SEPTEMBER 21, 2005

Calleguas Creek Watershed Copper Water-Effects Ratio (WER) Study

DRAFT

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GLOSSARY OF ACRONYMS

AMEL	Average Monthly Effluent Limit
BLM	Biotic Ligand Model
CCC	Continuous Criterion Concentration
CDA	Copper Development Association
CEQA	California Environmental Quality Act
cfs	cubic feet per second (measure of flow)
CMC	Criterion Maximum Concentration
CSJ	City of San Jose
Cu	Copper
Cu'	Complexed Copper
Cu^{2+}	Free Copper Ion
CV	Coefficient of Variance
CWA	Clean Water Act
DFG	Department of Fish and Game
DIC	Dissolved Inorganic Carbon
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EC50	50% Effect Concentration
EO	Executive Officer
FACR	Final Acute-to-Chronic Ratio
FB	Field Blank
FDPE	Fluorocarbon-lined High-Density Polyethylene
GPS	Global Positioning System
HDPE	High Density Polyethylene
ICP-MS	Inductively Coupled Plasma – Mass Spectrometer
LB	Laboratory Blank
LC50	50% Lethal Concentration
LOEC	Lowest Observable Effect Concentration
LWA	Larry Walker Associates
MDEL	Maximum Daily Effluent Limit
mg/L	milligrams per liter (aka: ppm)
Mn	Manganese
MSD	Minimum Significant Difference
neat water	Site or Lab water without salinity adjustment
ng/L	nanograms per liter (aka: ppt)
Ni	Nickel
NOEC	No Observable Effect Concentration
NPDES	National Pollutant Discharge Elimination System
OBS	Optical Backscatterance
PB	Procedure Blank
PER	Pacific EcoRisk Environmental Consulting and Testing
POTW	Publicly Owned Treatment Works
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand (salinity)

QA/QC	Quality Assurance/Quality Control
RPD	Relative Percent Difference
RWQCB	Los Angeles Regional Water Quality Control Board
SIP	State Implementation Policy
SOP	Standard Operating Procedures
SSO	Site-Specific Objective
SWRCB	State Water Resource Control Board
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TSS	Total Suspended Solids
ug/L	micrograms per liter (aka: ppb, parts per billion)
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WER	Water Effect Ratio
WQO	Water Quality Objective
WWTP	Wastewater Treatment Plant

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INTRODUCTION

Background

In accordance with Section 303(d) of the Clean Water Act (CWA), States are required to list waters that will not comply with adopted water quality objectives after imposition of technology-based controls on point source discharges. Mugu Lagoon (Lagoon) and Lower Calleguas Creek (Creek) were listed on the 1998 303(d) list for California due to levels of copper which exceeded 1986 Basin Plan total recoverable metals objectives and/or United States Environmental Protection Agency (USEPA) national criteria. These exceedances were the basis for a concern that copper was impairing aquatic uses in the Lagoon and Creek by producing either acute or chronic toxicity in sensitive aquatic organisms.

Bioavailability and toxicity of copper are dependent on site-specific factors such as pH, hardness, suspended solids, dissolved oxygen (i.e., Redox state), dissolved carbon compounds, salinity, and other constituents. Because of the potential for site-specific conditions to vary from the conditions used to derive the national aquatic-life criterion, USEPA has provided guidance concerning three procedures that may be used to convert a national criterion into a site-specific criterion (USEPA, 1994). One of these, the Indicator Species procedure, is based on the assumption that characteristics of ambient water may influence the bioavailability and toxicity of a pollutant. Under this procedure, acute toxicity in site water and laboratory water is determined in concurrent toxicity tests using either resident species or acceptable sensitive non-resident species, which can be used as surrogates for the resident species. The ratio of the ambient to the laboratory water toxicity values, deemed a water-effects ratio (WER), can be used to convert a national concentration criterion for a pollutant to a site-specific concentration criterion (or site-specific objective (SSO) in California terminology).

The California Toxics Rule (CTR) defines the chronic criterion for dissolved copper as 3.1 ug/L for marine water and 9.0 ug/L (at hardness of 100 mg/L) for freshwater, *multiplied by a Water Effects Ratio or WER* (40 CFR 131.38 (b) and (c)(4)(i) and (iii)). The default value for the WER is 1.0 unless a WER has been developed using methods as set forth in US EPA's WER guidance (US EPA, 1994[1]). EPA has, in effect, streamlined SSOs for trace metals given this CTR adopted wording.

Study Purpose and Approach

The purpose of this study is to develop a WER for copper using methods set forth in the US EPA's guidance. The Work Plan and Sampling & Analysis Plan were developed during 2003 through a stakeholder process that included regulators, dischargers, researchers, and environmental advocates. In particular, the Work Plan was reviewed by Technical Advisory Committee member Russ Flegal of the University of California Santa Cruz, Technical Working Group member Sam Unger of the Los Angeles Regional Water Quality Control Board, and Lucie McGovern of the City of Camarillo. This approach is consistent with the WER guidance manual (USEPA, 1994) that recommends that a multi-disciplinary "design team" with site-specific knowledge be used. The guidance also recommends including the regulatory authority on the team from the beginning. Local RWQCB and EPA staff with knowledge of the Calleguas Creek Watershed have been active participants since the beginning.

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[1]US EPA, 1994. Interim Guidance on Determination and Use of Water Effect Ratios, USEPA Office of Water, EPA-823-B-94-001, February 1994.

The final Work Plan ("Calleguas Creek Watershed Metals TMDL Work Plan [2003])" included in Appendix 1 summarizes the rationale for selecting the sampling sites, monitoring and analytical procedures, and QA/QC protocols.

The primary purpose of the study outlined in the Work Plan was to collect data to improve understanding of the aquatic toxicity of copper in the Lagoon and Creek. The study included (a) the collection of water column data to broaden the knowledge regarding spatial and temporal variability of ambient concentrations of copper and associated chemical parameters and (b) the collection of copper bioassay data for a sensitive saltwater species (*Mytilus edulis*) in the Lagoon and Creek as well as for a sensitive freshwater species (*Ceriodaphnia dubia*) in the Creek to allow calculation of WERs for these reaches. Both saltwater and freshwater species were studied in Lower Calleguas Creek water due to the tidal influence in this zone. Performing toxicity tests on both species allowed the most sensitive and conservative WERs to be developed. The study was designed to help provide a scientific basis for site-specific objectives, the copper TMDL, and future 303(d) lists.

This study was intended to:

(1) provide technically sound analytical data (i.e., accurate, reproducible, etc.),
(2) provide data which impartially characterizes chemical and toxicological conditions at various locations in the Lagoon,
(3) provide data that will be useful in the evaluation of possible copper impairment in the water column of Mugu Lagoon and Lower Calleguas Creek, and
(4) provide data that will be useful in the development of site-specific water quality objectives (WQO) for copper in the Lagoon and Creek, through the use of water effect ratios.

Sample sites were selected to provide representative spatial coverage of the Lagoon and Reach 2 of Calleguas Creek (Figure 1). The sample schedule captured both wet and dry season conditions, with two sample events conducted for dry weather and one event under wet conditions. Sample runs included four Lagoon sample sites and two Creek sample sites sampled each event, during outgoing tidal conditions.

The WER guidance recommends that data from one sampling event be analyzed prior to the next sampling event, with the goal of improving the sampling design as the study progresses. Following the first sampling event, the data was evaluated to help determine any change in direction. No changes were made in study design, as the original sites appeared to capture any variability in the Lagoon and Creek.

Related Analyses

The primary emphasis of this study was on the development of WERs for copper and on characterizing ambient total and dissolved copper. Additional analyses for various conventional water quality parameters (total suspended solids (TSS), total organic carbon (TOC), dissolved organic carbon (DOC), salinity) were also conducted for each site during each of the three events in the study. This information will be used to augment existing data, and to aid in the interpretation of toxicity test results.

Biotic Ligand Model

Some constituents not included in previous monitoring efforts in the Watershed were added to this study to provide information useful to the national effort to develop a Biotic Ligand Model (BLM). The BLM was created to evaluate bioavailability and toxicity of metals that have been discharged into surface water. The model takes into consideration several water quality parameters, including hardness, DOC, chloride, pH, and alkalinity. The USEPA is currently reviewing the BLM as a potentially less resource intensive option to WER studies for the development of site-specific criteria. The Water Environment Research Foundation (WERF) is working closely with the USEPA in the development of this model. At this stage, the model has been developed and is being calibrated and beta-tested for copper and silver. Water quality constituents required as inputs into the model were collected as part of this study in the hopes of providing useful data to BLM researchers and to ensure the data set collected could be used in the BLM at a later date. This BLM work was funded and coordinated by the Copper Development Association (CDA) and results will be reported independently.

Technical Working Group & Technical Review Committee

A Technical Working Group (TWG) was established to review documents and provide input on decisions pertaining to the metals TMDL work. The TWG members are listed below:

- Carolyn Greene - City of Thousand Oaks
- Damon Wing - Ventura Coastkeeper
- John Bejhan - City of Simi Valley
- Morgan Wehtje - Department of Fish and Game
- Rick Farris - US Fish & Wildlife Service
- Sally Coleman - Ventura County Watershed Protection District
- Sam Unger - Los Angeles Regional Water Quality Control Board
- Steve Granade - US Navy

As part of this project, a Technical Advisory Committee (TAC) was convened to provide an independent outside critique of the project design and results. A list of TAC members proposed for review of the technical documents is provided in Table 1.

Table 1. Technical Advisory Committee Members

Area of Expertise	TAC Member
Modeling	
Regulatory/TMDL Process/Standards	William Walker
Toxicity - Metals - Pesticides	 Russ Flegal, UC Santa Cruz Ronald Tjeerderma, UC Davis
Habitat - Wetlands - Riparian	 Eric Stein, SCCWRP Michael Josselyn, WRA
Bioaccumulation/Risk Assessment	David Sedlak, UC Berkeley
Agriculture - Standards - BMP implementation	 Donald Suarez, USDA-ARS George E Brown Jr. Salinity Laboratory Stephen Grattan, UC Davis
Bacteria	Stanley Grant, UC Irvine
Treatment Technology Expertise	Michael Stenstrom, UCLA

Acknowledgements

This project has been a broad, stakeholder based effort from its beginnings. The project was developed as part of the Calleguas Creek Watershed Management Plan that includes the following groups.

General Purpose Agencies	**Water/Wastewater Management Agencies**
City of Camarillo	Berylwood Mutual Water Company
City of Moorpark	Calleguas Municipal Water District
City of Simi Valley	Camarillo Sanitary District
City of Thousand Oaks	Camrosa Water District
County of Ventura	Fox Canyon Groundwater Management Agency
Ventura County Flood Control District	Pleasant Valley County Water District
	United Water Conservation District
Other Property Owners/Business Organizations	Ventura County Waterworks Districts: 1, 8, 19
Business Industry Association	Zone Mutual Water Company
Naval Base Ventura County	Ventura County Association of Water Agencies
Ventura County Economic Development Association	
Ventura County Farm Bureau	**Recreational and Open Space Entities**
	California Department of Parks & Recreation
Agencies/Organizations	Conejo Valley Park & Recreation District
California Coastal Conservancy	Pleasant Valley Park & Recreation District
California Department of Water Resources	Rancho Simi Valley Recreation & Park District
California Native Plant Society	
California Wildlife Conservation Board	**Federal and State Agencies**
Caltrans	California Coastal Conservancy
Environmental Defense Center	CA Department of Fish and Game
Natural Resources Conservation Service	Regional Water Quality Control Board- Los Angeles
Santa Monica Mountains Conservancy	US Army Corps of Engineers
Surfrider Foundation	US Environmental Protection Agency
Ventura County Resource Conservation District	US Fish and Wildlife Service

RWQCB staff approved the Metals TMDL Work Plan and associated WER Sampling & Analysis Plan and are actively participating in work being conducted under the Work Plan.

SAMPLING PROCEDURES

Sampling Locations

Sampling was conducted at four Mugu Lagoon (Reach 1) stations and two Lower Calleguas Creek (Reach 2) stations (Figure 1). Sites were selected with the intent of providing spatial coverage and representing different hydrodynamic segments of Mugu Lagoon and Lower Calleguas Creek. Mugu Lagoon is located within the Naval Air Weapons Station at Point Mugu, making access to some areas of the Lagoon for sample collection difficult and/or impossible. In addition, the Lagoon serves as the pupping and nesting grounds for harbor seals, clapper rails, snowy plovers and least terns. Access to areas of the Lagoon where pupping and nesting is occurring is limited from February to July, and in some areas this extends into September. High flows in the Lagoon immediately following a storm event made sampling via boat unsafe and inaccessible during these times.

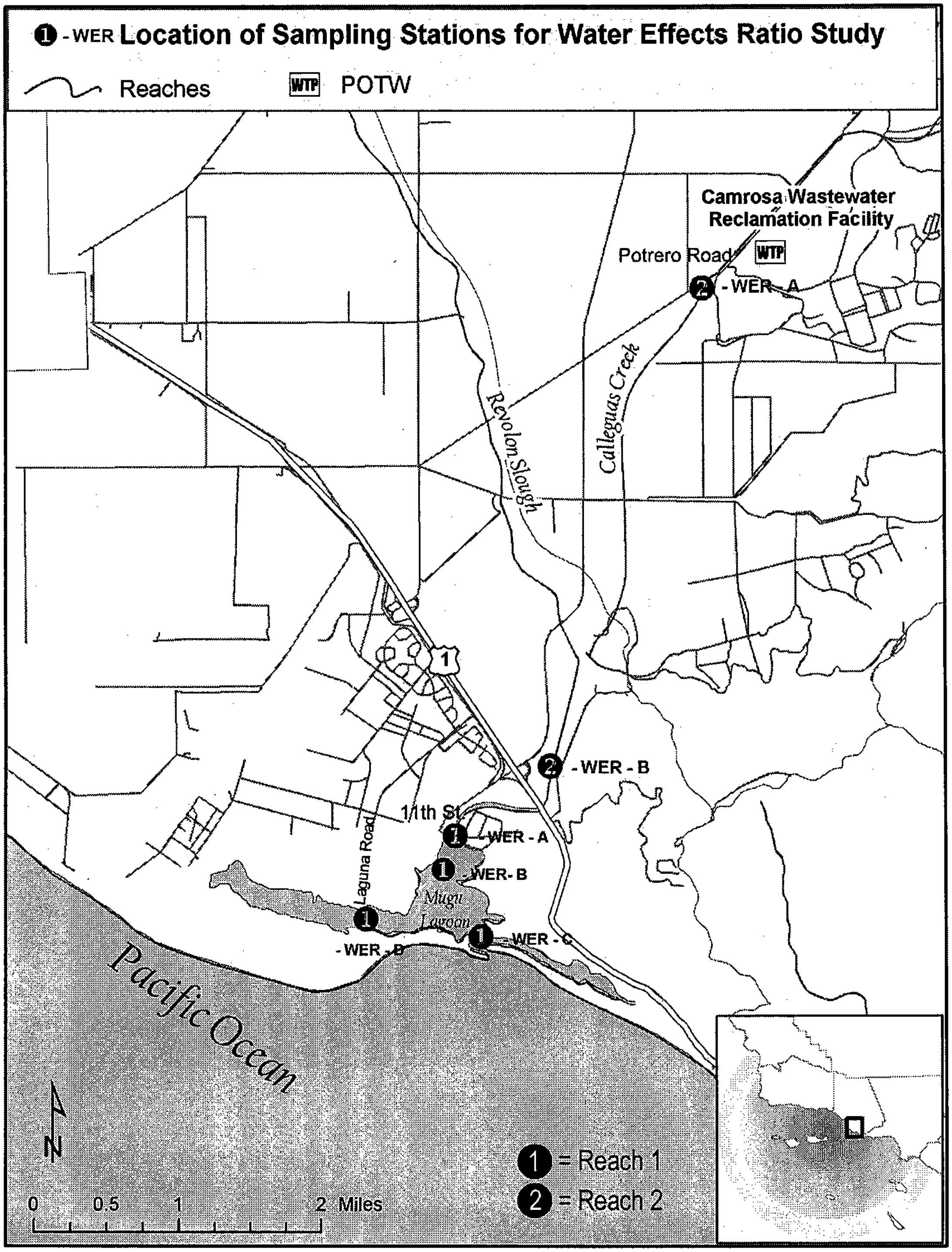

Figure 1. Map of Monitoring and Wastewater Treatment Plant Discharge Locations

Sampling Period and Site Water Collection

Sampling Period

USEPA guidance states that the selection of the number and timing of sampling events should take into account seasonal considerations and should result in at least three WERs determined with the primary test species (in this case, *Mytilus edulis* and *Ceriodaphnia dubia*) (USEPA 1994). In accordance with this guidance, three separate sets of surface-water measurements were included to assess ambient conditions and to calculate saltwater and freshwater copper WERs. The selected frequency also represented a balancing of temporal coverage with the need for extensive spatial coverage to address representative areas of the Lagoon and Creek.

Sampling events were conducted from August 2003 to March 2004 (Table 2). The goal of the sampling and toxicity testing was to produce three successful[2] WER events (two from the dry season and one from the wet season). The rationale behind the sampling period was to capture the dominant hydrological conditions observed during the year. The actual selection of sample dates was determined by a balancing of multiple criteria including favorable tidal conditions, coordination with analytical labs, availability of test organisms, and sampling boat and crew availability. Sampling conditions for each of the events included the following:

- Dry weather during late summer (August), low flows and calm conditions.
- Dry weather during winter (January), medium flows and somewhat calm conditions.
- Wet weather during winter (March), increased flows and turbid conditions following a storm event.

Table 2. Sampling Locations and Dates

Station Code	Site Location	Event 1	Event 2	Event 3
1-WER-A	Mugu Lagoon at 11th Street Bridge	8/26/03	1/27/04	3/1/04
1-WER-B	Central Mugu Lagoon			
1-WER-C	Mugu Lagoon at Mouth			
1-WER-D	Mugu Lagoon at Laguna Road Bridge			
2-WER-A	Calleguas Creek at Potrero Road	8/27/03		
2-WER-B	Calleguas Creek above Mugu Lagoon			

Site Water Collection

All samples were collected as grab samples from bridges, a boat or by wading into the sampling stream. In general, samples were taken at approximately mid-stream, mid-depth at the location of greatest flow (where feasible). Clean, powder-free nitrile gloves were worn for collection of all samples.

Upon arrival at the sampling stations, weather conditions, time, and station depth were recorded onto field logs. Using 'clean hands' techniques, samples were collected by direct submersion or using a peristaltic pump with appropriately cleaned tubing. Approximately 500 mL were collected into the cubitainer, the

[2] Samples were obtained and preponderance of test results were acceptable per QA/QC measures.

cubitainer was then capped and shaken to pre-rinse (repeated 3 times). The cubitainer was then filled with site water, sealed, and placed on ice.

Clean techniques (EPA Method 1669[3]) were used throughout all phases of the sampling and laboratory analytical work, including equipment preparation, water collection, sample handling and storage, and testing. Site water was collected in 5-gallon containers. All containers were acid-rinsed, with the exception of the scintillation vials used for the WER testing. The scintillation vials were rinsed with ultra pure water rather than acid due to associated toxicity of acid residue. Mugu Lagoon site water was collected at slack high tide to minimize TSS and DOC. In Lower Calleguas Creek, samples were collected to minimize tidal influences. After sampling, site water was placed in ice chests, on ice, until reaching the appropriate laboratories.

Upon arrival at the laboratory, water quality of the raw water was measured. Measurements included temperature, pH, total organic carbon (TOC), dissolved organic carbon (DOC), total suspended solids (TSS), total and dissolved copper, alkalinity, hardness, and salinity {see Appendix 4}. Samples were stored at 4±2°C. Site water samples were used in the toxicity tests within 24-36 hours of collection.

Routine water quality characteristics (temperature, pH, dissolved oxygen (DO) and salinity) for each event were measured in the field. Clean sampling techniques were used for all fieldwork (USEPA, 1995a). All tubing and sample containers used for the collection of ambient water samples were cleaned following USEPA guidelines (i.e., Alconox®, organic solvent, acid and de-ionized water). Methanol was used as the organic solvent, and its use was followed by a minimum of four DI rinses. Methanol was used on field sampling tubing and containers, volumetric flasks, pipettes, beakers etc., basically, all laboratory glassware and plasticware.

LABORATORY PROCEDURES

Site Water Preparation and Salinity Adjustment

Previous work has indicated that a salinity of below 25 parts per thousand (ppt) adversely affects the saltwater test species, *Mytilus edulis*. As a result, a toxicity test salinity of 30 ± 2 ppt was chosen. Site waters with a salinity <28 ppt were salinity adjusted to the selected range by adding GP-2 salts (a synthetic sea salt). Test solutions were mixed on a mechanical stir-plate (using a Teflon stir-bar) until the GP-2 salts were dissolved. The target salinity was confirmed by measuring an aliquot of water with a conductivity meter.

Synthetic Sea Salt Preparation

Synthetic sea salts were prepared as described in ASTM E-724-98: *Standard Guide for Conducting Static Acute Toxicity Tests Starting with Embryos of Four Species of Saltwater Bivalve Molluscs.* Reagent grade chemicals were combined in a one-gallon plastic container in the order provided in Table 3. The amount of salt prepared for each event varied by need. After the addition of each chemical, the container was shaken vigorously. Fresh synthetic seawater salts were prepared for each testing event.

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[3] USEPA. April 1995. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. EPA 821-R-95-034.

Table 3. Synthetic Seawater Salt Preparation

Chemical	Amount (mg)	Amount (mg/L)
NaF	3	0.79
$SrCl_2$*6$H_2$0	20	5.28
$NaSiO_3$*9$H_2$0[1]	39.4	10.41
H_3BO_3	30	7.93
KBr	100	26.42
$NaHCO_3$	200	52.84
KCl	700	184.94
$CaCl_2$*2$H_2$0	1470	388.38
Na_2SO_4	4000	1057
NaCl	23500	6209
$MgCl_2$*6$H_2$0	10780	2848
Total	40842.4	10791

[1]Substitution in place of Na_2SiO_3*$H_2$0 (20 mg)

Laboratory Dilution Water Preparation and Salinity Adjustment

Dilution water used in the laboratory water and reference toxicant tests for the saltwater tests was 1 µm sand-filtered natural seawater obtained from the Granite Canyon Marine Laboratory in Carmel, California. Seawater was collected into an appropriately cleaned and labeled 5-gallon FDPE container from a continuously running seawater source. After collection and temporary storage of the samples on wet ice in ice chests, the water was transported overnight to the Pacific EcoRisk (PER) laboratory. Upon receipt at PER, the laboratory water was logged in and placed in cold storage at 4°C ± 2°C until testing was initiated. Prior to the preparation of test solutions, an aliquot of lab water was filtered (0.45 µm) and adjusted (with reverse osmosis, 18.1 MΩ de-ionized water) to the test salinity of 30 ± 2 ppt.

The quality of seawater obtained from Granite Canyon Marine Laboratory met all laboratory standards. Granite Canyon seawater has been used since 1984 by the California Marine Bioassay Project to develop sensitive methods for testing discharges into California marine waters (USEPA, 1995b). These methods include the development of tests for abalone (*Haliotis rufescens*), topsmelt (*Atherinops affinis)*, giant kelp (*Macrocystic pyrifera*) and mysids (*Holmesimysis costata)*.

Dilution water used in the laboratory water and reference toxicant tests for the freshwater tests consisted of EPA synthetic freshwater at a hardness of 220 mg/L, prepared just prior to test initiation. This hardness was selected as a conservative estimate of Lower Calleguas Creek ambient hardness, which ranged from 371 – 485 mg/L during the three events.

Copper Spiking and Test Solution Preparation

To bracket the expected EC50 value and obtain partial effects results for *Mytilus edulis* and *Ceriodaphnia dubia* development, nominal test copper concentrations were selected. Table 4 and Table 5 provide nominal (i.e., calculated) test copper concentrations used in this study. Each toxicity test had between seven and ten concentrations of copper. Test concentrations were prepared by spiking one-liter aliquots of the laboratory and site waters with a certified commercial copper nitrate standard (obtained from Inorganic Ventures of Lakewood, New Jersey). A two-liter volume of test solution was prepared for solutions used as "duplicates". Prior to analysis, test solutions were allowed to sit for approximately three hours. This allowed copper partitioning to reach equilibrium with site water constituents and is consistent with WER guidance.

Table 4. Nominal total copper additions to site water and lab water for *Mytilus edulis* tests

Site	Nominal Test Concentrations (Total Cu ug/L)
Mugu Lagoon Sites	100, 70, 49, 34, 24, 17, 12, 8, 6, 0
Lab Water	34, 24, 17, 12, 8, 6, 4, 0
2-WER-A	500, 350, 245, 172, 120, 84, 58.8, 41, 29 and 0
2-WER-B	1000, 700, 490, 343, 240, 168, 118, 82, 58, 40 and 0
Lab Water1	100, 50, 35, 24.5, 17.2, 12.0, 8.4, 5.9, 4.1, and 0
Lab Water2	100, 70, 49, 34, 24, 17, 12, 8, 6, 4, and 0

Table 5. Nominal total copper additions to site waters and lab water for *Ceriodaphnia* tests.

Site	Nominal Test Concentrations (Total Cu ug/L)
2-WER-A	500, 350, 245, 172, 120, 84, 58.8, 41, 29 and 0
2-WER-B	1000, 700, 490, 343, 240, 168, 118, 82, 58, 40 and 0
Lab Water1	100, 50, 35, 24.5, 17.2, 12.0, 8.4, 5.9, 4.1, and 0
Lab Water2	100, 70, 49, 34, 24, 17, 12, 8, 6, 4, and 0

Toxicity Testing Procedure

Saltwater

Mytilus edulis is the ideal organism for use in saltwater WER studies with copper. When deriving a site-specific criterion, it is critical to use a test species that is sensitive at Criterion Continuous Concentrations (CCC) or Criterion Maximum Concentrations (CMC). The concentrations that affected *Mytilus edulis* approximate the criteria concentrations. *Mytilus edulis* is the most appropriate species to use both as a surrogate for brackish water species and to set a site-specific criterion for copper for a number of important reasons:

- The CTR saltwater criterion for copper is determined exclusively by *M. edulis*. Since it is used exclusively to set the current national criterion, it is appropriate to use it exclusively to set a site-specific criterion for the Lagoon and Creek.

- It is the most sensitive species in the national saltwater database. It therefore is not only a good surrogate for invertebrate species (which tend to be more sensitive to copper than vertebrates) and not only a good surrogate for mollusks (a phylum sensitive to copper – the 3rd, 4th, and 6th most sensitive species in the national copper database are mollusks), but it is a good surrogate for any sensitive saltwater animal (at any salinity above ~ 2 ppt).

- The most sensitive freshwater species to copper are daphnids (water fleas). In soft water, where copper is more bioavailable, they are about as sensitive as *M. edulis* (GMAV of 14.48 ug/L for the genus *Daphnia*, 9.92 ug/L for *Ceriodaphnia* and 9.63 ug/L for *Mytilus*).

The *Mytilus edulis* toxicity test used for this study followed the guidelines established by the USEPA manual (USEPA, 1995b). A summary of test conditions and acceptability criteria used in *Mytilus edulis* toxicity testing is provided in Appendix 6.

The adult, reproductive mussels were obtained from a commercial supplier (Carlsbad Aquafarms, Carlsbad, CA). Upon receipt and prior to spawning, the adult bivalves were stored in filtered seawater at a temperature of 15°C ± 1°C. Bivalve embryos were generated from gravid *Mytilus edulis.* To induce spawning, the gravid adults were placed into clean Bodega Bay seawater (0.45 µm-filtered) at 20°C. This increase in temperature induced the bivalves to release sperm and eggs. When an individual bivalve was observed releasing sperm or eggs, it was transferred to a separate container for isolation and collection of gametes. To evaluate viability and quality, gametes were examined microscopically. The highest quality gametes were then used to prepare freshly-fertilized embryos by mixing a solution of sperm (at the appropriate concentration) to an aliquot of the best quality eggs. The resulting embryos were examined approximately one hour after fertilization to ensure viability.

Toxicity testing required the use of five replicates at each treatment level. Each replicate consisted of a 20-mL glass scintillation vial containing 10 mL of appropriate test solution. To initiate the test, approximately 150 to 300 embryos at or beyond the two-celled stage were inoculated into each test scintillation vial. Initial embryo density numbers were not used to calculate endpoints but to verify that the controls were behaving normally (i.e., adequate survival). Additional replicates were established to determine initial embryo density, successful embryo development (i.e., to allow monitoring of the test conditions without affecting actual test replicates) and final water quality characteristics. Water quality vials contained 20 mL of test solution at the same embryo density as the test vials. Test and observation/monitoring vials were then placed into a temperature-controlled water bath at 15°C ± 1°C under a 16L: 8D photoperiod.

After 48 hrs, the "observation" vials were examined to ensure that ≥ 90% of the surviving embryos achieved normal development to the "D-hinge" stage. If normal embryo development was confirmed, the test was terminated by adding 0.5 mL of 5% glutaraldehyde. At test termination, the water quality vials at each treatment level were composited and analyzed for salinity, D.O., and pH. Each preserved test vial was subsequently examined microscopically to determine the percent of embryos exhibiting normal development.

To determine any developmental impairment or toxicity, the percent normal development results (for each treatment level) were compared to the control treatment results. Determinations of the No Observable Effect Concentration (NOEC), Lowest Observable Effect Concentration (LOEC) and key Effect Concentration (EC) point estimates were made using the CETIS® statistical package (Version 1.023, TidePool Scientific, McKinleyville, CA). EC50 values were calculated using either the Maximum Likelihood Probit or Trimmed Spearman-Karber Method. After an initial statistical evaluation using nominal copper concentrations was conducted, specific copper concentrations test treatments were selected and measured for total and dissolved copper. Test response data were reanalyzed to determine EC50 point estimates based on measured copper concentrations.

Freshwater

The acute survival test with *Ceriodaphnia dubia* was performed only on the two water samples for which the ambient salinity was below a threshold value of 2,000 + 500 µS/cm conductivity (Lower Calleguas Creek stations).

The range-finding tests for *Ceriodaphnia* consisted of acute (48-hr) exposures to test solutions that were prepared by spiking the site waters and "Lab" water with copper from a commercial $CuNO_3$ standard at concentrations of 10, 50, 100, 200, 500, and 1000 ug/L Cu. "New" water quality characteristics (pH, D.O., and conductivity) were measured for each test solution prior to use in these tests.

There were 2 replicates for each test treatment, each replicate consisting of 60-mL of test solution in a 100-mL HDPE beaker; a third "water quality" replicate was similarly established for measurement of test solution water quality characteristics. Neonate *Ceriodaphnia* (<24 hrs old), from in-house laboratory cultures, were used to start these acute tests, which were initiated by allocating 10 *Ceriodaphnia* into each of the replicate cups. The cups containing the test treatments were placed in a temperature-controlled water bath so as to maintain the water temperature in each replicate cup at 20°C, under fluorescent lighting on a 16L:8D photoperiod. Routine water quality characteristics (pH and D.O.) of the test waters were measured each day and at the end of the test in the water quality replicate. After 48 hrs, the tests were terminated and the number of live neonates in each replicate cup was determined.

The survival data for the treatments for each site water were analyzed to determine key dose response endpoints (e.g., EC50 values); all statistical analyses were performed using the CETIS® statistical package. The results of these range-finding tests were then used to determine the nominal definitive test copper concentrations based upon identification of copper concentrations that would be expected to bracket the potential range of *Ceriodaphnia dubia* acute survival EC50 values.

The control treatment for each of the two site waters consisted of an aliquot of the site water without any added copper. Nominal definitive test copper concentrations (Table 5) were selected based on the results of the copper range-finding tests performed on site waters and Lab waters so as to bracket the expected range of *Ceriodaphnia dubia* acute survival EC50 values. Test solutions at these concentrations were prepared by spiking 1.0-L aliquots of the site waters and Lab water with copper from a commercial $CuNO_3$ standard. Test solutions were allowed to sit for approximately 3 hours prior to test initiation to allow for copper partitioning to reach an equilibrium with the site water constituents. Initial test water quality characteristics (pH, D.O., and salinity) were determined for each treatment test solution prior to use in the tests.

There were 4 replicates for each test treatment, each replicate consisting of 60-mL of test solution in a 100-mL HDPE beaker; an additional "water quality" replicate was similarly established for measurement of test solution water quality characteristics. These acute tests were initiated by allocating 5 neonate *Ceriodaphnia* (< 24 hrs old), from in-house laboratory cultures, into each of the replicate beakers. The test replicates were then placed in a foam board which floated in a temperature-controlled water bath so as to maintain the water temperature in each replicate cup at 20°C, under fluorescent lighting on a 16L:8D photoperiod.

Routine water quality characteristics (pH and DO) of each of the test treatment test solutions were measured in the water quality replicate each day and at the end of the test. After 48 hrs, the tests were terminated and the number of live neonates in each replicate cup was determined. The survival data for each test treatment were analyzed and compared to the appropriate Control treatment to determine key dose-response endpoints (e.g., EC50 values); all statistical analyses were performed using the CETIS® statistical package.

Secondary and Supportive Testing

In this study, a secondary freshwater and saltwater aquatic test species were not used to verify WER results obtained from *Mytilus edulis* and *Ceriodaphnia dubia.* It was determined to be unnecessary in large part because *Mytilus edulis* is the same (and most sensitive) species used to set the USEPA saltwater quality objective for copper. Likewise, the Streamlined Water-Effect Ratio Procedure for Copper recognizes that daphnids are quite sensitive to copper and have been the most useful organisms for freshwater WER studies (USEPA, 2001). Other species for which approved toxicity tests exist would be less sensitive to copper resulting in less applicable WERs. In addition, Cu WER studies using only one species have been completed and approved in other areas. Additionally, the Streamlined Water-Effect Ratio Procedure for Copper (USEPA, 2001) requires the testing of only one species and states "the 1994 Interim Procedure recommendation for a test with a second species has been dropped, because the additional test has not been found to have value."

Reference Toxicant Testing

To confirm that the *Mytilus edulis* embryos were responding to toxic stress in a typical fashion, a reference toxicant test was run concurrently with each set of site water (and Lab water) tests. The control water used for reference toxicant testing consisted of 0.45 µm filtered seawater from Bodega Bay at 30 ppt. Test solutions were prepared by spiking the control water with copper (as $CuCl_2$) at copper concentrations of 1.25, 2.5, 5, 10, 15 and 20 ug/L.

To confirm that the *Ceriodaphnia dubia* embryos were responding to toxic stress in a typical fashion, a reference toxicant test was run concurrently with each set of site water (and Lab water) tests. The control water used for reference toxicant testing consisted of 80% Arrowhead and 20% Evian commercial spring waters. Test solutions were prepared by spiking the control water with copper (as $CuCl_2$) at copper concentrations of 4, 8, 16, 32, and 64 ug/L. Test results were used to determine EC50 endpoints to compare to the ongoing laboratory reference toxicant database to ensure that test result responses were consistent with previous test results. Statistical analyses were performed using the CETIS® statistical package.

Reference toxicity test results were used to determine key dose-response endpoints (e.g., EC50 values) to compare to the ongoing laboratory reference toxicant database to ensure that test result responses are consistent with previous test results. Statistical analyses were performed using the CETIS® statistical package.

Collection of Site water and Test Solutions

Prior to analysis, the following samples were collected for chemical analyses: samples of each test solution, "neat" (i.e., without salinity adjustment) ambient site waters and lab water. Samples undergoing copper analyses were collected by directly pouring an aliquot (800 mL to 850 mL) of test solution into a uniquelylabeled and pre-cleaned one-liter HDPE bottle. Collected samples were sealed, placed on ice and shipped to CRG Marine Laboratory in Torrance, California for analysis.

Samples of the "neat" ambient site waters and lab water were similarly collected for analyses of dissolved manganese. Additional samples of salinity-adjusted ambient site and lab waters were collected for analyses of selected major ions and other parameters associated with the bioavailability and/or toxicity of copper. Collected samples were sealed, placed on ice and shipped to CRG Marine Laboratory for ancillary analysis.

Collection of Site Waters and Test Solutions for Chemical Analyses

Immediately prior to test initiation and again at test termination, samples of each test solution were collected for copper analysis. These samples were collected into labeled, pre-cleaned 250-mL HDPE bottles (supplied by the analytical lab), which were sealed and placed within an insulated cooler. At this time, 1-L samples of each of the two site waters and of the "Lab" water were similarly collected for analysis of TSS, TOC, DOC, hardness, alkalinity and ammonia. These samples were immediately shipped via overnight delivery, on ice and under chain of custody, to the analytical laboratory (CRG Laboratories, Inc).

Measurement of Toxicity Test Solutions for Total and Dissolved Copper

Once toxicity testing was completed, guidance found in the USEPA Memorandum *Interim Guidance on the Determination and Use of Water Effect Ratios for Metals* was used to select test solutions for chemical analysis (USEPA, 1994). Rather than measuring all test solutions, this guidance recommends measuring test solutions (for initial and final dissolved copper) that are used in determining the endpoint. This study followed the USEPA recommendation of measuring only values used in determining the endpoint but with one modification. WER calculations were based on initial copper concentrations as opposed to a time-weighted average of initial and final values. This is a more conservative approach given that a proportionately greater copper recovery is expected in site water than in lab water when measured at the test conclusion (San Jose, 1998). This is most likely due to the lab water experiencing a greater loss of copper to glassware, as opposed to the site water that has more constituents that can coat the glass and prevent copper loss. The net effect of using the weighted average instead of the initial concentrations would be to have a disproportionately lower lab water EC50 that in turn would produce a disproportionately higher WER. Thus it is more conservative to analyze only the initial concentrations. Initial and final results were measured for one station's tests during the first sampling event for comparison.

Chemical Analysis of Water Samples and Test Solutions

Spiked samples were delivered to the analytical laboratory in <24 hours. Samples were handled in this manner so that all of the filtration, preservation, and other sample handling after spiking could be conducted in the analytical laboratory's clean room facilities and using their equipment and distilled acid.

Upon arrival at CRG Marine Laboratory, all samples for copper analyses were split. One of the split aliquots was then filtered (0.45 µm) and placed into a separate pre-cleaned HDPE bottle. Both aliquots (filtered and unfiltered) were preserved with ultra-pure HNO_3. "Neat" (unadjusted salinity) waters, salinity-adjusted ambient site waters, lab water and selected test solutions were analyzed for copper (total and dissolved). Copper analyses were performed using USEPA Method 200.8.

Additional samples of salinity-adjusted ambient site and lab waters were analyzed for selected major ions and other parameters associated with the bioavailability and/or toxicity of copper and nickel. In addition, Pacific EcoRisk performed pH and salinity measurements of the test solutions. Most of these constituents were included to support a parallel study using these data as input into the Biotic Ligand Model (BLM).

Table 6. Summary of Measured Parameters and Analytical Methods

Analyte	Laboratory	Method	Holding Time[a]	MDL
Total Suspended Solids (TSS)	CRG	SM 2540-D	7 days	0.1 mg/L
Total Organic Carbon (TOC)	CRG	EPA 415.1	28 days	0.5 mg/L
Dissolved Organic Carbon (DOC)	CRG	EPA 415.1	24 hrs (filter), 28 days	0.5 mg/L
Total Dissolved Solids (TDS)	CRG	SM 2540-C	7 days	0.1 mg/L
Ammonia	CRG	SM 4500-NH3 F	28 days	0.01 mg/L
Chloride	CRG	SM 4500-Cl E	28 days	0.01 mg/L
Total Hardness as CaCO3	CRG	SM 2340-B	180 days	1 mg/L
Dissolved Alkalinity	CRG	EPA 310.2	14 days	1 mg/L
Dissolved Calcium (Ca)	CRG	EPA 1640/200.8	24 hrs (filter), 180 days	0.5 mg/L
Dissolved Magnesium (Mg)	CRG	EPA 1640/200.8	24 hrs (filter), 180 days	5 mg/L
Dissolved Sodium (Na)	CRG	EPA 1640/200.8	24 hrs (filter), 180 days	5 mg/L
Dissolved Potassium (K)	CRG	EPA 1640/200.8	24 hrs (filter), 180 days	5 mg/L
Dissolved Sulfate (SO4)	CRG	SM 4500-SO4 F	24 hrs (filter), 28 days	0.01 mg/L
Total Recoverable Copper	CRG	EPA 1640/200.8	180 days	0.005/0.1 ug/L
Dissolved Copper	CRG	EPA 1640/200.8	48 hrs (filter), 180 days	0.005/0.1 ug/L

[a]Holding times are from date/time of sample collection.

QUALITY ASSURANCE/QUALITY CONTROL

Quality control/quality assurance (QA/QC) practices were maintained during all facets of this study (sampling, testing, chemical analysis). This is evidenced by the high quality, low variability results obtained in compliance with the individual lab's QA/QC criteria. QA/QC data is provided in Appendix 3.

The laboratories used, CRG Marine Laboratory and Pacific Ecorisk are NELAP/NELAC certified, and in addition, they are also certified in California.

Chemistry QA/QC

Extensive QA/QC requirements were designed into this study as part of the agreements with the contract laboratories that performed the physical, chemical, and biological analyses. This QA/QC analysis summarizes the acceptability of data generated during the three sampling events. Holding times, analytical accuracy and precision, potential contamination, and conformance to data acceptability criteria were reviewed. Questionable raw data, results or missing data were identified and referred back to the originating lab for further investigation and qualification as appropriate.

Analytical chemistry accuracy and precision were monitored throughout the three sampling events of this study using blanks, duplicates and spikes. Accuracy was assessed through percent recovery analysis of external reference standards and matrix-spike experiments. Precision of methods was determined through the calculation of relative percent difference (RPD) between matrix duplicate and field duplicate analyses. Control limits for precision and accuracy for these analyses were 20% maximum RPD, and 75% minimum to 125% maximum recovery, respectively. The potential for contamination of environmental samples was investigated through the collection and analysis of lab, field, method, filtered, and procedure blanks to determine if contamination arose at the various stages of sampling and analysis.

Analytical results, toxicity test results, and QA/QC results from each sampling event were compared with QA/QC parameters. Limited QA/QC evaluation of hardness, Mg, TOC and TSS values was performed given that precision of these parameters was less critical to the interpretation of results.

Chemistry Data Quality

Holding Times

The USEPA analytical holding time guidelines require metals sample filtration and preservation within 48 hours of sampling and analysis within 6 months. These guidelines were consistently met. A few samples (alkalinity, TDS, TSS) were analyzed outside of the recommended holding times, so these samples were qualified (Appendix 2) as "estimated" values. These qualifications did not affect the WER calculations.

Precision

Laboratory duplicate samples were analyzed and did not require any data qualifications.

Accuracy

Percent recoveries of external reference standard measurements and matrix-spike duplicates were deemed acceptable when measured values were between 75% - 125% of the certified concentration values. One sample (TOC) was qualified as "high bias" because the recovery was greater than 125%. This indicates that the concentration of TOC reported for that sample may be higher than the actual sample concentration. This qualification did not affect the subsequent WER analyses and calculations.

Toxicity Bioassay Test QA/QC

Test acceptability requirements set forth in the USEPA Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms (USEPA, 1995b) and WER test guidance (USEPA, 1994) were used in the assessment of toxicity data.

Standard Test Conditions/Test Acceptability Criteria

The toxicity testing of the ambient site waters with *Mytilus sp.* and *Ceriodaphnia dubia* incorporated standard QA procedures to ensure that the test results were valid, including the use of negative controls, positive controls, test replicates, and measurement of water quality during testing. These QA procedures are consistent with methods described in the USEPA guidelines. Water samples for the bioassay testing were shipped/stored at ≤4°C and were used within the 36 hour holding time period. All measurements of routine water quality characteristics were performed as described in the PER Standard Operating Procedures.

Lab Water Quality and Holding Times

Table 7 provides sample collection dates and respective test initiations.

Table 7. Copper WER Study Sample Collection and Test Initiation Dates

Event	Location	Site Water Collection Date	Lab Water Collection Date	Test Initiation Date[a]
Event 1	Lagoon	8/26/03	8/26/03[S]	8/27/03
	Creek	8/27/03	8/28/03[F]	8/28/03
Event 2	Lagoon	1/27/04	1/26/04[S]	1/28/04
	Creek	1/27/04	1/27/04[F]	1/28/04
Event 3	Lagoon	3/01/04	2/26/04[S]	3/02/04
	Creek	3/01/04	3/02/04[F]	3/02/04

a – All tests were initiated on the day following site water collection.
S – Saltwater
F – freshwater

Sea Salt Controls

A "sea salt" control with the maximum salinity addition (salting from zero to 30 ± 2 ppt) was used for each event to evaluate the affects of synthetic sea salts on embryo development. Salt controls were compared to lab control water to test statistical significance. Test results indicated that the addition of sea salts did not effect normal development. A summary of synthetic sea salt control results is provided in Table 8. In addition, initial test water quality characteristics (pH, D.O., and salinity) were determined for each treatment test solution prior to testing.

Table 8. Summary Results for Synthetic Sea Salt Control

Treatment	Mean Normal Development (%)
GP2 Control (8/26/04)	91.3
GP2 Control (1/27/04)	91.6
GP2 Control (3/01/04)	98.0

Initial versus Final Copper Concentrations

The CCW Study followed the initial versus final copper test sample analysis protocols established during previous studies (San Francisco Bay, New York Harbor) given the fact that these protocols had been peer reviewed and approved by both the San Francisco Bay Technical Review Committees and EPA specialists.

The 1984 WER guidance conservatively recommends that both initial and final copper measurements be made on all concentrations used in determining the EC50 endpoint. Based on previous results, in this study, only initial total and dissolved copper measurements were made for selected concentrations and the control. Subsequent statistical analyses and WER calculation were based on measured copper concentrations at the beginning of the test, rather than on a time-weighted average of initial and final values.

In the San Jose Copper WER study, for example, in which both initial and final copper values were measured for many samples, data showed that laboratory water loses more copper (proportionally) than site water (Appendix 5). This difference in percent lost results in the calculation of a higher WER (i.e., laboratory water, the denominator in the equation, has a smaller value). Therefore, using the final copper concentration, or an average of initial and final, will result in a higher WER value for all samples. Using the initial copper concentration is thus a conservative approach to WER calculation. A site-specific copper study conducted in the New York/New Jersey Harbor, analyzed both initial and final copper concentrations and then calculated the mean of the two values. The results of this study found that initial measurements of copper produced more conservative WERs because site water copper concentrations increased from initial to final, while lab water concentrations stayed virtually the same.

Initial and final copper concentrations were measured during one event of the CCW work to verify this conservative assumption. Site data (Table 9) showed a slight average increase in copper from initial to final. Lab water results showed that for spiked samples, there was a decrease in copper concentration in the final samples. Therefore, if there is an average increase in copper concentrations in site water and decrease in lab water concentrations, using the initial copper concentration will be a more conservative option as it will produce lower WER values.

Table 9. Copper concentrations in site water and lab water (ug/L) before and after toxicity testing.

Nominal Spike	Dissolved		Total	
	Initial	Final	Initial	Final
Site Water:				
0	2.13	3.54	2.92	3.36
172	125	132	141	143
245	171	180	191	196
350	210	231	263	264
Lab Water:				
0	1.11	1.92	1.34	1.59
17	14.4	14.3	14.8	12.8

Based on the San Francisco Bay and New York/New Jersey data and conclusions, along with initial and final concentrations measured in this study, it was determined that using only initial copper concentrations would be a reasonable and conservative approach for calculating WERs.

Comparison to Standard Parameters

To ensure that toxicity testing was performed during "typical conditions" in Mugu Lagoon and Lower Calleguas Creek, a couple standard parameters collected during the three events were compared to long term average and median concentrations of these same parameters (Table 10, Table 11). These comparisons indicate that conventional parameters were within the expected range for the sites based on historic data.

Table 10. Comparison of Event Hardness to Average Hardness (mg/L)

	Event 1	Event 2	Event 3
1-WER-A	6120	3550	na
1-WER-B	5990	3170	na
1-WER-C	6310	5550	1800
1-WER-D	5980	5020	3670
Reach 1 Average*		3134 mg/L	
Reach 1 Median*		2044 mg/L	
Reach 1 Range*		569 – 7000 mg/L	
2-WER-A	264	272	306
2-WER-B	451	400	371
Reach 2 Average*		541	
Reach 2 Median*		484	
Reach 2 Range*		170 –2930 mg/L	

*Reach averages, medians and ranges incorporate data from 1986 – 2004.

Table 11. Comparison of Event TSS to Average TSS (mg/L)

	Event 1	Event 2	Event 3
1-WER-A	6.0	13	78
1-WER-B	6.1	9.5	na
1-WER-C	8.4	9.8	19
1-WER-D	12	6.1	41
Reach 1 Average*		77 mg/L	
Reach 1 Median*		12 mg/L	
Reach 1 Range*		4.5 - 1675 mg/L	
2-WER-A	5.7	43	222
2-WER-B	4.0	14	41
Reach 2 Average*		63 mg/L	
Reach 2 Median*		28 mg/L	
Reach 2 Range*		4 – 922 mg/L	

*Reach averages, medians and ranges incorporate data from 2003 – 2004.

QA/QC Conclusions

The results from the three sampling events are complete with sufficient QA data to support the validity of the reported chemical and toxicological bioassay data. Only the minor QA issues discussed above were identified. None of these issues impacted the calculation of the WERs.

RESULTS

Tables of results for all measured parameters are located in Appendix 2. Bar graphs and box and whisker plots were prepared for each of the main constituents to illustrate the results of all three sampling events. Graphs and plots for site water copper concentrations and for dissolved copper (site and lab water) EC50 and WER results are presented in this section along with simple summary statistics tables.

Table 12. **Total and dissolved copper EC50 determinations for site water and lab water (*Mytilus* tests).**

Site	Date Initiated	EC50 value (ug/L) Total Cu (95% confidence limits)	EC50 value (ug/L) Dissolved Cu (95% confidence limits)
1-WER-A	8/27/03	20.8 (20.6-21.0)	19.6 (19.3-19.8)
1-WER-B	8/27/03	18.5 (18.4-18.6)	15.9 (15.8-16.0)
1-WER-C	8/27/03	17.4 (17.1-17.7)	14.7 (14.2-15.0)
1-WER-D	8/27/03	25.7 (25.4-26.2)	20.0 (19.5-20.6)
"Lab" Water	8/27/03	12.3 (12.1-12.4)	11.7 (11.5-11.8)
2-WER-A	8/28/03	59.5 (55.6-67.0)	52.9 (49.5-58.7)
2-WER-B	8/28/03	54.1 (51.2-55.8)	48.2 (45.6-49.5)
"Lab" Water	8/28/03	12.3 (12.1-12.5)	11.8 (11.5-12.0)
1-WER-A	1/28/04	40.2 (39.6-40.8)	34.4 (34.0-34.8)
1-WER-B	1/28/04	39.6 (38.5-40.4)	33.8 (33.4-34.0)
1-WER-C	1/28/04	20.1 (18.9-21.4)	16.1 (15.3-17.2)
1-WER-D	1/28/04	28.1 (20.8-37.4)	22.5 (16.2-30.6)
2-WER-A	1/28/04	71.4 (66.2-74.8)	59.4 (54.3-62.6)
2-WER-B	1/28/04	65.2 (59.3-70.4)	54.0 (49.6-57.9)
"Lab" Water	1/28/04	12.9 (12.0-13.6)	12.3 (11.5-13.0)
1-WER-A	3/2/04	79.8 (78.0-81.0)	56.8 (55.7-57.8)
1-WER-C	3/2/04	85.7 (84.5-87.0)	41.6 (40.9-42.3)
1-WER-D	3/2/04	87.8 (86.3-89.3)	54.4 (53.8-55.2)
2-WER-A	3/2/04	60.2 (58.1-62.9)	47.9 (45.9-50.4)
2-WER-B	3/2/04	>92.4 (NA)	>47.8 (NA)
"Lab" Water	3/2/04	14.3 (13.1-16.4)	14.1 (12.5-16.1)

Table 13. Total and dissolved copper EC50 determinations for site water and lab water (*Ceriodaphnia* tests).

Site	Date	EC50 value (ug/L)	
		Total Cu (95% confidence limits)	Dissolved Cu (95% confidence limits)
2-WER-A	8/28/03	169 (157-182)	150 (139-161)
2-WER-B	8/28/03	195 (175-212)	179 (161-197)
"Lab" Water	8/28/03	17.3 (15.6-19.0)	16.8 (15.2-18.4)
2-WER-A	1/28/04	205 (197-209)	175 (168-178)
2-WER-B	1/28/04	252 (240-257)	183 (174-186)
"Lab" Water	1/28/04	27.9 (27.9-27.9)	25.7 (25.7-25.7)

Individual Station Results

Results for each station, for each event are provided in the figures below. Each bar represents a separate event at that specific site. For site 1-B, samples were not able to be collected during the 3/1/2004 event because of access restrictions due to seal pupping. Dissolved copper concentrations ranged from ~1-4 ug/L in Mugu Lagoon, and ~2-8 ug/L in Lower Calleguas Creek (Figure 2). Total copper concentrations (Figure 3) followed similar trends as dissolved, with the exception of a few spikes in total concentrations at sites 1-C and 2-B. In general, dissolved copper EC50 values (Figure 4) were lower at the Mugu Lagoon sites (1-A, 1-B, 1-C, 1-D) than at the Lower Calleguas Creek sites (2-A, 2-B). Likewise, dissolved copper WER values were also lower in Mugu Lagoon. This pattern is expected, as Lower Calleguas Creek has as stronger presence of binding agents than Mugu Lagoon, which contains much more mixing with ocean waters.

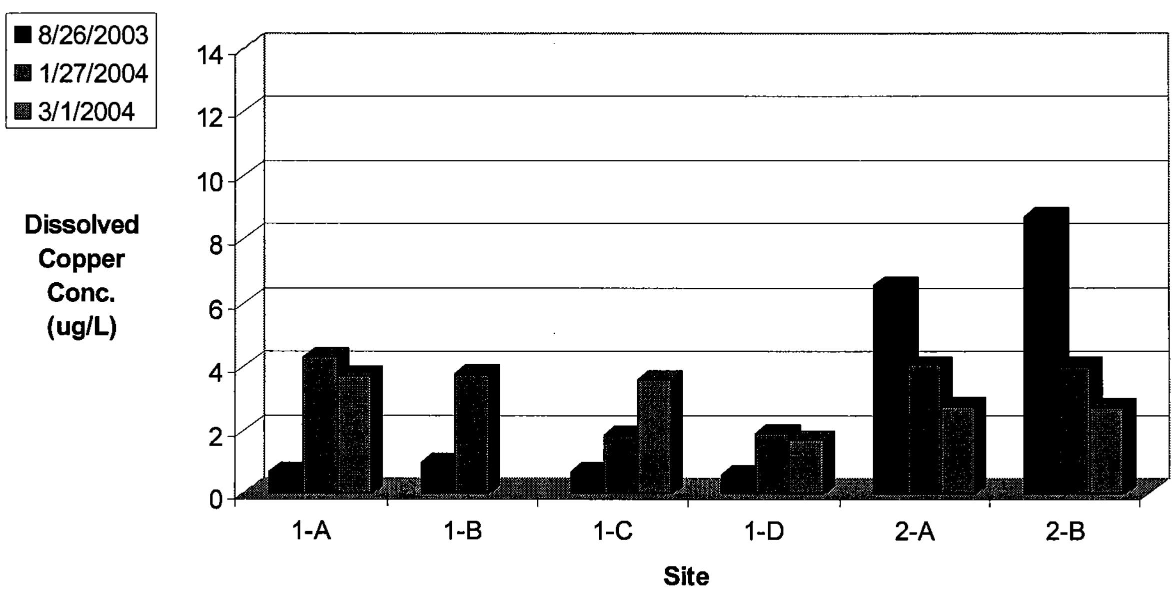

Figure 2. Dissolved copper at each site for each event (ug/L).

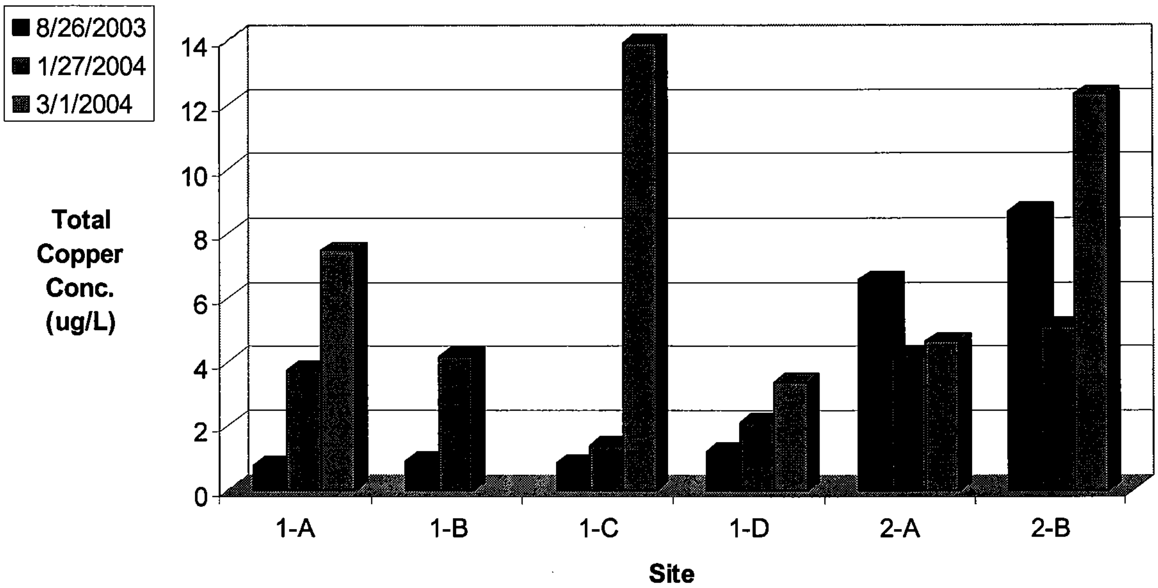

Figure 3. Total copper at each site for each event (ug/L).

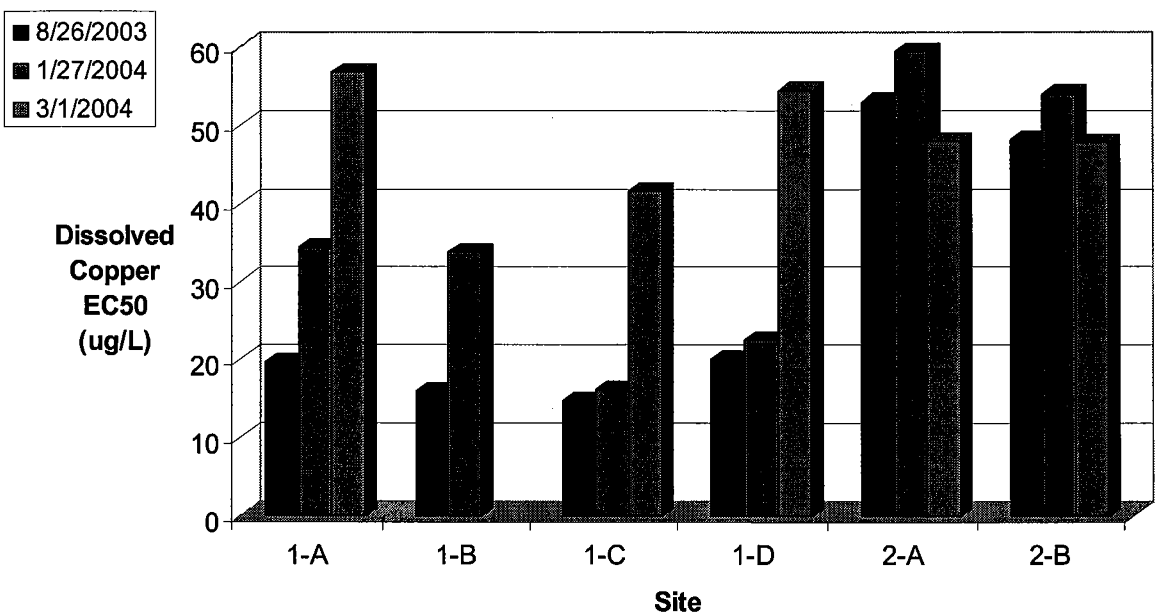

Figure 4. Dissolved copper EC50s at each Station for each event (ug/L).

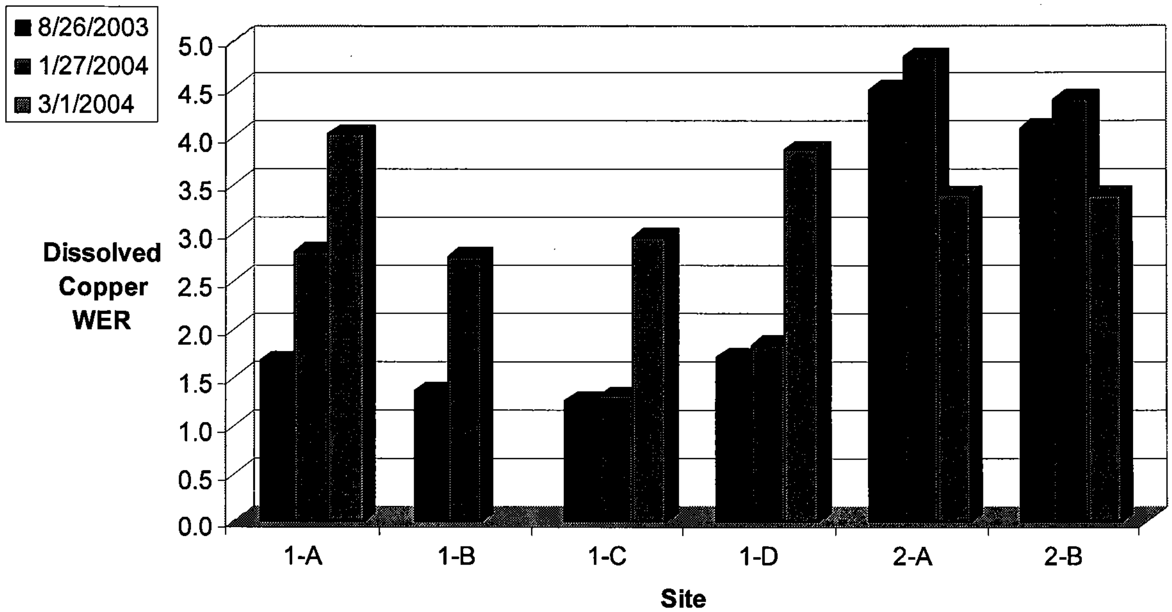

Figure 5. Dissolved copper WER at each station for each event.

Station-by-Station and Individual Event Comparisons

The bar charts presented above present all of the data collected for key constituents. Box plots are presented in this section as a simple visual way to begin to evaluate information about the distribution of the values.

The plots present the median, the 25th percentile, and the 75th percentile. The lower and upper boundaries of the box represent the 25th and 75th percentiles, respectively. The horizontal line inside the box represents the median. The length of the box corresponds to the inter-quartile range, which is the difference between the 75th and 25th percentiles.

Box plots are presented in pairs for each constituent with the upper plot showing spatial (station-by-station) results and the lower plot showing temporal (event-by-event) results. It is important to note that the station-by-station boxes include only three data points. Therefore, the 25th and 75th percentile values have minimal significance in these plots. However, these are still useful for illustrating differences between stations.

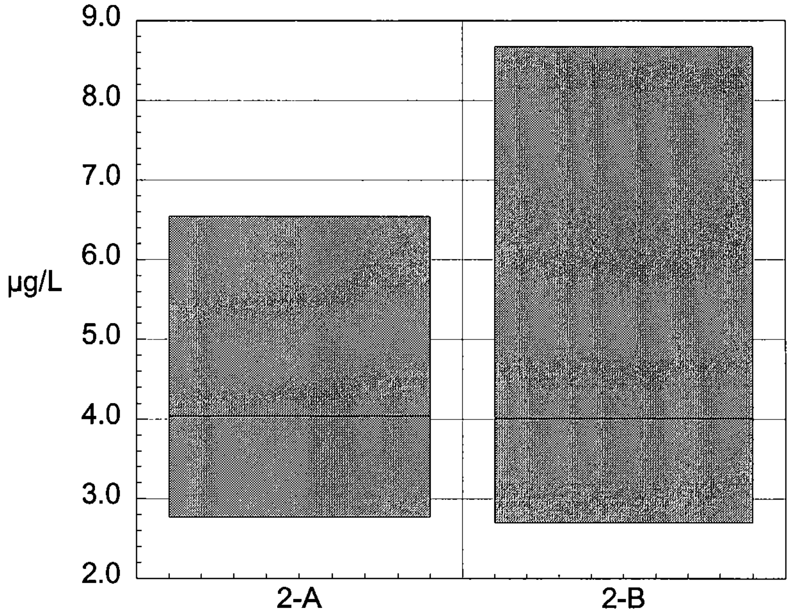

Figure 6. Lower Calleguas Creek dissolved copper ambient concentrations (ug/L) presented as box plots.

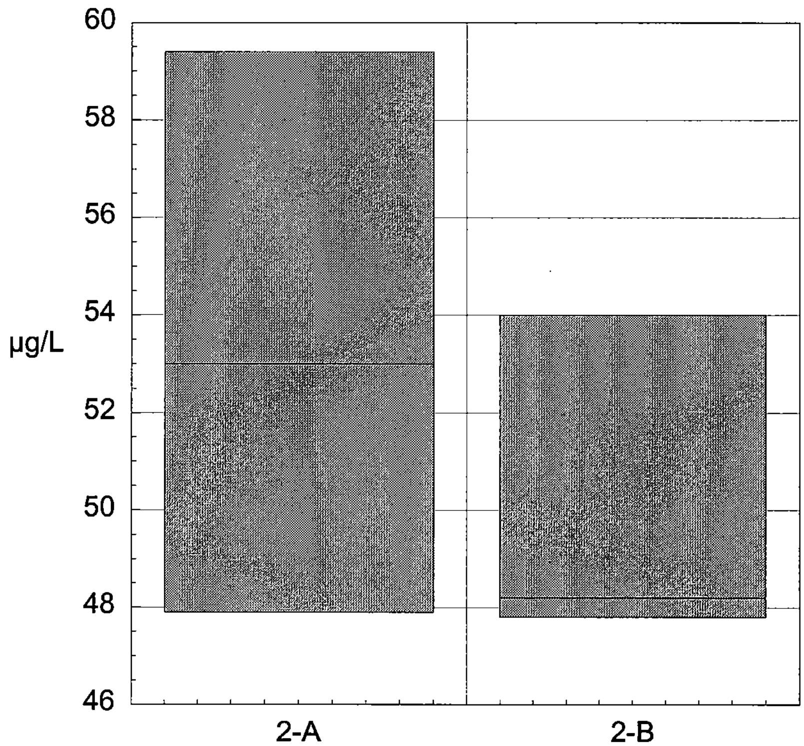

Figure 7. Lower Calleguas Creek dissolved copper EC50 (ug/L) results presented as box plots.

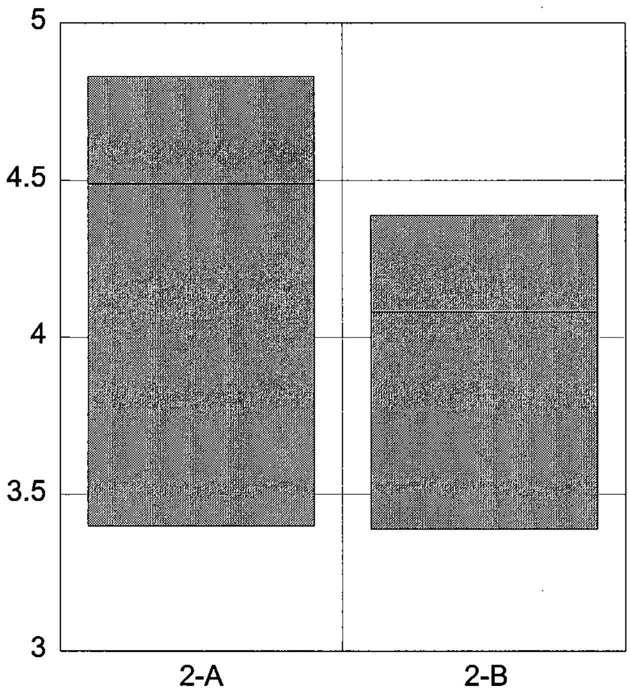

Figure 8. Lower Calleguas Creek dissolved copper WER results presented as box plots.

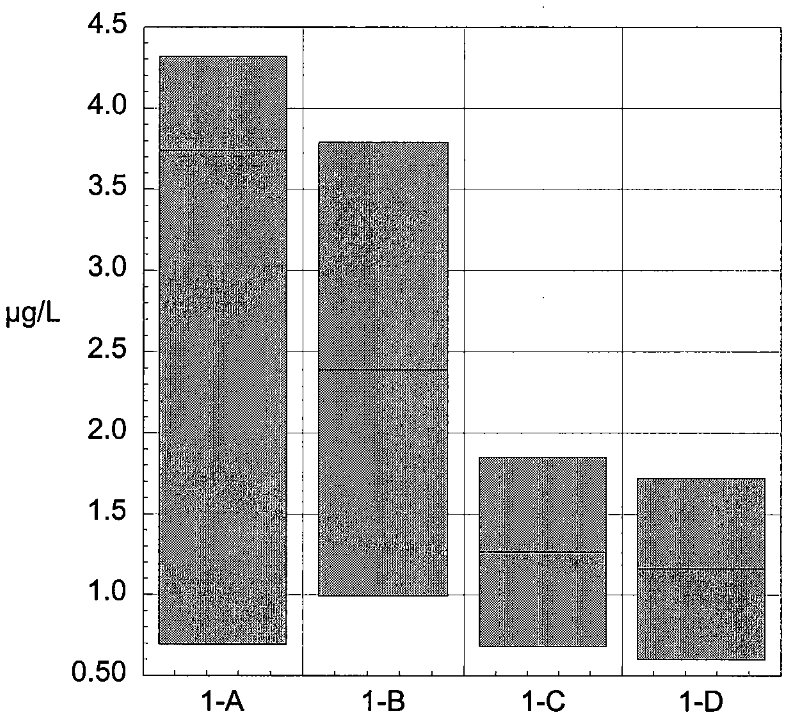

Figure 9. Mugu Lagoon dissolved copper ambient concentrations (ug/L) presented as box plots.

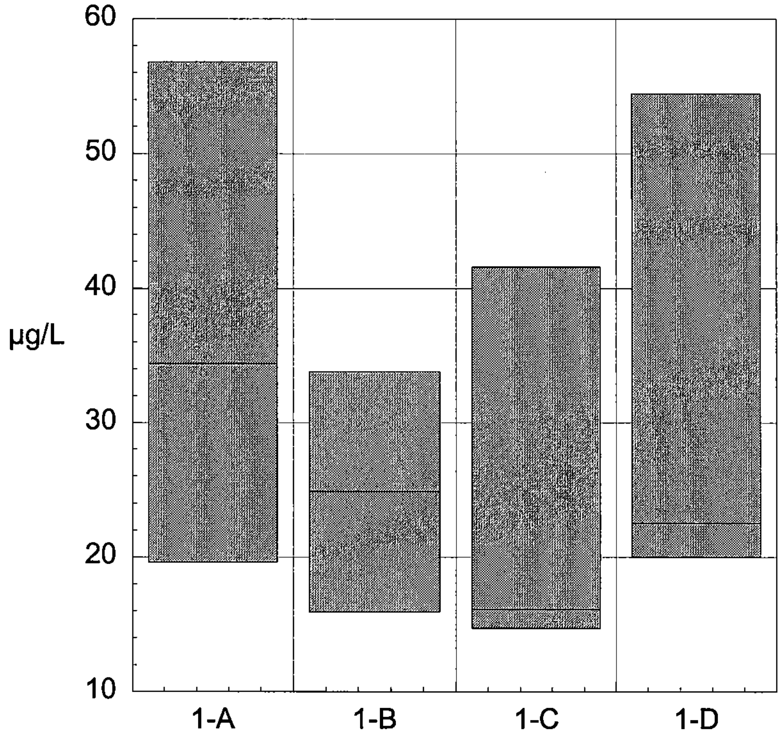

Figure 10. Mugu Lagoon dissolved copper EC50 (ug/L) results presented as box plots.

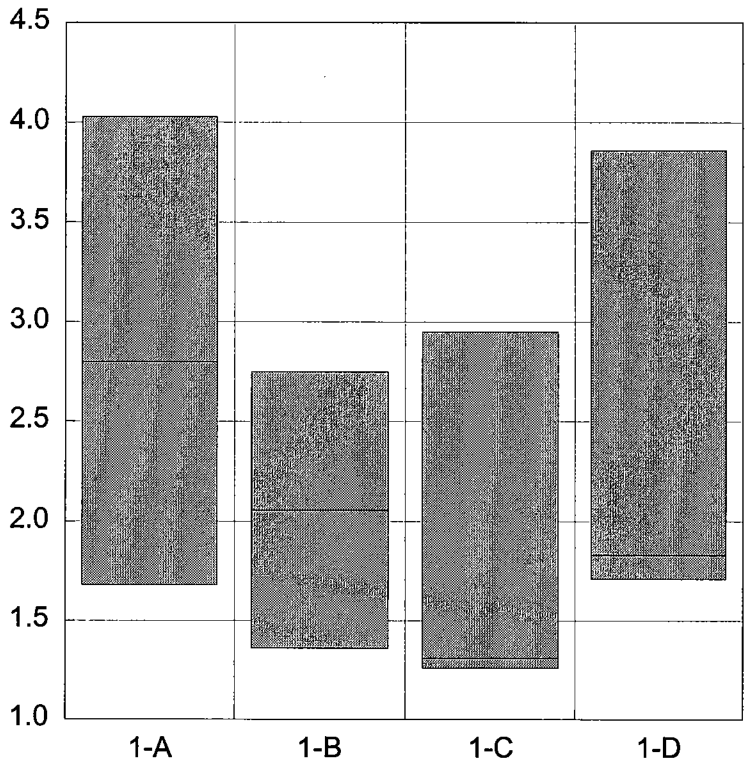

Figure 11. Mugu Lagoon dissolved copper WER results presented as box plots.

Summary Statistics

Summary statistics for dissolved copper concentrations and dissolved copper EC50s and WERs are presented in this section. Table 14 and Table 15 present the dissolved copper data measured in ambient samples collected in both Mugu Lagoon and Lower Calleguas Creek. Table 16, Table 17, and Table 18 present EC50 values for Mugu Lagoon and Lower Calleguas Creek. Results for Lower Calleguas Creek *Mytilus* and *Ceriodaphnia* tests are presented. Table 19, Table 20, and Table 21 summarize WER results for Mugu Lagoon and Lower Calleguas Creek (*Mytilus* and *Ceriodaphnia)*. Summaries are provided for each event, as well as all events combined. Finally, WER median values and geometric means are presented for a final comparison of site results (Table 22).

Table 14. Dissolved copper ambient concentrations (ug/L) in Mugu Lagoon.

Site	8/26/2003	1/27/2004	3/1/2004	All Events
1-WER-A	0.69	4.32	3.74	ave = 2.92
1-WER-B	0.99	3.79	na	ave = 2.39
1-WER-C	0.68	1.85	3.57	ave = 2.03
1-WER-D	0.60	1.90	1.72	ave = 1.41
number	4	4	3	11
minimum	0.60	1.85	1.72	0.60
maximum	0.99	4.32	3.74	4.32
a. mean	0.74	2.97	3.01	2.17
g. mean	0.73	2.75	2.84	1.71
90th Percentile	0.90	4.16	3.71	3.79
5th Percentile	0.61	1.86	1.91	0.64
median	0.69	2.85	3.57	1.85
std. deviation	0.17	1.28	1.12	1.43

Table 15. Dissolved copper ambient concentrations (ug/L) in Lower Calleguas Creek.

Site	8/26/2003	1/27/2004	3/1/2004	all events
2-WER-A	6.54	4.04	2.77	ave = 4.45
2-WER-B	8.67	4.01	2.7	ave = 5.13
number	2	2	2	6
minimum	6.54	4.01	2.70	2.70
maximum	8.67	4.04	2.77	8.67
a. mean	7.61	4.03	2.74	4.79
g. mean	7.53	4.02	2.73	4.36
90th Percentile	8.46	4.04	2.76	7.61
5th Percentile	6.65	4.01	2.70	2.72
median	7.61	4.03	2.74	4.03
std. deviation	1.51	0.02	0.05	2.36

Dissolved copper EC50 values and WERs were presented graphically above and summary statistics are provided below. Dissolved copper EC50 values were used to calculate the WERs for each station and event:

$$WER = \frac{\text{Site Water EC50}}{\text{Lab Water EC50}}$$

Table 16. Dissolved copper EC50 values (ug/L) and summary statistics in Mugu Lagoon.

Site	Event 1	Event 2	Event 3	All Events
Lab Water	11.7	12.3	14.1	ave = 12.7
1-WER-A	19.6	34.4	56.8	ave = 36.9
1-WER-B	15.9	33.8	NA	ave = 24.9
1-WER-C	14.7	16.1	41.6	ave = 24.1
1-WER-D	20.0	22.5	54.4	ave = 32.3
number	4	4	3	11
minimum	14.7	16.1	41.6	14.7
maximum	20.0	34.4	56.8	56.8
a. mean	17.5	26.7	50.9	30.0
g. mean	17.4	25.5	50.5	26.7
90th Percentile	19.9	34.2	56.3	54.4
5th Percentile	14.9	17.1	42.9	15.3
median	17.7	28.1	54.4	22.5
std. deviation	2.65	8.94	8.17	15.4

Table 17. Dissolved copper EC50 values (ug/L) and summary statistics in Lower Calleguas Creek (*Mytilus*).

Site	Event 1	Event 2	Event 3	All Events
Lab Water	11.7	12.3	14.1	ave = 12.7
2-WER-A	53.0	59.4	47.9	ave = 53.4
2-WER-B	48.2	54.0	47.8	ave = 50.0
number	2	2	2	6
minimum	48.2	54.0	47.8	47.8
maximum	53.0	59.4	47.9	59.4
a. mean	50.6	56.7	47.8	51.7
g. mean	50.5	56.6	47.8	51.5
90th Percentile	52.5	58.9	47.9	56.7
5th Percentile	48.4	54.2	47.8	47.8
median	50.6	56.7	47.8	50.6
std. deviation	3.39	3.82	0.07	4.65

Table 18. Dissolved copper EC50 values (ug/L) and summary statistics in Lower Calleguas Creek (*Ceriodaphnia*).

Site	Event 1	Event 2	All Events
Lab Water	16.8	25.7	ave = 21.3
2-WER-A	150	175	ave = 163
2-WER-B	179	183	ave = 181
number	2	2	4
minimum	150	175	150
maximum	179	183	183
a. mean	164	179	172
g. mean	163	179	171
90th Percentile	176	182	182
5th Percentile	151	175	154
median	164	179	177
std. deviation	20.5	5.66	14.9

Table 19. Dissolved copper WER values and summary statistics in Mugu Lagoon.

Site	Event 1	Event 2	Event 3	All Events
1-WER-A	1.68	2.80	4.03	ave = 2.8
1-WER-B	1.36	2.75	NA	ave = 2.1
1-WER-C	1.26	1.31	2.95	ave = 1.8
1-WER-D	1.71	1.83	3.86	ave = 2.5
number	4	4	3	11
minimum	1.26	1.31	2.95	1.26
maximum	1.71	2.80	4.03	4.03
a. mean	1.50	2.17	3.61	2.32
g. mean	1.49	2.07	3.58	2.13
90th Percentile	1.70	2.78	3.99	3.86
5th Percentile	1.27	1.39	3.04	1.28
median	1.52	2.29	3.86	1.83
std. deviation	0.23	0.73	0.58	1.01

Table 20. Dissolved copper WER values and summary statistics in Lower Calleguas Creek (*Mytilus*).

Site	Event 1	Event 2	Event 3	All Events
2-WER-A	4.49	4.83	3.40	ave = 4.2
2-WER-B	4.08	4.39	3.39	ave = 4.0
number	2	2	2	6
minimum	4.08	4.39	3.39	3.39
maximum	4.49	4.83	3.40	4.83
a. mean	4.29	4.61	3.39	4.10
g. mean	4.28	4.60	3.39	4.06
90^{th} Percentile	4.45	4.79	3.40	4.66
5^{th} Percentile	4.11	4.41	3.39	3.39
median	4.29	4.61	3.39	4.24
std. deviation	0.29	0.31	0.01	0.59

Table 21. Dissolved copper WER values and summary statistics in Lower Calleguas Creek (*Ceriodaphnia*).

Site	Event 1	Event 2	All Events
2-WER-A	8.93	6.81	ave = 7.87
2-WER-B	10.7	7.12	ave = 8.89
number	2	2	4
minimum	8.93	6.81	6.81
maximum	10.6	7.12	10.6
a. mean	9.79	6.96	8.38
g. mean	9.75	6.96	8.24
90^{th} Percentile	10.5	7.09	10.1
5^{th} Percentile	9.01	6.82	6.86
median	9.79	6.96	8.02
std. deviation	1.22	0.22	1.78

The 1994 WER guidance provides methodology for determining WERs for areas in or near plumes and areas away from plumes. Mugu Lagoon and Lower Calleguas Creek are not significantly impacted by plumes, as they are tidally influenced and treatment plant discharges are much further upstream than the sampling locations. The guidance for areas away from plumes specifies that "a WER is determined for each sample, and the final WER (FWER) is calculated as the geometric mean of some or all of the WERs" (USEPA, 1994). Additionally, the *Streamlined Water-Effect Ratio Procedure for Discharges of Copper* (though specific to situations where copper is elevated by point source effluents) also specifies that the final WER be calculated as the geometric mean of tow (or more) sample WERs. Therefore the geometric means were calculated and are presented in Table 22. All measured WERs were used in the geometric mean calculations, as there were no QA/QC issues with any of the WERs and the standard deviations between sites and events were low (Table 19, Table 20, Table 21).

Table 22. Individual site dissolved copper WER median values, and overall geometric mean WER values.

Test Species	Site	Median	Geometric Mean
Mytilus	1-WER-A	2.80	2.13
	1-WER-B	2.05	
	1-WER-C	1.31	
	1-WER-D	1.83	
	2-WER-A	4.49	4.06
	2-WER-B	4.08	
Ceriodaphnia	2-WER-A	7.87	8.24
	2-WER-B	8.89	

An aspect of spatial variability not directly addressed by WER measurements involves evaluating whether the measured ambient copper concentrations are exceeding toxicity threshold values. However the WER data can be used in an indirect manner to evaluate this issue by conducting what the WER guidance describes a "sample-specific WER approach" (USEPA, 1994).

$$\frac{\text{Measured Cu (ug/L)}}{\text{(3.1ug/L)(Cu WER)}}$$

In this approach, a quotient is calculated by dividing the concentration of dissolved copper (at each station) for each event by the product of the national WQC (3.1 ug/L) times the WER obtained for each station. The WER guidance states that "when the quotient for a sample is less than 1.0, the concentration of the metal in that sample is acceptable, when the quotient for a sample is greater than 1.0, the concentration of metal in that sample is too high (USEPA, 1994)." A table of these values using the data collected during this study shows that all such quotients are less than 1.0 (Table 23).

Table 23. Sample Specific WER Approach Results

	Event 1	Event 2	Event 3
1-WER-A	0.13	0.50	0.30
1-WER-B	0.23	0.44	*
1-WER-C	0.17	0.46	0.38
1-WER-D	0.11	0.33	0.14
2-WER-A	0.47	0.27	0.26
2-WER-B	0.69	0.29	0.26

RECOMMENDATIONS

As can be seen in Table 18, Table 21, and Table 22, the EC50 and calculated WER values from results of *Ceriodaphnia* tests are much greater than those calculated using *Mytilus* test data. Therefore, to take a conservative approach, only Mytilus results are used in subsequent calculations of WERs and site-specific objectives (SSOs). Table 24 presents all of the individual site-specific objectives that could be calculated for each site, based on test results, compared to each site's dissolved copper concentration. However, as stated above, WER guidance for areas away from plumes specifies that "a WER is determined for each

sample, and the final WER (FWER) is calculated as the geometric mean of some or all of the WERs" (USEPA, 1994). Therefore the geometric mean WERs calculated for *Mytilus,* presented in Table 22, were used to establish the SSO for Mugu Lagoon, and the SSO for Lower Calleguas Creek (
Table 25). The SSOs were determined by multiplying the CTR saltwater acute and chronic criteria by the final WERs.

Table 24. Comparison of calculated site-specific dissolved copper water quality objectives with ambient dissolved copper concentrations, using each site's WER.

Site	Event 1			Event 2			Event 3		
	WER	Chronic SSO (3.1*WER) (ug/L)	d_Cu (ug/L)	WER	Chronic SSO (3.1*WER) (ug/L)	d_Cu (ug/L)	WER	Chronic SSO (3.1*WER) (ug/L)	d_Cu (ug/L)
1-WER-A	1.68	5.21	0.69	2.8	8.68	4.32	4	12.40	3.74
1-WER-B	1.36	4.22	0.99	2.75	8.53	3.79	NA	NA	NA
1-WER-C	1.26	3.91	0.68	1.31	4.06	1.85	3	9.30	3.57
1-WER-D	1.71	5.30	0.6	1.83	5.67	1.90	3.9	12.09	1.72
2-WER-A	4.49	13.92	6.54	4.83	14.97	4.04	3.4	10.54	2.77
2-WER-B	4.08	12.65	8.67	4.39	13.61	4.01	3.4	10.54	2.7

Table 25. Recommended WERs and SSOs for Mugu Lagoon and Lower Calleguas Creek.

Reach	WER	Chronic SSO (3.1*WER)[1] (ug/L)	Acute SSO (4.8*WER)[1] (ug/L)	90^{th} Percentile Dissolved Copper Concentration (ug/L)
Mugu Lagoon	2.13	6.60	10.2	3.79
Lower Calleguas Creek	4.06	12.6	19.5	7.61

1. The Saltwater criterion is applied to both Mugu Lagoon and Lower Calleguas Creek. Mugu Lagoon salinities are >10ppt all of the time, and Lower Calleguas Creek salinities are most typically between 1-10ppt, indicating that the more stringent of the saltwater and freshwater criteria should be applied. For copper, the saltwater criterion is more stringent than the freshwater.

REFERENCES

ASTM. **1989**. Standard Guide for Conducting Static Acute Toxicity Tests Starting With the Embryos of Four Species of Saltwater Bivalve Mollusks. Standard E 724-89. American Society for Testing and Materials, Philadelphia, PA.

San Jose, City of. Environmental Service Department. **1998**. Development of a Site-Specific Water Quality Criterion for Copper in South San Francisco Bay.

USEPA. **2001**. Streamlined Water-Effect Ratio Procedure for Discharges of Copper. EPA 822-R-01-005.

USEPA. **1995a**. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. EPA 821-R-95-034.

USEPA. **1995b**. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms. EPA 600-R-95-136.

USEPA. **1994**. Interim Guidance on Determination and Use of Water-Effects Ratios for Metals. EPA 823-B-94-001.

January 2003

Appendix 1.
Calleguas Creek Watershed Copper WER Work Plan

Submitted to:
Calleguas Creek Watershed TMDL Task Force

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INTRODUCTION

In accordance with Section 303(d) of the Clean Water Act, States are required to list waters that will not comply with adopted water quality objectives after imposition of technology-based controls on point source discharges. Mugu Lagoon and Lower Calleguas Creek were listed on the 1998 and 2002 303(d) list for California due to levels of copper exceeding 1994 Basin Plan objectives and/or USEPA national criteria. These exceedances were the basis for concern that copper was impairing aquatic uses in these water bodies by producing either acute or chronic toxicity in sensitive aquatic organisms.

ISSUES

The actual bioavailability and toxicity of certain compounds can vary from waterbody to waterbody due to differences in factors such as pH, hardness, suspended solids, dissolved carbon compounds, salinity, and other characteristics. The calculation of a Water-Effect Ratio (WER) can provide information regarding the impact other compounds in the waterbody have on copper toxicity. The purpose of this work is to gather data necessary for assessing possible impairment of the Mugu Lagoon and Lower Calleguas Creek due to copper, and to evaluate whether these areas should remain on the 303(d) list for copper.

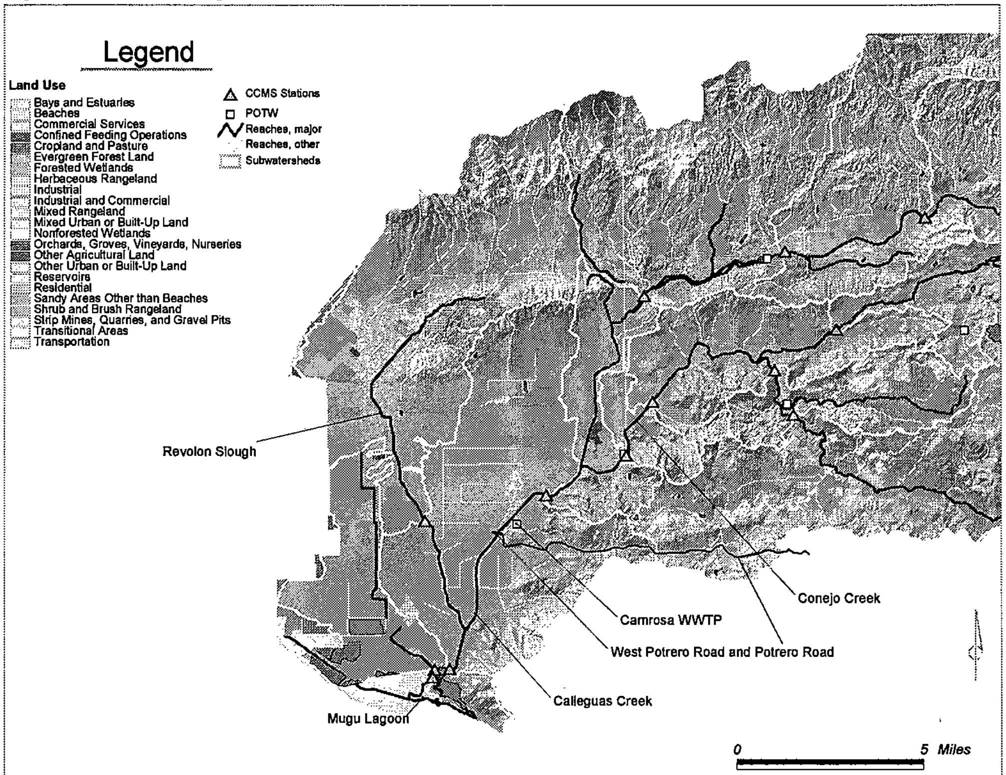
One major issue that will influence the planning of this study is that Mugu Lagoon is a salt marsh (salinity = 31-33 ppt) and Lower Calleguas Creek is a primarily freshwater system that is influenced by saltwater. Different species (saltwater and freshwater) may potentially need to be used for the development of WERs for these site waters. Below Portrero Road (see **Figure 1**) is tidally influenced, but has a low enough salinity to be considered freshwater most of the time (2.5 – 15 ppt). However, because of the varying salinity, both saltwater and freshwater objectives may be applicable to that part of the watershed. As a result, consultations with a technical review committee will be used to assess the appropriate species to use for testing in the Lower Calleguas Creek.

PURPOSE

The purpose of this work plan is to describe the studies that will be used to quantify the toxicity of copper in Mugu Lagoon and Lower Calleguas Creek. It is further envisioned that the information collected will be adequate for use in the 303(d) listing decision and the development of proposed site-specific objectives for copper.

It is intended that this work plan will be reviewed and approved by interested parties as the basis for performance of initial field studies. The work plan will be used to establish budget estimates and to seek commitments from various parties to participate in the proposed studies. After completion of an initial round of field work, the work plan will be reviewed and modified by experts serving on a technical review committee.

Figure 1. Lower Calleguas Creek Watershed



BACKGROUND

Because a national aquatic life criterion might be more or less protective than intended for the aquatic life in most bodies of water, EPA has provided guidance concerning three procedures that may be used to derive a site-specific criterion (USEPA 1994[1]):

- **The Recalculation Procedure** is intended to take into account relevant differences between the sensitivities of the aquatic organisms in the national data set and the sensitivities of organisms that occur at the site.
- **The Indicator Species Procedure** provides for the use of a WER that is intended to take into account relevant differences between the toxicity of the metal in laboratory dilution water and in site water.

[1]USEPA. 1994. Interim Guidance on Determination and Use of Water-Effects Ratios for Metals. Office of Water, Office of Science and Technology. EPA-823-B-94-001. February.

- **The Resident Species Procedure** is intended to take into account both differences in sensitivities of aquatic organisms and differences in toxicity of site water and lab water.

The Indicator Species procedure will be used in this study and is based on the assumption that characteristics of ambient water influence the bioavailability and toxicity of copper. Acute toxicity in site water and laboratory water is determined in side-by-side toxicity tests using acceptable sensitive species. The difference in toxicity values, expressed as a WER, is used to convert a national criterion for copper to a site-specific criterion.

AMBIENT DATA FOR MUGU LAGOON AND LOWER CALLEGUAS CREEK

Existing water quality data from Mugu Lagoon and Lower Calleguas Creek will be examined and compared to the water quality criteria (using a default WER of 1.0 as a first approximation) for those areas.

For data prior to 1998, analytical detection limits for copper were on the order of 10 – 100 ug/L. The majority of these results were not detected. Additional samples were collected in the Lower Calleguas Creek and Mugu Lagoon in 1998 and 1999 with a much lower copper detection limit of 0.01 ug/L. The samples in Lower Calleguas Creek (n=4) had dissolved copper concentrations ranging from 2.3 – 5.3 ug/L with an average hardness of 1400 mg/L. The Mugu Lagoon samples (n=6) had dissolved copper concentrations ranging from 2.0 – 5.1 ug/L, with an average hardness of 1978 mg/L.

LIMITATIONS OF EXISTING INFORMATION

The following data gaps currently restrict our understanding of copper toxicity in Mugu Lagoon and Lower Calleguas Creek. These issues will be addressed through this study.

- Understanding of resident species and their threshold for copper in comparison to the most sensitive species in the EPA criteria data set.
- Understanding of other constituents that may affect the toxicity of copper to sensitive species.
- Understanding true copper concentrations in these areas, since historic copper data had high detection limits.

PROPOSED APPROACH

The proposed work is comprised of the following elements.

Toxicity Testing

Toxicity tests will be used to develop copper Water-Effect Ratios (WERs) in each water body. A WER takes into account the (a) the site-specific toxicity of copper and (b) synergism, antagonism, and additivity with other constituents of the site water (USEPA 1994[2]). The calculation of a WER is performed as follows:

$$WER = \frac{\text{site water } EC_{50}}{\text{lab water } EC_{50}}$$

[2] USEPA. 1994. Interim Guidance on Determination and Use of Water-Effects Ratios for Metals. Office of Water, Office of Science and Technology. EPA-823-B-94-001. February.

If the value of the Water-Effect Ratio exceeds 1.0, water quality characteristics of the site water reduce the toxic effects of the pollutant being tested. Adjustment to the acute and chronic EPA criteria are made by multiplying the EPA's ambient water quality criteria values by the WER.

Toxicity tests in support of the development of WERs will be conducted for representative sites in Mugu Lagoon and Lower Calleguas Creek during wet and dry seasons. Detailed methodology of the testing is provided below.

The methodology for Mugu Lagoon is based on procedures employed in the City of San Jose's Site Specific Objective study for South San Francisco Bay, including the use of the indicator organism *Mytilus edulis* (blue mussel) and adherence to EPA protocols (*Interim Guidance for the Development of Water Effects Ratios for Metals*, 1994 and *Streamlined Water Effects Ratio Procedures for Copper*, 2000). For the Lower Calleguas Creek, the use of a freshwater species may be appropriate. The most sensitive freshwater species to copper are daphnids (water fleas). Therefore, the toxicity tests for Lower Calleguas Creek may use the indicator organism *Ceriodaphnia dubia*. It is intended that the first sampling run will be spatially diverse in order to provide data to a technical review committee who can then make recommendations for modifying sampling sites or other aspects of the study.

Water Quality Analysis

Analysis for specific water quality parameters (i.e. dissolved copper, TOC, DOC, TSS, salinity, hardness, alkalinity) will be conducted for each site in the study. This information is intended to augment existing data, to provide data required for the development of translators, and to aid in the interpretation of toxicity test results.

Comment:

GENERAL DESCRIPTION OF WORK

Sampling Plan

USEPA protocols favor the development of a robust data set (with an adequate number of samples). The goal is a minimum of four successful WER events, at a variety of sampling locations.

Sampling Locations

The proposed sampling plan is to perform WER testing and water quality analysis on samples taken at selected sites in each water body. These sites will be determined after field visits to the sampling areas have been completed. Sites will be selected with the intent of providing spatial coverage and representing different hydrodynamic segments of Mugu Lagoon and Lower Calleguas Creek. It is estimated that 4 stations will be chosen in Mugu Lagoon and 2 in Lower Calleguas Creek. It is likely that sampling stations used for the Calleguas Creek Monitoring Study (CCMS, see **Figure 1**) will also be chosen for this study.

Sampling Period

A one-year sampling period is proposed, ideally, beginning in summer 2003 and ending in summer 2004. EPA guidance states that the selection of the number and timing of sampling events should take into account seasonal considerations and should result in at least 3 WERs determined with the primary test species (USEPA 1994). The goal of the sampling and toxicity testing will be to produce 4 successful WER events. Funds have been budgeted to account for the possibility of failed WER events (i.e. failed spawn, failed reference toxicant test, etc.), which may require a repeat test.

Parameters to be Sampled

Two specialized and reliable environmental testing laboratories will be used for this project to conduct the analytical work on samples collected:

- CRG Marine Laboratories, Inc. (CRG), Torrance CA, will be used to conduct low detection limit copper testing [total recoverable, dissolved], total suspended solids (TSS) and dissolved organic carbon (DOC).
- Pacific EcoRisk Environmental Consulting and Testing (PER), Martinez CA, will be used to conduct the acute toxicity tests for copper. PER specializes in toxicity testing of this nature and has successfully completed a copper WER study for a coalition of NPDES permittees in San Francisco Bay.

The following table summarizes the analytical methods and sampling requirements for the parameters to be measured during the study.

Table 1. Analytical Requirements for Proposed Toxicity Tests

Constituent	Method	MDL	Holding Time	Volume Needed	Bottle(s)	Laboratory
Ceriodaphnia dubia	EPA 600/4-91-002	N/A	36 hours	2 gallons	5 gallon cubitainer	PER
Water Quality Constituents				3 gallons for all WQ constituents	5 gallon cubitainer	
Copper, TR and Diss.	EPA 1638M, ICP/MS detection	0.1 ug/L	6 months (preserved)			CRG
TSS	SM 2540C	10 mg/L	7 days			CRG
Ammonia	EPA 350.2	0.05 mg/L	28 days			PER
Hardness	SM 2340B	2.0 mg/L	6 months			PER
Alkalinity	SM 2320	1.0 mg/L	28 days			PER
DOC	SM 5310B	1 mg/L	28 days			CRG
TOC	SM 5310B	1 mg/L	28 days			CRG
pH	Meter					PER, field crew
Temperature	Meter					PER, field crew
D.O.	Meter					PER, field crew

Methodology

Sampling Preparation

Two weeks prior to the sampling event, two 5-gallon fluorocarbon-lined HDPE (FDPE) cubitainers and two 2-gallon fluorocarbon-lined HDPE (FDPE) cubitainers will be sent to CRG for cleaning. CRG will run equipment blanks on the containers and then return them for sample collection. Any bottles required for chemistry analyses will be ordered and sent directly to Pacific EcoRisk for use during sample splitting.

Water Collection

Clean techniques (EPA Method 1669[3]) will be used throughout all phases of the sampling and laboratory analytical work, including equipment preparation, water collection, sample handling and storage, and testing. Site water will be collected in 5-gallon cubitainers. Containers will be acid-rinsed, with the exception

[3] USEPA. April 1995. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. EPA 821-R-95-034.

of the scintillation vials used for the WER testing. The scintillation vials will be rinsed with ultra pure water rather than acid due to associated toxicity of acid residue. Mugu Lagoon site water will be collected at slack high tide to minimize TSS and DOC. Lower Calleguas Creek site water collection will depend on the species chosen for analysis. If *Ceriodaphnia dubia* is used, samples will be collected at locations and times that minimize tidal influences (upstream sites at low tide) to minimize the salinity in the sample water. After sampling, site water will be placed in ice chests, on ice, until it reaches the appropriate laboratories.

Upon arrival at the laboratory, water quality of the raw water should be measured. Measurements should include temperature, pH, total organic carbon (TOC), dissolved organic carbon (DOC), total suspended solids (TSS), total and dissolved copper, alkalinity, hardness, and salinity. Samples should be stored at 4±2°C. Site water samples should be used in the toxicity tests within 24-36 hours of collection.

Site Water Preparation and Salinity Adjustment
In order to remove potential predators site waters should be filtered through a 50 um filter screen. All saltwater toxicity tests should be conducted at ambient salinity of the laboratory water (30-32 ppt). Artificial salts will be added to site water, if necessary, to bring its salinity up to 32 ppt for testing. A saltwater control will be run to verify that the salt additions are not contributing to the toxicity of the site water.

If tested with a freshwater species, site waters from Lower Calleguas Creek will not require any salinity adjustments.

Laboratory Water
Seawater to be used as the laboratory water for saltwater toxicity tests will be collected from a continuously running seawater system one to two days prior to testing. Laboratory water for any freshwater samples will be moderately hard laboratory dilution water. Upon arrival at the laboratory, the seawater laboratory waters will be stored at 4±2°C. Basic water quality (temperature, pH, TOC, DOC, TSS, alkalinity, hardness, and salinity) and trace metal (total and dissolved copper, dissolved manganese) will be determined.

Toxicity Testing Procedure
Toxicity testing will be in accordance with established protocols. The methods used in conducting the WER tests will follow the guidelines established in EPA document "Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms, Third Edition" (EPA/600/4-91/002). Laboratory water/reference toxicant test water and site waters should be spiked with seven different concentrations of copper using a 0.7 dilution ratio. (It is possible that making ten different concentrations would be necessary during the first event to ensure a proper dose response curve is attained.) One liter of water should be prepared in a volumetric flask for each test. The flask can be used serially, first for the control water, and then for each of the seven concentrations, in order of increasing concentration. From the flask, 10 mL should be taken for each scintillation test vial. There should be five replicate test vials for each of the seven concentrations, plus a set of controls (total of 40 scintillation vials). The remaining water should be used for chemical analysis.

Chemical Analyses
Trace metals analysis for samples from Mugu Lagoon should be performed using a chelation/extraction technique to remove positive salinity interferences. EPA guidance recommends that the detection limit be less than one-tenth of the CCC or CMC that is to be adjusted. Analytical measurements must be sufficiently

sensitive and precise that variability in analyses will not greatly increase the variability of the WERs (EPA 1994).

Following each testing event, the chemistry results will be reviewed. Samples will be re-analyzed if measurements are outside reasonable limits (i.e. <80% ratio of nominal to total measurements, dissolved value is greater than total value, etc.).

The EPA WER procedure recommends that initial and final copper measurement be made on all concentrations used in determining the endpoint. For this study, only initial total and dissolved copper measurements will be made for selected concentrations and the control. Subsequent statistical analyses and WER calculation will be based only on measured copper concentrations at the beginning of the test, rather than on a time-weighted average of initial and final values. This is a conservative approach, as using only initial values for dissolved copper is likely to produce a lower WER. One test will be run in which both initial and final values are measured to verify that copper recovery over time in lab water tends to be lower than recovery in site water, yielding a higher WER if time-weighted averages are used in WER calculation rather than initial concentrations only.

QA/QC

The main goal of this work is to produce high quality data that can be used by regulatory and non-regulatory decision-makers with confidence. Several Quality Control/Quality Assurance measures will be built into the study to ensure the validity and reproducibility of the results. Clean techniques will be employed in all aspects of the study. Chemistry measurements will include a method blank and a standard (certified reference material). Blind standards will be used in chemistry samples for each WER event.

Program Management

The administration of the study will be addressed through the process discussed in the Administrative and Public Process document associated with these TMDLs. Management requirements specific to the data analysis and quality assurance for the study are discussed here.

Monitoring

A program coordinator will manage the performance of field and laboratory studies. The coordinator must be on board at the outset of the program and should continue throughout the data collection period.

Data Analysis

The data to be collected will be used to address main objectives of the study. Data will be evaluated for compliance with quality control criteria at the end of each sampling event. Poor data will be rejected and replaced in a timely fashion. Close scrutiny will be required over the WER testing.

Reporting

The results of the proposed studies will be summarized in a technical report submitted to the Regional Board. The report must describe the overall program and must clearly show the results from the toxicity testing and chemical analyses.

External Review

A technical review panel consisting of three experts in the field of toxicity, ecology and chemistry shall be assembled to assist in the review of the work plan and subsequent deliverables. A process for review of the technical report by important state and federal agencies will be established.

Stakeholder Outreach

Efforts will be made to reach out to other interested parties to solicit input regarding key aspects of the proposed program. This will include holding a technical workshop to review methods, results and conclusions for the proposed studies. The budget for this work plan does not include an allocation for performance of outreach activities.

Regulatory Liaison

The study will need to actively involve RWQCB, USEPA, and DFG staff throughout the process. In addition, a petition for the SSO will need to be submitted per the SIP. RWQCB staff will need to approve the work plan and any future changes. The TMDL working groups, including regulators and environmental groups, will be used for reviewing the work throughout the study.

Estimated Costs

A summary of estimated costs is included in the task list associated with the Metals TMDL Work Plan.

Appendix 2. Calleguas Creek Watershed Copper Water Effects Ratio Environmental Data

Reach	ProjectSiteID	Sample Date	Constituent	Sign	Result	Units	Qual	Method	Detection Limit	DL Type	Lab Qual
1	1-WER-A-0 (i)	8/27/2003	Copper, Dissolved	=	1.34	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-0 (i)	8/27/2003	Copper, Total	=	2.07	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-12	8/27/2003	Copper, Dissolved	=	9.36	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-12	8/27/2003	Copper, Total	=	11.2	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-17 (i)	8/27/2003	Copper, Dissolved	=	12.3	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-17 (i)	8/27/2003	Copper, Total	=	15.9	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-24	8/27/2003	Copper, Dissolved	=	18.1	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-24	8/27/2003	Copper, Total	=	21.8	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-0	8/27/2003	Copper, Dissolved	=	1.26	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-0	8/27/2003	Copper, Total	=	1.92	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-12	8/27/2003	Copper, Dissolved	=	9.36	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-12	8/27/2003	Copper, Total	=	11.1	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-17	8/27/2003	Copper, Dissolved	=	12.9	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-17	8/27/2003	Copper, Total	=	15.4	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-24	8/27/2003	Copper, Dissolved	=	19.1	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-24	8/27/2003	Copper, Total	=	21.8	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-34	8/27/2003	Copper, Dissolved	=	26.2	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-34	8/27/2003	Copper, Total	=	28.8	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-0	8/27/2003	Copper, Dissolved	=	1.24	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-0	8/27/2003	Copper, Total	=	1.76	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-12	8/27/2003	Copper, Dissolved	=	8.91	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-12	8/27/2003	Copper, Total	=	10.9	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-17	8/27/2003	Copper, Dissolved	=	11.7	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-17	8/27/2003	Copper, Total	=	15.2	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-24	8/27/2003	Copper, Dissolved	=	18.4	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-24	8/27/2003	Copper, Total	=	20.2	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-34	8/27/2003	Copper, Dissolved	=	27.4	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-34	8/27/2003	Copper, Total	=	27.2	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-0	8/27/2003	Copper, Dissolved	=	1.49	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-0	8/27/2003	Copper, Total	=	2.58	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-24	8/27/2003	Copper, Dissolved	=	15.9	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-24	8/27/2003	Copper, Total	=	22.4	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-34	8/27/2003	Copper, Dissolved	=	22	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-34	8/27/2003	Copper, Total	=	27.3	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-49	8/27/2003	Copper, Dissolved	=	29.7	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-49	8/27/2003	Copper, Total	=	40	µg/L		EPA 1640	0.005	MDL	
3	2-WER-A-0	8/28/2003	Copper, Dissolved	=	4.02	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-0	8/28/2003	Copper, Total	=	4.63	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-34	8/28/2003	Copper, Dissolved	=	27.6	µg/L		EPA 200.8	0.1	MDL	

Appendix 2. Calleguas Creek Watershed Copper Water Effects Ratio Environmental Data

Reach	ProjectSiteID	Sample Date	Constituent	Sign	Result	Units	Qual	Method	Detection Limit	DL Type	Lab Qual
3	2-WER-A-34	8/28/2003	Copper, Total	=	31.2	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-49	8/28/2003	Copper, Dissolved	=	40.2	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-49	8/28/2003	Copper, Total	=	44.1	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-70	8/28/2003	Copper, Dissolved	=	54.8	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-70	8/28/2003	Copper, Total	=	61.8	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-100	8/28/2003	Copper, Dissolved	=	77.6	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-100	8/28/2003	Copper, Total	=	87.8	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-0	8/28/2003	Copper, Dissolved	=	4.06	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-0	8/28/2003	Copper, Total	=	4.69	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-34	8/28/2003	Copper, Dissolved	=	27.4	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-34	8/28/2003	Copper, Total	=	31.2	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-49	8/28/2003	Copper, Dissolved	=	40.9	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-49	8/28/2003	Copper, Total	=	45.3	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-70	8/28/2003	Copper, Dissolved	=	57.6	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-70	8/28/2003	Copper, Total	=	65.4	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-100	8/28/2003	Copper, Dissolved	=	83.3	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-100	8/28/2003	Copper, Total	=	86.9	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-0	8/29/2003	Copper, Dissolved	=	3.13	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-0	8/29/2003	Copper, Total	=	3.21	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-0 t=48	8/31/2003	Copper, Dissolved	=	3.54	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-0 t=48	8/31/2003	Copper, Total	=	3.36	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-172 t=48	8/31/2003	Copper, Dissolved	=	132	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-172 t=48	8/31/2003	Copper, Total	=	143	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-245 t=48	8/31/2003	Copper, Dissolved	=	180	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-245 t=48	8/31/2003	Copper, Total	=	196	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-350 t=48	8/31/2003	Copper, Dissolved	=	231	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-350 t=48	8/31/2003	Copper, Total	=	264	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-0 t=48	8/31/2003	Copper, Dissolved	=	3.65	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-0 t=48	8/31/2003	Copper, Total	=	3.73	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-336.1 t=48	8/31/2003	Copper, Dissolved	=	129	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-336.1 t=48	8/31/2003	Copper, Total	=	135	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-480 t=48	8/31/2003	Copper, Dissolved	=	178	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-480 t=48	8/31/2003	Copper, Total	=	179	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-686 t=48	8/31/2003	Copper, Dissolved	=	257	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-686 t=48	8/31/2003	Copper, Total	=	264	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-980 t=48	8/31/2003	Copper, Dissolved	=	327	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-980 t=48	8/31/2003	Copper, Total	=	367	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-336.1	8/29/2003	Copper, Dissolved	=	126	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-336.1	8/29/2003	Copper, Total	=	140	µg/L		EPA 200.8	0.1	MDL	

Appendix 2. Calleguas Creek Watershed Copper Water Effects Ratio Environmental Data

Reach	ProjectSiteID	Sample Date	Constituent	Sign	Result	Units	Qual	Method	Detection Limit	DL Type	Lab Qual
2	2-WER-B-Cerio-480	8/29/2003	Copper, Dissolved	=	185	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-480	8/29/2003	Copper, Total	=	210	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-686	8/29/2003	Copper, Dissolved	=	244	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-686	8/29/2003	Copper, Total	=	238	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-980	8/29/2003	Copper, Dissolved	=	330	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-980	8/29/2003	Copper, Total	=	392	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-0	8/29/2003	Copper, Dissolved	=	2.13	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-0	8/29/2003	Copper, Total	=	2.92	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-172	8/29/2003	Copper, Dissolved	=	125	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-172	8/29/2003	Copper, Total	=	141	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-245	8/29/2003	Copper, Dissolved	=	171	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-245	8/29/2003	Copper, Total	=	191	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-350	8/29/2003	Copper, Dissolved	=	210	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-350	8/29/2003	Copper, Total	=	263	µg/L		EPA 200.8	0.1	MDL	
1	1-WER-A-0 (F)	8/29/2003	Copper, Dissolved	=	2.66	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-0 (F)	8/29/2003	Copper, Total	=	2.7	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-17 (F)	8/29/2003	Copper, Dissolved	=	11.9	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-17 (F)	8/29/2003	Copper, Total	=	13.9	µg/L		EPA 1640	0.005	MDL	
2	2-WER-B-Cerio-2000	8/29/2003	Copper, Dissolved	=	514	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-2000	8/29/2003	Copper, Total	=	921	µg/L		EPA 200.8	0.1	MDL	
1	1-WER-A-0	1/28/2004	Copper, Dissolved	=	3.13	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-0	1/28/2004	Copper, Total	=	3.7	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-24	1/28/2004	Copper, Dissolved	=	21.4	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-24	1/28/2004	Copper, Total	=	25.1	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-34	1/28/2004	Copper, Dissolved	=	29.9	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-34	1/28/2004	Copper, Total	=	35	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-0	1/28/2004	Copper, Dissolved	=	2.78	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-0	1/28/2004	Copper, Total	=	3.44	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-17	1/28/2004	Copper, Dissolved	=	16	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-17	1/28/2004	Copper, Total	=	19.2	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-24	1/28/2004	Copper, Dissolved	=	21.6	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-24	1/28/2004	Copper, Total	=	25.9	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-34	1/28/2004	Copper, Dissolved	=	31.6	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-34	1/28/2004	Copper, Total	=	33.5	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-49	1/28/2004	Copper, Dissolved	=	36.6	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-49	1/28/2004	Copper, Total	=	47.4	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-70	1/28/2004	Copper, Dissolved	=	58.4	µg/L		EPA 1640	0.005	MDL	
1	1-WER-B-70	1/28/2004	Copper, Total	=	58.7	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-0	1/28/2004	Copper, Dissolved	=	0.431	µg/L		EPA 1640	0.005	MDL	

Appendix 2. Calleguas Creek Watershed Copper Water Effects Ratio Environmental Data

Reach	ProjectSiteID	Sample Date	Constituent	Sign	Result	Units	Qual	Method	Detection Limit	DL Type	Lab Qual
1	1-WER-C-0	1/28/2004	Copper, Total	=	0.784	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-12	1/28/2004	Copper, Dissolved	=	9.93	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-12	1/28/2004	Copper, Total	=	12.1	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-17	1/28/2004	Copper, Dissolved	=	13.9	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-17	1/28/2004	Copper, Total	=	16.9	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-24	1/28/2004	Copper, Dissolved	=	18.8	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-24	1/28/2004	Copper, Total	=	24	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-34	1/28/2004	Copper, Dissolved	=	27.3	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-34	1/28/2004	Copper, Total	=	31.6	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-0	1/28/2004	Copper, Dissolved	=	1.16	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-0	1/28/2004	Copper, Total	=	1.37	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-34	1/28/2004	Copper, Dissolved	=	27	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-34	1/28/2004	Copper, Total	=	33.7	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-49	1/28/2004	Copper, Dissolved	=	38.9	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-49	1/28/2004	Copper, Total	=	44.4	µg/L		EPA 1640	0.005	MDL	
3	2-WER-A-0	1/28/2004	Copper, Dissolved	=	3.61	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-0	1/28/2004	Copper, Total	=	4.36	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-100	1/28/2004	Copper, Dissolved	=	83.1	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-100	1/28/2004	Copper, Total	=	93.4	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-49	1/28/2004	Copper, Dissolved	=	43	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-49	1/28/2004	Copper, Total	=	47.9	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-70	1/28/2004	Copper, Dissolved	=	52.4	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-70	1/28/2004	Copper, Total	=	65	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-0	1/28/2004	Copper, Dissolved	=	3.07	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-0	1/28/2004	Copper, Total	=	4.85	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-100	1/28/2004	Copper, Dissolved	=	74.4	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-100	1/28/2004	Copper, Total	=	90.6	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-49	1/28/2004	Copper, Dissolved	=	38.1	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-49	1/28/2004	Copper, Total	=	47.3	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-70	1/28/2004	Copper, Dissolved	=	51.9	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-70	1/28/2004	Copper, Total	=	62.6	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-0	1/28/2004	Copper, Dissolved	=	3.5	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-0	1/28/2004	Copper, Total	=	3.95	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-0	1/28/2004	Copper, Dissolved	=	3.33	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-0	1/28/2004	Copper, Total	=	4.35	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-118	1/28/2004	Copper, Dissolved	=	78.9	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-118	1/28/2004	Copper, Total	=	106	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-120	1/28/2004	Copper, Dissolved	=	92	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-120	1/28/2004	Copper, Total	=	103	µg/L		EPA 200.8	0.1	MDL	

Appendix 2. Calleguas Creek Watershed Copper Water Effects Ratio Environmental Data

Reach	ProjectSiteID	Sample Date	Constituent	Sign	Result	Units	Qual	Method	Detection Limit	DL Type	Lab Qual
2	2-WER-B-Cerio-168	1/28/2004	Copper, Dissolved	=	110	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-168	1/28/2004	Copper, Total	=	151	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-172	1/28/2004	Copper, Dissolved	=	142	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-172	1/28/2004	Copper, Total	=	165	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-240	1/28/2004	Copper, Dissolved	=	143	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-240	1/28/2004	Copper, Total	=	197	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-245	1/28/2004	Copper, Dissolved	=	212	µg/L		EPA 200.8	0.1	MDL	
3	2-WER-A-Cerio-245	1/28/2004	Copper, Total	=	250	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-343	1/28/2004	Copper, Dissolved	=	227	µg/L		EPA 200.8	0.1	MDL	
2	2-WER-B-Cerio-343	1/28/2004	Copper, Total	=	313	µg/L		EPA 200.8	0.1	MDL	
1	1-WER-A-0	3/2/2004	Copper, Dissolved	=	3.72	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-0	3/2/2004	Copper, Total	=	6.58	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-49	3/2/2004	Copper, Dissolved	=	35.8	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-49	3/2/2004	Copper, Total	=	50.6	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-70	3/2/2004	Copper, Dissolved	=	52.2	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-70	3/2/2004	Copper, Total	=	72.6	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-100	3/2/2004	Copper, Dissolved	=	65.6	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-101	3/2/2004	Copper, Total	=	93.6	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-0	3/2/2004	Copper, Dissolved	=	3.55	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-0	3/2/2004	Copper, Total	=	11.5	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-70	3/2/2004	Copper, Dissolved	=	33.3	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-70	3/2/2004	Copper, Total	=	70.3	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-100	3/2/2004	Copper, Dissolved	=	47.8	µg/L		EPA 1640	0.005	MDL	
1	1-WER-C-100	3/2/2004	Copper, Total	=	97.2	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-0	3/2/2004	Copper, Dissolved	=	1.47	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-0	3/2/2004	Copper, Total	=	3.46	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-70	3/2/2004	Copper, Dissolved	=	44	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-70	3/2/2004	Copper, Total	=	67.5	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-100	3/2/2004	Copper, Dissolved	=	58.4	µg/L		EPA 1640	0.005	MDL	
1	1-WER-D-100	3/2/2004	Copper, Total	=	95.4	µg/L		EPA 1640	0.005	MDL	
3	2-WER-A-0	3/2/2004	Copper, Dissolved	=	3.21	µg/L		EPA 1640	0.005	MDL	
3	2-WER-A-0	3/2/2004	Copper, Total	=	5.1	µg/L		EPA 1640	0.005	MDL	
3	2-WER-A-49	3/2/2004	Copper, Dissolved	=	37.3	µg/L		EPA 1640	0.005	MDL	
3	2-WER-A-49	3/2/2004	Copper, Total	=	49	µg/L		EPA 1640	0.005	MDL	
3	2-WER-A-70	3/2/2004	Copper, Dissolved	=	51	µg/L		EPA 1640	0.005	MDL	
3	2-WER-A-70	3/2/2004	Copper, Total	=	63.5	µg/L		EPA 1640	0.005	MDL	
3	2-WER-A-100	3/2/2004	Copper, Dissolved	=	70.5	µg/L		EPA 1640	0.005	MDL	
3	2-WER-A-100	3/2/2004	Copper, Total	=	94.4	µg/L		EPA 1640	0.005	MDL	
2	2-WER-B-0	3/2/2004	Copper, Dissolved	=	3.29	µg/L		EPA 1640	0.005	MDL	

Appendix 2. Calleguas Creek Watershed Copper Water Effects Ratio Environmental Data

Reach	ProjectSiteID	Sample Date	Constituent	Sign	Result	Units	Qual	Method	Detection Limit	DL Type	Lab Qual
2	2-WER-B-0	3/2/2004	Copper, Total	=	11.6	µg/L		EPA 1640	0.005	MDL	
2	2-WER-B-70	3/2/2004	Copper, Dissolved	=	38.9	µg/L		EPA 1640	0.005	MDL	
2	2-WER-B-70	3/2/2004	Copper, Total	=	70.6	µg/L		EPA 1640	0.005	MDL	
2	2-WER-B-100	3/2/2004	Copper, Dissolved	=	47.8	µg/L		EPA 1640	0.005	MDL	
2	2-WER-B-100	3/2/2004	Copper, Total	=	92.4	µg/L		EPA 1640	0.005	MDL	
1	1-WER-A-0	8/27/2003	Alkalinity	=	570	mg/L		SM 2320-B	1	MDL	
1	1-WER-B-0	8/27/2003	Alkalinity	=	560	mg/L		SM 2320-B	1	MDL	
1	1-WER-C-0	8/27/2003	Alkalinity	=	580	mg/L		SM 2320-B	1	MDL	
1	1-WER-D-0	8/27/2003	Alkalinity	=	580	mg/L		SM 2320-B	1	MDL	
1	1-WER-A-0	1/28/2004	Alkalinity	=	222	mg/L	EST-HT	SM 2320-B	1	MDL	
1	1-WER-B-0	1/28/2004	Alkalinity	=	250	mg/L	EST-HT	SM 2320-B	1	MDL	
1	1-WER-C-0	1/28/2004	Alkalinity	=	88	mg/L	EST-HT	SM 2320-B	1	MDL	
1	1-WER-D-0	1/28/2004	Alkalinity	=	150	mg/L	EST-HT	SM 2320-B	1	MDL	
1	1-WER-A-0	3/2/2004	Alkalinity	=	386	mg/L		SM 2320-B	1	MDL	
1	1-WER-C-0	3/2/2004	Alkalinity	=	272	mg/L		SM 2320-B	1	MDL	
1	1-WER-D-0	3/2/2004	Alkalinity	=	174	mg/L		SM 2320-B	1	MDL	
3	2-WER-A (Salt)	8/28/2003	Alkalinity	=	1650	mg/L		SM 2320-B	1	MDL	
2	2-WER-B (Salt)	8/28/2003	Alkalinity	=	1670	mg/L		SM 2320-B	1	MDL	
3	2-WER-A (Salt)	1/28/2004	Alkalinity	=	284	mg/L	EST-HT	SM 2320-B	1	MDL	
2	2-WER-B (Salt)	1/28/2004	Alkalinity	=	302	mg/L	EST-HT	SM 2320-B	1	MDL	
3	2-WER-A (Salt)	3/2/2004	Alkalinity	=	262	mg/L		SM 2320-B	1	MDL	
2	2-WER-B (Salt)	3/2/2004	Alkalinity	=	254	mg/L		SM 2320-B	1	MDL	
1	1-WER-A-0	8/27/2003	Ammonia as N	=	0.12	mg/L		SM 4500-NH3 F	0.01	MDL	
1	1-WER-B-0	8/27/2003	Ammonia as N	=	0.08	mg/L		SM 4500-NH3 F	0.01	MDL	
1	1-WER-C-0	8/27/2003	Ammonia as N	=	0.22	mg/L		SM 4500-NH3 F	0.01	MDL	
1	1-WER-D-0	8/27/2003	Ammonia as N	=	0.21	mg/L		SM 4500-NH3 F	0.01	MDL	
1	1-WER-A-0	1/28/2004	Ammonia as N	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
1	1-WER-B-0	1/28/2004	Ammonia as N	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
1	1-WER-C-0	1/28/2004	Ammonia as N	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
1	1-WER-D-0	1/28/2004	Ammonia as N	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
1	1-WER-A-0	3/2/2004	Ammonia as N	=	0.15	mg/L		SM 4500-NH3 F	0.01	MDL	
1	1-WER-C-0	3/2/2004	Ammonia as N	=	0.11	mg/L		SM 4500-NH3 F	0.01	MDL	
1	1-WER-D-0	3/2/2004	Ammonia as N	=	0.8	mg/L		SM 4500-NH3 F	0.01	MDL	
3	2-WER-A (Salt)	8/28/2003	Ammonia as N	=	0.03	mg/L		SM 4500-NH3 F	0.01	MDL	
2	2-WER-B (Salt)	8/28/2003	Ammonia as N	=	0.04	mg/L		SM 4500-NH3 F	0.01	MDL	
3	2-WER-A (Salt)	1/28/2004	Ammonia as N	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
2	2-WER-B (Salt)	1/28/2004	Ammonia as N	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
3	2-WER-A (Salt)	3/2/2004	Ammonia as N	=	0.28	mg/L		SM 4500-NH3 F	0.01	MDL	
2	2-WER-B (Salt)	3/2/2004	Ammonia as N	=	0.6	mg/L		SM 4500-NH3 F	0.01	MDL	

Appendix 2. Calleguas Creek Watershed Copper Water Effects Ratio Environmental Data

Reach	ProjectSiteID	Sample Date	Constituent	Sign	Result	Units	Qual	Method	Detection Limit	DL Type	Lab Qual
1	1-WER-A-0	8/27/2003	Calcium	=	221	mg/L		EPA 1640	0.05	MDL	
1	1-WER-B-0	8/27/2003	Calcium	=	225	mg/L		EPA 1640	0.05	MDL	
1	1-WER-C-0	8/27/2003	Calcium	=	229	mg/L		EPA 1640	0.05	MDL	
1	1-WER-D-0	8/27/2003	Calcium	=	229	mg/L		EPA 1640	0.05	MDL	
1	1-WER-A-0	1/28/2004	Calcium, Dissolved	=	299	mg/L		EPA 1640	0.05	MDL	
1	1-WER-B-0	1/28/2004	Calcium, Dissolved	=	305	mg/L		EPA 1640	0.05	MDL	
1	1-WER-C-0	1/28/2004	Calcium, Dissolved	=	224	mg/L		EPA 1640	0.05	MDL	
1	1-WER-D-0	1/28/2004	Calcium, Dissolved	=	231	mg/L		EPA 1640	0.05	MDL	
3	2-WER-A (Salt)	8/28/2003	Calcium	=	244.9	mg/L		EPA 200.8	0.05	MDL	
2	2-WER-B (Salt)	8/28/2003	Calcium	=	273	mg/L		EPA 200.8	0.05	MDL	
3	2-WER-A (Salt)	1/28/2004	Calcium, Dissolved	=	257	mg/L		EPA 200.8	0.05	MDL	
2	2-WER-B (Salt)	1/28/2004	Calcium, Dissolved	=	238	mg/L		EPA 200.8	0.05	MDL	
1	1-WER-A-0	1/28/2004	Chloride	=	1.25	mg/L		SM 4500-Cl E	0.01	MDL	
1	1-WER-B-0	1/28/2004	Chloride	=	1.65	mg/L		SM 4500-Cl E	0.01	MDL	
1	1-WER-C-0	1/28/2004	Chloride	=	2	mg/L		SM 4500-Cl E	0.01	MDL	
1	1-WER-D-0	1/28/2004	Chloride	=	1.6	mg/L		SM 4500-Cl E	0.01	MDL	
1	1-WER-A-0	3/2/2004	Chloride	=	15800	mg/L		SM 4500-Cl E	0.01	MDL	
1	1-WER-C-0	3/2/2004	Chloride	=	17900	mg/L		SM 4500-Cl E	0.01	MDL	
1	1-WER-D-0	3/2/2004	Chloride	=	19200	mg/L		SM 4500-Cl E	0.01	MDL	
3	2-WER-A (Salt)	1/28/2004	Chloride	=	0.1	mg/L		SM 4500-Cl E	0.01	MDL	
2	2-WER-B (Salt)	1/28/2004	Chloride	=	1	mg/L		SM 4500-Cl E	0.01	MDL	
3	2-WER-A (Salt)	3/2/2004	Chloride	=	18900	mg/L		SM 4500-Cl E	0.01	MDL	
2	2-WER-B (Salt)	3/2/2004	Chloride	=	18600	mg/L		SM 4500-Cl E	0.01	MDL	
1	1-WER-A (Salt)	3/2/2004	Dissolved Organic Carbon	=	11	mg/L		EPA 415.1	0.5	RL	
1	1-WER-C (Salt)	3/2/2004	Dissolved Organic Carbon	=	9.9	mg/L		EPA 415.1	0.5	RL	
1	1-WER-D (Salt)	3/2/2004	Dissolved Organic Carbon	=	12	mg/L		EPA 415.1	0.5	RL	
1	1-WER-A	8/27/2003	Dissolved Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
1	1-WER-B	8/27/2003	Dissolved Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
1	1-WER-C	8/27/2003	Dissolved Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
1	1-WER-D	8/27/2003	Dissolved Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
3	2-WER-A (Salt)	8/28/2003	Dissolved Organic Carbon	=	5.1	mg/L		EPA 415.1	5	RL	D
2	2-WER-B (Salt)	8/28/2003	Dissolved Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
3	2-WER-A (Salt)	3/2/2004	Dissolved Organic Carbon	=	9.7	mg/L		EPA 415.1	0.5	RL	
2	2-WER-B (Salt)	3/2/2004	Dissolved Organic Carbon	=	10	mg/L		EPA 415.1	0.5	RL	
1	1-WER-A-0	8/27/2003	Total Hardness as CaCO3	=	5910	mg/L		SM 2340-B	1	MDL	
1	1-WER-B-0	8/27/2003	Total Hardness as CaCO3	=	5970	mg/L		SM 2340-B	1	MDL	
1	1-WER-C-0	8/27/2003	Total Hardness as CaCO3	=	6120	mg/L		SM 2340-B	1	MDL	
1	1-WER-D-0	8/27/2003	Total Hardness as CaCO3	=	5910	mg/L		SM 2340-B	1	MDL	
1	1-WER-A-0	1/28/2004	Total Hardness as CaCO3	=	5330	mg/L		SM 2340-B	1	MDL	

Appendix 2. Calleguas Creek Watershed Copper Water Effects Ratio Environmental Data

Reach	ProjectSiteID	Sample Date	Constituent	Sign	Result	Units	Qual	Method	Detection Limit	DL Type	Lab Qual
1	1-WER-B-0	1/28/2004	Total Hardness as CaCO3	=	5170	mg/L		SM 2340-B	1	MDL	
1	1-WER-C-0	1/28/2004	Total Hardness as CaCO3	=	5150	mg/L		SM 2340-B	1	MDL	
1	1-WER-D-0	1/28/2004	Total Hardness as CaCO3	=	4900	mg/L		SM 2340-B	1	MDL	
1	1-WER-A-0	3/2/2004	Total Hardness as CaCO3	=	5850	mg/L		SM 2340-B	1	MDL	
1	1-WER-C-0	3/2/2004	Total Hardness as CaCO3	=	6060	mg/L		SM 2340-B	1	MDL	
1	1-WER-D-0	3/2/2004	Total Hardness as CaCO3	=	6000	mg/L		SM 2340-B	1	MDL	
3	2-WER-A (Salt)	8/28/2003	Total Hardness as CaCO3	=	5890	mg/L		SM 2340-B	1	MDL	
2	2-WER-B (Salt)	8/28/2003	Total Hardness as CaCO3	=	6010	mg/L		SM 2340-B	1	MDL	
3	2-WER-A (Salt)	1/28/2004	Total Hardness as CaCO3	=	5470	mg/L		SM 2340-B	1	MDL	
2	2-WER-B (Salt)	1/28/2004	Total Hardness as CaCO3	=	5180	mg/L		SM 2340-B	1	MDL	
3	2-WER-A (Salt)	3/2/2004	Total Hardness as CaCO3	=	6150	mg/L		SM 2340-B	1	MDL	
2	2-WER-B (Salt)	3/2/2004	Total Hardness as CaCO3	=	6320	mg/L		SM 2340-B	1	MDL	
1	1-WER-A-0	8/27/2003	Magnesium	=	1302	mg/L		EPA 1640	5	MDL	
1	1-WER-B-0	8/27/2003	Magnesium	=	1313	mg/L		EPA 1640	5	MDL	
1	1-WER-C-0	8/27/2003	Magnesium	=	1346	mg/L		EPA 1640	5	MDL	
1	1-WER-D-0	8/27/2003	Magnesium	=	1296	mg/L		EPA 1640	5	MDL	
1	1-WER-A-0	1/28/2004	Magnesium, Dissolved	=	1110	mg/L		EPA 1640	5	MDL	
1	1-WER-B-0	1/28/2004	Magnesium, Dissolved	=	1070	mg/L		EPA 1640	5	MDL	
1	1-WER-C-0	1/28/2004	Magnesium, Dissolved	=	1120	mg/L		EPA 1640	5	MDL	
1	1-WER-D-0	1/28/2004	Magnesium, Dissolved	=	1050	mg/L		EPA 1640	5	MDL	
3	2-WER-A (Salt)	8/28/2003	Magnesium	=	1282	mg/L		EPA 200.8	0.05	MDL	
2	2-WER-B (Salt)	8/28/2003	Magnesium	=	1293	mg/L		EPA 200.8	0.05	MDL	
3	2-WER-A (Salt)	1/28/2004	Magnesium, Dissolved	=	1170	mg/L		EPA 200.8	0.05	MDL	
2	2-WER-B (Salt)	1/28/2004	Magnesium, Dissolved	=	1110	mg/L		EPA 200.8	0.05	MDL	
1	1-WER-A-0	8/27/2003	Potassium	=	377.3	mg/L		EPA 1640	5	MDL	
1	1-WER-B-0	8/27/2003	Potassium	=	385	mg/L		EPA 1640	5	MDL	
1	1-WER-C-0	8/27/2003	Potassium	=	396	mg/L		EPA 1640	5	MDL	
1	1-WER-D-0	8/27/2003	Potassium	=	387	mg/L		EPA 1640	5	MDL	
1	1-WER-A-0	1/28/2004	Potassium, Dissolved	=	337	mg/L		EPA 1640	5	MDL	
1	1-WER-B-0	1/28/2004	Potassium, Dissolved	=	327	mg/L		EPA 1640	5	MDL	
1	1-WER-C-0	1/28/2004	Potassium, Dissolved	=	346	mg/L		EPA 1640	5	MDL	
1	1-WER-D-0	1/28/2004	Potassium, Dissolved	=	331	mg/L		EPA 1640	5	MDL	
3	2-WER-A (Salt)	8/28/2003	Potassium	=	437.8	mg/L		EPA 200.8	5	MDL	
2	2-WER-B (Salt)	8/28/2003	Potassium	=	371.9	mg/L		EPA 200.8	5	MDL	
3	2-WER-A (Salt)	1/28/2004	Potassium, Dissolved	=	378	mg/L		EPA 200.8	5	MDL	
2	2-WER-B (Salt)	1/28/2004	Potassium, Dissolved	=	296	mg/L		EPA 200.8	5	MDL	
1	1-WER-A-0	8/27/2003	Sodium	=	10770	mg/L		EPA 1640	5	MDL	
1	1-WER-B-0	8/27/2003	Sodium	=	10940	mg/L		EPA 1640	5	MDL	
1	1-WER-C-0	8/27/2003	Sodium	=	11180	mg/L		EPA 1640	5	MDL	

Appendix 2. Calleguas Creek Watershed Copper Water Effects Ratio Environmental Data

Reach	ProjectSiteID	Sample Date	Constituent	Sign	Result	Units	Qual	Method	Detection Limit	DL Type	Lab Qual
1	1-WER-D-0	8/27/2003	Sodium	=	10660	mg/L		EPA 1640	5	MDL	
1	1-WER-A-0	1/28/2004	Sodium, Dissolved	=	8800	mg/L		EPA 1640	5	MDL	
1	1-WER-B-0	1/28/2004	Sodium, Dissolved	=	8630	mg/L		EPA 1640	5	MDL	
1	1-WER-C-0	1/28/2004	Sodium, Dissolved	=	9400	mg/L		EPA 1640	5	MDL	
1	1-WER-D-0	1/28/2004	Sodium, Dissolved	=	8700	mg/L		EPA 1640	5	MDL	
3	2-WER-A (Salt)	8/28/2003	Sodium	=	10370	mg/L		EPA 200.8	5	MDL	
2	2-WER-B (Salt)	8/28/2003	Sodium	=	10340	mg/L		EPA 200.8	5	MDL	
3	2-WER-A (Salt)	1/28/2004	Sodium, Dissolved	=	9090	mg/L		EPA 200.8	5	MDL	
2	2-WER-B (Salt)	1/28/2004	Sodium, Dissolved	=	8760	mg/L		EPA 200.8	5	MDL	
1	1-WER-A-0	8/27/2003	Sulfate	=	3290	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-B-0	8/27/2003	Sulfate	=	2940	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-C-0	8/27/2003	Sulfate	=	3160	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-D-0	8/27/2003	Sulfate	=	3010	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-A-0	1/28/2004	Sulfate	=	369	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-B-0	1/28/2004	Sulfate	=	449	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-C-0	1/28/2004	Sulfate	=	244	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-D-0	1/28/2004	Sulfate	=	246	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-A-0	3/2/2004	Sulfate	=	3320	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-C-0	3/2/2004	Sulfate	=	3300	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-D-0	3/2/2004	Sulfate	=	2515	mg/L		SM 4500-SO4 F	0.01	MDL	
3	2-WER-A (Salt)	1/28/2004	Sulfate	=	298	mg/L		SM 4500-SO4 F	0.01	MDL	
2	2-WER-B (Salt)	1/28/2004	Sulfate	=	362	mg/L		SM 4500-SO4 F	0.01	MDL	
3	2-WER-A (Salt)	3/2/2004	Sulfate	=	2610	mg/L		SM 4500-SO4 F	0.01	MDL	
2	2-WER-B (Salt)	3/2/2004	Sulfate	=	2510	mg/L		SM 4500-SO4 F	0.01	MDL	
1	1-WER-A-0	8/27/2003	Total Dissolved Solids	=	37100	mg/L		SM 2540-C	0.1	MDL	
1	1-WER-B-0	8/27/2003	Total Dissolved Solids	=	24900	mg/L		SM 2540-C	0.1	MDL	
1	1-WER-C-0	8/27/2003	Total Dissolved Solids	=	29300	mg/L		SM 2540-C	0.1	MDL	
1	1-WER-D-0	8/27/2003	Total Dissolved Solids	=	23500	mg/L		SM 2540-C	0.1	MDL	
1	1-WER-A-0	1/28/2004	Total Dissolved Solids	=	28400	mg/L	EST-HT	SM 2540-C	0.1	MDL	
1	1-WER-B-0	1/28/2004	Total Dissolved Solids	=	28800	mg/L	EST-HT	SM 2540-C	0.1	MDL	
1	1-WER-C-0	1/28/2004	Total Dissolved Solids	=	30200	mg/L	EST-HT	SM 2540-C	0.1	MDL	
1	1-WER-D-0	1/28/2004	Total Dissolved Solids	=	29300	mg/L	EST-HT	SM 2540-C	0.1	MDL	
1	1-WER-A-0	3/2/2004	Total Dissolved Solids	=	22000	mg/L		SM 2540-C	0.1	MDL	
1	1-WER-C-0	3/2/2004	Total Dissolved Solids	=	30100	mg/L		SM 2540-C	0.1	MDL	
1	1-WER-D-0	3/2/2004	Total Dissolved Solids	=	19800	mg/L		SM 2540-C	0.1	MDL	
3	2-WER-A (Salt)	8/28/2003	Total Dissolved Solids	=	23500	mg/L		SM 2540-C	0.1	MDL	
2	2-WER-B (Salt)	8/28/2003	Total Dissolved Solids	=	25000	mg/L		SM 2540-C	0.1	MDL	
3	2-WER-A (Salt)	1/28/2004	Total Dissolved Solids	=	32700	mg/L	EST-HT	SM 2540-C	0.1	MDL	
2	2-WER-B (Salt)	1/28/2004	Total Dissolved Solids	=	27300	mg/L	EST-HT	SM 2540-C	0.1	MDL	

Appendix 2. Calleguas Creek Watershed Copper Water Effects Ratio Environmental Data

Reach	ProjectSiteID	Sample Date	Constituent	Sign	Result	Units	Qual	Method	Detection Limit	DL Type	Lab Qual
3	2-WER-A (Salt)	3/2/2004	Total Dissolved Solids	=	21300	mg/L		SM 2540-C	0.1	MDL	
2	2-WER-B (Salt)	3/2/2004	Total Dissolved Solids	=	38100	mg/L		SM 2540-C	0.1	MDL	
1	1-WER-A	8/27/2003	Total Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
1	1-WER-B	8/27/2003	Total Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
1	1-WER-C	8/27/2003	Total Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
1	1-WER-D	8/27/2003	Total Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
1	1-WER-A-0	3/2/2004	Total Organic Carbon	=	13	mg/L		EPA 415.1	0.5	RL	
1	1-WER-C-0	3/2/2004	Total Organic Carbon	=	13	mg/L		EPA 415.1	0.5	RL	
1	1-WER-D-0	3/2/2004	Total Organic Carbon	=	17	mg/L		EPA 415.1	0.5	RL	
3	2-WER-A (Salt)	8/28/2003	Total Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
2	2-WER-B (Salt)	8/28/2003	Total Organic Carbon	<	5	mg/L		EPA 415.1	5	RL	D
3	2-WER-A (Salt)	3/2/2004	Total Organic Carbon	=	11	mg/L		EPA 415.1	0.5	RL	
2	2-WER-B (Salt)	3/2/2004	Total Organic Carbon	=	14	mg/L		EPA 415.1	0.5	RL	
1	1-WER-A-0	8/27/2003	Total Suspended Solids	=	5.2	mg/L		SM 2540-D	0.1	MDL	
1	1-WER-B-0	8/27/2003	Total Suspended Solids	=	6.8	mg/L		SM 2540-D	0.1	MDL	
1	1-WER-C-0	8/27/2003	Total Suspended Solids	=	18.1	mg/L		SM 2540-D	0.1	MDL	
1	1-WER-D-0	8/27/2003	Total Suspended Solids	=	35.3	mg/L		SM 2540-D	0.1	MDL	
1	1-WER-A-0	1/28/2004	Total Suspended Solids	=	9.46	mg/L	EST-HT	SM 2540-D	0.1	MDL	
1	1-WER-D-0	1/28/2004	Total Suspended Solids	=	5.72	mg/L	EST-HT	SM 2540-D	0.1	MDL	
1	1-WER-A-0	3/2/2004	Total Suspended Solids	=	65.9	mg/L		SM 2540-D	0.1	MDL	
1	1-WER-C-0	3/2/2004	Total Suspended Solids	=	181	mg/L		SM 2540-D	0.1	MDL	
1	1-WER-D-0	3/2/2004	Total Suspended Solids	=	38.2	mg/L		SM 2540-D	0.1	MDL	
3	2-WER-A (Salt)	8/28/2003	Total Suspended Solids	=	25.4	mg/L		SM 2540-D	0.1	MDL	
2	2-WER-B (Salt)	8/28/2003	Total Suspended Solids	=	21.5	mg/L		SM 2540-D	0.1	MDL	
3	2-WER-A (Salt)	1/28/2004	Total Suspended Solids	=	27.2	mg/L	EST-HT	SM 2540-D	0.1	MDL	
2	2-WER-B (Salt)	1/28/2004	Total Suspended Solids	=	69	mg/L	EST-HT	SM 2540-D	0.1	MDL	
3	2-WER-A (Salt)	3/2/2004	Total Suspended Solids	=	41.9	mg/L		SM 2540-D	0.1	MDL	
2	2-WER-B (Salt)	3/2/2004	Total Suspended Solids	=	177	mg/L		SM 2540-D	0.1	MDL	

D=The sample data was reported from a diluted analysis.

EST-HT = estimated value due to being analyzed outside of the recommended holding time.

Appendix 3. Quality Assurance/Quality Control Data

Site ID	QAQC Type	Replicate Number	Sample Date	Constituent	ResultType	Result		Units	Qual	Method	DL	DL Type	Lab Qual
SW	Lab Control	1	8/28/2003	Alkalinity	Concentration	=	540	mg/L		SM 2320-B	1	MDL	
LW-Cerio	Lab Control	1	8/28/2003	Alkalinity	Concentration	=	840	mg/L		SM 2320-B	1	MDL	
LW	Lab Control	1	8/27/2003	Alkalinity	Concentration	=	530	mg/L		SM 2320-B	1	MDL	
SC	Lab Control	1	1/28/2004	Alkalinity	Concentration	=	106	mg/L		SM 2320-B	1	MDL	
BL	Blank	1	1/28/2004	Alkalinity	Concentration	=	2	mg/L		SM 2320-B	1	MDL	
BL	Lab Duplicate	1	1/28/2004	Alkalinity	Concentration	=	2	mg/L		SM 2320-B	1	MDL	
LW-Cerio	Lab Control	1	1/28/2004	Alkalinity	Concentration	=	118	mg/L		SM 2320-B	1	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Alkalinity	Concentration	=	100	mg/L		SM 2320-B	1	MDL	
LW-Cerio	Lab Duplicate	1	3/2/2004	Alkalinity	Concentration	=	118	mg/L		SM 2320-B	1	MDL	
LW-Bivalve	Lab Control	1	3/2/2004	Alkalinity	Concentration	=	78	mg/L		SM 2320-B	1	MDL	
SC	Lab Control	1	3/2/2004	Alkalinity	Concentration	=	90	mg/L		SM 2320-B	1	MDL	
BL	Blank	1	3/2/2004	Alkalinity	Concentration	=	6	mg/L		SM 2320-B	1	MDL	
LW-Cerio	Lab Control	1	3/2/2004	Alkalinity	Concentration	=	120	mg/L		SM 2320-B	1	MDL	
SW	Lab Control	1	8/28/2003	Ammonia as N	Concentration	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
LW-Cerio	Lab Control	1	8/28/2003	Ammonia as N	Concentration	=	0.17	mg/L		SM 4500-NH3 F	0.01	MDL	
LW	Lab Control	1	8/27/2003	Ammonia as N	Concentration	=	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
BL	Blank	1	1/28/2004	Ammonia as N	Concentration	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
BL	Lab Duplicate	1	1/28/2004	Ammonia as N	Concentration	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
LW-Cerio	Lab Control	1	1/28/2004	Ammonia as N	Concentration	=	0.06	mg/L		SM 4500-NH3 F	0.01	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Ammonia as N	Concentration	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
SC	Lab Control	1	1/28/2004	Ammonia as N	Concentration	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
LW-Cerio	Lab Duplicate	1	3/2/2004	Ammonia as N	Concentration	=	0.12	mg/L		SM 4500-NH3 F	0.01	MDL	
LW-Bivalve	Lab Control	1	3/2/2004	Ammonia as N	Concentration	=	0.02	mg/L		SM 4500-NH3 F	0.01	MDL	
SC	Lab Control	1	3/2/2004	Ammonia as N	Concentration	<	0.01	mg/L		SM 4500-NH3 F	0.01	MDL	
BL	Blank	1	3/2/2004	Ammonia as N	Concentration	=	0.04	mg/L		SM 4500-NH3 F	0.01	MDL	
LW-Cerio	Lab Control	1	3/2/2004	Ammonia as N	Concentration	=	0.12	mg/L		SM 4500-NH3 F	0.01	MDL	
2-WER-A (Salt)	Lab Duplicate	1	8/28/2003	Calcium	Concentration	=	248	mg/L		EPA 200.8	0.05	MDL	
2-WER-B (Salt)	Lab Duplicate	1	8/28/2003	Calcium	Concentration	=	275	mg/L		EPA 200.8	0.05	MDL	
SW	Lab Control	1	8/28/2003	Calcium	Concentration	=	198	mg/L		EPA 1640	0.05	MDL	
SW	Lab Control	2	8/28/2003	Calcium	Concentration	=	199	mg/L		EPA 1640	0.05	MDL	
LW	Lab Control	1	8/27/2003	Calcium	Concentration	=	194	mg/L		EPA 1640	0.05	MDL	
LW	Lab Control	2	8/27/2003	Calcium	Concentration	=	190	mg/L		EPA 1640	0.05	MDL	
1-WER-D-0	Lab Duplicate	1	8/27/2003	Calcium	Concentration	=	225	mg/L		EPA 1640	0.05	MDL	
1-WER-A-0	Lab Duplicate	1	8/27/2003	Calcium	Concentration	=	223	mg/L		EPA 1640	0.05	MDL	
1-WER-B-0	Lab Duplicate	1	8/27/2003	Calcium	Concentration	=	226	mg/L		EPA 1640	0.05	MDL	
1-WER-C-0	Lab Duplicate	1	8/27/2003	Calcium	Concentration	=	227	mg/L		EPA 1640	0.05	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Calcium, Dissolved	Concentration	=	202	mg/L		EPA 1640	0.05	MDL	
SC	Lab Control	1	1/28/2004	Calcium, Dissolved	Concentration	=	187	mg/L		EPA 1640	0.05	MDL	
BL	Blank	1	1/28/2004	Calcium, Dissolved	Concentration	<	0.05	mg/L		EPA 200.8	0.05	MDL	

Appendix 3. Quality Assurance/Quality Control Data

Site ID	QAQC Type	Replicate Number	Sample Date	Constituent	ResultType	Result		Units	Qual	Method	DL	DL Type	Lab Qual
SC	Lab Control	1	1/28/2004	Chloride, Dissolved	Concentration	=	2.25	mg/L		SM 4500-Cl E	0.01	MDL	
BL	Blank	1	1/28/2004	Chloride, Dissolved	Concentration	=	5.75	mg/L		SM 4500-Cl E	0.01	MDL	
BL	Lab Duplicate	1	1/28/2004	Chloride, Dissolved	Concentration	=	7.42	mg/L		SM 4500-Cl E	0.01	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Chloride, Dissolved	Concentration	=	2.35	mg/L		SM 4500-Cl E	0.01	MDL	
LW-Bivalve	Lab Control	1	3/2/2004	Chloride	Concentration	=	10200	mg/L		SM 4500-Cl E	0.01	MDL	
SC	Lab Control	1	3/2/2004	Chloride	Concentration	=	2060	mg/L		SM 4500-Cl E	0.01	MDL	
BL	Blank	1	3/2/2004	Chloride	Concentration	=	45	mg/L		SM 4500-Cl E	0.01	MDL	
LW-0 (i)	Lab Control	1	8/27/2003	Copper, Dissolved	Concentration	=	1.11	µg/L		EPA 200.8	0.1	MDL	
LW-0 (i)	Lab Control	1	8/27/2003	Copper, Total	Concentration	=	1.34	µg/L		EPA 200.8	0.1	MDL	
LW-8	Lab Control	1	8/27/2003	Copper, Dissolved	Concentration	=	6.76	µg/L		EPA 200.8	0.1	MDL	
LW-8	Lab Control	1	8/27/2003	Copper, Total	Concentration	=	7.3	µg/L		EPA 200.8	0.1	MDL	
LW-12	Lab Control	1	8/27/2003	Copper, Dissolved	Concentration	=	9.66	µg/L		EPA 200.8	0.1	MDL	
LW-12	Lab Control	1	8/27/2003	Copper, Total	Concentration	=	10.4	µg/L		EPA 200.8	0.1	MDL	
LW-17 (i)	Lab Control	1	8/27/2003	Copper, Dissolved	Concentration	=	14.4	µg/L		EPA 200.8	0.1	MDL	
LW-17 (i)	Lab Control	1	8/27/2003	Copper, Total	Concentration	=	14.8	µg/L		EPA 200.8	0.1	MDL	
LW2-0	Lab Control	1	8/28/2003	Copper, Dissolved	Concentration	=	1.01	µg/L		EPA 200.8	0.1	MDL	
LW2-0	Lab Control	1	8/28/2003	Copper, Total	Concentration	=	1.18	µg/L		EPA 200.8	0.1	MDL	
LW2-6	Lab Control	1	8/28/2003	Copper, Dissolved	Concentration	=	5.01	µg/L		EPA 200.8	0.1	MDL	
LW2-6	Lab Control	1	8/28/2003	Copper, Total	Concentration	=	5.63	µg/L		EPA 200.8	0.1	MDL	
LW2-8	Lab Control	1	8/28/2003	Copper, Dissolved	Concentration	=	7.16	µg/L		EPA 200.8	0.1	MDL	
LW2-8	Lab Control	1	8/28/2003	Copper, Total	Concentration	=	7.93	µg/L		EPA 200.8	0.1	MDL	
LW2-12	Lab Control	1	8/28/2003	Copper, Dissolved	Concentration	=	10.3	µg/L		EPA 200.8	0.1	MDL	
LW2-12	Lab Control	1	8/28/2003	Copper, Total	Concentration	=	10.9	µg/L		EPA 200.8	0.1	MDL	
LW2-17	Lab Control	1	8/28/2003	Copper, Dissolved	Concentration	=	14.3	µg/L		EPA 200.8	0.1	MDL	
LW2-17	Lab Control	1	8/28/2003	Copper, Total	Concentration	=	14.7	µg/L		EPA 200.8	0.1	MDL	
LW2-24	Lab Control	1	8/28/2003	Copper, Dissolved	Concentration	=	19.8	µg/L		EPA 200.8	0.1	MDL	
LW2-24	Lab Control	1	8/28/2003	Copper, Total	Concentration	=	20.5	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-0 t=48	Lab Control	1	8/31/2003	Copper, Dissolved	Concentration	=	3.19	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-0 t=48	Lab Control	1	8/31/2003	Copper, Total	Concentration	=	3.57	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-24.5 t=48	Lab Control	1	8/31/2003	Copper, Dissolved	Concentration	=	17.7	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-24.5 t=48	Lab Control	1	8/31/2003	Copper, Total	Concentration	=	17.6	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-35 t=48	Lab Control	1	8/31/2003	Copper, Dissolved	Concentration	=	21.9	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-35 t=48	Lab Control	1	8/31/2003	Copper, Total	Concentration	=	22.2	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-50 t=48	Lab Control	1	8/31/2003	Copper, Dissolved	Concentration	=	33.7	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-50 t=48	Lab Control	1	8/31/2003	Copper, Total	Concentration	=	33.8	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-17.2 t=48	Lab Control	1	8/31/2003	Copper, Dissolved	Concentration	=	8.43	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-17.2 t=48	Lab Control	1	8/31/2003	Copper, Total	Concentration	=	9.01	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-0	Lab Control	1	8/29/2003	Copper, Dissolved	Concentration	=	0.43	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-0	Lab Control	1	8/29/2003	Copper, Total	Concentration	=	0.51	µg/L		EPA 200.8	0.1	MDL	

Appendix 3. Quality Assurance/Quality Control Data

Site ID	QAQC Type	Replicate Number	Sample Date	Constituent	ResultType	Result		Units	Qual	Method	DL	DL Type	Lab Qual
LW-Cerio-17.2	Lab Control	1	8/29/2003	Copper, Dissolved	Concentration	=	10.3	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-17.2	Lab Control	1	8/29/2003	Copper, Total	Concentration	=	10.2	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-24.5	Lab Control	1	8/29/2003	Copper, Dissolved	Concentration	=	15.9	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-24.5	Lab Control	1	8/29/2003	Copper, Total	Concentration	=	16.2	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-35	Lab Control	1	8/29/2003	Copper, Dissolved	Concentration	=	19.2	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-35	Lab Control	1	8/29/2003	Copper, Total	Concentration	=	20.1	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-50	Lab Control	1	8/29/2003	Copper, Dissolved	Concentration	=	30.6	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-50	Lab Control	1	8/29/2003	Copper, Total	Concentration	=	32	µg/L		EPA 200.8	0.1	MDL	
LW-A-0 (F)	Lab Control	1	8/29/2003	Copper, Total	Concentration	=	1.92	µg/L		EPA 200.8	0.1	MDL	
LW-A-0 (F)	Lab Control	1	8/29/2003	Copper, Dissolved	Concentration	=	1.59	µg/L		EPA 200.8	0.1	MDL	
LW-A_17 (F)	Lab Control	1	8/29/2003	Copper, Total	Concentration	=	14.3	µg/L		EPA 200.8	0.1	MDL	
LW-A_17 (F)	Lab Control	1	8/29/2003	Copper, Dissolved	Concentration	=	12.8	µg/L		EPA 200.8	0.1	MDL	
2-WER-B-Cerio-2000	Lab Duplicate	1	8/29/2003	Copper, Total	Concentration	=	895	µg/L		EPA 200.8	0.1	MDL	
2-WER-B-Cerio-2000	Lab Duplicate	1	8/29/2003	Copper, Dissolved	Concentration	=	517	µg/L		EPA 200.8	0.1	MDL	
2-WER-B-Cerio-118	Matrix Spike	1	1/28/2004	Copper, Total	% Recovery	=	77	%		EPA 200.8			
2-WER-B-Cerio-118	Matrix Spike Dup	1	1/28/2004	Copper, Total	% Recovery	=	78	%		EPA 200.8			
LW-0	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	0.242	µg/L		EPA 200.8	0.1	MDL	
LW-6	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	5.75	µg/L		EPA 200.8	0.1	MDL	
LW-8	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	7.38	µg/L		EPA 200.8	0.1	MDL	
LW-12	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	10.5	µg/L		EPA 200.8	0.1	MDL	
LW-17	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	15.5	µg/L		EPA 200.8	0.1	MDL	
LW-24	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	20.8	µg/L		EPA 200.8	0.1	MDL	
LW-34	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	27.3	µg/L		EPA 200.8	0.1	MDL	
LW-0	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	0.374	µg/L		EPA 200.8	0.1	MDL	
LW-6	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	5.35	µg/L		EPA 200.8	0.1	MDL	
LW-8	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	6.94	µg/L		EPA 200.8	0.1	MDL	
LW-12	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	10.3	µg/L		EPA 200.8	0.1	MDL	
LW-17	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	14.5	µg/L		EPA 200.8	0.1	MDL	
LW-24	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	20.5	µg/L		EPA 200.8	0.1	MDL	
LW-34	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	28.6	µg/L		EPA 200.8	0.1	MDL	
SC	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	0.545	µg/L		EPA 1640	0.005	MDL	
LW-Cerio-0	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	0.48	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-0	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	0.5	µg/L		EPA 200.8	0.1	MDL	
BL	Blank	1	1/28/2004	Copper, Dissolved	Concentration	=	0.25	µg/L		EPA 200.8	0.1	MDL	
BL	Blank	1	1/28/2004	Copper, Total	Concentration	=	0.11	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-24	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	19	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-24	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	21.1	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-35	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	32.4	µg/L		EPA 200.8	0.1	MDL	
LW-Cerio-35	Lab Control	1	1/28/2004	Copper, Total	Concentration	=	34.7	µg/L		EPA 200.8	0.1	MDL	

Appendix 3. Quality Assurance/Quality Control Data

Site ID	QAQC Type	Replicate Number	Sample Date	Constituent	ResultType	Result		Units	Qual	Method	DL	DL Type	Lab Qual
SC	Lab Control	1	1/28/2004	Copper, Dissolved	Concentration	=	0.794	µg/L		EPA 1640	0.005	MDL	
LW	Lab Control	1	8/27/2003	Dissolved Organic Carbon	Concentration	<	5	mg/L		EPA 415.1	5	RL	D
LW-Cerio	Lab Control	1	8/28/2003	Dissolved Organic Carbon	Concentration	<	5	mg/L		EPA 415.1	5	RL	D
LW-Bivalve	Lab Control	1	3/2/2004	Dissolved Organic Carbon	Concentration	=	3.2	mg/L		EPA 415.1	0.5	RL	
SC	Lab Control	1	3/2/2004	Dissolved Organic Carbon	Concentration	=	2.1	mg/L		EPA 415.1	0.5	RL	
LW-Cerio	Lab Control	1	3/2/2004	Dissolved Organic Carbon	Concentration	=	3	mg/L		EPA 415.1	0.5	RL	
BL	Blank	1	3/2/2004	Dissolved Organic Carbon	Concentration	=	1.3	mg/L		EPA 415.1	0.5	RL	
LW-Cerio	Matrix Spike Dup	1	3/2/2004	Dissolved Organic Carbon	% Recovery	=	109	%		EPA 415.1			
LW-Cerio	Matrix Spike	1	3/2/2004	Dissolved Organic Carbon	% Recovery	=	111	%		EPA 415.1			
LW-Cerio	Matrix Spike, RPD	1	3/2/2004	Dissolved Organic Carbon	Rel. % Difference	=	1	%		EPA 415.1			
SW	Lab Control	1	8/28/2003	Dissolved Organic Carbon	Concentration	<	5	mg/L		EPA 415.1	5	RL	D
2-WER-A (Salt)	Lab Duplicate	1	8/28/2003	Total Hardness as CaCO3	Concentration	=	5940	mg/L		SM 2340-B	1	MDL	
2-WER-B (Salt)	Lab Duplicate	1	8/28/2003	Total Hardness as CaCO3	Concentration	=	5970	mg/L		SM 2340-B	1	MDL	
SW	Lab Control	1	8/28/2003	Total Hardness as CaCO3	Concentration	=	5820	mg/L		SM 2340-B	1	MDL	
SW	Lab Control	2	8/28/2003	Total Hardness as CaCO3	Concentration	=	5780	mg/L		SM 2340-B	1	MDL	
LW-Cerio	Lab Control	1	8/28/2003	Total Hardness as CaCO3	Concentration	=	5930	mg/L		SM 2340-B	1	MDL	
LW	Lab Control	1	8/27/2003	Total Hardness as CaCO3	Concentration	=	5870	mg/L		SM 2340-B	1	MDL	
LW	Lab Control	2	8/27/2003	Total Hardness as CaCO3	Concentration	=	5134	mg/L		SM 2340-B	1	MDL	
1-WER-D-0	Lab Duplicate	1	8/27/2003	Total Hardness as CaCO3	Concentration	=	5910	mg/L		SM 2340-B	1	MDL	
1-WER-A-0	Lab Duplicate	1	8/27/2003	Total Hardness as CaCO3	Concentration	=	5960	mg/L		SM 2340-B	1	MDL	
1-WER-B-0	Lab Duplicate	1	8/27/2003	Total Hardness as CaCO3	Concentration	=	6010	mg/L		SM 2340-B	1	MDL	
1-WER-C-0	Lab Duplicate	1	8/27/2003	Total Hardness as CaCO3	Concentration	=	6040	mg/L		SM 2340-B	1	MDL	
SC	Lab Control	1	1/28/2004	Total Hardness as CaCO3	Concentration	=	4930	mg/L		SM 2340-B	1	MDL	
BL	Blank	1	1/28/2004	Total Hardness as CaCO3	Concentration	<	1	mg/L		SM 2340-B	1	MDL	
BL	Lab Duplicate	1	1/28/2004	Total Hardness as CaCO3	Concentration	<	1	mg/L		SM 2340-B	1	MDL	
LW-Cerio	Lab Control	1	1/28/2004	Total Hardness as CaCO3	Concentration	=	164	mg/L		SM 2340-B	1	MDL	
LW-Cerio	Lab Control	2	1/28/2004	Total Hardness as CaCO3	Concentration	=	164	mg/L		SM 2340-B	1	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Total Hardness as CaCO3	Concentration	=	4730	mg/L		SM 2340-B	1	MDL	
LW-Bivalve	Lab Control	1	3/2/2004	Total Hardness as CaCO3	Concentration	=	5830	mg/L		SM 2340-B	1	MDL	
SC	Lab Control	1	3/2/2004	Total Hardness as CaCO3	Concentration	=	5640	mg/L		SM 2340-B	1	MDL	
BL	Blank	1	3/2/2004	Total Hardness as CaCO3	Concentration	<	1	mg/L		SM 2340-B	1	MDL	
LW-Cerio	Lab Control	1	3/2/2004	Total Hardness as CaCO3	Concentration	=	213	mg/L		SM 2340-B	1	MDL	
2-WER-A (Salt)	Lab Duplicate	1	8/28/2003	Magnesium	Concentration	=	1295	mg/L		EPA 200.8	0.05	MDL	
2-WER-B (Salt)	Lab Duplicate	1	8/28/2003	Magnesium	Concentration	=	1284	mg/L		EPA 200.8	0.05	MDL	
SW	Lab Control	1	8/28/2003	Magnesium	Concentration	=	1294	mg/L		EPA 1640	5	MDL	
SW	Lab Control	2	8/28/2003	Magnesium	Concentration	=	1284	mg/L		EPA 1640	5	MDL	
LW	Lab Control	1	8/27/2003	Magnesium	Concentration	=	1129	mg/L		EPA 1640	5	MDL	
LW	Lab Control	2	8/27/2003	Magnesium	Concentration	=	1110	mg/L		EPA 1640	5	MDL	
1-WER-D-0	Lab Duplicate	1	8/27/2003	Magnesium	Concentration	=	1290	mg/L		EPA 1640	5	MDL	

Appendix 3. Quality Assurance/Quality Control Data

Site ID	QAQC Type	Replicate Number	Sample Date	Constituent	ResultType	Result		Units	Qual	Method	DL	DL Type	Lab Qual
1-WER-A-0	Lab Duplicate	1	8/27/2003	Magnesium	Concentration	=	1311	mg/L		EPA 1640	5	MDL	
1-WER-B-0	Lab Duplicate	1	8/27/2003	Magnesium	Concentration	=	1323	mg/L		EPA 1640	5	MDL	
1-WER-C-0	Lab Duplicate	1	8/27/2003	Magnesium	Concentration	=	1330	mg/L		EPA 1640	5	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Magnesium, Dissolved	Concentration	=	1030	mg/L		EPA 1640	5	MDL	
SC	Lab Control	1	1/28/2004	Magnesium, Dissolved	Concentration	=	1090	mg/L		EPA 1640	5	MDL	
BL	Blank	1	1/28/2004	Magnesium, Dissolved	Concentration	<	0.05	mg/L		EPA 200.8	0.05	MDL	
2-WER-A (Salt)	Lab Duplicate	1	8/28/2003	Potassium	Concentration	=	384.9	mg/L		EPA 200.8	5	MDL	
2-WER-B (Salt)	Lab Duplicate	1	8/28/2003	Potassium	Concentration	=	372.4	mg/L		EPA 200.8	5	MDL	
SW	Lab Control	1	8/28/2003	Potassium	Concentration	=	376.4	mg/L		EPA 1640	5	MDL	
SW	Lab Control	2	8/28/2003	Potassium	Concentration	=	379.1	mg/L		EPA 1640	5	MDL	
LW	Lab Control	1	8/27/2003	Potassium	Concentration	=	337	mg/L		EPA 1640	5	MDL	
LW	Lab Control	2	8/27/2003	Potassium	Concentration	=	333	mg/L		EPA 1640	5	MDL	
1-WER-D-0	Lab Duplicate	1	8/27/2003	Potassium	Concentration	=	384	mg/L		EPA 1640	5	MDL	
1-WER-A-0	Lab Duplicate	1	8/27/2003	Potassium	Concentration	=	380	mg/L		EPA 1640	5	MDL	
1-WER-B-0	Lab Duplicate	1	8/27/2003	Potassium	Concentration	=	388	mg/L		EPA 1640	5	MDL	
1-WER-C-0	Lab Duplicate	1	8/27/2003	Potassium	Concentration	=	395	mg/L		EPA 1640	5	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Potassium, Dissolved	Concentration	=	330	mg/L		EPA 1640	5	MDL	
SC	Lab Control	1	1/28/2004	Potassium, Dissolved	Concentration	=	303	mg/L		EPA 1640	5	MDL	
BL	Blank	1	1/28/2004	Potassium, Dissolved	Concentration	<	5	mg/L		EPA 200.8	5	MDL	
2-WER-A (Salt)	Lab Duplicate	1	8/28/2003	Sodium	Concentration	=	10430	mg/L		EPA 200.8	5	MDL	
2-WER-B (Salt)	Lab Duplicate	1	8/28/2003	Sodium	Concentration	=	10310	mg/L		EPA 200.8	5	MDL	
SW	Lab Control	1	8/28/2003	Sodium	Concentration	=	10380	mg/L		EPA 1640	5	MDL	
SW	Lab Control	2	8/28/2003	Sodium	Concentration	=	10410	mg/L		EPA 1640	5	MDL	
LW	Lab Control	1	8/27/2003	Sodium	Concentration	=	9382	mg/L		EPA 1640	5	MDL	
LW	Lab Control	2	8/27/2003	Sodium	Concentration	=	9264	mg/L		EPA 1640	5	MDL	
1-WER-D-0	Lab Duplicate	1	8/27/2003	Sodium	Concentration	=	10790	mg/L		EPA 1640	5	MDL	
1-WER-A-0	Lab Duplicate	1	8/27/2003	Sodium	Concentration	=	10840	mg/L		EPA 1640	5	MDL	
1-WER-B-0	Lab Duplicate	1	8/27/2003	Sodium	Concentration	=	11050	mg/L		EPA 1640	5	MDL	
1-WER-C-0	Lab Duplicate	1	8/27/2003	Sodium	Concentration	=	11100	mg/L		EPA 1640	5	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Sodium, Dissolved	Concentration	=	8590	mg/L		EPA 1640	5	MDL	
SC	Lab Control	1	1/28/2004	Sodium, Dissolved	Concentration	=	8660	mg/L		EPA 1640	5	MDL	
BL	Blank	1	1/28/2004	Sodium, Dissolved	Concentration	<	5	mg/L		EPA 200.8	5	MDL	
SC	Lab Control	1	1/28/2004	Sulfate, Dissolved	Concentration	=	460	mg/L		SM 4500-SO4 F	0.01	MDL	
BL	Blank	1	1/28/2004	Sulfate, Dissolved	Concentration	=	12.4	mg/L		SM 4500-SO4 F	0.01	MDL	
BL	Lab Duplicate	1	1/28/2004	Sulfate, Dissolved	Concentration	=	12.3	mg/L		SM 4500-SO4 F	0.01	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Sulfate, Dissolved	Concentration	=	326	mg/L		SM 4500-SO4 F	0.01	MDL	
BL	Lab Duplicate	1	3/2/2004	Sulfate	Concentration	=	0.4	mg/L		SM 4500-SO4 F	0.01	MDL	
LW-Bivalve	Lab Control	1	3/2/2004	Sulfate	Concentration	=	2400	mg/L		SM 4500-SO4 F	0.01	MDL	
SC	Lab Control	1	3/2/2004	Sulfate	Concentration	=	2520	mg/L		SM 4500-SO4 F	0.01	MDL	

Appendix 3. Quality Assurance/Quality Control Data

Site ID	QAQC Type	Replicate Number	Sample Date	Constituent	ResultType		Result	Units	Qual	Method	DL	DL Type	Lab Qual
BL	Blank	1	3/2/2004	Sulfate	Concentration	=	0.4	mg/L		SM 4500-SO4 F	0.01	MDL	
SW	Lab Control	1	8/28/2003	Total Dissolved Solids	Concentration	=	15900	mg/L		SM 2540-C	1	MDL	
LW-Cerio	Lab Control	1	8/28/2003	Total Dissolved Solids	Concentration	=	750	mg/L		SM 2540-C	1	MDL	
LW	Lab Control	1	8/27/2003	Total Dissolved Solids	Concentration	=	34700	mg/L		SM 2540-C	1	MDL	
SC	Lab Control	1	1/28/2004	Total Dissolved Solids	Concentration	=	25800	mg/L		SM 2540-C	0.1	MDL	
BL	Blank	1	1/28/2004	Total Dissolved Solids	Concentration	=	150	mg/L		SM 2540-C	0.1	MDL	
LW-Cerio	Lab Control	1	1/28/2004	Total Dissolved Solids	Concentration	=	300	mg/L		SM 2540-C	0.1	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Total Dissolved Solids	Concentration	=	30700	mg/L		SM 2540-C	0.1	MDL	
LW-Bivalve	Lab Control	1	3/2/2004	Total Dissolved Solids	Concentration	=	20800	mg/L		SM 2540-C	0.1	MDL	
SC	Lab Control	1	3/2/2004	Total Dissolved Solids	Concentration	=	21600	mg/L		SM 2540-C	0.1	MDL	
BL	Blank	1	3/2/2004	Total Dissolved Solids	Concentration	=	500	mg/L		SM 2540-C	0.1	MDL	
LW-Cerio	Lab Control	1	3/2/2004	Total Dissolved Solids	Concentration	=	1430	mg/L		SM 2540-C	0.1	MDL	
LW	Lab Control	1	8/27/2003	Total Organic Carbon	Concentration	<	5	mg/L		EPA 415.1	5	RL	D
LW-Cerio	Lab Control	1	8/28/2003	Total Organic Carbon	Concentration	<	5	mg/L		EPA 415.1	5	RL	D
LW-Bivalve	Lab Control	1	3/2/2004	Total Organic Carbon	Concentration	=	3.9	mg/L		EPA 415.1	0.5	RL	
SC	Lab Control	1	3/2/2004	Total Organic Carbon	Concentration	=	2.5	mg/L		EPA 415.1	0.5	RL	
LW-Cerio	Lab Control	1	3/2/2004	Total Organic Carbon	Concentration	=	4.9	mg/L	*	EPA 415.1	0.5	RL	
BL	Blank	1	3/2/2004	Total Organic Carbon	Concentration	=	1.3	mg/L		EPA 415.1	0.5	RL	
LW-Cerio	Matrix Spike Dup	1	3/2/2004	Total Organic Carbon	% Recovery	=	150	%		EPA 415.1			
LW-Cerio	Matrix Spike	1	3/2/2004	Total Organic Carbon	% Recovery	=	136	%		EPA 415.1			
LW-Cerio	Matrix Spike, RPD	1	3/2/2004	Total Organic Carbon	Rel. % Difference	=	7	%		EPA 415.1			
SW	Lab Control	1	8/28/2003	Total Organic Carbon	Concentration	<	5	mg/L		EPA 415.1	5	RL	D
SW	Lab Control	1	8/28/2003	Total Suspended Solids	Concentration	=	20.1	mg/L		SM 2540-D	0.1	MDL	
LW-Cerio	Lab Control	1	8/28/2003	Total Suspended Solids	Concentration	=	13	mg/L		SM 2540-D	0.1	MDL	
LW	Lab Control	1	8/27/2003	Total Suspended Solids	Concentration	=	20.8	mg/L		SM 2540-D	0.1	MDL	
SC	Lab Control	1	1/28/2004	Total Suspended Solids	Concentration	=	10.3	mg/L		SM 2540-D	0.1	MDL	
BL	Blank	1	1/28/2004	Total Suspended Solids	Concentration	<	0.1	mg/L		SM 2540-D	0.1	MDL	
LW-Cerio	Lab Control	1	1/28/2004	Total Suspended Solids	Concentration	=	6.12	mg/L		SM 2540-D	0.1	MDL	
LW-Bivalve	Lab Control	1	1/28/2004	Total Suspended Solids	Concentration	=	11	mg/L		SM 2540-D	0.1	MDL	
LW-Bivalve	Lab Control	1	3/2/2004	Total Suspended Solids	Concentration	=	9.33	mg/L		SM 2540-D	0.1	MDL	
SC	Lab Control	1	3/2/2004	Total Suspended Solids	Concentration	=	8.4	mg/L		SM 2540-D	0.1	MDL	
BL	Blank	1	3/2/2004	Total Suspended Solids	Concentration	=	2.02	mg/L		SM 2540-D	0.1	MDL	
LW-Cerio	Lab Control	1	3/2/2004	Total Suspended Solids	Concentration	=	0.4	mg/L		SM 2540-D	0.1	MDL	

D=The sample data was reported from a diluted analysis.

* = HB-MSR = high bias sample due to matrix spike recovery greater than 125%.

Appendix 4. Initial Water Quality Characteristics

Event	Site	Date Collected	Temp. (ºC)	pH	DO (mg/L)	Conductivity (umhos/cm)	Salinity (ppt)	Total Ammonia (mg/L)
1	1-WER-A	8/26/2003	11.9	7.93	8.3	43,100	31.1	<0.01
	1-WER-B	8/26/2003	11.9	7.98	8.6	42,800	31.0	<0.01
	1-WER-C	8/26/2003	11.9	8.06	8.7	43,500	31.4	<0.01
	1-WER-D	8/26/2003	11.9	8.11	8.9	43,600	31.5	<0.01
	2-WER-A	8/27/2003	9.8	8.54	11.3	1,256	0.5	<0.01
	2-WER-B	8/27/2003	9.0	8.54	11.7	2,580	1.4	<0.01
	Lab Water S	8/26/2003	1.8	7.93	7.9	43,800	31.8	<0.01
	Lab Water F	8/28/2003	na	7.76	8.2	704	na	<0.01
2	1-WER-A	1/27/2004	2.9	7.95	10.3	2,550	17.5	<0.01
	1-WER-B	1/27/2004	2.3	8.03	11.9	2,340	15.8	<0.01
	1-WER-C	1/27/2004	2.5	8.13	11.5	4,410	31.6	<0.01
	1-WER-D	1/27/2004	3.1	7.98	10.3	3,780	27.5	<0.01
	2-WER-A	1/27/2004	2.7	8.25	12.5	1,977	1.0	<0.01
	2-WER-B	1/27/2004	2.3	8.32	11.5	2,400	1.2	<0.01
	Lab Water S	1/26/2004	14.0	7.75	9.1	45	32.9	<0.01
	Lab Water F	1/27/2004	na	8.04	10.3	1,876	1.0	<0.01
3	1-WER-A	3/1/2004	0.9	7.64	10.9	7,640	4.7	<0.01
	1-WER-B	3/1/2004	na	na	na	na	na	na
	1-WER-C	3/1/2004	0.7	7.68	10.5	11,150	7.2	<0.01
	1-WER-D	3/1/2004	3.2	7.86	10.5	32,600	22.8	<0.01
	2-WER-A	3/1/2004	3.8	8.21	10.9	1,275	0.5	0.03
	2-WER-B	3/1/2004	3.8	8.03	11.0	1,602	0.7	<0.01
	Lab Water S	3/1/2004	na	na	na	na	na	na
	Lab Water F	3/1/2004	19.0	8.05	9.1	623	0.3	<0.01

Appendix 5. Initial versus Final Analysis of Copper Concentrations

Table A5-1. San Jose Initial and Final Dissolved Copper Data (ug/L)

Laboratory Water (µg/L)			
Nominal Conc.	Initial Conc.	Final Conc.	% Decrease
7	5.9	3.7	37.3%
7	5.8	5.7	1.7%
7	6.8	3.5	48.5%
7	4.4	3.6	18.2%
6.1	5.1	3.3	35.3%
6.1	4.5	4.1	8.9%
6.1	4.4	3.8	13.6%
6.1	5	4.1	18.0%
6.1	5.4	4.2	22.2%
6.1	4.7	3.2	31.9%
6.1	4.7	3.6	23.4%
6.1	4.5	3.3	26.7%
6.1	5.2	3	42.3%
6.1	4.3	3.2	25.6%
6.1	4.7	4.4	6.4%
6.1	4.6	4.3	6.5%
6.1	4.7	3.8	19.1%
6.1	4.4	3.5	20.5%
6.1	4.6	3.5	23.9%
6.1	4	3	25.0%
6.1	3	3.3	-10.0%
6.1	4.2	4.9	-16.7%
6.1	3.6	3.8	-5.6%
Average % Decrease			**18.4%**

Site Water (µg/L)							
Nominal Conc.	Initial Conc.	Final Conc.	% Decrease	Nominal Conc.	Initial Conc.	Final Conc.	% Decrease
25	19.7	16.7	15.2%	25.2	19.7	17.9	9.1%
25	22.7	14.9	34.4%	23.4	18	16.8	6.7%
25	19	17.6	7.4%	23.4	17	14	17.6%
25	22.7	22.3	1.8%	23.4	16.5	15.3	7.3%
25	22.5	18.8	16.4%	23.4	15.4	14	9.1%
25	21.6	17	21.3%	23.4	14.9	14.3	4.0%
25	21.9	20.3	7.3%	23.4	14.6	13	11.0%
25	21.6	15.7	27.3%	23.4	17.9	15.5	13.4%
25	21.2	22.1	-4.2%	23.4	16.9	16.8	0.6%
25	22.4	18.4	17.9%	23.4	18.9	15.3	19.0%
25	17.7	14.5	18.1%	23.4	19.4	16.5	14.9%
25	20.5	16.2	21.0%	23.4	23.9	21.1	11.7%
25.2	17.2	17.1	0.6%	23.4	23.2	20.3	12.5%
25.2	18.5	18.6	-0.5%	23.4	22.2	20.3	8.6%
25.2	16.8	18.3	-8.9%	23.4	19.1	17.9	6.3%
25.2	12.9	11.8	8.5%	23.4	21.5	20	7.0%
25.2	12.4	11.6	6.5%	23.4	20.5	18.4	10.2%
25.2	12.3	11.7	4.9%	23.4	21.6	16.8	22.2%
25.2	17.9	17.4	2.8%	23.4	18.3	15.9	13.1%
25.2	15.1	14.2	6.0%	23.4	16.8	17.2	-2.4%
25.2	16.7	15.4	7.8%	23.4	20.6	17.4	15.5%
25.2	18.4	17.1	7.1%	23.4	21.8	17.8	18.3%
25.2	18	15.6	13.3%	23.4	18	15.2	15.6%
25.2	16.5	13.4	18.8%	23.4	18.6	16.3	12.4%
25.2	17.8	14.7	17.4%	23.4	16.6	19.4	-16.9%
25.2	16	13	18.8%	23.4	11.2	18.8	-67.9%
25.2	18.3	15.3	16.4%	23.4	13	17.7	-36.2%
25.2	17.8	16	10.1%	23.4	14.7	17.8	-21.1%
25.2	17.3	14.2	17.9%	23.4	14.6	15.7	-7.5%
25.2	15.3	15.1	1.3%	23.4	12.8	14.2	-10.9%
25.2	18.6	18.3	1.6%	23.4	13.7	9.9	27.7%
25.2	22	18.4	16.4%	**Average % Decrease**			**7.6%**

Table A5-2. New York/New Jersey Harbor Initial and Final Dissolved Copper Data (µg/L)

Laboratory Water (µg/L)			
Nominal Conc.	Initial Conc.	Final Conc.	% Decrease
0	0.86	0.86	0.0%
2.8	2.52	2.92	-15.9%
4	3.29	4.08	-24.0%
5.6	5.65	4.97	12.0%
8.1	8.19	7.33	10.5%
11.5	10.4	10.1	2.9%
16.5	14.7	14.3	2.7%
23.5	17.2	21	-22.1%
0	0.86	0.89	-3.5%
2.8	2.72	3.58	-31.6%
4	3.22	4.3	-33.5%
5.6	6.16	5.28	14.3%
8.1	9.05	7.94	12.3%
11.5	10.6	10.6	0.0%
16.5	15.7	15	4.5%
23.5	17.4	18.2	-4.6%
0	1.2	0.86	28.3%
2.8	1.82	3	-64.8%
4	2.82	3.51	-24.5%
5.6	5.61	4.97	11.4%
8.1	7.9	6.54	17.2%
11.5	10	9.67	3.3%
16.5	14.5	13.7	5.5%
23.5	18	20.6	-14.4%
0	0.86	0.86	0.0%
2.8	1.77	2.96	-67.2%
4	2.9	3.69	-27.2%
5.6	5.41	5.64	-4.3%
8.1	7.88	7.18	8.9%
11.5	9.95	10	-0.5%
16.5	16.8	12.1	28.0%
Average % Decrease			**-5.7%**

Site Water (µg/L)							
Nominal Conc.	Initial Conc.	Final Conc.	% Decrease	Nominal Conc.	Initial Conc.	Final Conc.	% Decrease
0.0	4.17	4.41	-5.8%	16.5	15.9	16.5	-3.8%
23.5	12.9	10.9	15.5%	23.5	18.2	15.4	15.4%
33.6	15.7	19.2	-22.3%	33.6	27.8	29.8	-7.2%
48.0	23.2	25.3	-9.1%	48.0	36	40.9	-13.6%
68.6	32.3	26.4	18.3%	0	3.67	3.59	2.2%
0.0	4.07	4.18	-2.7%	16.5	16.9	17.8	-5.3%
23.5	13	15.6	-20.0%	23.5	18.9	20.6	-9.0%
33.6	16.7	18.6	-11.4%	33.6	26	30	-15.4%
48.0	21.5	24.2	-12.6%	0	4.58	3.81	16.8%
0.0	4.27	4.32	-1.2%	16.5	12.8	9.28	27.5%
16.5	15.1	15	0.7%	23.5	12.6	14.8	-17.5%
23.5	15.8	17	-7.6%	33.6	16	16.6	-3.8%
33.6	21.8	23.4	-7.3%	48.0	23.9	17.6	26.4%
48.0	27.9	35.2	-26.2%	**Average % Decrease**			**-5.3%**
0	3.37	3.5	-3.9%				
16.5	15.7	15.9	-1.3%				
23.5	18.3	20.4	-11.5%				
33.6	27.1	26	4.1%				
0	3.6	3.55	1.4%				
16.5	16.1	16.7	-3.7%				
23.5	17.5	21	-20.0%				
33.6	28.4	27.8	2.1%				
0	3.5	3.95	-12.9%				
16.5	15.2	16.6	-9.2%				
23.5	16.9	20.2	-19.5%				
33.6	22.7	27.4	-20.7%				
0	2.05	2.05	0.0%				
16.5	15.5	16.1	-3.9%				
23.5	16.1	21.4	-32.9%				
33.6	26.8	29	-8.2%				
0	2.7	3.05	-13.0%				

Appendix 6. Summary of Test Conditions and Test Acceptability Criteria

Summary of Test Conditions and Test Acceptability Criteria for the Mussel, *Mytilus sp.*	
1. Test type	Static non-renewal
2. Test duration	48 hours (or complete development up to 54 hrs.)
3. Temperature	15°C ± 1°C (WER tests) 18°C ± 1°C (Reftox test)
4. Salinity	30 ± 2 ppt
5. Light quality	Ambient laboratory illumination
6. Light intensity	10-20 uE/m^2/s (50-100 ft-c)
7. Photoperiod	16L/8D
8. Test chamber size	30 mL
9. Test Solution Volume	10 mL
10. # of organisms per test chamber	150-300
11. # of replicate chambers per concentration	5
12. Age of test organisms	Embryo < 4 hr old
13. Feeding regime	None
14. Test chamber aeration	None
15. Test Materials	Site waters and "Lab" waters
16. Test Endpoint	Survival and larval shell development
17. Sampling and holding requirements	Test initiation < 36 hours from collection of site waters.
18. Test acceptability	≥ 50% survival in Control; ≥ 90% normal development of surviving embryos in Control.
19. Reference toxicant results	within ± 2 SD of laboratory mean of last 20 tests