties have the option of developing individual workplans that identify the BMPs they plan to implement to achieve loading reductions, including implementation schedules, assessment mechanisms, and effectiveness targets. During this phase, coordinated efforts were identified that include (1) a basin-wide vessel tracking program to quantify loading reductions based on conversions of vessels from copper to non-copper and low-copper paints and (2) a basin-wide water quality monitoring program that quantifies dissolved copper levels and toxicity. Both the vessel tracking and water quality monitoring program comply with the requirements of Investigative Order.

2.1 Cooperation among Named Parties

All of the Named Parties undertaking activities in SIYB have a responsibility to reduce pollutants that discharge or have the potential to discharge from their facility or actions. While each party named in the SIYB TMDL is responsible for ensuring their individual compliance under the TMDL, it is recognized that basin-wide compliance may be best achieved through cooperative efforts. Additionally, coordination of certain key elements may result in cost savings for all parties involved.

Showing basin-wide compliance for both interim and final TMDL loading reduction targets requires that Named Parties provide information on vessel hull conversions from copper-based to non-copper and low-copper hull paints (i.e., vessel tracking data). Named Parties have agreed on the tracking data to be collected, compiled, and submitted in order to meet TMDL reporting requirements as established in the Investigative Order. Similarly, water quality monitoring efforts will be conducted using a basin-wide approach that also complies with the Investigative Order requirements. The Named Parties will facilitate the collection of monitoring data within their leaseholds, when applicable.

2.2 Roles and Responsibilities of Each Named Party

The roles and responsibilities of Named Parties in implementing collective efforts are described in Table 2-1. The Port will serve as the technical lead of the Implementation Plan, inclusive of the tracking program, basin-wide water quality monitoring, and Port-led special studies. For these efforts, the Port will provide overall project management, coordination of technical studies, and submittal of annual monitoring and progress reports to the Regional Board as required by the Investigative Order. Named Parties who moor vessels or operate facilities for individual boat owners who moor vessels in SIYB will maintain records on the hull paints of all vessels within

their facility and the percent of time vessels are moored in their facilities (to the extent practicable) between January 1 to December 31 and will provide this information to the Port on an annual basis no later than January 15 for inclusion in the vessel tracking report to the Regional Board.

Table 2-1. Roles and Responsibilities for Collective Efforts by Named Party

Roles & Responsibilities	Port	Marinas & Yacht Clubs	Individual Boat Owners	Hull Cleaners	City
Tracking Program Development and Assessment	Lead	X	X		
Water Quality Monitoring	Lead	1			
MS4 Discharge Monitoring					Lead
Special Studies	Lead				X
Hull Cleaning BMPs & Certification Development	Lead	X		X	

1 Marina and yacht club owner/operators are to provide access to leaseholds, where applicable.

As required in the Investigative Order, Named Parties will be required to identify and describe the BMPs implemented to reduce dissolved copper discharges to SIYB (Table 2-2). For the purposes of the Implementation Plan, BMPs are defined as those actions or projects that indirectly or directly contribute to dissolved copper load reductions and/or water quality improvements. Named Parties will have the option of preparing individual workplans that describe, assess, and report on the BMPs, activities, and efforts they have selected or intend to use to comply with the staged load reduction targets. Named Parties will then annually report to the Port the BMPs and actions implemented to reduce dissolved copper loads to SIYB in compliance with Investigative Order reporting requirements.

Table 2-2. Roles and Responsibilities for Individual Efforts by Named Party

Roles & Responsibilities	Port	Marinas & Yacht Clubs	Individual Boat Owners	Hull Cleaners	City	Schedule
Identify BMPs	X	X	N/A	X	X	Begin Immediately
Develop Individual Workplans	X	X	N/A	X	X	Optional
Implement BMPs	X	X	N/A	X	X	Begin Immediately
Report on BMPs Implemented	X	X	N/A	X	X	Annually

2.2.1 Establishment of Individual Workplans

Each Named Party has the option of developing individual workplans. A workplan template is provided in Appendix B that details the BMPs to be implemented, the schedule for implementation, the desired outcome of BMPs, methods of assessing BMP effectiveness, and measures to be taken in the event that BMPs are not achieving desired outcomes. An "Implementation Tracking Matrix" developed by the San Diego Yacht Club is also provided in Appendix B.

The purpose of a workplan is to identify the BMPs to be implemented and to define the implementation schedule for each activity. The implementation of activities will be scheduled to achieve interim and final loading targets in compliance with the TMDL.

Workplans may include the following key components:

- BMP Description: The description will detail the objectives and scope of the BMP to be implemented.
- Implementation Schedule: The workplan has been divided into Stages 2-4 of the compliance schedule period (2007-2012, 2012-2017, and 2017-2022). Named Parties will schedule the implementation of BMPs to achieve the 10%, 40%, and 76% interim loading targets or water quality conditions that are protective of SIYB beneficial uses.
- BMP Purpose(s): Each BMP will have a specific purpose or will have at least one answerable, focused study question to frame its development, implementation, and assessment.
- Assessment Mechanism(s): Named Parties will define mechanisms to assess the effectiveness of BMPs (e.g., numbers of boaters contacted during education and outreach events).
- Targeted Outcome(s): The ultimate outcome is to achieve water quality conditions that are protective of beneficial uses in SIYB. BMPs will have defined goals and objectives towards achieving these outcomes (e.g., number of vessels to be converted to achieve dissolved copper loading reduction targets). These targets will become the basis for assessing the effectiveness of activities.

2.2.2 Establishment of Collective Tracking Efforts

Given the principal importance of anti-fouling paints to WQO exceedances, the main assessment of loading reductions will be tracking conversions of hull paints from copper to non-copper and low-copper paints for vessels moored within SIYB. The vessel tracking program will quantify both reductions in loading from passive leaching and hull cleaning. Named Parties will be responsible for instituting a tracking program to determine the number of vessels with copper, non-copper, and low-copper hull paints and the percentages of time that vessels are moored within SIYB. This will provide a direct, cost-effective measure of basin-wide annual loading, as well as loading reduction. Vessel tracking is described in greater detail in Section 4.2.1.

2.2.3 Establishment of Collective Monitoring Efforts

The Port will be responsible for the implementation of the water quality monitoring program, as well as the analysis and reporting of findings to assess basin-wide water quality conditions. The other Named Parties will facilitate the collection of monitoring data within their leasehold, when applicable. Water quality monitoring is described in greater detail in Section 4.2.2.

3.0 IMPLEMENTATION

This section defines how Named Parties can identify, select, and implement appropriate BMPs to meet SIYB TMDL interim and final loading reduction targets and/or water quality conditions that are protective of SIYB beneficial uses. Named Parties have the option of implementing BMPs, ranging from voluntary to more prescriptive measures, based on site-specific parameters and individual and collective effectiveness assessments. For the purposes of this Implementation Plan, BMPs are defined to be those actions or projects that directly or indirectly result in dissolved copper load reductions and/or water quality improvements.

3.1 Types of BMPs

Table 3-1 describes categories of BMPs that may be used by the Named Parties. This list in no way is intended to limit the BMPs that Named Parties may use to achieve TMDL goals. Named Parties may identify and implement other activities or BMPs if desired. Using the adaptive management approach developed in this Implementation Plan, it is anticipated that this list will be modified over the 17-year compliance schedule. A more detailed list of potential BMPs can be found in Appendix D of the Regional Harbor Monitoring Program (RHMP) Copper Literature Review and Biotic Ligand Model Analysis Report (WESTON, 2011a).

Table 3-1. Best Management Practices

Category	Description
Hull Paint Transition	Efforts that result in the transitioning of boats from copper to low-copper or non-copper paints and/or track hull paint transitions. This category will also include projects or activities designed to identify non-copper and low-copper hull paints available for making the transition. Activities could be individual or collective efforts. Examples of activities fitting into this category include, but are not limited to: • Developing schedules for boat transition and implementing boat transitions. • Developing data tracking mechanisms to track hull-paint transition. • Partnering with boatyards to track boat transition efforts • Implementing a "Green Boater" certification program with a criterion of using non-copper and low-copper antifouling paints.
Hull Cleaning	Measures taken to minimize copper inputs during in-water hull cleaning activities. In general, most activities in this category would be conducted by hull cleaners or individual boat owners. This category does not include education on hull cleaning, which would be best categorized under Education/Outreach. It may include implementation of a hull cleaner certification program to reduce loading from hull cleaning activities.
Structural and Mechanical BMP Implementation	Efforts to minimize inputs of pollutants through source/treatment controls for land-based and marine operations. Some examples include, but are not limited to: • Storm drain filters in parking lot storm drains. • Regularly sweeping parking lots. • Slip liners for boats. • Alternative small boat storage methods. Also included in this category would be facilities undergoing redevelopment that triggers Standard Urban Stormwater Mitigation Plan (SUSMP) compliance and the identification of the BMPs installed as part of the SUSMP process.
Grant Funding/ Incentives	Incentives include the projects or activities designed to encourage a voluntary transition by providing either monetary or preferential treatment options. These efforts could be undertaken by single or multiple entities. Examples include, but are not limited to: • Offering funding for boaters to switch to non-copper hull paint. • Preferred slip options or slip fee discounts for boaters using non-copper hull paints. • Grant submittals seeking hull paint transition funding may also be included here.
Education/ Outreach	Efforts to provide education to marinas, boatyards, boaters, staff, hull cleaners and the general public. Topics can include general information about water quality problems, the local copper hull paint issue, or other copper related topics around the state. Specific education elements could consist of workshops or events identifying what boaters can do to transition to available

Category	Description
	non-copper or low-copper hull paint alternatives, or specific practices/limitations occurring within a marina/yacht club. As with all education/outreach, it is important to have a metric to gauge the project's effectiveness, such as whether it improved the target audience's understanding or resulted in having boaters transition to non-copper and low-copper hull paints.
Alternative Hull Paint Studies	The Port and marina owners/operators may coordinate and oversee commercial and scientific special studies. Demonstration special studies by commercial entities may confirm and demonstrate the efficacy and longevity of available nontoxic and less toxic boat hull coating products. These studies would allow boat repair yards and underwater hull cleaners the opportunity to develop expertise and acquire special equipment needed for the application and maintenance of nontoxic and less toxic boat hull coatings.
Monitoring	Monitoring conducted for TMDL compliance and for the purposes of assessing BMPs, refining site conditions, or furthering the understanding of water-sediment-toxicity interactions. Monitoring efforts may be conducted by a single entity or by several entities. Examples include assessing contributions of hull cleaning efforts, evaluating conditions for site specific objectives, and identifying the contributions to or from sediments.
Reporting	Includes TMDL compliance reporting and reporting of any special studies or investigations relating to hull paint or copper water quality issues. Reports could be collective efforts or they could be individual reports. Results of tracking vessel transitions to non-copper and low-copper hull paints would also be identified in this category.
Lease Updates	Lease updates may include efforts to require boaters to provide information, structured slip fees based on the presence/absence of copper paints, or updates to lease language to reflect current policy or regulations. It could also include timelines or schedules for updating leases to include more stringent language relating to copper-based hull paints.
Policy/ Regulation	Limitations or restrictions on the inputs of copper to the water. Polices can be specific to sources and activities, or policies can be broad phase-out based options. Policies may include: • Limitations to hull cleaning. • Leasehold agreements. • Restrictions on the use of copper paints.

3.2 BMP Selection and Implementation

The types of BMPs applicable to each Named Party are presented in Table 3-2. The activities defined in Table 3-1 will aid Named Parties in BMP selection and development of individual workplans, if desired. BMP selection will consider desired outcomes of actions, mechanisms for assessing success, and modifications and alternative actions to be taken if success criteria are not achieved.

Table 3-2. Applicability of BMPs to Named Parties

Type of BMP	Port	Marinas & Yacht Clubs	Individual Boat Owners	Hull Cleaners	City of San Diego
Hull Paint Transition	X	X	X	X	
Hull Cleaning	X	X	X	X	
Structural & Mechanical BMP Implementation	X	X	X	X	X
Grant Funding / Incentives	X	X		X	X
Education & Outreach	X	X		X	X
Alternative Hull Paint Studies	X	X	X	X	X
Monitoring	X	X		X	X
Reporting	X	X		X	X
Lease Updates	X	X	X		
Policy / Regulation	X	X			X

Named Parties will have the option of selecting from BMPs that range from voluntary actions (e.g., education and outreach) to prescriptive actions (e.g., enactment of policies and regulations). It is anticipated that voluntary efforts will achieve the interim loading target of a 10% reduction by 2012. The individual and collective assessments implemented by the Named Parties will identify the most effective suite of activities needed to achieve loading allocations. If voluntary measures are not sufficient to meet loading reduction targets, Named Parties may progressively pilot and implement more stringent measures, such as lease updates and policies limiting use of copper-based antifouling paints, to achieve target loading allocations.

4.0 ASSESSMENT

Assessment includes individual efforts to determine BMP effectiveness and collective efforts to verify TMDL compliance with interim and final loading allocations. Collective assessments include vessel hull paint conversion tracking to quantify loading reductions and water quality monitoring to assess trends in water quality.

The assessment process follows the flow chart presented in Figure 4-1. Named Parties may use this process as a guide for developing activity-specific assessment programs for their individual workplans and collective tracking and monitoring studies.

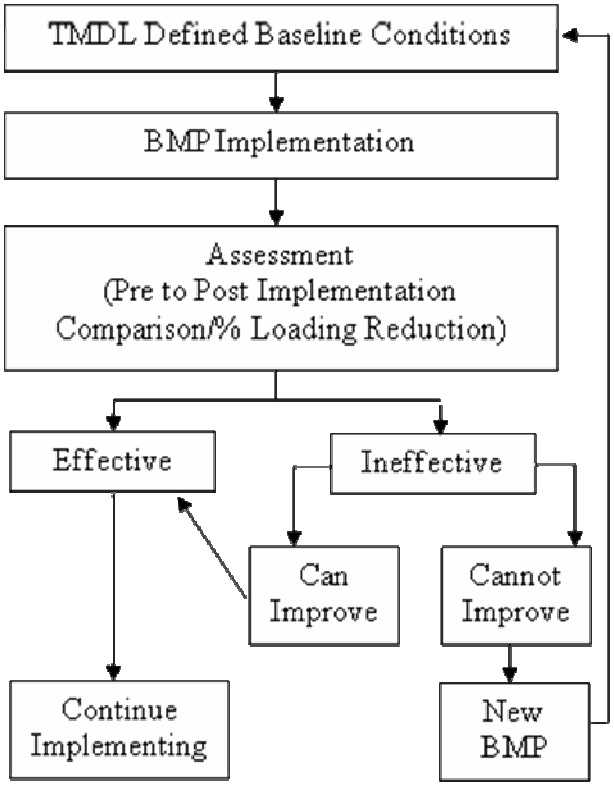

Figure 4-1. Effectiveness Assessment Process

Key elements of assessment include:

1) **Defining Baseline Conditions –** The SIYB TMDL defines the baseline dissolved copper loading to SIYB. Baseline dissolved copper water quality conditions were established using recent water quality monitoring studies performed in SIYB during the 2005-2008 RHMP surveys (WESTON, 2008 and 2010) and during 2006 and 2007 by Neira et al. (2009), as detailed in the SIYB TMDL Monitoring Plan.
2) **BMP Implementation** – Each Named Party will determine the implementation process for individual BMPs.

3) **Assessment** – Assessment may involve cooperative tracking, water quality monitoring, and/or other evaluations specific to the activity under assessment. Pre- and post-BMP implementation conditions will be compared to determine effectiveness.
    a. **Effective** – If the BMP achieves the desired targeted outcome(s), implementation may be continued and other Named Parties may choose to implement elsewhere, as appropriate.

    b. **Ineffective** – If the BMP as implemented cannot achieve the defined targeted outcome(s), the activity will be assessed for improvement opportunities. If the BMP can be modified to achieve the targeted outcome(s), the Named Party may choose to implement the practice with refinements (if necessary). If not, the Named Party may elect to discontinue the BMP and implement another.

4.1 Individual Assessment

Named Parties, including the Port, the City, SIYB marina and yacht club owners/operators, and SIYB underwater hull cleaners will document the actions implemented to reduce dissolved copper loads to SIYB and/or achieve WQOs and beneficial uses in accordance with the requirement of the Investigative Order.

To assess BMP effectiveness, Named Parties will have the option of using pre- and post-implementation assessments to determine the effectiveness of BMPs in achieving desired outcomes (e.g., increases in public awareness, development of non-copper and low-copper coatings, load reductions, and water quality improvements). Additionally, Named Parties will have the option of assessing individual reductions in loading due to conversion of vessels within their facilities to non-copper or low-copper paints or the enactment of BMPs that reduce inputs due to hull cleaning. Management questions and assessment mechanisms that can be used to quantify BMP effectiveness are presented in Appendix C.

4.2 Basin-Wide Assessments

Since TMDL compliance must be achieved basin-wide to ensure restoration and protection of beneficial uses, assessment of loading reductions must also be performed basin-wide. Assessment of TMDL compliance will be accomplished through basin-wide tracking of conversion of vessels from copper to non-copper and low-copper hull paints. Basin-wide water quality monitoring will track long-term trends in dissolved copper levels and toxicity. Summaries of basin-wide efforts are provided in the following sections. A more detailed discussion is presented in the SIYB TMDL Monitoring Plan.

4.2.1 Vessel Tracking

Tracking of vessel conversions from copper to non-copper and low-copper hull paints will be used to assess annual dissolved copper loading reductions. This will involve collection of vessel

conversion data from which annual dissolved copper loads and loading reductions will be calculated.

4.2.1.1 Data Collection

Named Parties operating facilities that aggregate vessels in SIYB (i.e., marina and yacht club owners and operators) will be responsible for collecting and submitting the following vessel tracking data to the Port on an annual basis (Table 4-1). These Named Parties will collect, maintain, and submit tracking information annually by January 15 to the Port in a standardized format for inclusion in annual monitoring and progress reports to the Regional Board.

Table 4-1. Required Vessel Tracking Data

Element	Vessel Tracking Data
1	Name of marina or yacht club
2	Date of report
3	Total number of slips or buoys in facility available to be occupied by vessels
4	Slip/mooring occupation data
4a	Percent of time unoccupied
4b	Percent of time occupied by vessel(s) with known copper hull paint
4c	Percent of time occupied by vessel(s) with documented low-copper hull paint
4d	Percent of time occupied by vessel(s) with documented non-copper hull paint
5	Vessel-specific information
5a	Document or registration numbers of vessels moored in slips/moorings
5b	Vessel type (sail, power, multi-hull, etc.)
5c	Vessel length
5d	Vessel beam width

As a data quality assurance/quality control and confirmation check, additional information on paint type and application will be required for vessels reported to have low-copper (less than 40% copper) or non-copper hull paints (Table 4-2).

Table 4-2. Required Low-Copper and Non-Copper Hull Paint Vessel Data

Element	Low-Copper and Non-Copper Vessel Hull Paint Confirmation Data
1	Vessel document or registration number
2	Hull paint name
3	Product number
4	Name of boatyard that applied paint
5	Painting date
6	Percent copper if low-copper hull paint is indicated

The Port will compile the vessel tracking data from SIYB marinas and yacht clubs to report on the percent of time that slips are unoccupied or are occupied by vessels with copper, low-copper, non-copper, or unknown hull paints as required by the Investigative Order (Table 4-3). This data will be used to calculate the annual dissolved copper load to SIYB from vessels, the number of vessels converted from copper to low-copper or non-copper hull paints, and the reduction in dissolved copper loading achieved annually.

Table 4-3. Investigative Order Required Vessel Tracking Data to be Reported Annually

Element	Vessel Tracking Data
1	Total number of slips or buoys in facility available to be occupied by vessels
2	Number of unoccupied slips or buoys and length of time unoccupied during each year
3	Number of vessels confirmed with copper-based hull paints and approximate length of time occupying a slip or buoy in facility each year
4	Number of vessels confirmed with alternative hull paints, by hull paint type, and approximate length of time occupying a slip or buoy in facility each year
5	Number of vessels with unconfirmed information about hull paints and approximate length of time occupying a slip or buoy in facility each year
6	Estimate of the dissolved copper load reduction achieved for the year (kg/yr and %)

4.2.1.2 Assessment of Annual Dissolved Copper Loading Reductions

Compliance with interim and final TMDL loading reduction goals will be assessed through basin-wide vessel tracking. Tracking of vessel conversions from copper-based to non-copper or low-copper (i.e., less than 40% copper) hull paints, as well as permanent slip and mooring conversions, will be used to calculate annual dissolved copper loading reductions. This assessment incorporates the following assumptions used by the Regional Board in determining loading allocations (Regional Board 2005, Appendix 2).

- All 2,363 SIYB slips or buoys were occupied by vessels (N_v).
- All 2,363 recreational vessels moored within SIYB have copper-based paints.
- Annual loading from passive leaching basin wide (L_p) equals 2000 kg/year.
- Annual loading from hull cleaning (L_h) equals100 kg/yr.
- Avg. annual loading (L_v) per vessel equals 0.9 kg/yr. Where $L_v = (L_p + L_h)/N_v$.

Based on the Regional Board assumptions in determining dissolved copper loading via passive leaching and hull cleaning combined, there will be an average loading reduction of 0.9 kg/yr for every vessel in SIYB that converts from copper to non-copper hull paints. The use of low-copper hull paints (i.e., hull coatings with less than 40% copper) also was recognized in the TMDL as a viable means of reducing copper loading to the basin. The loading reduction analysis assumes that each vessel transitioned to low-copper hull paints on average will reduce annual dissolved copper loading by 0.45 kg/yr. Thus, annual dissolved copper loading reductions will be based on the following assumptions (Table 4-4).

Table 4-4. Dissolved Copper Loading Calculation Assumptions

Dissolved Copper Loading Assumptions
1. All vessels moored in SIYB at the enactment of the TMDL had copper hull paints.
2. Average annual dissolved copper load from a vessel with copper paint equals 0.9 kg/yr.
3. Vessels with unknown hull paints will be assumed to have copper.
4. Annual dissolved copper load from a vessel with non-copper hull paint equals 0 kg/yr.
5. Low copper hull paints include paints with less than 40% copper.
6. Average annual dissolved copper load from a vessel with low-copper paint equals 0.45 kg/yr.

7. Annual loads will be normalized by the percent of time vessels are in SIYB.

The achievement of interim and final loading targets along with overall TMDL compliance will be dependent on reductions in the number of vessels with copper-based hull paints. In completing the source analysis, the Regional Board assumed that 100% of recreational boats in SIYB used copper-based paints (Regional Board, 2005); therefore, any reported reduction in the number of boats with copper-based paints would equate to a nearly directly proportional decline in copper loading into the water column. The following schedule provides an estimate of the number vessels to be converted from copper-based to non-copper-based paints in order to meet interim and final loading targets (Table 4-5).

Table 4-5. Vessel Hull Paint Conversion Schedule to Meet Loading Targets

Stage	Time Period	Percent Reduction from Current Estimated Loading	Reduction to be Attained by End of Year	Estimated Interim Target Loading (kg/yr)	Annual Loading Reduction Target (kg/yr)	Reduction in Vessels with Copper Paints to Achieve Loading Target[1]
1	2005-2007	0%	N/A	2,163	0	0
2	2007-2012	10%	7	1,900	263	292
3	2012-2017	40%	12	1,300	863	959
4	2017-2022	76%	17	567	1,596	1,773

[1] Vessel reductions based on average-sized 40-ft vessel converted to non-copper hull paints (i.e., 0.9 kg/yr/vessel) loading reduction, as assumed by SIYB TMDL Technical Report

4.2.2 Monitoring

The purpose for conducting water quality monitoring within SIYB is to document improvements in water quality conditions. Monitoring for this project will include annual water quality assessments of copper levels and toxicity; storm drain monitoring by the City; and monitoring of a broader range of water-column, sediment, and biotic indicators throughout San Diego Bay by the Port and City on a 5-year basis through integration with the RHMP. This information will be used to assess long-term trends in water quality in SIYB. A summary of monitoring programs is presented below.

4.2.2.1 Water Quality Monitoring

Water quality monitoring will be conducted throughout SIYB to assess basin-wide trends in dissolved copper concentrations and toxicity. The monitoring will be conducted using methods consistent with the prior Regional Board studies in SIYB used to establish baseline copper levels and loading reduction requirements of the TMDL (Appendix 6; Regional Board, 2005). In 2000, the Regional Board surveyed six stations within SIYB to determine the average basin-wide concentration (5.45 µg/L) and maximum concentration (8.0 µg/L). By multiplying the chronic WQO (3.1 µg/L) by the ratio of the average concentration to the maximum concentration, the target basin-wide dissolved copper concentration (2.11 µg/L) was established. To be consistent with studies conducted by the Regional Board, this monitoring program will use a similarly placed sampling grid consisting of six stations and one reference station in the main channel of

San Diego Bay adjacent to SIYB. These station locations meet the Investigative Order requirement of being spatially representative of dissolved copper concentrations in SIYB, as described in the Monitoring Plan.

Sampling will be conducted once per year during the summer (i.e., August), and will include analyses of water column chemistry and toxicity as described in detail in the Monitoring Plan. Annual monitoring during the summer will facilitate integration with RHMP, which includes sampling once every five years during summer to determine the general health of San Diego Bay, as well as other San Diego region embayments. Performing annual sampling at the same station locations each summer will allow for repeated measures and temporal trend analyses to determine changes in dissolved copper concentrations with time. Additionally, as BMPs are implemented (e.g., conversion of vessels with copper-based hull paints to non-copper-based hull paints), correlation analyses can be used to assess BMP effectiveness in reducing dissolved copper concentrations within the water column.

4.2.2.2 Storm Drain Sampling

The City, as a Named Party under the TMDL, is responsible for the urban runoff contribution to SIYB from the MS4. From 2008-2011, wet and dry weather monitoring of the three City MS4s was conducted by the City to empirically quantify dissolved copper loading from urban runoff to SIYB (WESTON, 2011b). Dissolved copper loads to SIYB were modeled using dissolved copper concentration and flow data. Results indicated that dissolved copper loading was well below the TMDL estimates of 1% of the total load to the SIYB. The total annual dissolved copper load from all three outfalls into SIYB was calculated to be 3.67 kg/yr, inclusive of wet and dry weather loads.

During subsequent years, the City will continue to implement dry and wet weather monitoring to evaluate if runoff inputs and loads are in compliance with the 30 kg/year load allocation, subject to the availability of funds.

4.2.2.3 Integration with Regional Harbor Monitoring Program

SIYB TMDL water quality monitoring will be integrated with the RHMP. This regional program is performed on a five-year cycle concurrently with Southern California Bight Regional Monitoring Studies. The RHMP assesses a much wider array of conditions, including water quality, sediment chemistry, sediment toxicity, and benthic infaunal analyses. By conducting the broader suite of analyses, the RHMP will be able to not only assess copper impacts, but also assess the accumulation of other potential contaminants that may be contributed by non-copper-paints. Furthermore, integration with the RHMP core monitoring will allow for assessments of MAR and WILD beneficial uses within SIYB. The RHMP core monitoring program will be conducted in 2013 and again in 2018.

4.3 Special Studies

During the course of the SIYB TMDL, special studies will be conducted to further the understanding of available non-copper and low-copper hull paints, BMP effectiveness, and the physical and chemical conditions within SIYB that affect copper impacts on MAR and WILD

beneficial uses. These studies will provide data needed to verify or refine assumptions, resolve uncertainties, and improve the scientific foundation of the TMDL. As a component of the RHMP, the Port and the City will conduct special studies that further investigate copper toxicity, bioavailability, and fate and transport in SIYB. The Port is also leading special studies to assess new and emerging non-copper boat hull paints (Appendix D).

5.0 Reporting

Reporting under the SIYB TMDL will include annual Monitoring and Progress Reports to be submitted to the Regional Board by the Port no later than March 31 of each year, beginning on March 31, 2012. Monitoring and Progress Reports will contain information on SIYB TMDL Implementation (i.e., BMP implementation, vessel conversion, and associated annual loading reduction), San Diego Bay-wide BMP implementation, and SIYB TMDL monitoring (i.e., water quality monitoring results, water quality trends, and as-needed conceptual model updates), as required by the Investigative Order. A more thorough description of the vessel tracking and water quality monitoring reporting elements are provided in the SIYB TMDL Monitoring Plan.

6.0 References

California Regional Water Quality Control Board, San Diego Region (Regional Board). 1994. Water Quality Control Plan for San Diego Basin – Region 9 (Basin Plan).

California Regional Water Quality Control Board, San Diego Region (Regional Board). 2005. Total Maximum Daily Load for Dissolved Copper in Shelter Island Yacht Basin, San Diego Bay. Resolution No. R9-2005-0019. Basin Plan Amendment and Technical Report.

U.S. Environmental Protection Agency (USEPA). 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California. Federal Register. Vol. 65. No. 97. May 18, 2000. Rules and Regulations.

Weston Solutions, Inc. (WESTON). 2011a. Regional Harbor Monitoring Program Copper Literature Review & Biotic Ligand Model. Prepared for the Port of San Diego, City of San Diego, City of Oceanside, and County of Orange. May 2011.

Weston Solutions, Inc. (WESTON). 2011b. Shelter Island Copper TMDL Final Monitoring Report. Prepared for the City of San Diego. April 2011.

APPENDIX A

Summary of Roles and Responsibilities for Named Parties

Summary of Roles and Responsibilities for Named Parties

The Shelter Island Yacht Basin (SIYB) Dissolved Copper Total Maximum Daily Load (TMDL) was adopted by the San Diego Regional Water Quality Control Board (Regional Board) to identify and implement actions to reduce dissolved copper loads to SIYB to attain numeric (3.1 µg/L) and narrative water quality objectives (WQOs) (Regional Board, 2005). According to the TMDL, the primary source of dissolved copper to SIYB was determined to be antifouling hull paints of vessels, which contributed 98% (2,100 kg/yr) of the total annual load via passive leaching and in-water hull cleaning. The TMDL provided a compliance schedule for reducing annual loads to SIYB in four stages (Table A-1), and listed the Named Parties responsible for discharges, including:

- The Port of San Diego (Port);
- SIYB marina and yacht club owners/operators;
- Persons owning boats in SIYB; and
- SIYB underwater hull cleaners.

Additionally, the City of San Diego (City) was listed for discharges from municipal separate storm sewer systems (MS4s) to SIYB, totaling 1% (30 kg/yr) of the total annual load. All other loads were attributed to background inputs from San Diego Bay and atmospheric deposition.

Table A-1. Interim and Final Loading Targets for TMDL Attainment

Stage	Time Period	Percent Reduction from Current Estimated Loading	Reduction to be Attained by end of Year	Estimated Interim Target Loading (kg/yr of Dissolved Copper)
1	2005-2007	0%	N/A	N/A
2	2007-2012	10%	7	1,900
3	2012-2017	40%	12	1,300
4	2017-2022	76%	17	567

The Port, in coordination with the other Named Parties, developed the SIYB TMDL Implementation Plan to detail the adaptive management approach for reducing copper loading to the basin in order to obtain water quality conditions that are protective of the most sensitive SIYB beneficial uses – marine habitat (MAR) and wildlife habitat (WILD). According to the Implementation Plan, Named Parties will implement best management practices (BMPs) that both directly and indirectly reduce copper loads to SIYB in compliance with the TMDL interim and final loading reduction targets or until WQOs are obtained. Assessment of loading reductions will primarily be determined through tracking of vessel conversions from copper to non-copper and low-copper (less than 40% copper) hull paints. Water quality assessments will be accomplished through annual monitoring of dissolved copper concentrations and toxicity using a monitoring network of six stations that are representative of dissolved copper concentrations in SIYB waters and one reference station located in the main channel of San Diego Bay.

This appendix summarizes the roles and responsibilities of the Named Parties to implement their required efforts under the TMDL as detailed in the SIYB TMDL Implementation Plan. Potential BMPs and their applicability to the various Named Parties are presented in Tables A-2 and A-3, respectively.

Table A-2. Potential Best Management Practices

Category	Description
Hull Paint Transition	Efforts that result in the transitioning of boats from copper to low-copper or non-copper paints and/or track hull paint transitions. This category will also include projects or activities designed to identify non-copper and low-copper hull paints available for making the transition. Activities could be individual or collective efforts. Examples of activities fitting into this category include, but are not limited to: • Developing schedules for boat transition and implementing boat transitions. • Developing data tracking mechanisms to track hull-paint transition. • Partnering with boatyards to track boat transition efforts • Implementing a "Green Boater" certification program with a criterion of using non-copper and low-copper antifouling paints.
Hull Cleaning	Measures taken to minimize copper inputs during in-water hull cleaning activities. In general, most activities in this category would be conducted by hull cleaners or individual boat owners. This category does not include education on hull cleaning, which would be best categorized under Education/Outreach. It may include implementation of a hull cleaner certification program to reduce loading from hull cleaning activities.
Structural and Mechanical BMP Implementation	Efforts to minimize inputs of pollutants through source/treatment controls for land-based and marine operations. Some examples include, but are not limited to: • Storm drain filters in parking lot storm drains. • Regularly sweeping parking lots. • Slip liners for boats. • Alternative small boat storage methods. Also included in this category would be facilities undergoing redevelopment that triggers Standard Urban Stormwater Mitigation Plan (SUSMP) compliance and the identification of the BMPs installed as part of the SUSMP process.
Grant Funding/ Incentives	Incentives include the projects or activities designed to encourage a voluntary transition by providing either monetary or preferential treatment options. These efforts could be undertaken by single or multiple entities. Examples include, but are not limited to: • Offering funding for boaters to switch to non-copper hull paint. • Preferred slip options or slip fee discounts for boaters using non-copper hull paints. • Grant submittals seeking hull paint transition funding may also be included here.
Education/ Outreach	Efforts to provide education to marinas, boatyards, boaters, staff, hull cleaners and the general public. Topics can include general information about water

Category	Description
	quality problems, the local copper hull paint issue, or other copper related topics around the state. Specific education elements could consist of workshops or events identifying what boaters can do to transition to available non-copper or low-copper hull paint alternatives, or specific practices/limitations occurring within a marina/yacht club. As with all education/outreach, it is important to have a metric to gauge the project's effectiveness, such as whether it improved the target audience's understanding or resulted in having boaters transition to non-copper and low-copper hull paints.
Alternative Hull Paint Studies	The Port and marina owners/operators may coordinate and oversee commercial and scientific special studies. Demonstration special studies by commercial entities may confirm and demonstrate the efficacy and longevity of available nontoxic and less toxic boat hull coating products. These studies would allow boat repair yards and underwater hull cleaners the opportunity to develop expertise and acquire special equipment needed for the application and maintenance of nontoxic and less toxic boat hull coatings.
Monitoring	Monitoring conducted for TMDL compliance and for the purposes of assessing BMPs, refining site conditions, or furthering the understanding of water-sediment-toxicity interactions. Monitoring efforts may be conducted by a single entity or by several entities. Examples include assessing contributions of hull cleaning efforts, evaluating conditions for site specific objectives, and identifying the contributions to or from sediments.
Reporting	Includes TMDL compliance reporting and reporting of any special studies or investigations relating to hull paint or copper water quality issues. Reports could be collective efforts or they could be individual reports. Results of tracking vessel transitions to non-copper and low-copper hull paints would also be identified in this category.
Lease Updates	Lease updates may include efforts to require boaters to provide information, structured slip fees based on the presence/absence of copper paints, or updates to lease language to reflect current policy or regulations. It could also include timelines or schedules for updating leases to include more stringent language relating to copper-based hull paints.
Policy/ Regulation	Limitations or restrictions on the inputs of copper to the water. Polices can be specific to sources and activities, or policies can be broad phase-out based options. Policies may include: • Limitations to hull cleaning. • Leasehold agreements. • Restrictions on the use of copper paints.

Table A-3. Applicability of BMPs to Named Parties

Type of BMP	Port	Marinas & Yacht Clubs	Individual Boat Owners	Hull Cleaners	City
Hull Paint Transition	X	X	X	X	
Hull Cleaning	X	X	X	X	
Structural & Mechanical BMP Implementation	X	X	X	X	X
Grant Funding / Incentives	X	X		X	X
Education & Outreach	X	X		X	X
Alternative Hull Paint Studies	X	X	X	X	X
Monitoring	X	X		X	X
Reporting	X	X		X	X
Lease Updates	X	X	X		
Policy / Regulation	X	X			X

A-1 Port of San Diego

In accordance with Investigative Order No. R9-2011-0036 issued to the Port by the Regional Board on March 11, 2011, the Port has the primary monitoring and reporting responsibility for the TMDL. As such, the Port is responsible for the development and submission of the Implementation Plan, Monitoring Plan, and annual monitoring and progress reports to the Regional Board. To accomplish these obligations, the Port will require that SIYB Named Parties, including marina and yacht club owners/operators, underwater hull cleaners, and boat owners, report the BMPs implemented to reduce dissolved copper loading to SIYB. Additionally, the Port will require that marina and yacht club owners/operators submit annual vessel tracking data no later than January 15 to the Port for inclusion in annual monitoring and progress reports to be submitted to the Regional Board by March 31.

The Port has prepared, with input from the other Named Parties, and submitted to the Regional Board this final Implementation Plan and Monitoring Plan. The Monitoring Plan includes a Quality Assurance Project Plan (QAPP), Conceptual Model, spatially representative water quality monitoring network, and characterization of baseline conditions using existing data and information, as required by the Investigative Order.

Each year, the Port will submit annual monitoring and progress reports on the following information:

- ***SIYB TMDL Implementation:*** Evaluation, interpretation, and tabulation of vessel conversions and BMPs implemented by Named Parties in SIYB to reduce dissolved copper discharges from boat hulls to SIYB.
- ***San Diego Bay-wide BMP Implementation:*** Description of BMPs that the Port has implemented or will implement to reduce dissolved copper loading in areas of San Diego Bay other than SIYB.

- ***SIYB TMDL Monitoring:*** Evaluation, interpretation, and tabulation of water quality monitoring data to determine trends in dissolved copper concentrations in SIYB waters and assessment of new data and studies that may refine or update the Conceptual Model.

The Port is responsible for the implementation of BMPs, such as conversion of Port vessels moored within SIYB to non-copper and low-copper hull paints, to facilitate the reduction of copper loading to SIYB in compliance with interim and final loading reduction targets. It has taken on the lead role in implementing special studies that include identification and testing of alternative non-copper hull paints, assessments of copper bioavailability and site-specific conditions that affect copper toxicity, and testing of copper flux from sediments. Additionally, the Port has secured 319(h) grant funds and is implementing a grant program to remove copper hull paints from vessels moored in SIYB to facilitate conversion to non-copper, non-biocide hull paints. It is also leading bay-wide efforts to certify in-water hull cleaners and has developed policies to encourage transitions away from copper hull paints. Lastly, the Port is supporting the development of state legislation that will phase out the use of copper paints on most recreational vessels in California.

A-2 Marina and Yacht Club Owners/Operators

As described in the Implementation Plan, SIYB marina and yacht club owners/operators have three responsibilities.

1. Implement BMPs that directly or indirectly result in dissolved copper loading reductions to SIYB in compliance with TMDL loading reduction targets. BMP implementation is to be continued until final loading reduction targets are achieved and/or water quality conditions protective of MAR and WILD beneficial uses are realized. Marina and Yacht Clubs can use the BMPs identified in Tables A-2 and A-3 to assist in selecting BMPs to implement. They may also elect to choose an activity that is not included in the table, but is believed to result in copper reductions. The choice to implement any of the BMPs is individual and left to the respective marina or yacht club's discretion. Elements to consider in BMP selection include implementation costs, staffing costs, feasibility and other factors that may influence the selection process.
2. Report BMPs implemented from January 1 to December 31to the Port no later than January 15 annually.
3. Track vessel hull paint data for vessels moored within marina and yacht club facilities from January 1 to December 31, and report vessel tracking data to the Port no later than January 15 annually. Marina and yacht club owner/operators will be required to provide the information presented in Table A-4 for all slips/moorings in their facilities. As a data quality assurance/quality control and confirmation check, additional information on paint type and application will be required for vessels reported to have low-copper (less than 40% copper) or non-copper hull paints (Table A-5)..

Table A-4. Required Vessel Tracking Data

Element	Vessel Tracking Data
1	Name of marina or yacht club
2	Date of report
3	Total number of slips or buoys in facility available to be occupied by vessels
4	Slip/mooring occupation data
4a	Percent of time unoccupied
4b	Percent of time occupied by vessel(s) with known copper hull paint
4c	Percent of time occupied by vessel(s) with documented low-copper hull paint
4d	Percent of time occupied by vessel(s) with documented non-copper hull paint
5	Vessel-specific information
5a	Document or registration numbers of vessels moored in slips/moorings
5b	Vessel type (sail, power, multi-hull, etc.)
5c	Vessel length
5d	Vessel beam width

Table A-5. Required Low-Copper and Non-Copper Hull Paint Vessel Data

Element	Low-Copper and Non-Copper Vessel Hull Paint Confirmation Data
1	Vessel document or registration number
2	Hull paint name
3	Product number
4	Name of boatyard that applied paint
5	Painting date
6	Percent copper if low-copper hull paint is indicated

A-3 In-Water Hull Cleaners

SIYB hull cleaners have two responsibilities under the Implementation Plan:

1. Implement BMPs to reduce copper loading from in-water hull cleaning to SIYB in compliance with the TMDL interim and final loading reduction schedule or until water quality conditions are obtained that are protective of SIYB beneficial uses. The choice to implement any of the BMPs is individual and left to the respective hull cleaner's discretion.
2. Report BMPs implemented from January 1 to December 31 to the Port annually no later than January 15.

A-4 Boat Owners

Persons owning boats moored in SIYB have two responsibilities under the Implementation Plan.

1. Implement BMPs to reduce copper loading to SIYB in compliance with the TMDL interim and final loading reduction schedule or until water quality conditions are obtained

that are protective of SIYB beneficial uses. The choice to implement any of the BMPs is individual and left to the respective boater's discretion. BMPs may include conversion of vessels from copper to non-copper and low-copper hull paints, participation in special studies to test non-copper or low-copper hull paints, and hiring hull cleaners that clean hulls with the least abrasive method possible to control fouling, as described in Table A-2.

2. Report required vessel hull paint tracking information to marinas or yacht clubs where the boat owner's vessel is moored.

A-5 City of San Diego

The City has two responsibilities under the Implementation Plan.

1. Monitor MS4 discharges to SIYB to ensure annual loading does not exceed the urban runoff load allocation of 30 kg/yr.
2. Implement BMPs, as needed, to maintain copper loading levels from MS4s at less than 30 kg/yr.

As a Regional Harbor Monitoring Program stakeholder, the City is also partnering with the Port to implement special studies that include assessments of copper bioavailability and site-specific conditions that affect copper toxicity and testing of copper flux from sediments.

APPENDIX B

Individual Workplan Template

and

Implementation Tracking Matrix

Shelter Island Yacht Basin Total Maximum Daily Load Workplan Template– NAMED PARTY

BMP TYPE	DESCRIPTION	LOCATION	PURPOSE(S)	TARGETED OUTCOME(S)	ASSESSMENT MECHANISM	SCHEDULE	PARTNERING OPPORTUNITY
Defined Projects for Stage 2 (2007-2012)							
Planned Projects for Stage 3 (2012-2017)							
Planned Projects for Stage 4 (2017-2022)							
Cooperative Efforts							
Vessel Tracking Program	Track vessel conversion from copper to non-copper and low-copper hull paints to determine annual loading reductions	SIYB	Monitor implementation progress and assess progress towards interim and final loading targets	Interim and final loading reduction targets	Annual basin-wide vessel tracking assessments and loading reduction calculations	Annually beginning in 2011; reporting to Regional Board March 31 annually	All Named Parties
Water Quality Monitoring	Monitor water quality basin wide to assess long term trends in dissolved copper levels and attainment of WQOs	SIYB	Monitor implementation progress and assess progress towards attaining dissolved copper concentrations protective of SIYB beneficial uses	Water quality conditions protective of beneficial uses	Annual basin-wide chemistry and toxicity assessments	Annually beginning August 2011; reporting to Regional Board March 31 annually	All Names Parties

Implementation Tracking Matrix

Pollutant: Copper						**Implementation Tracking Matrix**	
SOURCE *What sources of this pollutant are under your jurisdiction?*	**STRATEGY** *What is being done, or will you do, to reduce and/or control pollution from this source?*	**HOW** *Specifically, how will this be done?*	**FISCAL ANALYSIS** *What is the expected resource need? Are there existing resources budgeted? If not, where will the resources come from?*	**MEASURE** *How will you quantitatively or qualitatively demonstrate successful implementation or completion of this strategy?*	**TIMELINE** *When do you expect it to be completed?*	**MILESTONE** *What intermediate goals do you expect to achieve, and by when, to know progress is being made?*	**STATUS** *Include summary and date.*
Diver BMPs							
Boatyard recommendations for antifouling							
Boat owner choices for diving companies							
Boat owner choices of boatyards							
Boat owner choices of marinas							
Boat owner choices of antifouling paint							

Developed by John Adriany – San Diego Yacht Club

APPENDIX C

Management Questions and Assessment Mechanisms

Management Questions and Assessment Mechanisms

C-1 Management Questions

Named Parties may choose to use management questions to ensure implemented best management practices (BMPs) and implementation activities are focused and assessable. Management questions are designed to evaluate BMP's effectiveness using the most simple and straightforward approaches possible to reduce the number of variables in the assessment process. Based on overall management or BMP goals, Named Parties may use or modify the below questions for BMP effectiveness assessments.

Possible Management Questions:

- Is the product/activity/BMP effective? *(Were the objectives, goals, and effectiveness outcomes achieved? If not, why not?)*
- Did the activity or BMP result in the transition of vessels from copper to non-copper or low-copper hull paints?
- Did the public outreach workshops attract the desired number of attendees?
- Did the public demonstrate a greater knowledge of copper issues and willingness to transition from copper to non-copper or low-copper hull paints?
- Are incentive programs effective in reducing abrasive hull cleaning techniques?
- Do voluntary measures result in the transition from copper to non-copper and low-copper hull paints? *(If not, are more prescriptive measures required?)*
- Does the BMP need to be modified to improve its effectiveness? *(How?)*

C-2 Assessment Mechanisms and Targeted Outcomes

Named Parties can use the following assessment mechanisms to relate the effectiveness of an implemented BMP to desired targeted outcomes, including interim and final total maximum daily load (TMDL) loading targets. The four levels of Targeted Outcomes defined in this Implementation Plan include: Project Completeness, a measureable Change in Awareness, a measureable Change in Behavior, and a measureable Loading Reduction.

FOUR LEVELS of TARGETED OUTCOMES
1. COMPLETENESS
2. CHANGE IN AWARENESS
3. CHANGE IN BEHAVIOR
4. LOADING REDUCTION

Completeness: The BMP was successfully implemented, monitored, assessed, and reported. This outcome is typically associated with the submission of a final report for a special study or data submission from an education/outreach activity.

Change in Awareness: Changes in public awareness due to public education/outreach efforts may, or may not, lead to an equivalent change in behavior or loading reduction. This outcome is typically associated with the number of visitors to an information booth, fliers distributed, or

similar numeric attendance records. At workshops, changes in public awareness may be quantified through pre- and post-survey questionnaires.

Change in Behavior: Changes in behavior may be observed in boat owners, product manufacturers, hull cleaners, and boatyards. This outcome may be quantified by selection of non-copper or low-copper hull paints by boat owners, implementation of less-abrasive hull-cleaning techniques by hull cleaners, and increased recommendation and application of non-copper and low-copper products by boatyards. Changes in behavior are typically the result of voluntary outreach/education programs.

Loading Reduction: Loading reductions are directly comparable to the loading targets defined in the Shelter Island Yacht Basin (SIYB) TMDL. The primary assessment of loading reduction used in this Implementation Plan is the number of vessels converted from copper to non-copper or low-copper hull paints. Additional loading reductions may include reductions of inputs via hull cleaning, control of upstream inputs, and alternative boat storage methods. The output may be compared to the baseline conditions defined in the TMDL and translated into a percent loading reduction.

When developing individual workplans, Named Parties may elect to define Targeted Goals. These goals define the anticipated loading reduction that will be achieved by each BMP. Comparing the targeted goals with the actual assessment results will allow for a simple evaluation of BMP effectiveness, as well as progress towards the TMDL targets on an individual and basin-wide level.

APPENDIX D

Potential Special Studies

Potential Special Studies

The purpose of special studies is to provide data needed to verify or refine assumptions, resolve uncertainties, and improve the scientific foundation of the Shelter Island Yacht Basin (SIYB) Total Maximum Daily Load (TMDL). During the course of the SIYB TMDL, special studies will be conducted to further the understanding of available non-copper and low-copper hull paints, determine and improve best management practice (BMP) effectiveness, and assess the physical and chemical conditions within SIYB that affect copper impacts on marine life habitat (MAR) and wildlife habitat (WILD) beneficial uses. Projects may include, but are not limited to:

- Biotic Ligand Modeling
- Toxicity Identification Evaluations (TIEs)
- Sediment Copper Flux Studies
- Water Effects Ratios Evaluations (WERs)
- Hull Cleaning BMP Development and Loading Evaluations
- Assessments of new and emerging non-copper and low-copper boat hull paints

Current, planned, and potential special studies are described below.

D-1 Biotic Ligand Modeling

The marine Biotic Ligand Model (BLM) is a promising framework for predicting metal speciation, complexation, and toxicity to aquatic organisms using site-specific water characteristics (i.e., pH, dissolved organic carbon [DOC], salinity and total metal concentration). Copper exists in multiple chemical forms depending on the physical conditions of the waters and sediments in which it occurs, including pH, alkalinity, and organic compounds. As a consequence, the bioavailability and toxicity of copper is dependent upon the form in which it occurs. The most bioavailable forms of copper include inorganic or ionic forms of dissolved copper, while bioavailability and toxicity decrease with higher alkalinity and organic carbon. The model takes into account water chemistry factors to determine the projected level of toxicity for a particular metal as measured by the metal's binding affinity to a biotic ligand (for example, the gills of an aquatic organism) (Niyogi and Wood, 2004). The copper BLM can be used to calculate median lethal concentration (LC_{50}) and median effective concentration (EC_{50}) values and predict whether copper concentrations are likely to be protective of marine biota based on physical water quality parameters.

D-2 Toxicity Identification Evaluations

Water and sediment TIEs will be performed to identify the causes of toxicity within SIYB and other areas of San Diego Bay found to be toxic during the RHMP 2008 study. While concentrations of dissolved copper may be elevated, it may not be the primary causative agent. At stations where sediment and/or surface water toxicity are found to occur, TIEs will be used to experimentally examine the constituents likely to cause toxic effects. Typically, TIEs consist of several tiers of testing. Tier I involves procedures designed to provide general information for

identifying the class of the toxic constituents within samples based on their chemical and/or physical characteristics (e.g., volatility, ionization state, degree of adsorption to particulates, polarity, oxidative state, pH sensitivity, and interaction with synergistic and antagonistic compounds). Classification characteristics are examined by comparing the results of toxicity tests conducted on unmanipulated samples to tests on samples that have been physically or chemically adjusted. Additional tiers of TIEs involve further manipulations and associated chemical analyses of samples to identify specific toxicants that are potential causative agents of toxicity.

A full suite of TIE treatments (including several tests targeted at copper and other metals) will be used to evaluate the potential causative agents of toxicity in surface water and sediment from SIYB in accordance with U.S. Environmental Protection Agency (USEPA) methods (USEPA, 1991; 2007). Depending on the results of the first tier of TIE tests, additional studies may be conducted to confirm the identity of the causative agent(s). Chemical analyses of water or sediment extracts will also be used to verify TIE test results, and confirm the causative agent(s) of toxicity, when appropriate.

D-3 Sediment Copper Flux Studies

Laboratory and field studies will be performed to assess the potential for copper-laden sediments to serve as a net source or sink for copper into and from the water column depending on the concentration of copper within the overlying water. Performing such a study may be crucial to understanding and predicting the effectiveness of converting vessel hull paints from copper-based to non-copper-based products as a means of reducing dissolved copper concentrations in the water column to levels below the numeric water quality objective (WQOs), 3.1 µg/L. Although sediments in SIYB appear to be serving as a sink for copper at current copper levels, it has yet to be tested if reductions in water column copper concentrations to levels approaching the chronic California Toxics Rule (CTR) threshold will shift sediments from a net sink to a source. This study will increase the understanding of the efforts required to meet TMDL WQOs.

D-4 Water Effects Ratios

As a follow-up to the BLM study, a WER study may be conducted to evaluate the relevance of numeric WQOs (i.e., CTR thresholds) to protection of SIYB MAR and WILD beneficial uses based on the physical properties. Because WQOs were developed based on laboratory studies of toxicity using filtered seawater, they often do not account for many of the physical constituents that may interfere with the toxicity of potential chemicals of concern, such as copper. Rivera-Duarte and others (2005) demonstrated that the bioavailability and toxicity of free copper ions within San Diego Bay was dependent upon the concentration of particulate and dissolved organic matter. Furthermore, Rosen and others (2005) measured dissolved and total copper concentrations, particulate and dissolved organic matter, and toxicity using both the mussel *Mytilus galloprovincialis* and the sea urchin *Strongylocentrotus purpuratus* at numerous stations within San Diego. Their estimates of copper WERs for the whole bay ranged from 1.54 to 1.67, which indicated that a WER study in SIYB may lead to the development of site specific objectives (SSOs) above the CTR threshold that would still be protective of MAR and WILD beneficial uses.

Dr. Bruland's independent review of the SIYB TMDL recommended conducting WERs to determine the actual level of loading reduction required to reduce the bioavailable forms of copper to levels that do not adversely affect biota (p. 131, Appendix 7; Regional Board, 2005). WERs will be performed using *M. galloprovincialis* and *S. purpuratus* in accordance with USEPA WER guidance (USEPA, 1994). Determination of the final WER will be dependent on the results of the most sensitive test, from which an SSO will be calculated.

D-5 Testing of New and Emerging Alternative Paints

Special studies are being conducted by the Port to identify and evaluate alternatives to copper-based paints, such as the USEPA funded "Safer Alternative to Copper Antifouling Paints" project. The purpose of the project is to develop a list of viable alternative antifouling coatings for boaters. The coatings on the list will be those which will substantially reduce or eliminate copper release into San Diego Bay. Coatings will be evaluated based on effectiveness to repel fouling organisms and easiness to clean. Additional ongoing testing of new and emerging non-copper and low-copper coatings will be necessary as coating suppliers are continuously developing new coatings and reformulating existing coatings.

D-6 Coating Application Standards

The Named Parties may elect to implement studies to define BMP application procedures and standards for approved hull coatings. In doing so, they will work with coating manufacturers to establish certification standards for coating application at boatyards.

D-7 Hull Cleaning Standards

The Named Parties may elect to implement studies to define hull cleaning standards and BMPs. In doing so, they will determine appropriate hull cleaning methods and establish a hull cleaner certification program.

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