

**CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD  
SAN DIEGO REGION**

**RESOLUTION NO. R9-2005-0019**

**A RESOLUTION ADOPTING AN AMENDMENT TO THE WATER QUALITY  
CONTROL PLAN FOR THE SAN DIEGO REGION TO INCORPORATE  
A TOTAL MAXIMUM DAILY LOAD FOR DISSOLVED COPPER  
IN SHELTER ISLAND YACHT BASIN, SAN DIEGO BAY**

**WHEREAS**, The California Regional Water Quality Control Board, San Diego Region (hereinafter, Regional Board), finds that:

1. **BASIN PLAN AMENDMENT:** The proposed amendment of the Water Quality Control Plan for the San Diego Basin – Region 9 (Basin Plan) described in the recitals below was developed in accordance with California Water Code (CWC) section 13240 et seq.
2. **NECESSITY STANDARD** [Government Code section 11353(b)]: This regulatory action meets the “Necessity” standard of the Administrative Procedures Act, Government Code, section 11353, subdivision (b). Amendment of the Basin Plan to establish and implement a Total Maximum Daily Load (TMDL) for Shelter Island Yacht Basin (SIYB) is necessary because the existing water quality does not meet applicable numeric water quality objectives for copper, or narrative water quality objectives for toxicity and pesticides. The federal Clean Water Act (CWA) section 303(d) requires the Regional Board to establish and oversee the implementation of a TMDL under the water quality conditions that exist in SIYB. This TMDL for dissolved copper is necessary to ensure attainment of applicable water quality objectives and restoration of beneficial uses designated for SIYB.
3. **CLEAN WATER ACT SECTION 303(d):** The SIYB portion of San Diego Bay was placed on the Clean Water Act section 303(d) list of impaired waters in 1996 due to elevated levels of dissolved copper in the water column.
4. **BENEFICIAL USE IMPAIRMENTS:** SIYB supports the same suite of beneficial uses as San Diego Bay. The most sensitive beneficial uses are those designated for protection of marine aquatic life and aquatic dependent wildlife as described in the Basin Plan definition of the marine habitat (MAR) and wildlife habitat (WILD) beneficial uses. The MAR and WILD beneficial uses of SIYB are threatened or impaired due to elevated levels of dissolved copper.
5. **WATER QUALITY OBJECTIVES:** The water quality objectives for copper in SIYB specify that concentrations in seawater for dissolved copper should not exceed 3.1 micrograms/liter ( $\mu\text{g/L}$ ) for continuous or chronic exposures (not to be exceeded over a four-day average), and 4.8  $\mu\text{g/L}$  of copper for brief or acute exposures (not to be exceeded over a one-hour average). These water quality objectives are based on, and equal, to the California Toxics Rule (CTR) water quality criteria for dissolved copper promulgated by the

United States Environmental Protection Agency (USEPA). The USEPA's CTR criteria are the legally applicable water quality standards in the State of California for inland surface waters, enclosed bays, and estuaries for all purposes and programs under the CWA.

In addition, the Basin Plan establishes the following narrative water quality objectives for "toxicity" and "pesticides" to ensure the protection of the MAR and WILD beneficial uses.

**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.*

*The survival of aquatic life in surface waters subjected to a waste discharge or other controllable water factors, shall not be less than that for the same water body in areas unaffected by the waste discharge or, when necessary, for other control water that is consistent with requirements specified in USEPA, State Water Resources Control Board (State Board) or other protocol authorized by the Regional Board. As a minimum, compliance with this objective as stated in the previous sentence shall be evaluated with a 96-hour acute bioassay.*

*In addition, effluent limits based upon acute bioassays of effluents will be prescribed where appropriate, additional numerical receiving water objectives for specific toxicants will be established as sufficient data become available, and source control of toxic substances will be encouraged.*

**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 that will bioaccumulate in aquatic organisms to levels harmful to human health, wildlife or aquatic organisms.*

Meeting the numeric water quality objectives for copper will ensure that the narrative toxicity and pesticides objectives are met in the water column with respect to copper.

6. **NUMERIC TARGETS:** TMDL Numeric Targets interpret and implement water quality standards (i.e., numeric and narrative water quality objectives and beneficial uses) and are established at levels necessary to achieve water quality standards. The Regional Board has set the copper TMDL Numeric Targets for both the numeric and narrative water quality objectives equal to the numeric water quality objectives for copper cited in Finding 5. The numeric targets for dissolved copper are 3.1 µg/L for continuous or chronic exposure (4-day average) and 4.8 µg/L (1-hour average) for brief or acute exposures. Attainment of the TMDL numeric targets will result in attainment of water quality standards in SIYB.
7. **SOURCES OF DISSOLVED COPPER:** Approximately 98 percent of the total copper loading to SIYB originates from copper-based antifouling paints applied to the hulls of recreational vessels moored in SIYB marinas. Of this total, 93 percent is attributable to

copper entering the water column through passive leaching of copper from antifouling paints. The remaining five percent enters the water column during periodic underwater hull cleaning of recreational vessel hulls in the marinas. Four other insignificant sources of copper were identified in the TMDL source analysis including urban runoff, direct atmospheric deposition, marine sediment and background.

8. **WATER QUALITY OBJECTIVE VIOLATIONS:** Elevated dissolved copper concentrations in SIYB have been sustained over time through continuous passive leaching of copper from antifouling paints. The effects of these discharges on water quality are exacerbated by factors such as a) the large number of vessels congregated in SIYB marinas (approximately 2,200 vessels); b) the large combined surface area of vessel hulls leaching copper; and c) reduced tidal flushing caused by the configuration of the enclosed basin. Furthermore, since recreational vessels spend most of their time moored in marinas, most of the copper from antifouling paints on the vessel hulls is released in the marinas. Sampling surveys conducted by the Regional Board in SIYB during 1994 and 2000 documented water column concentrations as high as 12 µg/L and 8 µg/L of copper, respectively.
9. **ADVERSE EFFECTS OF COPPER:** Copper is used as the biocide in antifouling paints because of its known toxicity to marine aquatic life. At relatively low concentration levels, copper is toxic to aquatic organisms. Copper toxicity to aquatic life varies between species and within individual species life stages. The early life stages of fish, bivalves and echinoderms are especially vulnerable to copper contamination. Copper tends to accumulate in sediment, threatening the benthic life at SIYB. Copper in the sediment may need to be removed through human intervention, such as dredging which can be very costly. Because of these adverse effects of copper, the use of copper-based antifouling paints is restricted or banned in parts of Europe.
10. **TOTAL MAXIMUM DAILY LOAD:** [40 Code of Federal Regulations (CFR), section 130.2(i)] The TMDL for copper discharges into SIYB is calculated to be 1.6 kilograms of copper per day (kg/day), or 567 kilograms of copper per year (kg/year). The TMDL is defined as the maximum amount of copper that SIYB can receive and still attain water quality objectives and protection of designated beneficial uses. The TMDL is comprised of the sum of all individual Wasteload Allocations (WLAs) for point source discharges of copper, the sum of all Load Allocations (LAs) for nonpoint source discharges of copper, and background. The TMDL includes a margin of safety (MOS) that takes into account any uncertainties in the TMDL calculation. (i.e.  $TMDL = WLAs + LAs + MOS$ ). The TMDL calculations also account for seasonal variations and critical conditions.
11. **ALLOCATIONS AND REDUCTIONS:** A 76 percent overall reduction of residual copper loading to SIYB is required to meet the TMDL of 567 kg/year. The assigned allocations from each source translate into a percent reduction of dissolved copper from current loading. Loading due to passive leaching must be reduced by 81 percent from current loading. Loading due to underwater hull cleaning must be reduced by 28 percent from current loading. From an overall perspective, passive leaching loading must be reduced by 75 percent from the combined total loading of all sources to SIYB. Underwater hull cleaning

loading must be reduced by one percent from the combined total loading of all sources to SIYB.

12. **DISCHARGERS:** The San Diego Unified Port District (Port), SIYB marina owners/operators, persons owning boats moored in SIYB, and SIYB underwater hull cleaners are accountable for the discharges of copper from boat hull antifouling paints to SIYB. To a much lesser extent, the City of San Diego (City) also discharges copper from its Municipal Separate Storm Sewer Systems (MS4s).
13. **IMPLEMENTATION ACTIONS:** Strategies that the Regional Board could take to implement the TMDL are described in the Basin Plan Amendment and Technical Report for *Total Maximum Daily Load for Dissolved Copper in Shelter Island Yacht Basin, San Diego Bay*, dated February 9, 2005.
14. **SAMPLING PROTOCOL:** Future sampling should be done in accordance with the best current protocols to reduce sample bias regarding low concentrations of metals in marine waters.
15. **COMPLIANCE MONITORING:** Water quality monitoring will be required to assess compliance in SIYB with the copper load and wasteload reductions specified in this TMDL and with the water quality objectives for copper.
16. **COMPLIANCE SCHEDULE:** Copper load and wasteload reductions are required over a 17-year staged compliance schedule period. The first stage consists of an initial 2-year orientation period during which no copper load and wasteload reductions are required. The subsequent 15-year reduction period is comprised of three stages during which incremental copper load and wasteload reductions are required.
17. **SCIENTIFIC PEER REVIEW:** The scientific basis of this TMDL has undergone external peer review pursuant to Health and Safety Code section 57004. The Regional Board has considered and responded to all comments submitted by the peer review panel.
18. **STAKEHOLDER PARTICIPATION:** Interested persons and the public have had reasonable opportunity to participate in review of the amendment to the Basin Plan. A California Environmental Quality Act (CEQA) scoping meeting was held on March 19, 2003. Efforts to solicit public review and comment included three public workshops held between May 2000 and December 2003; a public review and comment period of 90 days preceding and following the Regional Board public hearing; a second public comment period of 30 days following the release of the revised TMDL Technical Report dated October 14, 2004; and written responses from the Regional Board to oral and written comments received from the public.
19. **ECONOMIC ANALYSIS:** The Regional Board has considered the costs of reasonably foreseeable methods of compliance with the load and wasteload reductions specified in this TMDL.

20. **CEQA REQUIREMENTS:** The basin planning process has been certified as functionally equivalent to the CEQA requirements for preparing environmental documents and is, therefore, exempt from those requirements (Public Resources Code section 21000 et seq.). The required environmental documentation (Basin Plan amendment, technical report, and environmental checklist) has been prepared.

The Regional Board finds that the analysis contained in the TMDL Technical Report, the CEQA checklist, and the responses to comments comply with the requirements of the State Board's certified regulatory CEQA process, as set forth in the California Code of Regulations, title 23, section 3375 et seq. Furthermore, the Regional Board finds that the analysis fulfills the Regional Board's obligations attendant with the adoption of regulations "requiring the installation of pollution control equipment, or a performance standard treatment or requirement", as set forth in section 21159 of the Public Resources Code.

21. **DE MINIMIS ENVIRONMENTAL EFFECTS:** This Basin Plan amendment will result in no potential for adverse effect, either individually or cumulatively, on wildlife.
22. **PUBLIC NOTICE:** The Regional Board has notified all known interested parties and the public of its intent to consider adoption of this Basin Plan amendment in accordance with CWC section 13244.
23. **PUBLIC HEARING:** The Regional Board has, at a public meeting on December 10, 2003, held a public hearing and heard and considered all comments pertaining to this Basin Plan amendment.
24. **BASIN PLAN ORGANIZATION:** Basin Plan Chapter 4, Implementation needs to be reorganized to create a subsection in which to include the Shelter Island Yacht Basin Dissolved Copper TMDL, and the Chollas Creek Diazinon TMDL Basin Plan amendments, and any future TMDL Basin Plan amendments.


**NOW, THEREFORE, BE IT RESOLVED** that

1. **AMENDMENT ADOPTION:** The Regional Board hereby adopts this amendment to the Basin Plan to incorporate the Shelter Island Yacht Basin Dissolved Copper TMDL, and to reorganize Chapter 4 as set forth in Attachment A hereto.
2. **TECHNICAL REPORT APPROVAL:** The Regional Board hereby approves the Technical Report for *Total Maximum Daily Load for Dissolved Copper In Shelter Island Yacht Basin, San Diego Bay*, dated February 9, 2005.
3. **CERTIFICATE OF FEE EXEMPTION:** The Executive Officer is authorized to sign a Certificate of Fee Exemption.
4. **AGENCY APPROVALS:** The Executive Officer is directed to submit this Basin Plan amendment to the State Board in accordance with CWC section 13245. The Regional Board requests that the State Board approve the Basin Plan amendment and forward it to Office of

Administrative Law (OAL) and the USEPA for approval.

5. **NON-SUBSTANTIVE CORRECTIONS:** If, during the approval process for this amendment, the State Board or OAL determines that minor, non-substantive corrections to the language of the amendment are needed for clarity or consistency, the Executive Officer may make such changes, and shall inform the Regional Board of any such changes.

*I, John H. Robertus, Executive Officer, do hereby certify the foregoing is a full, true and correct copy of a Resolution adopted by the California Regional Water Quality Control Board, San Diego Region, on February 9, 2005.*

  
**JOHN H. ROBERTUS**  
Executive Officer

**ATTACHMENT A  
TO RESOLUTION NO. R9-2005-0019**

**AMENDMENT TO THE WATER QUALITY CONTROL PLAN FOR THE SAN DIEGO  
REGION TO INCORPORATE A TOTAL MAXIMUM DAILY LOAD FOR DISSOLVED  
COPPER IN SHELTER ISLAND YACHT BASIN, SAN DIEGO BAY**

This Basin Plan amendment establishes a Total Maximum Daily Load (TMDL) and associated load and wasteload reductions for dissolved copper in the Shelter Island Yacht Basin portion of San Diego Bay. This amendment includes a program to implement the TMDL and monitor its effectiveness. This amendment also reorganizes portions of Chapter 4 of the Basin Plan dealing with TMDLs and creates a new subsection in which to include the Chollas Creek Diazinon TMDL, the Shelter Island Yacht Basin Dissolved Copper TMDL, and any future TMDL Basin Plan amendments. Chapters 2, 3, and 4 of the Basin Plan are amended as follows:

**Chapter 2. Beneficial Uses**

***Table 2-3. Beneficial Uses of Coastal Waters, San Diego Bay***

Add the following footnote 3 to San Diego Bay

<sup>3</sup>The Shelter Island Yacht Basin portion of San Diego Bay is designated as an impaired water body for dissolved copper pursuant to Clean Water Act section 303(d). A Total Maximum Daily Load (TMDL) has been adopted to address this impairment. See Chapter 3, Water Quality Objectives for Pesticides, Toxicity and Toxic Pollutants and Chapter 4, Total Maximum Daily Loads.

**Chapter 3. Water Quality Objectives**

***Inland Surface Waters, Enclosed Bays and Estuaries, Coastal Lagoons, and Ground Waters***

***Water Quality Objectives for Pesticides:***

Add a third paragraph as follows:

The Shelter Island Yacht Basin portion of San Diego Bay is designated as an impaired water body for dissolved copper pursuant to Clean Water Act section 303(d). A Total Maximum Daily Load (TMDL) has been adopted to address this impairment. See Chapters 2, Table 2-3, *Beneficial Uses of Coastal Waters, San Diego Bay*, Footnote 3 and Chapter 4, Total Maximum Daily Loads.

***Water Quality Objectives for Toxicity:***

Add a fourth paragraph as follows:

The Shelter Island Yacht Basin portion of San Diego Bay is designated as an impaired water body for dissolved copper pursuant to Clean Water Act section 303(d). A Total Maximum Daily Load (TMDL) has been adopted to address this

impairment. See Chapters 2, Table 2-3, *Beneficial Uses of Coastal Waters, San Diego Bay*, Footnote 3 and Chapter 4, Total Maximum Daily Loads.

***Water Quality Objectives for Toxic Pollutants:***

Add a second paragraph as follows:

The Shelter Island Yacht Basin portion of San Diego Bay is designated as an impaired water body for dissolved copper pursuant to Clean Water Act section 303(d). A Total Maximum Daily Load (TMDL) has been adopted to address this impairment. See Chapters 2, Table 2-3, *Beneficial Uses of Coastal Waters, San Diego Bay*, Footnote 3 and Chapter 4, Total Maximum Daily Loads.

**Chapter 4, Implementation**

Change the second order subsection "*California Water Quality Assessment (WQA)*" to a first order section by removing it from and placing it before the section "*Other Programs*."

Change the second order subsection "*California's 303(d) Process*" to a first order section by removing it from the section "*Other Programs*" and placing it after the section "*California Water Quality Assessment (WQA)*." Change the name of the section "*California's 303(d) Process*" to "*Clean Water Act Section 303(d) Requirements for Impaired Waterbodies*." Move the sixth paragraph (which begins with "The 303(d) list of WQLS...") to the position after the first sentence in the second paragraph. Begin a new paragraph with the second sentence of paragraph 2 (which begins with "Section 303(d) requires...").

Remove "(TMDL)" from the title of the subsection "*Total Maximum Daily Load (TMDL) for Diazinon, Chollas Creek Watershed, San Diego County*" and move this subsection from "*Other Programs*" into the section "*Clean Water Act Section 303(d) Requirements for Impaired Waterbodies*."

After the subsection on the Chollas Creek Diazinon TMDL add the following subsection:

***Total Maximum Daily Load for Dissolved Copper, Shelter Island Yacht Basin, San Diego Bay***

On February 9, 2005, the Regional Board adopted Resolution No. R9-2005-0019, *A Resolution Adopting an Amendment to the Water Quality Control Plan for the San Diego Region to Incorporate a Total Maximum Daily Load for Dissolved Copper in the Shelter Island Yacht Basin, San Diego Bay*. The TMDL Basin Plan Amendment was subsequently approved by the State Water Resources Control Board on [Insert Date], the Office of Administrative Law on [Insert Date], and the United States Environmental Protection Agency on [Insert Date]. The TMDL is described in the *Total Maximum Daily Load for Dissolved Copper in Shelter Island Yacht Basin, San Diego Bay*, Technical Report dated February 9, 2005.



### **Problem Statement**

Dissolved copper levels in Shelter Island Yacht Basin (SIYB) waters violate water quality objectives for copper, toxicity, and pesticides. Dissolved copper concentrations in SIYB threaten and impair the designated beneficial uses of marine habitat (MAR), and wildlife habitat (WILD).

### **Numeric Target**

The TMDL Numeric Targets for copper, toxicity and pesticides are set equal to the numeric water quality objectives for dissolved copper as defined in the California Toxics Rule (CTR) and shown below.

*Table 4-10. TMDL Numeric Targets.*

Exposure	Water Quality Objective*	Numeric Target*
Continuous or Chronic (4 day average)	3.1 µg/L** of copper (Cu)	3.1 µg/L** of Cu
Maximum or Acute (1 hour average)	4.8 µg/L** of Cu	4.8 µg/L** of Cu

\* Concentrations should not be exceeded more than once every three years.

\*\* micrograms/liter (µg/L)

If the water quality objectives for dissolved copper in SIYB are modified in the future, as in the case of a site-specific objective, then the numeric targets will be set equal to the new water quality objectives.

### **Source Analysis**

Approximately 98 percent of all copper loading to SIYB is attributable to copper-based antifouling paints applied to the hulls of recreational boats. The passive leaching of copper from antifouling paint is 93 percent of the total loading. The remaining five percent of total copper loading results from underwater hull cleaning operations in SIYB.

*Table 4-11. Summary of Dissolved Copper Sources to SIYB.*

Source	Mass Load (kg/year)	Percent Contribution (% Cu)
Passive Leaching	2,000	93
Hull Cleaning	100	5
Urban Runoff	30	1
Background	30	1
Direct Atmospheric Deposition	3	<1
Sediment	0	0
<b>Combined Sources</b>	<b>2,163</b>	<b>100</b>

### **Total Maximum Daily Load**

The TMDL or loading capacity for dissolved copper discharges into SIYB is 1.6 kilograms/day (kg/day) or 567 kilograms/year (kg/year).

### **Margin of Safety**

The TMDL includes an explicit and implicit margin of safety (MOS). Ten percent of the loading capacity was reserved as an explicit MOS and calculated to be 57 kg/year. The implicit MOS was incorporated into the TMDL source analysis through numerous conservative assumptions.

### **Allocations and Reductions**

A 76 percent overall reduction of residual copper loading to SIYB is required to meet the TMDL of 567 kg/year as shown in the table below. The assigned allocations from each source translate into a percent reduction of dissolved copper from current loading. Loading due to passive leaching must be reduced by 81 percent from current loading. Loading due to underwater hull cleaning must be reduced by 28 percent from current loading. From an overall perspective, passive leaching loading must be reduced by 75 percent from the combined total loading of all sources to SIYB. Underwater hull cleaning loading must be reduced by one percent from the combined total loading of all sources to SIYB.

*Table 4-12. TMDL and Allocation Summary.*

Source	Current Load (kg/year of Cu)	Percent Contribution (% Cu)	Allocation (kg/year of Cu)	Percent Reduction From Current Source Load (%)	Percent Reduction from Total Loading to SIYB (%)
Passive Leaching	2,000	93	375	81	75
Hull Cleaning	100	5	72	28	1
Urban Runoff	30	1	30	0	0
Background	30	1	30	0	0
Direct Atmospheric Deposition	3	<1	3	0	0
Sediment	0	0	0	0	0
Current Mass Load	2,163	100			0
Margin of Safety			57		0
TMDL			567		0
Total Load Reduction				76	76

### **Recalculations if Water Quality Objectives Change**

If the water quality objectives for dissolved copper in SIYB are changed in the future, then the MOS, TMDL and allocations will be recalculated using the method shown in Appendix D of the Basin Plan.

## TMDL Implementation Plan

The TMDL will be implemented as follows:

- The Regional Board will coordinate with governmental agencies having legal authority over the use of copper-based antifouling paints to protect water quality from the adverse effects of copper-based antifouling paints in SIYB; and
- The Regional Board will regulate discharges of copper to SIYB through the issuance of Waste Discharge Requirements (WDRs), Waivers of WDRs (waivers), or adoption of Waste Discharge Prohibitions. WDRs could build upon pollution control programs developed by discharger organizations or the Port. Likewise, waivers or prohibitions could be conditioned on implementation of pollution control programs through third party agreements between the Regional Board and discharger organizations, and/or other agencies.
- The Regional Board will amend Order No. 2001-01, "Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm /Sewer Systems" to require that discharges of copper into SIYB waters via the City's municipal separate storm/sewer system not exceed a 30 mg/kg wasteload for copper.

The dischargers will be required to monitor SIYB waters and provide monitoring reports to the Regional Board for the purpose of assessing the effectiveness of the alternatives implemented.

### Compliance Schedule

Copper load and wasteload reductions are required over a 17-year staged compliance schedule period. The first stage consists of an initial 2-year orientation period during which no copper load reductions are required. The subsequent 15-year reduction period is comprised of three stages during which incremental copper load and wasteload reductions are required as shown below.

*Table 4-13. Interim Loading Targets for Attainment of the TMDL.*

Stage	Time Period	Percent Reduction from Current Estimated Loading	Reduction to be Attained by End of Year	Estimated Interim Target Loading (kg/year of dissolved Cu)
Stage 1	Years 1-2	0%	N/A	N/A
Stage 2	Years 2-7	10%	7	1,900
Stage 3	Years 7-12	40%	12	1,300
Stage 4	Years 12-17	76%	17	567

At the end of the Basin Plan, add the following Appendix D:

**APPENDIX D**  
**METHOD FOR RECALCULATION OF THE TOTAL MAXIMUM DAILY LOAD**  
**FOR DISSOLVED COPPER IN THE SHELTER ISLAND YACHT BASIN,**  
**SAN DIEGO BAY**

This appendix describes the method for recalculating the Shelter Island Yacht Basin TMDL for dissolved copper if the water quality objectives for dissolved copper are modified in the future.

**Numeric Target**

The numeric targets are set equal to the new water quality objectives.

**Margin of Safety**

The explicit margin of safety (MOS) equals ten percent of the loading capacity. The equation to calculate the loading capacity is given below.

**Total Maximum Daily Load**

The TMDL or loading capacity is recalculated using equations 1 through 4 below.

The loading capacity is recalculated according to equation 1 below:

$$(1) \quad R_s = C_2 \left( \frac{KA_c}{\Delta x} + k_L V_2 \right) - A_c C_1 \left( \frac{eA_s}{A_c} + \frac{K}{\Delta x} \right)$$

where  $C_1$  = average background concentration of copper measured in the area of San Diego Bay adjacent to SIYB, expressed as total copper, (0.05 µg/L)

$C_2$  = average target concentration for copper in the SIYB (expressed as total copper) when the maximum concentration of copper in SIYB is equal to or less than the numeric target (mass/volume)

$K$  = dispersion coefficient calculated from salinity measurements and mixing length approximation (15.3 m<sup>2</sup>/sec)

$A_c$  = cross-sectional area of entrance to SIYB (1,000 m<sup>2</sup>)

$A_s$  = surface area of SIYB (740,000 m<sup>2</sup>)

$\Delta x$  = average mixing length between SIYB and adjacent area; estimated distance between the endpoints for  $S_1$  and  $S_2$  (2,000 m)

$V_2$  = volume of SIYB (31,000,000 m<sup>3</sup>)

$e$  = evaporation rate (0.43 cm/day)

$k_L$  = rate of total copper loss to sediment (7%/day)

$R_s$  = loading capacity, expressed as total copper (mass/time);  $R_s$  is calculated iteratively to find the maximum possible value that does not cause  $C_2$  to exceed the numeric target.

The dispersion coefficient K is calculated using equation 2 below:

$$(2) \quad K \cong \frac{eA_s S_1 \Delta x}{A_c (S_2 - S_1)}$$

where  $S_1, S_2$  = salinity data obtained in SIYB and San Diego Bay adjoining SIYB (33.62 practical salinity units (psu) and 33.46 psu, respectively).

The average target concentration,  $C_2$ , must be lower than the numeric target concentration to ensure that the loading capacity will not cause an exceedance of the numeric target anywhere in SIYB.  $C_2$  is calculated by multiplying the numeric target for chronic exposure by the ratio of the average measured concentration of copper in SIYB to the maximum measured concentration as expressed in equation 3 below:

$$(3) \quad C_2 = \text{numeric target} [\text{average measured concentration} / \text{maximum measured concentration}]$$

Or,

$$C_2 = \text{numeric target} * [5.45 \mu\text{g/L} / 8 \mu\text{g/L}]$$

To convert  $C_2$  from dissolved copper concentration to total copper concentration, the number calculated from equation 3 is multiplied by the ratio of dissolved copper to total copper in seawater. If site-specific data are not available, the ratio of 0.83 can be used. This is the USEPA's conversion factor for saltwater acute criteria.<sup>1</sup>

Finally, the TMDL is calculated according to equation 4 below:

$$(4) \quad \text{TMDL} = R_s - \text{MOS}$$

### Allocations

Equation 5 is used to determine the new allocation for passive leaching. In equation 5, the only variable is the allocation for passive leaching (Ap), while the other source allocations are constants. The allocation for hull cleaning remains the same, since it was based on the assumption that all of the divers will use Management Practices (MPs) to clean boat hulls that have copper bottom paints. Allocations for the other sources, namely urban runoff, background and sediment will not be recalculated because these sources of copper are insignificant.

$$(5) \quad \text{TMDL} = \text{Wasteload Allocation} + \text{Load Allocations} + \text{MOS}$$

$$\text{TMDL} = A_u + A_p + A_h + A_s + A_b + A_a + \text{MOS}$$

where:

$A_u$  = allocation for urban runoff = 30 kg/year

$A_p$  = allocation for passive leaching

$A_h$  = allocation for hull cleaning = 72 kg/year

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<sup>1</sup> USEPA. 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule. 40 CFR Part 131. May 18, 2000.

As = allocation for sediment = load from sediment = 0 kg/year

Ab = allocation for background = load from background = 30 kg/year

Aa = allocation for direct atmospheric deposition = load from direct atmospheric deposition = 3 kg/year.