Final Technical Report | **2008**

Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006:

North East Bay Creeks
Central East Bay Creeks
Arroyo Mocho Watershed
South Coastal Marin Creeks
San Francisco Creeks

December 2008

SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD

www.waterboards.ca.gov/swamp

(Intentionally blank)

SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP)

SAN FRANCISCO BAY REGION

WATER QUALITY MONITORING AND BIOASSESSMENT IN SELECTED SAN FRANCISCO BAY REGION WATERSHEDS IN 2004-2006

NORTH EAST BAY CREEKS
Baxter, Cerrito, Codornices, and Strawberry Creeks

CENTRAL EAST BAY CREEKS
Temescal, Glen Echo, Sausal, Peralta, Lion, and Arroyo Viejo Creeks

ARROYO MOCHO WATERSHED

SOUTH COASTAL MARIN CREEKS
Audubon Canyon, Morses Gulch, Pine Gulch, Easkoot, Webb, Redwood, Tennessee Valley, and Rodeo Creeks

SAN FRANCISCO CREEKS
Lobos and Islais Creeks

2004-2006

(Years 4 & 5)

Final Report
December 23, 2008

SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD

List of Authors

Revital Katznelson[1]
Matt Cover[2]
Karissa Anderson[2]
Peter Otis[2]
Karen Taberski[2]

[1] Independent contractor, Berkeley, CA
(revitalk@sbcglobal.net)

[2] San Francisco Bay Regional Water Quality Control Board
1515 Clay St. Suite 1400
Oakland CA 94612

With assistance from SWAMP Data Management Team members Cassandra Lamerdin Stacey Swenson, Marco Sigala, and Mark Pranger of the Moss Landing Marine Laboratory

This report should be cited as follows:

SFBRWQCB 2008. Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006. Surface Water Ambient Monitoring Program, San Francisco Bay Regional Water Quality Control Board, Oakland, CA

List of Acronyms

Acronym	what it means
BMI	Benthic Macroinvertebrates
CAMLnet	California Aquatic Macroinvertebrate Laboratory Network
COBS	Chironomidae, Oligochaeta, Baetis sp., and Simuliidae (BMI taxa)
CRM	Certified Reference Material
CSBP	California Stream Bioassessment Procedure
CTR	California Toxics Rule
DFG	Department of Fish and Game
DFG-ABL	Department of Fish and Game, Aquatic Biology Laboratory
DFG-WPCL	Department of Fish and Game - Water Pollution Control Laboratory
DO	Dissolved Oxygen
DQI	Data Quality Indicator
EPT	Ephemeroptera, Plecotera, Trichoptera (BMI taxa)
LCS	Laboratory Control Sample
MDL	Minimum detection limit
MLML	Moss Landing Marine Laboratory
MPN	Most Probable Number
MPSL	Marine Pollution Studies Laboratory
MQO	Measurement Quality Objective
MS/MSD	Matrix Spike / Matrix Spike Duplicate
MWAT	Maximum Weekly Average Temperature
MWMT	Maximum Weekly Maximum Temperature
NMS	Non-metric multidimensional scaling
OC	OrganoChlorine
OP	OrganoPhosphate (pesticide)
PAHs	Polynucleated Aromatic Hydrocarbons
PCBs	PolyChlorinated Biphenyls
PEC	Probable Effect Concentration
PHAB	Physical habitat
QAPP	Quality Assurance Project Plan
QC	Quality control
QMP, or QAMP	Quality Management Plan
RB2	Regional Board 2 (SF Bay Regional Board)
RL	Reporting limit
RPD	Relative Percent Difference
SC	Specific Conductance
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
STE	Standard Taxonomic Effort
SWAMP	Surface Water Ambient Monitoring Program
TEC	Threshold Effect Concentration
TRL	Target reporting limit
UCD-GC	UC Davis (Laboratory) at Granite Canyon
WPCL	Water Pollution Control Laboratory

Table of Contents

List of Appendices

List of Tables

List of Figures

1 Introduction

1.1 Overview of the Surface Water Ambient Monitoring Program (SWAMP) in California

California Assembly Bill 982 (Water Code Section 13192; Statutes of 1999) required that the State Water Resources Control Board (SWRCB) assess and report on State water monitoring programs and prepare a proposal for a comprehensive surface water quality monitoring program. The SWRCB proposed to restructure the existing water quality monitoring programs into a new program, the Surface Water Ambient Monitoring Program (SWAMP). This program consists of statewide environmental monitoring focused on providing the information needed to effectively manage the State's water resources. SWAMP is designed to be consistent, cooperative, adaptable, scientifically sound, and to meet clear monitoring objectives. It will also facilitate reporting and categorizing of the State's water quality under Sections 305 (b) and 303 (d) of the federal Clean Water Act.

SWAMP has conducted statewide monitoring through the SWRCB and regional monitoring through the Regional Water Quality Control Boards. Recently, both the statewide component and the regional components have been redesigned. Monitoring per both redesigned components commenced in FY 2007-2008.

1.2 Overview of the San Francisco Bay Region SWAMP Monitoring Program

The objectives of SWAMP in the San Francisco Bay Region included:

- Monitoring watersheds to assess water quality impacts and establish regional reference sites; and
- Monitoring edible fish for contaminant levels in reservoirs and coastal areas where people catch and consume fish.

Five years of watershed monitoring based on the rotating basins design have been completed in 2006. Data collected in the first three years of monitoring has been reported in two previous documents on "Water Quality Monitoring and Bioassessment in San Francisco Bay Region Watersheds": (a) **The Years 1&2 Report** included nine watersheds monitored in 2001-2002 (Walker Creek, Lagunitas Creek, San Leandro Creek, Wildcat/San Pablo Creeks, Suisun Creek, Arroyo Las Positas) and 2002-2003 (Pescadero/Butano Creeks, San Gregorio Creek, and Stevens/Permanente Creeks) (SFBRWQCB 2007a), and (b) **The Year 3 Report** includes four watersheds monitored in 2003-2004 (Kirker Creek, Mt. Diablo Creek, the Petaluma River and San Mateo Creek)) (SFBRWQCB 2007b). This report, referred to as the **Years 4&5 Report**, summarizes data collected in numerous small watersheds in the East Bay and in the Arroyo Mocho watershed in 2004-2005, as well as data collected in several small watersheds in south-west Marin County and in San Francisco in 2005-2006.

From 1998 to 2001 SWAMP and previous monitoring programs (Toxic Substances Monitoring Program and Coastal Fish Contamination Program), conducted contaminant monitoring in edible fish in coastal areas and reservoirs popular for fishing. The results of these fish tissue studies can be found in the report "Chemical Concentrations in Fish Tissues from Selected Reservoirs and Coastal Areas in the San Francisco Bay Region" (SFBRWQCB 2005). San Francisco Bay Region SWAMP personnel also pioneered the trash assessment efforts, which are summarized in the report "A Rapid Trash Assessment Method Applied to Waters of the San Francisco Bay Region: Trash Measurement in Streams" (SFBRWQCB 2007c). The watersheds, fish tissue, and trash reports are available on the SWAMP websites at
http://www.waterboards.ca.gov/sanfranciscobay/water_quality.shtml and
http://www.waterboards.ca.gov/water_issues/programs/swamp/reports.shtml

1.3 Goals and Objectives of the Watershed Component of SWAMP in the San Francisco Bay Region

The goal of the Surface Water Ambient Monitoring Program (SWAMP) in the San Francisco Bay Region has been to monitor and assess watersheds in the Region using a weight-of-evidence approach based on measurement of physical, chemical, and biological water quality characteristics. Data developed in this program are intended to be used for evaluating watersheds for 305b reporting and 303d listing.

Specific objectives of the monitoring program are to develop new data to evaluate beneficial use protection; measure water quality indicators and stressors to characterize spatial and temporal trends; determine relationships between water quality indicators, specific stressors and land use, including water management; identify reference sites; and evaluate monitoring tools. Due to a reduction in regional SWAMP funding, in the future we plan to meet these objectives in collaboration with other watershed monitoring programs.

1.4 Scope of the Report

This report provides a data summary for watershed monitoring completed during years four and five of the regional program. Watershed data were compared with published water quality benchmarks and reviewed to identify spatial and/or temporal trends. Data analysis was also geared to augment regional findings from previous years' monitoring, including linkage of results to land use and evaluation of the SWAMP monitoring tools. This report does not provide an evaluation of beneficial use support, nor does it assess watershed impairment; however, data provided herein can be used in support of such determinations.

Section 2 of this report provides summary information on the watersheds sampled, and shows the sampling locations. It also describes the study design for years 4&5, the logistics of field operations, and the laboratory methodology. Section 3 shows highlights of the results, arranged for each group of watersheds in a separate sub-section (3.1 to 3.5); these are followed by a regional summary chapter (Sub-section 3.6). Section 4 provides discussion of all results. Section 5 lays out the conclusions and the recommendations, and Section 6 provides the references for the articles cited in the entire report. The body of this report (Sections 1 through 6) is followed by a set of appendices that contain the individual monitoring results and are an integral part of the reporting effort.

The authors of this report hope that all the basic information a reader will find essential to understanding the report has been provided. However, this report leans heavily on rationale, discussions, and details contained in five previously-released documents, and the reader is advised to have these documents accessible:

- SF Bay Region SWAMP interpretive report for years 1 and 2 (SFBRWQCB. 2007a);
- SF Bay Region SWAMP interpretive report for year 3 (SFBRWQCB. 2007b);
- SF Bay Region SWAMP work plan for FY 03-04 (SFBRWQCB. 2004a);
- SF Bay Region SWAMP work plan for FY 04-05 (SFBRWQCB. 2004b);
- The SWAMP Quality Management Plan with its appended protocols (Puckett 2002).

(blank)

2 Methods

2.1 Watershed and site descriptions

2.1.1 Watershed and site selection criteria

The watersheds selected for years 4&5 monitoring represented a variety of microclimates, terrains, urbanization history, water impoundment layouts, types of impacts, and distributions of land use activities. They also span different sides of the Bay and are located in different counties (SFBRWQCB 2004a and 2004b). Figures 2.1-1 through 2.1-5 below show the selected watersheds, and Figure 2.1-6 below shows their locations around the Bay.

In contrast to the previous years' monitoring, in which the monitoring design called for a number of stations within each relatively large watershed, the years 4&5 design expanded monitoring activities into small watersheds and short creeks typical of many parts of the Bay. These small creeks were clustered into local groups of similar drainages, an arrangement that facilitated sampling logistics and reporting. Each small creek was represented by 1-4 stations to optimize the use of monitoring resources. Thus, years 4&5 monitoring efforts present several small-creek clusters mixed with a number of larger watersheds which are represented by a greater number of stations.

In determining sampling sites within the larger watersheds, SWAMP first considers the potential water quality concerns in the watershed. By hypothesizing where the sources of potential problems may be, sites are considered in those areas, depending of course on factors such as site accessibility, access permission, and project funding. By placing monitoring sites in locations both upstream and downstream of high impact areas, it is possible to make inferences, directly related to specific land uses.

Establishing reference sites is of utmost importance. The criteria for establishing reference sites for a watershed have been a long-debated issue, but general requirements are that they are accessible, are found in geographic and geologic conditions similar to those of impacted sites, and are as close to pristine historical conditions as is available in the watershed. The need for urban land use reference sites has also been identified, but their selection will be based on a different set of criteria.

Integrator sites are established at the lowest point in the watershed that is not tidally influenced. Although these sites receive contaminants from all sources and land use impacts in the watershed, they are limited in providing a fully cumulative picture because of transience and dilution of contaminants. Integrator sites are used to evaluate the relative contribution of contaminants to the receiving waters (SFBRWQCB 2004a).

2.1.2 Years 4&5 sampling stations

Table 2.1-1a shows the lat/long coordinates for the 40 sites monitored by SWAMP in the watersheds selected for the fourth year of monitoring, and **Table 2.1-1b** shows the lat/long coordinates for the 21 sites monitored by SWAMP in the watersheds selected for the fifth year of monitoring (both years' stations were actually monitored in 2005-06). Station elevations were gleaned from the SWAMP database, and flow regime information was obtained from reconnaissance summaries, where available. Reconnaissance data sheets and summaries are available with SWAMP personnel at the SF Bay Region office.

Figures 2.1-1 through 2.1-5 show the eight maps of the watersheds selected for years 4&5. As mentioned above, locations were selected to characterize the stream network in relation to urban areas and to provide an integrated picture of potential contaminants. Figure 2.1-6 shows the locations of all the years 4&5 watersheds around the Bay

Table 2.1-1a: Stations monitored in year 4

Stn #	yr	Station	Station Name	Latitude	Longitude	Elev-ation		Flow regime
north East Bay Watershed (CalWater **203**)								
1.1	4	BAX030	Baxter at Booker	37.91828	-122.32587	8	m	Intermittent
1.2	4	BAX045	Lower Baxter @ Gateway Projec	37.9312	-122.32237	23	m	Intermittent
1.3	4	BAX050	Gateway	37.93151	-122.32097	23	m	Intermittent
2.1	4	CER020	Cerrito at Creekside Park	37.89821	-122.3039	5	m	Perennial
3.1	4	COD020	Codornices at 2nd Street	37.88188	-122.30692	13	m	Perennial
3.2	4	COD080	Albina Ave	37.88242	-122.28475	27	m	Perennial
3.3	4	COD120	Live Oak Park	37.88437	-122.26879	87	m	Perennial
4.1	4	STW010	Strawberry Creek Park	37.8679	-122.2869	25	m	Perennial
4.1a	4	STW020	Above Strawberry Creek Park	37.86806	-122.28568	27	m	Perennial
4.2	4	STW030	UCBerkeley at Oxford	37.87051	-122.26495	68	m	Perennial
central East Bay (Oakland) watersheds (CalWater **203** (TEM) **and 204)**								
5.1	4	TEM050	Hardy Park	37.84175	-122.25775	43	m	Intermittent
5.2	4	TEM060	Birch Court	37.84671	-122.24824	62	m	Perennial
5.3	4	TEM090	Above Lake Temescal	37.84359	-122.22686	136	m	Perennial
6.1	4	LME100	Glen Echo at 29th Street	37.81726	-122.26107	12	m	Perennial
6.2	4	LME130	Oak Glen Park	37.82024	-122.25863	12	m	Perennial
7.1	4	SAU030	Sausal at E.22nd	37.78566	-122.22424	24	m	Perennial
7.2	4	SAU060	Sausal at Lions Pool	37.80572	-122.21577	63	m	Perennial
7.3	4	SAU070	Sausal at El Centro	37.80716	-122.21565	69	m	Perennial
7.4	4	SAU080	Dimond Park	37.80791	-122.21563	80	m	Perennial
7.5	4	SAU130	Palo Seco	37.81596	-122.20153	174	m	Intermittent
8.1	4	PRL020	Cesar Chavez Park	37.7781	-122.21812	14	m	Perennial
8.2	4	PRL080	Peralta at Rettig	37.80263	-122.19499	98	m	Perennial
9.1	4	LIO030	Lion at Eastlawn	37.75957	-122.19562	4	m	Perennial
9.2	4	LIO070	Mills College at Wetmore Bridge	37.77738	-122.18292	31	m	Perennial
9.3	4	LIO080	Mills College at Alumni House	37.78223	-122.18021	53	m	Perennial
9.4	4	LIO090	Mills College above Aliso	37.78219	-122.17784	57	m	Perennial
9.5	4	LIO130	Horseshoe Creek	37.79185	-122.17948	103	m	Perennial
10.1	4	AVJ020	Arroyo Viejo Rec. Center	37.76253	-122.17539	15	m	Perennial
10.2	4	AVJ090	Country Club Branch	37.75769	-122.1469	82	m	Perennial
10.3	4	AVJ110	Rifle Range	37.77736	-122.14786	130	m	Perennial
10.4	4	AVJ130	Knowland Park Zoo	37.75314	-122.14926	55	m	Perennial
10.5	4	AVJ140	Above Zoo at Golf Links	37.75714	-122.14068	84	m	Perennial
Arroyo Mocho Watershed (CalWater **204)**								
11.1	4	AMO070	Above Vulcan Bridge Zone 7	37.67672	-121.81452	120	m	Perennial
11.2	4	AMO080	Madeiros Parkway at Stanley	37.67714	-121.78848	140	m	Perennial
11.3	4	AMO090	Mocho Park	37.67417	-121.78056	143	m	Perennial
11.4	4	AMO095	Robertson Park	37.67082	-121.76153	157	m	Perennial
11.5	4	AMO100	Wente Street (Concannon St.)	37.66747	-121.75031	168	m	Perennial
11.6	4	AMO160	Above SBA Zone 7	37.62683	-121.70485	232	m	Intermittent
11.7	4	AMO180	Hetch Hetchy	37.60316	-121.66948	331	m	Intermittent
11.8	4	AMO200	County Line	37.48213	-121.5324	758	m	Intermittent

Table 2.1-1b: Stations monitored in year 5

Stn #	yr	Station	Station Name	Latitude	Longitude	Elev-ation		Flow regime
south-west Marin watersheds (CalWater 201)								
12.1	5	AUD020	Audubon Canyon	37.93081	-122.68037	14	m	Intermittent
13.1	5	MRS020	Morses Gulch	37.9201	-122.66887	14	m	Intermittent
14.1	5	PNG010	Lower Pine Gulch	37.91971	-122.69181	4	m	Perennial
14.2	5	PNG050	Teixeira	37.95451	-122.718	53	m	Perennial
15.1	5	EAS020	Easkoot	37.89844	-122.64174	7	m	Perennial
15.2	5	EAS050	Fitzhenry	37.90023	-122.63733	24	m	Perennial
16.1	5	WBB010	Steep Ravine	37.88671	-122.62655	115	m	Perennial
17.1	5	RDW010	Redwood @ Muir Beach	37.86039	-122.57448			Perennial
17.2	5	RDW040	Green Gulch	37.86306	-122.57202	13	m	Perennial
17.3	5	RDW060	Lower Redwood	37.86369	-122.57514	2	m	Perennial
17.4	5	RDW100	Miwok Bridge	37.88444	-122.57005	31	m	Perennial
17.5	5	RDW120	Muir Woods	37.90023	-122.57811	57	m	Perennial
18.1	5	TVY030	Tennessee Valley	37.84857	-122.54224	17	m	Intermittent
19.1	5	ROD010	Rodeo Lagoon Foot Bridge	37.83138	-122.53669	4	m	
19.2	5	ROD020	Rodeo Lagoon Car Bridge	37.83202	-122.52606	4	m	
19.3	5	ROD030	Rodeo Lake	37.83198	-122.5258	4	m	Perennial
19.4	5	ROD035	Rodeo Pond	37.83203	-122.52395	4	m	Perennial
19.5	5	ROD040	Gerbode	37.83904	-122.51644	22	m	Perennial
19.6	5	ROD050	Lower Rodeo	37.83291	-122.51613	12	m	Perennial
San Francisco watersheds (CalWater 203 and 204)								
20.1	5	LOB020	Lobos Below Lincoln	37.78827	-122.48393	15	m	
21.1	5	ISL050	Glen Canyon Park	37.74169	-122.44293	94	m	

Blank spaces indicate that station elevation and flow regime information was not available.

Figure 2.1-1: Location of year 4 monitoring stations in north East Bay watersheds: Baxter, Cerrito, Codornices, and Strawberry Creeks

Figure 2.1-2a: Location of year 4 monitoring stations in central East Bay (north Oakland) watersheds: Temescal, Glen Echo, Sausal, and Peralta Creeks

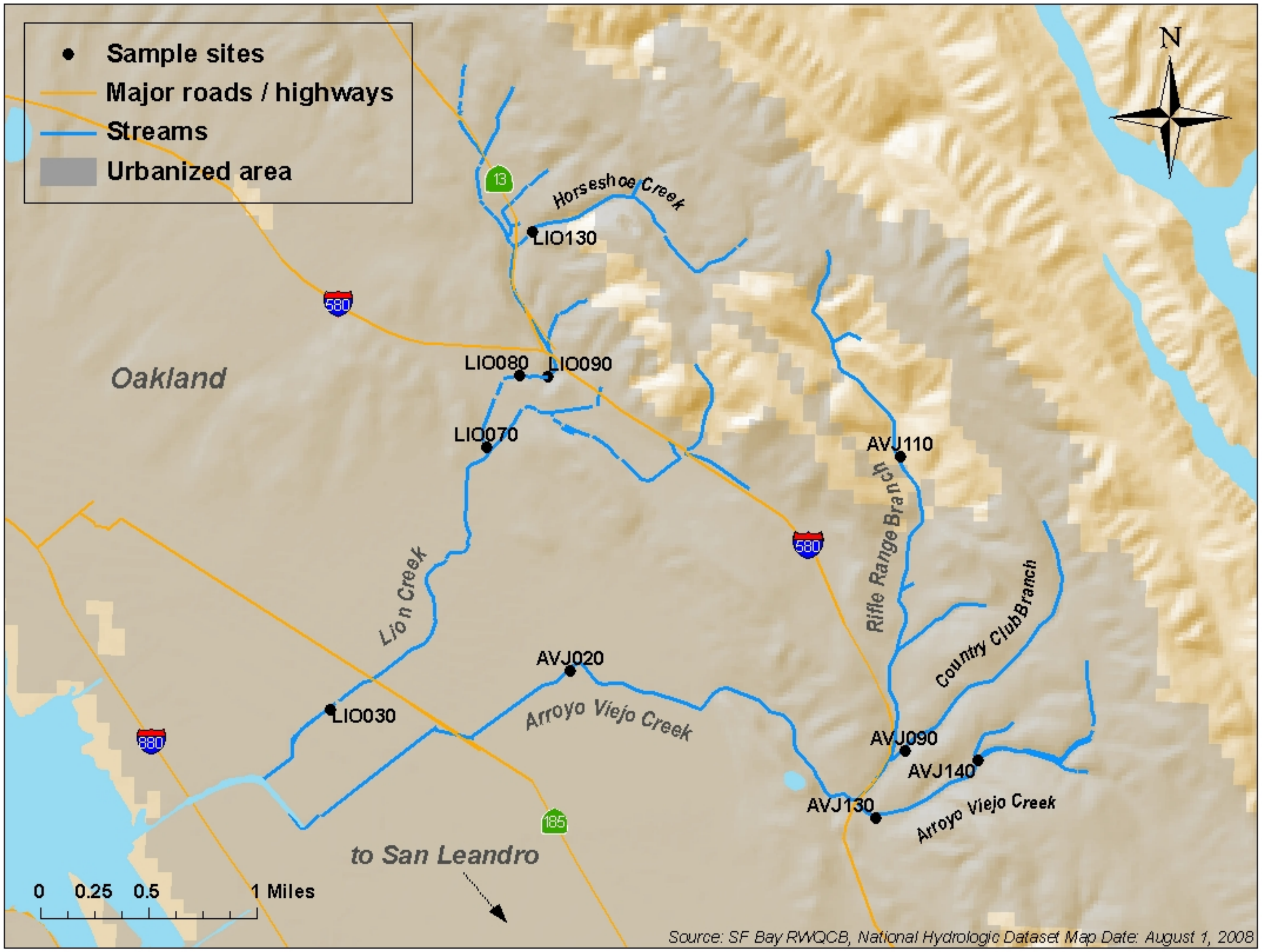


Figure 2.1-2b: Location of year 4 monitoring stations in central East Bay (south Oakland) watersheds: Lion and Arroyo Viejo Creeks

Figure 2.1-3: Location of year 4 monitoring stations in Arroyo Mocho watershed

Figure 2.1-4a: Location of year 5 monitoring stations in Marin Co. (Bolinas area) watersheds: Audubon Canyon, Morses Gulch, Pine Gulch, Easkoot, and Webb Creeks

Figure 2.1-4b: Location of year 5 monitoring stations in south Marin Co watersheds: Redwood and Tennessee Valley Creeks

Figure 2.1-4c: Location of year 5 monitoring stations in south Marin Co watersheds: Rodeo Creek

Figure 2.1-5: Location of year 5 monitoring stations in San Francisco watersheds: Lobos and Islais Creeks Creek

Figure 2.1-6: San Francisco Bay watersheds monitored in years 4&5

(blank)

2.2 Sampling design summary

One of the overall goals of SWAMP statewide is to develop a general picture of watershed health in the State. This calls for application of the probabilistic sampling design principle, in which each location has the same probability of being selected as all the other locations (so there is no 'bias' in the conditions monitored). However this approach required collection of a large number of samples to obtain good representation of the State's highly-variable waterways.

Monitoring goals at the regional level tend to focus on specific problem areas and potential reference sites. In this case the deterministic sampling design principle (in which locations are selected based on prior knowledge and the choices are directed to answer specific monitoring questions) was preferred. In the SF Bay Region, this directed sampling design was used to: 1) evaluate the influence of tributaries, 2) determine if beneficial uses are being protected at specific locations, 3) follow-up on previous data indicating potential impacts, 4) determine if specific land uses are having an impact on water quality and 5) identify reference sites for future studies.

To assure comprehensive coverage of the region under severe budget limitations, SWAMP implemented a rotating basin scheme: each year the Program monitored a few different watersheds, with the hope of returning to monitor each one every five years. The time unit allocated for each set was one year, which covered an entire cycle of seasons. Watershed and station selections for years 4&5 have been described above (Section 2.1). The timing selection rationale is described below, followed by description of the tiered monitoring approach that was developed to maximize the use of resources in obtaining relevant information.

2.2.1 Seasonal considerations

The strategy used for the Regional Water Board studies under SWAMP focused on three sampling events based on three hydrologic periods. The three **hydrologic periods** were the wet season (January-March), decreasing hydrograph/spring (April-May) and the dry season (June-October), although sampling time was decided primarily by water patterns (rather than by month).

2.2.2 Application of a tiered monitoring approach

"Tier 1" was the set of monitoring parameters that addresses the general health of the watershed. These included observations and field measurements during every Station visit, benthic macroinvertebrates (BMI) and physical habitat assessments in the spring, and periods of continuous field measurements throughout the watersheds at all seasons.

"Tier 2a" monitoring provided an opportunity to answer basic questions concerning protection of beneficial uses and potential impacts of land use and water management. Nutrients, various contaminants, pathogens, and toxicity were monitored at sites with potential impacts from land uses, or in reference sites to provide background levels. Tier 2a samples were collected during 3 hydrologic cycles.

"Tier 2b" monitoring looked at the cumulative effects of environmental contamination, both temporally (by selecting media that integrate contaminants over time, such as sediments) and spatially (by sampling at an 'integrator site' at the bottom of each watershed, or the lowest point before tidal influence). Sediment sampling at the integrator stations was targeted to collection of fine-grain sediment samples for chemical analyses and for toxicity testing using the amphipod *Hyalella azteca.*

Table 2.2-1 shows a summary of monitoring activities performed in years 4&5 by the different participants in relation to these three tiers.

Table 2.2-1: Summary of 2004 and 2005 monitoring activities included in this report.

Characteristic group	Medium	Tier	Personnel	Activity type	Activity Frequency and Interval	Season & Timing *(Note 1)*	Total # of Stations	*Total # of Station Visits (Note 2)*
Local conditions *(Note a)*	all	Tier 1	MLML	Field Observations	3/yr, 3 months apart	all	22	62
"Vital signs" *(Note b)*	water	Tier 1	MLML	Discrete Field Measurements	3/yr, 3 months apart	all	22	62
Sonde probes suite *(Note c)*	water	Tier 1	RB2	Continuous Field Measurement deployments	up to 4/yr, 3 months apart	all	46	139
Physical habitat attributes	all	Tier 1	DFG-ABL	Field Observations	1/yr	spring	41	41
Benthic macroinvertebrate assemblages	biota	Tier 1	DFG-ABL	Sample; lab ID and count	1/yr	spring	43	43
Conventional WQ characteristics (including salts & nutrients)	water	Tier 2a	MLML	Sample, lab analysis	3/yr, 3 months apart	all	20	59
Water chemistry (Metals, organics) and toxicity	water	Tier 2a	MLML	Sample, lab analysis/tests	3/yr, 3 months apart	all	14	40
Coliform counts	water	Tier 2a	RB2	Sample, lab counts	5/yr, one week apart	summer	17	85
Sediment chemistry and toxicity	sediment	Tier 2b	MLML	Sample, lab analysis/tests	1/yr	spring	13	13

DFG-ABL -Department of Fish and Game, Aquatic Biology Laboratory; MLML - Moss Landing Marine Laboratory; RB2 - Regional Board 2 (SF Bay Region)

Note 1 Station visits occurred any time of day (not directed to a specific time). Trip scheduling was directed to non-rainy weather, i.e., base flow conditions.
Note 2 Activities done at specific stations are shown in Appendix Table A-1 and in the data appendix tables (B-1, C-1, D-1, and E-1).
Note a Local conditions include estimated flow, weather, Station appearance & odors, water color, and presence of special features;
Note b The “vital signs” are: temperature, pH, dissolved oxygen, and specific conductance; these were measured during sample collection to support lab data. Discrete measurements of turbidity and instantaneous current velocity were added in some cases.
Note c The YSI 6600 Sonde probe suite included temperature, pH, dissolved oxygen, and specific conductance, measured every 15 min. for 1-3 weeks.

(blank)

2.3 Field operations

Field operations were conducted by several crews. Each crew had its own logistics, used the field data sheet tailored for its work, and followed the appropriate chain of custody procedures if shipping samples. Crews that performed multiple activities kept a consistent order to assure that one activity does not interfere with another. For example, Moss Landing Marine Laboratory (MLML) crews always began with observations and field measurements, followed by collection of water samples, and culminated by collection of sediment samples.

2.3.1 Department of Fish and Game, Aquatic Biology Laboratory (DFG-ABL): Bioassessment and Physical Habitat assessments

Several DFG-ABL crews, working in parallel, collected benthic macroinvertebrate (BMI) samples at 41 stations between April 11 and April 20, 2005 (see Appendix Table B-1), following an interim protocol which was used during the transition from the California Stream Bioassessment Procedure (CSBP, Harrington 1999) to the new SWAMP bioassessment protocol (Ode 2007). Each BMI sample represents a collection of organisms captured with a D-net (0.5 mm mesh size) from 8 riffle sampling squares that were randomly-selected within a 150 m Reach. Each square had an area of 1x1 ft and was sampled to the depth of 4-6". The eight sub-samples were pooled together and preserved in 95 percent ethanol in the field. The crews also conducted physical habitat assessments at 41 of these stations, following the same interim protocol. Two stations, ROD040 and ROD050, were passed over by DFG-ABL crews but were later sampled for BMI by Regional Board staff on May 18, 2005. Due to time and equipment constraints, Regional Board staff did not perform physical habitat surveys at these two sites.

2.3.2 Waterboard (RB2) SWAMP operators: continuous monitoring and bacterial counts

A. **Continuous field measurements:** Visits to deploy and retrieve data logging sondes were conducted at 46 sites by local SWAMP operators based at the SF Bay Region office (RB2). The sondes were programmed to measure pH, DO, temperature, specific conductivity (a.k.a 'specific conductance'), and depth every 15 minutes, and deployment episodes ranged between one and three weeks (with one exceptional deployment of 2 days due to battery failure). These crews were also responsible for pre-deployment calibrations and post-deployment accuracy checks. During sonde deployment and retrieval, crews recorded location attributes (vegetation, depth of stream, flow, visual turbidity, occurrence of pools and riffles, and substrate quality) on data sheets and in photographs.

B. B**acterial counts:** Water samples for bacterial counts were collected at 17 sites by local SWAMP operators based at the SF Bay Region office, following U.S.EPA methods for volunteer stream monitoring (U.S.EPA 1997). Samples were collected at weekly intervals (Year 4: 7/20/04, 7/27/04, 8/3/04, 8/10/04, and 8/17/04; Year 5: 7/12/05, 7/19/05, 7/26/05, 8/2/05 and 8/9/05) to enable generation of a 30-day average of 5 samples.

2.3.3 Moss Landing Marine Laboratory (MLML): Sampling of water and sediments for chemical analyses and toxicity testing

A. **Water:** Water sampling was conducted by crews from Marine Pollution Studies Laboratory (MPSL) at Moss Landing Marine Laboratory (MLML). Grab water samples for analysis of **conventional** characteristics were collected at **22 sites** by MLML crews. The spring (April 11-12, 2005) and summer (June 13-14, 2005) sampling Trips included visits to all sites (i.e., 'year-4' sites and 'year-5' sites). The winter Trips were done at different times for year 4 sites (January 10-11, 2005) and year 5 sites (February 16, 2006). The crew followed SWAMP protocols (i.e., the original Appendices to Puckett 2002), using a number of pre-cleaned plastic containers for each 'Sample'. At the time of sampling, the crew also recorded field observations (e.g., weather, flow conditions, sample color or odor, presence of algae, etc.) and conducted field measurements (temp, pH, DO, and specific conductance) to support lab data. During these sampling trips, the same crew also collected grab water samples for analysis of **metals & organics**, and for water column **toxicity** testing, at **14 selected sites**. The crew used pre-cleaned containers of glass or plastic, with the appropriate preservatives, as provided by each of the laboratories involved. At each sampling event, multiple containers were filled in sequence. All grab water samples were collected at stream locations that represent the bulk of the flow, about 10 cm below the surface. MLML crews were also responsible for collection of field blanks and field duplicates per SWAMP QAMP (Puckett 2002).

B. **Sediment:** Fine-grain sediment samples, for analysis of selected metals & organics and for bulk sediment toxicity testing, were collected at **13 sites** by MLML crew. The nine year-4 sites were visited on 4/12/05 and the four year-5 sites on 4/11/05. Samples were collected following the SWAMP protocol (Appendices to Puckett 2002). The crew searched for areas where deposition of finer particles occur, and collected these sediments deliberately. Samples were composited from multiple scoops of the top 2 cm and homogenized thoroughly before sub-sampling for the different tests.

2.4 Laboratory analyses

Tables 2.4-1 and 2.4-2 show the groups of analytes and other characteristics that were analyzed, tested, or counted in various laboratories using a variety of methods. These tables also show the actual ranges of detection limits and reporting limits achieved for each analyte in water (Table 2.4-1) and sediments (Table 2.4-2). Complete analytical suites for OCs, OPs, PAHs, and PCBs, with achieved ranges of detection limits and reporting limits, are presented in appendix Table D-2. Extensive description of SWAMP laboratory work has been provided in the Years 1&2 report (SFBRWQCB 2007, Section 4). A brief extract from that section, plus additional information on selected laboratory activities, is provided below.

2.4.1 Benthic Macroinvertebrates

All samples were sorted and identified by the DFG ABL in accordance with the 2003 CSBP and the Standard Taxonomic Effort (STE) developed by the California Aquatic Macroinvertebrate Laboratory Network (CAMLnet; now called the Southwestern Association of Freshwater

Invertebrate Taxonomists, or SAFIT; www.safit.org). Five hundred individual organisms were randomly sub-sampled from each sample for identification (to the level of genus for most insects) and enumeration. The raw taxonomic data was standardized to the taxonomic levels specified in the CAMLnet STE (to accommodate analyses by different taxonomists) as described previously (SFBRWQCB 2007a). The biological metrics shown in Appendix Table B-2 were then calculated.

2.4.2 Chemical analyses

Chemical analyses of water and sediment samples were performed at a number of laboratories, predominantly: Department of Fish and Game Water Pollution Control Laboratory (DFG-WPCL) and Marine Pollution Studies Laboratory, Department of Fish and Game (MPSL-DFG), which were able to deliver the low detection levels required by SWAMP. Details are shown in Tables 2.4-1 and 2.4-2 , In Appendix Table B-2, and in Year 1& report (SFBRWQCB. 2007).

2.4.3 Toxicity testing

Water column and bulk sediment toxicity testing was performed at the UC Davis Marine Pollution Studies Laboratory at Granite Canyon (UCD-GC). The U.S.EPA whole effluent toxicity protocol (U.S.EPA 1994) was used to test the effect of water samples on three freshwater test organisms. Testing included the 7-day static renewal (chronic) tests for *Pimephales promelas* survival and growth and *Ceriodaphnia dubia* survival and reproduction, as well as the 96-hour static test for *Selenastrum capricornutum* growth. Sediment samples were used in the 10-day bulk toxicity test for *Hyalella azteca* survival and growth (U.S.EPA 2000a), but the test exposure was extended to 28 days**.**

2.4.4 Coliform counts

Coliform counts in water samples were performed by the U.S. EPA Region IX Laboratory in Richmond, CA. The lab used Standard Method 9223 (APHA 1998), a new enzyme-substrate method that uses the IDEXX Colilert ™ reagent to count total coliforms and *Escherichia coli*. This method was used in conjunction with SOP #1103 developed by U.S.EPA Region IX laboratory. Years 4&5 samples were tested at 1:10 dilutions to extend the count range up to 24000 per 100 ml, and values were corrected for this dilution and reported as MPN/100mL in the original sample.

Table 2.4-1: Laboratory analyses, tests, or counts performed with water samples in 2004-05

Group	Analyte	Laboratory	Method	Unit	MDLs Min	MDLs Max	RLs Min	RLs Max
Conventional								
	Alkalinity as CaCO3	DFG-WPCL	QC 10303311A	mg/L	3	3	8	10
	Ammonia as N	DFG-WPCL	EPA 350.3	mg/L	0.04	0.04	0.1	0.1
	Boron,Total	MLML-TM	EPA 1638M	mg/L	0.0001	0.0001	0.0003	0.0003
	Boron,Total	SFL	EPA 200.7	mg/L	0.0044	0.0097	0.05	0.05
	Chloride	DFG-WPCL	EPA 300.0	mg/L	0.2	4	0.35	7
	Chlorophyll a	MPSL-DFG	EPA 445.0M	µg/L	0.045	0.045	0.045	0.045
	Dissolved Organic Carbon	AMS	EPA 415.1	mg/L	0.1	0.1	0.1	0.1
	Dissolved Solids,Total	DFG-WPCL	SM 2540 C	mg/L	10	10	10	10
	Hardness as CaCO3	DFG-WPCL	QC 10301311B	mg/L	5	5	10	10
	Hardness as CaCO3	DFG-WPCL	SM 2340 C	mg/L	1	1	1	1
	Manganese,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.03	0.03
	Nickel,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.05	0.05
	Nitrate as N	DFG-WPCL	QC 10107041B	mg/L	0.01	0.2	0.02	0.4
	Nitrite as N	DFG-WPCL	QC 10107041B	mg/L	0.002	0.005	0.005	0.01
	Nitrogen, Total Kjeldahl	DFG-WPCL	QC 10107062E	mg/L	0.12	0.12	0.25	0.25
	OrthoPhosphate as P,Dissolved	DFG-WPCL	QC 10115011M	mg/L	0.005	0.005	0.01	0.01
	Phosphorus as P,Total	DFG-WPCL	QC 10115011D	mg/L	0.03	0.03	0.05	0.05
	Sulfate	DFG-WPCL	EPA 300.0	mg/L	0.5	10	0.7	14
	Suspended Sediment Concentration	MPSL-DFG	ASTM D3977M or SM 2540 B	mg/L	5	5	5	5
	Total Organic Carbon	AMS	EPA 415.1	mg/L	0.1	0.1	0.1	0.1
	Total Organic Carbon	DFG-WPCL	EPA 415.1M	mg/L	0.2	0.2	1	1
Metals								
	Aluminum,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.1	0.1	0.5	0.5
	Arsenic,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.1	0.1	0.5	0.5
	Cadmium,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.03	0.03
	Chromium,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.03	0.03	0.1	0.1
	Copper,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.03	0.03
	Lead,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.03	0.03
	Mercury,Total	MPSL-DFG	EPA 1631EM	**ng/L**	0.16	0.2	0.16	0.2
	Selenium,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.1	0.1	0.5	0.5
	Silver,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.05	0.05
	Zinc,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.1	0.1	0.3	0.3
Organics								
	Chlorpyrifos	UCD-GC or ToxScan	ELISA	µg/L	0.05	0.05	0.1	0.1
	Diazinon	UCD-GC or ToxScan	ELISA	µg/L	0.03	0.03	0.06	0.06
	Herbicides Suite	DFG-WPCL	EPA 619M	µg/L	0.02	0.02	0.05	0.05
	Carbaryl Suite	DFG-WPCL	EPA 632M	µg/L	var	var	var	var
	Organochlorine Pesticides	DFG-WPCL	EPA 8081AM/BM	µg/L	var	var	var	var
	OrganophosphatePesticides	DFG-WPCL	EPA 8141AM	µg/L	var	var	var	var
	PAHs Suite	DFG-WPCL	EPA 8270M	µg/L	0.005	0.005	0.005	0.005
	PCBs Suite	DFG-WPCL	EPA 8082M	µg/L	0.001	0.001	0.002	0.002
Toxicity testing								
	Ceriodaphnia dubia	MPSL-DFG or ToxScan	EPA 600/4-91-002 mod	NA	NA	NA	NA	NA
	Pimephales promelas	MPSL-DFG or ToxScan	EPA 600/4-91-002 mod	NA	NA	NA	NA	NA
	Selenastrum capricornutum	MPSL-DFG or ToxScan	EPA 600/4-91-002 mod	NA	NA	NA	NA	NA
Coliform counts								
	total coliform	EPA R-IX	SM 9223 IDEXX	MPN /100mL	10	10	10	10
	E, coli	EPA R-IX	SM 9223 IDEXX	MPN /100mL	10	10	10	10

MDL - minimum detection limit; RL - reporting limit; NA - not applicable
Complete analytical suites for OCs, OPs, PAHs, and PCBs are presented in appendix Table D-2

AMS: Applied Marine Sciences
DFG-WPCL: Department of Fish and Game Water Pollution Control Laboratory
EPA R-IX: EPA Region IX laroatroy, Richmond CA
MLML-TM
MPSL-DFG: Marine Pollution Studies Laboratory, Department of Fish and Game
SAL: Sequoia Analytical Laboratories, Inc.
SFL: Sierra Foothill Laboratory
ToxScan - ToxScan Inc. Watsonville
UCD-GC: University of California at Davis, Granite Canyon Laboratory

Table 2.4-2: Laboratory analyses performed with **sediment** samples in 2004-05

Group	Analyte	Laboratory	Method	Unit	MDLs Min	MDLs Max	RLs Min	RLs Max
Conventional analytes and sediment properties								
	Particle size distribution	AMS	ASTM D422	%	0.01	0.01	0.01	0.01
	Total Organic Carbon	AMS	EPA 9060	%	0.01	0.01	0.01	0.01
	Moisture	var	var	%				
Metals (Total)								
	Aluminum	MPSL-DFG	EPA 200.8	mg/Kg	125	125	400	400
	Arsenic	MPSL-DFG	EPA 200.8	mg/Kg	1.8	1.8	5	5
	Cadmium	MPSL-DFG	EPA 200.8	mg/Kg	0.02	0.02	0.05	0.05
	Chromium	MPSL-DFG	EPA 200.8	mg/Kg	0.7	0.7	2	2
	Copper	MPSL-DFG	EPA 200.8	mg/Kg	1.5	1.5	5	5
	Lead	MPSL-DFG	EPA 200.8	mg/Kg	0.4	0.4	1	1
	Manganese	MPSL-DFG	EPA 200.8	mg/Kg	0.5	0.5	2	2
	Mercury	MPSL-DFG	DFG SOP 103	mg/Kg	0.004	0.004	0.013	0.013
	Nickel	MPSL-DFG	EPA 200.8	mg/Kg	0.4	0.4	1	1
	Selenium	DFG-WPCL	EPA 7742M	mg/Kg	0.05	0.05	0.2	0.2
	Silver	MPSL-DFG	EPA 200.8	mg/Kg	0.07	0.07	0.2	0.2
	Zinc	MPSL-DFG	EPA 200.8	mg/Kg	2	2	6	6
Organics								
	OC Pesticides Suite	DFG-WPCL	EPA 8081AM	ng/g	var	var	var	var
	OP Pesticides Suite	DFG-WPCL	EPA 8141AM	ng/g	var	var	var	var
	Pyrethriod Pesticides Suite	DFG-WPCL	EPA 8081BM	ng/g	var	var	var	var
	PAHs Suite	DFG-WPCL	EPA 8270M	ng/g	0.565	1.15	0.565	1.15
	PCBs Suite	DFG-WPCL	EPA 8082M	ng/g	0.114	0.229	0.228	0.458
	PCB AROCLORS	DFG-WPCL	Newman, et al., 1988	ng/g	var	var	var	var
Toxicity testing								
	Hyalella azteca 28d bulk	UCD-GC or MPSL-DFG	EPA 600/R-99-064 mod		NA	NA	NA	NA

MDL - minimum detection limit; RL - reporting limit; NA - not applicable
Complete analytical suites for OCs, OPs, PAHs, and PCBs are presented in appendix Table D-2

AMS: Applied Marine Sciences
DFG-WPCL: Department of Fish and Game Water Pollution Control Laboratory
MPSL-DFG: Marine Pollution Studies Laboratory, Department of Fish and Game
UCD-GC: University of California at Davis, Granite Canyon Laboratory

(blank)

2.5 Data analysis and interpretation

The term "data analysis" often refers to six types of formal activities: **(a) endpoint derivation** for individual samples (e.g., BMI metrics, percent survival,); this often involves the use of statistical tables (e.g., for MPN/100 mL) or programs (e.g. Probit for LC50) to derive the endpoint value and the confidence limits around it. These endpoints are derived for a single sample. **(b)** basic statistical treatment of raw data to test for **significance** and/or confidence (e.g., running the statistical package to detect significant toxicity); **(c)** computation of **summary statistics** (e.g., median, geometric mean, MWAT) for data sets made of multiple measurements, **(d)** comparisons of constituent concentrations to **quality benchmarks**, either individually or in compilations (e.g., mean toxicity quotient); **(e) hypothesis testing** to detect change (e.g., before vs after, or reference vs downstream sites); and **(f)** derivation of **correlation** coefficients and/or application **of multivariate analyses** to detect **associations or relationships** between different types of results or factors. Another common "data analysis" activity refers to **(g)** creation of result presentation items such as **tables and figures,** and conducting **observations** of these items.

Note that the data verification and validation process is an essential but a totally separate part of the data handling process.

Data analysis activities "a" and "b" were performed by the laboratories according to their Standard Operating Procedures; these activities are an integral part of the measurement systems themselves. RB2 SWAMP operators calculated summary statistics (activity type "c") for continuous field measurements and for bacterial counts, following procedures established for year 1&2 (SFBRWQCB. 2007a Sections 4.6.2 and 4.6.5). The authors of this report conducted all comparisons to quality benchmarks (activity type "d"), as well as tabulating and plotting the results (activity type "g"). These presentation items were used to look at seasonality, upstream-downstream differences, spatial variability within the stream network, etc. The following sub-sections provide further description of selected years 4&5 data analysis activities.

2.5.1 Land use, BMI, and ordination plots

The years 1&2 report contained an elaborate review of land use in the watersheds monitored and presented a categorization system that enabled sorting of all year 1&2 sites into six land-use classes, ranging from open space to highly urbanized drainages (SFBRWQCB. 2007a). Benthic macroinvertebrate (BMI) results from year 1&2 sites were analyzed using non-metric multidimensional scaling (NMS), an ordination procedure that groups sites based on similarity in benthic macroinvertebrate assemblages. The NMS plot from the year 1&2 report showed clear relationships between BMI assemblages and three land use groups that represented (a) open space and rural residential, (b) grazing, agriculture and mixed, and (c) urban (SFBRWQCB. 2007a, Section 6). Although, no resources were available to conduct a similar review of watershed land use for year 4&5 watersheds, the same NMS ordination process was used in order to explore similarities in benthic macroinvertebrate assemblages among sites and watersheds.

Ordination is a technique whereby multiple variables are reduced and expressed in a small number of dimensions. For this analysis, sites were graphed in a two-dimensional ordination space based on the abundance of taxa present at each site. Presence/absence data was used in analyses in previous reports (SFBRWQCB. 2007a, SFBRWQCB 2007b) because raw abundance data was not available for all of the sites**.** Because abundance data was available for the years 4&5 samples, abundance data was used in the NMS analysis. A ln(x+1) transformation was applied to the raw abundance data prior to the NMS analysis in order to improve the normality of the data. Sites that are close together in ordination space exhibit similar benthic assemblages; increasing distance between sites indicates that a greater number of different taxa were present at the sites. Non-metric multidimensional scaling (NMS) is the most generally effective ordination technique for ecological community data (McCune and Grace 2002).

For the years 4&5 report, the values of a selected physical habitat variable (% fine sediment) were added to the NMS graph as a **biplot**. While the sites are shown as points, the biplot displays a habitat variable as a **vector** emanating from the center (zero values on the ordination axes) towards a certain direction in the graph; that direction reflects the correlation between the habitat variable values and the ordination axes (Axis 1 and Axis 2). In other words, this vector represents the correlation of the "% fine sediment" values with the ordination of sample sites. The vector points towards sites with high values of fine sediment, while sites in the opposite direction of the vector are associated with low values of fine sediment.

2.5.2 Summary statistics and box plots for continuous monitoring episodes

Each sonde file, generated from one deployment episode, contained between 93 and 2107 individual measurements for each water quality characteristic (pH, temperature, dissolved oxygen, and specific conductivity). The minimum and maximum values within each data set were easily identified by an Excel function, and so were the median, the 25th percentile, and the 75th percentile values used to construct a box-plot presentation for each episode. This type of 'box and whisker' plots is widely used to explore the distribution of independent data points (e.g., Helsel and Hirsch 2005), but it has often been used for presentation of the general tendencies of continuous monitoring data as well.

The continuous temperature data were used to compute one endpoint: the Maximum Weekly Average Temperature (MWAT), also described as the "7-day mean". Dissolved oxygen (DO) data were used to calculate a similar endpoint – the 7-day average minimum. These endpoints, calculated separately for each season, were used for comparison to water quality benchmarks as described below. In reality, the MWAT benchmark applies to data collected for a whole year, but it was necessary to do a theoretical extrapolation of 1-2 weeks to the entire year to generate an endpoint that enables checking for exceedances.

2.5.3 Comparison of monitoring results to water quality benchmarks.

The phrase 'water (or sediment) quality benchmark' is a catch-all term to include objectives, guidelines, limits, targets, standards, and other types of values for concentrations of constituents that should not be exceeded in a given water body. There may be a profound difference between each sub-set of benchmarks, for example, objectives are used as regulatory tools, while guidelines are used for evaluation but are not legally binding. The term ‘threshold’ is often used in this report to convey the same meaning as ‘benchmark’. For constituent concentrations, the word ‘exceedance’ means that the sample value was above the benchmark (and this was not ‘good’). However, dissolved oxygen values are ‘good’ if they are above the benchmark, and ‘good’ pH values are within a defined range (usually 6.5 to 8.5), above and below which the conditions are considered ‘not good’, i.e., an ‘exceedance’.

Tables 2.5-1 and 2.5 -2 show a compilation of quality benchmarks for water and sediments, respectively. These benchmarks were used by this report’s authors to assess exceedances (activity type “d”). First, the data were compared to benchmarks developed for the regional Basin Plan for protection of aquatic life. If there were no objectives for an analyte in the Basin Plan, the benchmarks from the California Toxics Rule were used (CTR; Federal Register, Part III; U.S.EPA; 40 CFR Part 131 Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule. May 18, 2000). If there were no benchmarks in either of these documents, other documents (California Department of Fish and Game benchmarks, TMDLs, U.S.EPA criteria) or peer reviewed literature articles were screened for the most appropriate benchmark. Some U.S.EPA benchmarks for nutrients may not be applicable to all types of streams monitored in years 4&5.

There are two levels of impact for some of the constituents, expressed either in relation to exposure duration (e.g., chronic or acute, for water), or in terms of probability of impact (i.e., PEC or TEC, for sediment). Essentially, measured sediment chemical concentrations below Threshold Effects Concentrations (TECs) are considered unlikely to contribute to adverse effects in sediment-dwelling organisms. In contrast, sediment chemical concentrations above Probable Effects Concentrations (PECs) are considered likely to be toxic to sediment-dwelling organisms. To estimate the effects of a mixture of contaminants, the Sediment Quality Guideline Quotient (SQGQ) values, a.k.a mean toxicity quotients, were calculated based on PEC values and the specifications recommended by MacDonald *et al* (2000). The breakdown of mean PEC quotients for metals, PAHs, and PCBs is shown in Appendix Table D-7c, with the toxicity test results. Further information about mean PEC quotients is contained in Years 1&2 report (SFBRWQCB. 2007a). The reader is also referred to the SWAMP years 4&5 archive for the spreadsheet used to calculate PEC quotients for individual constituents and to compute the mean quotients for the different analyte groups.

.

2.5.4 Toxicity results significance

The derivation of toxicity endpoints (data analysis activity type “a”) is usually straightforward, and most statistical packages include tests for statistical significance (activity type “b”). However, statistical significance may not necessarily indicate a **meaningful** toxic effect, and there are several variations on what construes a meaningful effect. Current SWAMP criteria require that organisms’ response in the sample be significantly different ($\alpha = 0.05$) from the response in the negative control, and be less than 80% of the response in the control. The combination of both criteria was used for years 4&5 results to denote different ‘levels’ of toxicity (Appendix Table D-6).

2.5.5 Coliform counts endpoints

The MPN/100 mL count results from the five consecutive sampling events conducted weekly in the summer of 2004, and then again – in different watersheds - in the summer of 2005, were used to generate the following summary statistics for each station:

- The geometric mean, or 'geomean', was calculated for *E. coli*
- The median was calculated for total coliforms

These endpoints were compared to water quality benchmarks as described in item 2.5.3 above.

Table 2.5-1: Water Quality Benchmarks for Protection of Aquatic Life

Characteristic	Description of Benchmark	Numeric Limit	Units	Reference
Temperature	Max, salmonids	24	° C	USEPA, 1977
	MWAT for Coho	19.7	° C	Sullivan *et al* , 2000
	7-day Mean for Coho	14.8	° C	Sullivan *et al* , 2000
	MWAT for steelhead	19.6	° C	Sullivan *et al* , 2000
	7-day Mean for steelhead	17	° C	Sullivan *et al* , 2000
Oxygen, dissolved	7-day Avg. Min, WARM	5	mg/L	Basin Plan, 2005
	7-day Avg. Min, COLD	7	mg/L	Basin Plan, 2005
pH	Range	6.5 to 8.5	S.U.	Basin Plan, 2005
Ammonia, unionized	Annual median	0.025	mg/L	Basin Plan, 2005
Nitrate as N	Maximum	0.16	mg/L	USEPA, 2000b
Phosphorus, total as P	Maximum	30	µg/L	USEPA, 2000b
Arsenic, dissolved	1-hour average WQO	340	µg/L	Basin Plan, 2005
	4-day average WQO	150	µg/L	Basin Plan, 2005
Arsenic, total	Maximum	10 µg/L		(Dept. of Public Health)
Cadmium, total[a]	1-hour average WQO	3.9	µg/L	Basin Plan, 2005
	4-day average WQO	1.1	µg/L	Basin Plan, 2005
Chromium VI, dissolved	1-hour average WQO	16	µg/L	Basin Plan, 2005
	4-day average WQO	11	µg/L	Basin Plan, 2005
Copper, dissolved[a]	1-hour average WQO	13	µg/L	Basin Plan, 2005
Copper, dissolved	4-day average WQO	9	µg/L	Basin Plan, 2005
Lead, dissolved[a]	1-hour average WQO	65	µg/L	Basin Plan, 2005
	4-day average WQO	2.5	µg/L	Basin Plan, 2005
Mercury, total	1-hour average WQO	2.4	µg/L	Basin Plan, 2005
Nickel, dissolved[a]	1-hour average WQO	470	µg/L	Basin Plan, 2005
	4-day average WQO	52	µg/L	Basin Plan, 2005
Selenium, total	1-hour average WQO	20	µg/L	Basin Plan, 2005
	4-day average WQO	5	µg/L	Basin Plan, 2005
Silver, dissolved[a]	1-hour average WQO	3.4	µg/L	Basin Plan, 2005
Zinc, dissolved[a]	1-hour average WQO	120	µg/L	Basin Plan, 2005
	4-day average WQO	120	µg/L	Basin Plan, 2005
PCBs	Continuous 4-day average	0.014	µg/L	CTR
Chlorpyrifos	Continuous 4-day average	0.015	µg/L	CVRWQCB, 2006
Dacthal (DCPA)	Instantaneous max. AWQC	14,300	µg/L	USEPA, 1987
Diazinon	1-hour average	0.1	µg/L	SFBRWQCB, 2005
Disulfoton (Disyston)	Instantaneous max. AWQC	0.05	µg/L	USEPA, 1973
Endosulfan	Instantaneous maximum	0.22	µg/L	CTR
	Continuous 4-day average	0.056	µg/L	CTR
HCH, gamma- (gamma-BHC, Lindane)	Maximum 1-hour average	0.95	µg/L	CTR
Parathion, methyl	Instantaneous max. AWQC	0.08	µg/L	CDFG
Thiobencarb	Instantaneous max. AWQC	3.1	µg/L	CDFG
E. coli	log mean	126	MPN/100 mL	Basin Plan, 2005
Total Coliforms	median	240	MPN/100 mL	Basin Plan, 2005
	maximum	10000	MPN/100 mL	Basin Plan, 2005

Note [a]: Table values for total cadmium and for dissolved copper, lead, nickel, silver, and zinc assume a hardness of 100 mg/L CaCO3. Samples at other hardness levels must be calculated using formulas in the Basin Plan.

Table 2.5-2: Sediment Quality Benchmarks

Characteristic	Description of Benchmark	Numeric Limit	Units
Arsenic	PEC	33	mg/kg
	TEC	9.79	mg/kg
Cadmium	PEC	4.98	mg/kg
	TEC	0.99	mg/kg
Chromium	PEC	111	mg/kg
	TEC	43.4	mg/kg
Copper	PEC	149	mg/kg
	TEC	31.6	mg/kg
Lead	PEC	128	mg/kg
	TEC	35.8	mg/kg
Mercury	PEC	1.06	mg/kg
	TEC	0.18	mg/kg
Nickel	PEC	48.6	mg/kg
	TEC	22.7	mg/kg
Zinc	PEC	459	mg/kg
	TEC	121	mg/kg
Anthracene	PEC	845	µg/kg
	TEC	57.2	µg/kg
Benz(a)anthracene	PEC	1050	µg/kg
	TEC	108	µg/kg
Benzo(a)pyrene	PEC	1450	µg/kg
	TEC	150	µg/kg
Chlordane	PEC	17.6	µg/kg
	TEC	3.24	µg/kg
Chrysene	PEC	1290	µg/kg
	TEC	166	µg/kg
DDD (sum op + pp)	PEC	28	µg/kg
	TEC	4.88	µg/kg
DDE (sum op + pp)	PEC	31.3	µg/kg
	TEC	3.16	µg/kg
DDT (sum op + pp)	PEC	62.9	µg/kg
	TEC	4.16	µg/kg
DDT (total)	PEC	572	µg/kg
	TEC	5.28	µg/kg
Dibenz(a,h)anthracene	**TEC**	33	µg/kg
Dieldrin	PEC	61.8	µg/kg
	TEC	1.9	µg/kg
Endrin	PEC	207	µg/kg
	TEC	2.22	µg/kg
Fluoranthene	PEC	2230	µg/kg
	TEC	423	µg/kg
Fluorene	PEC	536	µg/kg
	TEC	77.4	µg/kg
HCH, gamma	PEC	4.99	µg/kg
	TEC	2.37	µg/kg
Heptachlor epoxide	PEC	16	µg/kg
	TEC	2.47	µg/kg
Naphthalene	PEC	561	µg/kg
	TEC	176	µg/kg
PAH (total)	PEC	22800	µg/kg
	TEC	1610	µg/kg
PCB (total)	PEC	676	µg/kg
	TEC	59.8	µg/kg
Phenanthrene	PEC	1170	µg/kg
	TEC	204	µg/kg
Pyrene	PEC	1520	µg/kg
	TEC	195	µg/kg

Source: MacDonald et al 2000a

2.6 Data quality

Field and lab operators followed the SWAMP field procedures and the internal lab SOPs, as required to assure generation of data of known and documented quality. With some exceptions, the data reported in Section 3 and in Appendix Tables B, C, D, and E are SWAMP compliant. This means the following:

(a) Sample container, preservation, and holding time specifications of all measurement systems have been applied and were achieved as specified;

(b) All the quality checks required by SWAMP were performed at the required frequency;

(c) All measurement system runs included their internal quality checks and functioned within their performance/acceptance criteria; and

(d) All SWAMP measurement quality objectives (MQOs) were met.

Appendix F describes the actions done to **affect** (i.e., act to influence the outcome) and **check** (test to evaluate or verify) the different aspects of data quality in field measurements, sampling & shipping, and lab analyses. It also shows the inventory of the quality checks conducted in years 4&5, and discusses their relevance to the six data quality indicators mentioned in the U.S.EPA Quality Assurance Project Plan guidance and the SWAMP Quality Management Plan (Puckett 2002). Some of the data did not meet all the conditions stated above. However, these data are still usable if the flaw or omission was not considered detrimental, and they were flagged as "estimated". The reader is referred to RB2 SWAMP Year 4&5 archive for spreadsheets that provide all the data as well as the data quality flags for each Result.

(blank)

3 Results

This section presents the results obtained in the multiple watersheds selected for monitoring in the fourth and fifth year of SWAMP activities in the San Francisco Bay Region. Unlike the previous three monitoring years in which logistics and reporting sections were focused on individual watersheds, some of the years 4&5 monitoring efforts were organized by hydrologic units that contained several small watersheds. Thus, the information obtained in years 4&5 is presented in text, tables and figures pertaining to a group of small watersheds or to an individual watershed, each in their specific report subsection (3.1 through 3.5). Presentation items at the end of each subsection include one table (summary of exceedances), and two figures: a watershed map with results of selected BMI metrics, and summary box plots that highlight a selected set of continuous field measurements. Subsection 3.6 includes summary items that pertain to all watersheds monitored in 2004-06. The tables and figures are shown at the end of the sub-section, in conventional order (tables first.)

This Result section shows only highlights of the results, whereas the entire data set is given in an array of appendices, which constitute an integral part of this report. The appendix tables and figures are organized by subject matter, in the same internal order as the subjects in each of the subsections. This order, which reflects the data sources and the logistics, is as follows: Benthic Macroinvertebrates (BMI), continuous field measurements, water chemistry and toxicity, sediment chemistry and toxicity, and coliform counts. The appendices also contain a list of all samples, station visits, and continuous monitoring sonde files for each Station (appendix A), as well as sample inventories at the beginning of each subject appendix (Appendices B through E).

3.1 Year 4 north East Bay watersheds: Baxter, Cerrito, Codornices, and Strawberry Creeks

The four north East Bay watersheds (shown in Figure 2.1-1 above) are highly urbanized, and large portions of the original waterways have been altered or placed in culverts. The four creeks flow from their headwaters in the western slopes of the East Bay ridge, through East Bay cities, into the eastern side of the SF Bay. Sites monitored in year 4 represent mostly urban land use. The four creeks are spring fed to a limited extent. However, the adjacent cities often contribute dry weather flows, rendering the creeks wet year round.

3.1.1 Benthic macroinvertebrates and physical habitat

Benthic macroinvertebrates and physical habitat were sampled at two sites in the Baxter Creek watershed, one site in the Cerrito Creek watershed, three sites in the Codornices Creek watershed, and two sites in the Strawberry Creek watershed. Selected benthic macroinvertebrate results for these creeks are shown in **Figure 3.1-1**. Metric values for each site are shown in Appendix Table B-2a, the substrate where BMI were collected is shown in Appendix Table B-3, and the physical habitat summary data are shown in Appendix Table B-4.

Benthic macroinvertebrate assemblages from all eight sites in the north East Bay watersheds were in poor condition. Taxonomic richness, an indicator of biodiversity, was low at the sites in the Baxter Creek, Cerrito Creek, and Codornices Creek watersheds (11-15 as compared to over 30 in reference sites). Of the three BMI groups Ephemeroptera, Plecotera, and Trichoptera (EPT), the sensitive EPT taxa were completely absent in these creeks (Figure 3.1-1), indicating that the conditions there cannot support them. Taxonomic richness was slightly higher (16-17) and small numbers of sensitive EPT taxa (mainly the nemourid stonefly *Malenka* sp.) were present at the two sites on Strawberry Creek. BMI assemblages at most sites in the north East Bay watershed were dominated by common, tolerant COBS (Chironomidae, Oligochaeta, *Baetis sp.*, and Simuliidae) taxa. As a result, these sites are clustered very closely together on the NMS ordination plot (Figure 3.6-1 below), confirming the similarity of their BMI assemblages.

The upstream site on Baxter Creek (BAX050) was an exception; this assemblage was dominated by hydrobiid snails and other non-insects. Compared to the other sampling sites in the region, benthic macroinvertebrate assemblages from the north East Bay watersheds indicate a very degraded biological integrity (Figure 3.6-1). The low diversity, absence of sensitive EPT taxa, and dominance of COBS taxa at these sites is characteristic of benthic assemblages from highly urbanized streams in the San Francisco Bay region (SFBRWQCB. 2007a, SFBRWQCB 2007b).

Poor physical habitat conditions are associated with degraded benthic macroinvertebrate assemblages at some, but not all, of the sites in the north East Bay watershed. The streambed at the upstream site on Baxter Creek, BAX050, was nearly completely covered (98%) with fine sediment (<2 mm), with very little gravel present (2%, Appendix Table B-4). Fine sediment is usually preferred by burrowing organisms, such as oligochaete worms and snails, while gravel is required by many of the sensitive EPT taxa. Streamflow at BAX050 was negligible and was measured to be 0. Consequently, the only flow habitat type present was 'glide' (shallow, slow-velocity habitat). These physical habitat conditions are likely a function of the geomorphic setting of the stream: the slope of the streambed was negligible, and measured to be 0. The low slope of the stream at BAX050 likely results in extensive deposition of fine sediment and low or negligible water velocities at base flow, ideal conditions for snails and other non-insects more commonly found in lentic (still-water) habitats.

Abundant fine sediment (>30%) and small median grain size (<10 mm) were also present at three other sites in the north East Bay watershed: the downstream site on Baxter Creek (BAX030), the site on Cerrito Creek (CER020), and the downstream site on Codornices Creek (COD020). Two of these sites, CER020 and COD020, also had very low qualitative channel alteration scores (2 and 3, respectively), indicating a high degree of alteration. These three sites were dominated by tolerant COBS taxa, although BAX030 also had large numbers of the freshwater flatworm, Turbellaria, and BAX030 and CER020 had small numbers of hydrobiid snails.

In contrast to the sites discussed above, the upstream sites on Codornices Creek and the sites on Strawberry Creek did not have poor physical habitat conditions that could be directly associated with poor biological integrity. In other words, these sites all had suitable mixtures of sand, gravel, and cobble substrate, mixtures of fast-water and slow-water habitats, and moderate channel alteration scores (Appendix B-4) . Thus, the poor BMI assemblages at these sites (as manifested by low diversity, dominance of COBS taxa, and lack of sensitive EPT taxa) suggest that other factors, such as poor water quality conditions or other disturbances, are significantly affecting benthic assemblages in these urban stream sites.

3.1.2 Continuous field measurements

Figure 3.1-2a shows summary temperature box plots for Baxter, Cerrito and Codornices Creeks during the three hydrological periods. The temperature pattern appears to be very similar in the three watersheds: spring temperatures were below 17 C, summer temperatures usually exceeded that benchmark, and winter temperatures were always well below 14 C. **Figure 3.1-2b** shows the variations in specific conductance (SC) in response to a winter rain event in these creeks. The sharp SC drops indicate that low-conductivity rain runoff was flowing through the sonde. Although the watersheds are very close to each other and may have received similar rainfall over time, the sharp SC drops occurred at different times, sometimes hours apart, in different sites. If indeed the rain intensity was the same, the differential response could be attributed to differences in drainage area sizes, extent of impervious areas, or other factors.

The four-characteristics discussion below refers to the entire continuous field monitoring dataset shown in Appendix C, which is an integral part of this report. Appendix Tables C-2a-b detail the summary statistics for continuous monitoring in all Year 4 north East Bay creeks, and Appendix Figures C.1-2a-c display the box plot summaries of these data.

Temperature: During the summer and fall deployment periods, all four north East Bay creeks experienced average water temperature levels above the 14.8 C MWAT for Coho and 17.0 C MWAT for steelhead. Baxter Creek average water temperatures were the highest at 20.7 C and 20.3C respectively for the two deployment periods. In Codornices Creek, the 17.0 C MWAT was exceeded for long durations, sometimes for 5 days or longer. The spring deployment period exhibited a little more variability among the sites. While all sites had an average water temperature below the 17.0 C MWAT for Steelhead, BAX030 and CER020 exceeded the 14.8 C MWAT for Coho. As might be expected, all winter water temperature measurements at all stations were well below the physiological limits for both Coho and Steelhead.

Dissolved Oxygen (DO): Summer DO concentrations were above the 7-day average warm water minimum of 5.0 mg/l at all stations. All stations did not meet the coldwater minimum benchmark of 7.0 mg/l except COD020 and BAX030. During the fall deployment period, COD020 and BAX030 had average DO concentrations at or below the warm water minimum of 5.0 mg/l. Both COD020 and COD080 experienced intervals of very low DO concentrations during the deployment period. There was no fall deployment at Strawberry Creek. During the winter deployments, with one exception, average DO concentrations at all stations did not meet the coldwater minimum benchmark of 7.0 mg/l. Strawberry Creek, station STW020, exhibited a potential DO probe failure after recording a rain event and the subsequent data is suspect.

pH: Appendix Figures C.1-2a-c show the summaries of pH data. With the exception of four minor excursions above the upper limit, pH measurements at all stations for all deployment periods were within the Basin Plan range of 6.5 to 8.5. Generally, diurnal pH changes tracked photosynthetic activity as measured by DO concentrations.

Specific Conductance (SC): Appendix Figures C.1-2a-c show the summaries of SC data. With the exception of COD080 during the summer deployment period, SC at all other stations fell below the 1000 us/cm limit for pollution potential. During the summer deployment, COD080 experienced a spike of increased SC from approximately 500 us/cm to over 1000 us/cm (see). The cause is being investigated but is currently undetermined. As might be expected, winter rain events influenced the SC range considerably at all stations by lowering the SC during those brief periods (Figure 3.1-2b).

3.1.3 Water chemistry and toxicity

Twelve water samples were collected in the four north East Bay watersheds for analyses and testing in 2004; four of these samples were collected during the winter, four in the spring, and four in the dry season. The analytical results for conventional water quality characteristics, metals, and organics are shown in Appendix Tables D-3, D-4, and D-5. Toxicity test results are presented in Appendix Table D-6. Unlike continuous monitoring, water samples collected for chemical analyses and toxicity testing show a snapshot in time, and the results of 2004 can provide only an indication of the inherent variability and the potential for toxicity and elevated contaminant concentrations in these watersheds.

Water samples collected at Baxter, Cerrito, Codornices and Strawberry Creeks exceeded nutrient guidelines for nitrate and total phosphorus. There were no exceedances of metals and organic compounds benchmarks, and only one sample, collected at COD020 in the spring, elicited significant impairment of *Selenastrum* growth (Table 3.1-1)

3.1.4 Sediment chemistry and toxicity

One sediment sample was collected in each of the four north East Bay creeks, at a 'watershed integrator' site located close to the mouth of the creek. The results are shown in the tables of Appendix D-7, and exceedences of quality benchmarks are summarized in Table 3.1-1 below. Sediments of these urban creeks contained some trace metals and legacy organic pollutants at concentrations that exceeded Threshold Effect Concentrations (TEC) and, in some cases, the higher Probable Effect Concentrations (PEC). The mercury PEC was exceeded in Codornices Creek. Chromium and nickel concentrations exceeded PEC in Baxter and Codornices Creeks; concentrations of these metals in Bay Area sediments often exceed PEC because they are abundant in the Bay Area's geological formations. The TEC values for a number of organochlorine pesticides were exceeded in sediment samples from Baxter, Cerrito, and Codornices Creeks, with chlordane and sum DDD exceeding PEC in Codornices. Strawberry Creek sediment exceeded only the chlordane TEC. The pyrethroid pesticide bifenthrin was detected in COD020 at 2 ug/kg. The sediment quality benchmarks for pyrethroids are currently being developed. Exposure to sediments collected at Baxter, Codornices, and Strawberry Creeks inhibited *Hyalella azteca* growth but did not cause mortality in the toxicity test (Table 3.1-1).

3.1.5 Coliform counts

Bacterial counts were performed with Baxter Creek samples collected on July 20th and 27th and on August 3rd, 10th, and 17th, 2004. The results of these individual samples are shown in

Appendix Table E-1, and summary statistics are presented in Figure 3.6-7 below. Five of five bacterial samples collected at Baxter Creek contained total coliforms concentrations that exceeded total coliform objectives, and the log mean of these five samples exceeded the *E. coli* objective.

3.1.6 Summary of north East Bay creeks condition indicators

Baxter, Cerrito, Codornices and Strawberry Creeks run through watersheds that are almost entirely urbanized. Benthic macroinvertebrate assemblages were seriously degraded throughout these watersheds (Figure 3.1-1 and Appendix B). **Table 3.1-1** shows a summary of all the exceedances of water quality benchmarks in these creeks in 2004. Temperature and dissolved oxygen benchmarks were not met in most summer deployments. Of special concern are the durations of temperature exceedances in Codornices Creek. The 7-day mean for salmonids benchmark, set at 17 degrees C, was exceeded in all three stations during the two dry-weather deployments, and the duration of exceedance ranged from 19 to over 125 hours.

All water samples collected in north East Bay creeks exceeded nutrient criteria. These nutrient criteria are based on U.S.EPA's reference guidelines for aggregated Ecoregion III, Ecoregion 6 (South and central California chaparral and oak woodland) streams (U.S.EPA 200b). These guidelines were derived from the 25th percentile value of stream monitoring data collected from 1990 through 1999. The quantiles are not effect-based and may not be appropriate for this region.

Some metals and organic compound concentrations exceeded threshold-effect benchmarks in the sediment, and growth impairment (but not mortality) was observed in 3 of the four sediment samples collected in 2004.

Table 3.1-1: Exceedances of water quality benchmarks in north East Bay Creeks in 2004

					Baxter Creek		*Cerrito Creek*	*Cordonices Creek*			*Strawberry Creek*		
Group	***Characteristic***	***Benchmark type***	***Limit***	***Units***	**BAX030**	**BAX045**	**CER020**	**COD020**	**COD080**	**COD120**	**STW010**	**STW020**	**STW030**
Continuous Field Measurements					**4, SDDW**	**2, SW**	**4, SDDW**	**4, SDDW**	**4, SDDW**	**3, DDW**		**3, SDW**	**3, SDW**
	Temperature	Max, salmonids (and duration, hrs)	24	° C									
		7-day Mean for Coho	14.8	° C	1, S			2, DD	2, DD	2, DD		2, SD	2, SD
		7-day Mean for steelhead	17	° C	2, DD			2, DD	2, DD	2, DD		1, D	1, D
	Oxygen, dissolved	7-day Avg. Min, WARM	5	mg/L	2, DD	1, S		2, DD	1, D				
		7-day Avg. Min, COLD	7	mg/L	2, DD	1, S		2, DD	1, D				
	pH	Range	6.5 to 8.5	pH	2 >, SW		1, S (8.52)					1>, S	
Conventional & Nutrient Water Samples					**3, SDW**		**3, SDW**	**3, SDW**			**3, SDW**		
	Nitrate as N	Maximum	0.16	mg/L	3		3	3			3		
	Phosphorus, total as P	Maximum	30	µg/L	3		3	3			3		
Water Metals Samples					**3, SDW**		**3, SDW**	**3, SDW**			**3, SDW**		
Water Organics Samples					**3, SDW**		**3, SDW**	**3, SDW**			**3, SDW**		
Water Toxicity Samples					**3, SDW**		**3, SDW**	**3, SDW**			**3, SDW**		
	Selenastrum toxicity	Growth	80%					1, S					
Coliform Water Sample Series *(each result consists of 5 samples)*					**1, D**								
	E. coli	log mean	126	MPN/100 m	1								
	Total coliform	Median	240	MPN/100 m	1								
		Maximum *(any of 5 sample:*	10000	MPN/100 m	5 (5/5)								
Sediment Metals Samples					**1, S**		**1, S**	**1, S**			**1, S**		
	Arsenic	TEC	9.79	mg/kg				1					
	Chromium	PEC	111	mg/kg	1			1					
		TEC	43.4	mg/kg			1				1		
	Lead	TEC	35.8	mg/kg			1	1					
	Mercury	PEC	1.06	mg/kg				1					
		TEC	0.18	mg/kg			1						
	Nickel	PEC	48.6	mg/kg	1		1	1			1		
	Zinc	TEC	121	mg/kg				1					
Sediment Organics Samples					**1, S**		**1, S**	**1, S**			**1, S**		
	Chlordane	PEC	17.6	µg/kg	1			1					
		TEC	3.24	µg/kg			1				1		
	DDD (sum op + pp)	PEC	28	µg/kg				1					
		TEC	4.88	µg/kg	1								
	DDE (sum op + pp)	TEC	3.16	µg/kg	1		1	1					
	DDT (sum op + pp)	TEC	4.16	µg/kg	1		1	1					
	DDT (total)	TEC	5.28	µg/kg	1		1						
	Dieldrin	TEC	1.9	µg/kg	1		1	1					
	Heptachlor epoxide	TEC	2.47	µg/kg	1								
	PAH (total)	TEC	1610	µg/kg	1								
	PCB (total)	TEC	59.8	µg/kg				1					
Sediment Toxicity					**1, S**		**1, S**	**1, S**			**1, S**		
	Hyalella toxicity	Chronic - growth			1			1			1		

The total number of samples (or sonde deployments) are shown in bold for each characteristic group. Season codes are: D - Dry; S - spring; W - Wet season (not wet weather)
TEC - Threshold effect concentration; PEC - Probable effect concentration

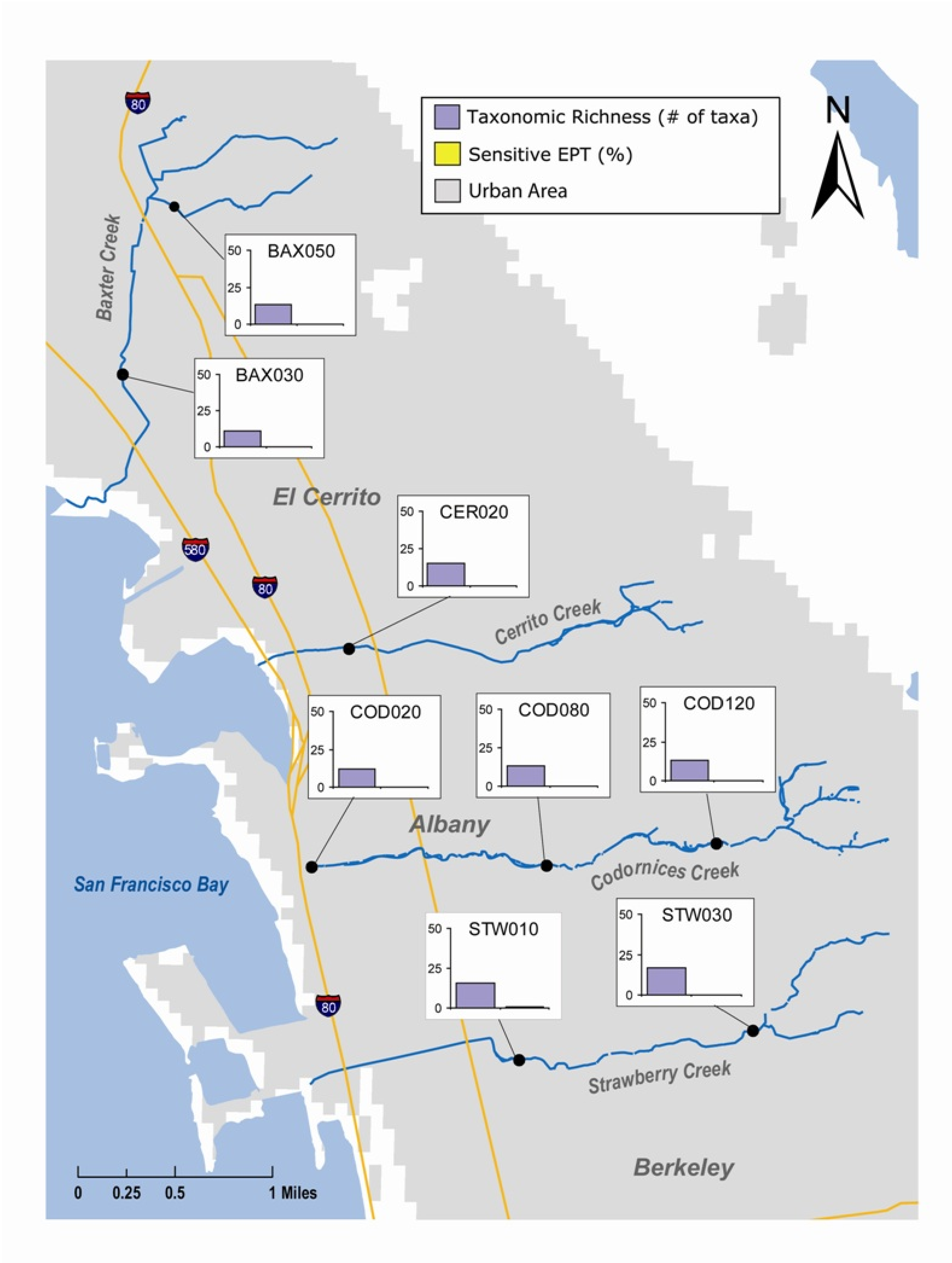


Figure 3.1-1: Results of selected BMI metrics in the north East Bay watersheds: Baxter, Cerrito, Codornices, and Strawberry Creeks

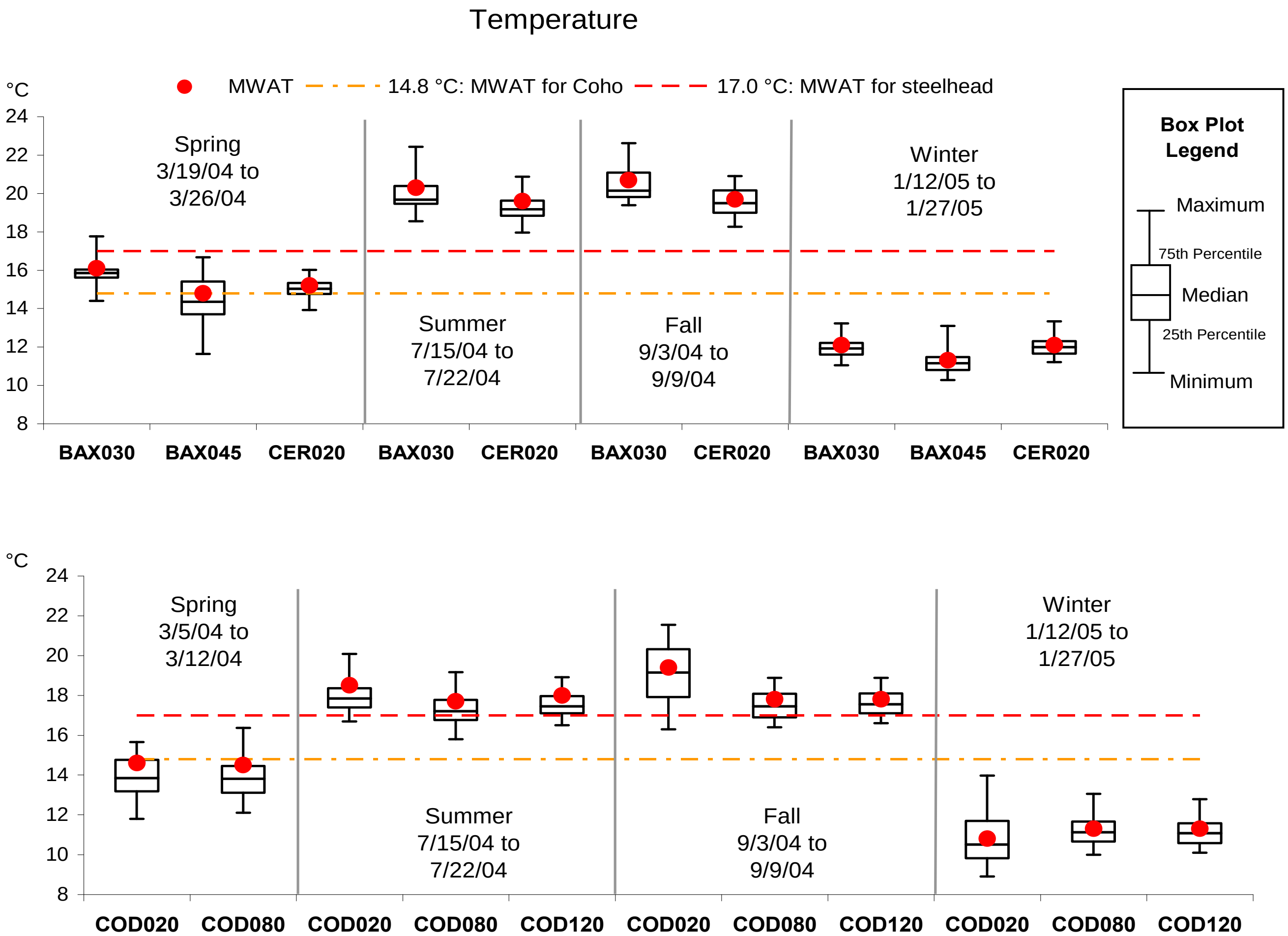
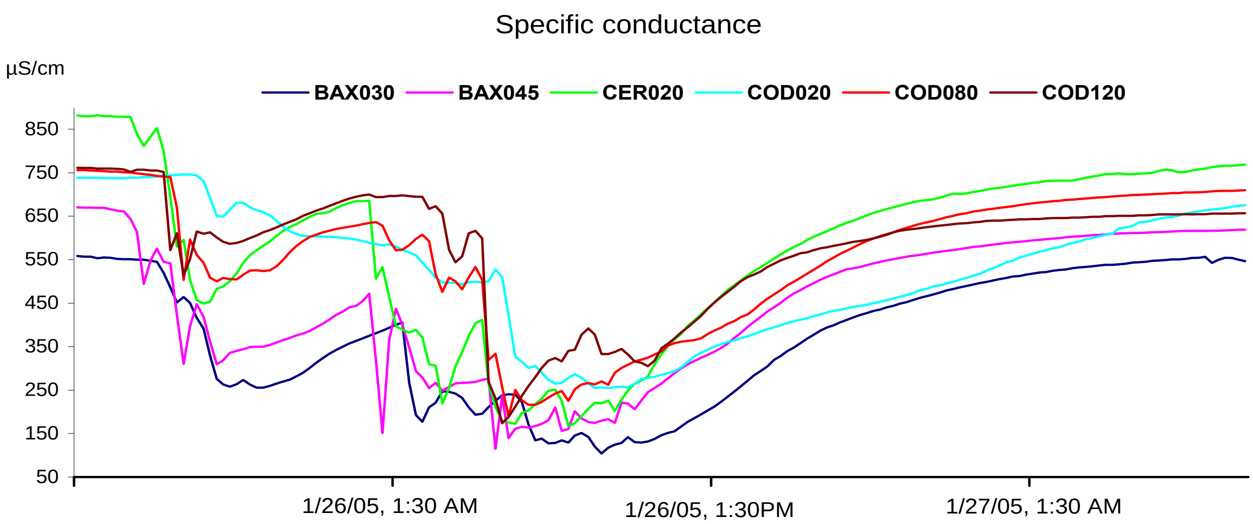


Figure 3.1-2a: Continuous temperature monitoring summaries for Baxter, Cerrito and Codornices Creeks



Trace shows response in three creeks during the period of January 25th, 1:30 PM through January 27th, 9:30 AM

Figure 3.1-2b: Time course of Specific Conductance values during a rain runoff event in three north East Bay watersheds

3.2 Year 4 central East Bay (Oakland) watersheds: Temescal, Glen Echo, Sausal, Peralta, Lion, and Arroyo Viejo Creeks

The six central East Bay (Oakland) watersheds, shown in Figures 2.1-2a and 2.1-2b above, are highly urbanized, and large portions of the original waterways have been altered or placed in culverts. The creeks and their tributaries flow from their headwaters in the western slopes of the East Bay ridge, through Oakland, into the eastern side of the SF Bay. Most sites monitored in year 4 represent urban land use. The creeks are spring fed to a limited extent. However, the adjacent urban areas often contribute dry weather flows, rendering the creeks wet year round. In comparison to the north East Bay watersheds visited in 2004 (see section 3.1 above), the Oakland creeks have larger drainage areas and some of the headwaters are within redwood or pine forests that are maintained as parks. There are two major impoundments in these watersheds: Lake Temescal, which drains the high-gradient headwaters of Temescal creek, and Lake Merritt, which is tidally influenced and receives water from Glen Echo and other Creeks. Lion and Arroyo Viejo Creeks share a tidal slough at the Bay edge but are shown as two separate creeks in this report.

3.2.1 Benthic macroinvertebrates and physical habitat

Fourteen sites were sampled for benthic macroinvertebrates and physical habitat in the Oakland watersheds: two sites on Temescal Creek, one site on Glen Echo Creek, three sites on Sausal Creek, two sites on Peralta Creek, two sites on Lion Creek, and four sites on Arroyo Viejo. Metric values for each site are shown in Appendix Tables B-2b and B-2c, the substrate where BMI were collected is shown in Appendix Table B-3, and the physical habitat summary data are shown in Appendix Table B-4.

The majority of the benthic macroinvertebrate assemblages at sites in the Oakland watersheds were in poor condition, similar to conditions in the north East bay watersheds. Taxonomic richness was generally low (<15), and sensitive EPT taxa were completely absent from most sites (**Figure 3.2-1a**, **Figure 3.2-1b**). The majority of the sites are grouped closely together with other urban creeks in the lower center of the NMS ordination plot (**Figure 3.6-1**), indicating similarly degraded conditions. Two sites, TEM060 and LIO080, are notable for the low numbers of invertebrates collected: whereas most other sites had several thousand individual organisms per sample, only 197 and 344 individuals were found in the entire samples from these sites, respectively (Appendix B-2). These low organism densities may reflect a recent disturbance or extremely poor habitat conditions.

Benthic macroinvertebrate assemblages at two sites, SAU130 and AVJ110, were more similar to minimally disturbed sites in west Marin County than to other urban streams in the East Bay. A site on Palo Seco Creek (SAU130), the upstream most site in the Sausal Creek watershed, is taxonomically most similar to sites on Pine Gulch and Redwood Creek in Marin County (**Figure 3.6-1**). Taxonomic richness and percent sensitive EPT metrics were relatively high (**Figure 3.2-1a**), and many pollution intolerant taxa were present, including riffle beetles (Elmidae), the stonefly *Calineuria californica*, and eight caddisfly taxa, including *Rhyacophila* sp. and *Neophylax* sp. Many of these same taxa were also present at AVJ110, located on the Country Club Branch of Arroyo Viejo, although diversity was somewhat lower (**Figure 3.2-1b**) and the assemblage was numerically dominated by *Baetis* sp. mayflies and chironomids. This site was taxonomically most closely related to sites in Marin County on Rodeo Creek and Tennessee Valley Creek (**Figure 3.6-1).**

Several other sites in the Oakland watersheds contained varying percentages of sensitive EPT, including SAU080 (1%), PRL080 (2%), AVJ020 (2%), LIO080 (8%), AVJ090 (17%), and LIO130 (46%) (**Figure 3.2-1a**, **Figure 3.2-1b**). Unlike at SAU130 and AVJ110, discussed above, the sensitive EPT organisms at these other sites generally are only represented by a single taxon, the nemourid stonefly *Malenka* sp. Although *Malenka* has been given a low tolerance value of 2, its presence in many urban, degraded streams in the Bay Area suggests that this taxa is actually fairly tolerant of pollution and poor habitat conditions, and should not necessarily be considered an indicator of pollution sensitivity.

In general, habitat conditions, as measured by the PHAB protocol, can **not** explain the degraded biological integrity indicated by the benthic macroinvertebrate assemblages at these sites in the Oakland watersheds. Most sites had suitable mixtures of substrate and flow habitats, and more than half of the sites had optimal or sub-optimal channel alteration and epifaunal substrate conditions (scores >10, Appendix C-3). Consequently, it appears that poor water quality, habitat measures not assessed by the PHAB protocol, or periodic disturbances may be responsible for the degraded benthic macroinvertebrate assemblages observed at most sites in the Oakland watersheds.

3.2.2 Continuous field measurements

Figure 3.2-2 shows temperature and dissolved oxygen box plots obtained from all the spring, summer and fall deployments in central East Bay (Oakland) creeks. The four-characteristics discussion below refers to the entire continuous field monitoring dataset, including data shown in Appendix C, which is an integral part of this report. Appendix Tables C-2b-d detail the summary statistics for continuous monitoring in these watersheds, namely Temescal, Glen Echo, Sausal, Peralta, Lion and Arroyo Viejo Creeks and Appendix Figures C.2-2a-f show the box plot summaries of this data. Deployment sites varied during the various deployment periods in each creek and deployments were not made in all creeks for all seasons.

Temperature: During the summer deployment periods, all 14 stations in the six central East Bay (Oakland) creeks experienced median water temperatures above the 14.8 C MWAT for Coho. During the same period, the 17.0 C MWAT for Steelhead was exceeded at nine stations: Temescal Creek at TEM 060 and TEM090, Glen Echo Creek at LME100, Sausal Creek at SAU070, Peralta Creek, Lion Creek at LIO080 and Arroyo Viejo Creek at AVJ 120 and AVJ130. For the fall period, sondes were only deployed at two sites in Temescal Creek and three sites in Sausal Creek. All five sites exceeded the 14.8 C MWAT for Coho and for the same period, TEM060 and SAU030 exceeded the 17.0 C MWAT for Steelhead. For the winter deployment period, all 15 stations at the six central East Bay creeks were well below the physiological limits for both Coho and Steelhead. During the spring deployments, some stations in the six central East Bay creeks experienced median water temperatures above the 14.8 C MWAT for Coho. During this same period, there was no exceedance of the 17.0 C MWAT for Steelhead at any of the stations.

Dissolved Oxygen (DO): The warm summer months are usually the most critical time for aquatic life as the warm water temperatures can lead to low oxygen saturation. With the exception of AVJ130 in Arroyo Viejo, all stations recorded median DO concentrations above the warm water minimum of 5.0 mg/l during summer, but several stations had a 7-day-average minimum DO below 7.0 mg/l. AVJ130 DO concentrations were low with a median concentration below 3.0 mg/l, however it is suspected that the DO probe was not functioning properly during this deployment and these measurements may be invalid. During the winter season, DO concentrations at all stations were above the cold water minimum of 7.0 mg/l. With the exception of TEM060 in Temescal creek, DO concentration variability was small during this period.

pH: Nearly all pH measurements at all stations for all deployment periods were within the Basin Plan range of 6.5 to 8.5. Generally, diurnal pH changes tracked photosynthetic activity as measured by DO concentrations. Excursions above the 8.5 pH maximum were noted only at TEM060 during the winter deployment period and at PRL020 during the Spring deployment period. See Appendix Figures C.2-2a-f for summaries of pH data.

Specific Conductance (SC): With a few exceptions, SC measurements in all creeks and at all stations were below the potential pollution limit of 1000 us/cm. Temescal Creek station TEM090 experienced consistently elevated SC measurements with average SC of over 1000 us/cm observed for all deployment periods except the winter, when the average fell just below the limit to 938 us/cm. Average SC above the this limit was also seen in Sausal Creek at SAU080 during the fall deployment and at AVJ130 in Arroyo Viejo during the summer deployment. See Appendix Figures C.2-2a-f for summaries of SC data.

3.2.3 Water chemistry and toxicity

Sixteen water samples were collected in the central East Bay (Oakland) watersheds (Temescal, Glen Echo, Sausal, Peralta, Lion, and Arroyo Viejo Creeks) for analyses and testing in 2004; six of these samples were collected during the winter, five in the spring, and five in the dry season. The analytical results for conventional water quality characteristics, metals, and organics are shown in Appendix Tables D-3, D-4, and D-5. Toxicity test results are presented in Appendix Table D-6. Water samples collected at all Oakland Stations exceeded nutrient guidelines for nitrate and total phosphorus. Un-ionized ammonia benchmark was exceeded in the AVJ020 sample collected in the summer, and diazinon benchmark was exceeded in the PRL020 sample collected in the winter. There were no exceedances of metals and organic compounds benchmarks, and only one sample, collected at TEM090 in the summer, elicited a statistically-significant reduction in fathead minnow growth (Appendix D-6). All three Temescal Creek samples (collected at TEM090, above Lake Temescal) had unusually high concentrations of sulfate and hardness-producing substances (Appendix D-3).

3.2.4 Sediment chemistry and toxicity

One sediment sample was collected in each of the following four Oakland creeks: Glen Echo, Sausal, Peralta, and Arroyo Viejo. Samples were collected at a ‘watershed integrator’ site located close to the mouth of the creek. The results are shown in the tables of Appendix D-7, and exceedences of quality benchmarks are summarized in Table 3.2-1 below. Sediments of these urban creeks contained some trace metals and legacy organic pollutants at concentrations that exceeded Threshold Effect Concentrations (TEC) and, in the case of nickel, the Probable Effect Concentrations (PEC). Nickel concentrations exceeded PEC in Glen Echo and Arroyo Viejo Creeks. Arsenic, chromium, copper, lead, mercury, and zinc exceeded TEC values in two of the four samples. The TEC values for a small number of organochlorine pesticides were exceeded in these sediment samples, but only DDT was ubiquitous. Pyrethroids, the new generation of pesticides, have been found in sediments in East Bay creeks (Amweg 2006) . In this study pyrethroids were also detected. Bifenthrin was detected at Glen Echo creek (LME100) at 0.9 ug/kg, and at Peralta Creek (PRL020) at 2.6 ug/kg. Total Cypermethrin at PRL020 was 32.3, well above the reported LC50. However, that sample did not cause toxicity, and neither did most other central East Bay samples. Exposure to sediments collected at Sausal Creek inhibited *Hyalella azteca* growth but did not cause mortality in the toxicity test (Tables 3.2-1a and 3.2-1b).

3.2.5 Coliform counts

The central East Bay (Oakland) watersheds were all monitored for bacterial indicators, some in more than one Station. Bacterial counts were performed with samples collected on July 20th and 27th and on August 3rd, 10th, and 17th, 2004 at nine locations. The results of these individual samples are shown in Appendix Table E-1, along with the summary statistics that were calculated for each site (based on the five individual samples that were collected there). The summary statistics are also presented in Figure 3.6-7 below. The *E. coli* 30-day (log mean) objective was exceeded in seven Stations (Table 3.2-1). Nine of nine Stations had total coliforms at concentrations that exceeded the total coliform objective for median 5-sample concentrations. However, only about 50% of the individual samples exceeded the maximum total coliform benchmarks set for individual samples.

3.2.6 Summary of central East Bay (Oakland) Creeks condition indicators

The year 4 central East Bay (Oakland) watersheds (Temescal, Glen Echo, Sausal, Peralta, Lion, and Arroyo Viejo Creeks) were monitored at a variety of locations, including downstream integrator sites, moderate-gradient sites, and headwater sites. Benthic macroinvertebrate assemblages were seriously degraded in the downstream areas but not necessarily upstream. (Figures 3.2-1 and Appendix B). **Tables 3.2-1** shows a summary of all the exceedances of water quality benchmarks in these creeks in 2004. Temperature and dissolved oxygen benchmarks were exceeded in many summer deployments. All water samples exceeded nutrient criteria. Some metals and organic compound concentrations exceeded threshold-effect benchmarks in the sediment, and growth impairment (but not mortality) was observed in 2 of the 4 sediment samples collected in 2004.

Table 3.2-1: Exceedances of water quality benchmarks in central East Bay (Oakland Watersheds) in 2004

a. Temescal Creek to Peralta Creek

										Sausal Creek Watershed						
					Temescal Creek			*Glen Echo Creek*		*Sausal Creek*				*Palo Seco Creek*	*Peralta Creek*	
Group	*Characteristic*	*Benchmark type*	*Limit*	*Units*	**TEM050**	**TEM060**	**TEM090**	**LME100**	**LME130**	**SAU030**	**SAU060**	**SAU070**	**SAU080**	**SAU130**	**PRL020**	**PRL080**
Continuous Field Measurements						**4, SDDW**	**5, SDDDW**	**3, SDW**	**1, W**	**4, SDDW**		**2, DD**	**3, SDW**	**3, DDW**	**3, SDW**	**3, SDW**
	Temperature	Max, salmonids (duration in h	24	° C												
		7-day Mean for Coho	14.8	° C		3, SDD	3, SDD	1, D		3, SDD		1, D	2, SD	2, DD	1, D	1, D
		7-day Mean for steelhead	17	° C		2, DD	2, DD	1, D		2, DD		1, D			1, D	1, D
	Oxygen, dissolved	7-day Avg. Min, WARM	5	mg/L									2, SD			
		7-day Avg. Min, COLD	7	mg/L									2, SD		1, D	
	pH	Range	6.5 to 8.5	pH		1>, W									1>, S	
Conventional & Nutrient Water Samples							**3, SDW**	**3, SDW**		**3, SDW**					**3, SDW**	
	Nitrate as N	Maximum	0.16	mg/L			3	3		3					3	
	Phosphorus, total as P	Maximum	30	µg/L			3	3		3					3	
Water Metals Samples							**3, SDW**	**3, SDW**		**3, SDW**					**3, SDW**	
Water Organics Samples							**3, SDW**	**3, SDW**		**3, SDW**					**3, SDW**	
	Diazinon	Acute	0.1	µg/L											1	
Water Toxicity Samples							**3, SDW**	**3, SDW**		**3, SDW**					**3, SDW**	
Coliform Water Sample Series *(each result consists of 5 samples)*					**1, D**				**1, D**		**1, D**				**1, D**	
	E. coli	log mean	126	MPN/100 mL	1				1		1				1	
	Total coliform	Median	240	MPN/100 mL	1				1		1				1	
		Maximum *(any of 5 samples)*	10000	MPN/100 mL	5 (5/5)				5 (5/5)		5 (5/5)				5 (5/5)	
Sediment Metals Samples								**1, S**		**1, S**					**1, S**	
	Chromium	PEC	111	mg/kg											1	
		TEC	43.4	mg/kg				1		1						
	Copper	TEC	31.6	mg/kg				1								
	Lead	TEC	35.8	mg/kg				1								
	Mercury	TEC	0.18	mg/kg						1						
	Nickel	PEC	48.6	mg/kg				1							1	
		TEC	22.7	mg/kg						1						
	Zinc	TEC	121	mg/kg				1							1	
Sediment Organics Samples								**1, S**		**1, S**					**1, S**	
	Chlordane	PEC	17.6	µg/kg				1								
		TEC	3.24	µg/kg											1	
	DDD (sum op + pp)	TEC	4.88	µg/kg				1							1	
	DDE (sum op + pp)	TEC	3.16	µg/kg				1							1	
	DDT (sum op + pp)	TEC	4.16	µg/kg				1		1					1	
	DDT (total)	TEC	5.28	µg/kg				1		1					1	
	Dieldrin	TEC	1.9	µg/kg				1							1	
	Heptachlor epoxide	TEC	2.47	µg/kg				1								
Sediment Toxicity								**1, S**		**1, S**					**1, S**	
	Hyalella toxicity	Chronic - growth								1						

The total number of samples (or sonde deployments) are shown in bold for each characteristic group. Season codes are: D - Dry; S - spring; W - Wet season (not wet weather)
TEC - Threshold effect concentration; PEC - Probable effect concentration

Table 3.2-1: Exceedances of water quality benchmarks in central East Bay (Oakland Watersheds) in 2004
b. Lion Creek and Arroyo Viejo Creek

					Lion Creek Watershed									
					Lion Creek				*Horseshoe Creek*	*Arroyo Viejo Creek*				
Group	***Characteristic***	***Benchmark type***	***Limit***	***Units***	**LIO030**	**LIO070**	**LIO080**	**LIO090**	**LIO130**	**AVJ020**	**AVJ090**	**AVJ110**	**AVJ130**	**AVJ140**
Continuous Field Measurements							**3, SDW**	**2, SW**	**2, SW**	**3, SDW**		**3, SDW**	**3, SDW**	
	Temperature	7-day Mean for Coho	14.8	° C			2, SD		1, D	1, D		1, D	1, D	
		7-day Mean for steelhead	17	° C			1, D			1, D			1, D	
	Oxygen, dissolved	7-day Avg. Min, WARM	5	mg/L								1, D		
		7-day Avg. Min, COLD	7	mg/L			1, D					1, D		
Conventional & Nutrient Water Samples										**3, SDW**				
	Ammonia, unionized	Annual median	0.025	mg/L						1				
	Nitrate as N	Maximum	0.16	mg/L						3				
	Phosphorus, total as P	Maximum	30	µg/L						3				
Water Metals Samples					**1**					**3, SDW**				
Water Organics Samples					**1**					**3, SDW**				
Water Toxicity Samples					**1**					**3, SDW**				
	Ceriodaphnia toxicity	Chronic - reproduction	80%							1, W				
Coliform Water Sample Series *(each result consists of 5 samples)*						**1, D**			**1, D**	**1, D**			**1, D**	**1, D**
	E. coli	log mean	126	MPN/100 mL					1	1				1
	Total coliform	Median	240	MPN/100 mL		1			1	1			1	1
		Maximum *(any of 5 samples)*	10000	MPN/100 mL						5 (5/5)				
Sediment Metals Samples										**1, S**				
	Arsenic	TEC	9.79	mg/kg						1				
	Chromium	TEC	43.4	mg/kg						1				
	Copper	TEC	31.6	mg/kg						1				
	Nickel	PEC	48.6	mg/kg						1				
Sediment Organics Samples										**1, S**				
	Chlordane	TEC	3.24	µg/kg						1				
	DDT (total)	TEC	5.28	µg/kg						1				
Sediment Toxicity										**1, S**				
	Hyalella toxicity	Chronic - growth								1				

The total number of samples (or sonde deployments) are shown in bold for each characteristic group. Season codes are: D - Dry; S - spring; W - Wet season (not wet weather)
TEC - Threshold effect concentration; PEC - Probable effect concentration

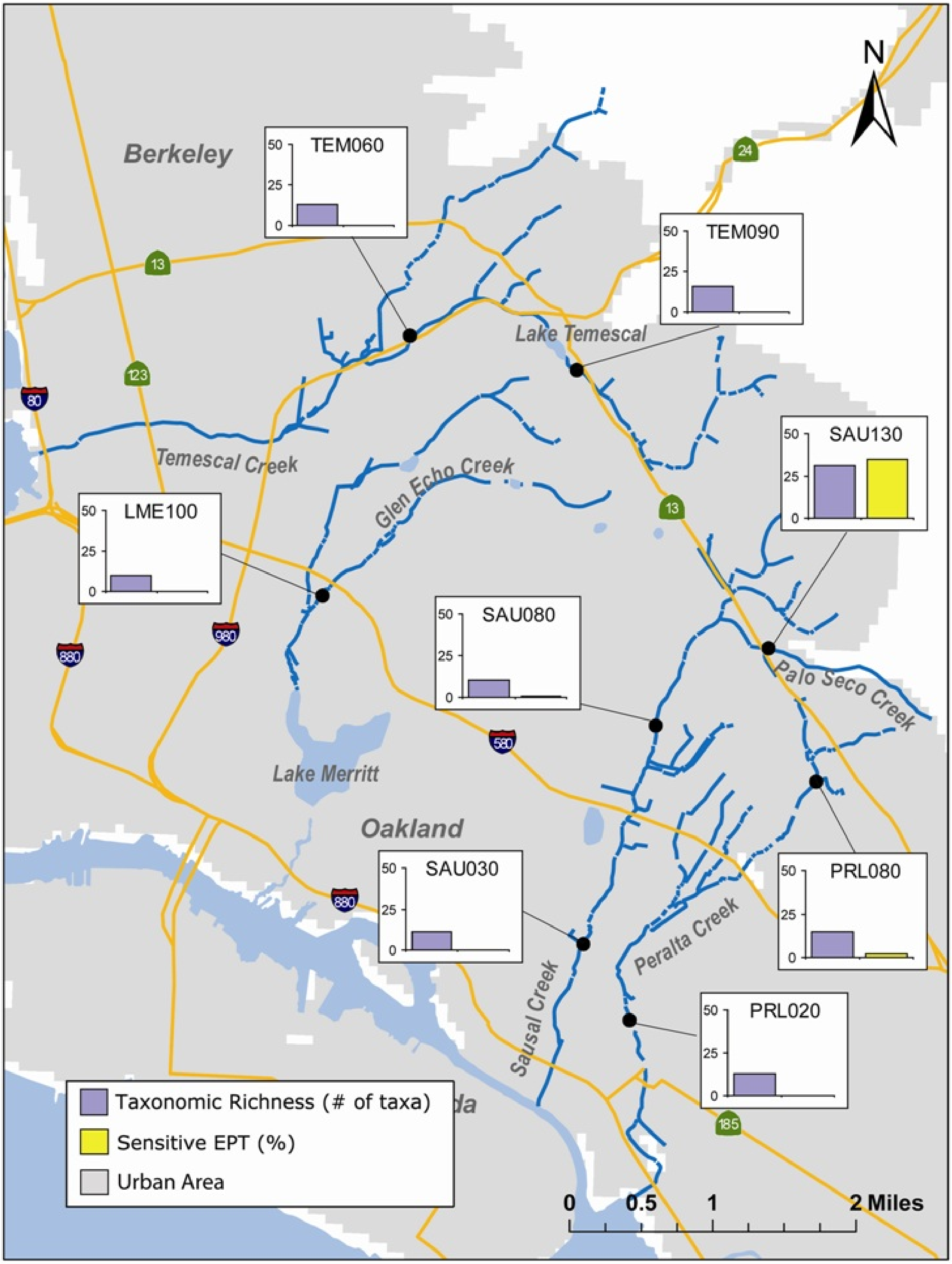


Figure 3.2-1a: Results of selected BMI metrics in the central East Bay (north Oakland) watersheds: Temescal, Glen Echo, Sausal, and Peralta Creeks

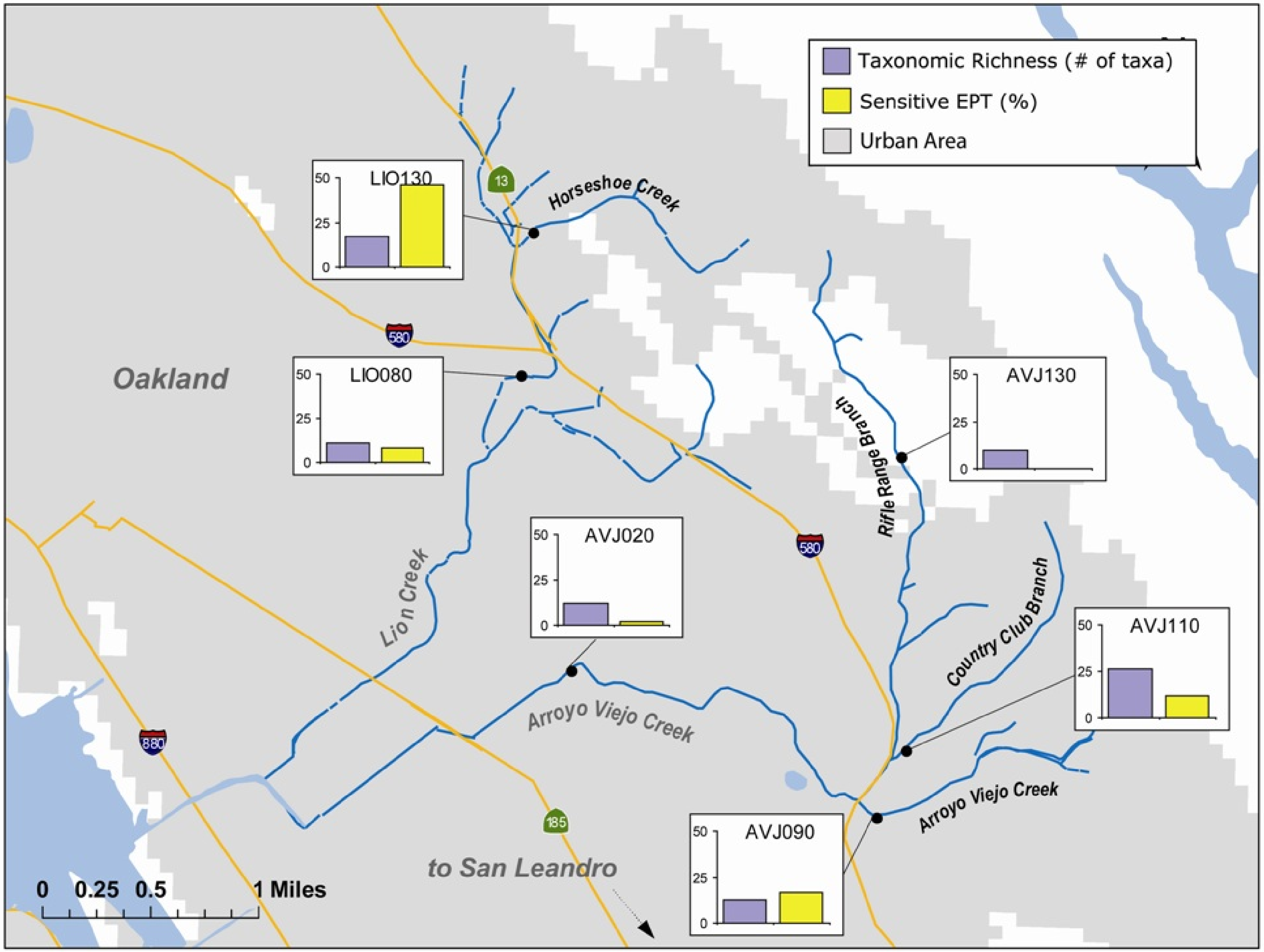
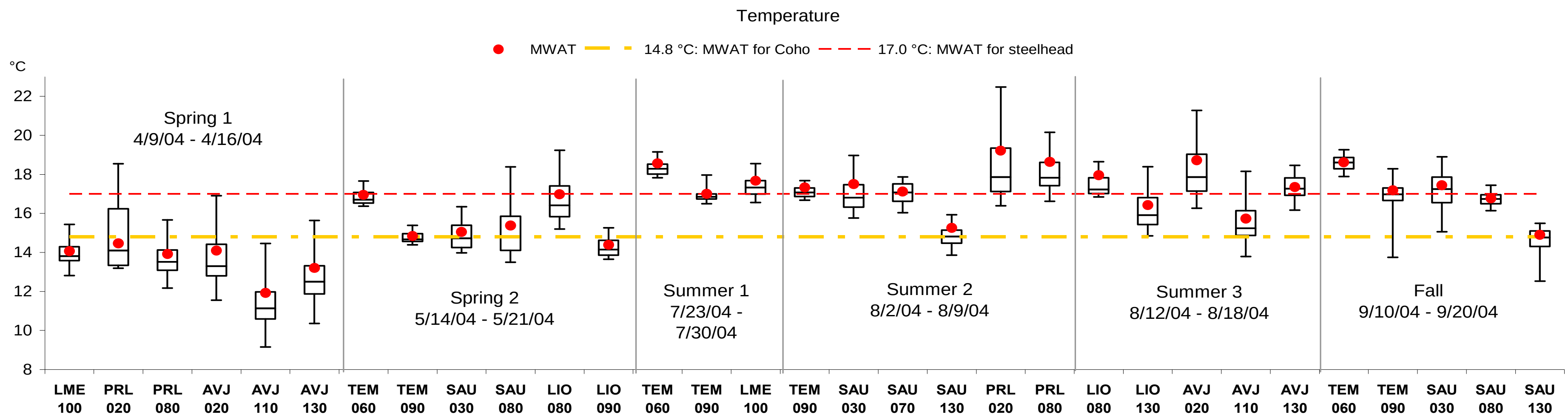


Figure 3.2-2b: Results of selected BMI metrics in the central East Bay (south Oakland) watersheds: Lion and Arroyo Viejo Creeks



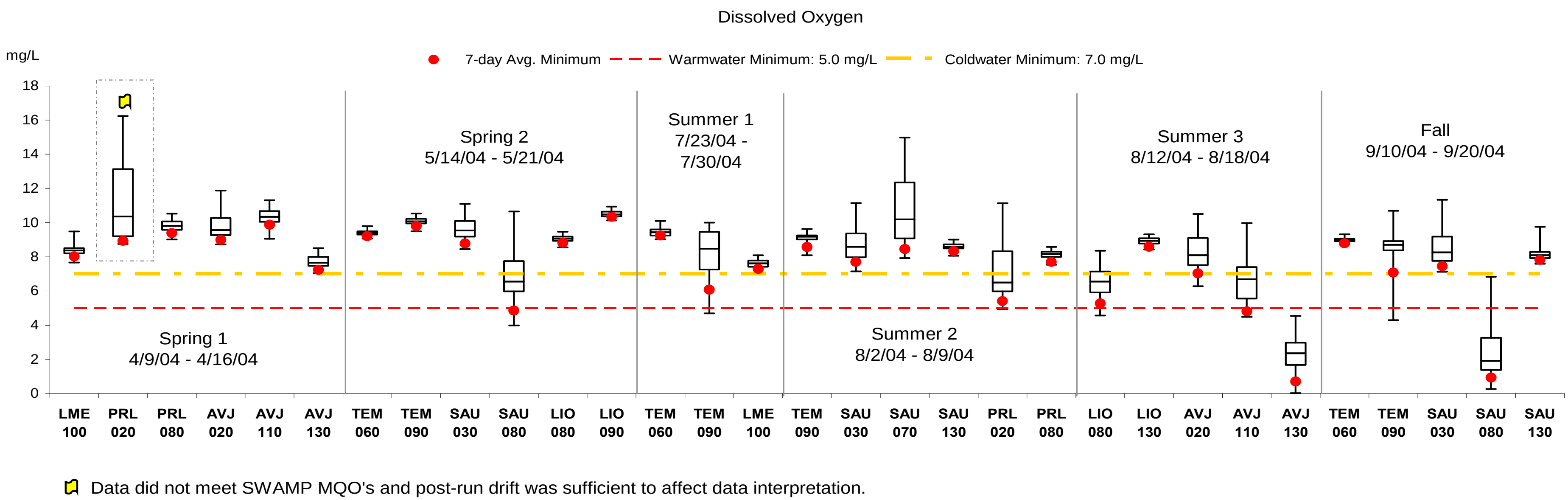


Figure 3.2-2: Continuous field monitoring summaries for temperature and dissolved oxygen in the central East Bay creeks during the spring, summer, and fall of 2004.

(blank)

3.3 Year 4 Arroyo Mocho Watershed

Arroyo Mocho is the watershed studied at the highest detail (at eight sites) in years 4&5 (Figure 2.1-3). It encompasses 71.4 square miles and is a sub-watershed of Alameda Creek watershed. Arroyo Mocho flows northwest from its headwaters on Mt. Mocho (Station AMO200) into the Livermore-Amador Valley through the city of Livermore, then west into Pleasanton. The Hetch Hetchy Aqueduct, owned by the City of San Francisco, passes below Arroyo Mocho via tunnel near AMO180. The South Bay Aqueduct (SBA), owned by the State of California, crosses Arroyo Mocho approximately 2.5 miles southeast of Livermore., a mile downstream of AMO160. At that point, SBA water is **released into the creek** at a rate of up to 20 cfs. Some of this water seeps into the Livermore Formation aquifer as it flows through AMO100, AMO095, AMO090, and AMO080. The remainder is diverted into the gravel pits located west of AMO070, the most downstream site monitored in year 4. The channelized confluence of Arroyo Mocho with Arroyo de la Laguna is at Interstate 680. The two major tributaries - Arroyo de las Positas and Tassajara Creek – open into Arroyo Mocho downstream of AMO070. This summary draws from the detailed description in the Arroyo Mocho Creek Workplan prepared for year 4 (SFBRWQCB 2004c).

3.3.1 Benthic macroinvertebrates and physical habitat

Five sites were sampled for benthic macroinvertebrates and physical habitat in the Arroyo Mocho watershed. All five sites were located on the mainstem of Arroyo Mocho. Metric values for each site are shown in Appendix Table B-2d, the substrate where BMI were collected is shown in Appendix Table B-3, and the physical habitat summary data are shown in Appendix Table B-4.

Three sites, AMO100, AMO160, and AMO200, were clustered near one another on the right side of the NMS ordination plot, suggesting that the sites are taxonomically similar (**Figure 3.6-1**). Although taxonomic richness is similar among the three sites (22-24), percent sensitive EPT varies considerably, from 1% at AMO100 to 15% at AMO200 (**Figure 3.3-1**). The three sites had moderate to high numbers of COBS taxa (77-90%), especially *Baetis* sp., *Simuliium* sp., and Chironomidae. The benthic macroinvertebrate assemblages at AMO160 and AMO200 are typical of intermittent streams; the presence of taxa such as Corydalidae (likely *Neohermes filicornis*) and perlodid stoneflies, and the absence of elmid beetles and most casddisflies, suggests temporary streamflow. In contrast, the presence of elmid beetles, hydropsychid caddisflies, and the Asian clam *Corbicula* sp., could indicate perennial streamflow at AMO100. AMO100 is located downstream of the South Bay Aqueduct, which regularly discharges large volumes of imported water from the Sacramento Delta into Arroyo Mocho.

The most downstream site on Arroyo Mocho, AMO070, is taxonomically most similar to urban Oakland creeks such as Temescal Creek and Glen Echo Creek (**Figure 3.6-1**). Taxa richness was very low (9), no sensitive EPT taxa were present, and the assemblage was dominated by *Baetis* sp. and Oligochaeta. The streambed at AMO070 contained much fine sediment (43%), which could explain the large numbers of oligochaete worms.

AMO180 was taxonomically distinct from other sites in the watershed and most other sites sampled in 2005, although it was most closely related to minimally disturbed sites in West Marin. This site was characterized by very high taxa richness (37), many sensitive and intolerant taxa, and relatively low overall density of organisms (**Appendix Table B-2d**). Notable taxa at this site included cold-water, sensitive taxa such as the water penny *Psephenus* sp., the stonefly *Calineuria californica*, the free-living caddisfly *Rhyacophila* sp., and the heptageniid mayfly *Nixe* sp. The presence of these taxa suggests that water could be present year-round at this site, perhaps only in the hyporheos, although taxa common in intermittent streams, such as Corydalidae, were also present.

Overall, the five sites in the Arroyo Mocho watershed exhibited a large range in biological integrity. As observed in other watersheds in the Bay Area, the most downstream site on Arroyo Mocho was highly degraded. Sites in the upper portion of the watershed were of moderate to high biological integrity. Variation in benthic assemblages could be due to differences in streamflow, although other factors could be responsible as well.

3.3.2 Continuous field measurements

Figure 3.3-2 shows the boxplot summaries for temperature, DO, pH, and SC in the Year 4 Arroyo Mocho Creek watershed. Table C-2e in Appendix C details the summary statistics for continuous monitoring in Arroyo Mocho Creek.

Temperature: Of all the watersheds monitored during the course of this investigation, Arroyo Mocho exhibited the highest average and highest maximum water temperatures recorded during the spring and summer deployments. The 24 C lethal benchmark for salmonids was exceeded in Stations AMO070, AMO100 and AMO180 during the spring, for durations of 6, 1, and 5 hours respectively. Temperatures at AMO100 during the summer deployment exceeded 24 C for 9 hours. The maximum water temperature recorded at AMO100 during that period was 27.7 C. During both the spring and summer deployments, the 14.8 C MWAT for Coho was exceeded at all stations except during the spring deployment at AMO200, which is located in the upper watershed. During the spring and summer deployments, the 17.0 C MWAT for steelhead was exceeded at all stations except AMO180 and AMO200. Water temperatures at all stations during the winter deployment period were well below the physiological limits for both Coho and Steelhead

Dissolved Oxygen (DO): During the spring and summer, DO measurements were highly variable among the stations. Sites AMO070, AMO100, and AMO180 all had median DO concentrations above the cold water minimum of 7.0 mg/l. In the spring at AMO160, the median DO concentration was just above the warm water minimum of 5.0 mg/l, while at AMO200 the median DO concentration was 2 mg/l, well below that benchmark. During the summer deployment, the median DO concentration at AMO160 was very near zero, far below the warm water minimum of 5.0 mg/l, and this was coupled with relatively low temperatures and high specific conductance. Deployment and retrieval observations for this summer deployment period noted that the sonde was deployed in a shallow, isolated pool located in the shade at the edge of a grade control structure. Thus, it appears likely that the deployment results represent waters flowing through the gravel rather than surface flow. Winter DO concentrations were well above the coldwater minimum of 7.0 mg/l at all stations.

pH: Although most pH measurements for all stations were within the Basin Plan range of 6.5 to 8.5, a few stations exhibited periodic excursions above the upper limit. At station AMO160, the average pH was very close to the upper limit during the winter season. Stations AMO070 and AMO100 in the spring and station AMO100 in the summer exhibited excursions in pH above the upper limit with the maximum value of 9.21 being recorded at AMO070 during the spring season.

Specific Conductance (SC): With one notable exception at AMO160 during the summer, all SC measurements were below the 1000 us/cm limit. Average SC at AMO160 during the summer deployment period was 1578 us/cm with a maximum of 1623.1 us/cm. This may be due to the fact that the monitoring instrument at this site had been deployed in an isolated pool with no surface flow and could possibly have been reading underflow, accounting for the high SC and very low dissolved oxygen.

3.3.3 Water chemistry and toxicity

Water chemistry and toxicity were assessed on three AMO070 samples collected in the three seasons. The analytical results for conventional water quality characteristics, metals, and organics are shown in Appendix Tables D-3, D-4, and D-5. Toxicity test results are presented in Appendix Table D-6. Water samples collected at AMO070 exceeded nitrate guidelines in winter and spring, and exceeded total phosphorus guidelines in winter and summer. There were no exceedances of metals and organic compounds benchmarks. One of the 9 samples caused a statistically-significant reproductive effect in Ceriodaphnia, and none of the samples caused mortality (Table 3.3-1).

3.3.4 Sediment chemistry and toxicity

One sediment sample was collected at Arroyo Mocho's 'watershed integrator' site AMO070. The results are shown in the tables of Appendix D-7, and exceedences of quality benchmarks are summarized in Table 3.3-1 below. Only the metals chromium and nickel, which are abundant in Bay Area's soil, were detected at concentrations that exceeded the TEC (chromium) or PEC (nickel). There were no exceedances of organic compounds benchmarks including legacy organic pollutants. Exposure to AMO070 sediments did not elicit any negative response in the *Hyalella azteca* toxicity test (Table 3.3-1).

3.3.5 Coliform counts

Bacterial counts were performed with samples collected at three Arroyo Mocho sites on July 20th and 27th and on August 3rd, 10th, and 17th, 2004. The results of these individual samples are shown in Appendix Table E-1, and summary statistics are presented in Figure 3.6-7 below. The 30-day median generated for three of three sets of samples collected at Arroyo Mocho exceeded total coliform objectives, and so did two of 15 individual samples, which exceeded the maximum benchmarks. However, there were not exceedances of the *E. coli* benchmark.

3.3.6 Summary of Arroyo Mocho condition indicators

Arroyo Mocho, a part of the headwaters of Alameda Creek, is less urbanized than the other watersheds studied in year 4 in the East Bay. We also have a more comprehensive representation of this watershed, including sites located at a variety of land-use settings. Benthic macroinvertebrate assemblages were seriously degraded at the downstream station (AMO070) and conditions appear to improve as we go upstream. (Figure 3.3-1 and Appendix B). **Table 3.3-1** shows a summary of all the exceedances of water quality benchmarks in this watershed in 2004. Temperature and dissolved oxygen benchmarks were exceeded in some spring and summer deployments, sometimes for many hours at a time. Two of three water samples exceeded nutrient criteria. Water and sediment samples contained relatively low concentrations of metals and organic compounds, bacterial indicator concentrations exceeded benchmarks for total coliforms but not for *E. coli*, and the only toxicity detected was statistically-significant reproduction effect in the Ceriodaphnia test. The temperature benchmark exceedances are significant because (a) temperatures above 24 C are considered lethal, (b) they occurred as early as April, and (c) they were recorded in historic steelhead rearing habitat. These exceedances may affect steelhead rearing success in Arroyo Mocho, despite the intensive steelhead fisheries restoration efforts currently being conducted in the Alameda Creek Watershed.

Table 3.3-1: Exceedances of water quality benchmarks in Arroyo Mocho Creek in 2004

					Arroyo Mocho Creek							
Group	***Characteristic***	***Benchmark type***	***Limit***	***Units***	**AMO070**	**AMO080**	**AMO090**	**AMO095**	**AMO100**	**AMO160**	**AMO180**	**AMO200**
Continuous Field Measurements					**2, SW**				**3, SDW**	**3, SDW**	**3, SWW**	**2, SW**
	Temperature	Max, salmonids (duration in hours	24	° C	1, S (5.75hrs)				2, SD (0.75, 9.5hrs)		1, S (5hrs)	
		7-day Mean for Coho	14.8	° C	1, S				2, SD	2, SD	1, S	
		7-day Mean for steelhead	17	° C	1, S				2, SD	2, SD	1, S	
	Oxygen, dissolved	7-day Avg. Min, WARM	5	mg/L						2, SD		1, S
		7-day Avg. Min, COLD	7	mg/L	1, S					2, SD		1, S
	pH	Range	6.5 to 8.5	pH	1>, S				2>, SD		1>, W	
Conventional & Nutrient Water Samples					**3, SDW**							
	Nitrate as N	Maximum	0.16	mg/L	2							
	Phosphorus, total as P	Maximum	30	µg/L	2							
Water Metals Samples					**3, SDW**							
Water Organics Samples					**3, SDW**							
Water Toxicity Samples					**3, SDW**							
	Ceriodaphnia toxicity	Chronic - reproduction	80%		1, D							
Coliform Water Sample Series *(each result consists of 5 samples)*						**1, D**	**1, D**	**1, D**				
	Total coliform	Median	240	MPN/100 mL		1	1	1				
		Maximum *(any of 5 samples)*	10000	MPN/100 mL		1 (1/5)		1 (1/5)				
Sediment Metals Samples					**1, S**							
	Chromium	TEC	43.4	mg/kg	1							
	Nickel	PEC	48.6	mg/kg	1							
Sediment Organics Samples					**1, S**							
Sediment Toxicity					**1, S**							

The total number of samples (or sonde deployments) are shown in bold for each characteristic group. Season codes are: D - Dry; S - spring; W - Wet season (not wet weather)
TEC - Threshold effect concentration; PEC - Probable effect concentration

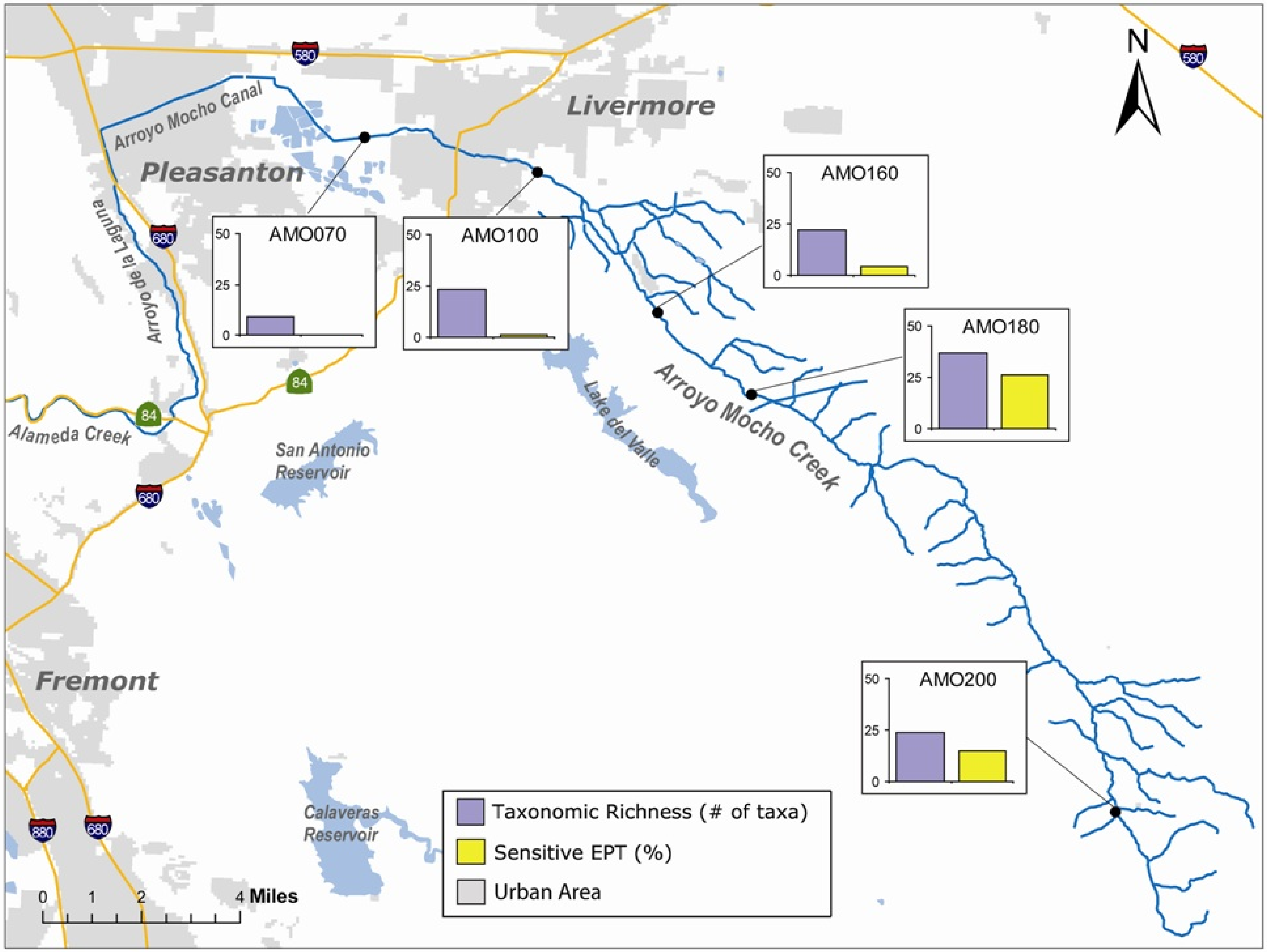
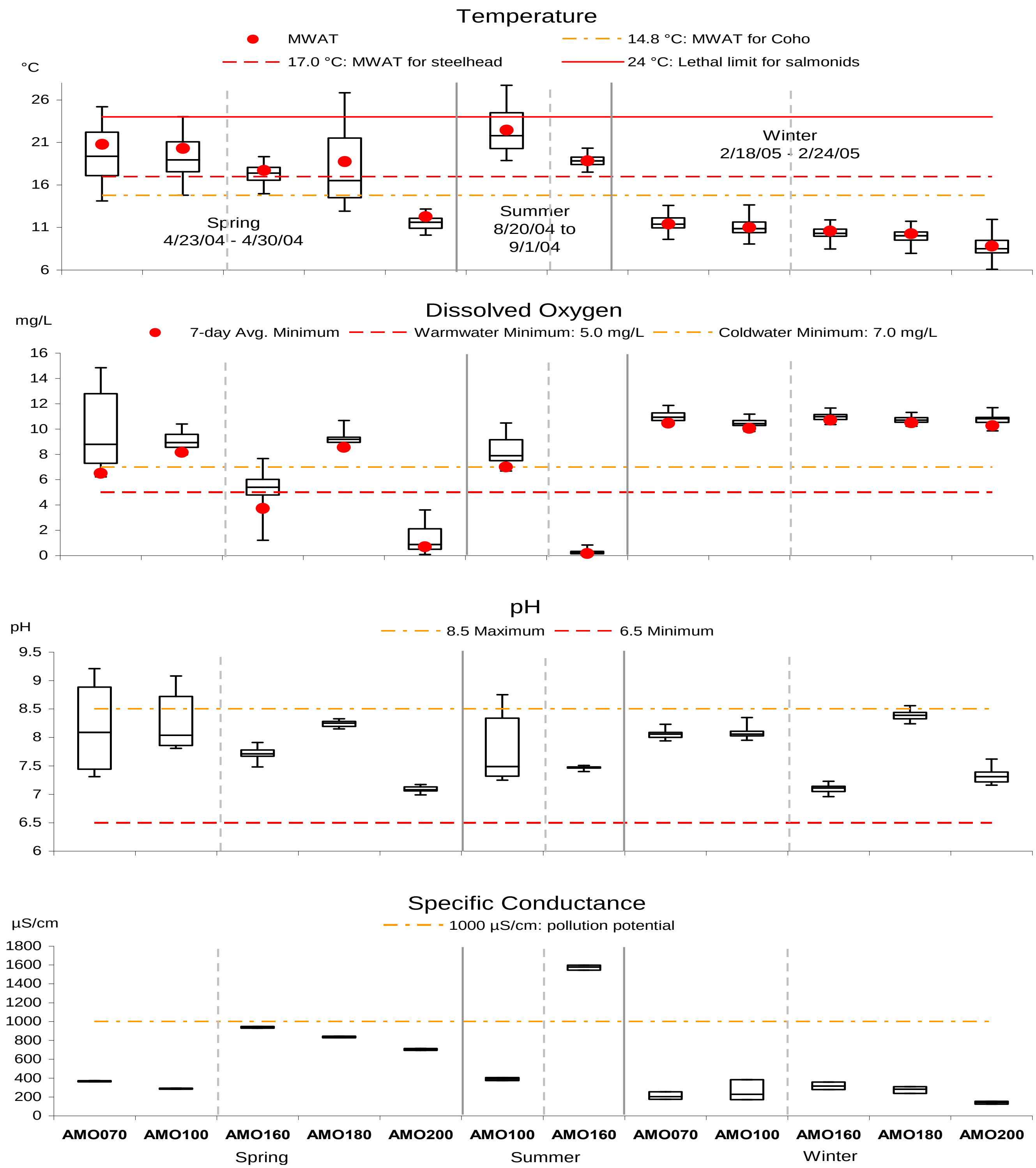


Figure 3.3-1: Results of selected BMI metrics in the Arroyo Mocho watershed



Note: Stations AMO070 and AMO100 are both downstream of an input into Arroyo Mocho Creek from the South Bay Aqueduct, which contributes a large portion of the flow in the lower reaches of the creek. The dashed lines in the figures above separate these reaches of the creek, showing the marked difference in results.

Figure 3.3-2: Continuous field monitoring summaries for Arroyo Mocho watershed

(blank)

3.4 Year 5 South-West Marin watersheds: Audubon Canyon, Morses Gulch, Pine Gulch, Easkoot, Webb, Redwood, Tennessee Valley, and Rodeo Creeks

The creeks in the South-West Marin watersheds provide a striking contrast to the East Bay watershed creeks. This is not surprising as these creeks are situated in watersheds that throughout the year are subject to the cool marine climate along the coast. There is less urban influence, even in the lower reaches of the watersheds. Riparian cover is often extensive, providing shade to keep the creek cool in the summer months when the flows are reduced. Marine layer clouds and fog further add to the cooling effects of the watershed environment by moderating diurnal heating during the summer months.

3.4.1 Benthic Macroinvertebrates (BMI) and physical habitat

Twelve sites were sampled for benthic macroinvertebrates and physical habitat in the South-West Marin watersheds: two sites on Pine Gulch, one site on Audobon Canyon, one site on Morses Gulch, two sites in the Easkoot Creek watershed, one site on Webb Creek, four sites in the Redwood Creek watershed, and one site on Tennessee Valley Creek. Two additional sites on Rodeo Creek were sampled for benthic macroinvertebrates but not for physical habitat. Metric values for each site are shown in Appendix Tables B-2e and B-2f, the substrate where BMI were collected is shown in Appendix Table B-3, and the physical habitat summary data are shown in Appendix Table B-4.

Benthic macroinvertebrate assemblages in the South-West Marin watersheds were generally in good to excellent condition, with uniformly high diversity (>25 taxa) and many pollution sensitive taxa present (**Figure 3.4-1a, Figure 3.4-1b, and Figure 3.5-1 below**). Nine sites were clustered near the top of the NMS ordination (Figure 3.6-1): PNG010, PNG050, WBB010, MRS020, EAS050, AUD020, RDW060, RDW100, and RDW120. These nine sites have benthic assemblages that are typical of minimally disturbed, perennial streams[1], including high taxa richness (31-46), high EPT richness (16-21), and high percent sensitive EPT (25-34%). Pollution sensitive taxa present at all or most of these sites include riffle beetles (Elmidae); water penny beetles (Psephenidae); cranefly larvae (Tipulidae) such as *Dicranota* sp., *Hexatoma* sp., and *Limnophila* sp.; ephemerellid and heptageniid mayflies; the perlid stonefly *Calineuria californica*; and the caddisflies *Parthina* sp., *Rhyacophila* sp., and *Neophylax* sp. Based on the taxonomic composition of these nine sites, biological integrity is excellent and there is no evidence of water quality or habitat degradation.

Benthic assemblages at five sites in the South-West Marin watersheds, EAS020, ROD040, ROD050, TVY030, and RDW040, exhibit significant differences from the minimally disturbed sites discussed previously. Based on their location in the center of the NMS ordination plot, these

[1] Two of the sites, MRS020 and EAS050, were hypothesized to have intermittent streamflow prior to sampling. Both sites had good flow in April and MRS020 had good flow in June (EAS050 was not sampled in June). Based on the presence of many taxa that require perennial flow, and their similarity to assemblages from nearby perennial streams, these streams may in fact be perennial.

five sites appear to be intermediate in disturbance between the minimally disturbed sites and the urban streams from the East Bay (**Figure 3.6-1**). The five sites generally have lower taxonomic richness (20-28), EPT richness (8-15), and percent sensitive EPT (1-38) than the nine minimally disturbed sites. These sites generally lacked or had fewer of the most pollution sensitive taxa, such as craneflies (Tipulidae), heptageniid mayflies, ephemerellid mayflies, the stonefly *Calineuria californica*, glossosomatid caddisflies, and the water mite *Torrenticola* sp. These five sites also had greater numbers of the filter-feeding blackfly *Simulium* sp. There are likely several reasons for the lowered diversity at these sites. Two sites, TVY030 and RDW040, had streambeds with no cobble and high amounts of fine sediment (67% and 70%, respectively). Thus, a lack of interstitial spaces in the stream bottom could be responsible for the lowered diversity. One site, ROD050, was dry during the June sampling event. The lowered richness at this site may be a result of flow intermittency, and may not reflect any human-caused disturbance. The lower site on Rodeo Creek, ROD040, may also be intermittent, although it had water during the June sampling event. The most downstream site on Easkoot Creek, EAS020, is the most urban of the sites in the South-West Marin watershed. Canopy cover at this site was very low (47%), but the increased solar radiation is not reflected in an increase in grazing macroinvertebrates.

3.4.2 Continuous field measurements

Figure 3.4-2 shows box plot summaries for temperature and dissolved oxygen monitored at all sites in the Year 5 South-West Marin watersheds. As mentioned above, South-West Marin watersheds have extensive riparian cover and are often exposed to marine layer clouds and fog. These conditions have a marked effect on temperatures and oxygen levels, which are very comfortable for aquatic life (i.e., water quality benchmarks are met in most sites throughout the year), as opposed to the conditions in East Bay watersheds which are further from the ocean and highly urbanized (Sections 3.1-3.3 above). The four-characteristics discussion below refers to the entire continuous field monitoring dataset shown in Appendix C, which is an integral part of this report. Tables C-2e-g in Appendix C detail the summary statistics for continuous monitoring in these creeks, namely Pine Gulch, Easkoot, Webb, Redwood, Tennessee Valley and Rodeo Creeks. Appendix Figures C.4-2a-d also display the box plot summaries for all these data. [Note: continuous field measurements were not performed in Audubon Canyon and Morses Gulch Creeks.]

Temperature: Median water temperatures observed in the six creeks during all seasons were below 14.8 C, with one exception observed at the lower watershed station in Easkoot creek, EAS020, during the summer deployment. Even then, the median water temperature was below 17.0 C. The instantaneous temperature datasets for EAS020 and RDW060 show a few short temperature excursions above 17.0 C during the summer deployments.

Dissolved Oxygen: With a few exceptions, median dissolved oxygen levels were generally quite good, often well above the 7.00 mg/l coldwater minimum. This is expected, as cooler water generally contains more dissolved oxygen. While the median DO levels measured in Easkoot Creek at station EAS020, Rodeo Creek at ROD030 and Redwood Creek at RDW040 were just above the 7.00 mg/l coldwater minimum, some DO excursions below the 5.0 mg/l minimum for warm water habitat were observed. The Rodeo Creek station at ROD030 experienced very low

DO concentrations during the spring and summer deployments. This is most likely the result of sonde positioning during the deployment. Field notes indicate the sonde was deployed near the bottom of the creek downstream from a small grade control structure. Water column stratification near the bottom could account for the consistently low DO values.Median pH values below 7 and slightly elevated SC values tend to support this interpretation.

pH: While most pH values recorded in all creeks at all stations fell between the Basin Plan limits of 6.5 and 8.5, there are a few notable exceptions. Excursions above the upper pH 8.5 limit were noted in Easkoot Creek at EAS050 during the winter deployment. Also, pH values at Rodeo Creek station ROD030 were low, and there were excursions below the Basin Plan lower limit at this station during both spring and summer deployments. See Appendix Figures C.4-2a-d for summaries of pH data at all sites in these watersheds.

Specific Conductance (SC): All average SC values observed in the six creeks during all seasons were well below the upper limit of 1000 us/cm. In most cases the values were below 400 us/cm reflecting the abundant precipitation, cool temperatures and lack of urban and agricultural influences. Only Redwood Creek at station RDW040 had brief SC excursions above 500 us/cm.

3.4.3 Water chemistry and toxicity

Twenty six water samples were collected in the South-West Marin watersheds: Audubon Canyon, Morses Gulch, Pine Gulch, Easkoot, Webb, Redwood, Tennessee Valley, and Rodeo Creeks for analyses and testing in 2005; 8 of these samples were collected during the winter, 9 in the spring, and 9 in the dry season. The analytical results for conventional water quality characteristics, metals, and organics are shown in Appendix Tables D-3, D-4, and D-5. Toxicity test results are presented in Appendix Table D-6. Many water samples collected at South-West Marin watersheds exceeded nutrient guidelines for nitrate (12 of 26) and total phosphorus (23 of 26). However, nutrient levels and exceedance frequencies were lower than those seen in urban creeks. As mentioned earlier (Section 3.1.6), these nutrient guidelines may not be appropriate for these watersheds. There were no exceedances of metals and organic compounds benchmarks, and none of the samples were toxic to the organisms tested (Table 3.4-1)

3.4.4 Sediment chemistry and toxicity

Two sediment samples were collected in South-West Marin, at Stations PNG010 and EAS020. The results are shown in the tables of Appendix D-7, and exceedences of quality benchmarks are summarized in Table 3.4-1 below. Sediments from these open-space creeks had elevated concentrations of arsenic, chromium, copper and nickel – most probably from geological sources. Arsenic, chromium, and nickel concentrations exceeded PEC at Easkoot Creek. There were no exceedances of organic compounds, and the toxicity test showed a growth effect in the Easkoot Creek sediment (Table 3.1-1).

3.4.5 Coliform counts

Bacterial counts were performed with samples collected at three Stations on July 12th, and 19th, and 26th and on August 2nd and 9th 2005. The results of these individual samples are shown in

Appendix Table E-1, and summary statistics are presented in Figure 3.6-7 below. Three of three sets of bacterial samples, collected at AUD020, RDW101, and ROD035, contained total coliforms at concentrations that exceeded total coliform objectives. None of the sample sets exceeded the *E. coli* benchmarks.

3.4.6 Summary of South-West Marin watersheds condition indicators

The creeks studied in 2005 (Audubon Canyon, Morses Gulch, Pine Gulch, Easkoot, Webb, Redwood, Tennessee Valley, and Rodeo Creeks) run through watersheds that are almost entirely in open space. Benthic macroinvertebrate assemblages were in good conditions, except in the Redwood Creek tributary draining Green Gulch (Figures 3.4-1 and Appendix B); in fact, the mainstem of Redwood Creek has been selected as a reference site for subsequent SWAMP studies. **Table 3.4-1** shows a summary of all the exceedances of water quality benchmarks in these creeks in 2005. Of the 39 freshwater deployments, the coho temperature benchmark was exceeded in 2 and dissolved oxygen benchmarks were exceeded in 5. pH exceedences were seen only in Easkoot creek and in Rodeo Lake (above the brackish part of Rodeo lagoon). About half of the water samples exceeded nitrate guidelines, and 23 or 26 samples exceeded total phosporopus guidelines. Metals and organic compound concentrations did not exceed water quality benchmarks in water samples, and very few metal TECs or PECS were exceeded in sediments, mostly for chromium and nickel. No organic compounds exceeded sediment guidelines. Growth impairment (but not mortality) was observed in one of the two sediment samples collected in south-west Marin in 2005.

Table 3.4-1: Exceedances of water quality benchmarks in south Marin Co. watersheds in 2005

a. Audobon Creek to Redwood Creek

								Easkoot Cr. Watershed			*Redwood Creek Watershed*				
				Aududon Canyon Creek	*Morses Gulch Creek*	*Pine Gulch Creek*		*Easkoot Creek*	*Fitzhenry Creek*	*Webb Creek*	*Redwood Creek*				*Green Gulch Creek*
Group	***Characteristic***	***Benchmark type***	***Limit***	***Units***	**AUD020**	**MRS020**	**PNG010**	**PNG050**	**EAS020**	**EAS050**	**WBB010**	**RDW010**	**RDW060**	**RDW100**	**RDW120**	**RDW040**
Continuous Field Measurements *(number of samples and season)*							***3, SDW***	***3, SDW***	***3, SDW***	***3, SDW***	***3, SDW***		***3, SDW***	***3, SDW***	***3, SDW***	***3, SDW***
	Temperature	7-day Mean for Coho	14.8	° C			1, D						1, D			
	Oxygen, dissolved	7-day Avg. Min, COLD	7	mg/L					1, D							1, D
	pH	Range (max duration)	6.5 to 8.5	pH						1, W, >8.5						
Conventional & Nutrient Water Samples					***3, SDW***	***3, SDW***	***3, SDW***		***3, SDW***				***3, SDW***			***3, SDW***
	Nitrate as N	Maximum	0.16	mg/L	1	3	3		3							1
	Phosphorus, total as P	Maximum	30	µg/L	2	3	3		3				2			2
Water Metals Samples							***3, SDW***		***3, SDW***							
Water Organics Samples							***3, SDW***		***3, SDW***							
Water Toxicity Samples							***3, SDW***		***3, SDW***							
Coliform Water Sample Series *(each result consists of 5 samples)*					***1, D***							***1, D***				
	Total coliform	Median	240	MPN/100 m	1							1				
Sediment Metals Samples							***1, S***		***1, S***							
	Arsenic	PEC	33	mg/kg					1							
	Chromium	PEC	111	mg/kg					1							
		TEC	43.4	mg/kg			1									
	Copper	TEC	31.6	mg/kg					1							
	Nickel	PEC	48.6	mg/kg					1							
		TEC	22.7	mg/kg			1									
Sediment Organics Samples							***1, S***		***1, S***							
Sediment Toxicity							***1, S***		***1, S***							
	Hyalella toxicity	Chronic - growth							1							

The total number of samples (or sonde deployments) are shown in bold for each characteristic group. Season codes are: D - Dry; S - spring; W - Wet season (not wet weather)
TEC - Threshold effect concentration; PEC - Probable effect concentration

Table 3.4-1: Exceedances of water quality benchmarks in south Marin Co. watersheds in 2005

b. Tennessee Vally Creek to Rodeo Creek watershed

						Rodeo Creek Watershed					
					Tennessee Valley Creek	*Rodeo Lagoon (brackish)*		*Rodeo Lake*		*Gerbode Creek*	*Rodeo Creek*
Group	*Characteristic*	*Benchmark type*	*Limit*	*Units*	TVY030	ROD010	ROD020	ROD030	ROD035	ROD040	ROD050
Continuous Field Measurements *(number of samples and season)*					***3, SDW***	***3, SDW***	***3, SDW***	***3, SDW***		***3, SDW***	***3, SDW***
	Temperature	7-day Mean for Coho	14.8	° C		2, SD	2, SD				
		7-day Mean for steelhead	17	° C		1, S	2, SD				
	Oxygen, dissolved	7-day Avg. Min, WARM	5	mg/L		2, SW	2, SD	2, SD			
		7-day Avg. Min, COLD	7	mg/L		3, SDW	2, SD	3, SDW			
	pH	Range (max duration)	6.5 to 8.5	pH		2 >, SD (524.5hrs, 233.25hrs)	2 >, SD (209.75hrs, 236.25hrs)	2 <, SD (13hrs, 21.75hrs)			
Conventional & Nutrient Water Samples					***3, SDW***					***3, SDW***	***2, SW***
	Nitrate as N	Maximum	0.16	mg/L	1						
	Phosphorus, total as P	Maximum	30	µg/L	3					3	2
Water Metals Samples											
Water Organics Samples											
Water Toxicity Samples											
Coliform Water Sample Series *(each result consists of 5 samples)*									***1, D***		
	Total coliform	Median	240	MPN/100 mL					1		
Sediment Metals Samples											
Sediment Organics Samples											
Sediment Toxicity											

The total number of samples (or sonde deployments) are shown in bold for each characteristic group. Season codes are: D - Dry; S - spring; W - Wet season (not wet weather)
TEC - Threshold effect concentration; PEC - Probable effect concentration

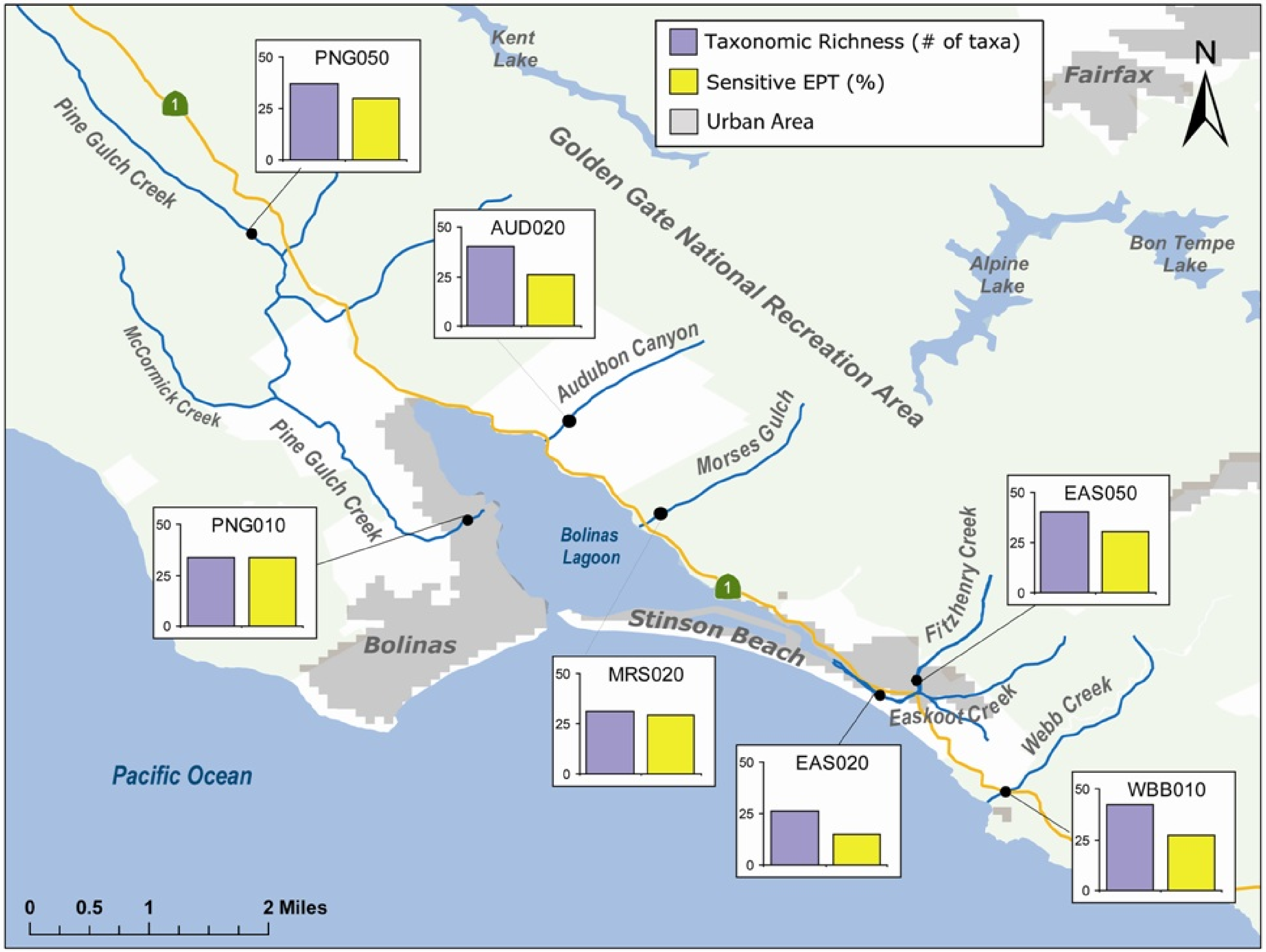


Figure 3.4-1a: Results of selected BMI metrics in Marin Co. (Bolinas area) watersheds: Audubon Canyon, Morse Gulch, Pine Gulch, Easkoot, and Webb Creeks

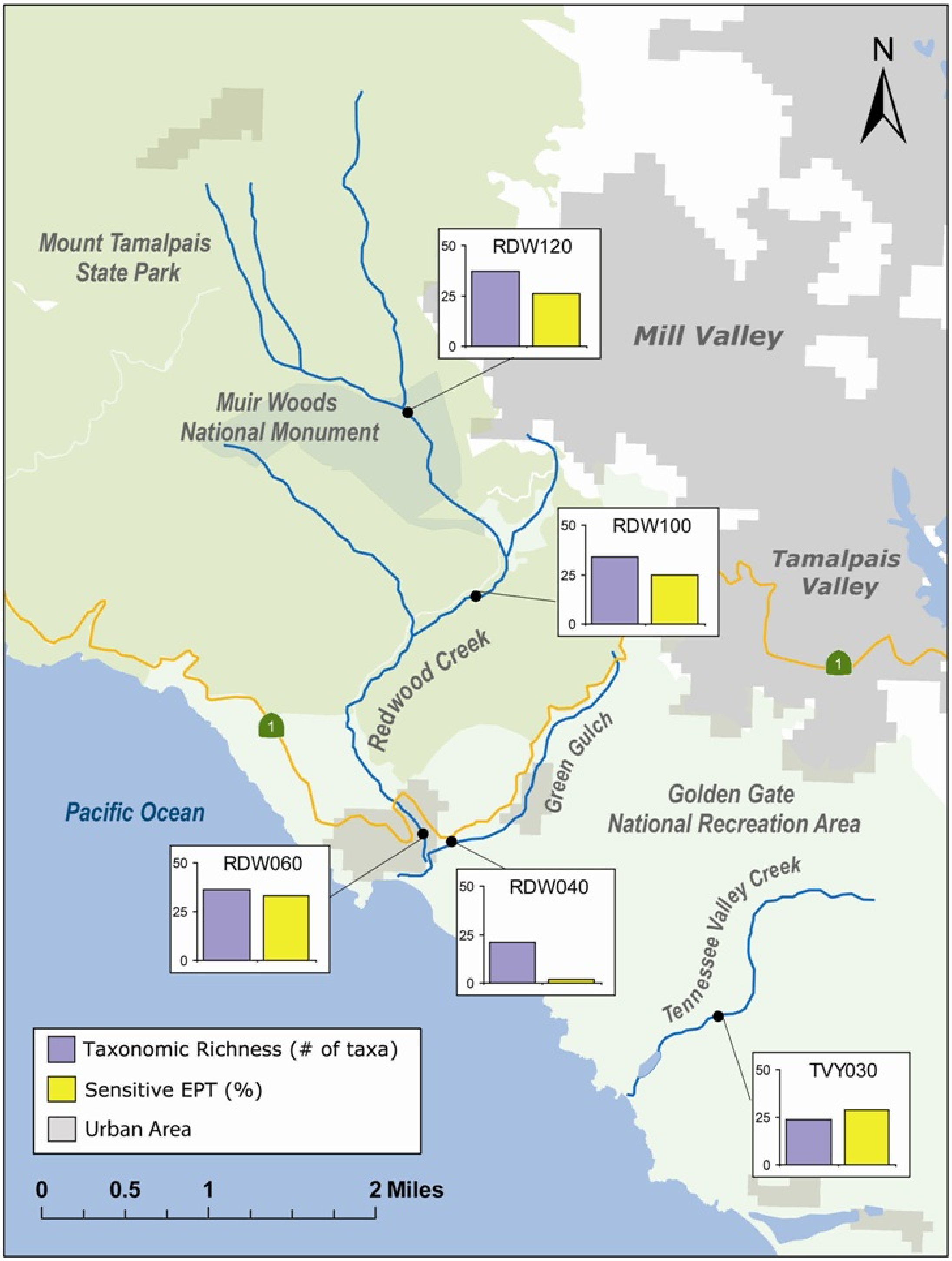
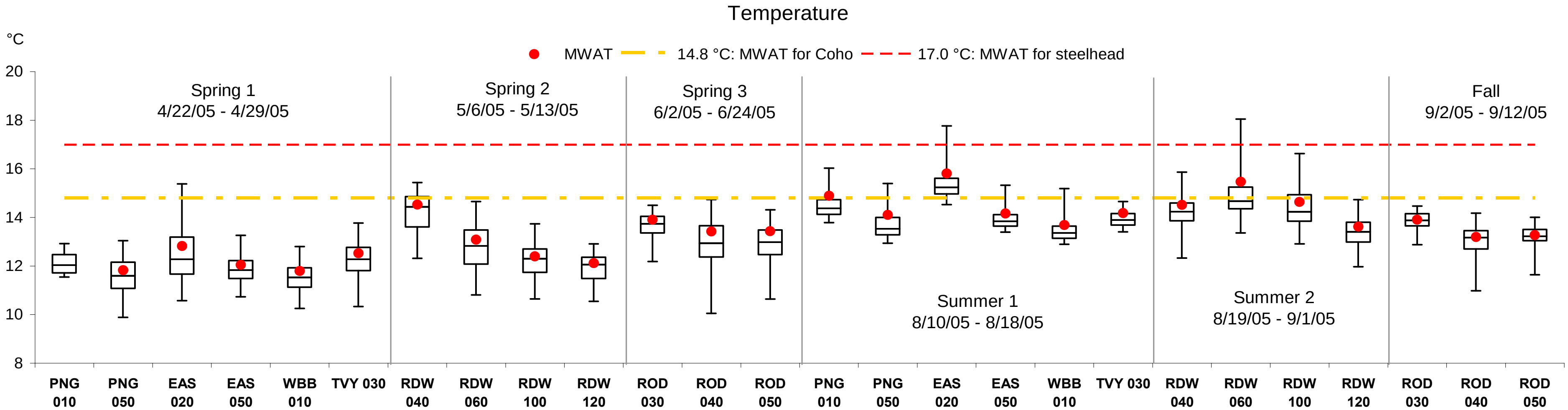
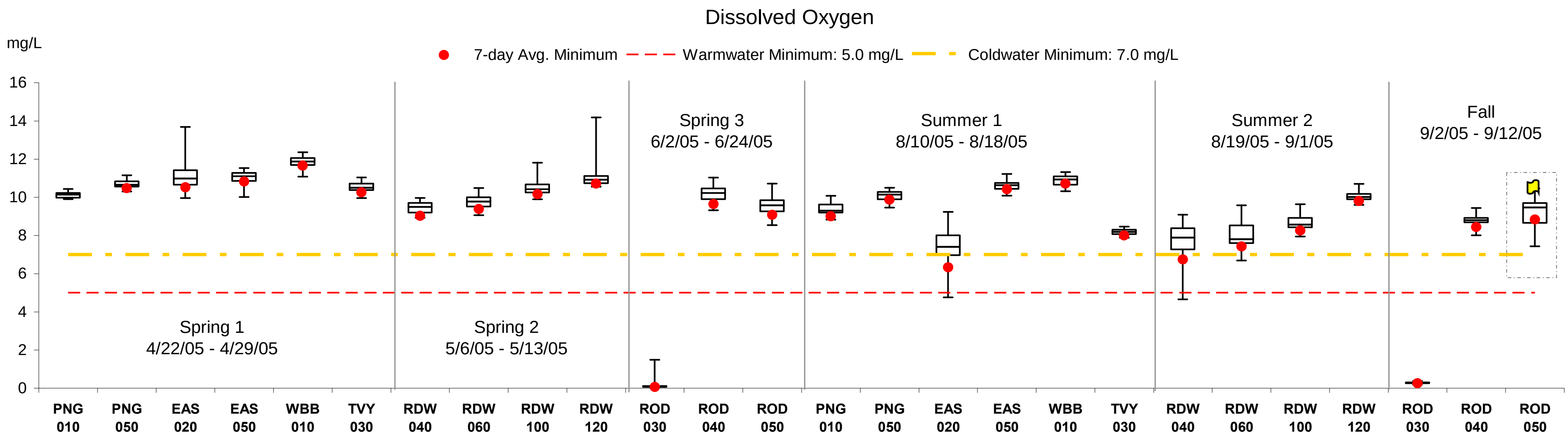


Figure 3.4-2b: Results of selected BMI metrics in south Marin Co. watersheds: Redwood and Tennessee Valley Creeks
[Note: BMI metrics for Rodeo Creek are shown in Figure 3.5-1 below]





Data did not meet SWAMP MQO's and post-run drift was sufficient to affect data interpretation.

Figure 3.4-2: Continuous field monitoring summaries for temperature and dissolved oxygen in Marin County watersheds during the spring, summer, and fall of 2005

(blank)

3.5 Year 5 San Francisco watersheds: Lobos and Islais Creeks

The city of San Francisco was represented in the 2005 monitoring by two Stations located in urban creeks. Lobos and Islais Creeks run through watersheds that are almost entirely urbanized, but parts of their riparian corridors are in city parks.

3.5.1 Benthic Macroinvertebrates (BMI) and physical habitat

Two sites were sampled for benthic macroinvertebrates and physical habitat in the San Francisco watersheds: one site on Lobos Creek and one site on Glen Canyon Creek (**Figure 3.5-1**). Metric values for each site are shown in Appendix Table B-2g, the substrate where BMI were collected is shown in Appendix Table B-3, and the physical habitat summary data are shown in Appendix Table B-4.

The benthic macroinvertebrate assemblages at the two sites in the San Francisco watersheds were taxonomically most similar to assemblages in urban creeks in the East Bay such as Baxter Creek and Codornices Creek (**Figure 3.6-1**). Taxonomic richness at LOB020 (18) and ISL050 (21) was slightly greater than at urban sites in the east bay, however. Both sites were numerically dominated by two COBS taxa, Chironomidae and *Simulium* sp. Non-insects such as hydrobiid, physid, and planorbid snails were also common. Two EPT taxa considered to be sensitive to pollution were collected from both sites: the stonefly *Malenka* sp. and the caddisfly *Lepidistoma* sp. Fine sediments were very abundant in the streambeds at LOB020 (86%) and ISL050 (55%), which may limit the diversity of benthic macroinvertebrates, especially EPT taxa.

3.5.2 Continuous field measurements

Figure 3.5-2 shows the boxplot summaries for temperature, DO, pH, and SC monitored in the Year 5 San Francisco watersheds – Lobos and Islais Creeks. The temperature and dissolved oxygen conditions in these urban creeks are very different from the East Bay urban creeks and can most likely be explained by the thick riparian cover and milder summer climate due to fog and clouds at these sites. Table C-2h in Appendix C details the summary statistics for continuous monitoring in these watersheds.

Temperature: Average water temperatures for Islais Creek at station ISL050 were below the 14.8 C MWAT for Coho during the spring and winter deployments. There was no summer deployment in Islais Creek. Lobos Creek average water temperatures were remarkably constant throughout the three deployment seasons, with the median temperatures falling between the 14.8 C and 17.0 C. There were a few temperature excursions above the steelhead MWAT(17 C) during the spring and summer, and these excursions were very brief in the winter.

Dissolved Oxygen (DO): For both creeks and for all seasons, DO values were all above the 7.0 mg/l value established for cold water aquatic life protection. All measurements exhibited little variation.

pH: For both creeks and for all seasons average pH values were between the Basin Plan limits of 6.5 and 8.5.

Specific Conductance: For both creeks and for all seasons average SC values were well below the upper limit of 1000 us/cm. Average SC values were slightly higher than the coastal creeks averaging around 600 us/cm. This is most likely due to urban runoff influence in the watersheds.

3.5.3 Water chemistry and toxicity

Water samples were collected only in one of the two San Francisco watersheds, Lobos Creek, once each season. The analytical results for conventional water quality characteristics, metals, and organics are shown in Appendix Tables D-3, D-4, and D-5. Toxicity test results are presented in Appendix Table D-6. All three samples exceeded nutrient guidelines but there were no exceedances of metals or organic compounds benchmarks and there was only a slight impairment of Selenastrum growth in the sample collected in the winter (Table 3.5-1)

3.5.4 Sediment chemistry and toxicity

One sediment sample was collected in each of the two San Francisco creeks. The results are shown in the tables of Appendix D-7, and exceedences of quality benchmarks are summarized in Table 3.5-1 below. Sediments of these urban creeks contained elevated concentration of chromium, copper, nickel, and zinc, in exceedance of several benchmarks. Chromium PEC was exceeded in both creeks, nickel PEC was exceeded in Islais Creek, and nickel TEC was exceeded in Lobos Creek. Copper and zinc TECs were also exceeded in Islais Creek. Legacy(e.g., organochlorine) pesticide concentrations did not exceed sediment benchmarks. However, total permethrins (pyrethroids of the third generation of pesticides) were detected at ISL050 at 6.4 ug/kg. Exposure to sediments collected at Islais and Lobos Creeks inhibited *Hyalella azteca* growth but did not cause mortality in the toxicity test (Table 3.5-1).

3.5.5 Coliform counts

Bacterial counts were performed with samples collected at the Islais Creek Station on July 12th, 19th, and 26th and on August 2nd and 9th 2005. The results of these individual samples are shown in Appendix Table E-1, and summary statistics are presented in Figure 3.6-7 below. This set of bacterial samples contained total coliforms concentrations that exceeded the total coliform objective for the 5-sample median, and 4 of 5 samples exceeded the individual sample objective for total coliforms. The log mean of these five samples exceeded the *E. coli* objective of 128 MPN/100mL.

3.5.6 Summary of San Francisco creeks condition indicators

Lobos and Islais Creeks run through watersheds that are almost entirely urbanized, although parts of their riparian corridors are in city parks. Benthic macroinvertebrate assemblages were less degraded then in the East Bay creeks, but biological metrics were nonetheless very different from minimally disturbed sites (Figure 3.5-1 and Appendix B). **Table 3.5-1** shows a summary of all the exceedances of water quality benchmarks in these creeks in 2005. Continuous monitoring Sondes were deployed three times in LOB020 and twice (spring and winter) in ISL050. There were no exceedances of temperature, pH, or dissolved oxygen benchmarks in ISL050. In

LOB020 only the Coho benchmark for temperature was exceeded, in all three seasons. All water samples from LOB020 exceeded nutrient guidelines, but there were no exceedences of metals and organic compounds benchmarks. The sediments had a few exceedances of metal benchmarks, the most severe being for chromium and nickel which may be a natural part of the local soils. Growth impairment (but not mortality) was observed in one of the two sediment samples collected in San Francisco in 2005.

Table 3.5-1: Exceedances of water quality benchmarks in San Francisco Creeks in 2005

Group	*Characteristic*	*Benchmark type*	*Limit*	*Units*	***Lobos Creek*** **LOB020**	***Islais Creek*** **ISL050**
Continuous Field Measurements *(number of samples and season)*					***3, SDW***	***2, SW***
	Temperature	Max, salmonids (max duration)	24	° C		
		MWAT for Coho	19.7	° C		
		7-day Mean for Coho	14.8	° C	3, SDW	
		MWAT for steelhead	19.6	° C		
		7-day Mean for steelhead	17	° C		
	Oxygen, dissolved	7-day Avg. Min, WARM	5	mg/L		
		7-day Avg. Min, COLD	7	mg/L		
	pH	Range (max duration)	6.5 to 8.5	pH		
Conventional & Nutrient Water Samples					***3, SDW***	
	Nitrate as N	Maximum	0.16	mg/L	3	
	Phosphorus, total as P	Maximum	30	µg/L	3	
Water Metals Samples					***3, SDW***	
Water Organics Samples					***3, SDW***	
Water Toxicity Samples					***3, SDW***	
	Selenastrum toxicity	Growth	80%		1, W	
Coliform Water Sample Series *(each result consists of 5 samples)*						***1, D***
	E. coli	log mean	126	MPN/100 mL		1
	Total coliform	Median	240	MPN/100 mL		1
		Maximum *(any of 5 samples)*	10000	MPN/100 mL		4 (4/5)
Sediment Metals Samples					***1, S***	***1, S***
	Chromium	PEC	111	mg/kg	1	1
	Copper	TEC	31.6	mg/kg		1
	Nickel	PEC	48.6	mg/kg		1
		TEC	22.7	mg/kg	1	
	Zinc	TEC	121	mg/kg		1
Sediment Organics Samples					***1, S***	***1, S***
Sediment Toxicity					***1, S***	***1, S***
	Hyalella toxicity	Chronic - growth			1	1

The total number of samples (or sonde deployments) are shown in bold for each characteristic group. Season codes are: D - Dry; S - spring; W - Wet season (not wet weather)
TEC - Threshold effect concentration; PEC - Probable effect concentration

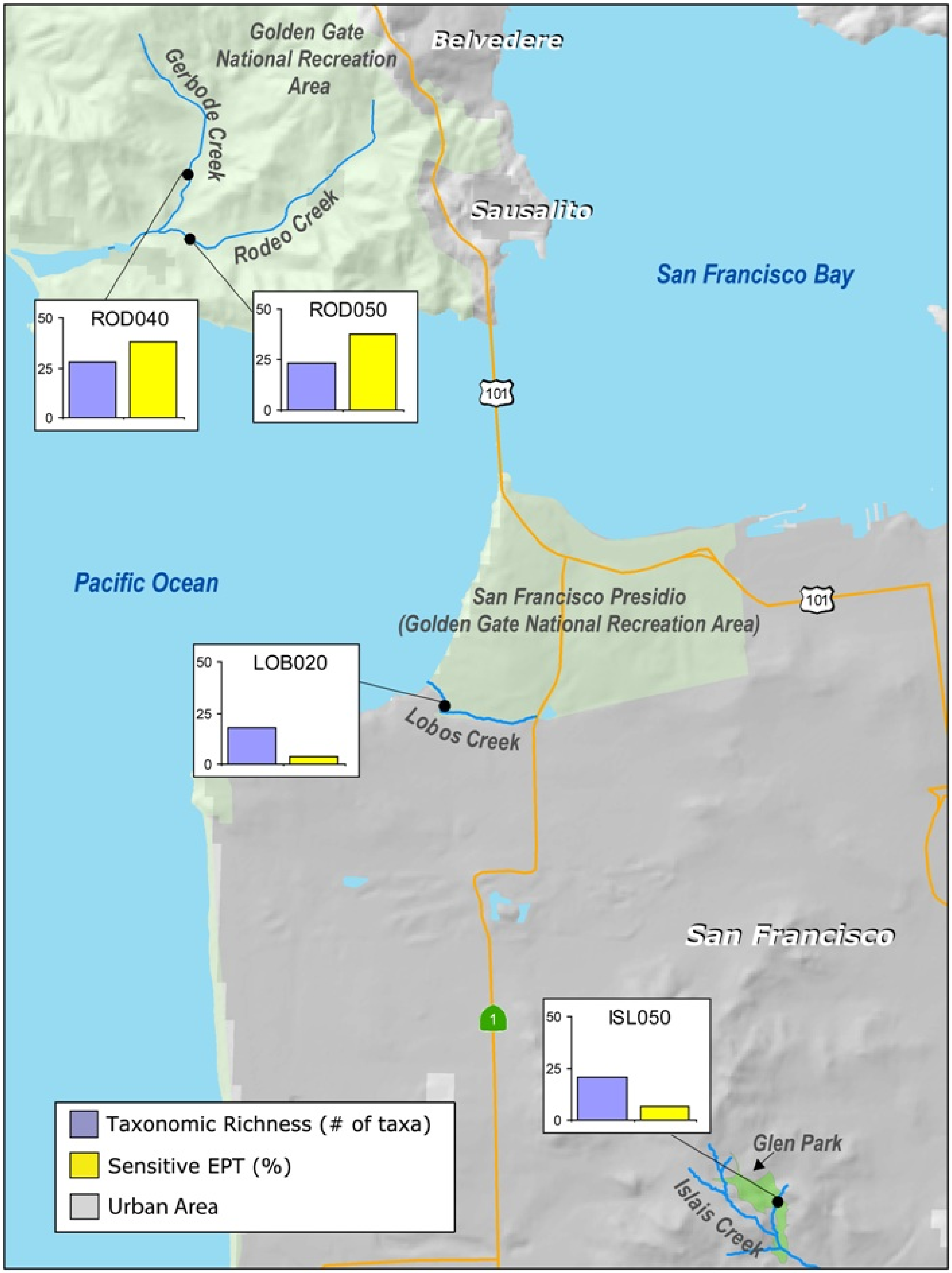


Figure 3.5-1: Results of selected BMI metrics in Rodeo Creek and in San Francisco watersheds: Lobos and Islais Creeks.

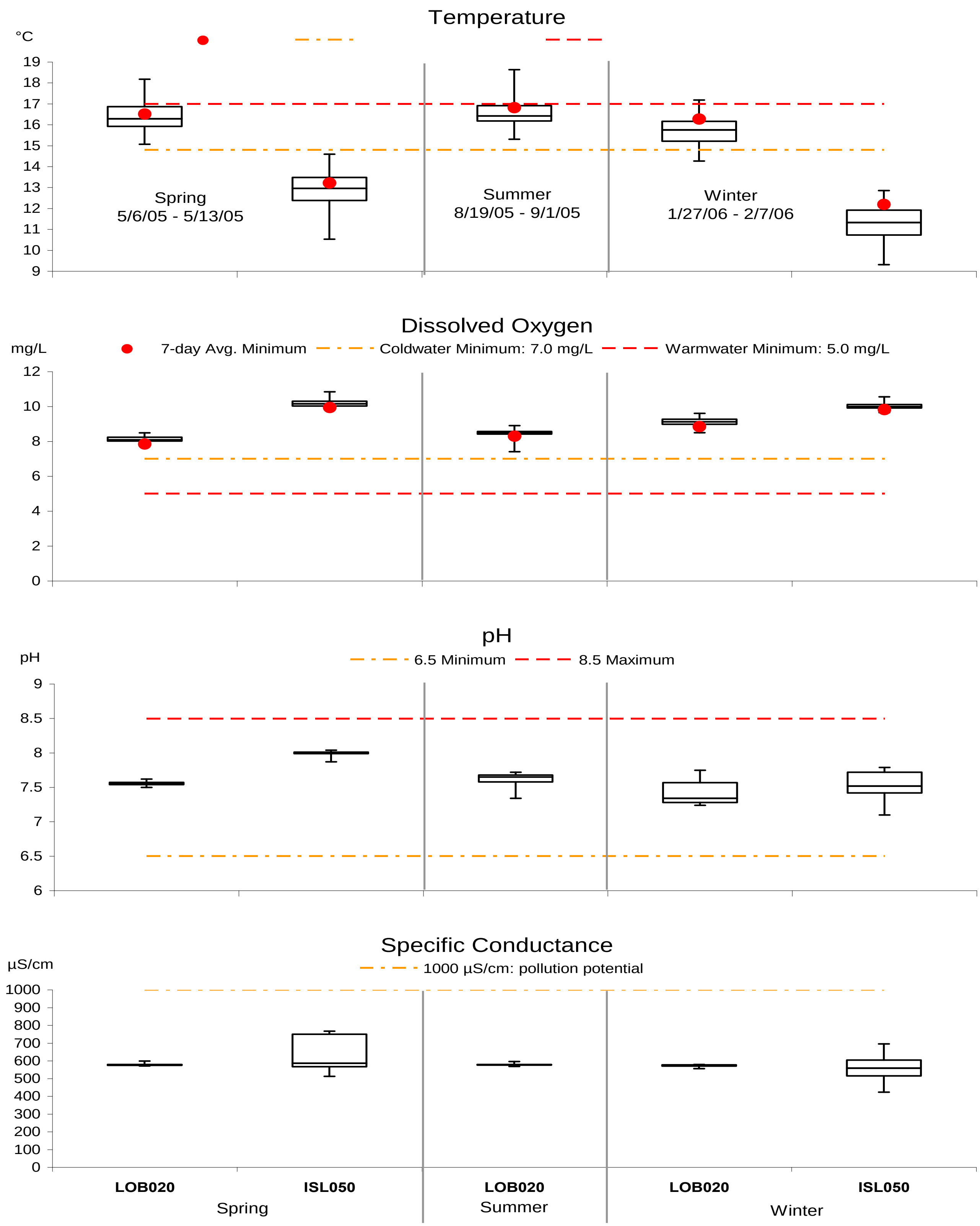


Figure 3.5-1: Continuous field monitoring summaries for San Francisco watersheds: Lobos and Islais Creeks

3.6 Regional summaries for all five watershed groups

3.6.1 Regional Trends in Benthic Macroinvertebrates (BMI) assemblages and Physical Habitat characteristics

Benthic macroinvertebrates were collected in a total of forty three sites, in a concentrated effort to sample all year 4 and year 5 watersheds during the spring of 2005. Physical habitat assessments were conducted in 41 of these sites. **Figure 3.6-1** shows a non-metric multidimensional scaling (NMS) ordination graph of years 4&5 sites, based on the taxonomic composition of benthic macroinvertebrate assemblages. The sites are color-coded by regions, i.e., by the watershed clusters monitored in year 4 and year 5. **Table 3.6.1** shows some of the physical habitat attributes associated with these sites.

An ordination graph consists of one, two, or three axes on which individual sites are plotted. The axes represent the most important gradients in the data set, representing the most variation in taxa presence between the sites. The proximity of sites to one another on the ordination graph is usually interpreted as an indication of their similarity. For example, sites close to one another would indicate that they tended to share similar taxa. Sites that are furthest away from one another on the graph indicate that they share very few or no taxa. Ordination and cluster analysis of benthic macroinvertebrate data from SWAMP sampling in previous years indicates that sites in urban areas generally have very similar invertebrate assemblages that are indicative of poor water quality conditions.

Among the sites sampled in years 4&5, sites located near the top of the Figure 3.6-1 ordination graph, including many sites in South-West Marin County as well a site on Sausal Creek (SAU130), appear to represent minimally disturbed conditions. There is considerable variation among these sites (shown by the large distances between sites on the NMS ordination) because many sites contained unique, rare benthic macroinvertebrate taxa with particular habitat requirements. Sites located near the bottom of the ordination graph, including many urban streams in the East Bay and San Francisco as well as the downstream site on Arroyo Mocho (AMO070), appear to represent the highly disturbed conditions that are characteristic of urban streams. Sites in the middle of the graph appear to represent a low or intermediate level of disturbance. Thus, Axis 2 (top to bottom) provides a better separation between clusters than Axis 1. In other words, Axis 2 accounted for a large amount of the taxonomic variation among sites (r^2 = 0.680), and appears to represent a meaningful gradient of disturbance and biological integrity. On the other hand, Axis 1 accounted for much less of the taxonomic variation (r^2 = 0.147), and its biological significance is less clear.

The values of the physical habitat variable '% fine sediment' were added to the NMS graph in figure 3.6-1 as a **biplot** which displays that variable as a **vector.** The vector, shown as a solid red line, emanates from the center (zero values on the ordination axes, shown as a "+" mark) and points towards the lower left corner of the graph, i.e., towards the negative values of Axis-2. This means that the percentage of fine sediment (<2 mm) was negatively correlated with Axis 2 of the NMS ordination, indicating that many of the urban sites with poor benthic macroinvertebrate assemblages also tended to have higher percentage of fine sediment.

Analysis of individual taxa revealed that a number of taxa were strongly positively correlated (r > 0.75) with Axis 2, indicating an association with minimally disturbed conditions. These taxa included the caddisfly *Rhyacophila* sp. (r = 0.829), the stonefly *Calineuria californica* (0.813), the caddisfly *Neophylax* sp. (0.792), and the elmid beetle *Optioservus* sp. (0.760). These four taxa, which are much more abundant at minimally disturbed sites and are infrequently collected at urban sites, are likely to serve as good indicators of excellent biological integrity. No taxa were strongly correlated with Axis 1.

Table 3.6-1 shows a selection of physical habitat attributes as assessed in years 4&5 sites. All sites were visited in April, the best-case scenario in terms of stream-flow, and indeed most streams had considerable flow (as related to their channel dimensions).

The first thing that becomes apparent in Table 3.6-1 is the huge variability in habitat conditions within the 41 sites. For example, average reach slope (which determines the overall flow energy, among other things) varied between 0.5 and 7.1 percent. The mean substrate particle size, which has a profound influence on BMI assemblages, ranged between 0.01mm (mud) and 119 mm (cobble) and was inversely correlated with the percentage of fine sediments (<2 mm). Fine sediments tend to be dominated by certain groups of BMI (e.g., chironomids) and are devoid of other groups that depend on gravel-based or cobble-based habitat niches. The combined human influence index tallies the observations recording structures (e.g., buildings or roads) and human activities (e.g., agriculture or vegetation management). This Index ranged between zero (i.e., no human influence) in the open-space sites and 3.77 in the highly-urbanized sites. The entire set of physical habitat endpoints is provided in Appendix Table B-4.

3.6.2 Continuous field measurements summary (regional trends)

The contrast between the East Bay creeks and the West Marin and San Francisco creeks is notable. Many of the East Bay creeks have had their riparian corridor highly modified and stripped of vegetation, especially in their lower reaches. Urban development often encroaches up to the stream bank. This fact alone is a major factor in the elevated water temperatures observed during the summer. All the urban creeks receive considerable amounts of storm water runoff during the wet season, as well as dry weather runoff during all seasons. The effects of these inputs may be seen, in part, by the elevated SC observed in the creeks of these watersheds as compared to West Marin creeks. Lack of riparian shade leading to elevated water temperatures and increased evaporation also tend to increase SC.

West Marin and San Francisco creeks are located in watersheds that throughout the year are subject to the cool marine climate along the coast. In the case of the West Marin Creeks, there is less urban influence, even in the lower reaches of the watersheds. Riparian cover is often extensive, providing shade to keep the creek cool in the summer months when the flows are reduced. The two San Francisco creeks have very small watersheds with minimal urban development influence. Islais Creek is channalized almost throughout its three mile length, only through Glen Canyon Park does the stream see daylight. This section is one of the last naturally occurring, unobstructed streambeds in San Francisco (Cutler 2006). Lobos Creek flows through the open areas of the south western Presidio and is the last free flowing creek in San Francisco (National Park Service, see reference)

3.6.3 Water Chemistry and toxicity highlights

Figure 3.6-2 shows concentrations of selected metals, in the dissolved form only, in water samples collected in the watersheds monitored during 2004-05. Urban and stormwater metals are shown in the first page (Figure 2.3-2a) and earth and other metals are shown on the second page. Dissolved arsenic was found at unusually high concentrations at Easkoot Creek. Dissolved chromium was elevated at Baxter Creek and Peralta Creek. Dissolved nickel was elevated in Baxter Creek and Peralta Creek, as well as in Temescal and Pine Gulch Creeks. There is no visible seasonality in dissolved metals concentrations.

Figure 3.6-3 shows concentrations of selected organic compounds in water samples collected in the years 4&5 watersheds. Most organic compounds were not detected in water, or detected sporadically and at low concentrations. Diazinon concentrations, where detected, were lower than the historically prominent concentrations found in the Bay Area in the 1990s. Two of the samples shown are believed to represent storm runoff (AVJ020-W and AMO070-W) based on high suspended solids and field observations records (Appendix Table D-3d). Some PAH compounds were present in these samples at concentrations that are considered low for storm runoff.

Figure 3.6-4 shows concentrations of selected salt indicators (specific conductance and hardness) as well as sulfate concentrations in all water samples collected in the years 4&5 watersheds. West Marin creeks are visibly less salty than the urban creeks monitored in the East Bay and in San Francisco. The conductivity in East Bay creeks is quite variable, and dramatic changes were observed in different seasons at the same site. As expected, salinity indicators were extremely low in the two samples that are believed to represent storm runoff (AVJ020-W and AMO070-W). The elevated concentrations of sulfate in Temescal Creek above Lake Temescal may be explained either by local geologic characteristics or by the presence of a land-use activity that may contribute sulfate locally; this can be easily determined by targeted reconnaissance and sampling but not through our current data.

Toxicity was observed in very few samples in years 4&5, and most of the toxic effects were chronic (rather than acute) when present.

3.6.4 Sediment quality

Figure 3.6-5 shows concentrations of selected metals in sediment samples collected in the watersheds monitored during 2004-05. Arsenic was found at unusually high concentrations at Easkoot Creek sediments (as in water).

Figure 3.6-6 shows concentrations of selected organic compounds in sediment samples collected in the watersheds monitored during 2004-05. Urban creeks had detectable concentrations of legacy organochlorine pesticides; these were not found in open space sites. PAHs were ubiquitous in sediments, with naphthalenee and phenanthrene/anthracenes appearing at the highest number of sites. Codornices Creek in the East Bay had numerous organic compounds at detectable concentrations.

3.6.5 Coliform counts summary

Figure 3.6-7 shows total coliform and *E. coli* summary statistics and exceedances in the summer of 2004 (East Bay) and the summer of 2005 (West Marin and San Francisco).

Water was sampled for coliform bacteria at selected stations, following the U.S.EPA protocol for five equally-spaced samplings within 30 days. This extended sampling regime accommodates the highly variable nature of bacterial contamination by using results from five well-spaced events to calculate a logarithmic mean, also called a geometric mean or geomean. Results are reported for individual samples in Appendix E, Table E-1. That Table also shows the geomeans for *E. coli* (which were calculated from the five sampling events), and the 5-sample medians for total coliforms.

Although the samples were diluted prior to conducting the bacterial counts to extend the method’s range, several samples still had counts beyond the modified method’s range. The total coliform counts from six (of 17) stations could not be used to generate a median. As for *E.coli*, only one Station had one sample with counts above the method’s range, and the geomean calculated for that Station is the minimum possible representations of the actual populations. The scales in Figure 3.6-7 are logarithmic to accommodate the variation in values typical for bacterial growth. Individual results are represented by an “x” and are connected with a vertical line to emphasize the range.

Water quality benchmarks for total coliform and *E. coli* were used to evaluate impacts at each of the Station for which we have data. For recreational waters, U.S.EPA recommends *E. coli* as the best indicator of waterborne pathogens. The geomean of nine stations (of the 17 tested) exceeded the benchmark of 126 MPN/100 mL, and the maximum per individual sample (235 MPN/100mL) was exceeded in 6 stations. Water samples were also analyzed for total coliform bacteria. Although total coliforms are no longer a recommended indicator, comparison to the benchmarks for total coliform are also shown in Figure 3.6-7. The median at all 11 stations with data exceeded the 240 MPN/100mL benchmark, and 4 of these stations exceeded the single sample limit of 10,000 MPN/100mL.

Table 3.6-1: Selected physical habitat attributes of years 4 and 5 bioassessment Stations

Stn#	Station	Date	Average slope (%)	Average width of wetted channel (m)	Average water depth (cm)	flow discharge at sampling time (cfs)	Percent Substrate <2 mm (%)	Geometric mean substrate diameter, Dgm (mm)	Natural shelter cover (%)	Riparian canopy presence (proportion of reach)	Combined Human Disturbance Index, all types	Land use setting
1.1	BAX030	4/11/2005	1.7	1.9	14.4	0.38	42	4	24	0.95	3.42	Urban
1.3	BAX050	4/19/2005	0.5 (Est)	1.7	16.1	<0.1	98	0.01	54	0.27	2.73	Urban
2.1	CER020	4/11/2005	2.7	2.5	10.1	0.95	30	4	5	0.82	3.15	Urban
3.1	COD020	4/11/2005	1.3	2.1	17.4	1.08	52	1	9	0.27	2.79	Urban
3.2	COD080	4/12/2005	3.5	2.3	17.0	0.81	17	22	34	0.86	3.08	Urban
3.3	COD120	4/13/2005	4.1	2.5	11.6	0.57	4	119	28	0.91	1.83	Urban
4.1	STW010	4/12/2005	2.9	2.6	13.7	1.21	28	8	21	0.64	2.30	Urban
4.2	STW030	4/13/2005	2.5	2.7	11.7	0.84	18	14	19	1.00	3.77	Urban
5.2	TEM060	4/19/2005	1.7	2.8	19.1	2.1	29	2	15	1.00	2.85	Urban
5.3	TEM090	4/12/2005	3.3	2.0	18.2	0.95	28	15	31	0.82	2.96	Urban
6.1	LME100	4/13/2005	1.6	2.7	15.4	0.95	12	15	22	0.91	3.71	Urban
7.1	SAU030	4/14/2005	1.5	4.3	18.9	2.4	12	11	9	0.68	2.78	Urban
7.4	SAU080	4/14/2005	3.0	3.3	12.5	1.73	7	81	33	0.91	1.14	Urban
7.5	SAU130	4/14/2005	7.1	1.3	8.0	0.49	14	19	33	0.73	0.23	
8.1	PRL020	4/13/2005	1.3	2.4	11.0	0.65	8	11	6	0.45	3.19	Urban
8.2	PRL080	4/13/2005	6.6	1.8	9.9	0.38	7	28	24	1.00	1.31	Urban
9.3	LIO080	4/13/2005	4.2	2.8	21.8	1.31	14	12	42	1.00	2.73	Urban
9.5	LIO130	4/13/2005	4.9	2.8	13.4	0.59	10	25	29	1.00	0.52	
10.1	AVJ020	4/15/2005	1.2	3.3	16.4	2.0	14	11	10	0.95	3.75	Urban
10.2	AVJ090	4/15/2005	2.9	1.6	7.7	0.21	7	47	20	1.00	0.69	
10.3	AVJ110	4/15/2005	4.6	1.5	6.7	0.32	8	45	33	1.00	0.50	
10.4	AVJ130	4/12/2005	2.0	2.4	14.7	0.36	24	5	16	0.95	1.96	Urban
11.1	AMO070	4/12/2005	1.4	6.0	27.5	5.9	43	2	10	1.00	1.22	Urban
11.5	AMO100	4/12/2005	2.2	4.1	21.7	4.6	13	10	24	0.68	1.48	Urban
11.6	AMO160	4/12/2005	2.9	4.6	16.7	3.9	8	24	21	0.45	0.99	
11.7	AMO180	4/11/2005	1.7	4.6	22.1	3.9	12	42	54	0.50	0.69	
11.8	AMO200	4/11/2005	3.5	3.1	17.4	0.77	14	29	41	0.91	1.11	Urban
12.1	AUD020	4/12/2005	6.5	1.5	9.9	0.60	23	23	24	0.82	0.00	Open space
13.1	MRS020	4/12/2005	2.6	1.8	10.0	1.10	25	15	49	0.95	0.00	Open space
14.1	PNG010	4/11/2005	1.0	4.8	29.6	26.8	40	3	24	0.86	0.61	
14.2	PNG050	4/12/2005	1.2	4.4	19.5	9.4	33	6	27	1.00	0.00	Open space
15.1	EAS020	4/13/2005	1.5	2.2	12.8	2.0	31	9	31	0.36	0.74	
15.2	EAS050	4/13/2005	6.4	1.5	10.3	1.09	12	47	50	1.00	0.09	Open space
16.1	WBB010	4/13/2005	4.2	2.3	16.7	2.0	18	39	53	1.00	0.03	Open space
17.2	RDW040	4/15/2005	1.2	1.8	25.4	1.06	70	2	51	0.23	0.24	
17.3	RDW060	4/14/2005	1.1	6.4	32.0	20.9	47	4	22	0.77	0.58	
17.4	RDW100	4/14/2005	1.2	4.5	26.0	3.7	21	16	40	0.95	0.00	Open space
17.5	RDW120	4/14/2008	1.3	4.1	20.1	9.4	18	27	26	1.00	0.00	Open space
18.1	TVY030	4/15/2005	1.4	1.8	27.7	1.21	67	2	30	0.09	0.00	Open space
20.1	LOB020	4/20/2005	1.9	2.7	16.1	0.88	86	0.19	40	0.86	1.42	Urban
21.1	ISL050	4/20/2005	2.8	1.0	6.4	0.21	55	0.30	38	0.86	1.67	Urban

Notes

Slope was averaged for the reach from 3 to 11 slope-segment measurements, and width was averaged from 11 transects and 10 inter-transects,
Average depth was calculated from all non-zero values measured at transect-points and inter-transect points
Geometric mean substrate diameter (Dgm) was calculated for all particulate substrate fractions plus bedrock and hardpan, per Kaufmann 2008 (personal communication)
Natural shelter cover, riparian canopy presence, and the combined human disturbance index were calculated per Kaufmann *et al* 1999.
Natural shelter cover is the sum of the following elements: large wood, brush, overhang, boulders, and undercut.

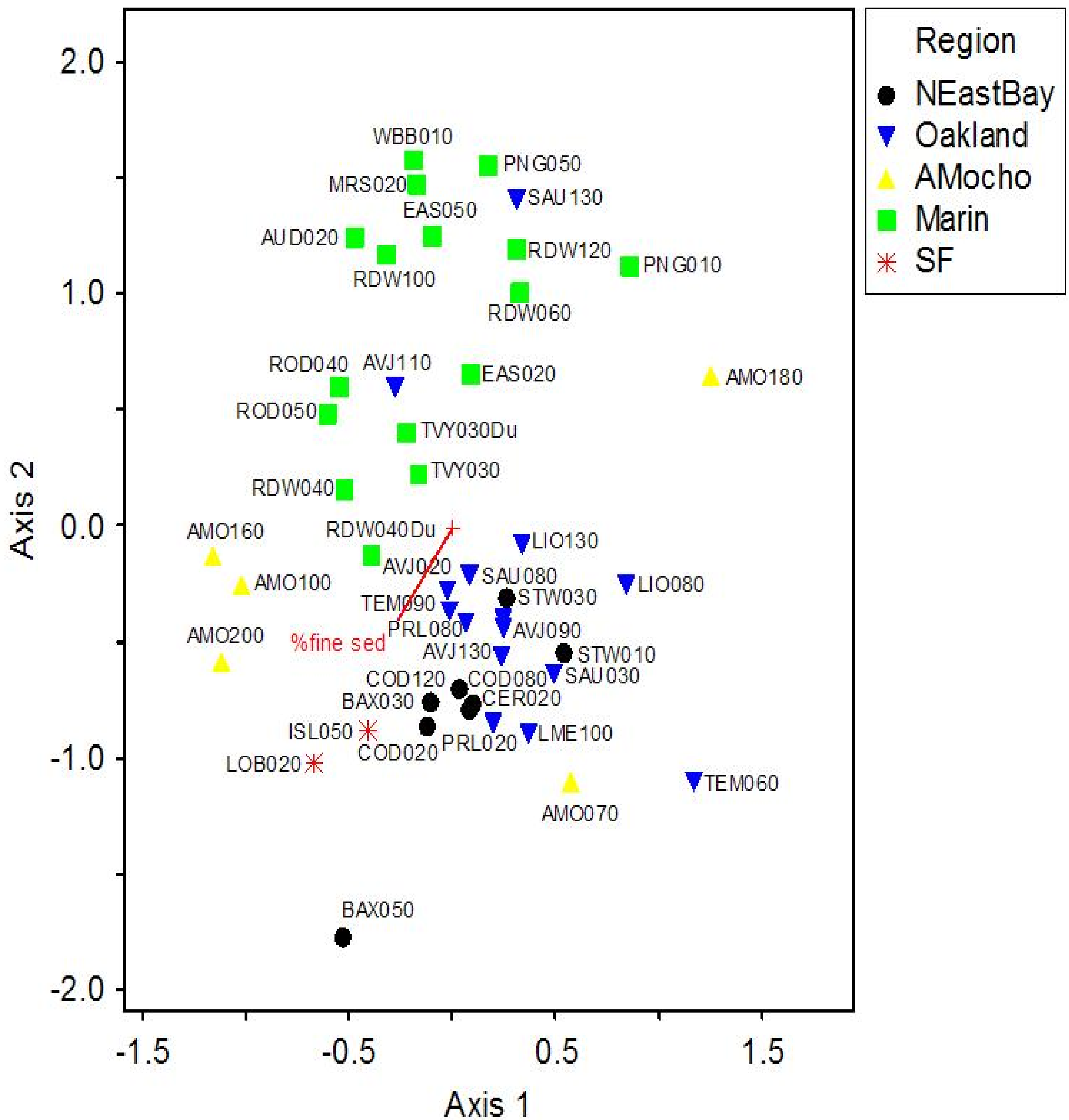


Figure 3.6-1: An NMS ordination plot of taxa presence at sites sampled in 2005

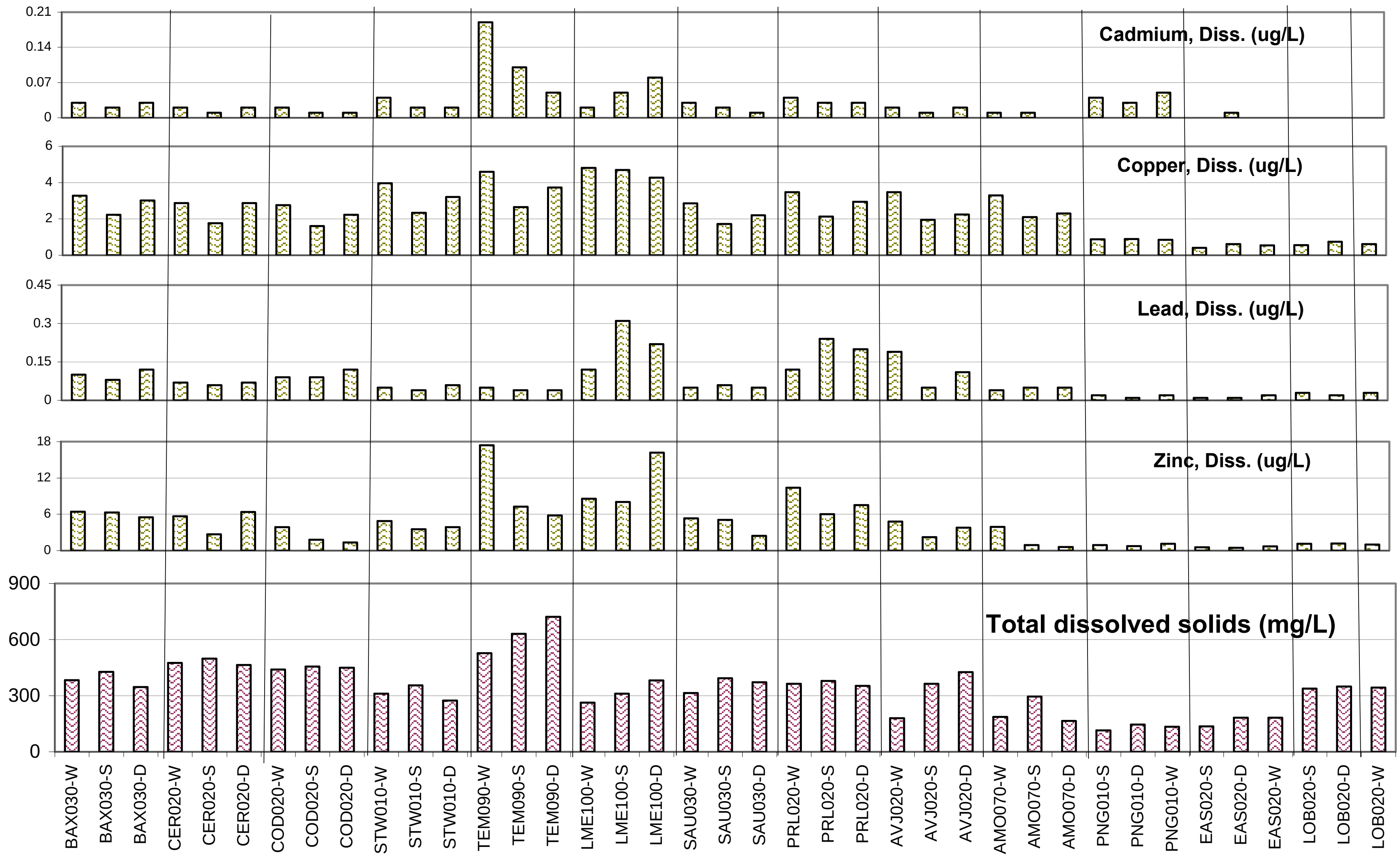


Figure 3.6-2a: Concentrations of selected metals in water samples collected in years 4&5 watersheds: Urban and stormwater DISSOLVED metals

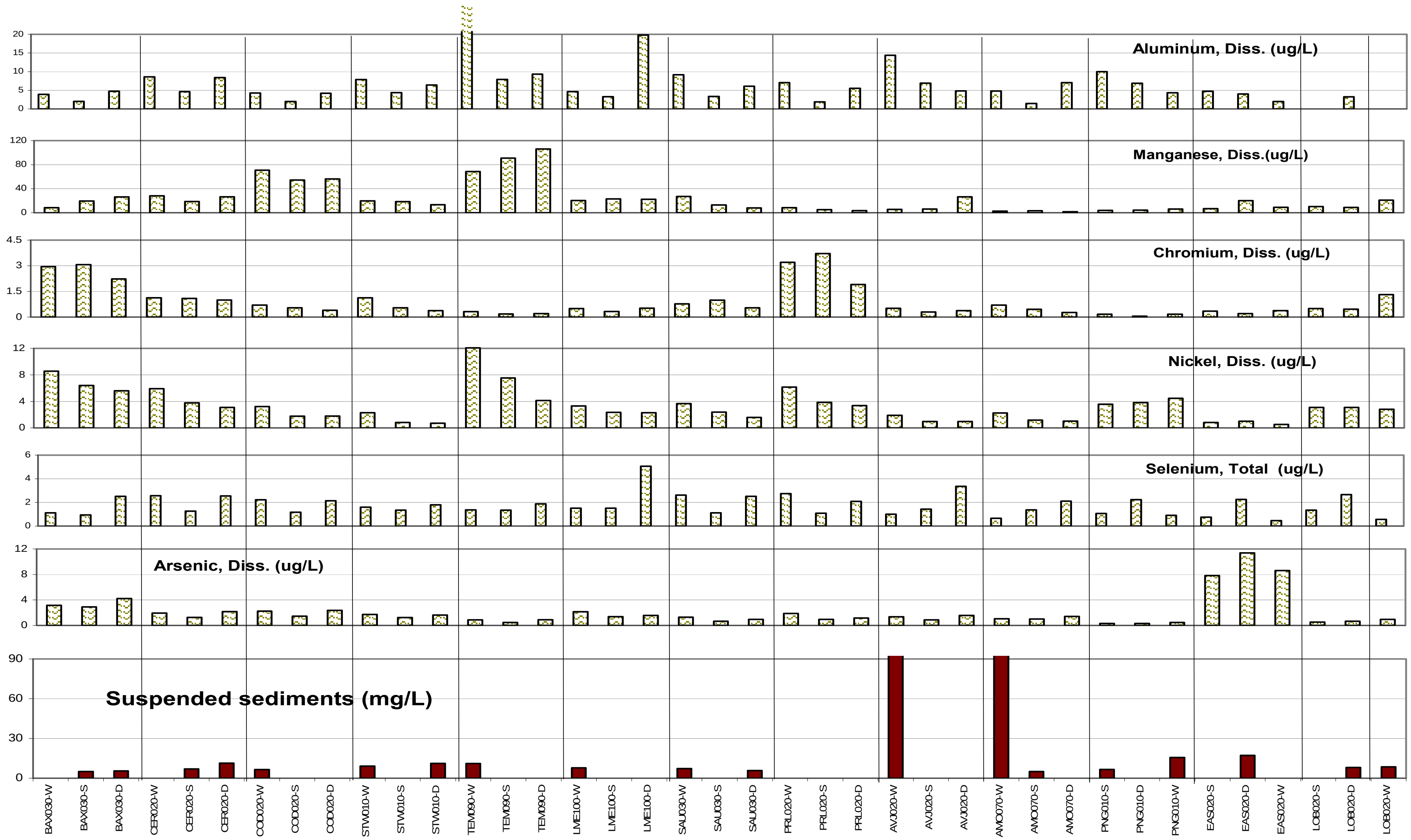


Figure 3.6-2b: Concentrations of selected metals in water samples collected in years 4&5 watersheds: Earth and other metals

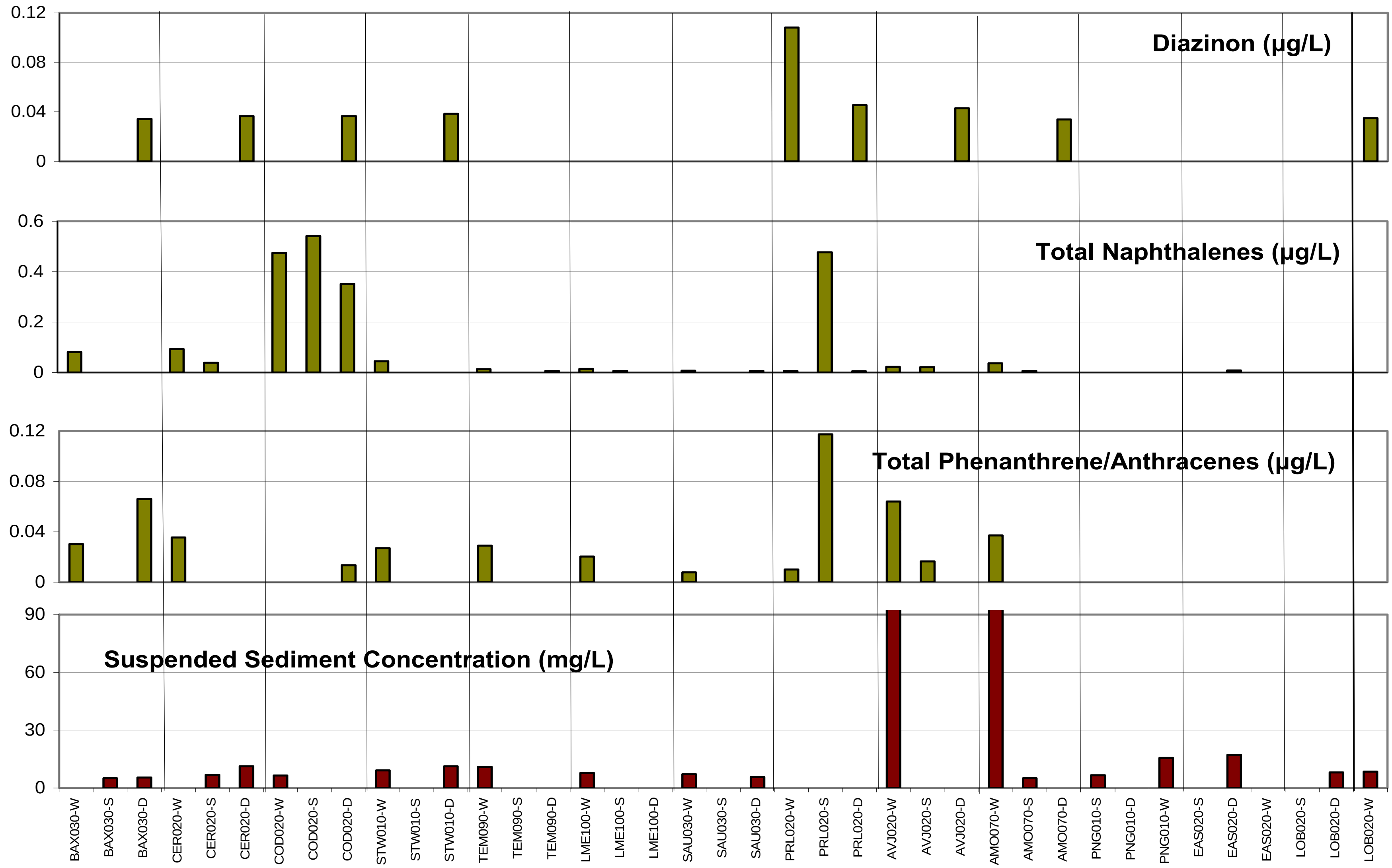


Figure 3.6-3: Concentrations of selected organic compounds in water samples collected in years 4&5.

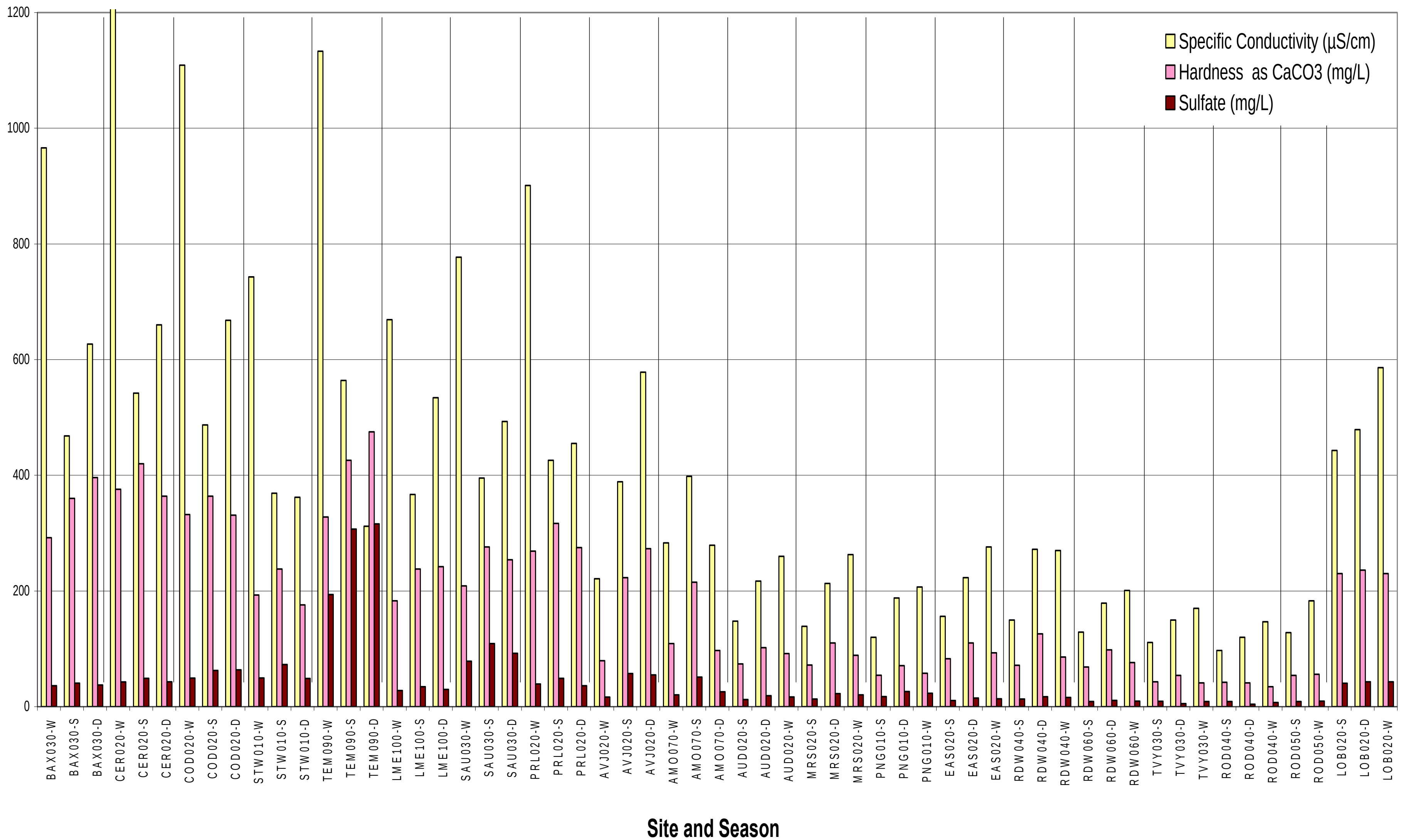


Figure 3.6-4 Salt concentrations and related characteristics in years 4&5 samples

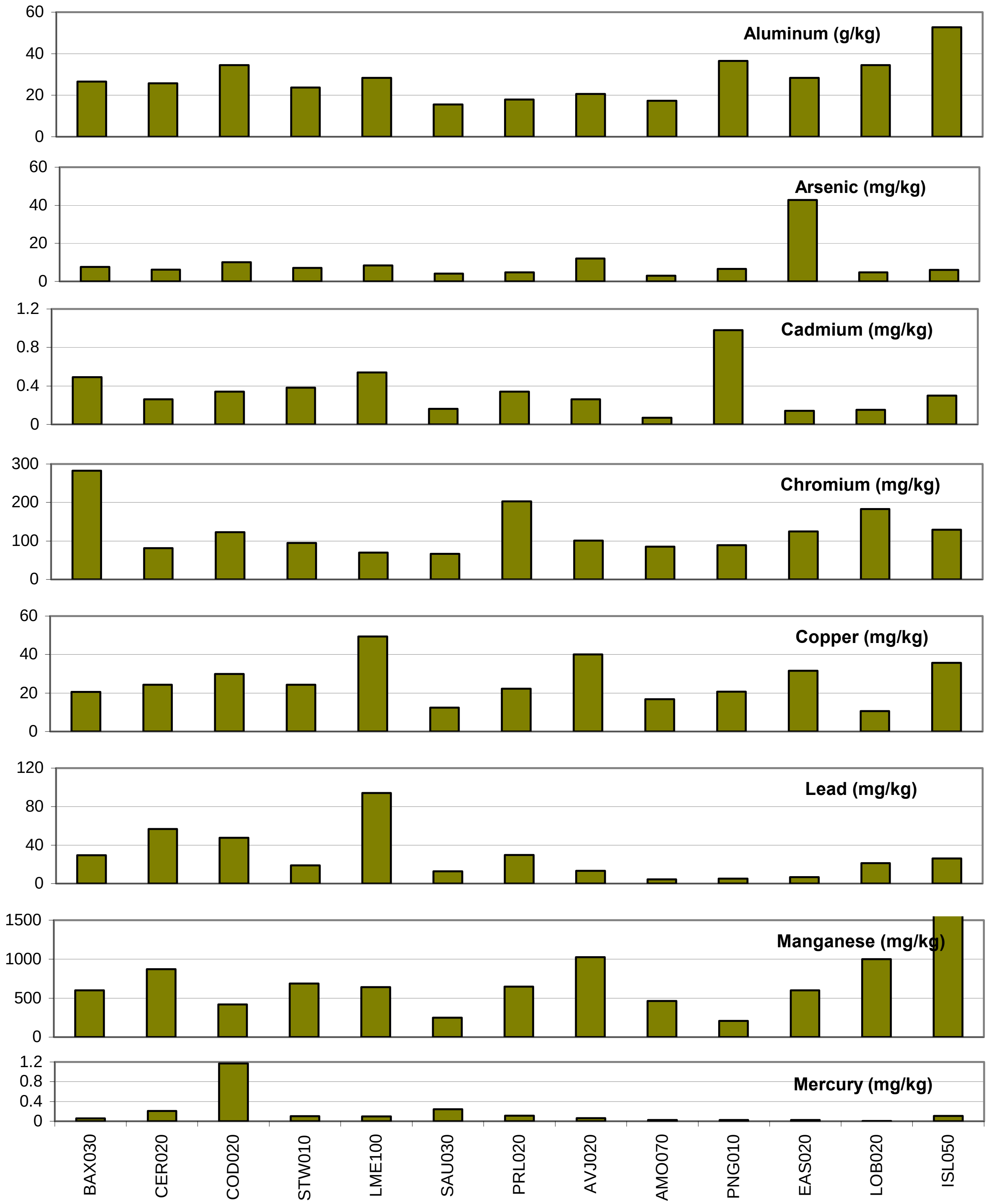


Figure 3.6-5: Concentrations of selected metals in Sediment samples collected in years 4&5

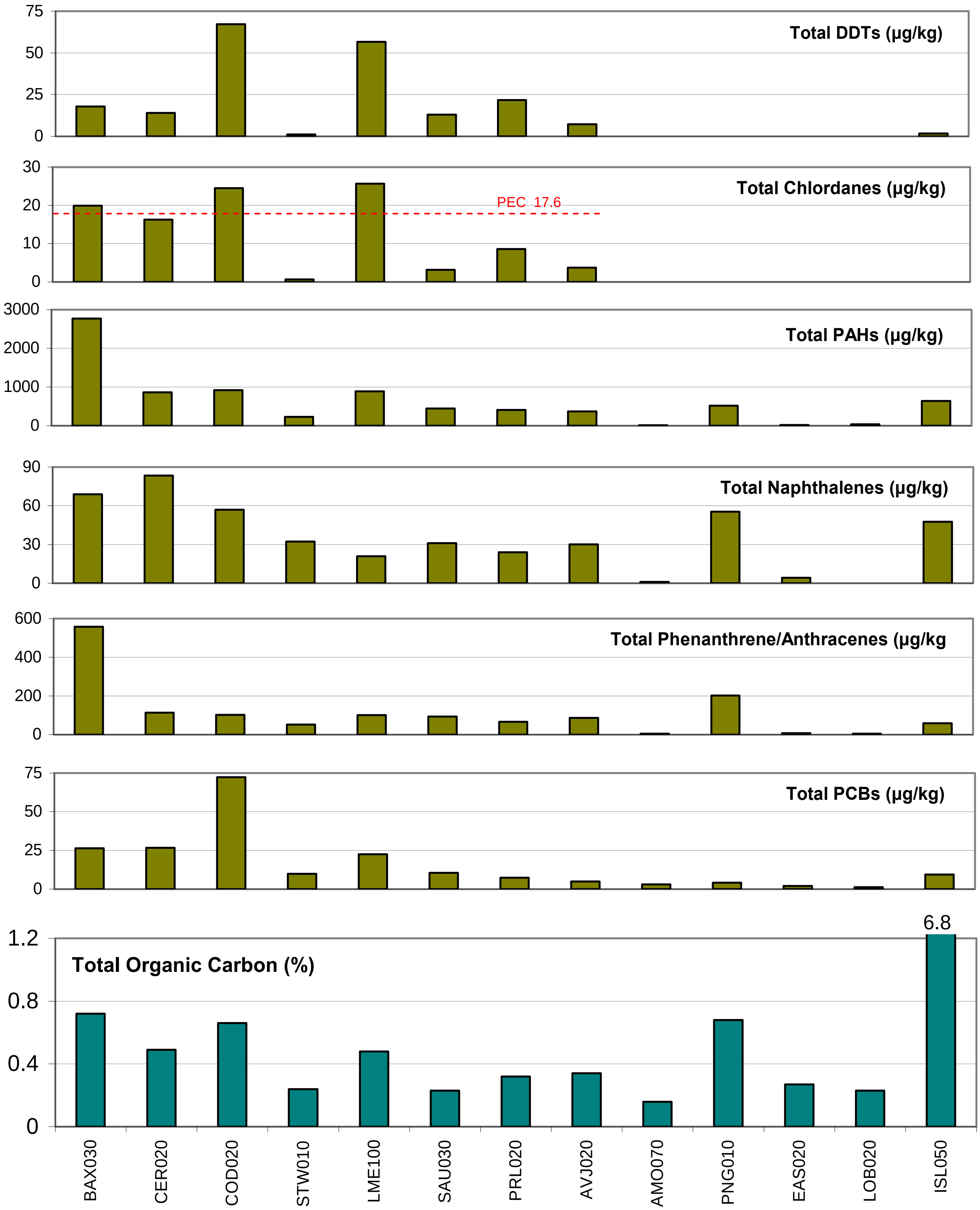
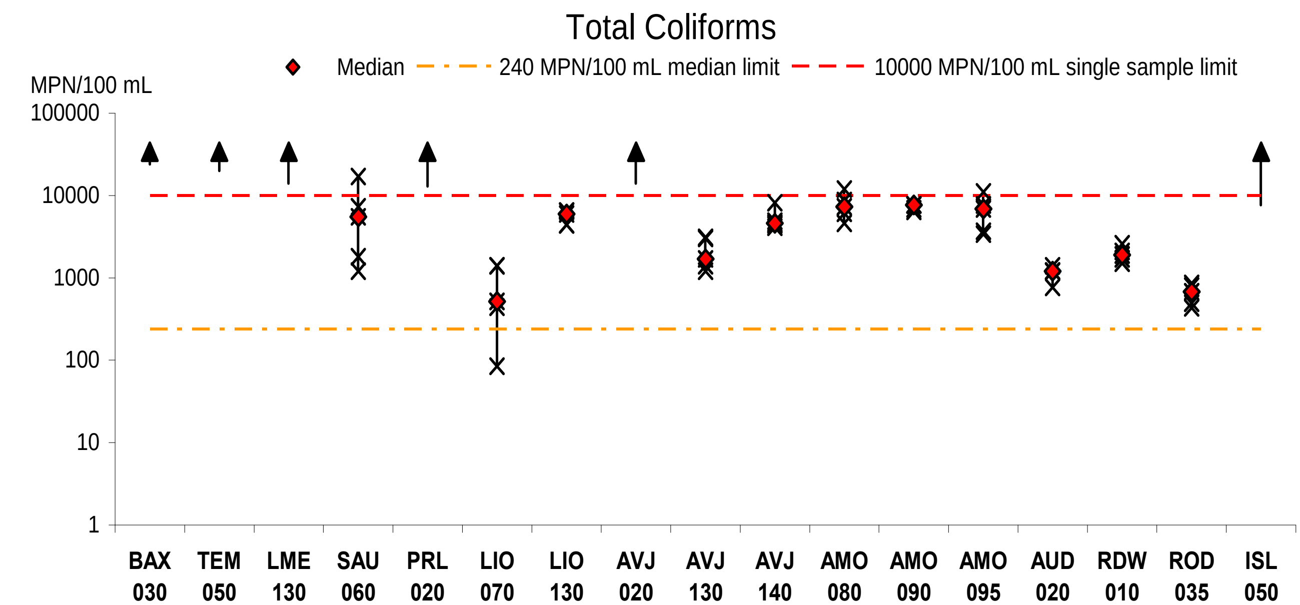
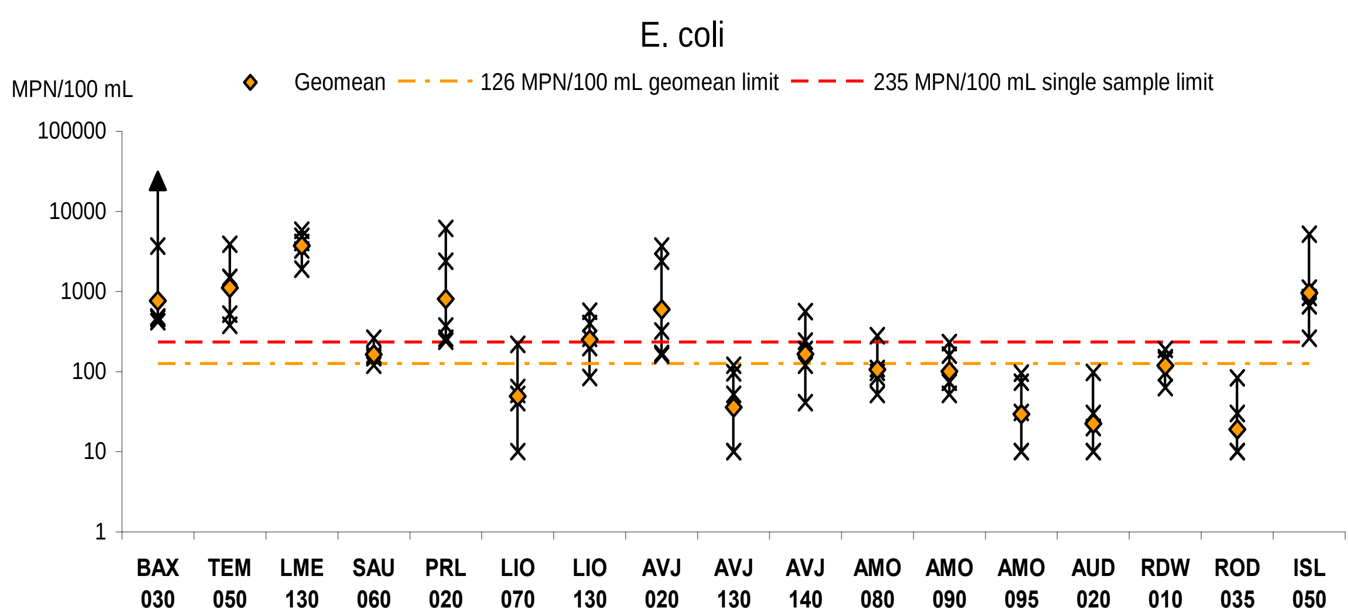


Figure 3.6-6: Concentrations of selected organic compounds in sediment samples collected in years 4&5.





Sites were sampled once weekly for five consecutive weeks; those with arrows at the top had one or more sample counts that exceeded the method reporting limit, so real medians and maximums could not be determined. All these stations exceeded limits. The geomean for E. coli for BAX030 was calculated without the sample count that exceeded the method reporting limit.

Figure 3.6-7: Total coliform and E. coli summary statistics and exceedances in 2004-2005

(blank)

4 Discussion

4.1 Methodology, comparisons to quality benchmarks, and data interpretation

4.1.1 Sampling design and protocol issues

Selection of watersheds and sampling sites

Years 4&5 sites were chosen carefully to provide a good representation of the watersheds selected for monitoring and to maximize the information attainable with the existing resources. In contrast to previous years' monitoring, many of the watersheds monitored in years 4&5 were very small, and a decision was made to include several of these short creeks in the plan while monitoring 1-4 sites on each. This design, although useful for getting information about multiple watersheds, precluded the option of making comparisons between sites in the same watershed when only one was sampled for a given set of analytes. However, several large watersheds were also monitored where multiple sites were selected for sampling.

The categorization of years 4&5 watersheds into "short creeks" and "large watersheds" enables some comparisons of selected features and characteristics that reveal the effects of urbanization. For example, the short Marin Creeks (Audubon, Webb, etc.), although different in geology and micro-climate, can serve as reference sites to the highly-urbanized short creeks in the north East Bay with respect to sediment chemistry and physical habitat. Within the larger watersheds, comparisons between the headwaters (usually in open space or sparsely urbanized areas) and the downstream section of the watershed (usually heavily urbanized) can also reveal the effects of urbanization.

PHAB in support of BMI

Years 4&5 data include the first set of quantitative physical habitat assessment data conducted in parallel with the benthic macroinvertebrates (BMI) sampling effort. In many situations, the information gleaned from the PHAB assessments can explain the BMI assemblage results. For example, habitat conditions such as substrate size can be correlated to certain assemblages that are typical of these conditions. Fine sediment (<2 mm) was negatively correlated with Axis 2 of the NMS ordination (Figure 3.6-1), indicating that urban sites with poor benthic macroinvertebrate assemblages also tended to have higher levels of fine sediment. It is anticipated that the utility of years 4&5 PHAB data will increase further when combined with the growing quantitative PHAB dataset collected for this Region.

Rain runoff versus base flows

The profound difference between base flows (dry weather) and storm runoff flows (wet weather) water quality has been established in numerous studies in the San Francisco Bay region and in many other semi-arid Ecoregions (e.g., WCC 1996). SWAMP activities are, by definition, directed to ambient conditions, i.e., base flows. Two of the water samples collected in 2004-05 had exceptionally high concentrations of suspended solids (Figure 3.5-2). Total metals were probably high in these samples, although this was not tested. These samples were collected in the East Bay at Arroyo Mocho and Arroyo Viejo on a rainy day in the winter, probably after the runoff had reached the sampling stations. SWAMP ambient monitoring protocols call for sampling during dry weather only, but field crews are instructed to collect the water sample, even when they encounter rain runoff, if the rain has started after the sampling trip has begun. It was noted that these samples represent different conditions.

4.1.2 Comparisons to Quality Benchmarks

Although SWAMP is not a regulatory program per se, it strives to collect data that can be used to evaluate the conditions in the State's watersheds via comparisons to water quality benchmarks such as water quality objectives (that have regulatory significance) and water quality criteria (that are used as guidelines but do not necessary lead to regulatory action). Comparison of years 4&5 data to these water quality benchmarks was an integral part of data interpretation and all exceedances were recorded (see sub-sections 3.1.6, 3.2.6, 3.3.6, etc. above). These exceedences were also evaluated as part of the state's 2008 303d impaired waterbodies listing process.

Years 4&5 samples often exceeded U.S.EPA's water quality criteria for nitrate and total phosphorous (Appendix Table D-3a). These nutrient criteria are based on U.S.EPA's reference guidelines for aggregated Ecoregion III, Ecoregion 6 (South and Central California chaparral and oak woodland) streams (U.S.EPA 200b). These guidelines were derived from the 25th percentile value of stream monitoring data collected from 1990 through 1999. Although these criteria were developed to protect waters from eutrophication, they are not effect-based. Thus, these guidelines may not be appropriate for indicating an impact in the San Francisco Bay Region. SWAMP is currently monitoring reference creeks for nutrients, algal biomass, flow and continuous monitoring of temperature and dissolved oxygen to assist in developing effects-based thresholds that are appropriate for this region.

Water quality benchmarks for temperature and dissolved oxygen were also often exceeded, particularly during summer at low flow. The temperature benchmarks that were exceeded were developed to protect salmonids, at a different Ecoregion, and do not apply to other, particularly warm water, forms of aquatic life. They are not regulatory benchmarks. The exceedances do, however, indicate stressful conditions for salmonids and, in general, for aquatic life, when coupled with the low concentrations of dissolved oxygen that were frequently observed. Such stressful conditions are common in watersheds with creeks that have intermittent flow and run dry in the summer.

4.1.3 Data interpretation

Intermittent vs perennial:

The flow regime, often categorized as either Intermittent or Perennial, can vary between watershed segments or even between sites. Isolated pools could manifest a 'borderline' condition between perennial and intermittent flow, or a transition between wet and dry in intermittent sites. Isolated pools were encountered in three sites during the 2004 continuous field monitoring study: AMO160 in August, SAU080 in September, and COD020 in September. The resulting data sets are characterized by elevated specific conductance and low dissolved oxygen. These water quality conditions are expected in drying intermittent sites, but may be interpreted as impaired for perennial sites.

It takes many site-visits during dry season to determine which category (Intermittent or Perennial), applies to a site, and it is also hard to generalize due to several factors:

a. Variability among different rain-years.

b. Dry-weather discharges contributing freshwater inputs during summer. This is often evident from reduction in specific conductance if the ground-water is saltier than the local tap water.

c. Difficulty in defining 'dry': sometimes sub-surface flows are sufficient to sustain BMI and other aquatic life through the summer. For example: Notable taxa at AMO180 included cold-water, sensitive taxa such as the water penny *Psephenus* sp., the stonefly *Calineuria californica*, the free-living caddisfly *Rhyacophila* sp., and the heptageniid mayfly *Nixe* sp. The presence of these taxa suggests that water could be present year-round at this site, perhaps only in the **hyporheos** (subsurface flow), although taxa common in intermittent streams, such as Corydalidae, were also present.

d. Contradiction between theoretical considerations and factual findings (i.e., when benthic organisms disprove what we think). Example: Sites MRS020 and EAS050 were hypothesized to have intermittent streamflow prior to sampling. Both sites had good flow in April and MRS020 had good flow in June (EAS050 was not sampled in June). Based on the presence of many taxa that require perennial flow, and their similarity to assemblages from nearby perennial streams, these streams may in fact be perennial. Thus, we can use evidence from presence of certain BMI taxa to infer intermittence: truly intermittent sites will be less supportive of taxa that are typical of perennial flow regime, and will be dominated by taxa that are often found in intermittent sites.

Taxa tolerance and pollution indicators

The use of indicator taxa has been honed over the years, and the presence or absence of some taxa can be a very good predictor for certain conditions. Example: four taxa (the caddisfly *Rhyacophila* sp., the stonefly *Calineuria californica*, the caddisfly *Neophylax* sp., and the elmid beetle *Optioservus* sp.) were strongly associated with minimally disturbed conditions, and they are likely to serve as good indicators of excellent biological integrity.

However these assumptions need to be revisited from time to time, for several reasons. One is the constant evolution of BMI population and the changes in their ability to cope with adversity. Another is the constant change in our understanding. Example: although *Malenka* has been given a low tolerance value of 2, its presence in many urban, degraded streams in the Bay Area suggests that this taxon is actually fairly tolerant of pollution and poor habitat conditions, and should not necessarily be considered an indicator of pollution sensitivity. A third reason for re-visiting our assumptions is that taxa assemblages in reference sites may also change over time, e.g., as a result of climate change, so our perception of 'excellent' may change.

4.2 Regional perspective

Results from year 4&5 monitoring reinforce the insights gained in previous years that the major factors affecting biological integrity in the San Francisco Bay Region are urbanization and flow regime. Whereas urbanization causes overwhelming changes in benthic assemblages (mostly through habitat degradation and pollution), the differential effects of flow regime (perennial vs. intermittent) on invertebrates are obvious only in relatively undisturbed watersheds.

Benthic macroinvertebrates in urban streams experience a quadruple-threat of potential impacts:

(1) impervious surfaces can cause rapid streamflow response during winter storms that can mobilize the stream bed and dislodge invertebrates and other biota;
(2) toxic pollutants in stormwater or dry season discharges, such as pesticides, detergents, or metals can cause sudden mortality;
(3) modified physical habitat caused by culverts or channelization can introduce barriers to organism dispersal, and removal of riparian vegetation can result in high temperatures and low dissolved oxygen levels, and
(4) the long, dry summers characteristic of our Mediterranean climate, coupled with streamflow diversions and groundwater pumping, can reduce streamflow to a trickle or cause the stream to dry out completely.

Together, these impacts result in dramatically poor benthic invertebrate assemblages in urban streams. This is often manifested by low taxonomic richness (<14 taxa), by the absence of sensitive EPT taxa, and by domination of tolerant COBS (Chironomidae, Oligochaeta, *Baetis sp.*, and Simuliidae) taxa, which usually make up >90% of all organisms in urban sites.

Contaminants such as heavy metals and toxic organic compounds may be an important issue during stormwater runoff events, but the data presented in this report do not indicate that they are that important during non-storm conditions. Of the contaminants tested, there were very few water quality benchmark exceedances, even in the urban creeks of the East Bay and San Francisco. In addition, the toxicity tests used in this study indicated that samples from these urban sites had very little toxicity, both in water and in sediments. With the caveat that this study may have missed episodes of contaminant discharge during non-storm flows, it appears that the main problems in these creeks are low water flows, high levels of nutrients, high temperatures, low dissolved oxygen, and disturbed physical habitat.

4.2.1 Flow regime

As in previous years, there were significant differences in invertebrate assemblages between streams that flow year-round and streams that go dry during the summer. Among minimally disturbed sites, intermittent streams had fewer taxa present, especially beetles and caddisflies, compared to perennial streams. One site, ROD050, was dry during the June sampling event. The lowered richness at this site may be a result of flow intermittency.

4.2.2 Physical habitat considerations

Substrate Effects

Benthic macroinvertebrate assemblages are highly influenced by substrate. Fine sediment is usually preferred by burrowing organisms, such as oligochaete worms and snails, while gravel is required by many of the sensitive EPT taxa. The streambed at the upstream site on Baxter Creek, BAX050, was nearly completely covered (98%) with fine sediment (<2 mm), with very little gravel present (2%, Appendix Table B-3). Similarly, TVY030 and RDW040 had streambeds with no cobble and high amounts of fine sediment (67% and 70%, respectively). Thus, a lack of interstitial spaces in the stream bottom could be responsible for the lowered diversity.

Slope

Low slope tends to result in deposition of fine grain sediment, especially in watersheds susceptible to erosion. The (estimated) low slope of the stream at BAX050 results in extensive deposition of fine sediment and low or negligible water velocities at base flow, ideal conditions for snails and other non-insects more commonly found in lentic (still-water) habitats.

Human Influence

The human influence assessment, a part of the PHAB protocol, consists of systematic observations and recording of buildings, roads, trash, agriculture, and other human activities seen from the streambed in and on both sides of the channel. The records are then tallied in a proximity-weighed process for each type of influence, and these indices are added up to generate the combined human influence index. As would be expected, the combined human influence index is much higher in urban creeks.

4.3 Local watershed issues

4.3.1 East Bay watersheds: short creeks, urbanization, human influence and degraded biological integrity.

The biological integrity in the short creeks monitored in the north East Bay was highly degraded. The causes seem obvious based on the degraded physical habitat conditions. However, habitat conditions in the Oakland watersheds (as measured by the PHAB protocol) can not be used to explain the degraded biological integrity indicated by the benthic macroinvertebrate assemblages at these sites. Most sites had suitable mixtures of substrate and flow habitats, and less than half of the sites had fair or poor (<10) channel alteration and epifaunal substrate scores. Since water quality (chemistry and toxicity) was measured during three seasons, it seems that intermittent or storm related water quality conditions, habitat measures not assessed by the PHAB protocol, or periodic physical disturbances may be responsible for the degraded benthic macroinvertebrate assemblages observed at most sites in the Oakland watersheds. However, sediment pollution, as inferred from sediment chemistry data, may be an important factor contributing to this degradation. Pyrethroid pesticides were detected in Codornices and Glen Echo Creeks, and elevated concentrations (35 ug/kg total pyrethroids) were found in Peralta Creek sediments. The presence of pyrethroids in sediments has been documented for many urban creeks in the last few years (e.g., Amweg et al 2006).

4.3.2 Southwest Marin watersheds:

Most watersheds monitored in southwest Marin County were in good condition, as gleaned from multiple indicators. Contaminant levels in the sediments were relatively low, BMI assemblages were healthy, and the physical habitats were not disturbed. Moreover, temperatures and dissolved oxygen were in ranges that support aquatic life and cold water fisheries almost all the time. These watersheds have precipitation patterns and marine influence that set them apart from the other watershed monitored in years 4&5. As far as sediment chemistry is concerned, the southwest Marin sites may represent the 'background' Bay Area conditions before urbanization. If the geological sources of metals are similar, the concentrations of metals and other constituents in southwest Marin waterways may serve as reference to urbanized watersheds. Like many other parts of the Bay Area, high concentrations of nickel and chromium were prevalent in southwest Marin, probably originating from natural serpentine soils.

5 Conclusions and Recommendations

5.1 BMI indicate poor conditions in urban creeks

Benthic macroinvertebrate (BMI) assemblages at sites influenced by urban areas are generally in very poor condition. This was clearly visible when the assemblages found in East Bay urban creeks were compared to the assemblages found in the open-space Marin creeks. Marin creeks had higher values of taxa richness and supported many sensitive EPT taxa, whereas the urban creeks generally had low richness and no sensitive EPT taxa.

The reasons for the poor BMI assemblages in urban creeks may vary. The main problems in these creeks appear to be low water flows, high levels of nutrients, high temperatures, low dissolved oxygen, and disturbed physical habitat. However, chemical toxicity, though not likely, cannot be ruled out. Under ambient (non-storm) conditions, waterborne contaminants such as heavy metals or toxic organic compounds may not present a problem. In fact, under ambient conditions even the urban creeks had potential contaminants at concentrations that exceeded very few water quality benchmarks, and had very few mild toxic effects. The data do not point to toxic effects of contaminants in sediments, either. On the other hand, during stormwater runoff events or during dry-weather discharge episodes, waterborne contaminants - although transient - can still affect BMI.

Recommendations:

Since bioassessments give us the most integrated and environmentally relevant assessments of the health of aquatic life in creeks, sampling and analysis of BMI, coupled with quantitative physical habitat assessments and flow measurements, should proceed in the future. Urban creeks that exhibit relatively healthy benthic communities should be studied in order to establish the best attainable urban conditions. These indicators should also be augmented by assessments of algal populations (biomass and taxonomy) and by sampling and analyses for nutrients and other indicators of eutrophication (e.g., continuous monitoring of dissolved oxygen levels).

5.2 Nutrients were detected in all watersheds

Most water samples collected in years 4&5 had nitrate and phosphorous at detectable concentrations, and the majority exceeded water quality guidelines, indicating a potential for eutrophication. However, it is not clear whether these guidelines are appropriate for the region and the beneficial uses of years 4&5 watersheds, primarily because they were developed for different Ecoregions and are not effect-based.

Recommendations:

New, effect-based nutrient criteria should be developed, for the Bay Area and similar Ecoregions. In order to gain understanding of the relationships between nutrients and eutrophication and establish thresholds, the following indicators should be monitored: nutrient concentrations, shade and canopy cover, algal biomass and taxonomic composition, temperature, flow, dissolved oxygen, and other eutrophication-related characteristics. SWAMP is currently conducting these studies at 6 reference sites, representing different environmental conditions, throughout the Bay area. The relationships between nutrient concentrations and their effects may be different in urban sites which are already disturbed or impacted by other factors. Therefore, the evaluation of monitoring data from urban sites is also necessary if more reliable effects-based nutrient criteria are to be developed.

5.3 Other conclusions and recommendations

Non-point source pollution is a significant issue in urban creeks.
During dry weather discharge episodes in urban creeks, BMI may be affected by detergents, drinking water disinfectants such as chlorine (e.g., water mains breaks), or other compounds not measured in this study. Stormwater runoff is often laced with soluble pollutants, and although BMI may be exposed for a short period of time these toxic compounds can still affect the. Fine-grain sediments, often carrying pollutants, enter the creeks during stormwater runoff events.

Recommendations:

Because SWAMP has very limited resources that could be dedicated to monitoring of non-point pollution sources, it is collaborating with other monitoring entities that address non-point source pollution and these efforts should be supported and enhanced.

Although this report's recommendations address future monitoring and assessment activities, there are several recommendations regarding actions to reduce pollution, including the following:

> Keeping fine sediment out of the creek is critical. This can be accomplished via constructed stormwater controls, street sweeping, manhole and drop inlet cleaning, and implementation of citizen awareness programs (e.g., storm-drain stenciling). Timely identification and repair of water main breaks is also important, especially when the drinking water purveyor uses non-degradable chlorine compounds in the delivery system.
>
> Creek restoration projects are highly recommended as a means of improving the physical habitat as well as reducing erosion and input of fine-grain sediments into the creeks. Restoration projects that increase riparian shade will lower stream temperatures especially when the flow drops in the summer, and provide the conditions needed for restoration of historical salmonid fisheries.

6 References

Amweg., E.L., D.P. Weston, J. You, and M.J. Lydy. 2006. Pyrethroid insecticides and sediment toxicity in urban creeks from California and Tennessee. *Environmental Science & Technology* 40(March 1):1700-1706. Abstract available at http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/asap/abs/es051407c.html.

APHA. 1998. Standard Methods for the Examination of Water and Wastewater, 20th ed. L.S. Clesceri, A.E. Greenberg, A.D. Eaton (eds). American Public Health Association, American Water Works Association, and Water Environment Federation, Washington, DC.

Cutler, K. 2006. California Islais Creek: From Stream to Sewer. The Noe Valley Voice, April 2006 http://www.noevalleyvoice.com/2006/April/Byli.html

CVRWQCB. 2003. A Compilation of Water Quality Goals. Prepared by J.B. Marshack, Central Valley Regional Water Quality Control Board, Sacramento, CA. 30 pp. plus tables.

Harrington, J.M. 1999. California stream bioassessment procedures (CSBP). California Department of Fish and Game, Water Pollution Control Laboratory. Rancho Cordova, CA.

Helsel D.R., and R.M. Hirsch. 2005. *Statistical Methods in Water Resources;* U.S. Geological Survey, Techniques of Water-Resources Investigations Book 4, Chapter

MacDonald, D.D., G.G. Ingersoll and T.A. Berger. 2000a. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Archives of Environmental Contamination and Toxicology* 39(1): 20-31.

MacDonald, D. D., Dipinto, L. M., Field, J., Ingersoll, C. G, Long, E. R., Swartz, R. C. 2000b. Development and evaluation of consensus-based sediment effect concentrations for polychlorinated biphenyls. *Environmental Toxicology and Chemistry* 19:1403-1413.

McCune, B., and Grace, J. B. MjM Software Design. Gleneden Beach, Oregon. 300 pp

National Park Service (NPS), Presidio of San Francisco, Lobos Creek Valley."
http://www.nps.gov/prsf/planyourvisit/lobos-creek-valley.htm

Ode, P.R.. 2007. Standard operating procedures for collecting macroinvertebrate samples and associated physical and chemical data for ambient bioassessments in California. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 001.

Puckett M. 2002. Quality Assurance Program Plan for the State of California's Surface Water Ambient Monitoring Program ("S.W.A.M.P.") (dated 12/22/02). California Department of Fish and Game, Monterey, CA. 145 pp. plus appendices.

SFBRWQCB. 1995. San Francisco Bay Basin (Region 2) Water Quality Control Plan. California Regional Water Quality Control Board, San Francisco Bay Region. 167 pp.

SFBRWQCB. 2004a. Surface Water Ambient Monitoring Program (SWAMP) Workplan. Long-term 5-year Workplan and Annual 03-04 Workplan. San Francisco Bay Regional Water Quality Control Board, January 2004.

SFBRWQCB. 2004b. Surface Water Ambient Monitoring Program (SWAMP) Annual Workplan 2004-2005. San Francisco Bay Regional Water Quality Control Board, November 2004.

SFBRWQCB. 2004c. Arroyo Mocho Creek Workplan. San Francisco Bay Regional Water Quality Control Board.

SFBRWQCB. 2005. Chemical Concentrations in Fish Tissues from Selected Reservoirs and Coastal Areas in the San Francisco Bay Region. Report prepared for the Surface Water Ambient Monitoring Program by University of California, Davis, CA Dept of Fish and Game, and the San Francisco Bay Regional Water Quality Control Board.

SFBRWQCB. 2007a. Water quality monitoring and bioassessment in nine San Francisco Bay Region watersheds: Walker Creek, Lagunitas Creek, San Leandro Creek, Wildcat Creek/San Pablo Creek, Suisun Creek, Arroyo las Positas, Pescadero Creek/Butano Creek, San Gregorio Creek, and Stevens/Pemanente Creeks. Surface Water Ambient Monitoring Program, San Francisco Bay Regional Water Quality Control Board, Oakland, CA.

SFBRWQCB 2007b. Water Quality Monitoring and Bioassessment in Four San Francisco Bay Region Watersheds in 2003-2004: Kirker Creek, Mt. Diablo Creek, Petaluma River, and San Mateo Creek. Surface Water Ambient Monitoring Program, San Francisco Bay Regional Water Quality Control Board, Oakland, CA

SFBRWQCB 2007c. A Rapid Trash Assessment Method Applied to Waters of the San Francisco Bay Region: Trash Measurement in Streams. Surface Water Ambient Monitoring Program, San Francisco Bay Regional Water Quality Control Board, Oakland, CA

Sullivan K., Martin, D.J., Cardwell, R.D., Toll, J.E., Duke, S. 2000. An Analysis of the Effects of Temperature on Salmonids of the Pacific Northwest with Implications for Selecting Temperature Criteria. Sustainable Ecosystems Institute, Portland, Oregon.

U.S.EPA. 1977. Temperature criteria for freshwater fish: protocol and procedures. Ecological Research Series. U.S. Environmental Protection Agency, Office of

Research and Development, Environmental Research Laboratory, Duluth, Minnesota. EPA-600/3-77-061. 130 pp.

U.S.EPA. 1986. Ambient Water Quality Criteria for Bacteria – 1986. EPA 440/5-84-002. Office of Water, Regulations and Standards, Criteria and Standards Division, Washington, D.C.

U.S.EPA. 1994. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms, third edition. U.S. Environmental Protection Agency, Office of Research and Development. EPA/600/4-91/002.

U.S.EPA. 1997. Volunteer Stream Monitoring: A Methods Manual. EPA 841-B-97-003. Office of Water.

U.S.EPA. 2000a. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates, second edition. Washington, D.C.: U.S. Environmental Protection Agency, Office of Water and Office of Research and Development. EPA/600/R-99/064. March 2000.

U.S.EPA. 2000b. Ambient Water Quality Criteria Recommendations—Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion III. EPA 822-B-00-016. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Health and Ecological Criteria Division, Washington, D.C. December 2000.

U.S.EPA. 2002. Guidance for Quality Assurance Project Plans, EPA QA/G-5. U.S.EPA publication EPA/240/R-02/009, Office of Environmental Information, Washington DC. December. http://www.epa.gov/quality/qa_docs.html#guidance

Woodward-Clyde Consultants (WCC). 1996. San Francisco Bay Area stormwater runoff monitoring data analysis 1988-1995. Report prepared for the Bay Area Stormwater Management Agencies Association, Oakland, CA, October 1996.

APPENDICES

TO

WATER QUALITY MONITORING AND BIOASSESSMENT IN SELECTED SAN FRANCISCO BAY REGION WATERSHEDS IN 2004-2006

NORTH EAST BAY CREEKS
CENTRAL EAST BAY CREEKS
ARROYO MOCHO WATERSHED
SOUTH COASTAL MARIN CREEKS
SAN FRANCISCO CREEKS

2004-2006

Final Report
December 23, 2008

SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD

List of Appendices

List of Appendix Tables and Figures

Table A-1: Summary of all monitoring activities performed in years 4&5 watersheds

Stn #	Station	StationName	BMI analyses	Physical Habitat Assessment	Continuous monitoring deployment Events	Observations and Field Measure-ments	Conventional WQ characteristics (including Nutrients)	Water chemistry (Metals, organics) and toxicity	Sediment chemistry and toxicity	Bacterial Counts
1.1	BAX030	Baxter at Booker	1	1	4	3	3	3	1	5
1.2	BAX045	Lower Baxter @ Gateway Project			2					
1.3	BAX050	Gateway	1	1						
2.1	CER020	Cerrito at Creekside Park	1	1	4	3	3	3	1	
3.1	COD020	Codornices at 2nd Street	1	1	4	3	3	3	1	
3.2	COD080	Albina Ave	1	1	4					
3.3	COD120	Live Oak Park	1	1	3					
4.1	STW010	Strawberry Creek Park	1	1	3	3	3	3	1	
4.15	STW020	Above Strawberry Creek Park			3					
4.2	STW030	UCBerkeley at Oxford	1	1	3					
5.1	TEM050	Hardy Park								5
5.2	TEM060	Birch Court	1	1	4					
5.3	TEM090	Above Lake Temescal	1	1	5	3	3	3		
6.1	LME100	Glen Echo at 29th Street	1	1	3	3	3	3	1	
6.2	LME130	Oak Glen Park			2					5
7.1	SAU030	Sausal at E.22nd	1	1	4	3	3	3	1	
7.2	SAU060	Sausal at Lions Pool								5
7.3	SAU070	Sausal at El Centro			4					
7.4	SAU080	Dimond Park	1	1						
7.5	SAU130	Palo Seco	1	1	3					
8.1	PRL020	Cesar Chavez Park	1	1	3	3	3	3	1	5
8.2	PRL080	Peralta at Rettig	1	1	3					
9.1	LIO030	Lion at Eastlawn				1		1		
9.2	LIO070	Mills College at Wetmore Bridge								5
9.3	LIO080	Mills College at Alumni House	1	1	3					
9.4	LIO090	Mills College above Aliso			2					
9.5	LIO130	Horseshoe Creek	1	1	2					5
10.1	AVJ020	Arroyo Viejo Rec. Center	1	1	3	3	3	3	1	5
10.2	AVJ090	Country Club Branch	1	1						
10.3	AVJ110	Rifle Range	1	1	3					
10.4	AVJ130	Knowland Park Zoo	1	1	3					5
10.5	AVJ140	Above Zoo at Golf Links								5
11.1	AMO070	Above Vulcan Bridge Zone 7	1	1	2	3	3	3	1	
11.2	AMO080	Madeiros Parkway at Stanley								5
11.3	AMO090	Mocho Park								5
11.4	AMO095	Robertson Park								5
11.5	AMO100	Wente Street (Concannon St.)	1	1	3					
11.6	AMO160	Above SBA Zone 7	1	1	3					
11.7	AMO180	Hetch Hetchy	1	1	2					
11.8	AMO200	County Line	1	1	2					

Numbers in the table indicate number of Samples, Sonde Event files, and/or Station Visits

Table A-1: (cont., year 5 watersheds)

Stn #	Station	StationName	BMI analyses	Physical Habitat Assessment	Continuous monitoring deployment Events	Observations and Field Measure-ments	Conventional WQ characteristics (including Nutrients)	Water chemistry (Metals, organics) and toxicity	Sediment chemistry and toxicity	Bacterial Counts
12.1	AUD020	Audubon Canyon	1	1		3	3			5
13.1	MRS020	Morses Gulch	1	1		3	3			
14.1	PNG010	Lower Pine Gulch	1	1	3	3	3	3	1	
14.2	PNG050	Teixeira	1	1	3					
15.1	EAS020	Easkoot	1	1	3	3	3	3	1	
15.2	EAS050	Fitzhenry	1	1	3					
16.1	WBB010	Steep Ravine	1	1	3					
17.1	RDW010	Redwood @ Muir Beach								5
17.2	RDW040	Green Gulch	1	1	3	3	3			
17.3	RDW060	Lower Redwood	1	1	3	3	3			
17.4	RDW100	Miwok Bridge	1	1	3					
17.5	RDW120	Muir Woods	1	1	3					
18.1	TVY030	Tennessee Valley	1	1	3	3	3			
19.1	ROD010	Rodeo Lagoon Foot Bridge			3					
19.2	ROD020	Rodeo Lagoon Car Bridge			3					
19.3	ROD030	Rodeo Lake			3					
19.4	ROD035	Rodeo Pond								5
19.5	ROD040	Gerbode	1		3	3	3			
19.6	ROD050	Lower Rodeo	1		3	3	2			
20.1	LOB020	Lobos Below Lincoln	1	1	3	3	3	3	1	
21.1	ISL050	Glen Canyon Park	1	1	2	1			1	5
		Number of sites monitored in years 4&5	43	41	46	22	20	14	13	17
		Total events for years 4&5	**43**	**41**	**139**	**62**	**59**	**40**	**13**	**85**

Numbers in the table indicate number of Samples, Sonde Event files, and/or Station Visits

Table B-1: Sites monitored for BMI and PHAB in years 4 & 5

Stn #	Station	Site Name	Date Sampled	BMI	PHAB	Duplicate
1.1	BAX030	Baxter at Booker	4/11/2005	X	X	
1.3	BAX050	Gateway	4/19/2005	X	X	
2.1	CER020	Cerrito at Creekside Park	4/11/2005	X	X	
3.1	COD020	Codornices at 2nd Street	4/11/2005	X	X	
3.2	COD080	Albina Ave	4/12/2005	X	X	
3.3	COD120	Live Oak Park	4/13/2005	X	X	
4.1	STW010	Strawberry Creek Park	4/12/2005	X	X	
4.2	STW030	UCBerkeley at Oxford	4/13/2005	X	X	
5.2	TEM060	Birch Court	4/19/2005	X	X	
5.3	TEM090	Above Lake Temescal	4/12/2005	X	X	X
6.1	LME100	Glen Echo at 29th Street	4/13/2005	X	X	
7.1	SAU030	Sausal at E.22nd	4/14/2005	X	X	
7.4	SAU080	Dimond Park	4/14/2005	X	X	
7.5	SAU130	Palo Seco	4/14/2005	X	X	
8.1	PRL020	Cesar Chavez Park	4/13/2005	X	X	
8.2	PRL080	Peralta at Rettig	4/13/2005	X	X	X
9.3	LIO080	Mills College at Alumni House	4/13/2005	X	X	
9.5	LIO130	Horseshoe Creek	4/13/2005	X	X	
10.1	AVJ020	Arroyo Viejo Rec. Center	4/15/2005	X	X	
10.2	AVJ090	Country Club Branch	4/15/2005	X	X	X
10.3	AVJ110	Rifle Range	4/15/2005	X	X	
10.4	AVJ130	Knowland Park Zoo	4/12/2005	X	X	
11.1	AMO070	Above Vulcan Bridge Zone 7	4/12/2005	X	X	
11.5	AMO100	Wente Street (Concannon St.)	4/12/2005	X	X	
11.6	AMO160	Above SBA Zone 7	4/12/2005	X	X	
11.7	AMO180	Hetch Hetchy	4/11/2005	X	X	
11.8	AMO200	County Line	4/11/2005	X	X	
12.1	AUD020	Audubon Canyon	4/12/2005	X	X	
13.1	MRS020	Morses Gulch	4/12/2005	X	X	
14.1	PNG010	Lower Pine Gulch	4/11/2005	X	X	
14.2	PNG050	Teixeira	4/12/2005	X	X	
15.1	EAS020	Easkoot	4/13/2005	X	X	
15.2	EAS050	Fitzhenry	4/13/2005	X	X	
16.1	WBB010	Steep Ravine	4/13/2005	X	X	
17.2	RDW040	Green Gulch	4/15/2005	X	X	
17.3	RDW060	Lower Redwood	4/14/2005	X	X	
17.4	RDW100	Miwok Bridge	4/14/2005	X	X	
17.5	RDW120	Muir Woods	4/14/2005	X	X	
18.1	TVY030	Tennessee Valley	4/15/2005	X	X	
19.5	ROD040	Gerbode	5/18/2005	X		
19.6	ROD050	Lower Rodeo	5/18/2005	X		
20.1	LOB020	Lobos Below Lincoln	4/20/2005	X	X	
21.1	ISL050	Glen Canyon Park	4/20/2005	X	X	

Table B-2: Summaries of BMI metrics in years 4&5 watersheds

Table B-2a: BMI metrics in the Northern East Bay Watersheds

Metric *(Note 1)*	BAX030	BAX050	CER020	COD020	COD080	COD120	STW010	STW030
Coleoptera Taxa	0	0	0	0	0	0	1	1
Diptera Taxa	3	1	3	3	4	4	3	3
Ephemeroptera Taxa	1	0	1	1	1	1	1	1
Hemiptera Taxa	0	0	0	0	0	0	0	0
Lepidoptera Taxa	0	0	0	0	0	0	0	0
Megaloptera Taxa	0	0	0	0	0	0	0	0
Odonata Taxa	0	1	0	0	1	1	1	1
Plecoptera Taxa	0	0	0	0	0	0	1	1
Trichoptera Taxa	0	0	1	0	1	0	0	1
Non-Insect Taxa	7	11	10	8	6	7	9	9
Taxa Richness	11	13	15	12	13	13	16	17
EPT Taxa	1	0	2	1	2	1	2	3
Abundance (#/sample)	5250	10160	1360	17152	2068	2289	651	1279
% EPT	17	0	49	9	42	30	28	46
% Sensitive EPT	0	0	0	0	0	0	1	7
% Chironomidae	43	10	20	30	29	35	59	40
% Coleoptera	0	0	0	0	0	0	0	0
% Oligochaeta	5	3	19	53	17	23	8	4
% Non-insect	36	90	28	56	23	29	11	11
% Baetis	17	0	49	9	41	30	27	39
% Simulium	4	0	2	5	6	4	1	2
% COBS	68	13	90	97	93	92	96	85
% Intolerant	0	0	0	0	0	0	1	7
% Tolerant	4	83	5	2	7	8	2	2
Tolerance Value	5.32	7.53	5.35	5.42	5.55	5.60	5.66	5.22
% Predator	28	7	5	1	1	2	1	3
% Collector-filterer	4	1	2	6	6	4	1	2
%Collector-gatherer	65	25	89	92	89	88	95	87
% Scraper	4	68	3	1	4	6	2	2
% Shredder	0	0	0	0	0	0	1	7
% Other	0	0	0	0	0	0	0	0

Note 1: See metric definitions in Table B-2g below

Table B-2b: Northern Oakland Watersheds

Metric *(Note 1)*	**TEM060**	**TEM090**	**LME100**	**SAU030**	**SAU080**	**SAU130**	**PRL020**	**PRL080**
Coleoptera Taxa	0	2	0	3	1	5	0	1
Diptera Taxa	4	5	1	2	3	6	5	3
Ephemeroptera Taxa	1	1	1	1	1	3	1	1
Hemiptera Taxa	0	0	0	0	0	0	0	0
Lepidoptera Taxa	0	0	0	0	0	0	0	0
Megaloptera Taxa	0	0	0	0	0	0	0	0
Odonata Taxa	1	1	0	1	0	0	0	1
Plecoptera Taxa	0	1	0	0	1	3	1	1
Trichoptera Taxa	0	1	0	0	0	8	0	0
Non-Insect Taxa	7	5	8	4	4	6	6	8
Taxa Richness	13	16	10	11	10	31	13	15
EPT Taxa	1	3	1	1	2	14	2	2
Abundance (#/sample)	197	4072	3405	2545	10752	672	6643	1891
% EPT	52	12	18	45	65	60	19	20
% Sensitive EPT	0	0	0	0	1	35	0	2
% Chironomidae	29	34	20	21	16	6	21	48
% Coleoptera	0	1	0	1	0	26	0	0
% Oligochaeta	6	43	59	32	17	3	56	23
% Non-insect	17	47	61	33	18	5	58	28
% Baetis	52	12	18	45	64	24	19	18
% Simulium	0	6	0	0	1	0	0	3
% COBS	87	95	97	99	97	33	97	92
% Intolerant	0	0	0	0	1	36	0	2
% Tolerant	9	3	2	1	0	1	2	5
Tolerance Value	5.55	5.47	5.26	5.23	5.13	3.45	5.27	5.59
% Predator	10	3	1	1	1	10	0	3
% Collector-filterer	0	6	0	0	1	3	0	4
%Collector-gatherer	89	89	98	99	97	36	97	89
% Scraper	1	2	1	0	0	27	2	2
% Shredder	0	0	0	0	1	24	0	2
% Other	0	0	0	0	0	0	0	0

Note 1: See metric definitions in Table B-2g below

Table B-2c: Southern Oakland Watersheds

Metric *(Note 1)*	LIO080	LIO130	AVJ020	AVJ090	AVJ090dup	AVJ110	AVJ130
Coleoptera Taxa	1	2	1	0	0	3	0
Diptera Taxa	4	6	4	6	3	7	5
Ephemeroptera Taxa	1	1	1	1	1	4	1
Hemiptera Taxa	1	0	0	0	0	0	0
Lepidoptera Taxa	0	0	0	0	0	0	0
Megaloptera Taxa	0	0	0	0	0	0	0
Odonata Taxa	0	1	0	0	0	1	0
Plecoptera Taxa	1	2	1	1	1	3	1
Trichoptera Taxa	0	1	1	0	0	4	0
Non-Insect Taxa	3	4	4	5	3	4	3
Taxa Richness	11	17	12	13	8	26	10
EPT Taxa	2	4	3	2	2	11	2
Abundance (#/sample)	344	1504	6618	2016	2992	4326	7269
% EPT	29	69	53	35	37	62	40
% Sensitive EPT	8	46	2	17	19	12	0
% Chironomidae	38	18	22	16	24	18	28
% Coleoptera	1	1	0	0	0	9	0
% Oligochaeta	9	7	20	4	4	6	18
% Non-insect	9	8	21	6	5	6	18
% Baetis	21	24	51	19	19	49	40
% Simulium	1	3	4	40	34	3	10
% COBS	69	52	96	79	80	75	96
% Intolerant	8	46	2	17	19	13	0
% Tolerant	1	1	1	2	1	1	3
Tolerance Value	5.40	3.82	5.23	5.12	5.06	4.61	5.54
% Predator	22	3	1	1	1	10	0
% Collector-filterer	1	3	4	41	34	3	10
%Collector-gatherer	68	49	93	40	47	74	89
% Scraper	1	1	0	1	0	11	0
% Shredder	8	43	2	17	19	2	0
% Other	0	0	1	0	0	0	0

Note 1: See metric definitions in Table B-2g below

Table B-2d: Arroyo Mocho Watershed

Metric *(Note 1)*	**AMO070**	**AMO100**	**AMO160**	**AMO180**	**AMO200**
Coleoptera Taxa	0	2	0	4	2
Diptera Taxa	1	3	5	7	7
Ephemeroptera Taxa	2	5	6	8	3
Hemiptera Taxa	0	0	0	0	0
Lepidoptera Taxa	0	0	0	0	0
Megaloptera Taxa	0	0	1	1	1
Odonata Taxa	0	1	0	1	0
Plecoptera Taxa	0	0	3	5	4
Trichoptera Taxa	0	4	3	6	1
Non-Insect Taxa	6	8	4	5	6
Taxa Richness	9	23	22	37	24
EPT Taxa	2	9	12	19	8
Abundance (#/sample)	2112	10733	10042	680	2112
% EPT	44	51	31	72	28
% Sensitive EPT	0	1	4	26	15
% Chironomidae	8	22	46	14	42
% Coleoptera	0	2	0	1	1
% Oligochaeta	41	3	5	2	2
% Non-insect	49	7	9	4	6
% Baetis	42	48	25	37	13
% Simulium	0	17	12	0	19
% COBS	91	90	87	54	77
% Intolerant	0	1	4	28	15
% Tolerant	7	4	1	6	3
Tolerance Value	5.29	5.41	5.42	4.16	5.21
% Predator	0	3	6	10	8
% Collector-filterer	0	18	12	1	20
%Collector-gatherer	92	77	81	75	67
% Scraper	7	2	1	12	0
% Shredder	0	0	0	2	4
% Other	0	0	0	0	1

Note 1: See metric definitions in Table B-2g below

Table B-2e: Northern South-West Marin Watersheds

Metric *(Note 1)*	**AUD020**	**MRS020**	**PNG010**	**PNG050**	**EAS020**	**EAS050**	**WBB010**
Coleoptera Taxa	6	7	2	3	2	5	7
Diptera Taxa	7	4	5	9	5	7	8
Ephemeroptera Taxa	9	5	7	7	6	6	5
Hemiptera Taxa	1	0	0	0	0	0	0
Lepidoptera Taxa	0	0	0	0	0	0	0
Megaloptera Taxa	0	0	0	0	0	0	0
Odonata Taxa	0	0	0	0	0	2	0
Plecoptera Taxa	5	5	5	5	4	4	6
Trichoptera Taxa	7	6	6	7	5	8	8
Non-Insect Taxa	5	4	9	6	4	8	8
Taxa Richness	40	31	34	37	26	40	42
EPT Taxa	21	16	18	19	15	18	19
Abundance (#/sample)	5380	3280	681	1265	3366	2148	3453
% EPT	60	37	58	53	59	59	45
% Sensitive EPT	26	29	34	30	15	30	27
% Chironomidae	12	6	26	20	19	28	6
% Coleoptera	7	39	2	8	1	3	30
% Oligochaeta	15	10	3	4	18	1	3
% Non-insect	17	13	9	8	19	8	9
% Baetis	26	6	2	6	39	23	18
% Simulium	1	0	0	0	1	0	0
% COBS	54	22	32	29	78	52	26
% Intolerant	27	34	36	37	16	31	36
% Tolerant	0	1	6	1	1	5	2
Tolerance Value	4.15	3.36	3.84	3.70	4.68	4.28	3.54
% Predator	11	14	18	27	5	19	19
% Collector-filterer	3	0	1	1	2	6	1
%Collector-gatherer	61	25	48	38	78	53	29
% Scraper	13	41	29	23	6	13	31
% Shredder	13	21	3	10	9	9	19
% Other	0	0	0	0	0	0	1

Note 1: See metric definitions in Table B-2g below

Table B-2f: Southern South-West Marin Watersheds

Metric *(Note 1)*	RDW040	RDW040dup	RDW060	RDW100	RDW120	TVY030	TVY030dup	ROD040	ROD050
Coleoptera Taxa	1	1	5	5	7	1	2	1	1
Diptera Taxa	5	6	7	7	5	6	4	6	4
Ephemeroptera Taxa	4	3	10	9	7	4	3	5	4
Hemiptera Taxa	0	0	0	0	0	0	0	0	0
Lepidoptera Taxa	0	0	0	0	0	0	0	0	0
Megaloptera Taxa	0	0	0	0	0	0	0	0	0
Odonata Taxa	0	0	0	0	0	0	0	0	0
Plecoptera Taxa	1	1	4	3	5	2	1	2	3
Trichoptera Taxa	3	2	6	5	8	4	2	4	3
Non-Insect Taxa	7	7	4	5	5	7	8	10	8
Taxa Richness	21	20	36	34	37	24	20	28	23
EPT Taxa	8	6	20	17	20	10	6	11	10
Abundance (#/sample)	5200	10720	2249	4296	956	2989	2819	4128	10160
% EPT	28	16	68	44	63	38	33	51	46
% Sensitive EPT	2	1	33	25	26	29	26	38	38
% Chironomidae	23	34	6	16	5	14	9	13	10
% Coleoptera	0	0	10	21	11	8	8	4	3
% Oligochaeta	8	9	13	6	17	6	6	1	1
% Non-insect	12	13	13	11	18	9	10	6	8
% Baetis	25	13	20	16	32	5	5	2	5
% Simulium	35	35	1	1	0	30	38	26	31
% COBS	91	91	40	39	53	55	58	42	47
% Intolerant	3	2	34	31	29	30	26	39	38
% Tolerant	1	2	0	1	0	3	4	4	7
Tolerance Value	5.49	5.70	3.63	4.02	3.83	4.45	4.61	4.05	4.35
% Predator	2	1	10	17	17	5	7	14	9
% Collector-filterer	35	35	1	1	3	30	39	26	32
%Collector-gatherer	61	59	63	43	56	32	24	27	24
% Scraper	1	3	18	25	15	10	11	6	4
% Shredder	1	1	8	14	9	23	20	27	32
% Other	0	0	0	0	0	0	0	0	0

Note 1: See metric definitions in Table B-2g below

Table B-2g: San Francisco Watersheds

Metric	LOB020	ISL050	Metric Definitions
Coleoptera Taxa	0	1	Number of Coleoptera (beetle) taxa
Diptera Taxa	4	8	Number of Diptera (true fly) taxa
Ephemeroptera Taxa	0	1	Number of Epehemeroptera (mayfly) taxa
Hemiptera Taxa	0	0	Number of Hemiptera (true bug) taxa
Lepidoptera Taxa	0	0	Number of Lepidoptera (moth) taxa
Megaloptera Taxa	0	0	Number of Megaloptera (hellgrammite) taxa
Odonata Taxa	1	0	Number of Odonata (dragonfly and damselfly) taxa
Plecoptera Taxa	1	1	Number of Plecoptera (stonefly) taxa
Trichoptera Taxa	2	1	Number of Trichoptera (caddisfly) taxa
Non-Insect Taxa	10	9	Number of non-insect taxa
Taxa Richness	18	21	Total number of invertebrate taxa
EPT Taxa	3	3	Number of Epehemeroptera, Plecoptera, and Trichoptera taxa
Abundance (#/sample)	3367	1047	Estimated number of organisms collected in entire sample
% EPT	4	7	Percent composition of Ephemeroptera, Plecoptera, and Trichoptera
% Sensitive EPT	4	7	Percent composition of EPT with tolerance values <3
% Chironomidae	61	58	Percent composition of Chironimidae (midges)
% Coleoptera	0	0	Percent composition of Coleoptera (beetles)
% Oligochaeta	2	10	Percent composition of Oligochaeta (worms)
% Non-insect	15	20	Percent composition of non-insect organisms
% Baetis	0	0	Percent composition of Baetis
% Simulium	17	13	Percent composition of Simulium (black flies)
% COBS	80	82	Percent composition of Chironimidae, Oligochaeta, Baetis, and Simulium
% Intolerant	4	7	Percent of organisms with tolerance values <3
% Tolerant	10	8	Percent of organisms with tolerance values >7
Tolerance Value	5.92	5.75	Average tolerance value of all organisms
% Predator	5	4	Percent of organisms that feed on other organisms
% Collector-filterer	18	14	Percent of organisms that filter fine particulate organic matter
%Collector-gatherer	65	69	Percent of organisms that gather fine particulate organic matter
% Scraper	8	6	Percent of organisms that graze on periphyton
% Shredder	4	7	Percent of organisms that shred coarse particulate organic matter
% Other	0	0	Percent of organisms with other types of feeding

Table B-3: Substrate characteristic in BMI sampling plots

Stn #	Station	Date	BMI plots substrate type distribution (Percent, average of 8 estimated values)				
			Avg % Fines&Sand	Avg. % Gravel	Avg. % Cobble	Avg. % Boulder	Avg. % Bedrock
1.1	BAX030	4/11/2005	46	49	5	0	0
1.3	BAX050	4/19/2005	100	0	0	0	0
2.1	CER020	4/11/2005	38	61	2	0	0
3.1	COD020	4/11/2005	48	52	0	0	0
3.2	COD080	4/12/2005	27	41	26	6	0
3.3	COD120	4/13/2005	19	43	28	11	0
4.1	STW010	4/12/2005	29	48	19	4	0
4.2	STW030	4/13/2005	32	37	31	0	0
5.2	TEM060	4/19/2005	46	51	3	0	0
5.3	TEM090	4/12/2005	20	39	9	33	0
6.1	LME100	4/13/2005	14	49	26	0	11
7.1	SAU030	4/14/2005	25	46	28	2	0
7.4	SAU080	4/14/2005	19	48	33	1	0
7.5	SAU130	4/14/2005	24	60	16	0	0
08.1	PRL020	4/13/2005	27	58	11	3	0
8.2	PRL080	4/13/2005	25	48	23	4	0
9.3	LIO080	4/13/2005	31	31	38	0	0
09.5	LIO130	4/13/2005	22	48	29	1	0
10.1	AVJ020	4/15/2005	33	59	4	3	0
10.2	AVJ090	4/15/2005	14	46	39	0	0
10.3	AVJ110	4/15/2005	16	44	37	3	0
10.4	AVJ130	4/12/2005	35	40	24	1	0
11.1	AMO070	4/12/2005	43	56	0	0	0
11.5	AMO100	4/12/2005	26	51	23	0	0
11.6	AMO160	4/12/2005	20	49	31	0	0
11.7	AMO180	4/11/2005	18	44	40	0	0
11.8	AMO200	4/11/2005	27	48	25	0	0
12.1	AUD020	4/12/2005	22	54	27	0	0
13.1	MRS020	4/12/2005	20	62	18	0	0
14.1	PNG010	4/11/2005	24	73	4	0	0
14.2	PNG050	4/12/2005	18	68	14	0	0
15.1	EAS020	4/13/2005	22	60	18	0	0
15.2	EAS050	4/13/2005	16	51	33	0	0
16.1	WBB010	4/13/2005	19	42	39	0	0
17.2	RDW040	4/15/2005	54	45	1	0	0
17.3	RDW060	4/14/2005	24	73	4	0	0
17.4	RDW100	4/14/2005	22	55	23	0	0
17.5	RDW120	4/14/2008	10	30	60	0	0
18.1	TVY030	4/15/2005	48	51	1	0	0
20.1	LOB020	4/20/2005	89	10	1	0	0
21.1	ISL050	4/20/2005	45	31	24	0	0

Table B-4: Physical habitat characteristics in years 4&5 sites. Page 1 of 5

	Station	Date	Avg. slope (%)	Average width of wetted channel (m)	*SD of Avg. width*	Average water depth (cm)	*SD of Avg Depth*	flow discharge at sampling time (m^3/sec)	flow discharge at sampling time **(cfs)**	Channel conditions - estimated scores (out of 20): Epifaunal Substrate/Available Cover	Sediment Deposition	Channel Alterations	Flow habitat units distribution (% of total reach length): Pools	Glides	Runs	Riffles	Cascades /falls	Dry channel
1.1	BAX030	4/11/2005	1.7	1.9	*0.6*	14.4	*9.3*	0.011	0.4	12	8	16	25	43	0	32	0	0
1.3	BAX050	4/19/2005	0.0	1.7	*0.5*	16.1	*13.8*	0.000	0.0	5	3	4	0	100	0	0	0	0
2.1	CER020	4/11/2005	2.7	2.5	*1.0*	10.1	*6.1*	0.027	0.9	9	8	2	5	52	0	43	0	0
3.1	COD020	4/11/2005	1.3	2.1	*0.3*	17.4	*13.2*	0.031	1.1	5	3	3	33	37	3	27	0	0
3.2	COD080	4/12/2005	3.5	2.3	*0.7*	17.0	*12.4*	0.023	0.8	10	11	8	37	7	0	54	1	0
3.3	COD120	4/13/2005	4.1	2.5	*0.8*	11.6	*9.9*	0.016	0.6	14	8	13	12	6	0	82	0	0
4.1	STW010	4/12/2005	2.9	2.6	*0.6*	13.7	*11.0*	0.034	1.2	16	13	10	13	17	0	70	0	0
4.2	STW030	4/13/2005	2.5	2.7	*0.5*	11.7	*7.9*	0.024	0.8	12	8	13	28	18	0	54	0	0
5.2	TEM060	4/19/2005	1.7	2.8	*1.8*	19.1	*10.2*	0.060	2.1	12	10	8	3	56	0	41	1	0
5.3	TEM090	4/12/2005	3.3	2.0	*0.6*	18.2	*13.3*	0.027	0.9	13	8	10	40	3	23	27	7	0
6.1	LME100	4/13/2005	1.6	2.7	*0.5*	15.4	*12.7*	0.027	1.0	9	7	2	60	15	0	25	0	0
7.1	SAU030	4/14/2005	1.5	4.3	*0.8*	18.9	*10.5*	0.068	2.4	5	6	2	20	47	0	31	2	0
7.4	SAU080	4/14/2005	3.0	3.3	*0.6*	12.5	*8.3*	0.049	1.7	16	14	17	13	29	0	55	6	0
7.5	SAU130	4/14/2005	7.1	1.3	*0.2*	8.0	*6.1*	0.014	0.5	14	7	15	5	11	0	79	5	0
08.1	PRL020	4/13/2005	1.3	2.4	*1.0*	11.0	*6.9*	0.018	0.6	6	6	1	76	0	0	24	0	0
8.2	PRL080	4/13/2005	6.6	1.8	*0.7*	9.9	*5.9*	0.011	0.4	11	12	15	0	37	0	49	14	0
9.3	LIO080	4/13/2005	4.2	2.8	*1.4*	21.8	*19.2*	0.037	1.3	10	6	15	1	44	0	55	0	0
09.5	LIO130	4/13/2005	4.9	2.8	*1.0*	13.4	*12.8*	0.017	0.6	12	8	17	1	37	0	62	0	0
10.1	AVJ020	4/15/2005	1.2	3.3	*0.9*	16.4	*9.6*	0.056	2.0	3	2	2	7	65	0	28	0	0
10.2	AVJ090	4/15/2005	2.9	1.6	*0.7*	7.7	*6.8*	0.006	0.2	15	12	18	10	24	0	66	0	0
10.3	AVJ110	4/15/2005	4.6	1.5	*0.4*	6.7	*3.8*	0.009	0.3	16	14	19	7	12	0	77	4	0
10.4	AVJ130	4/12/2005	2.0	2.4	*0.8*	14.7	*12.1*	0.010	0.4	11	13	11	2	55	0	43	0	0
11.1	AMO070	4/12/2005	1.4	6.0	*1.0*	27.5	*27.0*	0.168	5.9	11	11	12	7	69	0	24	0	0
11.5	AMO100	4/12/2005	2.2	4.1	*1.6*	21.7	*12.5*	0.131	4.6	13	15	12	0	53	7	40	0	0
11.6	AMO160	4/12/2005	2.9	4.6	*1.9*	16.7	*8.8*	0.110	3.9	14	17	16	0	29	0	71	0	0
11.7	AMO180	4/11/2005	1.7	4.6	*1.2*	22.1	*11.4*	0.111	3.9	10	17	19	2	12	0	86	0	0
11.8	AMO200	4/11/2005	3.5	3.1	*1.2*	17.4	*12.4*	0.022	0.8	12	16	17	5	45	0	48	2	0
12.1	AUD020	4/12/2005	6.5	1.5	*0.3*	9.9	*4.7*	0.017	0.6	16	14	19	2	0	6	89	3	0
13.1	MRS020	4/12/2005	2.6	1.8	*0.5*	10.0	*5.3*	0.031	1.1	16	12	19	3	0	7	90	0	0
14.1	PNG010	4/11/2005	1.0	4.8	*0.6*	29.6	*15.4*	0.758	26.8	15	11	16	6	0	74	20	0	0
14.2	PNG050	4/12/2005	1.2	4.4	*1.1*	19.5	*12.5*	0.266	9.4	18	10	19	5	7	49	39	0	0
15.1	EAS020	4/13/2005	1.5	2.2	*0.4*	12.8	*5.2*	0.056	2.0	16	14	13	12	15	16	57	0	0
15.2	EAS050	4/13/2005	6.4	1.5	*0.5*	10.3	*5.4*	0.031	1.1	17	15	19	14	0	14	69	3	0
16.1	WBB010	4/13/2005	4.2	2.3	*0.5*	16.7	*9.3*	0.057	2.0	18	16	19	26	0	23	44	7	0
17.2	RDW040	4/15/2005	1.2	1.8	*0.6*	25.4	*18.8*	0.030	1.1	14	10	12	35	9	40	15	0	0
17.3	RDW060	4/14/2005	1.1	6.4	*1.0*	32.0	*15.7*	0.593	20.9	14	10	14	20	49	17	13	0	0
17.4	RDW100	4/14/2005	1.2	4.5	*1.2*	26.0	*16.3*	0.105	3.7	17	15	19	20	3	50	27	0	0
17.5	RDW120	4/14/2008	1.3	4.1	*0.7*	20.1	*9.6*	0.266	9.4	17	12	16	5	17	37	54	0	0
18.1	TVY030	4/15/2005	1.4	1.8	*0.6*	27.7	*17.3*	0.034	1.2	14	11	187	19	32	24	25	0	0
19.5	ROD040																	
19.6	ROD050																	
20.1	LOB020	4/20/2005	1.9	2.7	*1.7*	16.1	*7.0*	0.025	0.9	13	5	10	0	59	0	41	0	0
21.1	ISL050	4/20/2005	2.8	1.0	*0.5*	6.4	*3.1*	0.006	0.2	11	9	18	0	69	0	31	0	0

Table B-4 (cont.) Page 2

	Station	Date	Reach-wide substrate composition (percent, derived from size-class determinations at each Transect-and Intertransect-point)													Percent Substrate smaller than sand (<2 mm)	Percent Substrate fine gravel or smaller (<16 mm)	Percent Substrate larger than fine gravel (>16 mm)	Percent Substrate as Bedrock
			% Bedrock - smooth	% Bedrock - rough	% Concrete /asphalt	% Boulders- large (1000-4000mm)	% Boulders - small (250-1000mm)	% Cobble (64-250mm)	% Gravel - coarse (16-64mm)	% Gravel - fine (2-16mm)	% Sand (0.06-2mm)	% Fines (silts/clay/muck, <0.06mm))	% Hardpan	% Wood (any size)	% Other substrate				
1.1	BAX030	4/11/2005	0	0	0	0	1	4	7	32	25	17	14	0	0	42	74	11	0
1.3	BAX050	4/19/2005	0	0	0	0	0	0	0	2	0	98	0	0	0	98	100	0	0
2.1	CER020	4/11/2005	0	0	4	0	0	3	20	43	25	5	0	0	0	30	73	27	0
3.1	COD020	4/11/2005	0	0	0	0	0	2	14	31	24	29	0	0	0	52	84	16	0
3.2	COD080	4/12/2005	0	5	8	0	16	9	9	19	12	5	1	17	0	17	36	47	5
3.3	COD120	4/13/2005	0	0	2	0	22	25	18	13	4	0	13	3	0	4	17	67	0
4.1	STW010	4/12/2005	0	0	11	0	11	14	18	17	15	12	2	0	0	28	45	54	0
4.2	STW030	4/13/2005	0	0	2	0	6	15	21	17	16	2	0	19	1	18	36	44	0
5.2	TEM060	4/19/2005	0	0	10	0	0	1	31	28	10	19	0	1	0	29	56	43	0
5.3	TEM090	4/12/2005	0	0	1	9	9	9	9	30	24	4	4	3	0	28	58	36	0
6.1	LME100	4/13/2005	0	0	16	0	5	19	15	22	8	4	0	11	1	12	34	54	0
7.1	SAU030	4/14/2005	0	0	39	0	3	5	17	21	12	0	0	3	0	12	33	64	0
7.4	SAU080	4/14/2005	0	0	0	3	27	26	13	13	6	1	3	9	0	7	20	69	0
7.5	SAU130	4/14/2005	0	0	6	3	7	19	24	24	11	3	0	3	0	14	39	59	0
08.1	PRL020	4/13/2005	0	0	51	0	3	9	10	20	6	2	0	0	0	8	28	72	0
8.2	PRL080	4/13/2005	3	1	0	0	7	18	28	34	5	2	3	0	0	7	41	56	4
9.3	LIO080	4/13/2005	0	1	3	0	2	21	32	22	4	10	1	4	0	14	36	59	1
09.5	LIO130	4/13/2005	0	0	1	3	14	17	33	20	3	7	0	2	0	10	30	69	0
10.1	AVJ020	4/15/2005	0	0	29	0	6	3	23	25	13	1	0	0	0	14	39	61	0
10.2	AVJ090	4/15/2005	1	0	0	0	1	28	32	18	5	2	10	3	0	7	25	62	1
10.3	AVJ110	4/15/2005	0	0	0	1	15	20	21	21	5	3	7	8	0	8	29	57	0
10.4	AVJ130	4/12/2005	0	0	0	0	0	10	24	42	13	10	0	0	0	24	66	34	0
11.1	AMO070	4/12/2005	0	0	0	0	0	1	38	18	17	26	0	0	0	43	61	39	0
11.5	AMO100	4/12/2005	0	0	0	0	0	10	39	36	7	7	1	0	0	13	50	50	0
11.6	AMO160	4/12/2005	0	0	0	0	3	25	46	18	5	3	0	1	0	8	26	73	0
11.7	AMO180	4/11/2005	0	4	0	0	12	21	51	0	9	3	0	0	1	12	12	88	4
11.8	AMO200	4/11/2005	0	0	0	10	9	23	26	18	10	5	0	1	0	14	32	67	0
12.1	AUD020	4/12/2005	0	0	0	0	15	24	23	15	22	1	0	0	0	23	38	62	0
13.1	MRS020	4/12/2005	0	0	0	0	5	23	24	23	25	0	1	0	0	25	48	51	0
14.1	PNG010	4/11/2005	0	0	0	0	0	2	24	29	31	9	0	6	0	40	69	26	0
14.2	PNG050	4/12/2005	0	0	0	0	0	6	35	25	29	5	1	0	0	33	58	41	0
15.1	EAS020	4/13/2005	0	0	0	0	4	8	30	25	31	0	0	2	0	31	56	42	0
15.2	EAS050	4/13/2005	0	0	0	0	22	33	18	14	12	0	0	0	0	12	27	73	0
16.1	WBB010	4/13/2005	2	0	0	0	21	23	23	10	18	0	0	2	1	18	29	69	2
17.2	RDW040	4/15/2005	0	0	5	0	0	2	9	14	69	1	0	1	0	70	84	15	0
17.3	RDW060	4/14/2005	0	0	2	0	0	0	24	27	47	0	0	0	1	47	73	26	0
17.4	RDW100	4/14/2005	0	0	0	0	2	24	31	20	21	0	0	2	0	21	41	57	0
17.5	RDW120	4/14/2008	0	0	0	0	13	27	26	13	17	1	0	1	1	18	32	66	0
18.1	TVY030	4/15/2005	0	0	0	0	0	0	13	20	67	0	0	0	0	67	88	13	0
19.5	ROD040																		
19.6	ROD050																		
20.1	LOB020	4/20/2005	0	0	5	0	0	1	2	7	47	38	0	0	0	86	92	8	0
21.1	ISL050	4/20/2005	0	0	0	2	1	7	20	13	1	54	0	2	0	55	69	30	0

Table B-4 (cont.) Page 3

	Station	Date	Geometric mean of particulate substrate size (mm)	Geometric mean substrate diameter (Dgm)	Esimated geometric mean substrate diameter (mm)	Cobble embeddedness (%)	Habitat & shelter value - percent cover of habitat elements (Average of numeric-range-categories medians from 11 Habitat Plots)									Shelter types present (count)	Natural shelter cover (sum LW, brush, overhang,boulders , undercut) (%)	Big shelters cover (sum LW, boulder, artificial) (%)
			(boulders to fines)	per revised calc	anti-log of LSUB_DMM		Filamentous algae cover (%)	Macrophytes cover (%)	Large Woody Debris cover (%)	Small Woody Debris/brush cover (%)	Live tree roots cover (%)	Overhanging vegetation cover (%)	Undercut Banks cover (%)	Boulders cover (%)	Artificial structures cover (%)		[XFC_NAT]	
1.1	BAX030	4/11/2005	2	4	2	66	12	19	0	0	4	21	2	1	2	7	24	4
1.3	BAX050	4/19/2005	0	0	0		0	88	0	0	0	54	0	0	2	3	54	2
2.1	CER020	4/11/2005	8	4	5	17	0	4	0	0	1	5	0	0	8	6	5	8
3.1	COD020	4/11/2005	2	1	1	68	17	3	0	0	0	7	2	0	0	6	9	0
3.2	COD080	4/12/2005	20	22	77	37	0	0	0	2	4	7	6	19	8	7	34	28
3.3	COD120	4/13/2005	89	119	96	49	0	0	0	3	3	5	4	17	7	6	28	23
4.1	STW010	4/12/2005	14	8	14	49	5	1	0	0	1	8	2	11	1	7	21	11
4.2	STW030	4/13/2005	18	14	60	45	0	0	0	2	12	6	7	4	7	6	19	10
5.2	TEM060	4/19/2005	5	2	4	40	0	0	2	2	2	9	1	0	2	7	15	5
5.3	TEM090	4/12/2005	19	15	11	33	2	3	0	0	3	7	7	17	5	8	31	21
6.1	LME100	4/13/2005	28	15	42	37	0	0	0	1	4	9	3	9	13	6	22	22
7.1	SAU030	4/14/2005	18	11	10	25	1	0	0	0	1	4	1	3	59	7	9	63
7.4	SAU080	4/14/2005	95	81	182	49	4	0	0	2	4	12	5	14	3	7	33	17
7.5	SAU130	4/14/2005	26	19	23	55	0	0	1	5	4	10	2	15	1	7	33	18
08.1	PRL020	4/13/2005	22	11	8	24	8	0	0	1	4	1	0	4	40	6	6	44
8.2	PRL080	4/13/2005	27	28	21	36	0	0	0	4	4	3	7	10	2	7	24	13
9.3	LIO080	4/13/2005	27	12	18	32	0	0	16	14	5	9	1	2	2	7	42	20
09.5	LIO130	4/13/2005	43	25	42	35	0	0	1	2	8	1	4	22	0	6	29	23
10.1	AVJ020	4/15/2005	17	11	10	40	1	1	0	3	0	2	0	5	48	6	10	53
10.2	AVJ090	4/15/2005	37	47	25	43	0	0	0	1	7	13	4	3	0	5	20	3
10.3	AVJ110	4/15/2005	44	45	65	40	2	0	0	2	6	19	5	7	0	6	33	7
10.4	AVJ130	4/12/2005	9	5	6	46	0	0	6	6	1	0	3	1	0	6	16	7
11.1	AMO070	4/12/2005	3	2	4	40	2	2	0	5	4	5	0	0	0	7	10	0
11.5	AMO100	4/12/2005	13	10	10	26	0	1	1	12	7	8	0	3	1	9	24	5
11.6	AMO160	4/12/2005	39	24	30	35	4	0	1	5	6	10	0	4	0	7	21	5
11.7	AMO180	4/11/2005	45	42	55	29	6	6	0	1	5	34	3	16	0	7	54	16
11.8	AMO200	4/11/2005	45	29	25	40	16	12	4	3	0	10	6	18	0	7	41	22
12.1	AUD020	4/12/2005	29	23	38	34	0	7	0	4	4	13	2	5	0	7	24	5
13.1	MRS020	4/12/2005	18	15	17	44	0	0	6	15	4	14	12	1	0	8	49	8
14.1	PNG010	4/11/2005	4	3	6	5	0	4	5	8	9	6	5	0	0	7	24	5
14.2	PNG050	4/12/2005	7	6	7	21	0	0	5	4	7	5	13	0	0	5	27	5
15.1	EAS020	4/13/2005	14	9	12	44	0	6	9	4	5	8	9	1	0	7	31	10
15.2	EAS050	4/13/2005	63	47	89	33	0	0	5	9	5	19	5	11	0	7	50	16
16.1	WBB010	4/13/2005	44	39	71	37	0	0	7	3	5	9	6	28	0	7	53	35
17.2	RDW040	4/15/2005	2	2	2	10	0	2	10	12	9	17	10	1	3	8	51	15
17.3	RDW060	4/14/2005	5	4	4		0	1	2	1	3	9	10	0	0	7	22	3
17.4	RDW100	4/14/2005	20	16	20	30	0	0	9	11	11	6	14	0	0	6	40	9
17.5	RDW120	4/14/2008	35	27	44	30	0	0	2	4	3	3	7	10	0	6	26	13
18.1	TVY030	4/15/2005	2	2	2		0	6	5	6	7	10	10	0	0	6	30	5
19.5	ROD040																	
19.6	ROD050																	
20.1	LOB020	4/20/2005	0	0	0	50	2	24	0	13	9	24	3	0	0	8	40	1
21.1	ISL050	4/20/2005	1	0	1	34	0	23	1	6	7	31	0	0	0	5	38	1

Table B-4 (cont.) Page 4

	Station	Date	Average shade and canopy cover (%)	Bank vegetation percent cover on LB+RB, by cover type (Average of numeric-range-categories medians from11 Riparian Plots)							Riparian canopy presence (proportion of reach)
				Big tree Canopy (%)	Small tree Canopy (%)	Small tree Understory (%)	Non-wood Understory (%)	Woody Shrubs Ground Cover (%)	Non-woody Ground Cover (%)	Barren Ground cover (%)	XPCAN
1.1	BAX030	4/11/2005	87	17	13	25	15	10	75	14	0.95
1.3	BAX050	4/19/2005	94	0	8	4	13	11	66	0	0.27
2.1	CER020	4/11/2005	89	12	19	26	11	4	36	53	0.82
3.1	COD020	4/11/2005	55	10	5	7	20	1	28	71	0.27
3.2	COD080	4/12/2005	95	34	10	11	7	31	36	29	0.86
3.3	COD120	4/13/2005	99	59	11	17	2	41	15	46	0.91
4.1	STW010	4/12/2005	93	42	11	33	13	40	27	25	0.64
4.2	STW030	4/13/2005	99	79	2	17	2	18	15	65	1.00
5.2	TEM060	4/19/2005	95	46	17	15	1	59	14	14	1.00
5.3	TEM090	4/12/2005	87	8	24	12	6	4	50	41	0.82
6.1	LME100	4/13/2005	99	56	4	25	1	36	11	53	0.91
7.1	SAU030	4/14/2005	95	31	8	18	5	21	26	49	0.68
7.4	SAU080	4/14/2005	91	34	13	24	7	35	35	24	0.91
7.5	SAU130	4/14/2005	97	57	12	32	1	72	6	18	0.73
08.1	PRL020	4/13/2005	72	7	3	3	1	10	14	69	0.45
8.2	PRL080	4/13/2005	98	42	14	9	1	57	7	30	1.00
9.3	LIO080	4/13/2005	96	69	5	3	0	82	1	4	1.00
09.5	LIO130	4/13/2005	98	39	17	18	0	46	20	24	1.00
10.1	AVJ020	4/15/2005	94	34	20	21	3	18	19	57	0.95
10.2	AVJ090	4/15/2005	99	66	13	23	3	41	9	46	1.00
10.3	AVJ110	4/15/2005	99	58	7	19	2	52	18	22	1.00
10.4	AVJ130	4/12/2005	96	46	13	14	2	44	37	20	0.95
11.1	AMO070	4/12/2005	84	20	11	10	5	11	74	3	1.00
11.5	AMO100	4/12/2005	64	5	6	20	1	43	22	28	0.68
11.6	AMO160	4/12/2005	49	15	3	6	1	32	34	35	0.45
11.7	AMO180	4/11/2005	44	0	7	17	4	22	59	14	0.50
11.8	AMO200	4/11/2005	60	10	40	28	6	9	67	17	0.91
12.1	AUD020	4/12/2005	83	33	6	17	6	9	59	26	0.82
13.1	MRS020	4/12/2005	88	41	18	13	8	15	61	16	0.95
14.1	PNG010	4/11/2005	93	26	19	12	11	20	45	25	0.86
14.2	PNG050	4/12/2005	97	34	32	14	7	9	68	13	1.00
15.1	EAS020	4/13/2005	49	10	0	20	5	9	72	9	0.36
15.2	EAS050	4/13/2005	90	30	16	12	8	4	82	3	1.00
16.1	WBB010	4/13/2005	90	32	26	26	6	15	57	23	1.00
17.2	RDW040	4/15/2005	96	5	2	19	7	5	59	26	0.23
17.3	RDW060	4/14/2005	73	21	8	27	15	8	64	22	0.77
17.4	RDW100	4/14/2005	89	29	16	26	6	16	60	18	0.95
17.5	RDW120	4/14/2008	87	59	25	22	4	7	19	77	1.00
18.1	TVY030	4/15/2005	96	1	0	55	5	10	85	2	0.09
19.5	ROD040										
19.6	ROD050										
20.1	LOB020	4/20/2005	81	22	12	7	3	49	26	21	0.86
21.1	ISL050	4/20/2005	96	12	10	14	1	53	25	20	0.86

Table B-4 (cont.) Page 5

	Station	Date	Human Distrubance Index by Activity (proximity-weighed index)											Combined Human Disurbance Index (all types)
			Buildings	Landfill/Trash	Logging operations	Mining activity	Park/Lawn	Pasture/Range/hayfield	Pavement/Cleared lot	Pipes (Inlet/outlet)	Road/Railroad	Row crops	Wall/Dyke/rip-rap/revetment/Dam	W1_HALL
1.1	BAX030	4/11/2005	0.15	**1.68**	0.00	0.00	0.89	0.00	0.17	0.00	0.44	0.00	0.09	3.42
1.3	BAX050	4/19/2005	0.67	0.75	0.00	0.00	0.06	0.00	0.58	0.00	0.67	0.00	0.00	2.73
2.1	CER020	4/11/2005	0.38	**1.48**	0.00	0.00	0.00	0.00	0.50	0.07	0.18	0.00	0.55	3.15
3.1	COD020	4/11/2005	0.68	1.09	0.00	0.00	0.00	0.00	0.79	0.05	0.09	0.00	0.09	2.79
3.2	COD080	4/12/2005	0.49	**1.34**	0.00	0.00	0.21	0.00	0.03	0.00	0.36	0.00	0.64	3.08
3.3	COD120	4/13/2005	0.62	0.34	0.00	0.00	0.00	0.00	0.00	0.11	0.18	0.00	0.57	1.83
4.1	STW010	4/12/2005	0.41	1.05	0.00	0.00	0.18	0.00	0.32	0.00	0.09	0.00	0.25	2.30
4.2	STW030	4/13/2005	0.68	**1.18**	0.00	0.00	0.52	0.00	0.00	0.05	0.70	0.03	0.61	3.77
5.2	TEM060	4/19/2005	0.65	0.55	0.00	0.00	0.21	0.00	0.33	0.07	0.67	0.00	0.37	2.85
5.3	TEM090	4/12/2005	0.15	**1.39**	0.00	0.00	0.44	0.00	0.38	0.14	0.33	0.05	0.09	2.96
6.1	LME100	4/13/2005	0.64	**1.43**	0.00	0.00	0.00	0.00	0.44	0.14	0.27	0.00	0.80	3.71
7.1	SAU030	4/14/2005	0.50	0.64	0.00	0.00	0.05	0.00	0.27	0.27	0.03	0.00	1.02	2.78
7.4	SAU080	4/14/2005	0.00	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	1.14
7.5	SAU130	4/14/2005	0.03	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.23
08.1	PRL020	4/13/2005	0.76	0.68	0.00	0.00	0.14	0.00	0.24	0.00	0.67	0.00	0.70	3.19
8.2	PRL080	4/13/2005	0.36	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.07	1.31
9.3	LIO080	4/13/2005	0.68	0.34	0.00	0.00	0.03	0.00	0.67	0.14	0.67	0.00	0.20	2.73
09.5	LIO130	4/13/2005	0.00	0.07	0.00	0.00	0.00	0.00	0.36	0.09	0.00	0.00	0.00	0.52
10.1	AVJ020	4/15/2005	0.65	**1.43**	0.00	0.00	0.05	0.00	0.20	0.17	0.33	0.00	0.92	3.75
10.2	AVJ090	4/15/2005	0.21	0.34	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.03	0.69
10.3	AVJ110	4/15/2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.45	0.00	0.00	0.50
10.4	AVJ130	4/12/2005	0.06	0.73	0.00	0.00	0.29	0.00	0.24	0.00	0.64	0.00	0.00	1.96
11.1	AMO070	4/12/2005	0.00	0.00	0.06	0.49	0.00	0.00	0.03	0.09	0.49	0.00	0.07	1.22
11.5	AMO100	4/12/2005	0.15	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.36	0.14	1.48
11.6	AMO160	4/12/2005	0.12	0.05	0.00	0.00	0.00	0.18	0.09	0.00	0.45	0.03	0.07	0.99
11.7	AMO180	4/11/2005	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.05	0.69
11.8	AMO200	4/11/2005	0.00	0.28	0.00	0.00	0.00	0.00	0.20	0.09	0.52	0.00	0.03	1.11
12.1	AUD020	4/12/2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.1	MRS020	4/12/2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14.1	PNG010	4/11/2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.61
14.2	PNG050	4/12/2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.1	EAS020	4/13/2005	0.09	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.24	0.00	0.00	0.74
15.2	EAS050	4/13/2005	0.06	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.09
16.1	WBB010	4/13/2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
17.2	RDW040	4/15/2005	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.24
17.3	RDW060	4/14/2005	0.23	0.00	0.00	0.00	0.00	0.00	0.12	0.05	0.14	0.00	0.05	0.58
17.4	RDW100	4/14/2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.5	RDW120	4/14/2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18.1	TVY030	4/15/2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.5	ROD040													
19.6	ROD050													
20.1	LOB020	4/20/2005	0.21	0.32	0.00	0.00	0.27	0.00	0.41	0.00	0.00	0.00	0.20	1.42
21.1	ISL050	4/20/2005	0.00	0.34	0.00	0.00	0.00	0.00	0.67	0.00	0.67	0.00	0.00	1.67

Note: numbers in brown font are higher than 0.5

Table C-1: Inventory and deployment periods of continuous monitoring events conducted in 2004-2006

Watershed	Station	Station #	Station Name	# of events	Spring	Summer	Fall	Winter
Baxter Creek	BAX030	1.1	Baxter at Booker	4	3/19/04 - 3/26/04	7/15/04 - 7/22/04	9/3/04 - 9/9/04	1/12/05 - 1/27/05
	BAX045	1.2	Lower Baxter at Gateway Project	2	3/19/04 - 3/26/04			1/12/05 - 1/27/05
Cerrito Creek	CER020	2.1	Creekside Park	4	3/19/04 - 3/26/04	7/15/04 - 7/22/04	9/3/04 - 9/9/04	1/12/05 - 1/27/05
Codornices Creek	COD020	3.1	Codornices at 2nd Street	4	3/5/04 - 3/12/04	7/15/04 - 7/22/04	9/3/04 - 9/9/04	1/12/05 - 1/27/05
	COD080	3.2	Albina Ave.	4	3/5/04 - 3/12/04	7/15/04 - 7/22/04	9/3/04 - 9/9/04	1/12/05 - 1/27/05
	COD120	3.3	Live Oak Park	3		7/15/04 - 7/22/04	9/3/04 - 9/9/04	1/12/05 - 1/27/05
Strawberry Creek	STW020	4.1a	Above Strawberry Creek Park	3	3/5/04 - 3/12/04	7/23/04 - 7/30/04		1/28/05 - 2/3/05
	STW030	4.2	UC Berkeley at Oxford	3	3/5/04 - 3/12/04	7/23/04 - 7/30/04		1/28/05 - 2/3/05
Temescal Creek	TEM060	5.2	Birch Court	4	5/14/04 - 5/21/04	7/23/04 - 7/30/04	9/10/04 - 9/20/04	1/28/05 - 2/3/05
	TEM090	5.3	Above Lake Temescal	5	5/14/04 - 5/21/04	7/23/04 - 7/30/04 8/2/04 - 8/9/04	9/10/04 - 9/20/04	1/28/05 - 2/3/05
Glen Echo Creek	LME100	6.1	Glen Echo at 29th Street	3	4/9/04 - 4/16/04	7/23/04 - 7/30/04		1/28/05 - 2/3/05
	LME130	6.2	Oak Glen Park	1				1/28/05 - 2/3/05
Sausal Creek	SAU030	7.1	Sausal at East 22nd	4	5/14/04 - 5/21/04	8/2/04 - 8/9/04	9/10/04 - 9/20/04	2/4/05 - 2/10/05
	SAU070	7.3	Sausal at El Centro	1		8/2/04 - 8/9/04		
	SAU080	7.4	Dimond Park	3	5/14/04 - 5/21/04		9/10/04 - 9/20/04	2/4/05 - 2/10/05
	SAU130	7.5	Palo Seco *(tributary)*	3		8/2/04 - 8/9/04	9/10/04 - 9/20/04	2/4/05 - 2/10/05
Peralta Creek	PRL020	8.1	Cesar Chavez Park	3	4/9/04 - 4/16/04	8/2/04 - 8/9/04		2/4/05 - 2/10/05
	PRL080	8.2	Peralta at Rettig	3	4/9/04 - 4/16/04	8/2/04 - 8/9/04		2/4/05 - 2/10/05
Lion Creek	LIO080	9.3	Mills College at Alumni House	3	5/14/04 - 5/21/04	8/12/04 - 8/18/04		2/11/05 - 2/17/05
	LIO090	9.4	Mills College above Aliso	2	5/14/04 - 5/21/04			2/11/05 - 2/17/05
	LIO130	9.5	Horseshoe Creek *(tributary)*	2		8/12/04 - 8/18/04		2/11/05 - 2/17/05
Arroyo Viejo	AVJ020	10.1	Arroyo Viejo Rec. Center	3	4/9/04 - 4/16/04	8/12/04 - 8/18/04		2/11/05 - 2/17/05
	AVJ110	10.3	Rifle Range	3	4/9/04 - 4/16/04	8/12/04 - 8/18/04		2/11/05 - 2/17/05
	AVJ130	10.4	Knowland Park Zoo	3	4/9/04 - 4/16/04	8/12/04 - 8/18/04		2/11/05 - 2/17/05
Arroyo Mocho	AMO070	11.1	Above Vulcan Bridge (Zone 7)	2	4/23/04 - 4/30/04			2/18/05 - 2/24/05
	AMO100	11.5	Wente Street	3	4/23/04 - 4/30/04	8/20/04 - 9/1/04		2/18/05 - 2/24/05
	AMO160	11.6	Above SBA Zone 7	3	4/23/04 - 4/30/04	8/20/04 - 9/1/04		2/18/05 - 2/24/05
	AMO180	11.7	Hetch Hetchy	2	4/23/04 - 4/30/04			2/18/05 - 2/24/05
	AMO200	11.8	County Line	2	4/23/04 - 4/30/04			2/18/05 - 2/24/05
Pine Gulch Creek	PNG010	14.1	Lower Pine Gulch	3	4/22/05 - 4/29/05	8/10/05 - 8/18/05		1/18/06 - 1/26/06
	PNG050	14.2	Teixeira	3	4/22/05 - 4/29/05	8/10/05 - 8/18/05		2/9/06 - 2/21/06

Table C-1 (cont.)

Watershed	Station	Station #	Station Name	# of events	Spring	Summer	Fall	Winter
Easkoot Creek	EAS020	15.1	Easkoot	3	4/22/05 - 4/29/05	8/10/05 - 8/18/05		1/18/06 - 1/26/06
	EAS050	15.2	Fitzhenry *(tributary)*	3	4/22/05 - 4/29/05	8/10/05 - 8/18/05		1/18/06 - 1/26/06
Webb Creek	WBB010	16.1	Steep Ravine	3	4/22/05 - 4/29/05	8/10/05 - 8/18/05		1/18/06 - 1/26/06
Redwood Creek	RDW040	17.2	Green Gulch *(tributary)*	3	5/6/05 - 5/13/05	8/19/05 - 9/1/05		1/27/06 - 2/7/06
	RDW060	17.3	Lower Redwood	3	5/6/05 - 5/13/05	8/19/05 - 9/1/05		1/27/06 - 2/7/06
	RDW100	17.4	Miwok Bridge	3	5/6/05 - 5/13/05	8/19/05 - 9/1/05		1/27/06 - 2/7/06
	RDW120	17.5	Muir Woods	3	5/6/05 - 5/13/05	8/19/05 - 9/1/05		1/27/06 - 2/7/06
Tennessee Valley Creek	TVY030	18.1	Tennessee Valley	3	4/22/05 - 4/29/05	8/10/05 - 8/18/05		1/18/05 - 1/26/06
Rodeo Creek	ROD010	19.1	Rodeo Lagoon Foot Bridge	3	6/2/05 - 6/24/05		9/2/05 - 9/12/05	2/9/06 - 2/21/06
	ROD020	19.2	Rodeo Lagoon Car Bridge	3	6/2/05 - 6/24/05		9/2/05 - 9/12/05	2/9/06 - 2/21/06
	ROD030	19.3	Rodeo Lake	3	6/2/05 - 6/24/05		9/2/05 - 9/12/05	2/9/06 - 2/21/06
	ROD040	19.5	Gerbode *(tributary)*	3	6/2/05 - 6/24/05		9/2/05 - 9/12/05	2/9/06 - 2/21/06
	ROD050	19.6	Lower Rodeo	3	6/2/05 - 6/24/05		9/2/05 - 9/12/05	2/9/06 - 2/21/06
Lobos Creek	LOB020	20.1	Lobos below Lincoln	3	5/6/05 - 5/13/05	8/19/05 - 9/1/05		1/27/06 - 2/7/06
Islais Creek	ISL050	21.1	Glen Canyon Park	2	5/6/05 - 5/13/05			1/27/06 - 2/7/06

Table C-2: Summary statistics of continuous field monitoring deployments in years 4&5

Table C-2a: Summary statistics of continuous monitoring conducted in Baxter, Cerrito and Codornices Creeks

Parameter	Units		Spring		Summer	Fall	Winter		Spring	Summer	Fall	Winter	Water Quality Benchmarks (Thresholds). Note: Highlighted results in table indicate benchmarks were not met.
		Start Date	3/19/04		7/15/04	9/3/04	1/12/05		3/19/04	7/15/04	9/3/04	1/12/05	
		End Date	3/26/04		7/22/04	9/9/04	1/27/05		3/26/04	7/22/04	9/9/04	1/27/05	
			BAX030	**BAX045**	**BAX030**	**BAX030**	**BAX030**	**BAX045**	**CER020**	**CER020**	**CER020**	**CER020**	
Temp	°C	**Min**	14.4	11.6	18.6	19.4	11.1	10.3	13.9	18	18.3	11.2	
		Median	15.9	14.4	22.4	20.2	11.9	11.2	15	19.2	19.5	12	
		Max	17.8	16.7	22.4	22.6	13.2	13.1	16	20.9	20.9	13.3	>24 — 24 °C, Lethal Limit
		7-day Mean	16.1	14.8	20.3	20.7	12.1	11.3	15.2	19.6	19.7	12.1	>14.8 Coho, >17 Steelhead
		Accuracy	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	
DO	mg/L	**Min**	8.3	1.2	*2.4*	2.8	*10.5*	9.0	6.7	*6.8*	*6.6*	*9.7*	
		Median	9.7	6.5	*6.0*	5.0	*11.2*	10.3	8.1	*7.6*	*7.3*	*10.9*	
		Max	15.6	9.7	*10.2*	6.9	*14.3*	11.3	9.8	*8.9*	*8.0*	*11.7*	*Coldwater and Warmwater limits*
		7-day Avg. Min	8.7	2.6	3.4	3.7	*10.9*	9.8	7.4	*7.0*	*7.0*	*10.6*	<7 mg/L COLD, < 5 mg/L WARM
		Accuracy (MQO: ± 0.5 mg/L)	*0.3*	*0.49*	*11.8%*[2]	*0.3*	*0.7*	*0.1*	*0.4*	*6%*[2]	*1.8*	*0.9*	
pH		**Min**	7.3	7.2	*7.0*	7.7	7.6	7.7	7.6	7.2	7.5	7.9	< 6.5 — 6.5 Basin Plan Minimun
		Median	8.1	7.7	*7.7*	8.0	8.2	8.1	8.2	7.7	7.7	8.3	
		Max	8.6	7.8	*8.1*	8.2	8.6	8.4	8.5	7.9	7.9	8.4	> 8.5 — 8.5 Basin Plan Maximui
		Accuracy (MQO: ± 0.5)	*0.1*	*0.03*	*NR*	*0.02*	*0.04*	*0.03*	*0.03*	*0.1*	*0.1*	*0.1*	
SC	µS/cm	**Min**	87	79	141	470	104	115	150	*101*	644	167	
		Median	706	620	615	633	518	624	731	*465*	685	869	
		Max	739	637	650	691	568	678	909	*536*	771	892	>1000 µS/cm (potential pollution)
		Accuracy (MQO: ± 5.0%)	*2.3%*	*0.3%*	*4.8%*	*1%*	*0.2%*	*0.1%*	*0.5%*	*13.3%*	*1.1%*	*0.2%*	>2000 µS/cm (freshwater limit)
		n	*657*	*664*	*678*	*582*	*1441*	*1441*	*664*	*672*	*581*	*1440*	

Parameter	Units		Spring		Summer			Fall			Winter			Benchmarks
		Start Date	3/5/04		7/15/04			9/3/04			1/12/05			
		End Date	3/12/04		7/22/04			9/9/04			1/27/05			
			COD020	**COD080**	**COD020**	**COD080**	**COD120**	**COD020**	**COD080**	**COD120**	**COD020**	**COD080**	**COD120**	
Temp	°C	**Min**	11.8	12.1	16.7	15.8	16.2	16.3	16.4	16.6	8.9	10	10.1	
		Median	13.8	13.8	17.9	17.2	17.5	19.2	17.5	17.6	10.5	11.1	11.1	
		Max	15.7	16.4	20.1	19.2	18.9	21.5	18.9	18.9	14	13.1	12.8	>24
		7-day Mean	14.6	14.5	18.5	17.7	18.0	19.4	17.8	17.8	10.8	11.3	11.3	>14.8, >17
		Accuracy	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	
DO	mg/L	**Min**	*6.7*	9.5	*5.2*	7.1	*9.4*	0.2	0.2	9.0	7.9	10.2	11.1	
		Median	*7.8*	10.4	*6.5*	8.5	*10.3*	1.0	5.3	9.4	10.3	11.1	11.4	
		Max	*8.9*	12.7	*9.0*	10.1	*11.5*	5.0	8.3	9.8	17.4	11.5	11.9	
		7-day Avg. Min	*7.1*	10.1	5.7	7.7	*10.0*	0.3	0.8	9.1	9.6	10.7	11.2	<7, < 5
		Accuracy (MQO: ± 0.5 mg/L)	*1.9*	*0.4*	*7.6%*[2]	*0.8%*[2]	*12.4%*[2]	*0.1*	*0.45*	*0.17*	*0.3*	*0.4*	*0.4*	
pH		**Min**	7.9	8.2	7.7	7.9	7.7	7.0	7.9	8.2	7.4	*7.9*	7.5	< 6.5
		Median	8.0	8.3	7.8	8.0	7.9	7.0	8.1	8.3	7.8	*8.4*	8.0	
		Max	8.1	8.3	8.0	8.1	8.1	7.0	8.2	8.4	8.3	*8.5*	8.3	> 8.5
		Accuracy (MQO: ± 0.5)	*0.1*	*0.2*	*0.1*	*0.04*	*0.1*	*0.1*	*0*	*0.1*	*0.2*	*NR*	*0.1*	
SC	µS/cm	**Min**	731	721	*502*	*373*	*309*	719	579	479	255	*190*	174	
		Median	740	733	*589*	*540*	*574*	742	649	556	763	*758*	771	
		Max	745	767	*615*	1003	*594*	798	659	584	771	*765*	781	>1000, >2000
		Accuracy (MQO: ± 5.0%)	*0.8%*	*1.1%*	*7.6%*	*11.9%*	*NR*	*0.8%*	*0.8%*	*1.8%*	*2.9%*	*NR*	*0.2%*	
		n	*653*	*652*	*655*	*654*	*642*	*568*	*564*	*564*	*1419*	*1402*	*1407*	

Notes: Color-Highlighted results in table indicate benchmarks were not met.
Red italicized font indicates that data did not meet SWAMP MQO's. **NR:** Value not recorded.
1 = Post-deployment accuracy checks performed during annual lab calibration - Temp. probe met SWAMP MQO's.
2 = Accuracy value gleaned from percent saturation check; substituted 5% for 0.5 mg/L SWAMP MQO.

Table C-2b: Summary statistics of continuous monitoring conducted in Strawberry and Temescal Creeks

			Spring		Summer		Winter		Evaluation thresholds
		Start Date	3/5/04		7/23/04		1/28/05		
		End Date	3/12/04		7/30/04		2/3/05		
			STW020	STW030	STW020	STW030	STW020	STW030	
Temp	°C	Min	12.9	12.3	17.4	17.6	12	11.5	
		Median	14.4	14.3	17.9	18.4	12.8	12.7	
		Max	15.5	16.3	18.9	20	14	14.6	>24
		7-day Mean	15.0	15.1	18.2	18.9	13.1	13.3	>14.8, >17
		Accuracy	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	
DO	mg/L	Min	9.3	10.3	7.8	7.9	0.1	9.7	
		Median	9.7	10.7	8.4	8.5	0.2	10.1	
		Max	10.3	11.3	9.0	8.8	10.6	10.6	
		7-day Avg. Min	9.5	10.4	7.9	8.2	0.2	9.9	<7, < 5
		Accuracy (MQO: ± 0.5 mg/L)	0.1	0.9	2.3% [2]	1.3% [2]	0.41 [3]	0.1	
pH		Min	8.1	8.1	7.8	7.0	7.8	7.8	< 6.5
		Median	8.2	8.2	7.9	7.4	8.1	8.0	
		Max	8.5	8.3	8.1	7.5	8.2	8.3	> 8.5
		Accuracy (MQO: ± 0.5)	0.02	0.2	0.04	0.1	0.04	0.1	
SC	µS/cm	Min	543	564	327	291	203	182	
		Median	588	585	397	391	569	570	
		Max	621	616	453	453	601	621	>1000, >2000
		Accuracy (MQO: ± 5.0%)	3.8%	1.3%	0.2%	0.9%	0.4%	0.6%	
		n	651	652	664	659	563	563	

Evaluation thresholds: for details see key on Table C-2-a

			Spring		Summer		Summer 2	Fall		Winter		Evaluation thresholds
		Start Date	5/14/04		7/23/04		8/2/04	9/10/04		1/28/05		
		End Date	5/21/04		7/30/04		8/9/04	9/20/04		2/3/05		
			TEM060	TEM090	TEM060	TEM090	TEM090	TEM060	TEM090	TEM060	TEM090	
Temp	°C	Min	16.4	14.4	17.8	16.5	16.7	17.9	13.8	11.4	9.3	
		Median	16.7	14.7	18.3	16.9	17.1	18.6	17	13.1	10.6	
		Max	17.7	15.4	19.2	18	17.7	19.3	18.3	14.6	12.5	>24
		7-day Mean	17	14.8	18.6	17	17.3	18.6	17.2	13.5	10.7	>14.8, >17
		Accuracy	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	
DO	mg/L	Min	9.1	9.5	9.0	4.7	8.1	8.7	4.3	6.2	10.7	
		Median	9.4	10.1	9.4	8.5	9.2	9.0	8.7	10.2	11.2	
		Max	9.8	10.5	10.1	10.0	9.6	9.3	10.7	11.5	11.6	
		7-day Avg. Min	9.2	9.8	9.3	6.1	8.6	8.8	7.1	7.4	11.0	<7, < 5
		Accuracy (MQO: ± 0.5 mg/L)	0.01	0.3	5.3% [2]	6.8% [2]	0.4% [2]	0.3	0.1	0.3	0.1	
pH		Min	7.4	8.1	7.7	8.2	8.0	8.3	7.0	7.7	7.1	< 6.5
		Median	8.2	8.3	8.0	8.3	8.1	8.3	7.9	8.3	7.4	
		Max	8.2	8.4	8.0	8.4	8.3	8.4	8.0	9.1	7.5	> 8.5
		Accuracy (MQO: ± 0.5)	0.1	0.04	0.01	0.01	NR	0.04	0.1	0.04	0.1	
SC	µS/cm	Min	672	794	600	518	985	391	266	233	236	
		Median	690	1021	645	1134	1085	651	1181	512	889	
		Max	708	1067	676	1177	1186	687	1323	697	938	>1000, >2000
		Accuracy (MQO: ± 5.0%)	0.7%	1.3%	0.3%	0.1%	1.6%	1.7%	1.1%	1.8%	0.1%	
		n	671	673	651	661	654	836	958	562	558	

Evaluation thresholds: for details see key on Table C-2-a

Notes:
Red italicized font indicates that data did not meet SWAMP MQO's. **NR:** Value not recorded.
1 = Post-deployment accuracy checks performed during annual lab calibration - Temp. probe met SWAMP MQO's.
2 = Accuracy value gleaned from percent saturation check; substituted 5% for 0.5 mg/L SWAMP MQO.
3 = Data met SWAMP MQO's but field operator noted suspected probe failure during rain event - data is unreliable.

Table C-2c: Summary statistics of continuous monitoring conducted in Glen Echo, Peralta and Sausal Creeks

Parameter	Unit		Spring	Summer	Winter		Spring		Summer		Winter		Evaluation thresholds
		Start Date	4/9/04	7/23/04	1/28/05		4/9/04		8/2/04		2/4/05		
		End Date	4/16/04	7/30/04	2/3/05		4/16/04		8/9/04		2/10/05		
			LME100	**LME100**	**LME100**	**LME130**	**PRL020**	**PRL080**	**PRL020**	**PRL080**	**PRL020**	**PRL080**	
Temp	°C	**Min**	12.8	16.6	10.3	10.2	13.2	12.2	16.4	16.6	11.3	10.8	
		Median	13.8	17.3	11.2	11.1	14.1	13.5	17.9	17.8	12.3	11.9	
		Max	15.4	18.6	12.2	12.2	18.5	15.7	22.5	20.2	13.7	12.8	>24
		7-day Mean	14.1	17.7	11.6	11.3	14.5	13.9	19.2	18.6	12.5	11.9	>14.8, >17
		Accuracy	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	
DO	mg/L	**Min**	7.7	7.0	9.6	10.4	8.8	9.0	4.9	7.5	8.9	9.5	
		Median	8.4	7.6	10.0	10.8	10.4	9.8	6.5	8.2	9.7	10.1	
		Max	9.5	8.1	10.4	12.2	16.2	10.5	11.1	8.6	11.1	10.9	
		7-day Avg. Min	8.0	7.3	9.8	10.6	8.9	9.4	5.4	7.7	9.2	9.9	<7, < 5
		Accuracy (MQO: ± 0.5 mg/L)	0.03	1.5% [2]	0.1	0.1	5.2 [3]	0.4	1.3% [2]	0.9% [2]	0.1	0.04	
pH		**Min**	7.4	7.4	7.3	8.0	7.9	7.9	7.3	7.5	7.8	7.4	< 6.5
		Median	7.6	7.6	7.3	8.2	8.1	8.1	7.4	7.6	8.1	7.8	
		Max	8.0	7.7	7.4	8.4	8.8	8.2	8.1	7.7	8.3	8.0	> 8.5
		Accuracy (MQO: ± 0.5)	0.1	0.1	0.1	0.01	0.3 [3]	0.1	0.2	0.04	0.03	0.1	
SC	µS/cm	**Min**	271	625	367	288	59	428	413	233	174	142	
		Median	618	660	525	517	485	517	445	245	617	729	
		Max	636	712	569	580	497	576	469	276	633	756	>1000, >2000
		Accuracy (MQO: ± 5.0%)	4.8%	0.3%	0.2%	0.8%	4.2% [3]	4.1%	0.1%	0.6%	0.2%	0.5%	
		n	671	639	548	557	322	665	653	654	568	565	

Evaluation thresholds: for details see key on Table C-2-a

Parameter	Unit		Spring		Summer			Fall			Winter			Evaluation thresholds
		Start Date	5/14/04		8/2/04			9/10/04			2/4/05			
		End Date	5/21/04		8/9/04			9/20/04			2/10/05			
			SAU030	**SAU080**	**SAU030**	**SAU070**	**SAU130**	**SAU030**	**SAU080**	**SAU130**	**SAU030**	**SAU080**	**SAU130**	
Temp	°C	**Min**	14	13.5	15.8	16	13.9	15.1	16.1	12.5	10.1	8.9	8.5	
		Median	14.7	14.8	16.8	17.1	14.8	17.3	16.7	14.8	11.2	10.3	9.3	
		Max	16.3	18.4	19	17.9	15.9	18.9	17.4	15.5	12.1	11.8	10	>24
		7-day Mean	15.1	15.4	17.5	17.1	15.3	17.4	16.8	14.9	11.3	10.3	9.3	>14.8, >17
		Accuracy	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	
DO	mg/L	**Min**	8.5	4.0	7.2	7.9	8.1	7.1	0.3	7.6	10.8	10.3	11.1	
		Median	9.5	6.6	8.6	10.2	8.6	8.3	1.9	8.1	11.4	11.0	11.7	
		Max	11.1	10.7	11.2	15.0	9.0	11.3	6.8	9.8	12.0	12.0	12.2	
		7-day Avg. Min	8.8	4.9	7.7	8.5	8.3	7.5	0.9	7.8	11.2	10.5	11.5	<7, < 5
		Accuracy (MQO: ± 0.5 mg/L)	0.2	0.1	5% [2]	6.6% [2]	1.2% [2]	0.2	0.6	0.1	0.7	0.3	0.4	
pH		**Min**	7.6	7.4	7.6	7.7	7.8	7.7	6.7	7.7	7.8	6.7	7.9	< 6.5
		Median	7.7	7.8	7.7	7.8	7.9	7.8	6.9	7.9	8.0	7.2	8.0	
		Max	7.9	8.3	8.1	8.1	8.0	8.2	7.1	8.0	8.2	7.4	8.1	> 8.5
		Accuracy (MQO: ± 0.5)	0.1	0.1	0.1	0.04	0.02	0.04	0.03	0.1	0.1	2	0.02	
SC	µS/cm	**Min**	330	634	210	960	726	249	1007	675	202	202	408	
		Median	464	759	419	969	739	407	1066	735	612	713	540	
		Max	490	781	438	975	749	459	1104	747	645	754	586	>1000, >2000
		Accuracy (MQO: ± 5.0%)	7.3%	3.1%	0.9%	0.7%	0.7%	1.4%	0.7%	0.8%	0.4%	0.4%	0.8%	
		n	669	667	654	469	655	828	831	958	573	570	567	

Evaluation thresholds: for details see key on Table C-2-a

Notes:
Red italicized font indicates that data did not meet SWAMP MQO's. **NR:** Value not recorded.
1 = Post-deployment accuracy checks performed during annual lab calibration - Temp. probe met SWAMP MQO's.
2 = Accuracy value gleaned from percent saturation check; substituted 5% for 0.5 mg/L SWAMP MQO.
3 = Data met SWAMP MQO's but field operator noted that probe was dewatered during deployment. Data has been clipped but may be unreliable.

Table C-2d: Summary statistics of continuous monitoring conducted in Lion and Arroyo Viejo Creeks

Parameter	Statistic	Spring LIO080	Spring LIO090	Summer LIO080	Summer LIO130	Winter LIO080	Winter LIO090	Winter LIO130	Evaluation thresholds
	Start Date	5/14/04		8/12/04		2/11/05			
	End Date	5/21/04		8/18/04		2/17/05			
Temp °C	**Min**	15.2	13.7	16.8	14.9	11	10.6	10.6	
	Median	16.4	14.2	17.2	15.9	12.5	12.4	11.5	
	Max	19.2	15.3	18.7	18.4	13.5	13.5	12.8	>24
	7-day Mean	17	14.4	18	16.4	12.5	12.4	12	>14.8, >17
	Accuracy	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	
DO mg/L	**Min**	8.6	10.1	4.6	8.4	10.4	*11.0*	10.6	
	Median	9.1	10.5	6.6	8.9	10.9	*11.7*	10.9	
	Max	9.5	10.9	8.4	9.3	11.7	*12.9*	11.5	
	7-day Avg. Min	8.8	10.4	5.3	8.6	10.7	*11.5*	10.7	<7, < 5
	Accuracy (MQO: ± 0.5 mg/L)	*0.04*	*0.4*	*0.3*	*0.2*	*0.3*	***0.5***	*0.1*	
pH	**Min**	7.7	7.6	7.1	8.1	6.9	6.5	6.7	< 6.5
	Median	7.8	7.8	7.2	8.2	7.7	7.5	7.1	
	Max	7.9	7.9	7.5	8.2	7.8	7.8	7.5	> 8.5
	Accuracy (MQO: ± 0.5)	*0.1*	*0.1*	*0.1*	*0.02*	*0.02*	*0.03*	*0.2*	
SC µS/cm	**Min**	762	*639*	873	584	90	2	79	
	Median	792	*735*	908	613	801	689	564	
	Max	824	*785*	959	622	839	820	586	>1000, >2000
	Accuracy (MQO: ± 5.0%)	*1.8%*	***7.8%***	*0.7%*	*0.3%*	*0.1%*	*0.2%*	*1.7%*	
	n	*668*	*666*	*575*	*574*	*567*	*566*	*572*	

Evaluation thresholds: for details see key on Table C-2-a

Parameter	Statistic	Spring AVJ020	Spring AVJ110	Spring AVJ130	Summer AVJ020	Summer AVJ110	Summer AVJ130	Winter AVJ020	Winter AVJ110	Winter AVJ130	Evaluation thresholds
	Start Date	4/9/04			8/12/04			2/11/05			
	End Date	4/16/04			8/18/04			2/17/05			
Temp °C	**Min**	11.6	9.2	10.4	16.3	13.8	16.2	11.3	9.3	9.6	
	Median	13.3	11.1	12.5	17.9	15.2	17.3	12.4	10.8	11.1	
	Max	16.9	14.5	15.6	21.3	18.2	18.5	13.9	12	12.9	>24
	7-day Mean	14.1	11.9	13.2	18.7	15.7	17.4	12.5	11.1	11.9	>14.8, >17
	Accuracy	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	
DO mg/L	**Min**	8.7	9.1	7.1	6.3	4.5	*0.0*	9.5	10.3	9.5	
	Median	9.6	10.3	7.7	8.1	6.7	*2.4*	10.2	10.8	9.9	
	Max	11.9	11.3	8.5	10.5	10.0	*4.6*	11.6	11.4	10.8	
	7-day Avg. Min	9.0	9.9	7.2	7.0	4.8	0.7	9.8	10.6	9.6	<7, < 5
	Accuracy (MQO: ± 0.5 mg/L)	*0.01*	*0.03*	*0.03*	*0.02*	*0.2*	*0.06*	*0.1*	*0.06*	*0.2*	
pH	**Min**	7.7	7.6	7.9	7.4	6.7	7.4	7.4	7.1	7.8	< 6.5
	Median	7.8	7.7	7.9	7.6	7.0	7.5	8.0	7.2	8.1	
	Max	8.2	7.8	8.0	7.9	7.1	7.7	8.3	7.4	8.4	> 8.5
	Accuracy (MQO: ± 0.5)	*0.03*	*0.03*	*0.1*	*0.04*	*0.01*	*0.03*	*0.1*	*0.1*	*0.1*	
SC µS/cm	**Min**	*335*	337	*814*	582	295	988	104	147	*132*	
	Median	*651*	340	*822*	674	342	996	670	385	*873*	
	Max	*692*	347	*827*	736	357	1005	702	405	*907*	>1000, >2000
	Accuracy (MQO: ± 5.0%)	***5.4%***	*4.4%*	***8.9%***	*0.3%*	*0.1%*	*0.2%*	*0.1%*	*0.1%*	***NR***	
	n	*661*	*662*	*660*	*570*	*578*	*580*	*571*	*563*	*561*	

Evaluation thresholds: for details see key on Table C-2-a

Notes:
Red italicized font indicates that data did not meet SWAMP MQO's. **NR:** Value not recorded.
1 = Post-deployment accuracy checks performed during annual lab calibration - Temp. probe met SWAMP MQO's.
2 = Accuracy value gleaned from percent saturation check; substituted 5% for 0.5 mg/L SWAMP MQO.

Table C-2e: Summary statistics of continuous monitoring conducted in Arroyo Mocho, Pine Gulch and Easkoot Creeks

		Spring					Summer		Winter					Evalutation thresholds: for details see key on Table C-2-a
	Start Date	4/23/04					8/20/04		2/18/05					
	End Date	4/30/04					9/1/04		2/24/05					
		AMO070	AMO100	AMO160	AMO180	AMO200	AMO100	AMO160	AMO070	AMO100	AMO160	AMO180	AMO200	
Temp °C	Min	14.1	14.8	15	12.9	10.1	18.9	17.5	9.6	9.1	8.5	8.0	6.1	
	Median	19.4	19	17.4	16.5	11.6	21.8	18.8	11.4	10.9	10.3	10	8.5	
	Max	25.2	24	19.3	26.9	13.2	27.7	20.3	13.6	13.7	11.9	11.7	12	>24
	7-day Mean	20.8	20.3	17.7	18.7	12.3	22.5	18.8	11.4	11	10.6	10.3	8.8	>14.8, >17
	Accuracy	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	
DO mg/L	Min	6.2	8.0	1.2	8.5	0.1	6.7	0.1	10.4	9.8	10.4	*10.2*	9.9	
	Median	8.8	8.9	5.4	9.2	0.9	7.9	0.2	10.9	10.4	11.0	*10.7*	10.8	
	Max	14.8	10.4	7.7	10.7	3.6	10.5	0.8	11.9	11.2	11.7	*11.3*	11.7	
	7-day Avg. Min	6.5	8.2	3.7	8.6	0.7	7.0	0.2	10.5	10.1	10.7	*10.5*	10.3	<7, < 5
	Accuracy (MQO: ± 0.5 mg/L)	*0.3*	*0.2*	*0.2*	*0.2*	*0.1*	*0.3*	*0.4*	*0.1*	*0.3*	*0.3*	***0.8***	*0.01*	
pH	Min	7.3	7.8	7.5	8.2	7.0	7.3	7.4	7.9	8.0	7.0	8.2	7.2	< 6.5
	Median	8.1	8.0	7.7	8.3	7.1	7.5	7.5	8.1	8.1	7.1	8.4	7.3	
	Max	9.2	9.1	7.9	8.3	7.2	8.8	7.5	8.2	8.4	7.2	8.6	7.6	> 8.5
	Accuracy (MQO: ± 0.5)	*0.1*	*0.02*	*0.03*	*0.1*	*0.2*	*0.1*	*0.01*	*0.1*	*0.04*	*0.2*	*0.1*	*0.01*	
SC µS/cm	Min	357	267	923	818	682	358	1490	142	141	192	153	99	
	Median	369	288	941	836	703	390	1578	203	228	315	283	140	
	Max	380	300	957	863	727	414	1623	318	468	414	389	196	>1000, >2000
	Accuracy (MQO: ± 5.0%)	*2.9%*	*4.1%*	*1.4%*	*3%*	*0.2%*	*1.2%*	*0.1%*	*0.2%*	*1.0%*	*3.1%*	*0.9%*	*0.6%*	
	n	*673*	*656*	*670*	*500*	*669*	*1050*	*1136*	*373*	*561*	*547*	*565*	*383*	

		Spring		Dry		Wet		Spring		Dry		Wet		Evalutation thresholds: for details see key on Table C-2-a
	Start Date	4/22/05		8/10/05		1/18/06	2/9/06	4/22/05		8/10/05		1/18/06		
	End Date	4/29/05		8/18/05		1/26/06	2/21/06	4/29/05		8/18/05		1/26/06		
		PNG010	PNG050	PNG010	PNG050	PNG010	PNG050	EAS020	EAS050	EAS020	EAS050	EAS020	EAS050	
Temp °C	Min	11.6	9.9	13.8	12.9	8.6	7.1	10.6	10.7	14.5	13.4	8.8	9.2	
	Median	12	11.6	14.4	13.5	9.9	9.5	12.3	11.8	15.2	13.8	10.2	10.5	
	Max	12.9	13	16	15.4	11.3	12.4	15.4	13.3	17.8	15.3	12.1	11.9	>24
	7-day Mean	NR*	11.8	14.9	14.1	10.3	11.5	12.8	12.1	15.8	14.2	10.6	10.9	>14.8, >17
	Accuracy	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	
DO mg/L	Min	9.9	10.3	8.8	9.5	*10.7*	10.6	10.0	10.0	4.8	*10.1*	10.6	10.9	
	Median	10.1	10.7	9.3	10.1	*11.8*	11.5	11.0	11.1	7.4	*10.6*	11.1	11.3	
	Max	10.4	11.2	10.1	10.5	*12.3*	12.4	13.7	11.5	9.2	*11.2*	11.6	13.7	
	7-day Avg. Min	NR*	10.5	9.0	9.9	*11.6*	11.2	10.5	10.8	6.3	*10.4*	10.9	11.2	<7, < 5
	Accuracy (MQO: ± 0.5 mg/L)	*0.3*	*0.2*	*0.1*	*0.4*	***1***	*0.1*	*0.4*	*0.2*	*0.3*	***0.7***	*0.2*	*0.2*	
pH	Min	7.6	7.8	7.5	7.7	7.0	7.2	7.6	7.9	6.8	7.8	7.3	7.9	< 6.5
	Median	7.6	7.8	7.5	7.8	7.0	7.3	7.7	8.0	7.1	7.9	7.3	8.0	
	Max	7.6	7.9	7.7	7.8	7.1	7.4	8.0	8.0	7.2	7.9	7.4	8.8	> 8.5
	Accuracy (MQO: ± 0.5)	*0.03*	*0.1*	*0.04*	*0.1*	*0.1*	*0.02*	*0.1*	*0.1*	*0.1*	*0.2*	*0.1*	*0.1*	
SC µS/cm	Min	206	190	260	239	174	166	224	235	347	325	202	212	
	Median	208	201	262	240	184	177	287	261	354	330	235	223	
	Max	217	205	263	244	197	181	299	271	367	338	254	242	>1000, >2000
	Accuracy (MQO: ± 5.0%)	*2.1%*	*0.7%*	*0.9%*	*1.2%*	*0.7%*	*0.6%*	*1.3%*	*0.9%*	*0.9%*	*0.3%*	*1.1%*	*0.1%*	
	n	*93*	*662*	*757*	*758*	*764*	*1144*	*659*	*661*	*761*	*755*	*763*	*768*	

** No 7-day metrics were calculated -- only two days of data were collected.*

Notes:

Red italicized font indicates that data did not meet SWAMP MQO's. **NR:** Value not recorded.

1 = Post-deployment accuracy checks performed during annual lab calibration - Temp. probe met SWAMP MQO's.

2 = Accuracy value gleaned from percent saturation check; substituted 5% for 0.5 mg/L SWAMP MQO.

Table C-2f: Summary statistics of continuous monitoring conducted in Redwood, Webb and Tennessee Valley Creeks

		Spring				Dry				Wet				Evaluation thresholds: for details see key on Table C-2-a
	Start Date	5/6/05				8/19/05				1/27/06				
	End Date	5/13/05				9/1/05				2/7/06				
		RDW040	RDW060	RDW100	RDW120	RDW040	RDW060	RDW100	RDW120	RDW040	RDW060	RDW100	RDW120	
Temp °C	Min	12.3	10.8	10.7	10.6	12.3	13.4	12.9	12.0	9.2	9.7	9.6	9.6	
	Median	14.4	12.8	12.3	12.1	14.2	14.7	14.2	13.4	11.3	11.2	11.2	11.3	
	Max	15.4	14.7	13.7	12.9	15.9	18.1	16.6	14.7	12.9	12.6	12.7	12.8	>24
	7-day Mean	14.5	13.1	12.4	12.1	14.5	15.5	14.6	13.6	12.2	12.1	12.2	12.2	>14.8, >17
	Accuracy	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	
DO mg/L	Min	8.9	9.1	9.9	10.6	4.7	6.7	8.0	9.6	*9.6*	10.1	*11.5*	10.8	
	Median	9.5	9.8	10.4	10.9	7.9	7.8	8.6	10.0	*12.0*	10.6	*12.0*	11.2	
	Max	10.0	10.5	11.8	14.2	9.1	9.6	9.6	10.7	*12.7*	11.0	*12.5*	11.9	
	7-day Avg. Min	9.0	9.4	10.2	10.7	6.7	7.4	8.3	9.8	*11.5*	10.4	*11.8*	11.0	<7, < 5
	Accuracy (MQO: ± 0.5 mg/L)	*0.2*	*0.2*	*0.03*	*0.01*	*0.03*	*0.4*	*0.1*	*0.1*	***0.9***	*0.1*	***0.8***	*0.3*	
pH	Min	7.5	7.5	7.7	7.7	6.9	7.0	7.2	7.7	7.0	7.0	6.9	7.3	< 6.5
	Median	7.6	7.6	7.8	7.8	7.1	7.2	7.3	7.8	7.5	7.1	7.1	7.5	
	Max	7.7	7.7	7.9	8.0	7.5	7.5	7.4	8.0	7.7	7.3	7.4	7.9	> 8.5
	Accuracy (MQO: ± 0.5)	*0.1*	*0.1*	*0.1*	*0.1*	*0.03*	*0.2*	*0.1*	*0.1*	*0.04*	*0.2*	*0.04*	*0.1*	
SC µS/cm	Min	305	194	181	160	394	255	242	242	168	105	97	77	
	Median	328	214	205	192	439	258	244	246	197	132	123	96	
	Max	342	231	217	215	550	263	247	253	256	199	178	174	>1000, >2000
	Accuracy (MQO: ± 5.0%)	*0.3%*	*0.2%*	*0.1%*	*1.3%*	*3%*	*3.6%*	*0.2%*	*0.6%*	*0.3%*	*1.2%*	*1.1%*	*0.6%*	
	n	*668*	*667*	*669*	*672*	*1246*	*1249*	*1245*	*1248*	*1048*	*1051*	*1050*	*1052*	

		Spring	Dry	Wet	Spring	Dry	Wet	Evaluation thresholds: for details see key on Table C-2-a
	Start Date	4/22/05	8/10/05	1/18/06	4/22/05	8/10/05	1/18/06	
	End Date	4/29/05	8/18/05	1/26/06	4/29/05	8/18/05	1/26/06	
		WBB010	WBB010	WBB010	TVY030	TVY030	TVY030	
Temp °C	Min	10.3	12.9	9.2	10.3	13.4	8.7	
	Median	11.5	13.4	10.3	12.3	13.9	10.1	
	Max	12.8	15.2	11.4	13.8	14.7	11.3	>24
	7-day Mean	11.8	13.7	10.5	12.5	14.2	10.3	>14.8, >17
	Accuracy	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	
DO mg/L	Min	*11.1*	*10.3*	11.1	10.0	7.9	10.6	
	Median	*11.9*	*10.9*	11.6	10.5	8.2	11.1	
	Max	*12.4*	*11.3*	12.0	11.0	8.5	11.5	
	7-day Avg. Min	*11.7*	*10.7*	11.4	10.3	8.0	10.8	<7, < 5
	Accuracy (MQO: ± 0.5 mg/L)	***0.9***	***0.8***	*0.4*	*0.3*	*0.2*	*0.1*	
pH	Min	8.0	7.9	8.0	7.0	6.9	7.1	< 6.5
	Median	8.1	7.9	8.0	7.2	7.1	7.2	
	Max	8.1	8.0	8.1	7.3	7.2	7.3	> 8.5
	Accuracy (MQO: ± 0.5)	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.04*	
SC µS/cm	Min	253	359	190	155	204	148	
	Median	285	361	211	178	209	166	
	Max	292	363	240	191	213	174	>1000, >2000
	Accuracy (MQO: ± 5.0%)	*1.4%*	*0.6%*	*0.2%*	*0.7%*	*0.4%*	*0.3%*	
	n	*658*	*761*	*765*	*656*	*760*	*765*	

Notes:
Red italicized font indicates that data did not meet SWAMP MQO's. **NR:** Value not recorded.
1 = Post-deployment accuracy checks performed during annual lab calibration - Temp. probe met SWAMP MQO's.
2 = Accuracy value gleaned from percent saturation check; substituted 5% for 0.5 mg/L SWAMP MQO.

Table C-2g: Summary statistics of continuous monitoring conducted in Rodeo Lagoon (ROD010-020) and Rodeo Creek (ROD030-050)

		Spring		Dry		Wet		Evaluation thresholds: for details see key on Table C-2-a
	Start Date	*Spring*		*Dry*		*Wet*		
	End Date	6/2/05		9/2/05		2/9/06		
		6/24/05		9/12/05		2/21/06		
	Min	**ROD010**	**ROD020**	**ROD010**	**ROD020**	**ROD010**	**ROD020**	
Temp °C	*Median*	16.5	14.5	15.3	15.7	8.1	11.2	
	Max	18.8	19	16.5	16.9	12.1	12.5	
	7-day Mean	21.0	21.3	18.4	19.3	14.2	13.8	>24
	Accuracy	19.3	19.1	16.5	17.1	12.6	13.0	>14.8, >17
DO mg/L	*Min*	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	
	Median	0.3	0.0	4.8	2.4	0.2	*0.03*	
	Max	7.5	0.1	9.2	6.8	10.1	*0.2*	
	7-day Avg. Min	14.8	14.1	13.6	11.4	12.1	*3.5*	
	Accuracy (MQO: ± 0.5 mg/L)	4.4	0.0	6.6	4.2	2.7	0.1	<7, < 5
pH	*Min*	*0.2*	*0.5*	*0.1*	*0.2*	*0.1*	*1.7*	
	Median	8.9	6.5	9.1	8.8	6.8	7.0	< 6.5
	Max	9.6	9.0	9.3	9.1	7.4	7.2	
	Accuracy (MQO: ± 0.5)	10.1	9.7	9.4	9.3	8.1	7.4	> 8.5
SC µS/cm	*Min*	*0.01*	*0.03*	*0.02*	*0.04*	*0.1*	*0.04*	
	Median	3370	420	5379	4787	1741	3419	
	Max	4992	4735	5792	5410	3610	16982	
	Accuracy (MQO: ± 5.0%)	6898	5445	5912	5597	26650	25560	>1000, >2000
	n	*0.1%*	*1.3%*	*3%*	*0.4%*	*3.1%*	*3.3%*	
		2096	*2107*	*933*	*945*	*1150*	*1140*	

		Spring			Dry			Wet			Evaluation thresholds: for details see key on Table C-2-a
	Start Date	*Spring*			*Dry*			*Wet*			
	End Date	6/2/05			9/2/05			2/9/06			
		6/24/05			9/12/05			2/21/06			
	Min	**ROD030**	**ROD040**	**ROD050**	**ROD030**	**ROD040**	**ROD050**	**ROD030**	**ROD040**	**ROD050**	
Temp °C	*Median*	12.2	10.1	10.6	12.9	11	11.6	6.7	5.8	6.7	
	Max	13.7	12.9	13.0	13.9	13.2	13.2	9.8	9.4	9.5	
	7-day Mean	14.5	14.7	14.3	14.5	14.2	14	13.2	12.9	12.3	>24
	Accuracy	13.9	13.4	13.4	13.9	13.2	13.3	11	10.5	10.5	>14.8, >17
DO mg/L	*Min*	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	NR[1]	
	Median	0.0	9.3	*8.5*	0.2	8.0	*7.4*	4.4	10.7	10.4	
	Max	0.1	10.2	*9.6*	0.3	8.8	*9.5*	8.1	12.0	11.3	
	7-day Avg. Min	1.5	11.0	*10.7*	0.4	9.4	*10.5*	10.2	13.5	12.3	
	Accuracy (MQO: ± 0.5 mg/L)	0.1	9.7	*9.1*	0.3	8.4	*8.8*	6.7	11.6	11.0	<7, < 5
pH	*Min*	*0.4*	*0.4*	*0.8*	*0.1*	*0.1*	*2.6*	*0.04*	*0.4*	*0.01*	
	Median	6.5	7.1	7.1	6.4	6.9	*7.2*	6.7	7.1	7.3	< 6.5
	Max	6.7	7.2	7.4	6.5	7.0	*7.3*	6.9	7.2	7.4	
	Accuracy (MQO: ± 0.5)	7.0	7.3	7.4	6.8	7.0	*7.4*	7.1	7.2	7.4	> 8.5
SC µS/cm	*Min*	*0.04*	*0.1*	*0.02*	*0.04*	*0.1*	*0.9*	*0.01*	*0.2*	*0.1*	
	Median	219	156	207	276	177	242	166	139	183	
	Max	246	168	243	301	179	244	177	147	193	
	Accuracy (MQO: ± 5.0%)	286	186	251	337	184	251	189	151	200	>1000, >2000
	n	*0%*	*0.4%*	*0.4%*	*2.5%*	*0.9%*	*1.3%*	*0.8%*	*0.9%*	*0.8%*	
		2107	*2099*	*2086*	*943*	*952*	*956*	*1141*	*1140*	*1144*	

Notes:
Red italicized font indicates that data did not meet SWAMP MQO's. **NR:** Value not recorded.
1 = Post-deployment accuracy checks performed during annual lab calibration - Temp. probe met SWAMP MQO's.
2 = Accuracy value gleaned from percent saturation check; substituted 5% for 0.5 mg/L SWAMP MQO.

Table C-2h: Summary statistics of continuous monitoring conducted in Lobos and Islais Creeks

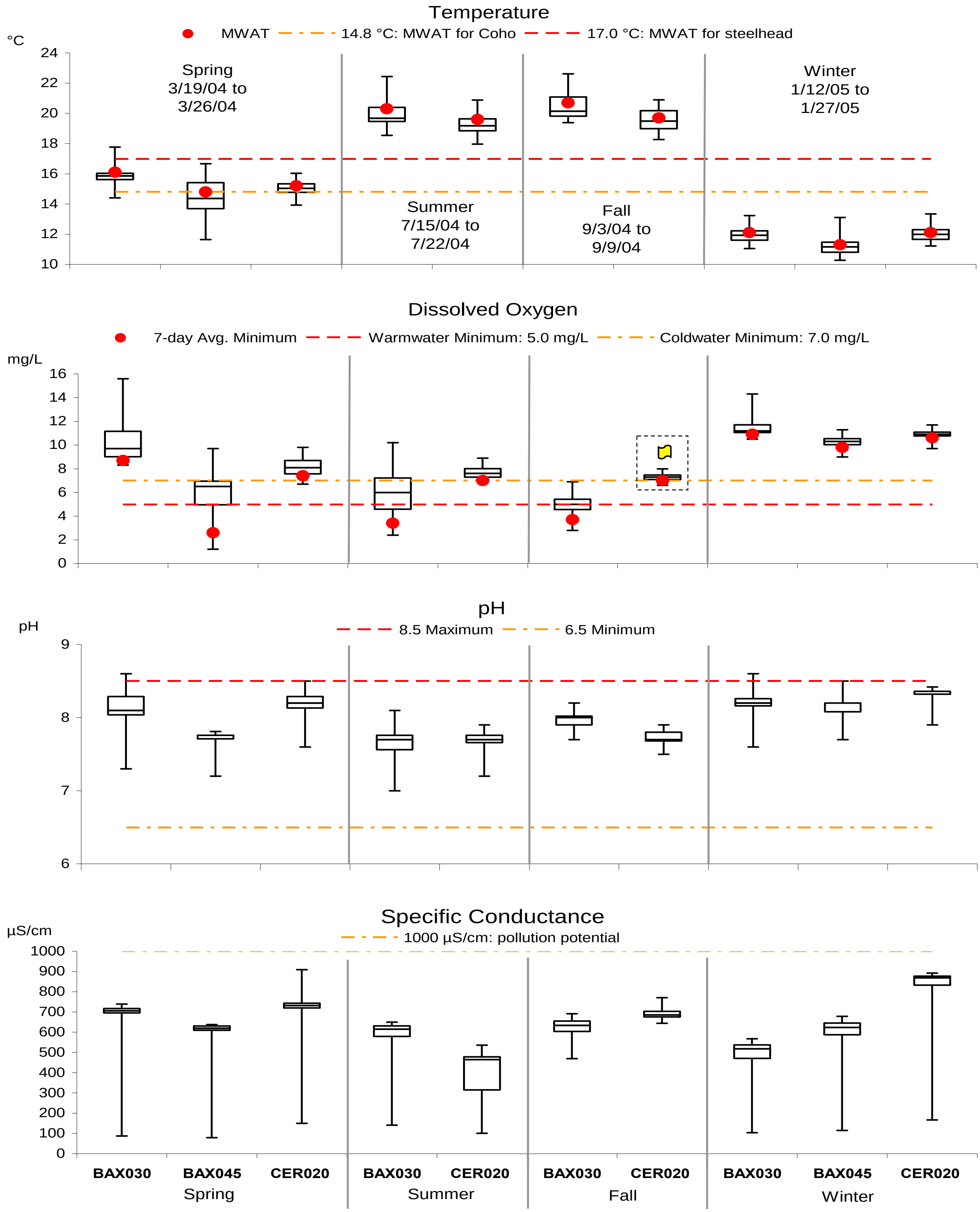
			Spring	Dry	Wet	Spring	Wet	Evalutation thresholds: for details see key on Table C-2-a
		Start Date	5/6/05	8/19/05	1/27/06	5/6/05	1/27/06	
		End Date	5/13/05	9/1/05	2/7/06	5/13/05	2/7/06	
			LOB020	**LOB020**	**LOB020**	**ISL050**	**ISL050**	
Temp	**°C**	***Min***	15.1	15.3	14.3	10.5	9.3	
		Median	16.3	16.4	15.8	13.0	11.3	
		Max	18.2	18.6	17.2	14.6	12.9	**>24**
		7-day Mean	16.5	16.8	16.3	13.2	12.2	>14.8, **>17**
		Accuracy	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	
DO	***mg/L***	***Min***	7.8	7.4	8.5	9.9	9.7	
		Median	8.1	8.5	9.1	10.2	10.0	
		Max	8.5	8.9	9.6	10.9	10.6	
		7-day Avg. Min	7.9	8.3	8.9	9.9	9.8	<7, **< 5**
		Accuracy (MQO: ± 0.5 mg/L)	*0.2*	*0.2*	*0.1*	*0.1*	*0.3*	
pH		***Min***	7.5	7.3	7.2	7.9	7.1	**< 6.5**
		Median	7.6	7.7	7.3	8.0	7.5	
		Max	7.6	7.7	7.8	8.0	7.8	**> 8.5**
		Accuracy (MQO: ± 0.5)	*0.1*	*0.02*	*0.04*	*0.1*	*0.1*	
SC	***µS/cm***	***Min***	572	569	556	514	424	
		Median	577	579	575	586	560	
		Max	599	597	580	767	696	>1000, **>2000**
		Accuracy (MQO: ± 5.0%)	*0%*	*2.9%*	*0.5%*	*0.3%*	*0.5%*	
		n	*669*	*1253*	*1048*	*666*	*1048*	

Notes:

Red italicized font indicates that data did not meet SWAMP MQO's. **NR:** Value not recorded.

1 = Post-deployment accuracy checks performed during annual lab calibration - Temp. probe met SWAMP MQO's.

2 = Accuracy value gleaned from percent saturation check; substituted 5% for 0.5 mg/L SWAMP MQO.



Data did not meet SWAMP MQO's and post-run drift was sufficient to affect data interpretation.

Note: For all plots, if the DO 7-day Avg. Minimum is at bottom of plot, it indicates that DO was consistently low most or every 24-hour period monitored; if the 7-day Avg. Min. was far above the minimum, then the minimum represents only an occasional occurrence.

Figure C.1-2a: Continuous field monitoring summaries for Baxter and Cerrito Creeks in 2004-2005

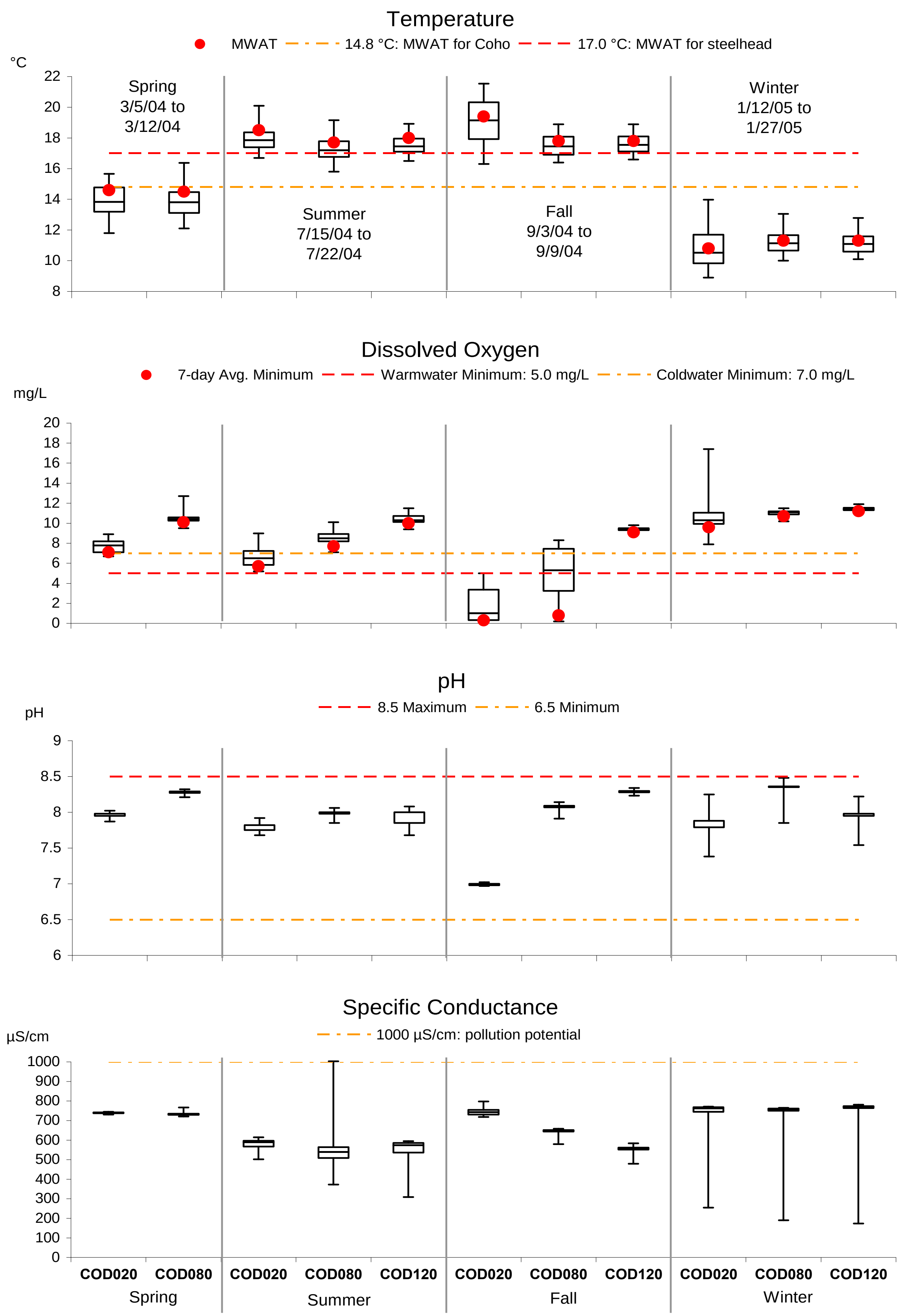


Figure C.1-2b: Continuous field monitoring summaries for Codornices Creek in 2004-2005

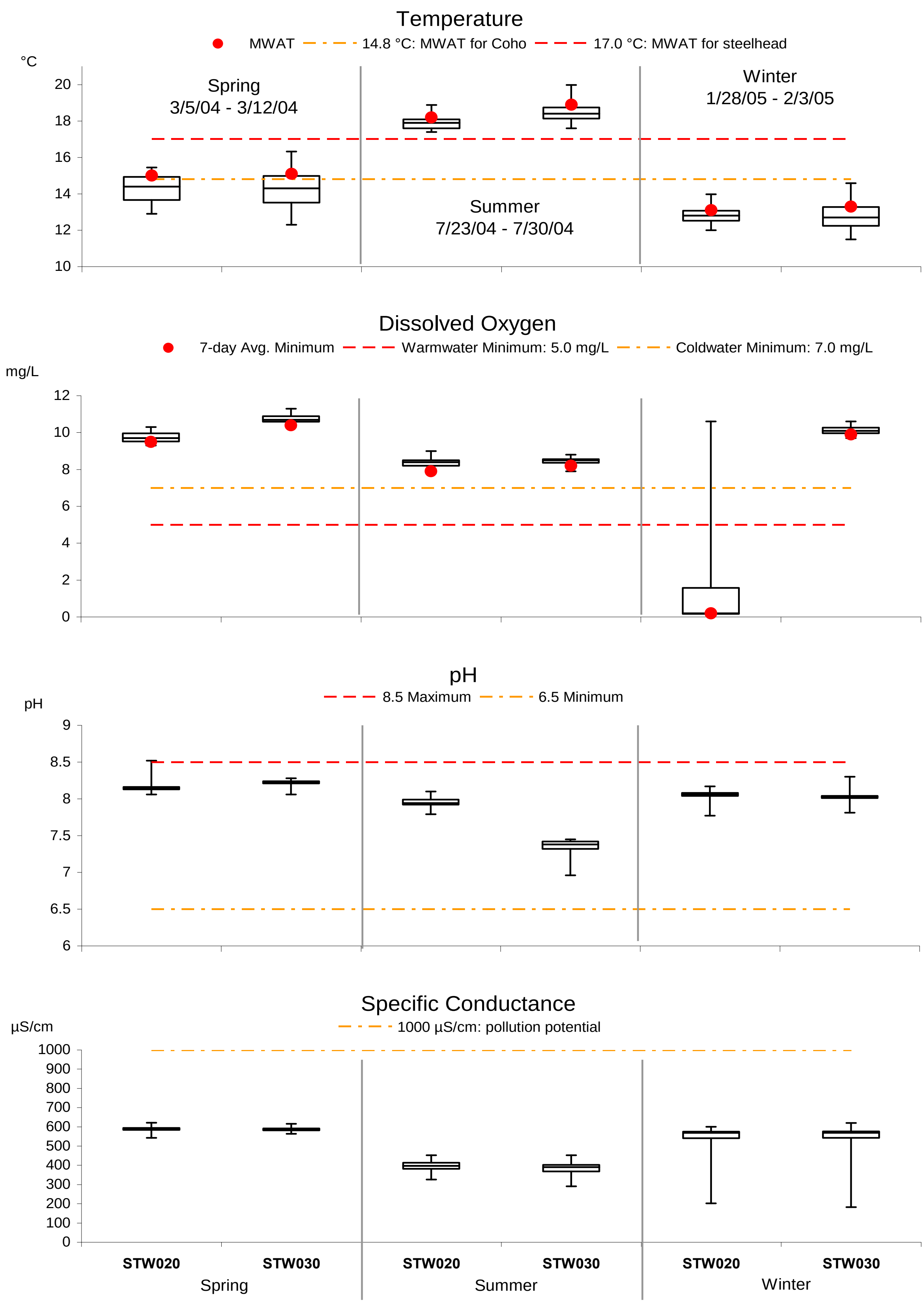


Figure C.1-2c: Continuous field monitoring summaries for Strawberry Creek in 2004-2005

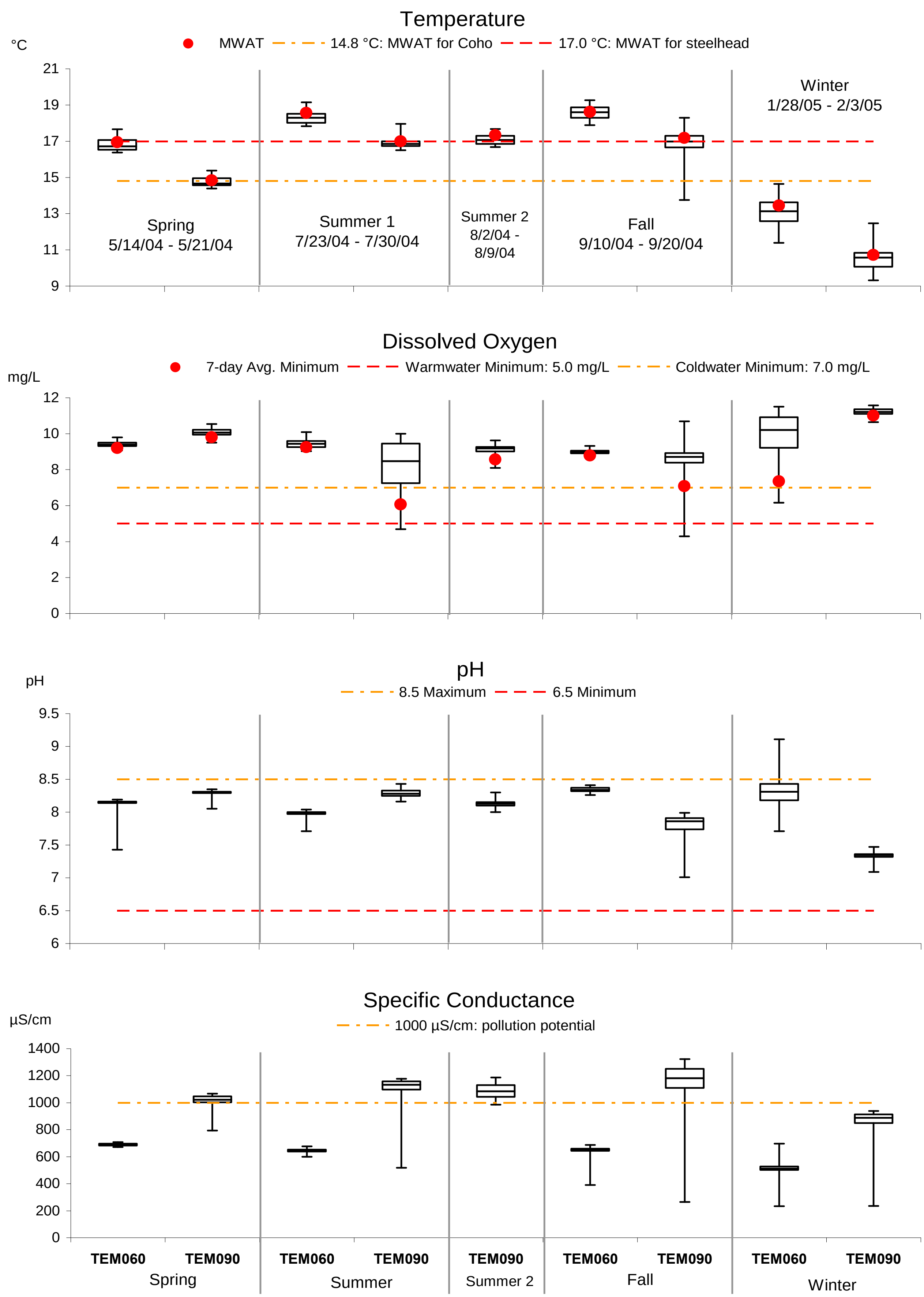


Figure C.2-2a: Continuous field monitoring summaries for Temescal Creek in 2004-2005

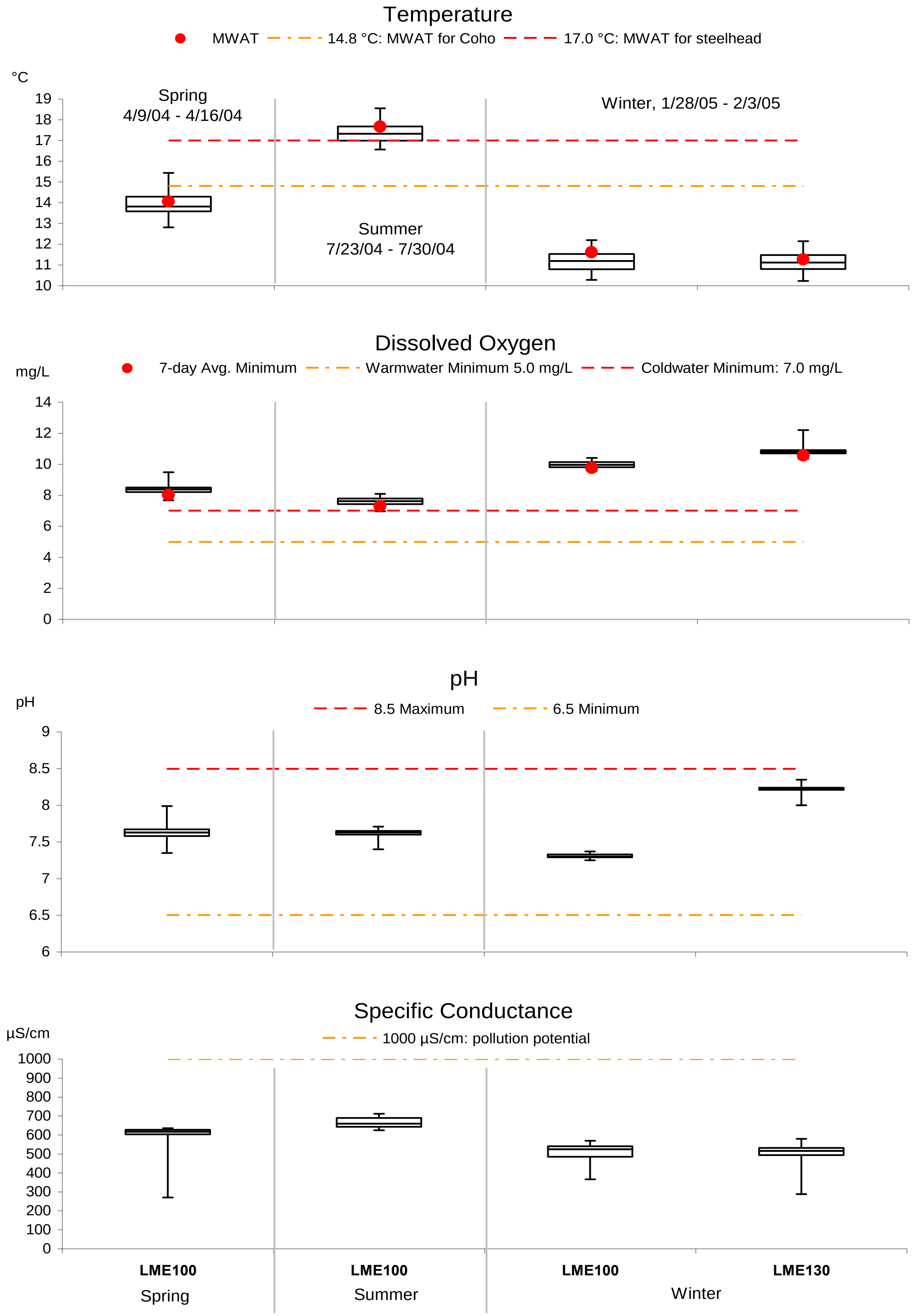


Figure C.2-2b: Continuous field monitoring summaries for Glen Echo Creek in 2004-2005

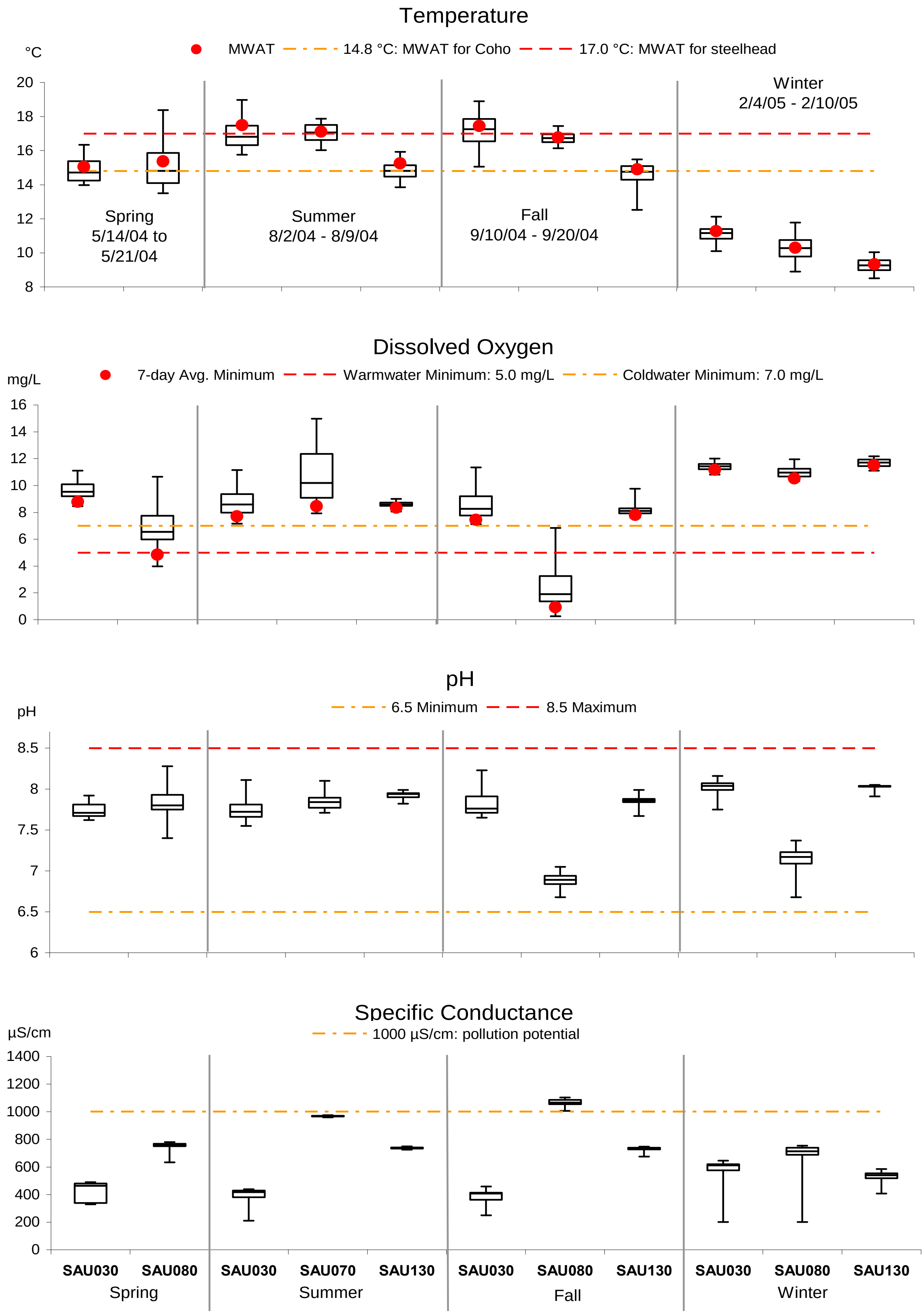


Figure C.2-2c: Continuous field monitoring summaries for Sausal Creek in 2004-2005

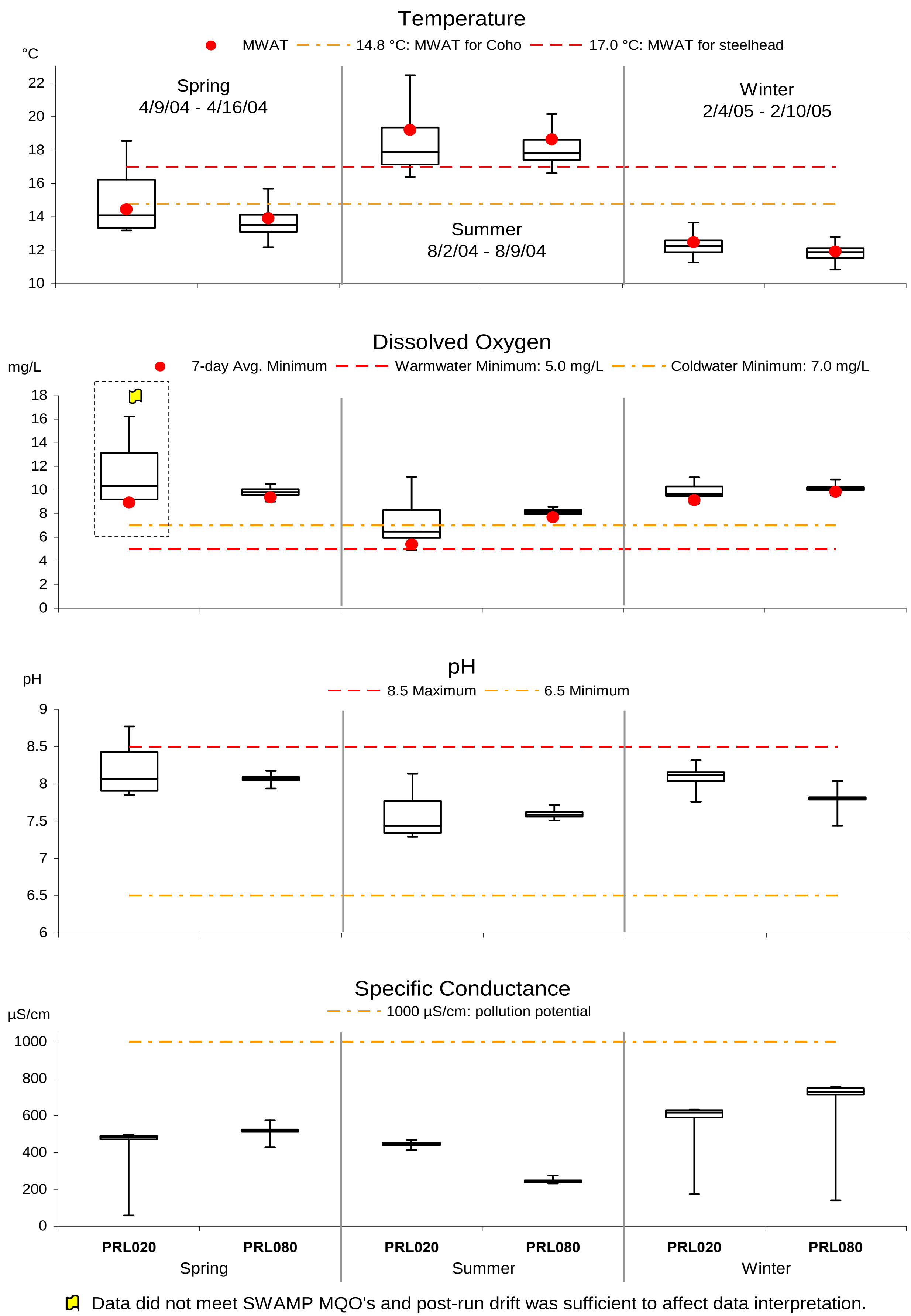


Figure C.2-2d: Continuous field monitoring summaries for Peralta Creek in 2004-2005

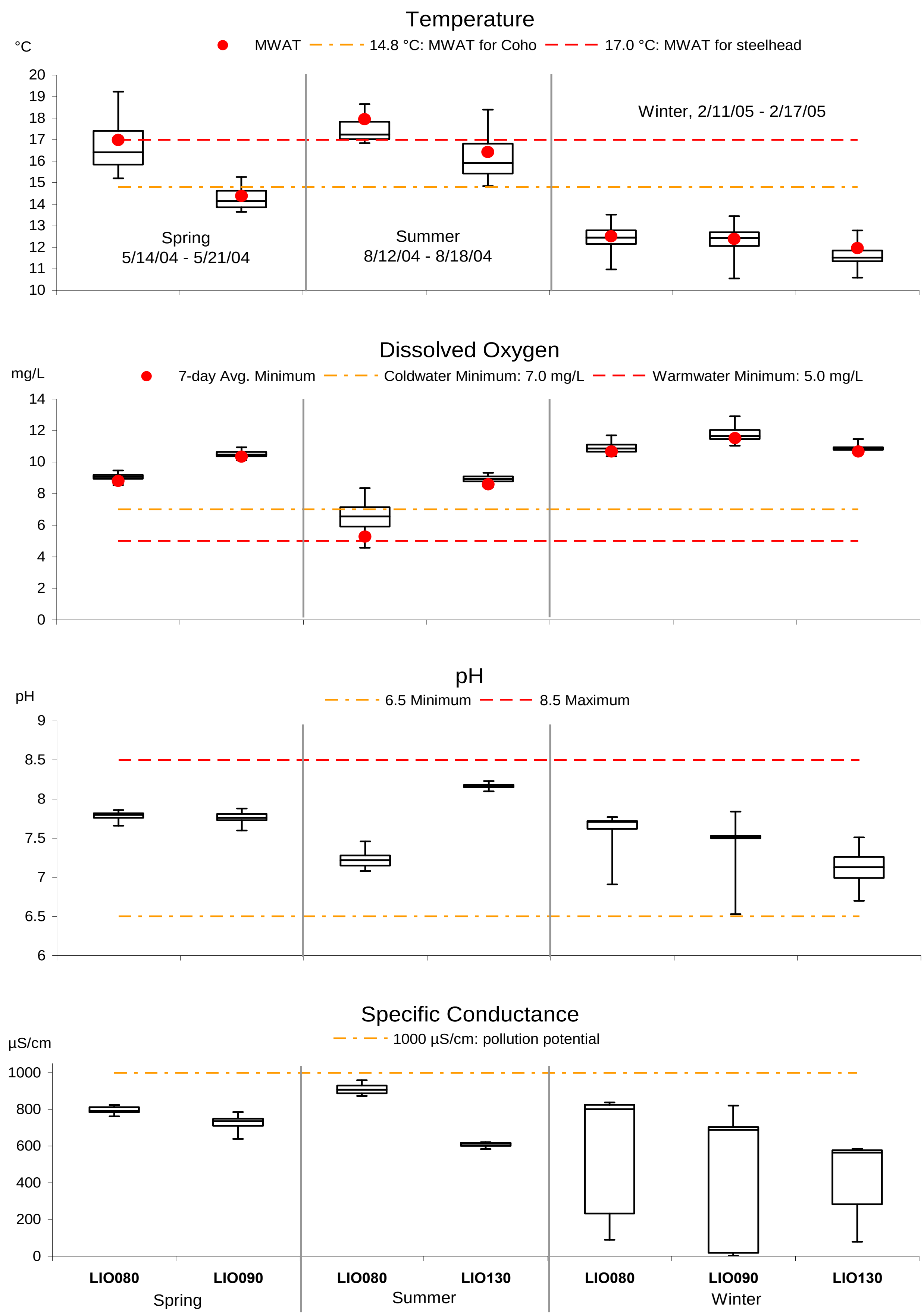


Figure C.2-2e: Continuous field monitoring summaries for Lion Creek in 2004-2005

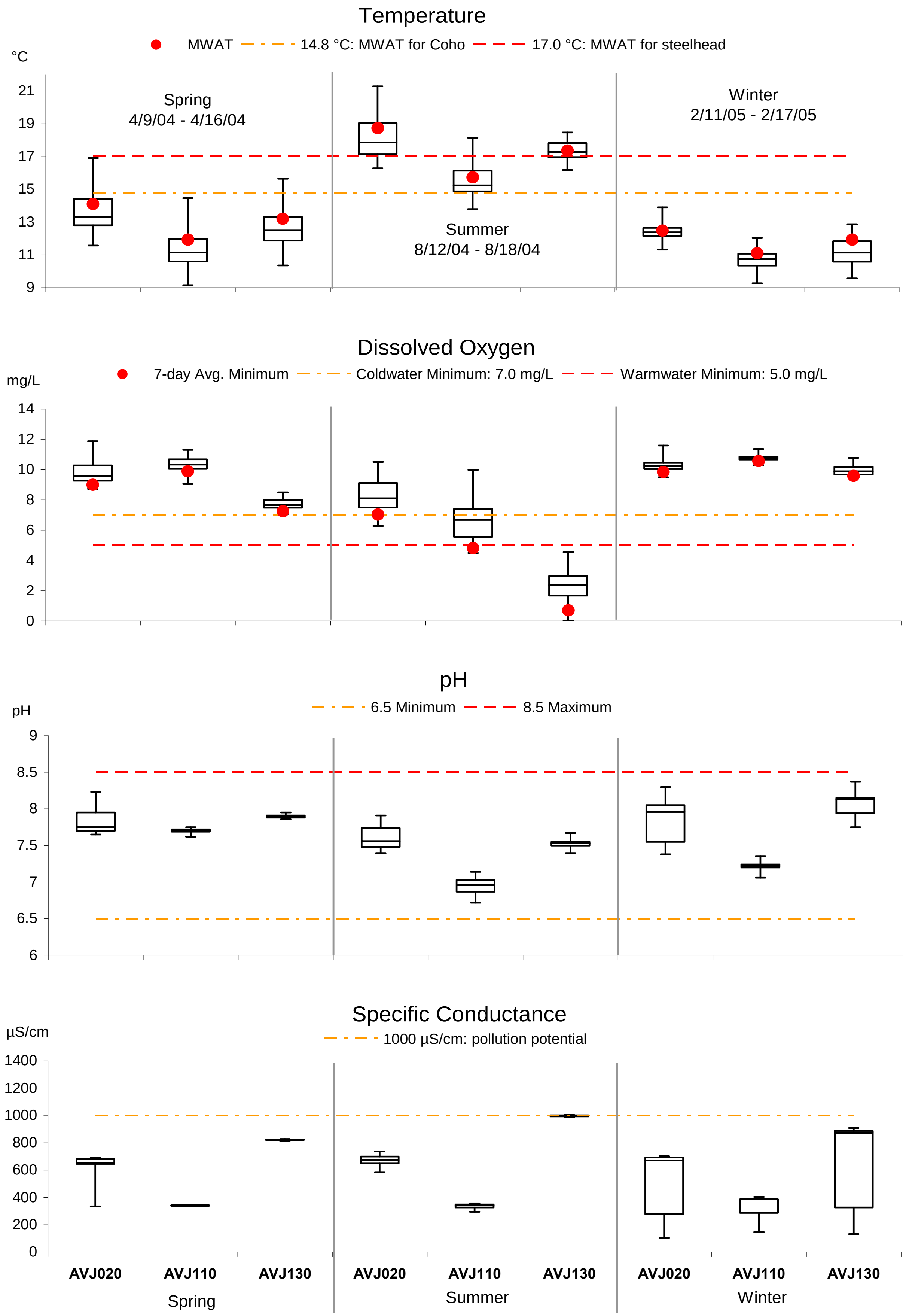
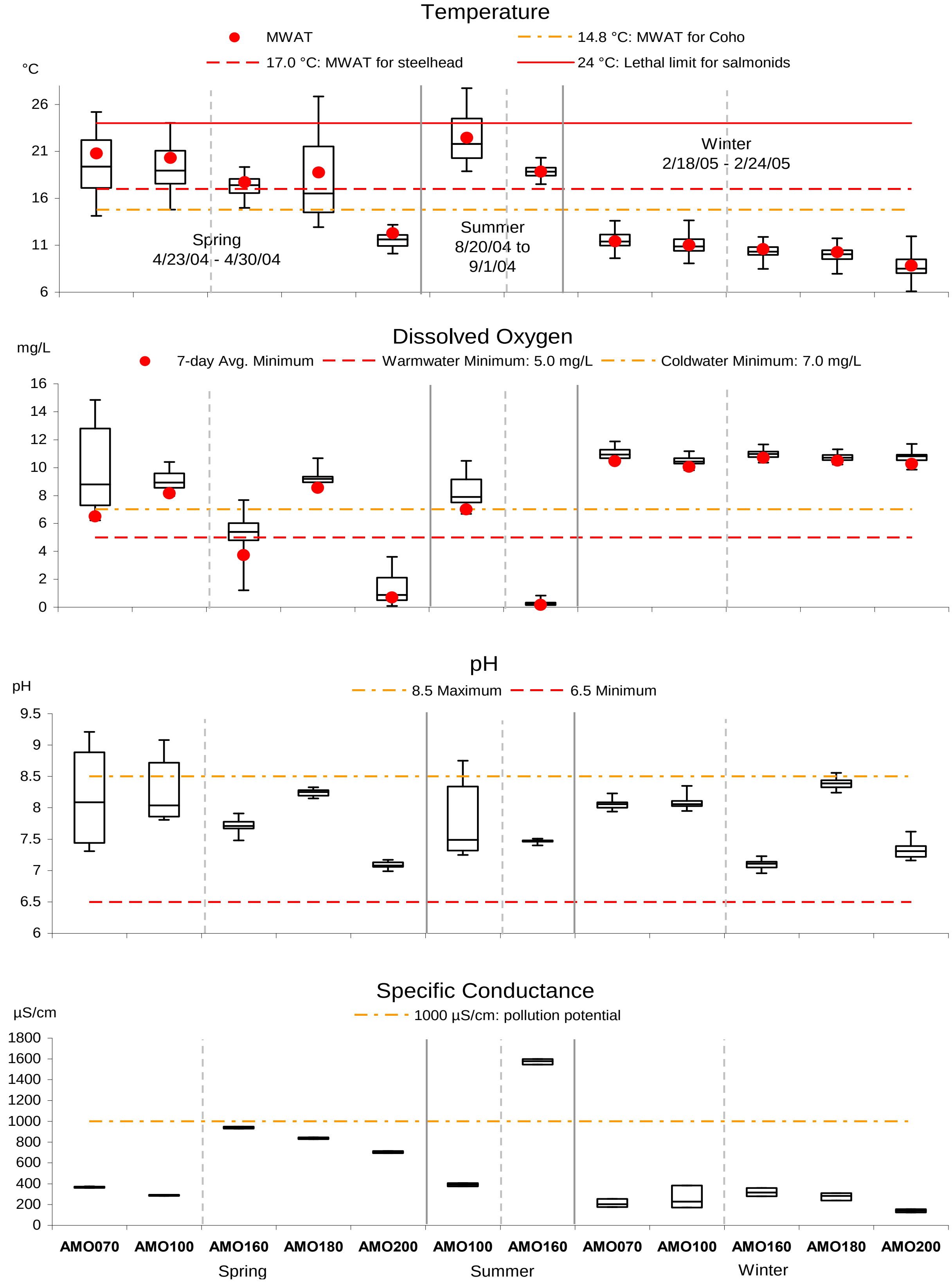


Figure C.2-2f: Continuous field monitoring summaries for Arroyo Viejo Creek in 2004-2005



Note: *Stations AMO070 and AMO100 are both downstream of an input into Arroyo Mocho Creek from the South Bay Aqueduct, which contributes a large portion of the flow in the lower reaches of the creek. The dashed lines in the figures above separate these reaches of the creek, showing the marked difference in results.*

Figure C.3-2: Continuous field monitoring summaries for Arroyo Mocho Creek in 2004-2005

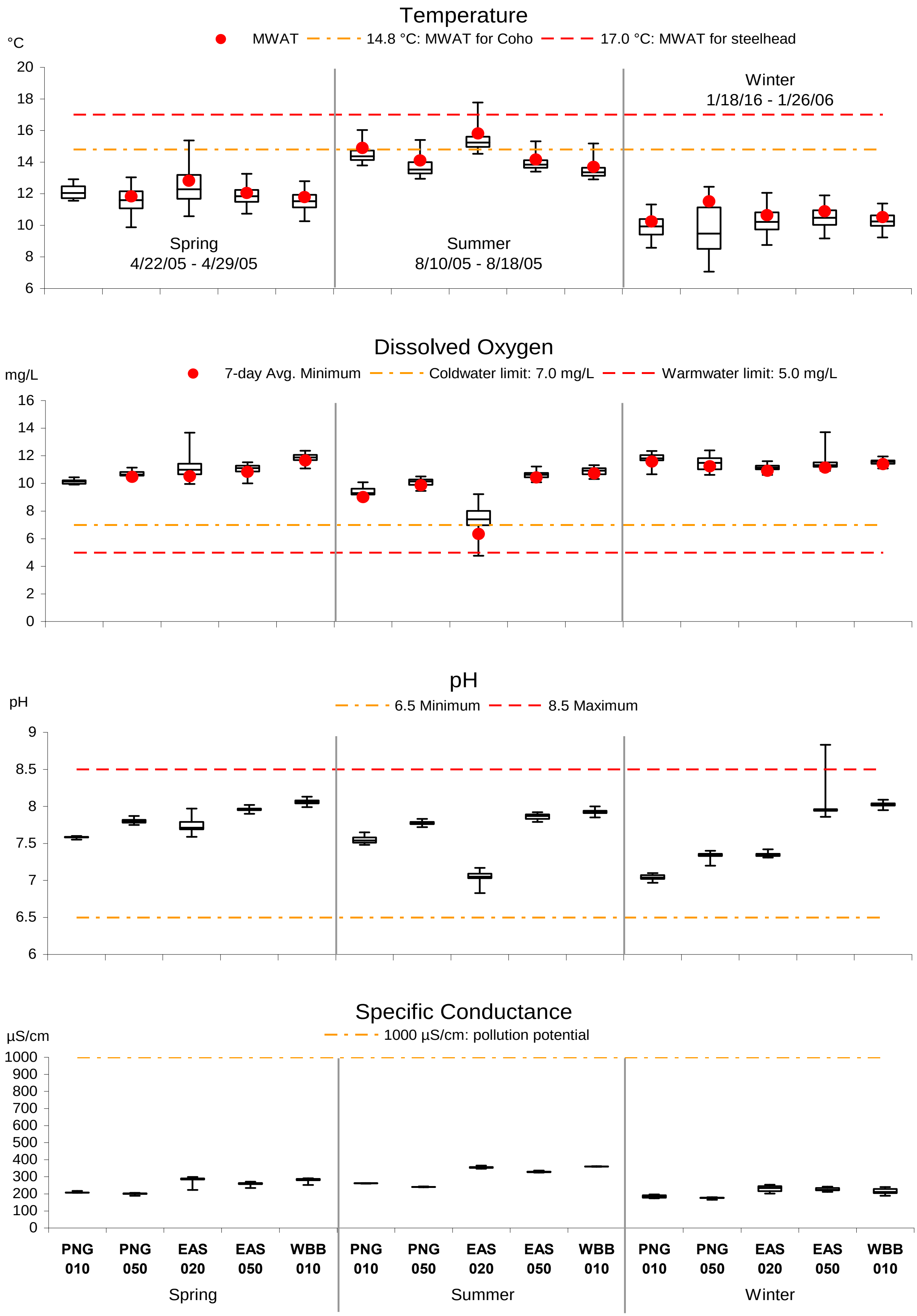


Figure C.4-2a: Continuous field monitoring summaries for Pine Gulch, Easkoot and Webb Creeks in 2005-2006

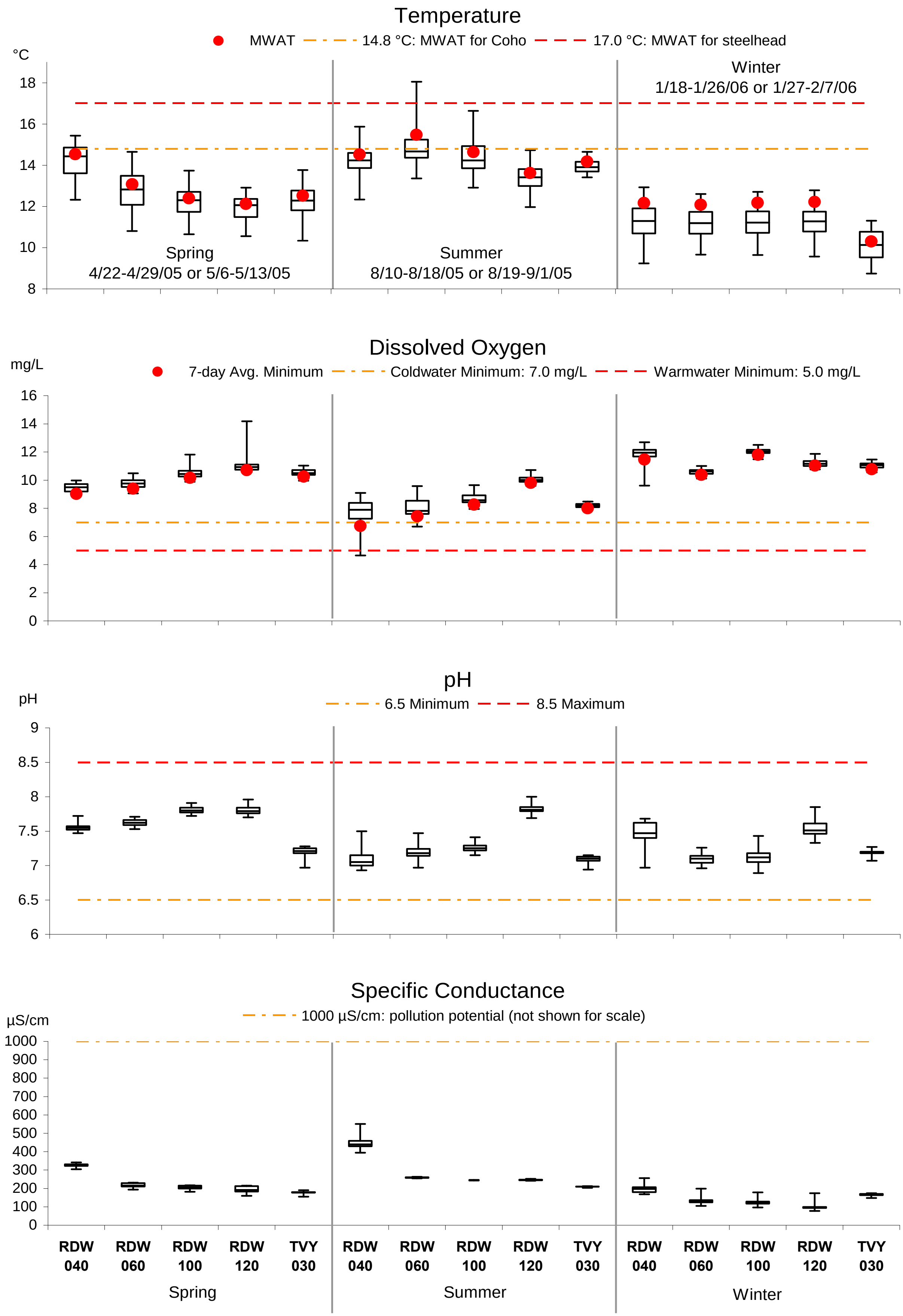
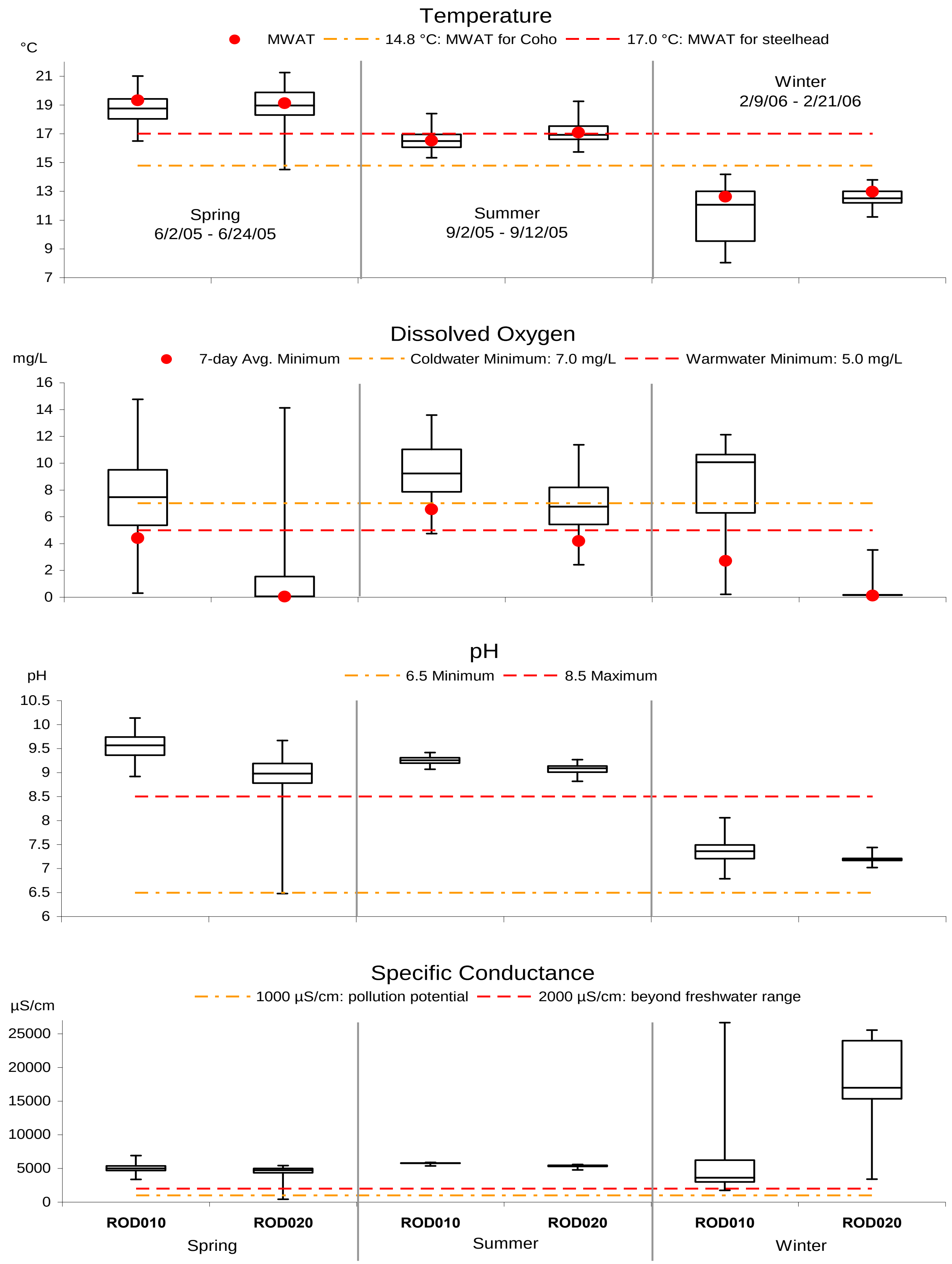


Figure C.4-2b: Continuous field monitoring summaries for Redwood and Tennessee Valley Creeks in 2005-2006



Note: Stations ROD010 and ROD020 are both located in Rodeo Lagoon, which is saline/brackish. This data is not comparable to the data collected upstream in Rodeo Creek (see Figure C.4-2d), which is a freshwater stream and not tidally influenced.

Figure C.4-2c: Continuous field monitoring summaries for Rodeo Lagoon in 2005-2006

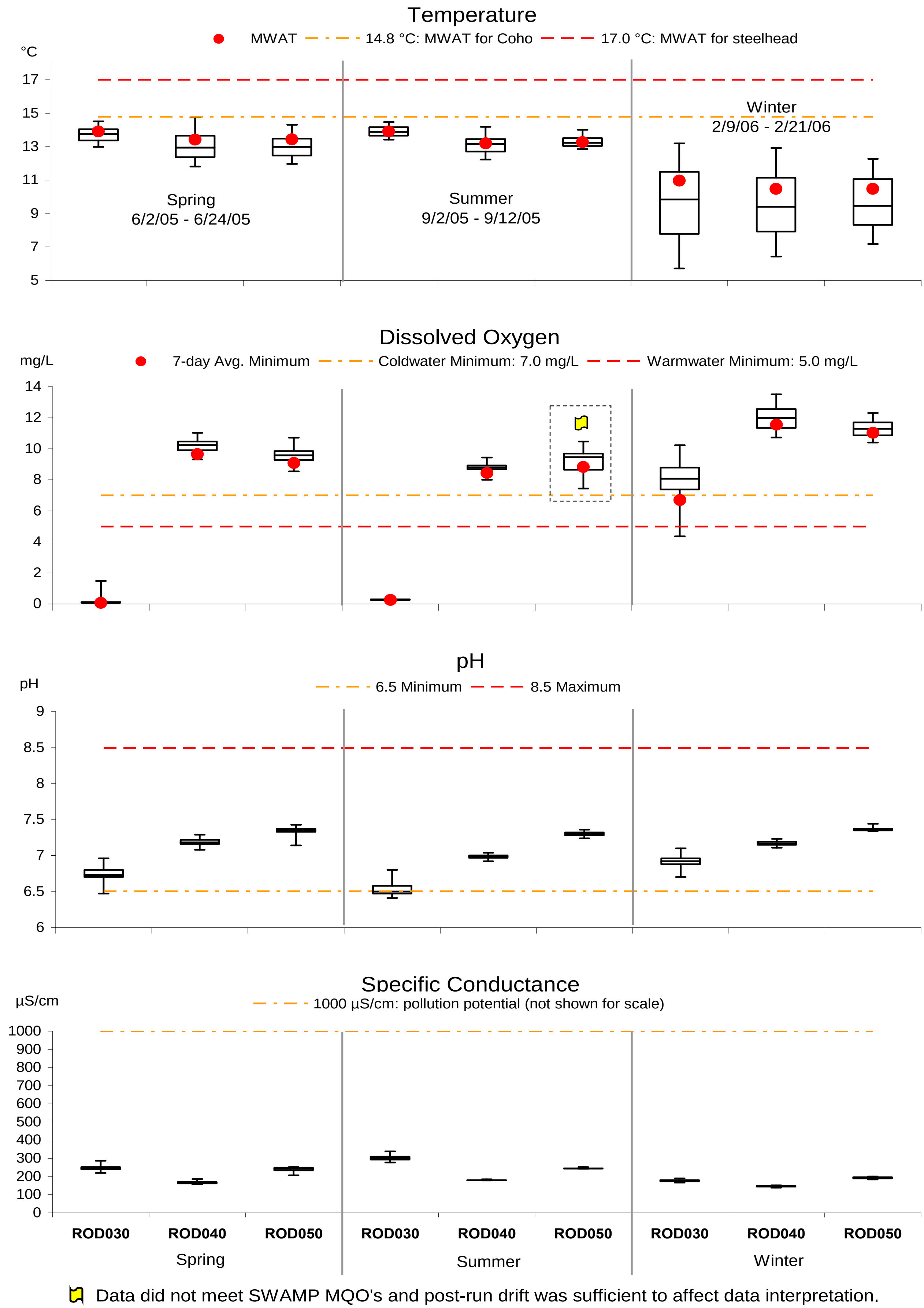


Figure C.4-2d: Continuous field monitoring summaries for Rodeo Creek in 2005-2006

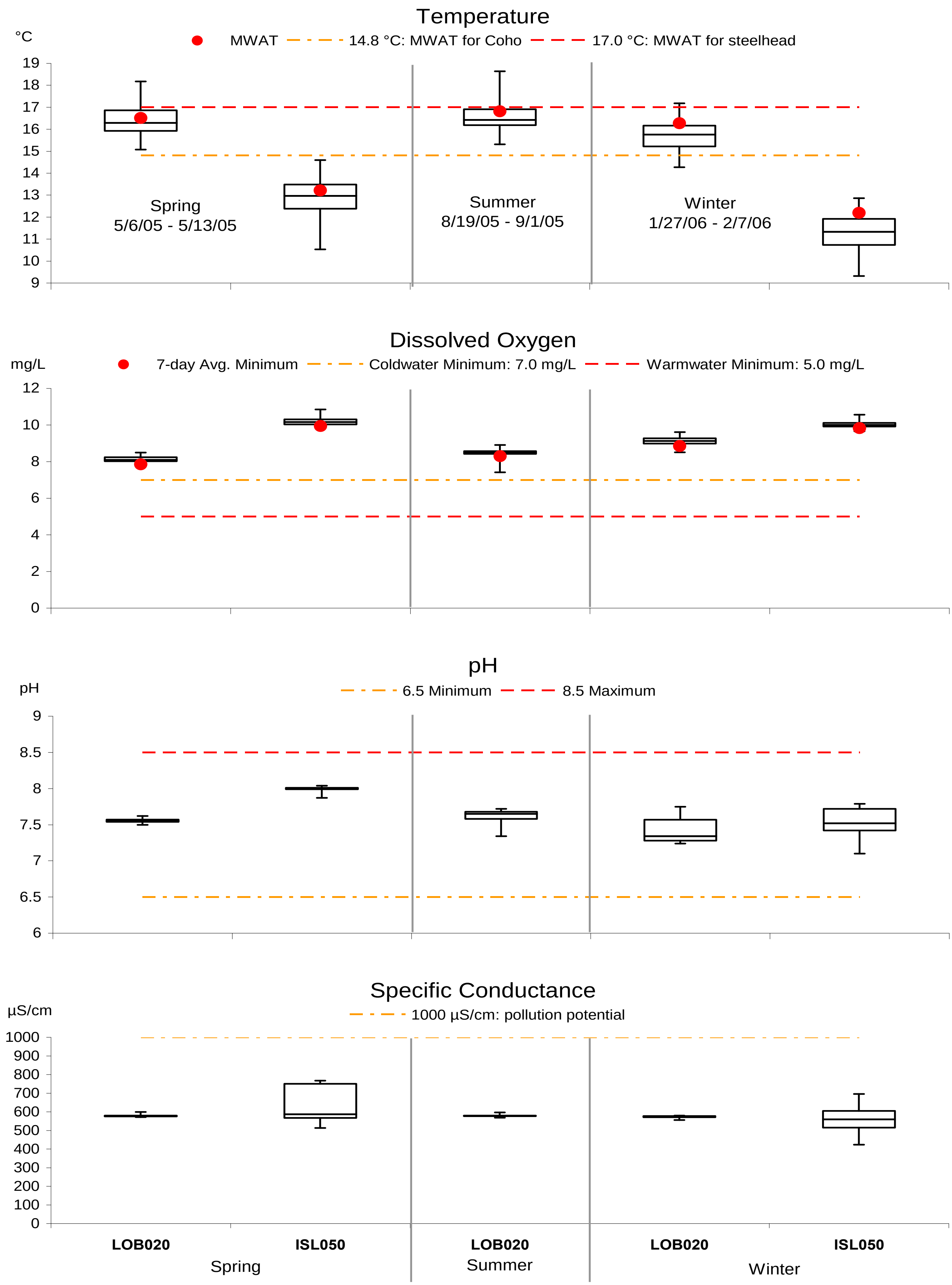


Figure C.5-2: Continuous field monitoring summaries for Lobos and Islais Creeks in 2005-2006

Table C-3: Field observations in 2004-2006 continuous monitoring station visits. Page 1 of 5

Watershed	Station	Station Name	# of Events	Station #	Season	Deployment - Retreival Dates	Water Clarity	Water Color	Sky Code	Precipitation	Observed Flow
Baxter Creek	203BAX030	Baxter at Booker	4	1.1	Sp	3/19/04	clear	green/brown	partly cloudy	none	1-5 cfs
						3/26/04	clear	brown	partly cloudy	none	1-5 cfs
					Su	7/15/04	clear	colorless	clear	none	0.1 -1 cfs
						7/22/04	clear	colorless	clear	none	trickle (<0.1 cfs)
					Fa	9/3/04	clear	colorless	clear	none	0.1 -1 cfs
						9/9/04	clear	colorless	clear	*NR*	0.1 -1 cfs
					Wn	1/12/05	clear	colorless	clear	none	1-5 cfs
						1/27/05	clear	colorless	overcast	rain	*NR*
	203BAX045	Lower Baxter at Gateway Project	2	1.2	Sp	3/19/04	clear	brown	clear	none	0.1 -1 cfs
						3/26/04	clear	brown	*NR*	none	0.1 -1 cfs
					Wn	1/12/05	cloudy (> 4" vis.)	brown	clear	none	0.1 -1 cfs
						1/27/05	clear	colorless	overcast	none	0.1 -1 cfs
Cerrito Creek	203CER020	Creekside Park	4	2.1	Sp	3/19/04	clear	brown	clear	none	1-5 cfs
						3/26/04	clear	brown	overcast	none	1-5 cfs
					Su	7/15/04	murky (< 4" vis.)	brown	clear	none	1-5 cfs
						7/22/04	clear	colorless	clear	none	0.1 -1 cfs
					Fa	9/3/04	cloudy (> 4" vis.)	brown	clear	none	1-5 cfs
						9/9/04	clear	colorless	clear	none	0.1 -1 cfs
					Wn	1/12/05	clear	yellow	clear	none	1-5 cfs
						1/27/05	clear	colorless	overcast	none	1-5 cfs
Codornices Creek	203COD020	Codornices at 2nd Street	4	3.1	Sp	3/5/04	clear	brown	clear	none	1-5 cfs
						3/12/04	cloudy (> 4" vis.)	brown	clear	none	1-5 cfs
					Su	7/15/04	cloudy (> 4" vis.)	brown	clear	none	0.1 -1 cfs
						1/22/04	clear	brown	clear	none	0.1 -1 cfs
					Fa	9/3/04	clear	brown	clear	none	0.1 -1 cfs
						9/9/04	murky (< 4" vis.)	*NR*	*NR*	none	isolated pool
					Wn	1/12/05	clear	brown	clear	none	1-5 cfs
						1/27/05	clear	colorless	partly cloudy	none	1-5 cfs
	203COD080	Albina Ave.	4	3.2	Sp	3/5/04	clear	brown	clear	none	1-5 cfs
						3/12/04	clear	colorless	clear	none	1-5 cfs
					Su	7/15/04	murky (< 4" vis.)	brown	clear	none	*NR*
						1/22/04	clear	brown	clear	none	0.1 -1 cfs
					Fa	9/3/04	clear	colorless	clear	none	1-5 cfs
						9/9/04	clear	colorless	clear	none	0.1 -1 cfs
					Wn	1/12/05	clear	brown	clear	none	1-5 cfs
						1/27/05	clear	brown	partly cloudy	none	0.1 -1 cfs
	203COD120	Live Oak Park	3	3.3	Su	7/15/04	murky (< 4" vis.)	brown	clear	none	0.1 -1 cfs
						1/22/04	clear	colorless	clear	none	0.1 -1 cfs
					Fa	9/3/04	clear	colorless	clear	none	0.1 -1 cfs
						9/9/04	clear	colorless	clear	none	1-5 cfs
					Wn	1/12/05	cloudy (> 4" vis.)	green/brown	clear	none	1-5 cfs
						1/27/05	clear	colorless	partly cloudy	none	0.1 -1 cfs
Strawberry Creek	203STW020	Above Strawberry Creek Park	3	4.1a	Sp	3/5/04	clear	brown	partly cloudy	none	1-5 cfs
						3/12/04	clear	colorless	clear	none	1-5 cfs
					Su	7/23/04	clear	brown	partly cloudy	none	1-5 cfs
						7/30/04	clear	colorless	overcast	none	1-5 cfs
					Wn	1/28/05	murky (< 4" vis.)	brown	partly cloudy	drizzle	1-5 cfs
						2/3/05	clear	colorless	clear	none	0.1 -1 cfs
	203STW030	UC Berkeley at Oxford	3	4.2	Sp	3/5/04	clear	brown	partly cloudy	none	1-5 cfs
						3/12/04	clear	green	clear	none	1-5 cfs
					Su	7/23/04	clear	colorless	partly cloudy	none	1-5 cfs
						7/30/04	cloudy (> 4" vis.)	brown	overcast	none	1-5 cfs
					Wn	1/28/05	murky (< 4" vis.)	brown	partly cloudy	none	1-5 cfs
						2/3/05	clear	colorless	clear	none	0.1 -1 cfs

Table C-3 (cont.) Page 2

Watershed	Station	Station Name	# of Events	Station #	Season	Deployment - Retreival Dates	Water Clarity	Water Color	Sky Code	Precipitation	Observed Flow
Temescal Creek	203TEM060	Birch Court	5	5.2	Sp	5/14/04	clear	colorless	partly cloudy	none	1-5 cfs
						5/21/04	clear	*NR*	overcast	none	1-5 cfs
					Su	7/23/04	*NR*	colorless	clear	none	1-5 cfs
						7/30/04	clear	colorless	overcast	none	1-5 cfs
					Fa	9/10/04	cloudy (> 4" vis.)	colorless	clear	none	0.1 -1 cfs
						9/20/04	murky (< 4" vis.)	green/gray	clear	none	0.1 -1 cfs
					Wn	1/28/05	cloudy (> 4" vis.)	brown	partly cloudy	none	1-5 cfs
						2/3/05	cloudy (> 4" vis.)	brown	clear	none	0.1 -1 cfs
	203TEM090	Above Lake Temescal	5	5.3	Sp	5/14/04	clear	brown	partly cloudy	none	1-5 cfs
						5/21/04	*NR*	colorless	overcast	*NR*	1-5 cfs
					Su	7/23/04	cloudy (> 4" vis.)	brown	partly cloudy	none	0.1 -1 cfs
						7/30/04	cloudy (> 4" vis.)	green	overcast	none	0.1 -1 cfs
					Su 2	8/2/04	*NR*	green	overcast	none	1-5 cfs
						8/9/04	cloudy (> 4" vis.)	green	overcast	none	0.1 -1 cfs
					Fa	9/10/04	cloudy (> 4" vis.)	yellow	clear	none	0.1 -1 cfs
						9/20/04	cloudy (> 4" vis.)	green	clear	none	0.1 -1 cfs
					Wn	1/28/05	murky (< 4" vis.)	green	partly cloudy	none	1-5 cfs
						2/3/05	clear	colorless	clear	none	0.1 -1 cfs
Glen Echo Creek	204LME100	Glen Echo at 29th Street	3	6.1	Sp	4/9/04	clear	colorless	clear	none	1-5 cfs
						4/16/04	clear	colorless	overcast	drizzle	1-5 cfs
					Su	7/23/04	clear	colorless	partly cloudy	none	0.1 -1 cfs
						7/30/04	clear	colorless	overcast	none	1-5 cfs
					Wn	1/28/05	*NR*	brown	partly cloudy	none	1-5 cfs
						2/3/05	clear	colorless	clear	none	0.1 -1 cfs
	204LME130	Oak Glen Park	1	6.2	Wn	1/28/05	cloudy (> 4" vis.)	brown	partly cloudy	none	1-5 cfs
						2/3/05	cloudy (> 4" vis.)	brown	clear	none	0.1 -1 cfs
Sausal Creek	204SAU030	Sausal at East 22nd	4	7.1	Sp	5/14/04	clear	green	clear	none	1-5 cfs
						5/21/04	murky (< 4" vis.)	colorless	partly cloudy	fog	1-5 cfs
					Su	8/2/04	*NR*	*NR*	*NR*	*NR*	*NR*
						8/9/04	clear	brown	overcast	none	0.1 -1 cfs
					Fa	9/10/04	clear	colorless	clear	none	0.1 -1 cfs
						9/20/04	*NR*	green	clear	none	1-5 cfs
					Wn	2/4/05	clear	colorless	clear	none	1-5 cfs
						2/10/05	clear	colorless	clear	none	0.1 -1 cfs
	204SAU070	Sausal at El Centro	1	7.3	Su	8/2/04	clear	brown	overcast	none	0.1 -1 cfs
						8/9/04	cloudy (> 4" vis.)	green	overcast	none	0.1 -1 cfs
	204SAU080	Dimond Park	3	7.4	Sp	5/14/04	clear	green	partly cloudy	none	0.1 -1 cfs
						5/21/04	clear	colorless	partly cloudy	fog	1-5 cfs
					Fa	9/10/04	clear	colorless	clear	none	isolated pool
						9/20/04	clear	yellow	clear	none	0.1 -1 cfs
					Wn	2/4/05	clear	colorless	partly cloudy	none	0.1 -1 cfs
						2/10/05	clear	colorless	clear	none	0.1 -1 cfs
	204SAU130	Palo Seco	3	7.5	Su	8/2/04	clear	colorless	overcast	none	0.1 -1 cfs
						8/9/04	clear	colorless	overcast	none	0.1 -1 cfs
					Fa	9/10/04	clear	colorless	clear	none	0.1 -1 cfs
						9/20/04	clear	*NR*	clear	none	0.1 -1 cfs
					Wn	2/4/05	cloudy (> 4" vis.)	brown	partly cloudy	none	1-5 cfs
						2/10/05	*NR*	colorless	clear	none	0.1 -1 cfs
Peralta Creek	204PRL020	Cesar Chavez Park	3	8.1	Sp	4/9/04	clear	colorless	clear	none	1-5 cfs
						4/16/04	clear	colorless	partly cloudy	none	1-5 cfs
					Su	8/2/04	clear	colorless	overcast	none	1-5 cfs
						8/9/04	clear	colorless	overcast	none	0.1 -1 cfs
					Wn	2/4/05	clear	colorless	partly cloudy	none	1-5 cfs
						2/10/05	clear	colorless	clear	none	0.1 -1 cfs
	204PRL080	Peralta at Rettig	3	8.2	Sp	4/9/04	clear	colorless	clear	none	0.1 -1 cfs
						4/16/04	clear	colorless	overcast	none	0.1 -1 cfs
					Su	8/2/04	clear	colorless	overcast	none	1-5 cfs
						8/9/04	clear	colorless	overcast	none	0.1 -1 cfs
					Wn	2/4/05	clear	colorless	partly cloudy	none	1-5 cfs
						2/10/05	clear	colorless	clear	none	0.1 -1 cfs

Table C-3 (cont.) Page 3

Watershed	Station	Station Name	# of Events	Station #	Season	Deployment - Retreival Dates	Water Clarity	Water Color	Sky Code	Precipitation	Observed Flow
Lion Creek	204LIO080	Mills College at Alumni House	3	9.3	Sp	5/14/04	cloudy (> 4" vis.)	brown	clear	none	*NR*
						5/21/04	cloudy (> 4" vis.)	colorless	overcast	drizzle	1-5 cfs
					Su	8/12/04	clear	brown	clear	none	0.1 -1 cfs
						8/18/04	cloudy (> 4" vis.)	brown	clear	none	0.1 -1 cfs
					Wn	2/11/05	murky (< 4" vis.)	yellow	overcast	none	0.1 -1 cfs
						2/17/05	murky (< 4" vis.)	brown	overcast	none	1-5 cfs
	204LIO090	Mills College above Aliso	2	9.4	Sp	5/14/04	murky (< 4" vis.)	brown	clear	none	1-5 cfs
						5/21/04	cloudy (> 4" vis.)	yellow	overcast	drizzle	1-5 cfs
					Wn	2/11/05	murky (< 4" vis.)	yellow	overcast	none	1-5 cfs
						2/17/05	murky (< 4" vis.)	*NR*	overcast	none	1-5 cfs
	204LIO130	Horseshoe Creek	2	9.5	Su	8/12/04	clear	colorless	clear	none	0.1 -1 cfs
						8/18/04	clear	colorless	clear	none	0.1 -1 cfs
					Wn	2/11/05	clear	colorless	overcast	none	0.1 -1 cfs
						2/17/05	cloudy (> 4" vis.)	*NR*	*NR*	*NR*	1-5 cfs
Arroyo Viejo	204AVJ020	Arroyo Viejo Rec. Center	3	10.1	Sp	4/9/04	clear	colorless	clear	none	1-5 cfs
						4/16/04	clear	colorless	partly cloudy	none	1-5 cfs
					Su	8/12/04	clear	colorless	overcast	none	0.1 -1 cfs
						8/18/04	clear	colorless	clear	none	0.1 -1 cfs
					Wn	2/11/05	clear	colorless	overcast	none	0.1 -1 cfs
						2/17/05	murky (< 4" vis.)	brown	partly cloudy	none	1-5 cfs
	204AVJ110	Rifle Range	3	10.3	Sp	4/9/04	clear	brown	clear	none	0.1 -1 cfs
						4/16/04	clear	colorless	partly cloudy	none	0.1 -1 cfs
					Su	8/12/04	clear	colorless	clear	none	trickle (<0.1 cfs)
						8/18/04	cloudy (> 4" vis.)	brown	clear	none	trickle (<0.1 cfs)
					Wn	2/11/05	clear	colorless	overcast	drizzle	0.1 -1 cfs
						2/17/05	cloudy (> 4" vis.)	brown	overcast	none	1-5 cfs
	204AVJ130	Knowland Park Zoo	3	10.4	Sp	4/9/04	*NR*	*NR*	clear	none	0.1 -1 cfs
						4/16/04	clear	colorless	*NR*	*NR*	*NR*
					Su	8/12/04	clear	brown	partly cloudy	none	0.1 -1 cfs
						8/18/04	clear	brown	clear	none	trickle (<0.1 cfs)
					Wn	2/11/05	clear	colorless	overcast	drizzle	0.1 -1 cfs
						2/17/05	murky (< 4" vis.)	brown	overcast	none	1-5 cfs
Arroyo Mocho	204AMO070	Above Vulcan Bridge (Zone 7)	2	11.1	Sp	4/23/04	clear	colorless	partly cloudy	none	*NR*
						4/30/04	clear	colorless	clear	none	5-20 cfs
					Wn	2/18/05	clear	yellow	partly cloudy	none	20-50 cfs
						2/24/05	clear	colorless	overcast	none	5-20 cfs
	204AMO100	Wente Street	3	11.5	Sp	4/23/04	cloudy (> 4" vis.)	*NR*	clear	none	5-20 cfs
						4/30/04	clear	colorless	clear	none	5-20 cfs
					Su	8/20/04	clear	colorless	clear	none	5-20 cfs
						9/1/04	clear	colorless	clear	none	1-5 cfs
					Wn	2/18/05	clear	colorless	partly cloudy	none	5-20 cfs
						2/24/05	clear	green/brown	overcast	none	5-20 cfs
	204AMO160	Above SBA Zone 7	3	11.6	Sp	4/23/04	clear	colorless	clear	none	0.1 -1 cfs
						4/30/04	clear	colorless	*NR*	none	0.1 -1 cfs
					Su	8/20/04	clear	yellow	clear	none	isolated pool
						9/1/04	clear	colorless	clear	none	isolated pool
					Wn	2/18/05	cloudy (> 4" vis.)	brown	partly cloudy	none	20-50 cfs
						2/24/05	clear	green	overcast	none	5-20 cfs
	204AMO180	Hetch Hetchy	3	11.7	Sp	4/23/04	clear	colorless	clear	none	0.1 -1 cfs
						4/30/04	*NR*	*NR*	clear	none	dry waterbody bed
					Wn	2/18/05	clear	colorless	partly cloudy	none	5-20 cfs
						2/24/05	clear	yellow	overcast	none	5-20 cfs
	204AMO200	County Line	2	11.8	Sp	4/23/04	clear	colorless	clear	none	trickle (<0.1 cfs)
						4/30/04	clear	colorless	clear	none	trickle (<0.1 cfs)
					Wn	2/18/05	cloudy (> 4" vis.)	yellow/brown	partly cloudy	none	5-20 cfs
						2/24/05	clear	colorless	overcast	none	1-5 cfs

Table C-3 (cont.) Page 4

Watershed	Station	Station Name	# of Events	Station #	Season	Deployment - Retreival Dates	Water Clarity	Water Color	Sky Code	Precipitation	Observed Flow
Pine Gulch Creek	201PNG010	Lower Pine Gulch	3	14.1	Sp	4/22/05	clear	colorless	partly cloudy	none	1-5 cfs
						4/29/05	clear	*NR*	partly cloudy	none	1-5 cfs
					Su	8/10/05	clear	colorless	overcast	none	5-20 cfs
						8/18/05	clear	colorless	overcast	*NR*	1-5 cfs
					Wn	1/18/06	murky (< 4" vis.)	brown	partly cloudy	none	20-50 cfs
						1/26/06	cloudy (> 4" vis.)	green	*NR*	fog and drizzle	5-20 cfs
	201PNG050	Teixeira	3	14.2	Sp	4/22/05	clear	colorless	partly cloudy	none	1-5 cfs
						4/29/05	clear	colorless	partly cloudy	none	*NR*
					Su	8/10/05	clear	colorless	partly cloudy	none	1-5 cfs
						8/18/05	clear	colorless	fog	none	1-5 cfs
					Wn	2/9/06	cloudy (> 4" vis.)	colorless	clear	none	1-5 cfs
						2/21/06	clear	colorless	clear	none	1-5 cfs
Easkoot Creek	201EAS020	Easkoot	3	15.1	Sp	4/22/05	clear	colorless	partly cloudy	none	1-5 cfs
						4/29/05	clear	colorless	partly cloudy	none	0.1 -1 cfs
					Su	8/10/05	cloudy (> 4" vis.)	yellow	fog	fog	0.1 -1 cfs
						8/18/05	clear	*NR*	fog	none	0.1 -1 cfs
					Wn	1/18/06	murky (< 4" vis.)	brown	overcast	rain	1-5 cfs
						1/26/06	cloudy (> 4" vis.)	brown	partly cloudy	none	0.1 -1 cfs
	201EAS050	Fitzhenry	3	15.2	Sp	4/22/05	clear	colorless	overcast	none	1-5 cfs
						4/29/05	clear	colorless	partly cloudy	none	0.1 -1 cfs
					Su	8/10/05	clear	*NR*	fog	none	0.1 -1 cfs
						8/18/05	clear	colorless	overcast	none	0.1 -1 cfs
					Wn	1/18/06	murky (< 4" vis.)	brown	partly cloudy	*NR*	1-5 cfs
						1/26/06	clear	colorless	partly cloudy	none	0.1 -1 cfs
Webb Creek	201WBB010	Steep Ravine	3	16.1	Sp	4/22/05	clear	colorless	overcast	none	1-5 cfs
						4/29/05	clear	colorless	partly cloudy	none	1-5 cfs
					Su	8/10/05	clear	colorless	fog	fog	1-5 cfs
						8/18/05	clear	colorless	fog	drizzle	1-5 cfs
					Wn	1/18/06	cloudy (> 4" vis.)	colorless/brown	partly cloudy	rain	1-5 cfs
						1/26/06	clear	colorless	partly cloudy	none	1-5 cfs
Redwood Creek	201RDW040	Green Gulch	3	17.2	Sp	5/6/05	clear	colorless	partly cloudy	none	0.1 -1 cfs
						5/13/05	clear	brown	fog	none	0.1 -1 cfs
					Su	8/19/05	cloudy (> 4" vis.)	colorless	fog	fog	0.1 -1 cfs
						9/1/05	cloudy (> 4" vis.)	brown	fog	fog	0.1 -1 cfs
					Wn	1/27/06	cloudy (> 4" vis.)	yellow	partly cloudy	none	1-5 cfs
						2/7/06	cloudy (> 4" vis.)	colorless	clear	none	1-5 cfs
	201RDW060	Lower Redwood	3	17.3	Sp	5/6/05	clear	colorless	partly cloudy	none	0.1 -1 cfs
						5/13/05	clear	colorless	overcastand fog	none	1-5 cfs
					Su	8/19/05	clear	colorless	fog	fog	1-5 cfs
						9/1/05	clear	colorless	fog	fog	1-5 cfs
					Wn	1/27/06	cloudy (> 4" vis.)	yellow	overcast	none	5-20 cfs
						2/7/06	cloudy (> 4" vis.)	green	clear	none	5-20 cfs
	201RDW100	Miwok Bridge	3	17.4	Sp	5/6/05	clear	*NR*	partly cloudy	none	5-20 cfs
						5/13/05	clear	colorless	partly cloudy	none	1-5 cfs
					Su	8/19/05	clear	colorless	fog	fog	1-5 cfs
						9/1/05	clear	colorless	fog	fog	1-5 cfs
					Wn	1/27/06	cloudy (> 4" vis.)	yellow	overcast	none	5-20 cfs
						2/7/06	cloudy (> 4" vis.)	colorless/green	clear	none	1-5 cfs
	201RDW120	Muir Woods	3	17.5	Sp	5/6/05	clear	*NR*	*NR*	*NR*	5-20 cfs
						5/13/05	clear	colorless	partly cloudy	none	1-5 cfs
					Su	8/19/05	clear	colorless	fog	drizzle	1-5 cfs
						9/1/05	clear	colorless	fog	fog	1-5 cfs
					Wn	1/27/06	cloudy (> 4" vis.)	yellow	overcast	none	5-20 cfs
						2/7/06	clear	colorless	clear	none	5-20 cfs

Table C-3 (cont.) Page 5

Watershed	Station	Station Name	# of Events	Station #	Season	Deployment - Retreival Dates	Water Clarity	Water Color	Sky Code	Precipitation	Observed Flow
Tennessee Valley Creek	201TVY030	Tennessee Valley	3	18.1	Sp	4/22/05	cloudy (> 4" vis.)	brown	overcast	drizzle	1-5 cfs
						4/29/05	cloudy (> 4" vis.)	brown	partly cloudy	none	0.1 -1 cfs
					Su	8/10/05	cloudy (> 4" vis.)	brown	fog	fog	0.1 -1 cfs
						8/18/05	cloudy (> 4" vis.)	brown	overcast	fog	0.1 -1 cfs
					Wn	1/18/06	murky (< 4" vis.)	brown	partly cloudy	none	1-5 cfs
						1/26/06	cloudy (> 4" vis.)	yellow/brown	partly cloudy	none	1-5 cfs
Rodeo Creek	201ROD010	Rodeo Lagoon Foot Bridge	3	19.1	Sp	6/2/05	*NR*	green	clear	none	*NR*
						6/24/05	murky (< 4" vis.)	green	overcast	none	*NR*
					Fa	9/2/05	cloudy (> 4" vis.)	green	overcast	none	NA
						9/12/05	cloudy (> 4" vis.)	*NR*	fog	drizzle	NA
					Wn	2/9/06	murky (< 4" vis.)	brown	clear	none	no observed flow
						2/21/06	cloudy (> 4" vis.)	brown	clear	none	no observed flow
	201ROD020	Rodeo Lagoon Car Bridge	3	19.2	Sp	6/2/05	murky (< 4" vis.)	green	clear	none	NA
						6/24/05	murky (< 4" vis.)	*NR*	fog	none	*NR*
					Fa	9/2/05	murky (< 4" vis.)	green	overcast	none	Lagoon
						9/12/05	cloudy (> 4" vis.)	green	fog	drizzle	0.1 -1 cfs
					Wn	2/9/06	murky (< 4" vis.)	brown	clear	none	no observed flow
						2/21/06	cloudy (> 4" vis.)	green and brown	clear	none	1-5 cfs
	201ROD030	Rodeo Lake	3	19.3	Sp	6/2/05	murky (< 4" vis.)	green	clear	none	1-5 cfs
						6/24/05	murky (< 4" vis.)	green	fog	none	1-5 cfs
					Fa	9/2/05	cloudy (> 4" vis.)	brown	overcast	none	0.1 -1 cfs
						9/12/05	cloudy (> 4" vis.)	brown	fog	fog	0.1 -1 cfs
					Wn	2/9/06	murky (< 4" vis.)	brown	clear	none	1-5 cfs
						2/21/06	cloudy (> 4" vis.)	brown	clear	none	1-5 cfs
	201ROD040	Gerbode	3	19.5	Sp	6/2/05	cloudy (> 4" vis.)	yellow	clear	none	0.1 -1 cfs
						6/24/05	cloudy (> 4" vis.)	green and brown	fog	none	0.1 -1 cfs
					Fa	9/2/05	cloudy (> 4" vis.)	colorless	overcast	none	0.1 -1 cfs
						9/12/05	cloudy (> 4" vis.)	brown	fog	fog	0.1 -1 cfs
					Wn	2/9/06	cloudy (> 4" vis.)	brown	clear	none	1-5 cfs
						2/21/06	cloudy (> 4" vis.)	green and brown	clear	none	1-5 cfs
	201ROD050	Lower Rodeo	3	19.6	Sp	6/2/05	cloudy (> 4" vis.)	yellow	clear	none	0.1 -1 cfs
						6/24/05	murky (< 4" vis.)	brown	fog	none	0.1 -1 cfs
					Fa	9/2/05	cloudy (> 4" vis.)	*NR*	fog	fog	0.1 -1 cfs
						9/12/05	cloudy (> 4" vis.)	*NR*	fog	fog	0.1 -1 cfs
					Wn	2/9/06	murky (< 4" vis.)	brown	clear	none	1-5 cfs
						2/21/06	cloudy (> 4" vis.)	gray	clear	none	1-5 cfs
Lobos Creek	203LOB020	Lobos below Lincoln	3	20.1	Sp	5/6/05	clear	colorless	partly cloudy	none	0.1 -1 cfs
						5/13/05	clear	colorless	fog	none	1-5 cfs
					Su	8/19/05	clear	colorless	fog	fog	0.1 -1 cfs
						9/1/05	clear	colorless	fog	none	20-50 cfs
					Wn	1/27/06	clear	colorless	partly cloudy	none	1-5 cfs
						2/7/06	clear	colorless	clear	none	0.1 -1 cfs
Islais Creek	204ISL050	Glen Canyon Park	2	21.1	Sp	5/6/05	clear	*NR*	partly cloudy	none	0.1 -1 cfs
						5/13/05	clear	colorless	clear	none	0.1 -1 cfs
					Wn	1/27/06	clear	colorless	partly cloudy	none	0.1 -1 cfs
						2/7/06	clear	colorless	clear	none	1-5 cfs

Table D-1: Inventory of Station Visits and associated chemistry & toxicity monitoring activities performed in 2004-2005

Stn #	Station	Station Name	Sample Date	Sample Time	Season		Field Measurements & observations	Conventionals and nutrients	Water chemsitry and toxicity	sediment chemistry and toxicity
1.1	BAX030	Baxter at Booker	10/Jan/2005	10:20	Wet		x	x	x	
			12/Apr/2005	7:30	Spring		x	x	x	x
			13/Jun/2005	15:15	Dry		x	x	x	
2.1	CER020	Cerrito at Creekside Park	10/Jan/2005	11:00	Wet		x	x	x	
			12/Apr/2005	8:45	Spring		x	x	x	x
			13/Jun/2005	15:45	Dry		x	x	x	
3.1	COD020	Codornices at 2nd Street	10/Jan/2005	12:30	Wet		x	x	x	
			12/Apr/2005	9:25	Spring		x	x	x	x
			13/Jun/2005	16:25	Dry		x	x	x	
4.1	STW010	Strawberry Creek Park	10/Jan/2005	13:00	Wet		x	x	x	
			12/Apr/2005	11:00	Spring		x	x	x	x
			13/Jun/2005	16:55	Dry		x	x	x	
5.3	TEM090	Above Lake Temescal	10/Jan/2005	14:00	Wet		x	x	x	
			12/Apr/2005	13:15	Spring		x	x	x	
			14/Jun/2005	10:20	Dry		x	x	x	
6.1	LME100	Glen Echo at 29th Street	10/Jan/2005	15:45	Wet		x	x	x	
			12/Apr/2005	13:55	Spring		x	x	x	x
			14/Jun/2005	9:45	Dry		x	x	x	
7.1	SAU030	Sausal at E.22nd	10/Jan/2005	16:00	Wet		x	x	x	
			12/Apr/2005	14:50	Spring		x	x	x	x
			14/Jun/2005	9:00	Dry		x	x	x	
8.1	PRL020	Cesar Chavez Park	10/Jan/2005	16:40	Wet		x	x	x	
			12/Apr/2005	15:30	Spring		x	x	x	x
			14/Jun/2005	8:25	Dry		x	x	x	
9.1	LIO030	Lion at Eastlawn	11/Jan/2005	7:30	Wet		x		x	
10.1	AVJ020	Arroyo Viejo Rec. Center	11/Jan/2005	8:30	Wet		x	x	x	
			12/Apr/2005	16:15	Spring		x	x	x	x
			14/Jun/2005	7:40	Dry		x	x	x	
11.1	AMO070	Above Vulcan Bridge Zone	11/Jan/2005	10:00	Wet		x	x	x	
			12/Apr/2005	17:55	Spring		x	x	x	x
			14/Jun/2005	11:20	Dry		x	x	x	

Table D-1 (cont., Year 5 visits)

Stn #	Station	Station Name	Sample Date	Sample Time	Season		Field Measurements & observations	Conventionals and nutrients	Water chemsitry and toxicity	sediment chemistry and toxicity
12.1	AUD020	Audubon Canyon	11/Apr/2005	10:25	Spring		x	x		
			13/Jun/2005	9:30	Dry		x	x		
			16/Feb/2006	9:15	Wet		x	x		
13.1	MRS020	Morses Gulch	11/Apr/2005	11:00	Spring		x	x		
			13/Jun/2005	9:45	Dry		x	x		
			16/Feb/2006	9:30	Wet		x	x		
14.1	PNG010	Lower Pine Gulch	11/Apr/2005	8:45	Spring		x	x	x	x
			13/Jun/2005	8:40	Dry		x	x	x	
			16/Feb/2006	8:30	Wet		x	x	x	
15.1	EAS020	Easkoot	11/Apr/2005	11:55	Spring		x	x	x	x
			13/Jun/2005	10:10	Dry		x	x	x	
			16/Feb/2006	9:45	Wet		x	x	x	
17.2	RDW040	Green Gulch	11/Apr/2005	13:30	Spring		x	x		
			13/Jun/2005	11:10	Dry		x	x		
			16/Feb/2006	10:55	Wet		x	x		
17.3	RDW060	Lower Redwood	11/Apr/2005	12:55	Spring		x	x		
			13/Jun/2005	10:55	Dry		x	x		
			16/Feb/2006	10:35	Wet		x	x		
18.1	TVY030	Tennessee Valley	11/Apr/2005	14:15	Spring		x	x		
			13/Jun/2005	11:50	Dry		x	x		
			16/Feb/2006	11:35	Wet		x	x		
19.5	ROD040	Gerbode	11/Apr/2005	15:30	Spring		x	x		
			13/Jun/2005	12:40	Dry		x	x		
			16/Feb/2006	12:40	Wet		x	x		
19.6	ROD050	Lower Rodeo	11/Apr/2005	15:00	Spring		x	x		
			13/Jun/2005	12:25	Dry		x	x		
			16/Feb/2006	12:10	Wet		x			
20.1	LOB020	Lobos Below Lincoln	11/Apr/2005	16:35	Spring		x	x	x	x
			13/Jun/2005	13:20	Dry		x	x	x	
			16/Feb/2006	13:15	Wet		x	x	x	
21.1	ISL050	Glen Canyon Park	11/Apr/2005	17:40	Spring		x			x

Table D-2: Analytical suites for selected organic compounds methods

Table D-2a: PAHs analyzed in water and sediment in 2004-05

PAH name	Water (EPA 8270M)		Sediment (EPA 8270M)	
	Detection Limit (µg/L)	Reporting Limit (µg/L)	Detection Limit (ng/g dry)	Reporting Limit (ng/g dry)
Acenaphthene	0.005	0.005	0.565	1.15
Acenaphthylene	"	"	"	"
Anthracene	"	"	"	"
Benz(a)anthracene	"	"	"	"
Benzo(a)pyrene	"	"	"	"
Benzo(b)fluoranthene	"	"	"	"
Benzo(e)pyrene	"	"	"	"
Benzo(g,h,i)perylene	"	"	"	"
Benzo(k)fluoranthene	"	"	"	"
Biphenyl	"	"	"	"
Chrysene	"	"	"	"
Chrysenes, C1 -	"	"	"	"
Chrysenes, C2 -	"	"	"	"
Chrysenes, C3 -	"	"	"	"
Dibenz(a,h)anthracene	"	"	"	"
Dibenzothiophene	"	"	"	"
Dibenzothiophenes, C1 -	"	"	"	"
Dibenzothiophenes, C2 -	"	"	"	"
Dibenzothiophenes, C3 -	"	"	"	"
Dimethylnaphthalene, 2,6-	"	"	"	"
Dimethylphenanthrene, 3,6-	"	"	"	"
Fluoranthene	"	"	"	"
Fluoranthene/Pyrenes, C1 -	"	"	"	"
Fluorene	"	"	"	"
Fluorenes, C1 -	"	"	"	"
Fluorenes, C2 -	"	"	"	"
Fluorenes, C3 -	"	"	"	"
Indeno(1,2,3-c,d)pyrene	"	"	"	"
Methyldibenzothiophene, 4-	"	"	"	"
Methylfluoranthene, 2-	"	"	"	"
Methylfluorene, 1-	"	"	"	"
Methylnaphthalene, 1-	"	"	"	"
Methylnaphthalene, 2-	"	"	"	"
Methylphenanthrene, 1-	"	"	"	"
Naphthalene	"	"	"	"
Naphthalenes, C1 -	"	"	"	"
Naphthalenes, C2 -	"	"	"	"
Naphthalenes, C3 -	"	"	"	"
Naphthalenes, C4 -	"	"	"	"
Perylene	"	"	"	"
Phenanthrene	"	"	"	"
Phenanthrene/Anthracene, C1 -	"	"	"	"
Phenanthrene/Anthracene, C2 -	"	"	"	"
Phenanthrene/Anthracene, C3 -	"	"	"	"
Phenanthrene/Anthracene, C4 -	"	"	"	"
Pyrene	"	"	"	"
Trimethylnaphthalene, 2,3,5-	"	"	"	"

Table D-2b: PCBs analyzed in water and sediment in 2004-05

PCB name	Water (EPA 8082M)		Sediment (EPA 8082M)	
	Detection Limit (µg/L)	Reporting Limit (µg/L)	Detection Limit (ng/g dry)	Reporting Limit (ng/g dry)
PCB 005	0.001	0.002		
PCB 008	"	"	0.114 to 0.229	0.228 to 0.458
PCB 015	"	"		
PCB 018	"	"	"	"
PCB 027	"	"	"	"
PCB 028	"	"	"	"
PCB 029	"	"	"	"
PCB 031	"	"	"	"
PCB 033	"	"	"	"
PCB 044	"	"	"	"
PCB 049	"	"	"	"
PCB 052	"	"	"	"
PCB 056	"	"	"	"
PCB 060	"	"	"	"
PCB 066	"	"	"	"
PCB 070	"	"	"	"
PCB 074	"	"	"	"
PCB 087	"	"	"	"
PCB 095	"	"	"	"
PCB 097	"	"	"	"
PCB 099	"	"	"	"
PCB 101	"	"	"	"
PCB 105	"	"	"	"
PCB 110	"	"	"	"
PCB 114	"	"	"	"
PCB 118	"	"	"	"
PCB 128	"	"	"	"
PCB 137	"	"	"	"
PCB 138	"	"	"	"
PCB 141	"	"	"	"
PCB 149	"	"	"	"
PCB 151	"	"	"	"
PCB 153	"	"	"	"
PCB 156	"	"	"	"
PCB 157	"	"	"	"
PCB 158	"	"	"	"
PCB 170	"	"	"	"
PCB 174	"	"	"	"
PCB 177	"	"	"	"
PCB 180	"	"	"	"
PCB 183	"	"	"	"
PCB 187	"	"	"	"
PCB 189	"	"	"	"
PCB 194	"	"	"	"
PCB 195	"	"	"	"
PCB 200	"	"	"	"
PCB 201	"	"	"	"
PCB 203	"	"	"	"
PCB 206	"	"	"	"
PCB 209	"	"	"	"

			Aroclors in sediment (Newman, et al., 1988)	
PCB AROCLOR 1248			11.4 to 22.9	28.5 to 57.2
PCB AROCLOR 1254			4.56 to 9.15	11.4 to 22.9
PCB AROCLOR 1260			4.56 to 9.15	11.4 to 22.9

Table D-2c: Organochlorine Pesticides analyzed in 2004-05

Pesticide Name	MDLs (µg/L)	RLs (µg/L)		MDLs Min	MDLs Max	RLs Min	RLs Max
				ng/g (dry weight)			
Organochlorine Pesticides In Water (EPA 8081AM/BM)				**OCs in Sediment (EPA 8081AM)**			
Aldrin	0.001	0.002		0.296	0.595	1.14	2.29
Chlordane, cis-	0.001	0.002		0.816	1.64	1.14	2.29
Chlordane, trans-	0.001	0.002		0.461	0.924	1.14	2.29
Chlordene, alpha-	0.001	0.002					
Chlordene, gamma-	0.001	0.002					
Dacthal	0.001	0.002		0.72	1.45	1.14	2.29
DDD(o,p')	0.001	0.002		0.876	1.76	1.14	2.29
DDD(p,p')	0.001	0.002		1.03	2.06	1.14	2.29
DDE(o,p')	0.001	0.002		0.766	1.54	2.28	4.58
DDE(p,p')	0.001	0.002		0.657	1.32	2.28	4.58
DDMU(p,p')	0.001	0.002		1.37	2.75	3.42	6.86
DDT(o,p')	0.001	0.002		1.16	2.32	3.42	6.86
DDT(p,p')	0.002	0.005		2.82	5.65	5.7	11.4
Dieldrin	0.001	0.002		0.479	0.961	0.57	1.14
Endosulfan I	0.001	0.002		1.23	2.47	2.28	4.58
Endosulfan II	0.001	0.002		3.1	6.22	5.7	11.4
Endosulfan sulfate	0.001	0.002		3.1	6.22	5.7	11.4
Endrin	0.001	0.002		1.07	2.15	2.28	4.58
Endrin Aldehyde	0.002	0.005					
Endrin Ketone	0.002	0.005					
HCH, alpha	0.001	0.002		0.543	1.09	0.57	1.14
HCH, beta	0.001	0.002		0.702	1.41	1.14	2.29
HCH, delta	0.001	0.002		0.41	0.824	2.28	4.58
HCH, gamma	0.001	0.002		0.388	0.778	0.57	1.14
Heptachlor	0.001	0.002		0.588	1.18	1.14	2.29
Heptachlor epoxide	0.001	0.002		0.575	1.15	1.14	2.29
Hexachlorobenzene	0.0005	0.001		0.123	0.247	0.342	0.686
Methoxychlor	0.001	0.002		1.69	3.39	3.42	6.86
Mirex	0.001	0.002		1.08	2.16	1.71	3.43
Nonachlor, cis-	0.001	0.002		1.12	2.24	1.14	2.29
Nonachlor, trans-	0.001	0.002		0.442	0.888	1.14	2.29
Oxadiazon	0.001	0.002		1.07	2.14	1.14	2.29
Oxychlordane	0.001	0.002		0.42	0.842	1.14	2.29
Tedion	0.001	0.002		0.839	1.68	2.28	4.58
Toxaphene				9.12	18.3	22.8	45.8

Table D-2d: Organophosphate Pesticides analyzed in 2004-05

Pesticide Name	MDLs Min	MDLs Max	RLs Min	RLs Max		MDLs Min	MDLs Max	RLs Min	RLs Max
	(µg/L)					ng/g (dry weight)			
Organophosphate Pesticides in water (EPA 8141AM)						**OPs in Sediment (EPA 8081AM)**			
Aspon	0.03	0.03	0.05	0.05					
Azinphos ethyl	0.03	0.03	0.05	0.05					
Azinphos methyl	0.03	0.03	0.05	0.05					
Bolstar	0.03	0.03	0.05	0.05					
Carbophenothion	0.03	0.03	0.05	0.05					
Chlorfenvinphos	0.03	0.03	0.05	0.05					
Chlorpyrifos	0.02	0.02	0.05	0.05		5	5	10	10
Chlorpyrifos methyl	0.02	0.02	0.05	0.05		25	25	50	50
Ciodrin	0.03	0.03	0.05	0.05					
Coumaphos	0.04	0.04	0.05	0.05					
Demeton-s	0.04	0.04	0.05	0.05					
Diazinon	0.005	0.005	0.02	0.02		5	5	10	10
Dichlofenthion	0.03	0.03	0.05	0.05		25	25	50	50
Dichlorvos	0.03	0.03	0.05	0.05					
Dicrotophos	0.03	0.03	0.05	0.05					
Dimethoate	0.03	0.03	0.05	0.05					
Dioxathion	0.03	0.03	0.05	0.05		25	25	50	50
Disulfoton	0.01	0.01	0.05	0.05					
Ethion	0.02	0.02	0.05	0.05		25	25	50	50
Ethoprop	0.03	0.03	0.05	0.05		25	25	50	50
Famphur	0.03	0.03	0.05	0.05					
Fenchlorphos	0.03	0.03	0.05	0.05		25	25	50	50
Fenitrothion	0.03	0.03	0.05	0.05		25	25	50	50
Fensulfothion	0.03	0.03	0.05	0.05					
Fenthion	0.03	0.03	0.05	0.05					
Fonofos	0.02	0.02	0.05	0.05		25	25	50	50
Leptophos	0.03	0.03	0.05	0.05					
Malathion	0.03	0.03	0.05	0.05		25	25	50	50
Merphos	0.03	0.03	0.05	0.05		25	25	50	50
Methidathion	0.03	0.03	0.05	0.05					
Mevinphos	0.03	0.03	0.05	0.05					
Molinate	0.02	0.1	0.05	0.2					
Naled	0.03	0.03	0.05	0.05					
Parathion, Ethyl	0.03	0.03	0.05	0.05		10	10	20	20
Parathion, Methyl	0.01	0.01	0.05	0.05		10	10	20	20
Phorate	0.05	0.05	0.1	0.1					
Phosmet	0.05	0.05	0.1	0.1					
Phosphamidon	0.03	0.03	0.05	0.05		25	25	50	50
Sulfotep	0.03	0.03	0.05	0.05		25	25	50	50
Terbufos	0.03	0.03	0.05	0.05					
Tetrachlorvinphos	0.03	0.03	0.05	0.05					
Thiobencarb	0.02	0.1	0.05	0.2					
Thionazin	0.04	0.04	0.05	0.05		25	25	50	50
Tokuthion	0.03	0.03	0.05	0.05		25	25	50	50
Trichlorfon	0.03	0.03	0.05	0.05					
Trichloronate	0.03	0.03	0.05	0.05		10	10	20	20

Table D-2e: Other Pesticides analyzed

Pesticide Name	MDLs	RLs		MDLs	RLs
	(µg/L)			ng/g (dry weight	
Organophosphate Pesticides (ELISA SOP 3.3)					
Chlorpyrifos	0.05	0.1			
Diazinon	0.03	0.06			
Herbicides in water (EPA 619M)					
Ametryn	0.02	0.05			
Atraton	0.02	0.05			
Atrazine	0.02	0.05			
Prometon	0.02	0.05			
Prometryn	0.02	0.05			
Propazine	0.02	0.05			
Secbumeton	0.02	0.05			
Simazine	0.02	0.05			
Simetryn	0.02	0.05			
Terbuthylazine	0.02	0.05			
Terbutryn	0.02	0.05			
Carbaryl Pesticides in water (EPA 632M)					
Aldicarb	0.01	0.02			
Captan	0.05	0.1			
Carbaryl	0.01	0.02			
Carbofuran	0.01	0.02			
Diuron	0.002	0.005			
Linuron	0.002	0.005			
Methiocarb	0.15	0.25			
Methomyl	0.01	0.02			
Pyrethroid Pesticides in Sediment (EPA 8081BM)					
Bifenthrin				0.5	1
Cyfluthrin, total				1.5	3
Cyhalothrin, lambda, total				0.5	1
Cypermethrin, total				1.5	3
Deltamethrin				0.5	1
Esfenvalerate/Fenvalerate, total				1	2
Permethrin, total				2	4

Table D-3: Concentrations of conventional WQ characteristics in years 4&5 samples

Table D-3a: Comparison of nutrient concentrations in years 4&5 samples to water quality benchmarks (WQBs)

Stn#	Station	Season	Ammonia as N (mg/L)	qual	pH	Temperature (°C)	Unionized Ammonia as N (mg/L) (WQB =0.025)	Unionized Ammonia Exceedance Factor	Nitrate as N (mg/L) (WQB =0.16)	Nitrate Exceedance Factor	Phosphorus as P,Total (mg/L) (WQB =0.03)	qual	Total P Exceedance Factor
1.1	BAX030	W	0.05	J	7.9	12.2			3.54	22.1	0.15		5.1
1.1	BAX030	S		ND	7.64	13.9			2.75	17.2	0.41		13.7
1.1	BAX030	D	0.116		7.6	20.8	0.002	0.08	1.92	12.0	0.29		9.5
2.1	CER020	W	0.065	J	8.12	12.4			1.92	12.0	0.08		2.5
2.1	CER020	S		ND	7.97	13.6			1.62	10.1	0.09		3.0
2.1	CER020	D	0.078	J	7.95	19.5			1.40	8.8	0.11		3.5
3.1	COD020	W	0.044	J	7.94	12.1			1.43	8.9	0.11		3.5
3.1	COD020	S		ND	7.71	12.6			1.03	6.4	0.10		3.2
3.1	COD020	D	0.062	J	8.04	24.9			0.37	2.3	0.11		3.8
4.1	STW010	W		ND	7.89	12.5			1.98	12.4	0.18		6.1
4.1	STW010	S		ND	7.87	13.0			1.12	7.0	0.11		3.6
4.1	STW010	D	0.054	J	7.73	18.3			0.86	5.4	0.10		3.4
5.3	TEM090	W		ND	7.87	11.5			2.00	12.5	0.10		3.2
5.3	TEM090	S		ND	7.61	12.2			0.95	5.9	0.08		2.6
5.3	TEM090	D	0.047	J	7.86	15.5			0.50	3.1	0.10		3.3
6.1	LME100	W	0.086	J	7.75	11.4			1.45	9.1	0.16		5.3
6.1	LME100	S		ND	7.37	13.9			1.44	9.0	0.09		2.9
6.1	LME100	D	0.075	J	7.16	15.9			1.81	11.3	0.16		5.2
7.1	SAU030	W	0.097	J	7.84	11.5	0.001	0.04	2.27	14.2	0.07		2.3
7.1	SAU030	S		ND	7.56	12.8			1.41	8.8	0.06		2.1
7.1	SAU030	D	0.05	J	7.68	15.5			1.25	7.8	0.08		2.7
8.1	PRL020	W	0.04	J	7.86	12.8			4.69	29.3	0.14		4.8
8.1	PRL020	S		ND	7.78	14.3			3.77	23.6	0.11		3.7
8.1	PRL020	D	0.064	J	7.74	16.6			2.82	17.6	0.14		4.6
10.1	AVJ020	W	0.047	J	7.24	9.1			0.90	5.7	0.40		13.2
10.1	AVJ020	S		ND	7.58	13.8			1.69	10.6	0.07		2.2
10.1	AVJ020	D	0.744		7.46	15.9	0.06	2.4	1.24	7.8	0.20		6.7
11.1	AMO070	W	0.054	J	7.8	8.3			0.37	2.3	0.20		6.6
11.1	AMO070	S		ND	8.55	18.2			0.61	3.8		ND	
11.1	AMO070	D	0.042	J	8.26	20.8			0.12	0.8	0.06		1.9
12.1	AUD020	S		ND	7.09	11.4			0.13	0.8		ND	
12.1	AUD020	D		ND	7.38	13.4			0.17	1.0	0.04	J	1.4
12.1	AUD020	W		ND	7.6	9.2			0.08	0.5	0.05		1.8
13.1	MRS020	S		ND	7.1	11.3			0.19	1.2	0.05	J	1.6
13.1	MRS020	D		ND	7.62	13.3			0.23	1.4	0.04	J	1.5
13.1	MRS020	W		ND	7.88	8.4			0.20	1.2	0.03	J	1.1
14.1	PNG010	S		ND	7.46	10.8			0.31	2.0	0.06		2.1
14.1	PNG010	D		ND	7.3	12.9			0.38	2.4	0.08		2.7
14.1	PNG010	W		ND	7.55	7.6			0.39	2.4	0.06		1.9
15.1	EAS020	S		ND	7.22	12.3			0.41	2.6	0.04	J	1.2
15.1	EAS020	D		ND	7.19	13.8			0.54	3.4	0.10		3.5
15.1	EAS020	W		ND	7.74	8.2			0.57	3.6	0.04	J	1.3
17.2	RDW040	S		ND	6.98	12.7			0.11	0.7	0.04	J	1.4
17.2	RDW040	D		ND	7.04	14.4			0.05	0.3	0.04	J	1.3
17.2	RDW040	W		ND	7.76	8.2			0.31	1.9		ND	
17.3	RDW060	S		ND	7.09	12.1			0.06	0.4		ND	
17.3	RDW060	D		ND	7.23	13.9			0.04	0.2	0.03	J	1.0
17.3	RDW060	W		ND	7.63	8.3			0.08	0.5	0.05	J	1.6
18.1	TVY030	S		ND	6.71	12.8			0.07	0.5	0.07		2.2
18.1	TVY030	D		ND	6.78	13.2			0.06	0.3	0.07		2.3
18.1	TVY030	W		ND	7.44	8.3			0.19	1.2	0.05		1.7
19.5	ROD040	S		ND	6.79	13.1			0.04	0.2	0.05	J	1.7
19.5	ROD040	D		ND	6.96	12.5			0.02	0.1	0.05		1.7
19.5	ROD040	W		ND	7.47	8.5			0.10	0.6	0.05		1.8
19.6	ROD050	S		ND	6.96	11.9			0.03	0.2	0.05		1.7
19.6	ROD050	W		ND	7.48	7.9			0.10	0.6	0.09		3.2
20.1	LOB020	S		ND	7.16	17.0			8.20	51.3	0.06		2.0
20.1	LOB020	D		ND	7.38	18.1			8.52	53.3	0.10		3.3
20.1	LOB020	W		ND	7.71	15.5			7.86	49.1	0.08		2.7

x Results that exceed WQBs shown in headers have Exceedance Factors higher than 1; these are highlighted in red font and gray fill.
ND=not detected. "J" is defined as 'estimated'; the analyte was detected, but the value is below the Reporting Limit

Table D-3b: Concentrations of selected nutrients, chlorophyll *a*, TOC, and SSC in years 4&5 water samples

Stn #	Station	Season	Nitrite as N (mg/L)		Nitrogen, Total Kjeldahl (mg/L)		Ortho - Phosphate as P (mg/L)	Chloro - phyll a (µg/L)	Total Organic Carbon (mg/L)	Suspended Sediment Conc. (mg/L)	
1.1	BAX030	W	0.03		0.57		0.18	0.41	2.8		ND
1.1	BAX030	S	0.01	J	0.40		0.27	0.52			ND
1.1	BAX030	D	0.02		0.77		0.25	1.13	4.9	5	
2.1	CER020	W	0.01	J	0.59		0.09	0.30	2.5		ND
2.1	CER020	S	0.01		0.40		0.10	0.35	6.0	7	
2.1	CER020	D	0.02		0.26		0.10	0.55	4.2	11	
3.1	COD020	W	0.01	J	0.48		0.12	0.19	1.9	6	
3.1	COD020	S	0.01	J	0.46		0.11	0.85	4.3		ND
3.1	COD020	D	0.01	J	0.38		0.11	1.90	3.8		ND
4.1	STW010	W	0.01	J	0.62		0.15	0.14	2.4	9	
4.1	STW010	S		ND	0.33		0.12	0.49	3.9		ND
4.1	STW010	D	0.02		0.17	J	0.10	0.27	3.0	11	
5.3	TEM090	W	0.01	J	0.48		0.06	0.29	2.0	11	
5.3	TEM090	S	0.01	J	0.30		0.07	0.94	4.4		ND
5.3	TEM090	D	0.01	J	0.27		0.10	0.63	3.7		ND
6.1	LME100	W	0.02		0.72		0.14	0.77	3.5	8	
6.1	LME100	S	0.02		0.60		0.09	0.38	6.6		ND
6.1	LME100	D	0.01		0.37		0.15	0.18	5.1		ND
7.1	SAU030	W	0.02		0.50		0.07	0.17	2.9	7	
7.1	SAU030	S	0.01	J	0.25		0.07	0.19	4.1		ND
7.1	SAU030	D	0.01	J	0.19	J	0.09	0.28	3.5	6	
8.1	PRL020	W	0.01		0.27		0.16	0.29	4.1		ND
8.1	PRL020	S	0.01	J		ND	0.13	0.42	4.6		ND
8.1	PRL020	D	0.02		0.37		0.16	1.98	3.9		ND
10.1	AVJ020	W	0.01	J	1.80		0.09	2.22	3.5	345	
10.1	AVJ020	S	0.01	J	0.40		0.06	0.44	6.0		ND
10.1	AVJ020	D	0.02		1.22		0.19	0.58	4.8		ND
11.1	AMO070	W	0.01	J	1.06		0.09	2.49	3.1	200	
11.1	AMO070	S	0.01	J	0.41		0.03	2.40	4.5		ND
11.1	AMO070	D		ND	0.36		0.03	4.15	4.3		ND
12.1	AUD020	S		ND	0.12	J	0.04	0.14	2.2		ND
12.1	AUD020	D		ND		ND	0.04	1.40	2.0		ND
12.1	AUD020	W		ND	0.14	J	0.07	0.21	2.7	18	
13.1	MRS020	S		ND		ND	0.04	0.22	2.0		ND
13.1	MRS020	D		ND		ND	0.04	0.27	1.9		ND
13.1	MRS020	W		ND		ND	0.05	0.11	3.9		ND
14.1	PNG010	S		ND	0.26		0.07	0.13	3.5	7	
14.1	PNG010	D		ND	0.21	J	0.08	0.27	3.5		ND
14.1	PNG010	W		ND	0.17	J	0.08	0.33	3.4	16	
15.1	EAS020	S		ND	0.18	J	0.05	0.23	2.8	229	
15.1	EAS020	D		ND	0.67		0.04	0.53	2.6	17	
15.1	EAS020	W		ND	0.14	J	0.06	0.17	2.9		ND
17.2	RDW040	S		ND	0.35		0.02	0.48	4.8	6	
17.2	RDW040	D		ND	0.29		0.02	0.66	4.1		ND
17.2	RDW040	W		ND	0.24	J	0.03	0.23	4.1		ND
17.3	RDW060	S		ND	0.18	J	0.03	0.25	3.1		ND
17.3	RDW060	D		ND	0.13	J	0.02	0.58	2.1		ND
17.3	RDW060	W		ND	0.25		0.03	0.33	6.1	71	
18.1	TVY030	S		ND	0.41		0.03	0.13	5.0	10	
18.1	TVY030	D		ND	0.34		0.02	0.16	4.7	9	
18.1	TVY030	W		ND	0.29		0.03	0.12	3.6	5	
19.5	ROD040	S		ND	0.40		0.02	0.14	5.2	6	
19.5	ROD040	D		ND	0.34		0.02	0.25	4.5	11	
19.5	ROD040	W		ND	0.35		0.03	0.13	3.6	37	
19.6	ROD050	S		ND	0.44		0.03	0.14	6.0	18	
19.6	ROD050	W		ND	0.61		0.03	0.17	4.5	47	
20.1	LOB020	S	0.02			ND	0.08	0.10	2.8		ND
20.1	LOB020	D	0.03			ND	0.06	0.73	2.2	8	
20.1	LOB020	W	0.02			ND	0.09	0.22	1.9	8	

ND=not detected. "J" is defined as 'estimated'; the analyte was detected, but the value is below the Reporting Limit

Table D-3c: Concentrations of salts in, and related attributes of, years 4&5 samples

Stn#	Station	Season	Alkalinity as CaCO3 (mg/L)	Chloride (mg/L)	Hardness as CaCO3 (mg/L)	Sulfate (mg/L)	Boron, Total (mg/L)	
1.1	BAX030	W	255	21.9	292	36.2	0.06	
1.1	BAX030	S	320	27.1	360	40.8	0.09	
1.1	BAX030	D	330	27.2	396	37.3	0.07	
2.1	CER020	W	341	28.4	376	42.6	0.26	
2.1	CER020	S	390	34.2	420	49.0	0.22	
2.1	CER020	D	354	39.7	364	43.2	0.44	
3.1	COD020	W	296	28.2	332	49.5	0.12	
3.1	COD020	S	322	34.9	364	62.8	0.10	
3.1	COD020	D	293	36.8	331	63.8	0.13	
4.1	STW010	W	161	18.4	193	49.6	0.11	
4.1	STW010	S	204	27	238	73.0	0.07	
4.1	STW010	D	151	25.5	176	48.7	0.09	
5.3	TEM090	W	149	20.3	328	194.0	0.08	
5.3	TEM090	S	194	33.6	426	307.0	0.06	
5.3	TEM090	D	217	32.3	475	316.0	0.11	
6.1	LME100	W	154	23.5	183	28.0	0.04	J
6.1	LME100	S	199	46	238	34.4		ND
6.1	LME100	D	202	77.8	242	30.0	0.06	
7.1	SAU030	W	134	20.7	209	78.5	0.09	
7.1	SAU030	S	178	31.4	276	109.0	0.08	
7.1	SAU030	D	182	30.5	254	92.3	0.13	
8.1	PRL020	W	226	21.9	269	39.0	0.17	
8.1	PRL020	S	265	31.9	317	49.0	0.17	
8.1	PRL020	D	230	26.1	275	36.0	0.24	
10.1	AVJ020	W	56.1	13.9	80	16.6	0.05	
10.1	AVJ020	S	197	46.4	223	57.4	0.15	
10.1	AVJ020	D	232	52.5	273	55.1	0.31	
11.1	AMO070	W	95.7	13.1	109	20.4	0.17	
11.1	AMO070	S	179	52	215	51.1	0.26	
11.1	AMO070	D	80.1	30.5	97	25.8	0.15	
12.1	AUD020	S	71.1	21.7	74	12.3	0.39	
12.1	AUD020	D	98.3	23.7	102	18.8		ND
12.1	AUD020	W	75.9	22.1	92	17.0		ND
13.1	MRS020	S	63.9	22.2	72	13.1	0.34	
13.1	MRS020	D	93.2	23.1	110	22.5		ND
13.1	MRS020	W	73.8	25.3	89	20.4		ND
14.1	PNG010	S	40.2	19.6	55	17.5	0.39	
14.1	PNG010	D	55.2	22.8	71	26.3		ND
14.1	PNG010	W	38.8	23.7	58	23.2		ND
15.1	EAS020	S	71.3	23.1	83	10.6	0.32	
15.1	EAS020	D	94.3	29.8	110	15.0		ND
15.1	EAS020	W	77.8	33.6	93	13.6		ND
17.2	RDW040	S	61.6	24.5	72	13.4		ND
17.2	RDW040	D	120	38.4	126	17.4	0.07	
17.2	RDW040	W	77.1	29.5	86	16.0		ND
17.3	RDW060	S	62.7	20.7	69	9.0		ND
17.3	RDW060	D	85.9	18.5	98	11.0		ND
17.3	RDW060	W	64.4	18.8	76	9.8		ND
18.1	TVY030	S	36.8	24.6	43	9.1		ND
18.1	TVY030	D	49.6	32.3	54	5.4		ND
18.1	TVY030	W	33.2	28.1	41	9.1		ND
19.5	ROD040	S	27.8	21	42	8.8		ND
19.5	ROD040	D	35.5	29.8	41	4.2		ND
19.5	ROD040	W	27.2	25.6	35	7.3		ND
19.6	ROD050	S	44.3	24.5	54	8.8		ND
19.6	ROD050	W	41.5	30.7	56	9.5		ND
20.1	LOB020	S	167	50.2	230	40.4	0.10	
20.1	LOB020	D	167	50.6	236	43.1	0.11	
20.1	LOB020	W	171	56	230	43.0		ND

ND=not detected. "J" is defined as 'estimated'; the analyte was detected below the Reporting Limit

Table D-3d: Field observations and measurement results in 2004-5 water sample collection Station Visits

Stn#	Station	Season		Oxygen, % Saturation	pH	Salinity (ppt)	Specific Conductivity (µS/cm)	Temperature (°C)	Turbidity (NTU)	Water Clarity	Water Color	Sky Code	Precipitation	Velocity (ft/s)	Flow Estimate
1.1	BAX030	W		101.2	7.9	0.48	966	12.15	1.13	Clear,	Colorless,	overcast,	none,	0.652	1-5 cfs,
1.1	BAX030	S		99.9	7.64	0.29	468	13.94	1.4	Clear,	Colorless,	clear,	none,		no observed flow
1.1	BAX030	D		79.2	7.6	0.33	627	20.78	0.31	Clear,	Colorless,	clear,	none,		no observed flow
2.1	CER020	W		96.6	8.12	0.61	1220	12.35	2.2	Clear,	Colorless,	overcast,	drizzle,	0.231	0.1 -1 cfs,
2.1	CER020	S		99.2	7.97	0.34	542	13.55	1.1	Clear,	Colorless,	clear,	none,		trickle (<0.1 cfs),
2.1	CER020	D		85.1	7.95	0.36	660	19.54		Cloudy (> 4"	yellow,	clear,	none,		0.1 -1 cfs,
3.1	COD020	W		97.1	7.94	0.35	1109	12.13	2.31	Clear,	Colorless,	overcast,	drizzle,	1.34	1-5 cfs,
3.1	COD020	S		103.1	7.71	0.31	487	12.59	0.67	Clear,	Colorless,	clear,	none,		trickle (<0.1 cfs),
3.1	COD020	D		144.2	8.04	0.32	668	24.94	0.92	Clear,	Colorless,	clear,	none,		1-5 cfs,
4.1	STW010	W		97	7.89	0.37	743	12.47	10.7	Murky (< 4"	Colorless,	clear,	none,	2.3	1-5 cfs,
4.1	STW010	S		100.8	7.87	0.23	369	12.97	1.9	Clear,	Colorless,	clear,	none,		1-5 cfs,
4.1	STW010	D		91.9	7.73	0.2	362	18.3	3.96	Clear,	Colorless,	clear,	none,		1-5 cfs,
5.3	TEM090	W		97.4	7.87	0.57	1133	11.54	16	Murky (< 4"	yellow,	overcast,	drizzle,	3.42	1-5 cfs,
5.3	TEM090	S		101.1	7.61	0.37	564	12.15	2.5	Clear,	Colorless,	clear,	none,		5-20 cfs,flow:
5.3	TEM090	D		87.1	7.86	0.49	312	15.47	1.2	Clear,	Colorless,	clear,	none,		0.1 -1 cfs,
6.1	LME100	W		95.2	7.75	0.33	669	11.44	5.46	Cloudy (> 4"	brown,	overcast,	none,	2.47	1-5 cfs,
6.1	LME100	S		88.9	7.37	0.23	367	13.87	1.2	Clear,	yellow,	clear,	none,		5-20 cfs,flow:
6.1	LME100	D		76.9	7.16	0.32	534	15.9	0.82	Clear,	Colorless,	clear,	none,		0.1 -1 cfs,
7.1	SAU030	W		97.6	7.84	0.38	777	11.46	5.55	Cloudy (> 4"	Colorless,	partly cloudy,	none,	0.786	1-5 cfs,
7.1	SAU030	S		99.6	7.56	0.25	395	12.81	1.2	Clear,	Colorless,	clear,	none,		1-5 cfs,
7.1	SAU030	D		91	7.68	0.29	493	15.45	0.07	Clear,	Colorless,	clear,	none,		0.1 -1 cfs,
8.1	PRL020	W		92.1	7.86	0.45	901	12.79	1.97	Clear,	Colorless,	overcast,	rain,	0.674	0.1 -1 cfs,
8.1	PRL020	S		99.4	7.78	0.26	426	14.33	0.2	Clear,	Colorless,	clear,	none,		5-20 cfs,
8.1	PRL020	D		93.2	7.74	0.26	455	16.59	0.08	Clear,	Colorless,	clear,	none,		0.1 -1 cfs,
10.1	AVJ020	W		93.6	7.24	0.11	221	9.11	**267**	Murky (< 4"	brown,	overcast,	drizzle,	2.74	1-5 cfs,
10.1	AVJ020	S		101.3	7.58	0.24	389	13.77	5.6	Clear,	Colorless,	clear,	none,		5-20 cfs,
10.1	AVJ020	D		79.1	7.46	0.34	578	15.86	1.76	Clear,	green,	clear,	none,		0.1 -1 cfs,
11.1	AMO070	W		96.9	7.8	0.14	283	8.32	**81.4**	Murky (< 4"	brown,	overcast,	rain,		5-20 cfs,
11.1	AMO070	S		138.2	8.55	0.22	398	18.18	1.1	Clear,	yellow,	clear,	none,		5-20 cfs,
11.1	AMO070	D		104.3	8.26	0.14	279	20.84	1.8	Clear,	yellow,	clear,	none,		0.1 -1 cfs,

Table D-3d (cont.)

Stn#	Station	Season		Oxygen, % Saturation	pH	Salinity (ppt)	Specific Conductivity (µS/cm)	Temperature (°C)	Turbidity (NTU)	Water Clarity	Water Color	Sky Code	Precipitation	Velocity (ft/s)	Flow Estimate
12.1	AUD020	S		94.6	7.09	0.1	148	11.43	1.3	Clear,	Colorless,	partly cloudy,	none,	3.46	5-20 cfs,
12.1	AUD020	D		96.8	7.38	0.13	217	13.36	0.48	Clear,	Colorless,	clear,	none,		1-5 cfs,
12.1	AUD020	W		93.3	7.6	0.12	260	9.21	0.9	Clear,	Colorless,	clear,	none,	4.88	1-5 cfs,
13.1	MRS020	S		86.3	7.1	0.09	139	11.3	4.7	Clear,	Colorless,	partly cloudy,	none,	4.78	5-20 cfs,
13.1	MRS020	D		98.6	7.62	0.13	213	13.27	1.25	Clear,	Colorless,	clear,	none,	1.5	1-5 cfs,
13.1	MRS020	W		96.2	7.88	0.13	263	8.35	1.96	Clear,	Colorless,	clear,	none,	1.06	1-5 cfs,
14.1	PNG010	S		73.2	7.46	0.08	120	10.79	4.6	Cloudy (> 4"	green,	clear,	none,	5.56	5-20 cfs,
14.1	PNG010	D		94.4	7.3	0.12	188	12.92	5.58	Clear,	Colorless,	clear,	none,	2.88	1-5 cfs,
14.1	PNG010	W		94.6	7.55	0.1	207	7.57	5.69	Clear,	green,	clear,	none,	1.66	1-5 cfs,
15.1	EAS020	S		96.8	7.22	0.1	156	12.33	4	Clear,	Colorless,	clear,	none,	6.58	5-20 cfs,
15.1	EAS020	D		93.3	7.19	0.14	223	13.82	0.6	Clear,	Colorless,	clear,	none,		1-5 cfs,
15.1	EAS020	W		98.9	7.74	0.13	276	8.24	3.6	Clear,	Colorless,	clear,	none,	3.46	1-5 cfs,
17.2	RDW040	S		92	6.98	0.09	150	12.68	21	Cloudy (> 4"	green,	overcast,	none,	2.94	5-20 cfs,
17.2	RDW040	D		87.3	7.04	0.16	272	14.43	0.93	Clear,	Colorless,	clear,	none,		no observed flow
17.2	RDW040	W		99.2	7.76	0.13	270	8.23	8.65	Clear,	green,	clear,	none,	1.55	1-5 cfs,
17.3	RDW060	S		88.6	7.09	0.09	129	12.09	7.6	Cloudy (> 4"	green,	overcast,	none,	1.62	5-20 cfs,
17.3	RDW060	D		95.5	7.23	0.11	179	13.94	1	Clear,	Colorless,	clear,	none,		1-5 cfs,
17.3	RDW060	W		99.5	7.63	0.1	201	8.33	3.15	Clear,	Colorless,	clear,	none,	1.77	1-5 cfs,
18.1	TVY030	S		88.1	6.71	0.07	111	12.82	24	Cloudy (> 4"	green,	overcast,	none,	4.51	5-20 cfs,
18.1	TVY030	D		90.4	6.78	0.09	150	13.16	9	Clear,	Colorless,	clear,	none,		1-5 cfs,
18.1	TVY030	W		95.8	7.44	0.08	170	8.28	19.8	Cloudy (> 4"	green,	clear,	none,	3.59	1-5 cfs,
19.5	ROD040	S		98.8	6.79	0.06	97	13.06	21	Cloudy (> 4"	brown,	partly cloudy,	none,	3.27	5-20 cfs,
19.5	ROD040	D		95.1	6.96	0.07	120	12.52	13	Cloudy (> 4"	brown,	clear,	none,		0.1 -1 cfs,
19.5	ROD040	W		94.7	7.47	0.07	147	8.45	24.4	Cloudy (> 4"	brown,	clear,	none,	3.05	1-5 cfs,
19.6	ROD050	S		87.4	6.96	0.08	128	11.85	21	Cloudy (> 4"	brown,	partly cloudy,	none,	1.89	5-20 cfs,
19.6	ROD050	W		93.3	7.48	0.09	183	7.91	21.6	Cloudy (> 4"	brown,	clear,	none,	1.68	1-5 cfs,
20.1	LOB020	S		80.8	7.16	0.26	443	16.96	0.38	Clear,	Colorless,	partly cloudy,	none,	1.17	5-20 cfs,
20.1	LOB020	D		84.4	7.38	0.27	479	18.09	1.7	Clear,	Colorless,	clear,	none,	1.75	1-5 cfs,
20.1	LOB020	W		88.7	7.71	0.29	586	15.52	1.68	Clear,	Colorless,	clear,	none,	0.749	0.1 -1 cfs,

Table D-4: Comparison of metal concentrations in years 4&5 samples to water quality objectives (WQOs)

D-4a: Trace metals with hardness-dependent WQOs

Stn #	Station ID	Sea-son	Hard-ness (mg/L)	Metal Name	Metal, Total (ug/L)		Metal, Dissolved (ug/L)		Acute WQ Objective (ug/L)	Acute Exceed-ance Factor	Chronic WQ Objective (ug/L)	Chronic Exceed-ance Factor	WQ Objective Fraction
1.1	BAX030	W	292	Cadmium			0.03						
1.1	BAX030	S	360	Cadmium			0.02	J					
1.1	BAX030	D	396	Cadmium			0.03						
2.1	CER020	W	376	Cadmium			0.02	J					
2.1	CER020	S	420	Cadmium			0.01	J					
2.1	CER020	D	364	Cadmium			0.02	J					
3.1	COD020	W	332	Cadmium			0.02	J					
3.1	COD020	S	364	Cadmium			0.01	J					
3.1	COD020	D	331	Cadmium			0.01	J					
4.1	STW010	W	193	Cadmium			0.04						
4.1	STW010	S	238	Cadmium			0.02	J					
4.1	STW010	D	176	Cadmium			0.02	J					
5.3	TEM090	W	328	Cadmium			0.19						
5.3	TEM090	S	426	Cadmium			0.1						
5.3	TEM090	D	475	Cadmium			0.05						
6.1	LME100	W	183	Cadmium			0.02	J					
6.1	LME100	S	238	Cadmium			0.05						
6.1	LME100	D	242	Cadmium			0.08						
7.1	SAU030	W	209	Cadmium			0.03						
7.1	SAU030	S	276	Cadmium			0.02	J					
7.1	SAU030	D	254	Cadmium			0.01	J					
8.1	PRL020	W	269	Cadmium			0.04						
8.1	PRL020	S	317	Cadmium			0.03						
8.1	PRL020	D	275	Cadmium			0.03						
10.1	AVJ020	W	79.6	Cadmium			0.02	J					
10.1	AVJ020	S	223	Cadmium			0.01	J					
10.1	AVJ020	D	273	Cadmium			0.02	J					
11.1	AMO070	W	109	Cadmium			0.01	J					
11.1	AMO070	S	215	Cadmium			0.01	J					
11.1	AMO070	D	97	Cadmium				ND					
14.1	PNG010	S	54.5	Cadmium			0.04						
14.1	PNG010	D	71	Cadmium			0.03						
14.1	PNG010	W	57.7	Cadmium			0.05						
15.1	EAS020	S	83	Cadmium				ND					
15.1	EAS020	D	110	Cadmium			0.01	J					
15.1	EAS020	W	93.3	Cadmium				ND					
20.1	LOB020	S	230	Cadmium				ND					
20.1	LOB020	D	236	Cadmium				ND					
20.1	LOB020	W	230	Cadmium				ND					

Dissolved Cadmium MDL = 0.01; RL=0.03 ug/L

1.1	BAX030	W	292	Copper			3.28		38.4	0.09	23.3	0.14	Dissolved
1.1	BAX030	S	360	Copper			2.23		46.8	0.05	27.9	0.08	Dissolved
1.1	BAX030	D	396	Copper			3.01		51.2	0.06	30.2	0.10	Dissolved
2.1	CER020	W	376	Copper			2.87		48.8	0.06	28.9	0.10	Dissolved
2.1	CER020	S	420	Copper			1.77		54.1	0.03	31.8	0.06	Dissolved
2.1	CER020	D	364	Copper			2.87		47.3	0.06	28.1	0.10	Dissolved
3.1	COD020	W	332	Copper			2.76		43.4	0.06	26.0	0.11	Dissolved
3.1	COD020	S	364	Copper			1.61		47.3	0.03	28.1	0.06	Dissolved
3.1	COD020	D	331	Copper			2.23		43.2	0.05	25.9	0.09	Dissolved
4.1	STW010	W	193	Copper			3.97		26.0	0.15	16.4	0.24	Dissolved
4.1	STW010	S	238	Copper			2.34		31.7	0.07	19.6	0.12	Dissolved
4.1	STW010	D	176	Copper			3.21		23.8	0.13	15.1	0.21	Dissolved
5.3	TEM090	W	328	Copper			4.6		42.9	0.11	25.7	0.18	Dissolved
5.3	TEM090	S	426	Copper			2.65		54.8	0.05	32.2	0.08	Dissolved
5.3	TEM090	D	475	Copper			3.73		60.8	0.06	35.3	0.11	Dissolved
6.1	LME100	W	183	Copper			4.81		24.7	0.19	15.6	0.31	Dissolved
6.1	LME100	S	238	Copper			4.69		31.7	0.15	19.6	0.24	Dissolved
6.1	LME100	D	242	Copper			4.27		32.2	0.13	19.9	0.22	Dissolved
7.1	SAU030	W	209	Copper			2.86		28.0	0.10	17.5	0.16	Dissolved
7.1	SAU030	S	276	Copper			1.73		36.4	0.05	22.2	0.08	Dissolved
7.1	SAU030	D	254	Copper			2.2		33.7	0.07	20.7	0.11	Dissolved
8.1	PRL020	W	269	Copper			3.48		35.6	0.10	21.7	0.16	Dissolved
8.1	PRL020	S	317	Copper			2.13		41.5	0.05	25.0	0.09	Dissolved
8.1	PRL020	D	275	Copper			2.95		36.3	0.08	22.1	0.13	Dissolved
10.1	AVJ020	W	79.6	Copper			3.47		11.3	0.31	7.7	0.45	Dissolved
10.1	AVJ020	S	223	Copper			1.95		29.8	0.07	18.5	0.11	Dissolved
10.1	AVJ020	D	273	Copper			2.24		36.1	0.06	22.0	0.10	Dissolved
11.1	AMO070	W	109	Copper			3.3		15.2	0.22	10.0	0.33	Dissolved
11.1	AMO070	S	215	Copper			2.1		28.8	0.07	17.9	0.12	Dissolved
11.1	AMO070	D	97	Copper			2.3		13.6	0.17	9.1	0.25	Dissolved
14.1	PNG010	S	54.5	Copper			0.88		7.9	0.11	5.6	0.16	Dissolved
14.1	PNG010	D	71	Copper			0.9		10.1	0.09	7.0	0.13	Dissolved
14.1	PNG010	W	57.7	Copper			0.86		8.3	0.10	5.8	0.15	Dissolved
15.1	EAS020	S	83	Copper			0.4		11.7	0.03	8.0	0.05	Dissolved
15.1	EAS020	D	110	Copper			0.62		15.3	0.04	10.1	0.06	Dissolved
15.1	EAS020	W	93.3	Copper			0.55		13.1	0.04	8.8	0.06	Dissolved
20.1	LOB020	S	230	Copper			0.56		30.7	0.02	19.0	0.03	Dissolved
20.1	LOB020	D	236	Copper			0.75		31.4	0.02	19.4	0.04	Dissolved
20.1	LOB020	W	230	Copper			0.62		30.7	0.02	19.0	0.03	Dissolved

Dissolved Copper MDL = 0.01; RL=0.03 ug/L

D-4a (cont.)

Stn #	Station ID	Sea-son	Hard-ness (mg/L)	Metal Name	Metal, Total (ug/L)		Metal, Dissolved (ug/L)		Acute WQ Objective (ug/L)	Acute Exceed-ance Factor	Chronic WQ Objective (ug/L)	Chronic Exceed-ance Factor	WQ Objective Fraction
1.1	BAX030	W	292	Lead			0.1		319.4	0.000	12.45	0.008	Dissolved
1.1	BAX030	S	360	Lead			0.08		417.0	0.000	16.25	0.005	Dissolved
1.1	BAX030	D	396	Lead			0.12		470.8	0.000	18.34	0.007	Dissolved
2.1	CER020	W	376	Lead			0.07		440.7	0.000	17.17	0.004	Dissolved
2.1	CER020	S	420	Lead			0.06		507.4	0.000	19.77	0.003	Dissolved
2.1	CER020	D	364	Lead			0.07		422.9	0.000	16.48	0.004	Dissolved
3.1	COD020	W	332	Lead			0.09		376.1	0.000	14.66	0.006	Dissolved
3.1	COD020	S	364	Lead			0.09		422.9	0.000	16.48	0.005	Dissolved
3.1	COD020	D	331	Lead			0.12		374.7	0.000	14.60	0.008	Dissolved
4.1	STW010	W	193	Lead			0.05		188.6	0.000	7.35	0.007	Dissolved
4.1	STW010	S	238	Lead			0.04		246.2	0.000	9.59	0.004	Dissolved
4.1	STW010	D	176	Lead			0.06		167.7	0.000	6.53	0.009	Dissolved
5.3	TEM090	W	328	Lead			0.05		370.4	0.000	14.43	0.003	Dissolved
5.3	TEM090	S	426	Lead			0.04		516.6	0.000	20.13	0.002	Dissolved
5.3	TEM090	D	475	Lead			0.04		593.4	0.000	23.12	0.002	Dissolved
6.1	LME100	W	183	Lead			0.12		176.2	0.001	6.87	0.017	Dissolved
6.1	LME100	S	238	Lead			0.31		246.2	0.001	9.59	0.032	Dissolved
6.1	LME100	D	242	Lead			0.22		251.5	0.001	9.80	0.022	Dissolved
7.1	SAU030	W	209	Lead			0.05		208.7	0.000	8.13	0.006	Dissolved
7.1	SAU030	S	276	Lead			0.06		297.3	0.000	11.59	0.005	Dissolved
7.1	SAU030	D	254	Lead			0.05		267.5	0.000	10.42	0.005	Dissolved
8.1	PRL020	W	269	Lead			0.12		287.7	0.000	11.21	0.011	Dissolved
8.1	PRL020	S	317	Lead			0.24		354.6	0.001	13.82	0.017	Dissolved
8.1	PRL020	D	275	Lead			0.2		295.9	0.001	11.53	0.017	Dissolved
10.1	AVJ020	W	79.6	Lead			0.19		61.1	0.003	2.38	0.080	Dissolved
10.1	AVJ020	S	223	Lead			0.05		226.6	0.000	8.83	0.006	Dissolved
10.1	AVJ020	D	273	Lead			0.11		293.2	0.000	11.43	0.010	Dissolved
11.1	AMO070	W	109	Lead			0.04		91.1	0.000	3.55	0.011	Dissolved
11.1	AMO070	S	215	Lead			0.05		216.3	0.000	8.43	0.006	Dissolved
11.1	AMO070	D	97	Lead			0.05		78.5	0.001	3.06	0.016	Dissolved
14.1	PNG010	S	54.5	Lead			0.02	J	37.7	0.001	1.47	0.014	Dissolved
14.1	PNG010	D	71	Lead			0.01	J	52.8	0.000	2.06	0.005	Dissolved
14.1	PNG010	W	57.7	Lead			0.02	J	40.5	0.000	1.58	0.013	Dissolved
15.1	EAS020	S	83	Lead			0.01	J	64.4	0.000	2.51	0.004	Dissolved
15.1	EAS020	D	110	Lead			0.01	J	92.2	0.000	3.59	0.003	Dissolved
15.1	EAS020	W	93.3	Lead			0.02	J	74.7	0.000	2.91	0.007	Dissolved
20.1	LOB020	S	230	Lead			0.03		235.7	0.000	9.19	0.003	Dissolved
20.1	LOB020	D	236	Lead			0.02	J	243.6	0.000	9.49	0.002	Dissolved
20.1	LOB020	W	230	Lead			0.03		235.7	0.000	9.19	0.003	Dissolved

Dissolved Lead MDL = 0.01; RL=0.03 ug/L

1.1	BAX030	W	292	Nickel			8.57		1162	0.01	129	0.07	Dissolved
1.1	BAX030	S	360	Nickel			6.41		1387	0.00	154	0.04	Dissolved
1.1	BAX030	D	396	Nickel			5.59		1503	0.00	167	0.03	Dissolved
2.1	CER020	W	376	Nickel			5.94		1439	0.00	160	0.04	Dissolved
2.1	CER020	S	420	Nickel			3.78		1580	0.00	176	0.02	Dissolved
2.1	CER020	D	364	Nickel			3.09		1400	0.00	156	0.02	Dissolved
3.1	COD020	W	332	Nickel			3.23		1295	0.00	144	0.02	Dissolved
3.1	COD020	S	364	Nickel			1.75		1400	0.00	156	0.01	Dissolved
3.1	COD020	D	331	Nickel			1.79		1292	0.00	144	0.01	Dissolved
4.1	STW010	W	193	Nickel			2.29		818	0.00	91	0.03	Dissolved
4.1	STW010	S	238	Nickel			0.83		977	0.00	109	0.01	Dissolved
4.1	STW010	D	176	Nickel			0.7		757	0.00	84	0.01	Dissolved
5.3	TEM090	W	328	Nickel			12.1		1282	0.01	142	0.08	Dissolved
5.3	TEM090	S	426	Nickel			7.53		1599	0.00	178	0.04	Dissolved
5.3	TEM090	D	475	Nickel			4.15		1753	0.00	195	0.02	Dissolved
6.1	LME100	W	183	Nickel			3.31		782	0.00	87	0.04	Dissolved
6.1	LME100	S	238	Nickel			2.34		977	0.00	109	0.02	Dissolved
6.1	LME100	D	242	Nickel			2.3		991	0.00	110	0.02	Dissolved
7.1	SAU030	W	209	Nickel			3.66		875	0.00	97	0.04	Dissolved
7.1	SAU030	S	276	Nickel			2.38		1107	0.00	123	0.02	Dissolved
7.1	SAU030	D	254	Nickel			1.59		1032	0.00	115	0.01	Dissolved
8.1	PRL020	W	269	Nickel			6.16		1084	0.01	120	0.05	Dissolved
8.1	PRL020	S	317	Nickel			3.83		1245	0.00	138	0.03	Dissolved
8.1	PRL020	D	275	Nickel			3.36		1104	0.00	123	0.03	Dissolved
10.1	AVJ020	W	79.6	Nickel			1.9		387	0.00	43	0.04	Dissolved
10.1	AVJ020	S	223	Nickel			0.97		925	0.00	103	0.01	Dissolved
10.1	AVJ020	D	273	Nickel			0.97		1097	0.00	122	0.01	Dissolved
11.1	AMO070	W	109	Nickel			2.27		505	0.00	56	0.04	Dissolved
11.1	AMO070	S	215	Nickel			1.16		897	0.00	100	0.01	Dissolved
11.1	AMO070	D	97	Nickel			1.04		457	0.00	51	0.02	Dissolved
14.1	PNG010	S	54.5	Nickel			3.59		281	0.01	31	0.12	Dissolved
14.1	PNG010	D	71	Nickel			3.8		351	0.01	39	0.10	Dissolved
14.1	PNG010	W	57.7	Nickel			4.47		295	0.02	33	0.14	Dissolved
15.1	EAS020	S	83	Nickel			0.81		401	0.00	45	0.02	Dissolved
15.1	EAS020	D	110	Nickel			0.99		509	0.00	57	0.02	Dissolved
15.1	EAS020	W	93.3	Nickel			0.52		442	0.00	49	0.01	Dissolved
20.1	LOB020	S	230	Nickel			3.09		949	0.00	106	0.03	Dissolved
20.1	LOB020	D	236	Nickel			3.07		970	0.00	108	0.03	Dissolved
20.1	LOB020	W	230	Nickel			2.81		949	0.00	106	0.03	Dissolved

Dissolved Nickel MDL = 0.01; RL=0.05 ug/L

D-4a (cont.)

Stn #	Station ID	Sea-son	Hard-ness (mg/L)	Metal Name	Metal, Total (ug/L)		Metal, Dissolved (ug/L)		Acute WQ Objective (ug/L)	Acute Exceed-ance Factor	Chronic WQ Objective (ug/L)	Chronic Exceed-ance Factor	WQ Objective Fraction
1.1	BAX030	W	292	Silver				ND	25.6				
1.1	BAX030	S	360	Silver				ND	36.7				
1.1	BAX030	D	396	Silver				ND	43.3				
2.1	CER020	W	376	Silver				ND	39.6				
2.1	CER020	S	420	Silver				ND	47.9				
2.1	CER020	D	364	Silver				ND	37.5				
3.1	COD020	W	332	Silver				ND	32.0				
3.1	COD020	S	364	Silver				ND	37.5				
3.1	COD020	D	331	Silver				ND	31.8				
4.1	STW010	W	193	Silver				ND	12.6				
4.1	STW010	S	238	Silver				ND	18.0				
4.1	STW010	D	176	Silver				ND	10.7				
5.3	TEM090	W	328	Silver				ND	31.3				
5.3	TEM090	S	426	Silver				ND	49.1				
5.3	TEM090	D	475	Silver				ND	59.2				
6.1	LME100	W	183	Silver				ND	11.5				
6.1	LME100	S	238	Silver				ND	18.0				
6.1	LME100	D	242	Silver				ND	18.6				
7.1	SAU030	W	209	Silver				ND	14.4				
7.1	SAU030	S	276	Silver				ND	23.3				
7.1	SAU030	D	254	Silver				ND	20.2				
8.1	PRL020	W	269	Silver				ND	22.3				
8.1	PRL020	S	317	Silver				ND	29.5				
8.1	PRL020	D	275	Silver			0.01	J	23.1	0.000			Dissolved
10.1	AVJ020	W	79.6	Silver				ND	2.7				
10.1	AVJ020	S	223	Silver				ND	16.1				
10.1	AVJ020	D	273	Silver				ND	22.8				
11.1	AMO070	W	109	Silver				ND	4.7				
11.1	AMO070	S	215	Silver				ND	15.1				
11.1	AMO070	D	97	Silver				ND	3.9				
14.1	PNG010	S	54.5	Silver				ND	1.4				
14.1	PNG010	D	71	Silver				ND	2.3				
14.1	PNG010	W	57.7	Silver				ND	1.6				
15.1	EAS020	S	83	Silver				ND	2.9				
15.1	EAS020	D	110	Silver				ND	4.8				
15.1	EAS020	W	93.3	Silver				ND	3.6				
20.1	LOB020	S	230	Silver				ND	17.0				
20.1	LOB020	D	236	Silver				ND	17.8				
20.1	LOB020	W	230	Silver				ND	17.0				

Dissolved Silver MDL = 0.01; RL=0.05 ug/L. Chronic objective is not available

Stn #	Station ID	Sea-son	Hard-ness (mg/L)	Metal Name	Metal, Total (ug/L)		Metal, Dissolved (ug/L)		Acute WQ Objective (ug/L)	Acute Exceed-ance Factor	Chronic WQ Objective (ug/L)	Chronic Exceed-ance Factor	WQ Objective Fraction
1.1	BAX030	W	292	Zinc			6.43		297.1	0.02	297.1	0.02	Dissolved
1.1	BAX030	S	360	Zinc			6.32		354.7	0.02	354.7	0.02	Dissolved
1.1	BAX030	D	396	Zinc			5.53		384.5	0.01	384.5	0.01	Dissolved
2.1	CER020	W	376	Zinc			5.67		368.0	0.02	368.0	0.02	Dissolved
2.1	CER020	S	420	Zinc			2.71		404.2	0.01	404.2	0.01	Dissolved
2.1	CER020	D	364	Zinc			6.4		358.0	0.02	358.0	0.02	Dissolved
3.1	COD020	W	332	Zinc			3.85		331.2	0.01	331.2	0.01	Dissolved
3.1	COD020	S	364	Zinc			1.82		358.0	0.01	358.0	0.01	Dissolved
3.1	COD020	D	331	Zinc			1.35		330.3	0.00	330.3	0.00	Dissolved
4.1	STW010	W	193	Zinc			4.87		209.2	0.02	209.2	0.02	Dissolved
4.1	STW010	S	238	Zinc			3.52		249.8	0.01	249.8	0.01	Dissolved
4.1	STW010	D	176	Zinc			3.87		193.4	0.02	193.4	0.02	Dissolved
5.3	TEM090	W	328	Zinc			17.4		327.8	0.05	327.8	0.05	Dissolved
5.3	TEM090	S	426	Zinc			7.27		409.1	0.02	409.1	0.02	Dissolved
5.3	TEM090	D	475	Zinc			5.82		448.6	0.01	448.6	0.01	Dissolved
6.1	LME100	W	183	Zinc			8.57		199.9	0.04	199.9	0.04	Dissolved
6.1	LME100	S	238	Zinc			8.05		249.8	0.03	249.8	0.03	Dissolved
6.1	LME100	D	242	Zinc			16.2		253.4	0.06	253.4	0.06	Dissolved
7.1	SAU030	W	209	Zinc			5.34		223.8	0.02	223.8	0.02	Dissolved
7.1	SAU030	S	276	Zinc			5.07		283.2	0.02	283.2	0.02	Dissolved
7.1	SAU030	D	254	Zinc			2.46		264.0	0.01	264.0	0.01	Dissolved
8.1	PRL020	W	269	Zinc			10.4		277.1	0.04	277.1	0.04	Dissolved
8.1	PRL020	S	317	Zinc			6.03		318.5	0.02	318.5	0.02	Dissolved
8.1	PRL020	D	275	Zinc			7.54		282.3	0.03	282.3	0.03	Dissolved
10.1	AVJ020	W	79.6	Zinc			4.81		98.8	0.05	98.8	0.05	Dissolved
10.1	AVJ020	S	223	Zinc			2.22		236.4	0.01	236.4	0.01	Dissolved
10.1	AVJ020	D	273	Zinc			3.79		280.6	0.01	280.6	0.01	Dissolved
11.1	AMO070	W	109	Zinc			3.92		128.9	0.03	128.9	0.03	Dissolved
11.1	AMO070	S	215	Zinc			0.92		229.2	0.00	229.2	0.00	Dissolved
11.1	AMO070	D	97	Zinc			0.59		116.8	0.01	116.8	0.01	Dissolved
14.1	PNG010	S	54.5	Zinc			0.91		71.6	0.01	71.6	0.01	Dissolved
14.1	PNG010	D	71	Zinc			0.76		89.6	0.01	89.6	0.01	Dissolved
14.1	PNG010	W	57.7	Zinc			1.13		75.2	0.02	75.2	0.02	Dissolved
15.1	EAS020	S	83	Zinc			0.54		102.3	0.01	102.3	0.01	Dissolved
15.1	EAS020	D	110	Zinc			0.48		129.9	0.00	129.9	0.00	Dissolved
15.1	EAS020	W	93.3	Zinc			0.71		113.0	0.01	113.0	0.01	Dissolved
20.1	LOB020	S	230	Zinc			1.13		242.7	0.00	242.7	0.00	Dissolved
20.1	LOB020	D	236	Zinc			1.16		248.0	0.00	248.0	0.00	Dissolved
20.1	LOB020	W	230	Zinc			1.01		242.7	0.00	242.7	0.00	Dissolved

Dissolved Zinc MDL = 0.01; RL=0.03 ug/L

Table D-4b: Trace metals with fixed WQOs

	Station	Season		Metal Name	Metal, Total (ug/L)		Metal, Dissolved (ug/L)		Acute WQ Objective (ug/L)	Acute Exceedance Factor	Chronic WQ Objective (ug/L)	Chronic Exceedance Factor	WQ Objective Fraction
1.1	BAX030	W		Arsenic			3.13		340.0	0.01	150.0	0.02	Dissolved
1.1	BAX030	S		Arsenic			2.89		340.0	0.01	150.0	0.02	Dissolved
1.1	BAX030	D		Arsenic			4.22		340.0	0.01	150.0	0.03	Dissolved
2.1	CER020	W		Arsenic			1.93		340.0	0.01	150.0	0.01	Dissolved
2.1	CER020	S		Arsenic			1.26		340.0	0.00	150.0	0.01	Dissolved
2.1	CER020	D		Arsenic			2.17		340.0	0.01	150.0	0.01	Dissolved
3.1	COD020	W		Arsenic			2.24		340.0	0.01	150.0	0.01	Dissolved
3.1	COD020	S		Arsenic			1.42		340.0	0.00	150.0	0.01	Dissolved
3.1	COD020	D		Arsenic			2.35		340.0	0.01	150.0	0.02	Dissolved
4.1	STW010	W		Arsenic			1.7		340.0	0.01	150.0	0.01	Dissolved
4.1	STW010	S		Arsenic			1.23		340.0	0.00	150.0	0.01	Dissolved
4.1	STW010	D		Arsenic			1.62		340.0	0.00	150.0	0.01	Dissolved
5.3	TEM090	W		Arsenic			0.86		340.0	0.00	150.0	0.01	Dissolved
5.3	TEM090	S		Arsenic			0.45	J	340.0	0.00	150.0	0.00	Dissolved
5.3	TEM090	D		Arsenic			0.9		340.0	0.00	150.0	0.01	Dissolved
6.1	LME100	W		Arsenic			2.14		340.0	0.01	150.0	0.01	Dissolved
6.1	LME100	S		Arsenic			1.38		340.0	0.00	150.0	0.01	Dissolved
6.1	LME100	D		Arsenic			1.57		340.0	0.00	150.0	0.01	Dissolved
7.1	SAU030	W		Arsenic			1.27		340.0	0.00	150.0	0.01	Dissolved
7.1	SAU030	S		Arsenic			0.64		340.0	0.00	150.0	0.00	Dissolved
7.1	SAU030	D		Arsenic			0.94		340.0	0.00	150.0	0.01	Dissolved
8.1	PRL020	W		Arsenic			1.85		340.0	0.01	150.0	0.01	Dissolved
8.1	PRL020	S		Arsenic			0.96		340.0	0.00	150.0	0.01	Dissolved
8.1	PRL020	D		Arsenic			1.17		340.0	0.00	150.0	0.01	Dissolved
10.1	AVJ020	W		Arsenic			1.34		340.0	0.00	150.0	0.01	Dissolved
10.1	AVJ020	S		Arsenic			0.86		340.0	0.00	150.0	0.01	Dissolved
10.1	AVJ020	D		Arsenic			1.57		340.0	0.00	150.0	0.01	Dissolved
11.1	AMO070	W		Arsenic			1.05		340.0	0.00	150.0	0.01	Dissolved
11.1	AMO070	S		Arsenic			1.02		340.0	0.00	150.0	0.01	Dissolved
11.1	AMO070	D		Arsenic			1.39		340.0	0.00	150.0	0.01	Dissolved
14.1	PNG010	S		Arsenic			0.31		340.0	0.00	150.0	0.00	Dissolved
14.1	PNG010	D		Arsenic			0.32		340.0	0.00	150.0	0.00	Dissolved
14.1	PNG010	W		Arsenic			0.47		340.0	0.00	150.0	0.00	Dissolved
15.1	EAS020	S		Arsenic			7.81		340.0	0.02	150.0	0.05	Dissolved
15.1	EAS020	D		Arsenic			11.4		340.0	0.03	150.0	0.08	Dissolved
15.1	EAS020	W		Arsenic			8.6		340.0	0.03	150.0	0.06	Dissolved
20.1	LOB020	S		Arsenic			0.53		340.0	0.00	150.0	0.00	Dissolved
20.1	LOB020	D		Arsenic			0.63		340.0	0.00	150.0	0.00	Dissolved
20.1	LOB020	W		Arsenic			0.94		340.0	0.00	150.0	0.01	Dissolved

Dissolved Arsenic MDL = 0.1; RL=0.5 ug/L

1.1	BAX030	W		Chromium*			2.96		16	0.19	11	0.27	Dissolved
1.1	BAX030	S		Chromium*			3.07		16	0.19	11	0.28	Dissolved
1.1	BAX030	D		Chromium*			2.23		16	0.14	11	0.20	Dissolved
2.1	CER020	W		Chromium*			1.12		16	0.07	11	0.10	Dissolved
2.1	CER020	S		Chromium*			1.09		16	0.07	11	0.10	Dissolved
2.1	CER020	D		Chromium*			1		16	0.06	11	0.09	Dissolved
3.1	COD020	W		Chromium*			0.71		16	0.04	11	0.06	Dissolved
3.1	COD020	S		Chromium*			0.55		16	0.03	11	0.05	Dissolved
3.1	COD020	D		Chromium*			0.4		16	0.03	11	0.04	Dissolved
4.1	STW010	W		Chromium*			1.13		16	0.07	11	0.10	Dissolved
4.1	STW010	S		Chromium*			0.55		16	0.03	11	0.05	Dissolved
4.1	STW010	D		Chromium*			0.38		16	0.02	11	0.03	Dissolved
5.3	TEM090	W		Chromium*			0.32		16	0.02	11	0.03	Dissolved
5.3	TEM090	S		Chromium*			0.18		16	0.01	11	0.02	Dissolved
5.3	TEM090	D		Chromium*			0.2		16	0.01	11	0.02	Dissolved
6.1	LME100	W		Chromium*			0.5		16	0.03	11	0.05	Dissolved
6.1	LME100	S		Chromium*			0.33		16	0.02	11	0.03	Dissolved
6.1	LME100	D		Chromium*			0.52		16	0.03	11	0.05	Dissolved
7.1	SAU030	W		Chromium*			0.77		16	0.05	11	0.07	Dissolved
7.1	SAU030	S		Chromium*			0.99		16	0.06	11	0.09	Dissolved
7.1	SAU030	D		Chromium*			0.55		16	0.03	11	0.05	Dissolved
8.1	PRL020	W		Chromium*			3.21		16	0.20	11	0.29	Dissolved
8.1	PRL020	S		Chromium*			3.72		16	0.23	11	0.34	Dissolved
8.1	PRL020	D		Chromium*			1.91		16	0.12	11	0.17	Dissolved
10.1	AVJ020	W		Chromium*			0.51		16	0.03	11	0.05	Dissolved
10.1	AVJ020	S		Chromium*			0.3		16	0.02	11	0.03	Dissolved
10.1	AVJ020	D		Chromium*			0.38		16	0.02	11	0.03	Dissolved
11.1	AMO070	W		Chromium*			0.71		16	0.04	11	0.06	Dissolved
11.1	AMO070	S		Chromium*			0.45		16	0.03	11	0.04	Dissolved
11.1	AMO070	D		Chromium*			0.27		16	0.02	11	0.02	Dissolved
14.1	PNG010	S		Chromium*			0.17		16	0.01	11	0.02	Dissolved
14.1	PNG010	D		Chromium*			0.06	J	16	0.00	11	0.01	Dissolved
14.1	PNG010	W		Chromium*			0.17		16	0.01	11	0.02	Dissolved
15.1	EAS020	S		Chromium*			0.35		16	0.02	11	0.03	Dissolved
15.1	EAS020	D		Chromium*			0.21		16	0.01	11	0.02	Dissolved
15.1	EAS020	W		Chromium*			0.37		16	0.02	11	0.03	Dissolved
20.1	LOB020	S		Chromium*			0.5		16	0.03	11	0.05	Dissolved
20.1	LOB020	D		Chromium*			0.47		16	0.03	11	0.04	Dissolved
20.1	LOB020	W		Chromium*			1.32		16	0.08	11	0.12	Dissolved

Dissolved Chromium MDL = 0.03; RL=0.1 ug/L

* Chromium data are for all chromium species (mostly III+VI); the Objectives are for chromium VI

* If all chromium species combined do not exceed WQOs, one component would not exceed it either

Table D-4b (cont.)

	Station	Sea-son		Metal Name	Metal, Total (ug/L)		Metal, Dissolved (ug/L)		Acute WQ Objective (ug/L)	Acute Exceed-ance Factor	Chronic WQ Objective (ug/L)	Chronic Exceed-ance Factor	WQ Objective Fraction
1.1	BAX030	W		Mercury	0.0053				2.4	0.002			Total
1.1	BAX030	S		Mercury	0.0025				2.4	0.001			Total
1.1	BAX030	D		Mercury	0.0056				2.4	0.002			Total
2.1	CER020	W		Mercury	0.0059				2.4	0.002			Total
2.1	CER020	S		Mercury	0.0044				2.4	0.002			Total
2.1	CER020	D		Mercury	0.0129				2.4	0.005			Total
3.1	COD020	W		Mercury	0.0058				2.4	0.002			Total
3.1	COD020	S		Mercury	0.0025				2.4	0.001			Total
3.1	COD020	D		Mercury	0.0124				2.4	0.005			Total
4.1	STW010	W		Mercury	0.0091				2.4	0.004			Total
4.1	STW010	S		Mercury	0.0035				2.4	0.001			Total
4.1	STW010	D		Mercury	0.0070				2.4	0.003			Total
5.3	TEM090	W		Mercury	0.0069				2.4	0.003			Total
5.3	TEM090	S		Mercury	0.0033				2.4	0.001			Total
5.3	TEM090	D		Mercury	0.0023				2.4	0.001			Total
6.1	LME100	W		Mercury	0.0084				2.4	0.003			Total
6.1	LME100	S		Mercury	0.0039				2.4	0.002			Total
6.1	LME100	D		Mercury	0.0030				2.4	0.001			Total
7.1	SAU030	W		Mercury	0.0630				2.4	0.026			Total
7.1	SAU030	S		Mercury	0.0023				2.4	0.001			Total
7.1	SAU030	D		Mercury	0.0022				2.4	0.001			Total
8.1	PRL020	W		Mercury	0.0060				2.4	0.002			Total
8.1	PRL020	S		Mercury	0.0034				2.4	0.001			Total
8.1	PRL020	D		Mercury	0.0041				2.4	0.002			Total
10.1	AVJ020	W		Mercury	0.0729				2.4	0.030			Total
10.1	AVJ020	S		Mercury	0.0051				2.4	0.002			Total
10.1	AVJ020	D		Mercury	0.0028				2.4	0.001			Total
11.1	AMO070	W		Mercury	0.0394				2.4	0.016			Total
11.1	AMO070	S		Mercury	0.0015				2.4	0.001			Total
11.1	AMO070	D		Mercury	0.0014				2.4	0.001			Total
14.1	PNG010	S		Mercury	0.0027				2.4	0.001			Total
14.1	PNG010	D		Mercury	0.0016				2.4	0.001			Total
14.1	PNG010	W		Mercury	0.0018				2.4	0.001			Total
15.1	EAS020	S		Mercury	0.0013				2.4	0.001			Total
15.1	EAS020	D		Mercury	0.0031				2.4	0.001			Total
15.1	EAS020	W		Mercury	0.0009				2.4	0.000			Total
20.1	LOB020	S		Mercury	0.0084				2.4	0.003			Total
20.1	LOB020	D		Mercury	0.0035				2.4	0.001			Total
20.1	LOB020	W		Mercury	0.0030				2.4	0.001			Total

Mercury was measured only as total, with variable MDLs and RLs in the range of 0.00016-0.0002 ug/L, depending on the sample.
Mercury chronic objective is not applicable for this comparison.

1.1	BAX030	W		Selenium			1.12						
1.1	BAX030	S		Selenium			0.93						
1.1	BAX030	D		Selenium			2.52						
2.1	CER020	W		Selenium			2.57						
2.1	CER020	S		Selenium			1.27						
2.1	CER020	D		Selenium			2.55						
3.1	COD020	W		Selenium			2.22						
3.1	COD020	S		Selenium			1.17						
3.1	COD020	D		Selenium			2.14						
4.1	STW010	W		Selenium			1.6						
4.1	STW010	S		Selenium			1.34						
4.1	STW010	D		Selenium			1.79						
5.3	TEM090	W		Selenium			1.37						
5.3	TEM090	S		Selenium			1.34						
5.3	TEM090	D		Selenium			1.87						
6.1	LME100	W		Selenium			1.51						
6.1	LME100	S		Selenium			1.52						
6.1	LME100	D		Selenium			5.07						
7.1	SAU030	W		Selenium			2.62						
7.1	SAU030	S		Selenium			1.12						
7.1	SAU030	D		Selenium			2.51						
8.1	PRL020	W		Selenium			2.75						
8.1	PRL020	S		Selenium			1.08						
8.1	PRL020	D		Selenium			2.08						
10.1	AVJ020	W		Selenium			1.01						
10.1	AVJ020	S		Selenium			1.43						
10.1	AVJ020	D		Selenium			3.36						
11.1	AMO070	W		Selenium			0.65						
11.1	AMO070	S		Selenium			1.37						
11.1	AMO070	D		Selenium			2.1						
14.1	PNG010	S		Selenium			1.07						
14.1	PNG010	D		Selenium			2.24						
14.1	PNG010	W		Selenium			0.9						
15.1	EAS020	S		Selenium			0.76						
15.1	EAS020	D		Selenium			2.26						
15.1	EAS020	W		Selenium			0.46	J					
20.1	LOB020	S		Selenium			1.35						
20.1	LOB020	D		Selenium			2.67						
20.1	LOB020	W		Selenium			0.56						

Dissolved Selenium MDL = 0.1; RL=0.5 ug/L

Table D-4c: Earth mineral metals with no WQOs

	Station	Sea-son		Metal Name	Metal, Total (ug/L)		Metal, Dissolved (ug/L)	
1.1	BAX030	W		Aluminum			3.92	
1.1	BAX030	S		Aluminum			2.01	
1.1	BAX030	D		Aluminum			4.74	
2.1	CER020	W		Aluminum			8.58	
2.1	CER020	S		Aluminum			4.65	
2.1	CER020	D		Aluminum			8.4	
3.1	COD020	W		Aluminum			4.29	
3.1	COD020	S		Aluminum			1.96	
3.1	COD020	D		Aluminum			4.2	
4.1	STW010	W		Aluminum			7.89	
4.1	STW010	S		Aluminum			4.36	
4.1	STW010	D		Aluminum			6.42	
5.3	TEM090	W		Aluminum			30.9	
5.3	TEM090	S		Aluminum			7.94	
5.3	TEM090	D		Aluminum			9.32	
6.1	LME100	W		Aluminum			4.63	
6.1	LME100	S		Aluminum			3.28	
6.1	LME100	D		Aluminum			19.8	
7.1	SAU030	W		Aluminum			9.18	
7.1	SAU030	S		Aluminum			3.35	
7.1	SAU030	D		Aluminum			6.09	
8.1	PRL020	W		Aluminum			7.03	
8.1	PRL020	S		Aluminum			1.87	
8.1	PRL020	D		Aluminum			5.5	
10.1	AVJ020	W		Aluminum			14.4	
10.1	AVJ020	S		Aluminum			6.94	
10.1	AVJ020	D		Aluminum			4.83	
11.1	AMO070	W		Aluminum			4.78	
11.1	AMO070	S		Aluminum			1.46	
11.1	AMO070	D		Aluminum			7.04	
14.1	PNG010	S		Aluminum			10	
14.1	PNG010	D		Aluminum			6.88	
14.1	PNG010	W		Aluminum			4.31	
15.1	EAS020	S		Aluminum			4.76	
15.1	EAS020	D		Aluminum			4.03	
15.1	EAS020	W		Aluminum			1.99	
20.1	LOB020	S		Aluminum				ND
20.1	LOB020	D		Aluminum			3.23	
20.1	LOB020	W		Aluminum				ND

Dissolved Aluminum MDL = 0.1; RL=0.5 ug/L

	Station	Sea-son		Metal Name	Metal, Total (ug/L)		Metal, Dissolved (ug/L)
1.1	BAX030	W		Manganese			8.33
1.1	BAX030	S		Manganese			19.3
1.1	BAX030	D		Manganese			26.1
2.1	CER020	W		Manganese			28.1
2.1	CER020	S		Manganese			18.6
2.1	CER020	D		Manganese			26.6
3.1	COD020	W		Manganese			70.7
3.1	COD020	S		Manganese			54.4
3.1	COD020	D		Manganese			56.2
4.1	STW010	W		Manganese			19.7
4.1	STW010	S		Manganese			18.4
4.1	STW010	D		Manganese			13.3
5.3	TEM090	W		Manganese			68.7
5.3	TEM090	S		Manganese			91
5.3	TEM090	D		Manganese			106
6.1	LME100	W		Manganese			20.3
6.1	LME100	S		Manganese			23.1
6.1	LME100	D		Manganese			22.2
7.1	SAU030	W		Manganese			27.2
7.1	SAU030	S		Manganese			13
7.1	SAU030	D		Manganese			8.16
8.1	PRL020	W		Manganese			8.25
8.1	PRL020	S		Manganese			5.07
8.1	PRL020	D		Manganese			3.53
10.1	AVJ020	W		Manganese			5.5
10.1	AVJ020	S		Manganese			6.27
10.1	AVJ020	D		Manganese			26.5
11.1	AMO070	W		Manganese			2.57
11.1	AMO070	S		Manganese			3.13
11.1	AMO070	D		Manganese			1.52
14.1	PNG010	S		Manganese			3.72
14.1	PNG010	D		Manganese			4.14
14.1	PNG010	W		Manganese			5.99
15.1	EAS020	S		Manganese			6.68
15.1	EAS020	D		Manganese			20
15.1	EAS020	W		Manganese			8.99
20.1	LOB020	S		Manganese			10.2
20.1	LOB020	D		Manganese			8.79
20.1	LOB020	W		Manganese			21.1

Dissolved Manganese MDL = 0.01; RL=0.03 ug/L

Acute WQ Objectives refer to 1-hour average; Chronic WQ Objectives refer to 4-day average.
Exceedance Factor is computed by dividing the actual concentration (dissolved or total, as indicated) by the Objectives, for each row
ND=not detected. "J" is defined as 'estimated'; the analyte was detected, but the value is below the Reporting Limit

Table D-5: Concentrations of organic compounds in Years 4&5 water samples

Table D-5a: Comparison of concentrations to water quality benchmarks (WQBs)

Stn#	Station ID	Season	Diazinon (µg/L) (WQB=0.1)	Diazinon Exceedance Factor	Parathion, Methyl (µg/L) (WQB=0.08)	Parathion, Methyl Exceedance Factor
1.1	BAX030	W				
1.1	BAX030	S				
1.1	BAX030	D	0.03	0.34		
2.1	CER020	W				
2.1	CER020	S				
2.1	CER020	D	0.04	0.37		
3.1	COD020	W				
3.1	COD020	S				
3.1	COD020	D	0.04	0.37		
4.1	STW010	W				
4.1	STW010	S				
4.1	STW010	D	0.04	0.38		
5.3	TEM090	W				
5.3	TEM090	S				
5.3	TEM090	D				
6.1	LME100	W				
6.1	LME100	S				
6.1	LME100	D				
7.1	SAU030	W				
7.1	SAU030	S				
7.1	SAU030	D				
8.1	PRL020	W	0.11	**1.08**		
8.1	PRL020	S				
8.1	PRL020	D	0.05	0.45		
10.1	AVJ020	W				
10.1	AVJ020	S				
10.1	AVJ020	D	0.04	0.43		
11.1	AMO070	W				
11.1	AMO070	S				
11.1	AMO070	D	0.03	0.34		
14.1	PNG010	S				
14.1	PNG010	D				
14.1	PNG010	W				
15.1	EAS020	S				
15.1	EAS020	D				
15.1	EAS020	W			0.03	0.3125
20.1	LOB020	S				
20.1	LOB020	D				
20.1	LOB020	W	0.04	0.35		

x Exceedance Factors higher than 1 are highlighted in red font and gray fill.

Notes: The following analytes were also measured in water samples, without any detections:

all PCB congeners	Disulfoton (Disyston)
Chlorpyrifos	Endosulfan
Dacthal (DCPA)	HCH, gamma- (gamma-BHC, Lindane)
	Thiobencarb

Diazinon benchmark is for 1-hour average (SFBRWQCB, 2005)
Parathion, Methyl benchmark is for instantaneus maximum, AWQC (CDFG)

Table D-5b: Concentrations of all organic compounds detected in Years 4&5 water samples (µg/L) Page 1 of 3

Station #	Station ID	Season	Total Organic Carbon	Acenaphthene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Biphenyl	Carbofuran	Chrysene	Chrysenes, C1	Chrysenes, C2	Chrysenes, C3	Diazinon
1.1	BAX030	W	2.8														
1.1	BAX030	S															
1.1	BAX030	D	4.9		0.009									0.016	0.014		0.034
2.1	CER020	W	2.5														
2.1	CER020	S	6.0														
2.1	CER020	D	4.2														0.037
3.1	COD020	W	1.9	0.024							0.009						
3.1	COD020	S	4.3	0.026							0.009						
3.1	COD020	D	3.8	0.038			0.014	0.010	0.015		0.013		0.007	0.007	0.006		0.037
4.1	STW010	W	2.4									0.460					
4.1	STW010	S	3.9														
4.1	STW010	D	3.0														0.038
5.3	TEM090	W	2.0									0.103					
5.3	TEM090	S	4.4														
5.3	TEM090	D	3.7														
6.1	LME100	W	3.5														
6.1	LME100	S	6.6														
6.1	LME100	D	5.1														
7.1	SAU030	W	2.9									0.110					
7.1	SAU030	S	4.1														
7.1	SAU030	D	3.5														
8.1	PRL020	W	4.1														0.108
8.1	PRL020	S	4.6	0.009							0.011						
8.1	PRL020	D	3.9														0.045
10.1	AVJ020	W	3.5		0.019	0.035	0.050	0.030	0.042	0.019			0.026	0.016	0.022	0.016	
10.1	AVJ020	S	6.0														
10.1	AVJ020	D	4.8														0.043
11.1	AMO070	W	3.1														
11.1	AMO070	S	4.5														
11.1	AMO070	D	4.3														0.034
14.1	PNG010	S	3.5														
14.1	PNG010	D	3.5														
14.1	PNG010	W	3.4														
15.1	EAS020	S	2.8														
15.1	EAS020	D	2.6														
15.1	EAS020	W	2.9														
20.1	LOB020	S	2.8														
20.1	LOB020	D	2.2														
20.1	LOB020	W	1.9														0.035

Notes: Non-detects are shown as Blank spaces. n/me = not measured

Table D-5b (Cont.)

Station #	Station ID	Season	Dibenzothiophenes, C1 -	Dibenzothiophenes, C2 -	Dibenzothiophenes, C3 -	Dimethylnaphthalene, 2,6-	Disulfoton	Diuron	Fluoranthene	Fluoranthene/ Pyrenes, C1 -	Fluorene	Fluorenes, C1 -	Fluorenes, C3 -	Indeno(1,2,3-c,d)pyrene	Methyldibenzothiophene, 4-	Methylfluorene, 1-	Methylnaphthalene, 1-	Methylnaphthalene, 2-	Methylphenanthrene, 1-
1.1	BAX030	W		0.006								0.007	0.008						
1.1	BAX030	S																	
1.1	BAX030	D		0.007			0.020		0.025	0.035									
2.1	CER020	W								0.006			0.007				0.018	0.013	
2.1	CER020	S															0.010	0.008	
2.1	CER020	D																	
3.1	COD020	W									0.015						0.036	0.047	
3.1	COD020	S							0.005	0.005	0.013						0.040	0.056	
3.1	COD020	D				0.007			0.018	0.014	0.021						0.045	0.040	
4.1	STW010	W																	
4.1	STW010	S																	
4.1	STW010	D					0.017												
5.3	TEM090	W		0.008	0.008				0.006										
5.3	TEM090	S																	
5.3	TEM090	D					0.014												
6.1	LME100	W	0.006	0.012	0.009							0.008							
6.1	LME100	S																	
6.1	LME100	D					0.037												
7.1	SAU030	W																	
7.1	SAU030	S																	
7.1	SAU030	D																	
8.1	PRL020	W																	
8.1	PRL020	S	0.012	0.013	0.010	0.027				0.007	0.019	0.057	0.015		0.006	0.023	0.041	0.041	0.007
8.1	PRL020	D					0.012												
10.1	AVJ020	W	0.008	0.016	0.019			1.800	0.045	0.029				0.037					
10.1	AVJ020	S																	
10.1	AVJ020	D																	
11.1	AMO070	W	0.009	0.015	0.016			1.770	0.008	0.006								0.007	
11.1	AMO070	S																	
11.1	AMO070	D																	
14.1	PNG010	S																	
14.1	PNG010	D																	
14.1	PNG010	W					0.038												
15.1	EAS020	S																	
15.1	EAS020	D																	
15.1	EAS020	W					0.036												
20.1	LOB020	S																	
20.1	LOB020	D																	
20.1	LOB020	W					0.037												

Notes: Non-detects are shown as Blank spaces. n/me = not measured

Table D-5b (Cont.)

Station #	Station ID	Season	Naphthalene	Naphthalenes, C1 -	Naphthalenes, C2 -	Naphthalenes, C3 -	Naphthalenes, C4 -	Oxadiazon	Parathion, Methyl	Phenanthrene	Phenanthrene/ Anthracene, C1 -	Phenanthrene/ Anthracene, C2 -	Phenanthrene/ Anthracene, C3 -	Phenanthrene/ Anthracene, C4 -	Pyrene	Simazine	Trimethylnaphthalene, 2,3,5-
1.1	BAX030	W	0.012	0.008	0.019	0.032	0.010				0.015	0.016				0.024	
1.1	BAX030	S															
1.1	BAX030	D						0.016			0.012	0.028	0.017	0.008	0.007	n/me	
2.1	CER020	W	0.035	0.032	0.015	0.011		0.032			0.009	0.019	0.008				
2.1	CER020	S	0.014	0.019	0.006			0.118									
2.1	CER020	D						0.037								n/me	
3.1	COD020	W	0.361	0.084	0.022	0.008				0.012							
3.1	COD020	S	0.417	0.099	0.018	0.007				0.011							
3.1	COD020	D	0.235	0.089	0.028					0.025	0.008	0.006			0.015	n/me	
4.1	STW010	W	0.009	0.007	0.013	0.016		0.019			0.009	0.012	0.006				
4.1	STW010	S						0.013									
4.1	STW010	D						0.011								n/me	
5.3	TEM090	W	0.006			0.007		0.023		0.006	0.009	0.013	0.007		0.007	0.033	
5.3	TEM090	S						0.018									
5.3	TEM090	D	0.006					0.009								n/me	
6.1	LME100	W			0.006	0.008		0.022			0.006	0.008	0.006			0.049	
6.1	LME100	S				0.006		0.023									
6.1	LME100	D						0.013								n/me	
7.1	SAU030	W	0.007									0.008				0.026	
7.1	SAU030	S															
7.1	SAU030	D	0.006							0.005						n/me	
8.1	PRL020	W	0.006									0.010				0.026	
8.1	PRL020	S	0.035	0.084	0.165	0.163	0.030			0.021	0.045	0.045	0.021	0.006			0.024
8.1	PRL020	D	0.005					0.002								n/me	
10.1	AVJ020	W	0.006		0.006	0.010		0.016		0.021	0.015	0.028	0.021		0.038	0.049	
10.1	AVJ020	S			0.008	0.013					0.008	0.008					
10.1	AVJ020	D						0.012								n/me	
11.1	AMO070	W	0.007	0.011	0.009	0.008		0.113		0.006	0.011	0.015	0.012		0.008	0.083	
11.1	AMO070	S			0.006												
11.1	AMO070	D						0.005								n/me	
14.1	PNG010	S															
14.1	PNG010	D														n/me	
14.1	PNG010	W														n/me	
15.1	EAS020	S															
15.1	EAS020	D	0.008													n/me	
15.1	EAS020	W							0.025							n/me	
20.1	LOB020	S															
20.1	LOB020	D															
20.1	LOB020	W															

Notes: Non-detects are shown as Blank spaces. n/me = not measured

Table D-6: Toxicity of years 4 and 5 water samples to three freshwater test organisms

			Ceriodaphnia dubia						Pimephales promelas						Selenastrum capricornutum		
Station #	Station	Season	Mean Survival (%)	% of Control	Code	Avg.# of Young /female	% of Control	Code	Survival (%)	% of Control	Code	Growth (Avg. weight, mg/ind)	% of Control	Code	Cell Count (Million cells/ml)	% of Control	Code
1.1	BAX030	W	100	100	NSG	29.3	98.32	NSG	85	87.2	NSG	0.676	99.7	NSG	11760000	156	NSG
1.1	BAX030	S	90	90	NSG	19.7	85.9	NSG	87.5	100	NSG	0.877	107.2	NSG	9240000	155.6	NSG
1.1	BAX030	D	100	100	NSG	28.7	90.5	NSG	95	95	NSG	0.876	96	NSG	5397056	96.3	NSG
2.1	CER020	W	100	100	NSG	29.2	97.99	NSG	97.5	100	NSG	0.68	100.2	NSG	10170000	145	NSG
2.1	CER020	S	100	100	NSG	23.3	101.7	NSG	82.5	94.3	NSG	0.973	118.7	NSG	7020000	118.2	NSG
2.1	CER020	D	90	90	NSG	35.3	111.4	NSG	97.5	97.5	NSG	0.922	100.96	NSG	5704624	101.8	NSG
3.1	COD020	W	100	100	NSG	28.2	94.63	NSG	92.5	94.9	NSG	0.757	111.6	NSG	**6692500**	**88.8**	**SG**
3.1	COD020	S	100	100	NSG	24.1	105.2	NSG	90	102.9	NSG	0.953	116.3	NSG	**2630000**	**44.3**	**SL**
3.1	COD020	D	90	90	NSG	29.1	89.8	NSG	95	95	NSG	0.913	100.05	NSG	5283390	94.1	NSG
4.1	STW010	W	100	100	NSG	28.2	94.63	NSG	95	97.4	NSG	0.712	105	NSG	10275000	136	NSG
4.1	STW010	S	100	100	NSG	25.8	112.7	NSG	82.5	94.3	NSG	0.944	115.3	NSG	6370000	107.2	NSG
4.1	STW010	D	80	80	NSG	26.1	80.6	NSG	95	95	NSG	0.838	91.83	NSG	6125858	109	NSG
5.3	TEM090	W	100	100	NSG	28.3	94.97	NSG	97.5	100	NSG	0.732	108	NSG	8425000	111.8	NSG
5.3	TEM090	S	90	90	NSG	23.3	101.7	NSG	97.5	100	NSG	1.001	120.8	NSG	7240000	121.9	NSG
5.3	TEM090	D	100	100	NSG	30.6	94.4	NSG	82.5	82.5	NSG	**0.681**	**74.6**	**SL**	5383684	96.06	NSG
6.1	LME100	W	100	100	NSG	32.3	104.53	NSG	95	97	NSG	0.627	92.5	NSG	10405000	138	NSG
6.1	LME100	S	100	100	NSG	29.1	138.6	NSG	97.5	100	NSG	0.886	106.9	NSG	6340000	106.7	NSG
6.1	LME100	D	90	100	NSG	33.3	101.2	NSG	100	100	NSG	0.917	100.5	NSG	5865094	104.6	NSG
7.1	SAU030	W	100	100	NSG	30.1	97.41	NSG	**87.5**	**89.7**	**SG**	0.667	98.4	NSG	10067500	134	NSG
7.1	SAU030	S	100	100	NSG	25.4	120.9	NSG	95	97.4	NSG	1.036	125	NSG	6670000	112.3	NSG
7.1	SAU030	D	90	100	NSG	30.4	92.4	NSG	95	95	NSG	0.945	103.5	NSG	5657820	100.95	NSG
8.1	PRL020	W	90	90	NSG	27.9	90.29	NSG	90	92.3	NSG	0.617	91	NSG	8892500	118	NSG
8.1	PRL020	S	100	100	NSG	25.7	122.4	NSG	97.5	100	NSG	0.938	113.1	NSG	6880000	115.8	NSG
8.1	PRL020	D	100	111.1	NSG	31.8	96.7	NSG	92.5	92.5	NSG	0.917	100.5	NSG	6279641	112	NSG
10.1	AVJ020	W	100	100	NSG	**18.8**	**60.84**	**SL**	97.5	100	NSG	0.586	86.4	NSG	8597500	114.1	NSG
10.1	AVJ020	S	100	100	NSG	29.1	138.6	NSG	95	97.4	NSG	0.817	98.5	NSG	5790000	97.5	NSG
10.1	AVJ020	D	90	90	NSG	28.5	88	NSG	95	95	NSG	0.855	93.64	NSG	5885153	105	NSG
11.1	AMO070	W	100	100	NSG	28.5	95	NSG	87.5	87.2	NSG	0.594	91.6	NSG	6992565	92.8	NSG
11.1	AMO070	S	100	100	NSG	26.7	127.1	NSG	97.5	100	NSG	0.987	119.1	NSG	7090000	119.3	NSG
11.1	AMO070	D	90	90	NSG	**22.5**	**69.4**	**SL**	95	95	NSG	**0.827**	**90.6**	**SG**	5497350	98.09	NSG
14.1	PNG010	S	100	100	NSG	22.5	122.9	NSG	95	108.6	NSG	0.871	106.3	NSG	6600000	111.1	NSG
14.1	PNG010	D	90	90	NSG	35.7	112.6	NSG	95	95	NSG	**0.797**	**87.29**	**SG**	5631075	100.5	NSG
14.1	PNG010	W	90	90	NSG	16.9	119	NSG	95	100	NSG	0.31875	105	NSG	1050000	100.96	NSG
15.1	EAS020	S	100	100	NSG	23.8	130	NSG	97.5	111.4	NSG	0.825	100.7	NSG	6360000	107	NSG
15.1	EAS020	D	100	100	NSG	32.7	103.2	NSG	95	95	NSG	0.878	96.13	NSG	5818290	103.8	NSG
15.1	EAS020	W	100	100	NSG	14.7	103.5	NSG	95	100	NSG	0.335	110.4	NSG	1690000	162.5	NSG
20.1	LOB020	S	100	100	NSG	23.9	130.1	NSG	85	97.1	NSG	0.891	108.7	NSG	7300000	122.9	NSG
20.1	LOB020	D	100	100	NSG	29.6	93.4	NSG	97.5	97.5	NSG	0.788	96.36	NSG	5931956	105.8	NSG
20.1	LOB020	W	100	100	NSG	15.3	107.7	NSG	95	100	NSG	0.29475	97.12	NSG	**674000**	**64.81**	**SL**

Codes:

	NSG	Not significantly different from negative control (alpha=0.05), and sample value was above 80% of control (No 'toxicity criteria' met)
SG	**SG**	Significantly different from negative control (alpha=0.05), BUT sample value is above 80% of control (Only first 'toxicity criteria' met)
	NSL	Not significantly different from negative control (alpha=0.05), but sample value was below 80% of control (only second 'toxicity criteria' met)
SL	**SL**	Significantly different from negative control (alpha=0.05), AND sample value is below 80% of control (Both 'toxicity criteria' met)

Columns with blue fill show the test results.

Table D-7: Chemical Concentrations and toxicity in 2003 sediment samples

Table D-7a: Sediment properties and metal concentrations in comparison to Quality Benchmarks

Metal concentrations

Stn#	Station	QB	Aluminum (mg/Kg)	Arsenic (mg/Kg)	Cadmium (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Manganese (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Silver (mg/Kg)	Zinc (mg/Kg)
1.1	BAX030		26594	7.68	0.49	283	20.6	29.4	601	0.059	247	0.18	113
2.1	CER020		25720	6.15	0.26	81.2	24.3	56.8	871	0.208	151	0.18	100
3.1	COD020		34523	10.1	0.34	123	29.9	47.6	420	1.171	74.7	0.25	131
4.1	STW010		23674	7.07	0.38	94.6	24.3	18.9	689	0.103	105	0.3	98.9
6.1	LME100		28283	8.41	0.54	69.6	49.4	94.1	642	0.101	62.5	0.19	241
7.1	SAU030		15552	4.2	0.16	66.5	12.4	12.7	250	0.243	44.3	0.11	50
8.1	PRL020		17954	4.73	0.34	203	22.2	29.8	648	0.117	269	0.15	213
10.1	AVJ020		20667	12	0.26	101	40	13.3	1026	0.066	95.5	0.28	112
11.1	AMO070		17330	2.93	0.07	84.9	16.7	4.24	465	0.026	116	0.11	47.6
14.1	PNG010		36532	6.6	0.98	89.2	20.7	5.21	210	0.025	43.2	0.29	65.8
15.1	EAS020		28399	42.8	0.14	125	31.6	6.54	599	0.023	106	0.28	53.6
20.1	LOB020		34497	4.82	0.15	183	10.6	21.2	1002	0.006	35.5	0.15	58.3
21.1	ISL050		52811	6.11	0.3	129	35.7	26.1	4655	0.109	49.4	0.28	199
		PEC		33	4.98	111	149	128		1.06	48.6		459
		TEC		9.79	0.99	43.4	31.6	35.8		0.18	22.7		121

X Results that exceeded the Probable Effect Concentration (PEC) values shown above and under the table for each metal are highlighted in red font and gray fill

X Results that exceeded the Threshold Effect Concentration (TEC) values shown above and under the table for each metal are highlighted in brown font and tan fill

Sediment properties

Stn#	Station	Total Organic Carbon (%)	Percent Moisture	% clay & silt (<0.075 mm)	% fine & medium sand (0.075 - 2 mm)	% coarse (> 2mm)
1.1	BAX030	0.72	30.5	3.7	73.4	22.9
2.1	CER020	0.49	26.2	0.0	75.0	25.0
3.1	COD020	0.66	25.2	17.4	79.0	3.6
4.1	STW010	0.24	20.0	0.1	74.4	25.5
6.1	LME100	0.48	24.0	0.0	79.8	20.2
7.1	SAU030	0.23	20.5	1.5	83.3	15.1
8.1	PRL020	0.32	17.8	1.1	86.7	12.2
10.1	AVJ020	0.34	21.5	0.5	64.0	35.6
11.1	AMO070	0.16	13.0	1.0	76.7	22.5
14.1	PNG010	0.68	25.2	0.0	99.8	0.2
15.1	EAS020	0.27	26.7	1.8	75.5	22.7
20.1	LOB020	0.23	26.0	1.0	98.4	0.7
21.1	ISL050	6.8	57.0	59.3	38.1	2.6

Table D-7b: Sediment concentrations of detected pesticides in comparison to quality objectives (µg/kg) Page 1 of 3

STN #	Station ID	Total Organic Carbon (%)	Moisture (%)	Aldrin	Bifenthrin	Biphenyl	Chlordane, cis-	Chlordane, trans-	Chlordane, Total	Cypermethrin-1	Cypermethrin-2	Cypermethrin-3	Cypermethrin-4
1.1	BAX030	0.72	31			1.81	10.2	9.73	**19.93** [PEC]				
2.1	CER020	0.49	26			4.75	7.64	8.64	**16.28** [TEC]				
3.1	COD020	0.66	25		1.91	2	11.6	12.9	**24.5** [PEC]				
4.1	STW010	0.24	20					0.62	0.62				
6.1	LME100	0.48	24		0.862	1.4	11.6	14.1	**25.7** [PEC]				
7.1	SAU030	0.23	21			4.68	1.64	1.54	3.18				
8.1	PRL020	0.32	18	0.326	2.58	2.37	4.23	4.35	**8.58** [TEC]	8.8	8.25	8.75	6.48
10.1	AVJ020	0.34	21				2.01	1.77	**3.78** [TEC]				
11.1	AMO070	0.16	13										
14.1	PNG010	0.68	25										
15.1	EAS020	0.27	27										
20.1	LOB020	0.23	26										
21.1	ISL050	6.8	57										
									chlordane (cis+trans)				
	PEC								**17.6**				
	TEC								**3.24**				

X Results that exceeded the Probable Effect Concentration (PEC) values shown above for each compound or sum are highlighted in red font and gray fill

X Results that exceeded the Threshold Effect Concentration (TEC) values shown above for each compound or sum are highlighted in brown font and tan fill

Table D-7b (cont.) page 2 of 3

STN #	Station ID	DDD (o,p')	DDD (p,p')	DDD (sum op + pp)	DDE(p,p')	DDE (sum op + pp)	DDT (o,p')	DDT (p,p')	DDT (sum op + pp)	Total DDTs	DDMU (p,p')
1.1	BAX030	1.92	4.8	**6.72**	5.74	**5.74**		5.45	**5.45**	**17.91**	
2.1	CER020	1.21	3.44	4.65	4.09	**4.09**		5.39	**5.39**	**14.13**	
3.1	COD020	8.39	31.7	**40.09**	11.1	**11.1**		16	**16**	**67.19**	5.03
4.1	STW010				1.24	1.24				1.24	
6.1	LME100	4.34	15.1	**19.44**	14.5	**14.5**	1.7	21	**22.7**	**56.64**	1.95
7.1	SAU030	1.3	3.28	4.58	2.87	2.87		5.59	**5.59**	**13.04**	
8.1	PRL020	2.15	6.22	**8.37**	4.43	**4.43**		9.04	**9.04**	**21.84**	
10.1	AVJ020		1.42	1.42	2.47	2.47		3.4	3.4	**7.29**	
11.1	AMO070										
14.1	PNG010										
15.1	EAS020										
20.1	LOB020										
21.1	ISL050				1.72	1.72				1.72	

	DDD (sum op + pp)	DDE (sum op + pp)	DDT (sum op + pp)	Total DDTs
PEC	**28**	**31.3**	**62.9**	**572**
TEC	**4.88**	**3.16**	**4.16**	**5.28**

X Results that exceeded the Probable Effect Concentration (PEC) values are highlighted in red font and gray fill

X Results that exceeded the Threshold Effect Concentration (TEC) values are highlighted in brown font and tan fill

Table D-7b (cont.) Page 3 of 3

STN #	Station ID	Dieldrin	*Endrin*	*HCH, gamma*	Heptachlor epoxide	Hexachloro-benzene	Nonachlor, cis-	Nonachlor, trans-	Oxadiazon	Oxychlordane	Permethrin-1	Permethrin-total	Tedion
1.1	BAX030	**12.6**			**2.78**	0.322	2.52	7.42	8.45	0.627			3.3
2.1	CER020	**7.95**			2.14	0.438	1.9	5.82	34.5				
3.1	COD020	**9.05**			1.83		3.08	8.06	1.65	0.503			1.8
4.1	STW010	0.795						0.678	1.72				
6.1	LME100	**4.25**			**3.2**	0.261	2.4	7.23	11.9				2.24
7.1	SAU030	1.74						1.32					1.52
8.1	PRL020	**4.16**			1.31	0.152	1.18	3.23	1.98				
10.1	AVJ020	1.45			0.708			1.71	2.49				
11.1	AMO070												
14.1	PNG010												
15.1	EAS020												
20.1	LOB020							0.53					
21.1	ISL050							0.905			6.43	6.43	

	Dieldrin	Endrin (ND)	HCH, gamma (ND)	Heptachlor epoxide
PEC	**61.8**	**207**	**4.99**	**16**
TEC	**1.9**	**2.22**	**2.37**	**2.47**

X Results that exceeded the Probable Effect Concentration (PEC) values shown above for each compound or sum are highlighted in red font and gray fill

X Results that exceeded the Threshold Effect Concentration (TEC) values shown above for each compound or sum are highlighted in brown font and tan fill

Table D-7c: Sediment observed toxicity and probable (toxic) effect concenrtation quotients for selected substances

Stn#	Station	Metals Mean PEC Quotient	PCB PEC Quotient	PAH PEC Quotient	Sample Mean PEC Quotient	Hyalella azteca Survival (%) Mean	Hyalella azteca Survival (%) % of Control		H. azteca Growth (weight, mg/ind) Mean	H. azteca Growth (weight, mg/ind) % of Control		% fines (<0.075 mm)	Total Organic Carbon (%)
1.1	BAX030	1.225	0.043	0.020	**0.43**	84	129	NSG	**0.34**	**53**	**SL**	4	0.72
2.1	CER020	0.700	0.042	0.013	**0.25**	97	118	NSG	0.71	103	NSG	0	0.49
3.1	COD020	0.554	0.110	0.013	**0.23**	93	142	NSG	**0.40**	**63**	**SL**	17	0.66
4.1	STW010	0.547	0.018	0.001	**0.19**	91	140	NSG	**0.47**	**74**	**SL**	0	0.24
6.1	LME100	0.553	0.037	0.012	**0.20**	83	127	NSG	**0.51**	**80**	**SG**	0	0.48
7.1	SAU030	0.280	0.020	0.002	**0.10**	81	125	NSG	**0.40**	**63**	**SL**	2	0.23
8.1	PRL020	1.203	0.014	0.004	**0.41**	80	123	NSG	0.55	87	NSG	1	0.32
10.1	AVJ020	0.558	0.011	0.003	**0.19**	81	125	NSG	**0.40**	**64**	**SL**	0	0.34
11.1	AMO070	0.500	0.007	0.000	**0.17**	71	86	NSG	0.73	104	NSG	1	0.16
14.1	PNG010	0.345	0.010	0.001	**0.12**	100	121	NSG	0.62	89	NSG	0	0.68
15.1	EAS020	0.716	0.007	0.000	**0.24**	85	131	NSG	**0.44**	**70**	**SL**	2	0.27
20.1	LOB020	0.417	0.006	0.001	**0.14**	81	125	NSG	**0.48**	**76**	**SL**	1	0.23
21.1	ISL050	0.472	0.024	0.013	**0.17**	75	91	NSG	**0.51**	**73**	**SL**	59	6.8

NSG = Not significantly different from negative control (alpha=0.05), and sample value was above 80% of control (No 'toxicity criteria' met)

SG SG = Significantly different from negative control (alpha=0.05), BUT sample value is above 80% of control (Only first 'toxicity criteria' met)

SL SL = Significantly different from negative control (alpha=0.05), AND sample value is below 80% of control (Both 'toxicity criteria' met)

Columns with blue fill show the test results.

PEC - probable effect concentration

PEC quotients for selected metals were derived by dividing the sample concentration of an individial metal by the PEC value, then calculating the mean (presented).

PEC quotients for sums of the 18 NIST PCBs were derived by dividing the summed concentration in each sample by the PEC value for total PCBs

PEC quotients for selected PAHs were derived by dividing the summed concentrations in each sample by the PEC value for total PAHs

Sample Mean PEC quotient is the mean calculated for all three groups of chemicals; mean quotient of over 0.5 is considered predictive of toxicity.

Table E-1a: Total coliforms counts (MPN/100mL) in years 4&5

Station	*7/20/04*	*7/27/04*	*8/3/04*	*8/10/04*	*8/17/04*	*Median*
BAX030	*24000*	*(this site sampled twice on this date)*				
BAX030	*24000*	*24000*	24000	*24000*	*24000*	24000
TEM050	*24000*	24000	20000	*24000*	24000	24000
LME130	*24000*	14000	24000	*24000*	17000	24000
SAU060	7300	5500	1800	17000	1200	5500
PRL020	13000	20000	*24000*	20000	*24000*	20000
LIO070	1400	520	440	1400	85	520
LIO130	4400	6000	4400	6500	6500	6000
AVJ020	20000	20000	14000	*24000*	20000	20000
AVJ130	1200	3000	1700	1400	3100	1700
AVJ140	4600	4900	4100	4400	8200	4600
AMO080	12000	6100	8700	7300	4600	7300
AMO090	6400	7700	7700	7700	6900	7700
AMO095	11000	7700	6900	3400	3700	6900
	7/12/05	*7/19/05*	*7/26/05*	*8/2/05*	*8/9/05*	
AUD020	1200	1200	1200	770	1400	1200
RDW010	1500	2600	1700	2100	1900	1900
ROD035	430	860	800	490	680	680
ISL050	7700	*24000*	*24000*	20000	20000	20000

Counts are Most Probable Number per 100 milliliters (MPN/100 mL). Values in underlined italic font are equal to or greater than 24000. The medians were calculated using 24000 as the most conservative value; however, in all cases the stations still exceeded the limits. Values in red highlight exceeded the EPA limit for freshwater recreation (240 for the median and no sample greater than 10,000).

Table E-1b: E. coli counts (MPN/100mL), as determined by the Colilert method

Station	***7/20/04***	***7/27/04***	***8/3/04***	***8/10/04***	***8/17/04***	***Geomean***
BAX030	230	*(this site sampled twice on this date)*				
BAX030	420	<u>*24000*</u>	460	3700	480	**1525**
TEM050	520	3900	1500	380	1500	**1116**
LME130	4900	1900	5800	3300	4100	**3739**
SAU060	260	120	*160*	150	160	**164**
PRL020	370	240	2400	260	6100	**805**
LIO070	63	52	41	220	10	49
LIO130	260	200	85	400	570	**252**
AVJ020	3700	320	170	160	2400	**599**
AVJ130	*10*	97	52	10	120	36
AVJ140	560	120	190	240	41	**166**
AMO080	52	98	280	85	110	106
AMO090	160	74	74	52	230	101
AMO095	10	96	74	10	31	29
	7/12/05	***7/19/05***	***7/26/05***	***8/2/05***	***8/9/05***	
AUD020	20	10	30	10	98	23
RDW010	140	190	150	97	63	120
ROD035	10	84	30	10	10	19
ISL050	260	1100	660	840	5200	**962**

Counts are Most Probable Number per 100 milliliters (MPN/100 mL). Values in underlined italic font are equal to or greater than 24000. Values in red highlight exceed the limit for freshwater recreation (126 MPN for the geomean).

Appendix F Data quality report

Table of Contents

Field and lab operators followed the SWAMP field procedures and the internal lab Standard Operating Procedures (SOPs), as required to assure generation of data of known and documented quality. With some exceptions, the data reported in Section 3 and in Appendix Tables B, C, D, and E are SWAMP compliant. This means the following:

(a) Sample container, preservation, and holding time specifications of all measurement systems have been applied and were achieved as specified;
(b) All the quality checks required by the SWAMP Quality Management Plan (QMP) were performed at the required frequency;
(c) All measurement system runs included their internal quality checks and functioned within their performance/acceptance criteria; and
(d) All SWAMP measurement quality objectives (MQOs) were met.

F.1 Actions to affect and check data quality

Table F-1 shows the types of actions done to **affect** and **check** the different aspects of data quality in field measurements, sampling & shipping, and lab analyses. The table includes actions related to water properties (physical water quality parameters & analyte concentrations), as well as actions related to benthic macroinvertebrate (BMI) assessments, toxicity testing, and bacterial counts. Actions are organized by 'operational' setting (field and lab) and grouped into the different aspects of data quality that need to be addressed.

Data quality checks sometimes focus on different aspects for different areas of inquiry. Measurement **precision** appears to be relevant to all groups of characteristics, but the concept of **accuracy** often does not apply if there is no real Standard for the 'true value'. This is often the case with BMI assessments, toxicity testing, and bacterial counts; however there are several checks that can provide confirmation and they are listed in Table F-1 as well.

Data batching in relation to quality checks is very variable, meaning that some quality checks apply to specific analytes, some to a specific instrument, some to a batch of samples collected in one trip (e.g. field blanks), some to a lab batch or a toxicity test, etc. SWAMP has a set of qualifiers for each 'level' and the specific information is easily gleaned from the basic database query created by the SWAMP data management team.

The following sections are focused on two functional batching principles: (s) sampling activities validation (via field duplicates and field blanks) is related to sample batch (i.e., all samples collected in one Trip by the same crew and with the same gear); and (b) laboratory activities validation (via an array of Standards and spiked samples) is related to the 'lab batch' (i.e., all results generated in one analytical run or test).

F.2 Years 4&5 Quality Checks inventory and outcomes

SWAMP field crews followed existing protocols to affect and check the accuracy of field measurements. Sample collection and handling activities followed method specifications and included most of the required quality checks, as shown in **Table F-2**.

The table shows the 'inventories' of blanks and duplicates collected for each trip (with the requirements shown in parentheses in some cases). Due to severe budget constraints, field blanks for analytes in water were not collected (to free more resources for environmental samples). However, because all samples were collected by direct filling (i.e, no grab & transfer or trap & transfer methods were used), and sample water entered into pre-cleaned containers from batches or lots that have been checked and found clean, this was justified given the low risk of contamination.

Assuring and checking **sample integrity** involves actions that span the entire process of cleaning, collection, shipping, receiving, and holding. Actions to assure **lack of contamination** included pre-cleaning and packaging of containers, use of clean gloves, collection facing upstream, double-packing wet ice in the cooler, etc. **Lack of deterioration** was assured by rapid sample cooling and/or addition of preservatives, cold shipping and storage, and analysis within holding time. Sample integrity was **checked** by collecting and analyzing blanks, as well as by noting sample temperatures during staging/shipping/receiving and by measuring the pH of acidified samples. The detailed outcomes of these checks are available upon request.

Table F-3 shows all the quality checks performed in the laboratories that analyzed years 4&5 samples. These quality checks cover the aspects of laboratory accuracy and precision, in terms of analyte recoveries and repeatability of the measurement (via replicates of the same sample). There were also checks for laboratory blanks, to establish lack of labware contamination.

F.3 Years 4&5 measurements quality summary

Per U.S.EPA guidance, the SWAMP QMP discusses three Data Quality Indicators (DQIs) that relate to measurement quality: accuracy (or bias), precision, and sensitivity (in terms of resolution and detection limit). Each indicator has an array of measurement quality objectives (MQOs) that have been developed for specific characteristics or analyte groups to allow maximum use of the data. **Table F-4** shows a condensed version of SWAMP MQOs for lab analyses. The majority of data reported herewith have met these MQOs, meaning that they are of known quality and that their accuracy and precision are within these ranges.

Accuracy is the degree of closeness of a measurement result to the 'true' value, which is often represented by a Standard solution or a natural condition (e.g., oxygen saturation). The accuracy of continuous field measurements was checked after every deployment by conducting post-deployment accuracy checks within 24 hours. Appendix Table C-2 specifies the deployment episodes that were rejected due to inadequate accuracy or lack of information (in addition to instrument malfunction). In analytical procedures, measurement accuracy is gleaned from the recovery of analytes that have been spiked at known concentrations - from laboratory Standards or certified reference material (CRM) solutions – into pure water and/or an environmental sample (to check the effect of sample matrix on recovery). Another way to check recovery of certain organic compounds is to spike a sample with known concentrations of their surrogates - synthetic molecules that have similar chemical properties but are not found naturally in the sample**.** Years 4&5 data have adequate accuracy for most purposes.

Accuracy of BMI identification is often checked by having two taxonomists analyze 10% of the samples, and resolving discrepancies by comparison to organisms in other voucher collections or by consulting with other taxonomists**.** Toxicity tests were validated by conducting reference toxicant tests to show that the batches of test organisms used in year 3 tests actually responded as expected, i.e., within the lab control chart established by the lab. The 'accuracy' of bacterial counts was confirmed by running positive and negative controls for each **lot** of media and reagents (the IDEXX lab usually buys about 200 tests of the same lot). The control cultures included *Pseudomonas sp.* (negative for total coliform, negative for E. coli); *Klebsiela sp*. (positive for total coliform, negative for *E. coli*); and *E. coli* (positive on both).

Precision is the degree of agreement between two independent measurements of the same thing. In other words, it is a measure of the reproducibility of the entire sampling and analysis process (via field duplicates), and it is also a measure of the repeatability of the measurement or analysis (via repeated field measurements, and lab replicates). A high percentage of years 4&5 analytical chemistry data are of known precision, with Relative Percent Difference (RPD) of less than 25%. Precision of bacterial counts is considered acceptable by most practitioners if the repeated measurement result is within an order of magnitude of the original. U.S.EPA used RPD of <75% or <60% for lab replicates. There are no MQOs for bacterial counts precision in the SWAMP QMP. All RPDs were <100%, indicating reasonably good reproducibility.

Detection sensitivity is addressed in the SWAMP QMP as recommended target reporting limits (TRLs), most of which were achieved in the analyses of year 3 samples (Tables 2.4-1, 2.4-2 in the main report and Appendix Table D-2). Another aspect of sensitivity is the **resolution** of the measurements. SWAMP field crews used high resolution probes for all discrete and continuous filed measurements (0.01 mg/L for DO, 0.01 C for Temperature, 0.01 pH unit, and 0.1 uS/cm for specific conductance).

F.4 Data completeness, representativeness, and comparability

The other three DQIs included in the U.S.EPA guidance, relate to three additional aspects of data quality: completeness, representativeness, and comparability.

Completeness is "a measure of the amount of valid data obtained from a measurement system" (U.S.EPA 2002). In the context of a Project, it can also be a property of the entire complement of samples planned for the project, and it is a measure of how many were actually collected (and yielded acceptable data) as compared to the sampling plan (i.e., to the number authorized in the work order, given budget constraints). The inventory of samples collected can be gleaned from Appendix Tables B-1, C-1, D-1, and E-1. In years 4&5, failure to collect a sample for chemical analyses occurred once when the creek was dry, and once when the water level was too high for wading and no sample collection alternatives were available. Of the samples collected, very few (less than 1%) of the analytical results (i.e., the single data points) were rejected. The number of continued field monitoring deployments actually exceeded plans, and several data sets were rejected due to instrument failure.

Representativeness is about how well a sample represents the monitored environment. Years 4&5 water samples are **representative** of the bulk of the flow at the spot where they were collected. However, because of the huge spatial variability during low flow conditions, it is uncertain how each water sample represents adjacent habitats and stream segments. The representativeness of sediment samples was enhanced by collection of sub-samples and pooling them into a composite sample. Similarly, the representativeness of every BMI sample was enhanced by pooling organisms obtained from eight 1x1 ft squares.

Comparability is a measure of the confidence with which one data set or method can be compared to another (U.S.EPA 2002).Years 4&5 data, by definition, are **SWAMP comparable.** Other data collection efforts in the region are striving to increase their comparability to SWAMP data.

Table F-1: Summary of Actions to Affect and Check the Quality of Years 4&5 Data

Activity	**data quality aspect**	**Affect** *(act to influence outcome)*	**Check** *(test to evaluate or verify)*
All	operator's competence	train, refresh, supervise	run proficiency tests, review work products
Field Measurements & assessments	Accuracy	calibrate (adjustable-reading instruments)	conduct accuracy check (all instruments)
	Precision	use consistent procedures under same conditions	repeat measurements
	Reproducibility	calibrate scoring & categorical observations made by different physical habitat assessors	repeat habitat value scoring by different operators
Sample collection & handling	Reproducibility	use consistent procedures under same conditions	collect and analyze field duplicates (exact same time & place)
	Lack of contamination	decontaminate sampling equipment and containers, seal & wrap samples; apply ‘clean-hands-dirty-hands’ technique; use sterile vessels for bacteria	collect and analyze blanks (Trip, Field, Equipment)
	Lack of deterioration	ship cold; preserve if appropriate	measure shipping temperature, pH upon arrival
	Lack of organism loss	collect BMI at appropriate depth and velocity, gather meticulously from D-net	deploy 2nd D-net behind 1st, examine content (Note 1)
Laboratory analyses & tests	Accuracy (or validity)	calibrate, use certified calibrator Standards; use appropriate BMI key; maintain acceptable water quality conditions in toxicity test chambers	run LCS, CRM, Matrix spikes, surrogates; compare IDs to other BMI voucher collections; run reference toxicant tests; run known positive and negative bacteria
	Precision	use consistent procedures under same conditions	run lab replicates, matrix spike duplicates; split BMI samples for separate examination (Note 1)
	Lack of contamination	decontaminate lab ware	analyze lab Blanks (method, reagent, etc.)
	Lack of deterioration	analyze within holding time	calculate holding time

Note 1: Quality checks for BMI were done during method development and are not done for every project

Table F-2: Quality checks conducted by field crews for water and sediment samples in 2004-05

Trip(s) dates	Characteristic group	Medium	Container type/volume	Number of env. Samples /trip *(Note 1)*	Field blanks (and required frequency) *(Note 2)*	field duplicate (and required frequency) *(Note 3)*
January 10,11 2005	Conventionals	water	polyethylene 0.5L	10	n/c	1 (1/trip)
	SSC	water	plastic 0.5L	10	n/c	1 (1/trip)
	Organics	water	amber glass 1L	11	n/c	1 (1/trip)
	Metals	water	polyethylene 60mL	11	n/c	1 (1/trip)
	Mercury	water	glass 0.25L	11	n/c	1 (1/trip)
	Toxicity	water	amber glass 2.25L	11	n/c	1 (1/trip)
April 11,12 2005	Conventionals	water	polyethylene 0.5L	20	n/c	2 (1/trip)
	SSC	water	plastic 0.5L	20	n/c	2 (1/trip)
	Organics	water	amber glass 1L	13	n/c	2 (1/trip)
	Metals	water	polyethylene 60mL	13	1	2 (1/trip)
	Mercury	water	glass 0.25L	13	n/c	2 (1/trip)
	Toxicity	water	amber glass 2.25L	13	NA	2 (1/trip)
	All groups	**sediment**	***(Note 4)***	13	NA	2 (1/trip)
June 13,14 2005	Conventionals	water	polyethylene 0.5L	20	n/c	1 (1/trip)
	SSC	water	plastic 0.5L	20	n/c	1 (1/trip)
	Organics	water	amber glass 1L	13	n/c	0 (1/trip)
	Metals	water	polyethylene 60mL	13	n/c	0 (1/trip)
	Mercury	water	glass 0.25L	13	n/c	0 (1/trip)
	Toxicity	water	amber glass 2.25L	13	n/c	0 (1/trip)
February 16, 2006	Conventionals	water	polyethylene 0.5L	9	n/c	0 (1/trip)
	SSC	water	plastic 0.5L	9	n/c	0 (1/trip)
	Organics	water	amber glass 1L	3	n/c	0 (1/trip)
	Metals	water	polyethylene 60mL	3	n/c	0 (1/trip)
	Mercury	water	glass 0.25L	3	n/c	0 (1/trip)
	Toxicity	water	amber glass 2.25L	3	n/c	0 (1/trip)
7/20/04	Bacterial counts	water	plastic sterile 0.125L	13	n/c	1 (1/trip)
7/27/04	Bacterial counts	water	plastic sterile 0.125L	13	n/c	1 (1/trip)
8/3/04	Bacterial counts	water	plastic sterile 0.125L	13	n/c	1 (1/trip)
8/10/04	Bacterial counts	water	plastic sterile 0.125L	13	n/c	1 (1/trip)
8/17/04	Bacterial counts	water	plastic sterile 0.125L	13	n/c	1 (1/trip)
7/12/05	Bacterial counts	water	plastic sterile 0.125L	4	1 (1/trip)	1 (1/trip)
7/19/05	Bacterial counts	water	plastic sterile 0.125L	4	1 (1/trip)	1 (1/trip)
7/26/05	Bacterial counts	water	plastic sterile 0.125L	4	1 (1/trip)	1 (1/trip)
8/2/05	Bacterial counts	water	plastic sterile 0.125L	4	1 (1/trip)	1 (1/trip)
8/9/05	Bacterial counts	water	plastic sterile 0.125L	4	1 (1/trip)	1 (1/trip)

NA = not applicable; n/c = not collected

Note 1 The number of samples is one Sample Batch, i.e. it includes all R2 year 4 and/or year 5 environmental samples (without field dups and blanks) collected by one Field Crew during one Trip.

Note 2 Field blanks for analytes in water were not collected due to budget constraints and given the low risk of contamination. All samples were collected by direct filling into pre-cleaned containers from certified lots. Trip blanks, equipment blank, or rinsate blanks were not required (no grab & transfer or trap & transfer)

Note 3 Apr 2005 Trip included visits to year 4 sites (4/12/05) and year 5 sites (4/11/05); each group had its own field duplicate.

Note 4 Crews used a pre-cleaned 2-L sampling jug for collection and homogenization of each sample

Note 5 Bacterial counts reproducibilityy was checked with field triplicates

Table F-3: Inventory of quality checks conducted by SWAMP laboratories for water and sediment samples in 2004-5

Characteristic group	Medium	Number of lab batches *(Note 1)*	Number of Method Blanks	Number of surrogate analytes per complement	Number of samples spiked with a surrogate complement (without Jan 2005)	Number of of samples spiked with MS/MSD complement (and required frequency)	Number of CRM, LCS, or LCM complements, or Bacteria Pos/Neg controls	Number of lab replicates (same env. Sample)
Conventionals ***(Note 2)***	Water	4 to 9	6-11 per indiv. analyte	NA	NA	6-9 MS/D spikes/analyte	6-11 per analyte, mostly LCS	5-6 pairs per analyte
OC Pesticides (EPA 8081AM or BM) 34 analytes	Water	4	4	2	31	3 (1/batch)	1 LCS pr, 3 LCM	0
OP Pesticides (EPA 8141AM) 46 analytes	Water	4	4	1	25	4 (1/batch)	4 LCM	0
Diazinon&chlorpyrifos ELISA	Water	3 runs each	3	NA	NA	3 [MS only] (1/analyte/batch)	3 LCM	2
Triazine Herbicides (EPA 619M) 11 analytes	Water	2	1	1	13	0 (1/batch)	0	0
Carbamate Pesticides (EPA 632 M) 8 analytes	Water	4	4			2 (1/batch)	2 LCSprs, 2 LCM	0
PCB Congenres (EPA 8082M) 50 analytes	Water	4	4	1	29	3 (1/batch)	1 LCS pr, 3 LCM	0
PAH (EPA 8270M) 47 analytes	Water	4	4	8	31	3 (1/batch)	1 LCS pr, 3 LCM	2
Metals (dissolved) (EPA1638M) 11 analytes	Water	4	5	NA	NA	4 (1/batch)	5 CRM (1/batch)	3
Mercury EPA (1631EM)	Water	4	12	NA	NA	4 (1/batch)	4 CRM (1/batch)	4
All groups	**Sediment**	1 per group	1-4 per group	1 to 8	15	1-2 per group	1 LCM and 1 CRM per group, CRM for some	0 or 1 per group
Total Coliform (SM 9223 B-SOP1103)	Water	11	11 (1/batch)	NA	NA	NA	1 set (1 set of 3 species per lot)	4 (1/batch)
E. coli (SM 9223 B-SOP1103)	Water	11	11 (1/batch)	NA	NA	NA	1 set (1 set of 3 species per lot)	4 (1/batch)

NA = not applicable; n/sp = not spiked
These quality checks do not apply to **toxicty tests,** where acceptability was confirmed by reference toxicant tests done with each batch of test organisms.
Note 1: A Lab Batch is made of all the samples analyzed in one day by one lab instrument between calibrations
Note 2: Conventional water quality analytes (salts and nutrients) were analyzed in multiple batches with a variable number of quality checks. Details are available with SWAMP RB2 and DMT

Table F-4: Measurement quality objectives for various groups of analytes in water.

Analyte Group	Surrogate Recovery (%)	Matrix Spike Recovery (%)	CRM, LCM, & LCS Recovery (%)	RPD (MS/MSD, Lab Rep, Field Dup) (%)
Conventional Constituents	NA	80-120	80-120	25
Trace Metals (Including Mercury)	NA	75-125	75-125	25
Synthetic Organics (PCBs, OCs, OPs, Triazines)	50-150	50-150	50-150	25

NA = not applicable
LCS = Laboratory Control Sample
CRM = Certified Reference Material
RPD = Relative Percent Difference – difference between two duplicates/replicates, expressed as a percentage of their average.