Quality Assurance Management Plan

for the State of California's Surface Water Ambient Monitoring Program:

"SWAMP"

prepared under contract by:

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Section A1. Title and Approval Sheet; Citation for QAMP; Preface/Acknowledgements

Program Title	State of California's Surface Water Ambient Monitoring Program ("SWAMP")
Lead Organization	California State Water Resources Control Board (SWRCB) Division of Water Quality, TMDL Section, Assessment and TMDL Support Unit 1001 "I" St, 15th Floor Sacramento, CA 95814
Primary Contact	Val Connor, SWAMP Program Manager, (916) 341-5573
Effective Date	This Quality Assurance Management Plan (QAMP) is effective from July 1, 2002 through June 30, 2004, unless otherwise revised, approved, and distributed accordingly at an earlier date.
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QAMP Preface and Acknowledgements

The preparation of this QAMP was funded by an Interagency Agreement from the SWRCB to DFG for the SWAMP Program (SWRCB Contract No.00-111-250-1). First and foremost, much gratitude is in order for the patience and support of all of the State and Regional Board staff for enduring and participating in the lengthy process that was necessary in order to produce this First Version of the SWAMP QAMP. Gathering the information in this QAMP involved literally each and every organization and individual mentioned in this document, and their many contributions are greatly appreciated. The information contained in many of the Appendices has been provided directly by SWAMP Program participants, and their contributions to this effort are also acknowledged (their authorship on those documents is duly noted on the cover pages of respective Appendices). Mark Stephenson, Dave Crane, Rusty Fairey, Bettina Sohst, Autumn Bonnema, Gary Ichikawa, Jon Goetzl, Marco Sigala, Cassandra Roberts, Mark Pranger, John Hunt, Brian Anderson, Bryn Phillips, and Sean Mundell in particular have spent a great deal of time assisting with much of the behind-the-scenes editing and reviewing of technical content. Much of the technical content was derived from concepts (or text directly utilized, as noted) provided in other QAPP's for programs of a similar nature, including the Sacramento River

Watershed Program, the San Francisco Bay Regional Monitoring Program (through the San Francisco Estuary Institute), the Southern California Bight Projects (through the Southern California Coastal Waters Research Program), the Western EMAP Project, the Puget Sound Ambient Monitoring Program, the USGS National Ambient Water Quality Assessment (NAWQA) program, and many others.

Information and text from the QAPP of the San Francisco Bay Regional Monitoring Program (developed through the San Francisco Estuary Institute) was used extensively in some sections of this document, and we want to make sure this is duly noted and credited.

The most significant contribution to the format and content of this QAMP, and of many of the Appendices, came from the State of Texas' Surface Water Quality Monitoring Program, with the direct assistance of Ms. Christine Kolbe. Ms. Kolbe, on behalf of the State of Texas Natural Resources Conservation Commission, provided numerous recently updated electronic files and documents that Texas has been using for their surface water ambient monitoring program, which has been in place since the late 1960's. Ms. Kolbe's extensive assistance is hereby duly acknowledged and very much appreciated.

Participation by all of the Regional Board and State Board SWAMP staff, as well as other SWAMP contract Agency and University laboratory staff, in the numerous technical workshops which were held for SWAMP planning purposes during 2001/2002 is also greatly appreciated, as the ideas generated and conclusions reached (when conclusions were able to be reached) at these workshops helped to provide much of the "backbone" for the criteria and recommendations put forth in this document. **"Standardize where possible, document otherwise"** has become one of our primary tenets in SWAMP for these "startup years" as a result of these workshops. This program is still in its "infancy", and as such, there will be programmatic and technical evolution as SWAMP advances with the progress of each year's work.

As explained in more detail further in this QAMP (Section A5), California Assembly Bill (AB) 982 (Water Code Section 13192; Statutes of 1999) required the SWRCB to assess and report on all State of California water quality monitoring programs, and to prepare a proposal for a comprehensive surface water quality monitoring program. The resulting report proposing SWAMP was submitted to the Legislature in November 2000. The passage of, and implementation of the requirements of, AB-982 ultimately provided for the administrative, political, financial, and technical means to create the SWAMP Program within the SWRCB. This was possible due to support from the California Legislature in Fiscal Year 2000-2001 provided in the Governor's Water Quality Initiative, which provided the authority and budget within the SWRCB for the formation of SWAMP.

The SWAMP Program is "in its infancy" currently, having only just begun to conduct field monitoring activities during the 2001-2002 fiscal year. We are in an evolving process of trying to standardize (to the extent possible) goals, objectives, designs, and methods, as appropriate,

under the existing staff and resource restrictions, and under the existing programmatic structure. Four existing SWRCB surface water monitoring programs have been included as part of SWAMP: these are the Toxic Substance Monitoring Program; the State Mussel Watch Program; the Toxicity Testing Program; and the Coastal Fish Contamination Program.

Extensive planning and preliminary research activities were conducted from 1999 through 2002 in order to try to provide the best guidance and framework possible to create an effective surface water quality ambient monitoring program for all of California's surface waters. Guidance documents (Work Plan preparation guidance documents) were prepared by the SWRCB in order to try to provide a framework within which RWQCB's could develop region-specific SWAMP projects; an external scientific panel was convened to review the overall SWAMP program guidance prepared by the SWRCB; technical workshops were conducted on sample collection and field data measurement methodology issues, on laboratory analytical methodology issues and quality assurance/quality control issues, on biological assessment and toxicological issues, and on data management issues; and dozens of regular meetings of the SWAMP Roundtable have been held over the last several years, with participation from key SWAMP staff at the SWRCB, all nine RWQCB's, DFG/University Laboratory SWAMP staff (contracted by the SWRCB), and others, to plan for and review SWAMP program structure, administration, contractual processing, fiscal management, data management, scientific/technical issues, etc. Resolution to many of these same issues is still evolving from the discussions held at these workshops and SWAMP Roundtable meetings. One of the primary focuses of the Roundtable's 2002 meetings has been the development of this QAPP, which is critical to ensure the high quality of data. Field-monitoring activities in accordance with SWAMP began in FY 2001-02 and focused on Regional priorities. RWQCB SWAMP workplans for FY 2002-03 have been completed, in which staff identified the water bodies to be monitored in the fiscal year. The external scientific panel mentioned above is the Scientific Planning and Review Committee (SPARC), whose purpose is to review study design, approaches, indicators, and other relevant topics.

Effectively then, this QAMP is deemed as a first step at putting into writing the initial plans for conducting and managing the quality assurance/quality control (QA/QC) aspects of the SWAMP Program, and beginning the process to attempt to standardize methods and strategies to the extent possible, practical, and applicable throughout the state. This QAMP also represents an attempt to merge, consolidate, and incorporate scientific thought, programmatic structures and ideas, and existing methodological information resulting from having conducted thorough research and discussions with numerous other major surface water quality monitoring programs throughout California and the nation. This includes reviewing, consolidating, and indirectly or directly incorporating information from QAPP's, protocols, methods manuals, and other literature from such projects/programs as previously mentioned.

Approvals:

Val Connor, SWRCB, SWAMP Program Manager
Assessment and TMDL Support Unit, TMDL Section, Division of Water Quality

_____ Date _____

William Ray, SWRCB, Quality Assurance Officer for all SWRCB Programs,
Division of Water Quality

_____ Date _____

Regional Water Quality Control Board--North Coast Region (RWQCB 1)--QA Officer or designee

_____ Date _____

Regional Water Quality Control Board--San Francisco Bay Region (RWQCB 2)--QA Officer or designee

_____ Date _____

Regional Water Quality Control Board--Central Coast Region (RWQCB 3)--QA Officer or designee

_____ Date _____

Regional Water Quality Control Board--Los Angeles Region (RWQCB 4)--QA Officer or designee

_____ Date _____

Regional Water Quality Control Board--Central Valley Region (RWQCB 5)--QA Officer or designee

_____ Date _____

Regional Water Quality Control Board--Lahontan Region (RWQCB 6)--QA Officer or designee

_____ Date _____

Regional Water Quality Control Board--Colorado River Basin Region (RWQCB 7)--QA Officer or designee

_____ Date _____

Regional Water Quality Control Board--Santa Ana Region (RWQCB 8)--QA Officer or designee

_____ Date _____

Regional Water Quality Control Board--San Diego (RWQCB 9)--QA Officer or designee

_____ Date _____

Section A2. Table of Contents

Section A1. Title and Approval Sheet; Citation for QAMP; Preface/Acknowledgements 2

Section A2. Table of Contents 7

Section A3. Distribution List and Contact Information 11

Section A4. SWAMP Program Organization 19

Section A5. Problem Definition/Background 32

Section A6. Program Description 35

Section A7. Quality Objectives and Criteria for Measurement Data 41

Section A8. Special Training Requirements/Safety 46

Section A9. Documentation and Records 49

Section B1. Sampling Process Design (Experimental Design) 51

Section B2. Sampling Methods Requirements 73

Section B3. Sample Handling and Custody Requirements 88

Section B4. Analytical Methods Requirements 97

Section B5. Quality Control Requirements 100

Section B6. Instrument/Equipment Testing, Inspection, and Maintenance Requirements 112

Section B7. Instrument Calibration and Frequency 113

Section B8. Inspection/Acceptance Requirements For Supplies And Consumables 114

Section B9. Data Acquisition Requirements (Non-direct Measurements) 115

Section B10. Data Management 116

Section C1. Assessments and Response Actions 127

Section C2. Reports to Management 129

Section D1. Data Review, Validation, and Verification Requirements 130

Section D2. Validation and Verification Methods 131

Section D3. Reconciliation with User Requirements 132

FIGURES

Figure 1 Map of California's Regional Water Quality Control Boards. 20

Figure 2 Organizational Chart: SWAMP Primary Programmatic Responsibilities 28

Figure 3 Organizational Chart: DFG Master Contract 29

Figure 4 Organizational Chart: USGS Master Contract 30

Figure 5 Organizational Chart: RWQCB-specific individual contracts 31

Figure 6 Outline of SWAMP Standardized Data Transfer Protocol Tables 121

Figure 7 Contents of SWAMP Standardized Data Transfer Protocol Tables 122

Figure 8 Flowchart of Statewide SWAMP Data Generators. 123

TABLES

Table 1 QAMP Distribution List/Contact Information for the Primary SWAMP Contact Person for Each Participating Organization 11

Table 2a-f Summary of Statewide Field, Laboratory, Administrative, and Technical Reporting Responsibilities for SWAMP. 22

Table 3 SWAMP Work Schedule FY 2002-03 through FY 2003-04 39

Table 4 Environmental Indicator Selection Criteria. 66

Table 5 List of indicators for Site-Specific and Regional Monitoring 67

Table 6 Summary of Sample Handling Requirements (Water). 89

Table 7 Summary of Sample Handling Requirements (Sediment, Tissue, and Biota). . . . 93

LIST OF ABBREVIATIONS. 133

REFERENCES. 135

APPENDICES

NOTE: individual appendices are available from the SWRCB SWAMP Program staff in electronic file, or are available for download from the official SWAMP Program SWRCB website, and are not provided as a part of this QAMP main body document.

Appendix A: SWAMP Program Contact Information, Programmatic Organization, and Agency/Organization Responsibilities

Appendix B: SWAMP Work Plans for FY 02-03 for each Regional Water Quality Control Board

Appendix C: SWAMP Recommended Data Acceptability Criteria Tables (Recommended QA Measures, Frequencies, and Corrective Actions--for all media and all analytes of primary interest);

SWAMP Recommended Target Reporting Limits Tables (for all media, for all analytes of primary interest); and

SWAMP Sample Handling Requirements Summary Tables (for all media, for all analytes of primary interest)

Appendix D: SWAMP Field Sample Collection SOP's (not including Biological Assessment and Benthic Infaunal Community Assessment Field Collection Procedures)

Appendix E: SWAMP Field Data Measurement SOP's (including equipment operation, calibration, and maintenance)

Appendix F: SWAMP Toxicity Testing SOP's

Appendix G: SWAMP Field and Laboratory QAPP's (including SOP's) for Biological Assessment and Benthic Infaunal Community Assessment

Appendix H: Recommended Minimum Health and Safety Guidance for SWAMP Field Activities

Appendix I: SWAMP Recommended Lab/Field QA Evaluation Guidance

Appendix J: INTERIM SWAMP Information Management System Plan

Section A3. Distribution List and Contact Information

A copy of this QAMP, in hardcopy or in electronic format (preferably), is to be received and retained by at least one person from each participating entity. Names of SWAMP staff at each participating entity are shown below, as provided to the SWAMP QA Program to date. At least one person from each participating entity (names shown with asterisk*) shall be responsible for receiving, retaining, and distributing to their respective SWAMP staff within their own organization. Contact information for the primary SWAMP contact person for each participating organization is also provided below in Table 1. This information is also repeated in **Appendix A**, along with a detailed description of SWAMP Programmatic Organization and Responsibilities.

Table 1. Contact Information for the Primary SWAMP Contact Person for Each Participating Organization

Name	Agency, Company, or Organization
STATE WATER RESOURCES CONTROL BOARD (SWRCB)	
Valerie Connor*, Emilie Reyes, Del Rasmussen, George Nichol, Pam Wilson	**SWRCB**/Div. of Water Quality/TMDL Section/Assessment and TMDL Support Unit 1001 "I" St, 15th Floor; Sacramento, CA 95814 Phone: (916)-341-5573; Email: ConnV@dwq.swrcb.ca.gov
Bill Ray*	**SWRCB**/Div. of Water Quality/SWRCB QA Officer Sacramento, CA (address shown above) Phone: (916)-341-5583; Email: RayB@dwq.swrcb.ca.gov
Holly Sheridan*, Eric Burres, Revital Katznelson	**SWRCB**/Div. of Water Quality/Clean Water Team Sacramento, CA (address shown above) Phone: (916)-341-5466; Email: SherH@dwq.swrcb.ca.gov
REGIONAL WATER QUALITY CONTROL BOARDS (RWQCB's)	
Peter Otis*	**RWQCB/Region 1 (North Coast Region)** 5550 Skylane Blvd, Suite A; Santa Rosa, CA 95403 Phone: (707)-576-2662; Email: OtisP@rb1.swrcb.ca.gov
Karen Taberski*, Glynnis Collins, Matt Cover, Nelia White	**RWQCB/Region 2 (San Francisco Bay Region)** 1515 Clay St., Suite 1400; Oakland, Ca. 94612 Phone: (510) 622-2424; Email: KMT@rb2.swrcb.ca.gov

Table 1. Contact Information for the Primary SWAMP Contact Person for Each Participating Organization

Name	Agency, Company, or Organization
	REGIONAL WATER QUALITY CONTROL BOARDS (RWQCB's) (Continued)
Karen Worcester*, Mary Adams	**RWQCB/Region 3 (Central Coast Region)** 81 Higuera St, Suite 200; San Luis Obispo, CA 93401-5427 Phone: (805)-549-3333; Email: KWorcest@rb3.swrcb.ca.gov
Tracy Vergets*, Jonathon Bishop, Michael Lyons, Shirley Birosik	**RWQCB/Region 4 (Los Angeles Region)** 320 W. Fourth St., Suite 200; Los Angeles, CA 90013 Phone: (213)-576-6661; Email: TVergets@rb4.swrcb.ca.gov
Dennis Heiman*, Guy Chetelat	**RWQCB/Region 5-Redding (Central Valley Region)** 415 Knollcrest Dr.; Redding, CA 96002 Phone: (530)-224-4845; Email: HeimanD@rb5r.swrcb.ca.gov
Jeanne Chilcotte*, Chad Dibble, Jay Rowan, Lori Webber, Robert Holmes	**RWQCB/Region 5-Sacramento (Central Valley Region)** 3443 Routier Rd., Suite A; Sacramento, CA 95827-3098 Phone: (916)-255-3088; Email: ChilcoJ@rb5s.swrcb.ca.gov
Annee Ferranti *	**RWQCB/Region 5-Fresno (Central Valley Region)** 1665 'E' Street, Suite 100, Fresno, CA 93706-2025 Phone: (559)-445-5576; Email: FerranA@rb5f.swrcb.ca.gov
Thomas Suk*, Jason Churchill, Laurie Scribe	**RWQCB/Region 6 (Lahontan Region)** 2501 Lake Tahoe Blvd., South Lake Tahoe, CA 96150 Phone: (530)-542-5419; Email: TSuk@rb6s.swrcb.ca.gov
Joan Stormo*, Maria Carpio-Obeso, Logan Raub	**RWQCB/Region 7 (Colorado River Basin)** 73-720 Fred Waring Dr., Ste. 100, Palm Desert, CA 92260 Phone: (760) 776-8982; Email: storj@rb7.swrcb.ca.gov

Table 1. Contact Information for the Primary SWAMP Contact Person for Each Participating Organization

Name	Agency, Company, or Organization
REGIONAL WATER QUALITY CONTROL BOARDS (RWQCB's) (Continued)	
Pavlova Vitale*	**RWQCB/Region 8 (Santa Ana Region)** 3737 Main St., Suite 500, Riverside, CA 92501-3339 Phone: (909)-782-4920; Email: pvitale@rb8.swrcb.ca.gov
Jimmy Smith, David Gibson*, Linda Pardy, Bruce Posthumus	**RWQCB/Region 9 (San Diego Region)** 9174 Sky Park Ct., Ste. 100, San Diego, CA 92124-1324 Phone: (858) 467-4387; Email: gibsd@rb9.swrcb.ca.gov
ORGANIZATIONS WITHIN MASTER CONTRACT TO CA DEPT FISH & GAME	
Mark Stephenson, Gary Ichikawa*, Jon Goetzl, Witold Piekarski	**California Department of Fish and Game** Marine Pollution Studies Lab/Moss Landing NORTE 7711 Sandholdt Road, Moss Landing, CA 95039 Phone: (831)-771-4162 Email: gichikawa@mlml.calstate.edu
Max Puckett*	**California Department of Fish and Game** Marine Pollution Studies Laboratory/Granite Canyon c/o 4580 Blufftop Lane; Hydesville, CA 95547 Phone: (707)-768-1999; Email: granite@redshift.com
Dave Crane*, Abdu Mekebri, Kathleen Regelado, Bob Todd, Marida Martin	**California Department of Fish and Game** Fish & Wildlife Water Pollution Control Lab. 2005 Nimbus Road; Rancho Cordova, CA 95670 Phone: (916)-358-2859; Email: dcrane@ospr.dfg.ca.gov
Jim Harrington*, Peter Ode, Shawn McBride, Glenn Sibbald, Andy Rehn; Angie Montalvo	**Calif. Dept. Fish and Game;** Aquatic Bioassessment Lab. 2005 Nimbus Road; Sacramento, CA 95670 Phone: (916)-358-2862; Email: harringj@ospr.dfg.ca.gov
ORGANIZATIONS WITHIN MASTER CONTRACT TO CA DEPT FISH & GAME	

Table 1. Contact Information for the Primary SWAMP Contact Person for Each Participating Organization

Name	Agency, Company, or Organization (Continued)
Karl Jacobs*	**California Department of Water Resources** Phone: (916)-227-0435; Email: kjacobs@water.ca.gov
Kenneth Coale, Russell Fairey*, Cassandra Roberts, Marco Sigala, Sean Mundell, Bettina Sohst, Autumn Bonnema, Bryan Frueh, Amy Byington, John Negrey	**San Jose State University Foundation** Moss Landing Marine Lab./Marine Pollution Studies Lab 7711 Sandholdt Road, Moss Landing, CA 95039 Phone: (831)-771-4161; Email: fairey@mlml.calstate.edu
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Jennifer Rotnam*	**California State University, Chico Research Foundation** Bidwell Environmental Institute; Chico, CA 95929-0555 Phone: (530) 898-5205; Email: jrotnem@csuchico.edu
Larry Cooper*	**South. CA Coastal Waters Research Proj. (SCCWRP)** 7171 Fenwick Lane; Westminster, CA Phone: (714)-894-2222; Email: larryc@SCCWRP.org www.sccwrp.org
Bruce Thompson*	**San Francisco Estuary Institute (SFEI)** 7770 Pardee Lane, 2nd Floor; Oakland, CA 94621-1424 Phone: (510)-746-7334; Email: brucet@sfei.org www.sfei.org

ORGANIZATIONS WITHIN MASTER CONTRACT TO CA DEPT FISH & GAME (Continued)

Table 1. Contact Information for the Primary SWAMP Contact Person for Each Participating Organization

Name	Agency, Company, or Organization
Michelle Gauthier*, Michael Miller, Beverly van Buuren	**Frontier Geosciences, Inc** 414 Pontius North; Seattle, WA 98109 Phone: (206)-622-6960 Email: michelleg@frontiergeosciences.com
Sandy Nurse*	**Sierra Foothills Laboratory, Inc** 255 Scottsville Blvd; Jackson, CA 95642 Phone: (209)-223-2800; Email: sfl@volcano.net
Kenneth Davis*	**Applied Marine Sciences, Inc.** 502 N. Highway 3, Suite B; League City, TX 77573 Phone: (281)-554-7272; Email: Kdavis1ams@aol.com
MASTER CONTRACT TO U.S. GEOLOGICAL SURVEY	
Jim Bowers*	**U.S. Geological Survey** 600 J Street-Placer Hall; Sacramento, CA 95819-6129 Email: JCBowers@usgs.gov
Paul Honeywell*, Gerald Rockwell	**U.S. Geological Survey/Carnelian Bay Field Office** P.O. Box 1360; Carnelian Bay, CA 96140 Phone: (530)-546-0187; Email: phoneywe@usgs.gov
RWQCB-DIRECT INDIVIDUAL SWAMP CONTRACTS	
Patty Penner*	**Sequoia Analytical Laboratories, Inc**

Table 1. Contact Information for the Primary SWAMP Contact Person for Each Participating Organization

Name	Agency, Company, or Organization
(for RWQCB 1 & 2; their general R1 & R2 lab contracts providing some services for R1 & R2 for SWAMP)	1455 N. McDowell Blvd. North, Suite D Petaluma, CA 94954 Phone: (707) 792-1865; Email: ppenner@sequoialabs.com www.sequoialabs.com
Aileen Cantorna* **(for RWQCB 3)**	**BC Laboratories, Inc.** 4100 Atlas Court, Bakersfield, CA 93308 Phone: (661) 327-4911; Email: bclabs@bclabs.com
Orval Osborne* **(for RWQCB 3)**	**Creek Environmental Laboratories, Inc.** 141 Suburban Road, Suite C-5 San Luis Obispo, CA 93401 Phone: (805) 545-9838; Email: oosborne@fix.net
Jim Hawley*, Matt Rose **(for RWQCB 5-Redding; and for RWQCB 1**--R1's general lab contract providing some services for R1 for SWAMP)	**Basic Laboratory, Inc.** 2218 Railroad Ave.; Redding, CA 96001 Phone: (530) 243-7234; Email: mrose@basiclabinc.com www.basiclabinc.com
Leslie Mink* **(for RWQCB 5-Redding)**	**Plumas Corporation** P.O. Box 3880, Quincy, CA 95971 Phone: (530)-283-3739; Email: plumasco@psln.com www.feather-river-crm.org
Todd Sloat* **(for RWQCB 5-Redding)**	**North. Calif. - Nevada Resource Conservation District** Phone: (530)-336-5456; Email: tsloat@citlink.net

RWQCB-DIRECT INDIVIDUAL SWAMP CONTRACTS
(Continued)

Table 1. Contact Information for the Primary SWAMP Contact Person for Each Participating Organization

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Jayna Kostura* **(for RWQCB 5-Sacramento)**	**Weck Laboratories, Inc.** 14859 East Clark Avenue; Industry, CA 91745 Phone: (626) 336-2139; Email: jkostura@wecklabs.com
Nancy Thiex* **(for RWQCB 5-Sacramento)**	**South Dakota State University** Olcar E. Olson Biochemical Lab/Analytical Services Lab. P.O. Box 2170 133 ASC; South Dakota State University Brookings, SD 57007-1217 Phone: (605) 688-5466; Email: nancy_thiex@sdstate.edu
Sandy Nurse* **(for RWQCB 5-Sacramento)**	**Sierra Foothills Laboratory, Inc** 255 Scottsville Blvd; Jackson, CA 95642 Phone: (209)-223-2800; Email: sfl@volcano.net
Randy A. Dahlgren* **(for RWQCB 5-Sacramento)**	**Univ. of California, Davis** 1 Shields Avenue LAWR - Hoagland 151, Davis, CA 95616 Phone: (530) 752-2814; Email: radahlgren@ucdavis.edu

RWQCB-DIRECT INDIVIDUAL SWAMP CONTRACTS
(Continued)

Table 1. Contact Information for the Primary SWAMP Contact Person for Each Participating Organization

Name	Agency, Company, or Organization
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Mark Palmer* **(for RWQCB 6)**	**High Sierra Water Lab** PO Box 171; Truckee, CA 96160 Phone: (530)-582-8150; Email: HSWaterLab@aol.com
Michael Machuzak* **(for RWQCB 8)**	**ABC Laboratories** Phone: (805) 643-5621; Email: aquabio@pacbell.net
Rich Gossett* **(for RWQCB 8)**	**CRG Marine Laboratories, Inc.** 2020 Del Amo Blvd., Suite 200; Torrance, California 90501 Phone: (310)-533-5190; Email: info@crgmarinelabs.com www.crgmarinelabs.com

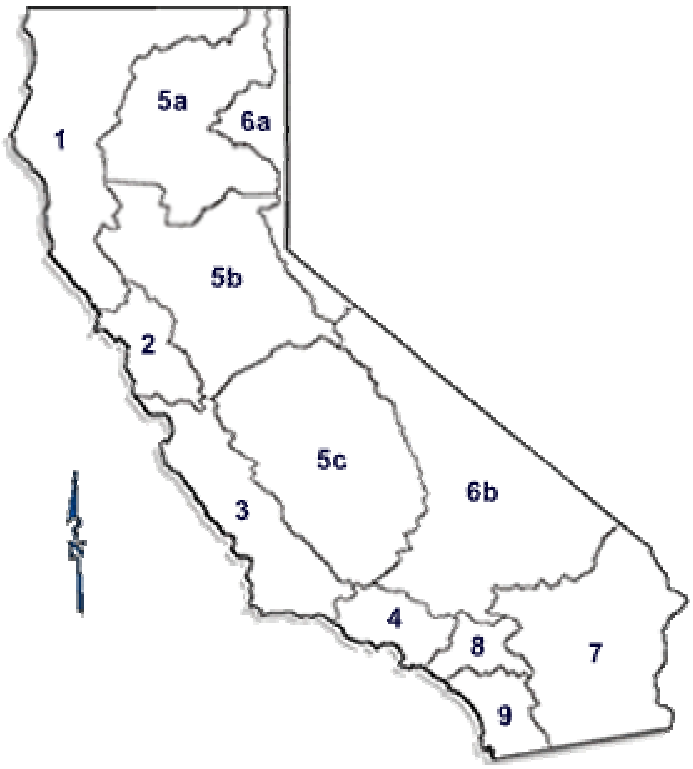
Section A4. SWAMP Program Organization

The SWAMP Program functions administratively under the leadership and auspices of the Assessment and TMDL Support Unit, within the TMDL Section of the Division of Water Quality at the California State Water Resources Control Board (SWRCB), and concurrently, is administered and managed regionally by SWAMP staff at the state's nine Regional Water Quality Control Boards (RWQCB's). The general mode of programmatic management and decision-making for administrative and technical issues is through consensus discussions that take place primarily at regular (bi-monthly) meetings of the SWAMP Roundtable. The Roundtable currently has representation from SWAMP staff at the SWRCB and all RWQCB's; representation from SWAMP staff from the California Department of Fish and Game, San Jose State University Foundation/Moss Landing Marine Laboratories, and the University of California-Davis/Granite Canyon Laboratory; and representation from the Morro Bay Foundation; and other agencies and organizations as desired and appropriate. Due to the complexity of describing the SWAMP program organization in detail, a thorough description of the SWAMP-specific programmatic organization and responsibilities is provided in **Appendix A**, along with all SWAMP participant contact information from Table 1 in Section A3.

General Overview of the State Water Resources Control Board and the Regional Water Quality Control Boards

The SWRCB was created by the Legislature of the state of California in 1967. The overall mission of the SWRCB is to ensure the highest reasonable quality of waters of the state, while allocating those waters to achieve the optimum balance of beneficial uses. The joint authority of water allocation and water quality protection enables the SWRCB to provide comprehensive protection for California's waters. The SWRCB consists of five full-time salaried members, each filling a different specialty position. Board members are appointed to four-year terms by the Governor and confirmed by the Senate. There are nine RWQCB's. The mission of the RWQCB's is to develop and enforce water quality objectives and implementation plans that will best protect the beneficial uses of the State's waters, recognizing local differences in climate, topography, geology and hydrology. Figure 1 provides a map of the geographic areas of jurisdiction of each RWQCB in California. Each RWQCB has nine part-time members appointed by the Governor and confirmed by the Senate. RWQCB's develop "basin plans" for their hydrologic areas, issue waste discharge requirements, take enforcement action against violators, and monitor water quality. The task of protecting and enforcing the many uses of water, including the needs of industry, agriculture, municipal districts, and the environment is an ongoing challenge for the SWRCB and RWQCB's.

Figure 1. Map of the nine California Regional Water Quality Control Board geographic areas of jurisdiction



RWQCB 1 = North Coast Region
RWQCB 2 = San Francisco Bay Region
RWQCB 3 = Central Coast Region
RWQCB 4 = Los Angeles Region
RWQCB 5 = Central Valley Region
(5a) = Redding Office
(5b) = Sacramento Office
(5c) = Fresno Office
RWQCB 6 = Lahontan Region
(6a) = South Lake Tahoe Office
(6b) = Victorville Office
RWQCB 7 = Colorado River Basin Region
RWQCB 8 = Santa Ana Region
RWQCB 9 = San Diego Region

Overview of SWAMP-specific Program Organization

The primary functional organizational chart for the SWAMP program is shown in Figure 2, followed by organizational charts for SWAMP field and analytical laboratory contractual services in Figure 3 (California Department of Fish and Game Master Contract), Figure 4 (U.S. Geological Survey Master Contract), and Figure 5 (Contracts directly specified/administered by RWQCB's for SWAMP services).

RESPONSIBILITIES OF PRIMARY SWAMP STAFF AT PARTICIPATING ORGANIZATIONS

Contact information and organizational structure information was previously provided for key SWAMP staff at participating entities in Table 1 (Section A3) and in Figures 2-5 (Section A4). Because of the very large number of agencies, organizations, and individuals involved in this SWAMP Program, this section provides a summary only, and for primary staff only. A summary chart of the major field, laboratory, administrative, and technical reporting activities of all participating SWAMP entities is provided in Table 2 at the end of Section A4. Due to the complexity of describing the SWAMP program organization in detail, a thorough description of the SWAMP-specific programmatic organization and responsibilities is provided in **Appendix A**, along with all SWAMP participant contact information from Table 1 in Section A3.

Table 2, starting on the next page, provides a matrix of responsibilities and lists the entities involved in data collection efforts within the nine Regional Boards and the DWQ Clean Water Team, the Citizen Monitoring Program of the SWRCB.

Table 2a. Summary of SWAMP Field Activity Responsibilities for Organizations Conducting Statewide Services and for RWQCB 1 and 2

Entity for whom service is being conducted	Agency, University, Corporation, or Other Entity Conducting Service (and showing contract "route" where can)	FIELD SAMPLE COLLECTION AND FIELD DATA MEASUREMENTS								
		Sample Collection					Pre-collect	Probe	Flow/veloc	Phys Habit
		Water	Sed	Tiss	Benth	Bugs	site recon	measure	measure	Assess
State Water Resources Control Board--Statewide Services										
Organizations providing services for SWAMP statewide (services for all regions)	CDFG--statewide planning assistance, including technical workshops, WQMCC meetings, and SPARC meetings, statewide QA planning/QA oversight									
	CDFG/SJSUF--statewide planning assistance, including technical workshops, WQMCC meetings, and SPARC meetings									
	CDFG/UCD Granite Cyn--statewide planning assistance, including technical workshops, WQMCC meetings, and SPARC meetings									
	CDFG/SJSUF--statewide data mgmt									
	CDFG/SJSUF/SCCWRP--socal data mgmt									
	CDFG/SJSUF/SFEI--centvall data mgmt									
	CDFG/SJSUF/Frontier Geo--ext QA									
	CDFG/SJSUF/Don Stevens--stats									
North Coast Regional Water Quality Control Board										
RWQCB 1: North Coast Region	R1 staff	1					1	1	1	1
	R1 student contract staff									
	R1 citizen monitors									
	CDFG Nimbus--Organics									
	CDFG Nimbus--Conv WQ									
	CDFG/SJSUF--Metals									
	CDFG Nimbus/CSU Chico--ABL Bioassess					1	1	1	1	1
	CDFG/SJSUF/Applied Mar. Sci.--conv wq									
	CDFG/SJSUF/Sierra Foothills--conv wq									
	SWRCB/Sequoia Analytical									
	SWRCB/North Coast Labs									
	SWRCB/Basic Laboratory									
	USGS								stream gage	
San Francisco Bay Regional Water Quality Control Board										
RWQCB 2: San Francisco Bay Region	R2 staff	1					1	1	1	1
	R2 student contract staff						1	1	1	1
	R2 citizen monitors						1	1	1	1
	CDFG Nimbus--Organics									
	CDFG Nimbus--Conv WQ									
	CDFG/SJSUF--Metals									
	CDFG Nimbus/CSU Chico--ABL Bioassess					1	1	1	1	1
	CDFG/SJSUF--Sample Collection	1	1	1				1	1	
	CDFG/UCD Granite Cyn--Tox Testing									
	CDFG/SJSUF/Applied Mar. Sci.--conv wq									
	CDFG/SJSUF/Sierra Foothills--conv wq									
	SWRCB/Sequoia Analytical--bact									

Table 2b. Summary of SWAMP Laboratory, Administrative, and Technical Reporting Responsibilities for Organizations Conducting Statewide Services and for RWQCB 1 and 2

Entity for whom service is being conducted	Agency, University, Corporation, or Other Entity Conducting Service (and showing contract "route" where can)	ANALYTICAL LABORATORY SERVICES								Other services (QA, Data Mgmt, Stats, Interp Rept)
		Org Chem	Metal Chem	Convent W.Q.	Tox Test	Benthic Infauna	Biolog Assess	Bact/ Path	Sed charac	
State Water Resources Control Board--Statewide Services										
Organizations providing services for SWAMP statewide (services for all regions)	CDFG--statewide planning assistance, including technical workshops, WQMCC meetings, and SPARC meetings, statewide QA planning/QA oversight									1
	CDFG/SJSUF--statewide planning assistance, including technical workshops, WQMCC meetings, and SPARC meetings									1
	CDFG/UCD Granite Cyn--statewide planning assistance, including technical workshops, WQMCC meetings, and SPARC meetings									1
	CDFG/SJSUF--statewide data mgmt									1
	CDFG/SJSUF/SCCWRP--socal data mgmt									1
	CDFG/SJSUF/SFEI--centvall data mgmt									1
	CDFG/SJSUF/Frontier Geo--ext QA									1
	CDFG/SJSUF/Don Stevens--stats									1
North Coast Regional Water Quality Control Board										
RWQCB 1: North Coast Region	R1 staff									1
	R1 student contract staff									
	R1 citizen monitors									
	CDFG Nimbus--Organics	1								
	CDFG Nimbus--Conv WQ			1						
	CDFG/SJSUF--Metals		1							
	CDFG Nimbus/CSU Chico--ABL Bioassess						1			1
	CDFG/SJSUF/Applied Mar. Sci.--conv wq			1						
	CDFG/SJSUF/Sierra Foothills--conv wq			1						
	SWRCB/Sequoia Analytical									
	SWRCB/North Coast Labs									
	SWRCB/Basic Laboratory									
	USGS									
San Francisco Bay Regional Water Quality Control Board										
RWQCB 2: San Francisco Bay Region	R2 staff									1
	R2 student contract staff									1
	R2 citizen monitors									
	CDFG Nimbus--Organics	1								
	CDFG Nimbus--Conv WQ			1						
	CDFG/SJSUF--Metals		1							
	CDFG Nimbus/CSU Chico--ABL Bioassess						1			
	CDFG/SJSUF--Sample Collection									
	CDFG/UCD Granite Cyn--Tox Testing				1					
	CDFG/SJSUF/Applied Mar. Sci.--conv wq			1					1	
	CDFG/SJSUF/Sierra Foothills--conv wq			1						
	SWRCB/Sequoia Analytical--bact							1		

Table 2c. Summary of SWAMP Field Activity Responsibilities for RWQCB 3, 4, and 5

Entity for whom service is being conducted	Agency, University, Corporation, or Other Entity Conducting Service (and showing contract "route" where can)	FIELD SAMPLE COLLECTION AND FIELD DATA MEASUREMENTS								
		Sample Collection					Pre-collect	Probe	Flow/veloc	Phys Habit
		Water	Sed	Tiss	Benth	Bugs	site recon	measure	measure	Assess
Central Coast Regional Water Quality Control Board										
RWQCB 3: Central Coast Region	R3 staff	1				1	1	1	1	1
	R3 student contract staff	1				1	1	1	1	1
	R3 citizen monitors									
	CDFG Nimbus--Organics									
	CDFG/SJSUF--Metals									
	CDFG Nimbus/CSU Chico--ABL Bioassess									
	CDFG/SJSUF--Sample Collection		1	1						
	CDFG/UCD Granite Cyn--Tox Testing									
	CDFG/SJSUF/Applied Mar. Sci.--conv wq									
	SWRCB/BC Labs									
Los Angeles Regional Water Quality Control Board										
RWQCB 4: Los Angeles Region	R4 staff	1					1	1	1	1
	R4 student contract staff									
	R4 citizen monitors									
	CDFG Nimbus--Organics									
	CDFG Nimbus--Conv WQ									
	CDFG/SJSUF--Metals									
	CDFG Nimbus/CSU Chico--ABL Bioassess					1	1	1	1	1
	CDFG/SJSUF--Sample Collection	1	1	1				1	1	
	CDFG/UCD Granite Cyn--Tox Testing									
	CDFG/SJSUF/Applied Mar. Sci.--conv wq									
	CDFG/SJSUF/Sierra Foothills--conv wq									
Central Valley Regional Water Quality Control Board										
RWQCB 5: Central Valley Region	R5 staff	1	1			1	1	1	1	1
	R5 student contract staff	1	1			1	1	1	1	1
	R5 citizen monitors									
	CDFG/MLML/SJS Sample Collection									
	CDFG/UCD/Granite Cyn Tox Testing									
	CDFG/SJS/Applied Marine Sciences									
	SWRCB/UC Davis - Aquatic Toxicology Lab	1				1	1	1	1	1
	SWRCB/UC Davis - LAWR									
	SWRCB/UC Davis - Aquatic Limnology Lab									
	SWRCB/Plumas Corporation	1				1	1	1	1	1
	SWRCB/Northern Cal-Nevada RCD	1				1	1	1	1	1
	SWRCB/Twining Laboratories									
	SWRCB/Weck Laboratories									
	SWRCB/Basic Laboratory									
	SWRCB/So. Dakota St. Univ.--Olsen Chem Lab									
	SWRCB/Countyof Madera--Public Wks	1								
	SWRCB/Sierra Foothill Laboratory									

Table 2d. Summary of SWAMP Laboratory, Administrative, and Technical Reporting Responsibilities for RWQCB 3, 4, and 5

Entity for whom service is being conducted	Agency, University, Corporation, or Other Entity Conducting Service (and showing contract "route" where can)	ANALYTICAL LABORATORY SERVICES								Other services (QA, Data Mgmt, Stats, Interp Rept)
		Org Chem	Metal Chem	Convent W.Q.	Tox Test	Benthic Infauna	Biolog Assess	Bact/ Path	Sed charac	
Central Coast Regional Water Quality Control Board										
RWQCB 3: Central Coast Region	R3 staff									1
	R3 student contract staff									
	R3 citizen monitors									
	CDFG Nimbus--Organics	1								
	CDFG/SJSUF--Metals		1							
	CDFG Nimbus/CSU Chico--ABL Bioassess						1			1
	CDFG/SJSUF--Sample Collection									
	CDFG/UCD Granite Cyn--Tox Testing				1					1
	CDFG/SJSUF/Applied Mar. Sci.--conv wq			1					1	
	SWRCB/Creek Laboratory			1				1		
	SWRCB/BC Labs	1	1	1				1		
Los Angeles Regional Water Quality Control Board										
RWQCB 4: Los Angeles Region	R4 staff									1
	R4 student contract staff									
	R4 citizen monitors									
	CDFG Nimbus--Organics	1								
	CDFG Nimbus--Conv WQ			1						
	CDFG/SJSUF--Metals		1							
	CDFG Nimbus/CSU Chico--ABL Bioassess						1			1
	CDFG/SJSUF--Sample Collection									
	CDFG/UCD Granite Cyn--Tox Testing				1					1
	CDFG/SJSUF/Applied Mar. Sci.--conv wq			1					1	
	CDFG/SJSUF/Sierra Foothills--conv wq			1						
Central Valley Regional Water Quality Control Board										
RWQCB 5: Central Valley Region	R5 staff			1				1		1
	R5 student contract staff			1				1		
	R5 citizen monitors									
	CDFG/MLML/SJS Sample Collection									
	CDFG/UCD/Granite Cyn Tox Testing				1					
	CDFG/SJS/Applied Marine Sciences								1	
	SWRCB/UC Davis - Aquatic Toxicology Lab				1		1			1
	SWRCB/UC Davis - LAWR	1		1						
	SWRCB/UC Davis - Aquatic Limnology Lab			1						
	SWRCB/Plumas Corporation			1					1	
	SWRCB/Northern Cal-Nevada RCD			1					1	
	SWRCB/Twining Laboratories	1	1	1					1	
	SWRCB/Weck Laboratories		1							
	SWRCB/Basic Laboratory	1	1	1				1		
	SWRCB/So. Dakota St. Univ.--Olsen Chem Lab	1	1	1						
	SWRCB/Countyof Madera--Public Wks									
	SWRCB/Sierra Foothill Laboratory			1				1		

Table 2e. Summary of SWAMP Field Activity Responsibilities for Organizations Conducting Statewide Services and for RWQCB 6, 7, 8, 9 and DWQ

Entity for whom service is being conducted	Agency, University, Corporation, or Other Entity Conducting Service (and showing contract "route" where can)	FIELD SAMPLE COLLECTION AND FIELD DATA MEASUREMENTS								
		Sample Collection					Pre-collect	Probe	Flow/veloc	Phys Habit
		Water	Sed	Tiss	Benth	Bugs	site recon	measure	measure	Assess
Lahontan Regional Water Quality Control Board										
RWQCB 6: Lahontan Region	R6 staff	1				1	1	1	1	1
	R6 student contract staff									
	R6 citizen monitors									
	USGS--Carnelian Bay	1					1	1	1	1
	SWRCB/UC Santa Barbara-SNARL					1	1	1	1	1
	SWRCB/NEL Lab									
	SWRCB/High Sierra Labs									
	SWRCB/Desert Research Institute									
Colorado River Basin Regional Water Quality Control Board										
RWQCB 7: Colorado River Basin Region	R7 staff	1					1	1	1	1
	R7 student contract staff									
	R7 citizen monitors									
	CDFG Nimbus--Organics									
	CDFG Nimbus--Conv WQ									
	CDFG/SJSUF--Metals									
	CDFG Nimbus/CSU Chico--ABL Bioassess					1	1	1	1	1
	CDFG/SJSUF--Sample Collection	1	1					1	1	
	CDFG/UCD Granite Cyn--Tox Testing									
	CDFG/SJSUF/Applied Mar. Sci.--conv wq									
	CDFG/SJS/Babcock & Sons, Inc.									
	CDFG/SJSUF--Sierra Foothills conv wq									
	USGS-San Diego	1	1					1	1	
Santa Ana Regional Water Quality Control Board										
RWQCB 8: Santa Ana Region	R8 staff	1	1		1		1	1		1
	R8 student contract staff									
	R8 citizen monitors	1			1		1	1		1
	SWRCB/ABC Labs				1		1	1		1
	SWRCB/CRG Labs	1	1				1	1		1
	SWRCB/SCCWRP									
San Diego Regional Water Quality Control Board										
RWQCB 9: San Diego Region	R9 staff					1	1	1	1	1
	R9 student contract staff									
	R9 citizen monitors	1				1	1	1	1	1
	CDFG Nimbus--Organics									
	CDFG Nimbus--Conv WQ									
	CDFG/SJSUF--Metals									
	CDFG Nimbus/CSU Chico--ABL Bioassess					1	1	1	1	1
	CDFG/SJSUF--Sample Collection	1	1	1				1	1	
	CDFG/UCD Granite Cyn--Tox Testing									
	CDFG/SJSUF/Applied Mar. Sci.--conv wq									
	CDFG/SJSUF/Sierra Foothills--conv wq									
SWRCB/Division of Water Quality										
DWQ	DWQ SWAMP staff									
	DWQ Clean Water Team staff	1	1			1	1	1	1	1

Table 2f. Summary of SWAMP Laboratory, Administrative, and Technical Reporting Responsibilities for RWQCB 6, 7, 8, 9 and DWQ

Entity for whom service is being conducted	Agency, University, Corporation, or Other Entity conducting service (and showing contract "route" where can)	ANALYTICAL LABORATORY SERVICES								Other services (QA, Data Mgmt, Stats, Interp Rept)
		Org Chem	Metal Chem	Convent W.Q.	Tox Test	Benthic Infauna	Biolog Assess	Bact/ Path	Sed charac	
Lahontan Regional Water Quality Control Board										
RWQCB 6: Lahontan Region	R6 staff			1						1
	R6 student contract staff									
	R6 citizen monitors									
	USGS--Carnelian Bay	1	1	1						1
	SWRCB/UC Santa Barbara-SNARL						1			1
	SWRCB/NEL Lab	1	1	1						
	SWRCB/High Sierra Labs			1						
	SWRCB/Desert Research Institute			1						
Colorado River Basin Regional Water Quality Control Board										
RWQCB 7: Colorado River Basin Region	R7 staff							1		1
	R7 student contract staff									
	R7 citizen monitors									
	CDFG Nimbus--Organics	1								
	CDFG Nimbus--Conv WQ			1						
	CDFG/SJSUF--Metals		1							
	CDFG Nimbus/CSU Chico--ABL Bioassess						1			1
	CDFG/SJSUF--Sample Collection									
	CDFG/UCD Granite Cyn--Tox Testing				1					
	CDFG/SJSUF/Applied Mar. Sci.--conv wq			1					1	
	CDFG/SJS/Babcock & Sons, Inc.							1		
	CDFG/SJSUF--Sierra Foothills conv wq			1						
	USGS-San Diego	1	1	1					1	1
Santa Ana Regional Water Quality Control Board										
RWQCB 8: Santa Ana Region	R8 staff									1
	R8 student contract staff									
	R8 citizen monitors									
	SWRCB/ABC Labs				1	1				
	SWRCB/CRG Labs	1	1	1				1	1	
	SWRCB/SCCWRP									1
San Diego Regional Water Quality Control Board										
RWQCB 9: San Diego Region	R9 staff									1
	R9 student contract staff									
	R9 citizen monitors									
	CDFG Nimbus--Organics	1								
	CDFG Nimbus--Conv WQ			1						
	CDFG/SJSUF--Metals		1							
	CDFG Nimbus/CSU Chico--ABL Bioassess						1			
	CDFG/SJSUF--Sample Collection									
	CDFG/UCD Granite Cyn--Tox Testing				1					
	CDFG/SJSUF/Applied Mar. Sci.--conv wq			1					1	
	CDFG/SJSUF/Sierra Foothills--conv wq			1						
SWRCB/Division of Water Quality										
DWQ	DWQ SWAMP staff									1
	DWQ Clean Water Team staff			1				1	1	1

Figure 2: State of California's ***S***urface ***W***ater ***A***mbient ***M***onitoring ***P***rogram (***"S.W.A.M.P."***)
Organizational Chart for Primary-Level Responsiblities

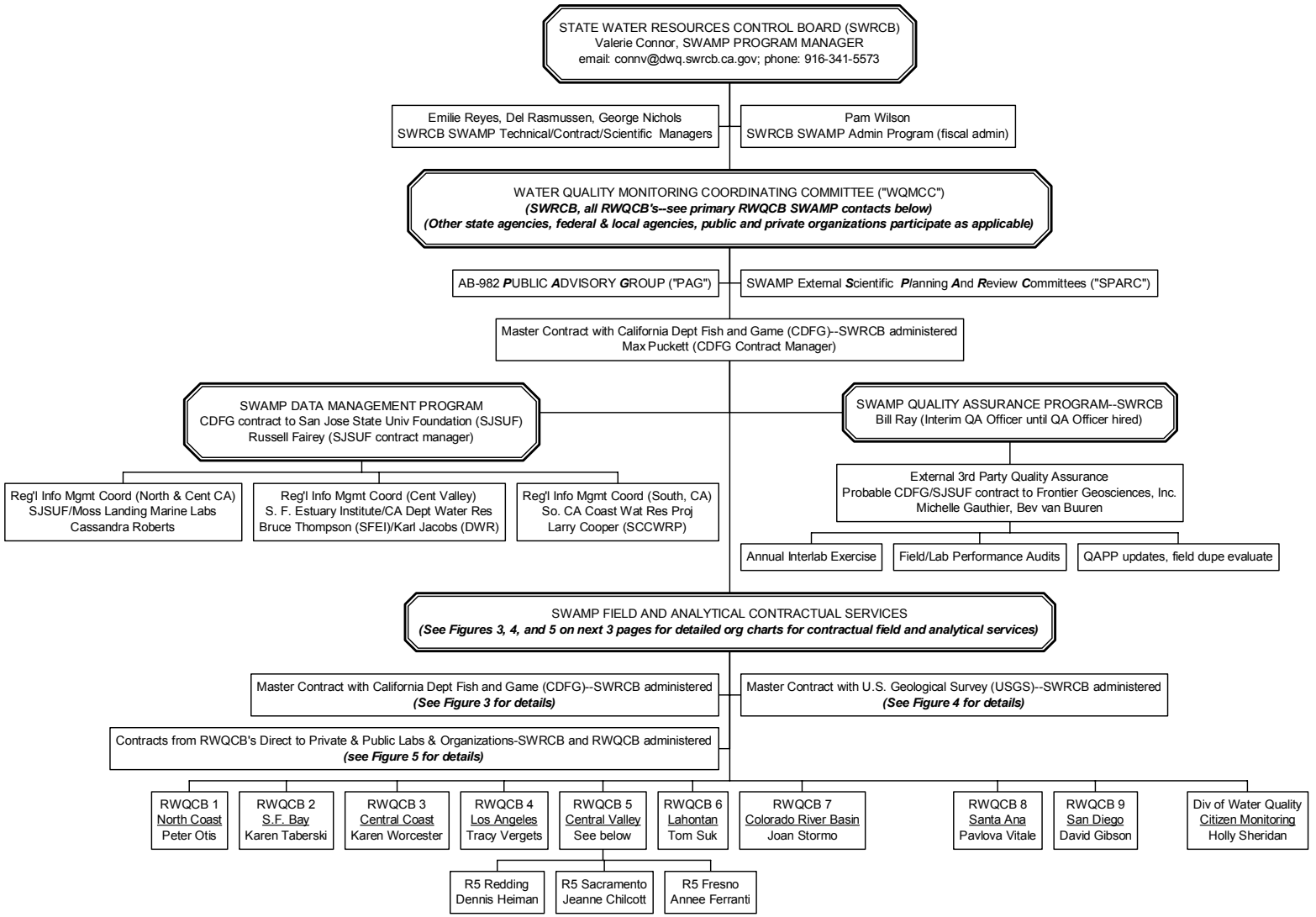
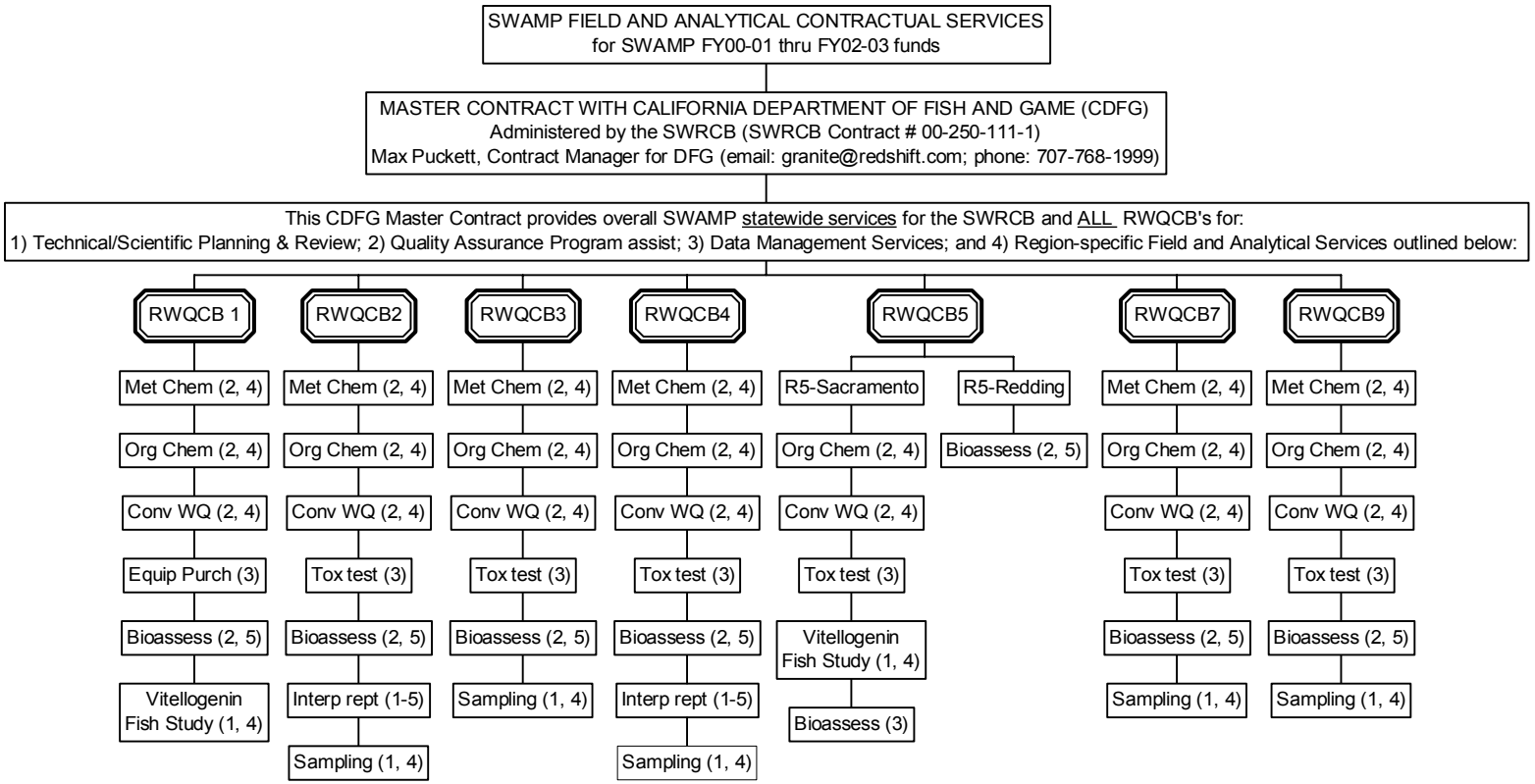


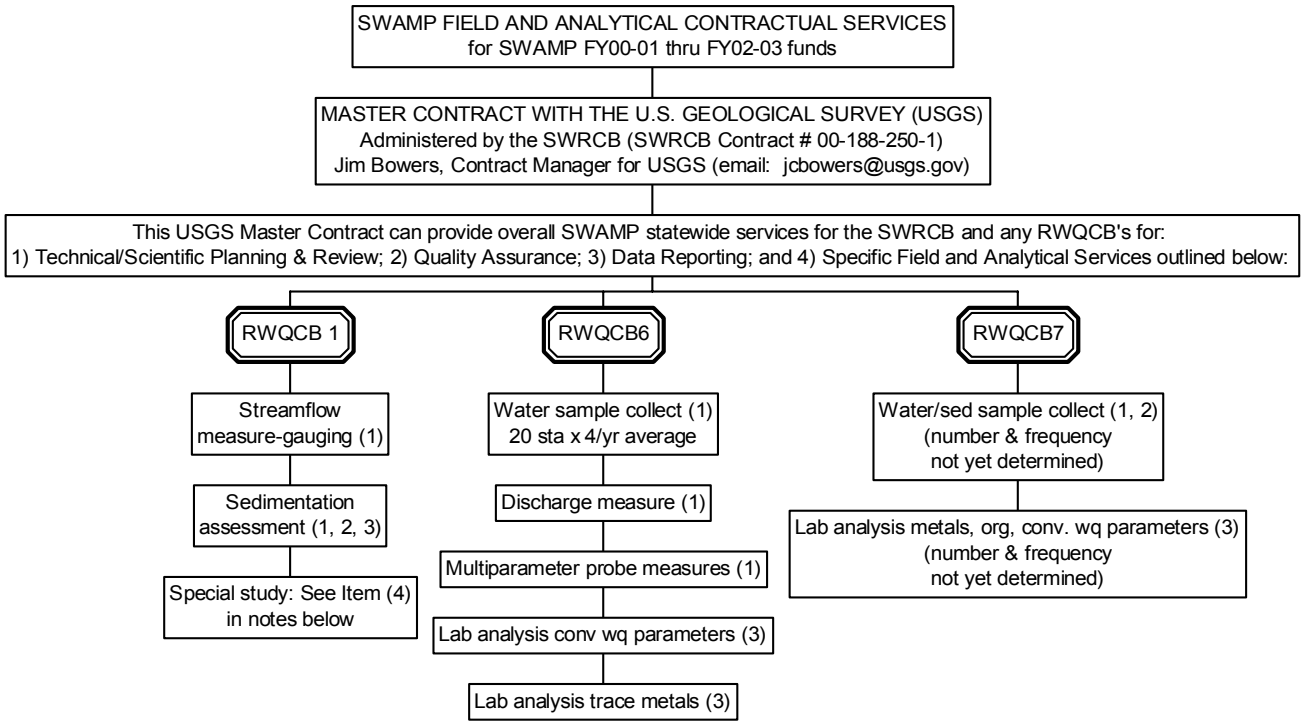
Figure 3. State of California's Surface Water Ambient Monitoring Program ("S.W.A.M.P.")
Details of Organizational Responsibilities for Field and Analytical Services
for the California Department of Fish and Game's Master Contract with the SWRCB



For the master Contract with CDFG, field and analytical services for specific Regional Boards, as listed by number (#) above & below, are provided by the following:

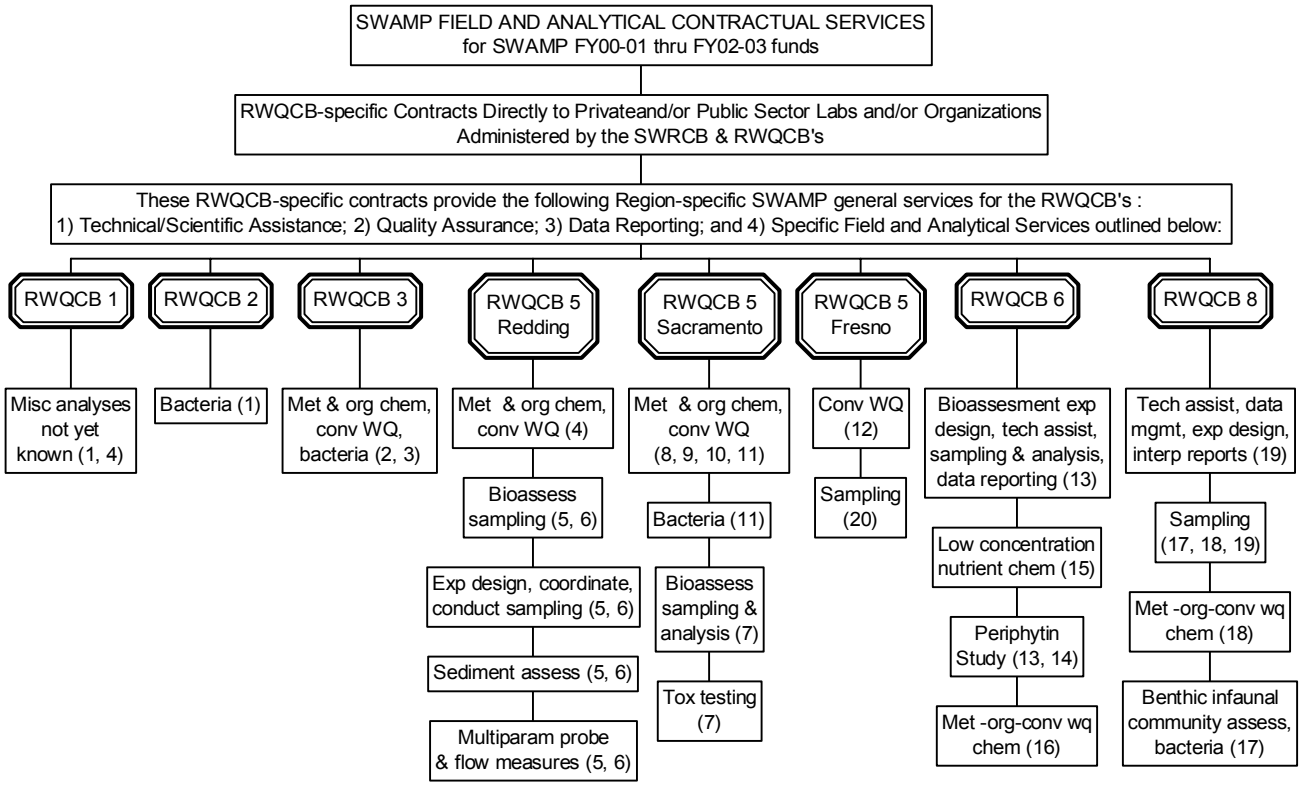
1) CDFG Moss Landing: Technical/scientific planning & review; quality assurance program; sample collect logistics & mgmt; contracts mgmt; interp rpts
2) CDFG Rancho Cordova/Nimbus: Technical/scientific planning & review; organic chemistry, conventional water quality, aquatic bioassessment; interp rpts
3) CDFG contract to UC Davis/Granite Canyon (Env. Tox. Dept.) & Aquatic Tox Lab (Vet Med): Technical/scientific planning & review, toxicity testing, interpretive reports; equipment purchases; vitellogenin fish studies & bioassessment & tox (UCD ATL).
4) CDFG contract to San Jose State Univ Fndtn/Moss Landing Marine Labs: Technical /scientific planning & review; statewide data management; trace metal & organic chem, sample collect & processing, sampling logistics & coordination, TSS/SSC, sed TOC, chlor-a; subcontract to Applied Marine Sciences (Houston, TX) for sed grain size, water TOC/DOC; subcontract to Sierra Foothills Lab (Jackson, CA) for boron; subcontract to CLS Labs (Rancho Cordova) for conv wq).
5) CDFG contract to California State University, Chico Research Foundation: Biological assessment field and analytical services.

Figure 4. State of California's Surface Water Ambient Monitoring Program ("S.W.A.M.P.")
Details of Organizational Responsibilities for Field and Analytical Services
for the U.S. Geological Survey Master Contract with the SWRCB



For the master Contract from SWRCB to USGS, the following outlines of field and analytical services are provided to Regional Boards, as shown above:
1) Collecting and processing of sediment, and/or water, and/or streamflow (discharge) samples or other materials from California surface waters, including the use of all appropriate QA/QC measures necessary to collect and process samples, as outlined in respective task orders;
2) Field sample collection of suspended sediment, bed material, and bedload samples, complete or partial particle-size distributions, routine maintenance and repairs to gage structures and instrumentation, and necessary water quality sampling, as outlined in respective task orders;
3) Conduct water quality analytical chemistry on field-collected environmental samples as outlined in respective Task Orde;
4) Evaluate the Board's water availability methodology of using the rational and drainage area ratio methods at ungaged locations in northern coastal California from San Mateo County to Oregon (North Coast region). These methods are used to estimate selected streamflow characteristics, which are used to evaluate applications to appropriate water. These characteristics include daily streamflow, various monthly and seasonal statistics, mean-annual discharge, and selected flood-frequencies and magnitudes. Quantify the accuracy and bias of the techniques to estimate streamflow statistics, identify regions where they perform relatively well or poorly and identify the combination of factors that may affect their applicability.

Figure 5. State of California's Surface Water Ambient Monitoring Program ("S.W.A.M.P.")
Details of Organizational Responsibilities for Field and Analytical Services
for RWQCB-specific Contracts Direct to Private and/or Public Sector Labs and/or Organizations



1) Sequoia Analytical Labs (R1 & R2)--not thru swamp funds; 2) BC Laboratories, Inc. (R3); 3) Creek Environmental Laboratories, Inc. (R3); 4) Basic Laboratory, Inc. (R5-Redding); 5) Plumas Corporation (R5-Redding); 6) Northern California-Nevada Resource Conservation District (R5-Redding); 7) U.C. Davis Aquatic Toxicology Laboratory (R5-Sacramento); 8) Twining Laboratories, Inc. (R5-Sacramento); 9) Weck Laboratories (R5-Sacramento); 10) South Dakota State University/Olson Biochemical Laboratory (R5-Sacramento); 11) Sierra Foothills Laboratory, Inc. (R5-Sacramento); 12) U.C. Davis Aquatic Limnology Laboratory (R5-Fresno); 13) U.C. Sierra-Nevada Aquatic Resources Laboratory (R6); 14) Subcontract from U.C. SNARL to Professor Dean Blinn, No. Arizona University (R6); 15) High Sierra Water Laboratory, Inc. (R6); 16) Contract Lab (not yet known) (R6); 17) ABC Laboratories, Inc. (R8); 18) CRG Laboratories, Inc. (R8); 19) Southern California Coastal Waters Research Project (R8); 20) County of Madera Public Works Department.

Section A5. Problem Definition/Background

Summary of Creation of SWAMP Program

Proposed mission statement for the SWAMP Program:

> *The mission of the SWAMP Program is to provide for an integrated evaluation of physical, chemical, and biological characteristics of ambient conditions within California's aquatic systems in relation to human health concerns, ecological condition, and designated uses. SWAMP data provide a basis for the establishment of effective State Water Resources Control Board (SWRCB) and Regional Water Quality Control Board (RWQCB) management policies that promote the protection, restoration, and wise use of California surface-water resources.*

This section provides a background of the need for, and the creation of, the SWAMP Program. Most of the information in this section from this point forward is taken directly from the SWRCB Report to the Legislature from November 2000 entitled "Proposal for a Comprehensive Ambient Surface Water Quality Monitoring Program" (November 2000 Legislative Report), which is available from the SWRCB SWAMP Program staff.

California Assembly Bill (AB) 982 (Water Code Section 13192; Statutes of 1999) required the State Water Resources Control Board (SWRCB) to assess and report on state of California monitoring programs, and to prepare a proposal for a comprehensive surface water quality monitoring program. The passage of, and implementation of the requirements of, AB-982 ultimately provided for the administrative, political, financial, and technical means to create the SWAMP Program within the SWRCB. This was possible due to support from the California Legislature in Fiscal Year 2000-2001 provided in the Governor's Water Quality Initiative, which provided the authority and budget within the SWRCB for the formation of SWAMP.

The Porter-Cologne Water Quality Control Act and the federal Clean Water Act (CWA) direct the water quality programs to implement efforts intended to protect and restore the integrity of waters of the State. California Assembly Bill (AB) 982 (Water Code Section 13192; Statutes of 1999) requires the State Water Resources Control Board (SWRCB) to assess and report on the State monitoring programs and to prepare a proposal for a comprehensive surface water quality monitoring program. Ambient monitoring is independent of the water quality programs and serves as a measure of (1) the overall quality of water resources and (2) the overall effectiveness of Regional Water Quality Control Boards' (RWQCB's) prevention, regulatory, and remedial actions. Current monitoring and assessment capability at the SWRCB is limited and tends to be focused on specific program needs. This has led to a fragmentation of monitoring efforts resulting in gaps in needed information and a lack of integrated analyses.

The November 2000 Legislative Report contains the monitoring program proposal that is the basis of the SWAMP Program. It was designed to address a number of programmatic objectives focused on assessing the quality of the beneficial uses of the State's water resources. Some of these objectives are satisfied with the information produced by existing monitoring efforts within the SWRCB and other agencies. Each of the SWRCB and RWQCB's existing monitoring programs e.g., the State Mussel Watch Program (SMWP), the Toxic Substances Monitoring Program (TSMP), the Toxicity Testing Program (TTP), Coastal Fish Contaminants Project (CFCP) and fish/shellfish contamination studies, shall be incorporated to the extent and manner possible into SWAMP to ensure a coordinated approach without duplication. SWAMP shall also coordinate with other programs implemented in the State to assure that the ambient monitoring efforts are not duplicated.

However, in the November 2000 Legislative Report, the SWRCB proposed to restructure the existing water quality monitoring programs into a new program, the Surface Water Ambient Monitoring Program (SWAMP). The major activities planned for SWAMP when fully implemented, as proposed in the November 2000 Legislative Report, are described below.

1. The SWRCB will implement comprehensive environmental monitoring focused on providing the information the SWRCB and RWQCB's need to manage effectively the State's water resources. This will be an umbrella program that monitors and interprets data for each hydrologic unit at least one time every five years. This program shall focus on all waters of the State without bias to known impairment.

2. The program will have consistent monitoring methods with respect to sampling and analysis, data quality objectives, and centralized reporting requirements. Furthermore, the monitoring efforts implemented through SWAMP will be: adaptable to changing circumstances, built on cooperative efforts, established to meet clear monitoring objectives, inclusive of already available information, implemented using scientifically sound monitoring design with meaningful indicators of water quality, comparable methods, regular reporting, and data management.

3. The program will focus on spatial status and temporal trends in water quality statewide. To do this the program will determine the site-specific locations, the areal extent, and temporal trends in a number of measures of the quality of water, sediments, and biota that are widely applicable throughout the State depending on the type of water body being monitored. In watersheds, the program will implement a rotating basin framework. In coastal waters, a smaller amount of probabilistic monitoring will be completed.

4. The SWRCB will also develop a Water Quality Control Policy, and a means to implement the Policy, to provide listing/delisting criteria, an approach for setting priorities, minimum data needed to list water bodies, categories of acceptable data quality, and other factors that will allow consistent implementation of the CWA Section 303(d) requirements.

Additionally, the Federal Clean Water Act (CWA) requires the use and collection of ambient water quality information. Section 305(b) of the CWA requires that states and other jurisdictions receiving CWA grant funding submit a water quality report to USEPA every two years. The 305(b) report (SWRCB, 1999b) contains summary information about water quality conditions in rivers, lakes, estuaries, bays, harbors, wetlands, and coastal waters. States must also identify and prepare a list [Section 303(d) list] of waters that do not meet water quality standards after applying existing required controls (e.g., minimum sewage treatment technology). States are required to prioritize waters/watersheds and target high priority waters/watersheds for TMDL development. SWAMP data and findings will provide direct support for the 305(b) and 303(d) programs at the SWRCB and RWQCB's.

However, to date, funding has not been made available to fully implement the SWAMP program as laid out in the November 2000 Legislative Report, resulting in SWAMP primarily focusing on site-specific monitoring needs of each RWQCB, rather than monitoring which can answer questions of statewide trends.

Section A6. Program/Task Description

SWAMP was proposed as a new comprehensive program which will (1) integrate the existing water quality monitoring of the SWRCB and RWQCB's and (2) coordinate with monitoring programs of other agencies, dischargers, and citizens groups. To ensure that the Program is coordinated and integrated, the monitoring efforts shall be overseen centrally by the SWRCB. The RWQCB's will establish monitoring priorities for the water bodies within their jurisdictions, in coordination with the SWRCB. This monitoring will be done in accordance with protocols and methodologies laid out in the program, and through the statewide SWAMP Quality Assurance Management Plan herein.

SWAMP is intended to meet four goals as follows:

1. Create an ambient monitoring program that addresses all hydrologic units of the State using consistent and objective monitoring, sampling and analytical methods; consistent data quality assurance protocols; and centralized data management. This will be an umbrella program that monitors and interprets that data for each hydrologic unit at least one time every five years.

2. Document ambient water quality conditions in potentially clean and polluted areas. The scale for these assessments ranges from the site-specific to statewide.

3. Identify specific water quality problems preventing the SWRCB, RWQCB's, and the public from realizing beneficial uses of water in targeted watersheds.

4. Provide the data to evaluate the overall effectiveness of water quality regulatory programs in protecting beneficial uses of waters of the State.

Additionally, the SWAMP program is essential to the success of the Total Maximum Daily Load (TMDL) program. Extensive monitoring data and information on the quality of the waters of the State are the backbone of the TMDL program. The SWRCB's SWAMP program, once fully implemented, is intended to produce water quality data to improve RWQCB's abilities to list and delist 303(d) waters.

Quality Assurance

SWAMP has been and will continue to be developed and implemented with the objective of collecting high quality monitoring data that could be of the most use to the SWRCB and RWQCB programs. One of the primary focuses of the Roundtable's 2002 meetings has been the development of this QAPP, which is critical to ensure high quality of data. The SWAMP Roundtable sponsored scientific workshops on quality assurance in 2002. SWAMP has organized an external scientific panel, the Scientific Planning and Review Committee (SPARC),

to review study design, approaches, indicators, and other relevant topics. SPARC members are representatives from federal and state agencies and academics with expertise in the fields that include monitoring program management, fish habitat, invertebrates, sediment, organic chemistry, metals chemistry, quality assurance, pathogens, toxicology, and statistics, etc. SPARC held a two-day meeting in May 2002, at which staff from the nine RWQCB's gave presentations on past and future SWAMP activities within each Region. One major comment from SPARC members at the meeting was that statewide data comparability needs to be the first step towards statewide consistency for SWAMP. Statewide data comparability means that ambient water quality measurements taken in one part of the state can be directly compared with like measurements taken in other parts of the state. Data comparability in SWAMP is being achieved through requirements in the SWAMP QAPP. Statewide data comparability issues and other comments and recommendations in SPARC report will be the subject of future Roundtable meetings. Lastly, a significant external 3rd party (referee) QA program is a major component of the Quality Assurance Program for SWAMP, with Frontier Geosciences, Inc (Seattle, WA) contracted to provide external QA services such as QA planning and review assistance, conducting of and documenting the annual interlaboratory calibration exercise program, and conducting/assisting with laboratory performance audits, as well as data validation and verification efforts.

Data Management, Data Evaluation, and Reporting

SWAMP was developed with the objective of collecting high quality monitoring data to be used by SWRCB and RWQCB programs. Data management, evaluation, and reporting will be high priorities of SWAMP. The SWAMP database is being developed through a contract with the San Jose State University Foundation (through subcontract from DFG). Once in full operation, this database will be the central depository of all data collected by SWAMP with links to other available databases. This database will eventually be included in SWRCB's 'Water Information Network (WIN)'. It is the goal of the SWAMP data management program to ultimately provide standardized data management, evaluation, and reporting. It is also a goal of SWAMP to be as "paperless" as possible, and to develop a database that will allow internet web access to all parties interested in the data and findings and technical reports produced through SWAMP studies. SWAMP will include the use of existing data to the extent it can be verified and placed or linked into centralized locations, but such "outside data" shall not be a part of the official SWAMP database at this time. Any data that are collected as part of SWAMP will be made available to all stakeholders centrally along with accompanying metadata. A summary of the SWAMP Information Management System is provided in **Section B10** of this QAPP, and **Appendix J** contains the Interim SWAMP Information Management System Plan.

Anticipated SWAMP Cost Considerations

Water Code Section 13192 also requires the SWRCB to estimate the costs of implementing the proposed comprehensive surface water quality monitoring program. Financial information is not

normally documented within a QAMP, but for these start-up years of SWAMP, a brief outline of the anticipated costs of the program, as well as anticipated staffing needs that SWAMP will ultimately require, a brief review of financial and staffing issues is merited. It is estimated that the annual cost to implement fully the SWAMP Program, as outlined in the November 2000 Legislative Report, ranges from approximately $59 million to $115 million. These cost estimates also include 87 to 132 additional staff at the SWRCB and RWQCB's. As SWAMP is gradually implemented, the actual costs of the efforts may differ from the estimates due to increased costs to perform the monitoring and other factors. The majority of funding will be used for regional monitoring and sufficient funding will be allocated to implement site-specific monitoring as proposed. To ensure that SWAMP is coordinated and integrated, the monitoring efforts shall be overseen centrally by the SWRCB. The RWQCB's shall establish monitoring priorities for the water bodies within their jurisdictions.

The unmet funding need to fully implement SWAMP is anticipated to be approximately $44 million to $87 million per year. In Fiscal Year 2000-01, the Governor's budget included the SWRCB's Water Quality Initiative (WQI) to support and expand the implementation of ambient monitoring. The WQI is consistent with the approach proposed for SWAMP. As monitoring efforts are further developed and refined through the evolving SWAMP Program, additional funding requests may be made. The SWRCB anticipates SWAMP will be phased in over several years.

AB-982 Advisory Group Review

The AB 982 Public Advisory Group (PAG) and AB 982 Scientific Advisory Group (SAG) reviewed the Draft of what became in final format the November 2000 Legislative Report, and provided significant comments. The comments of the AB 982 PAG and the AB 982 SAG were incorporated into the November 2000 Legislative Report proposal for a comprehensive surface water monitoring program, and have likewise been incorporated to the extent possible into this SWAMP QAMP. The PAG and SAG comments are available for review from the SWRCB SWAMP Program staff.

SPECIFIC MONITORING AND ANALYSIS WORK TO BE PERFORMED FOR SWAMP

Because of the budget constraints during 2001-02, the SWRCB and RWQCB's began implementing SWAMP by primarily focusing on site-specific monitoring to better characterize problem sites or clean locations (reference sites) to meet each RWQCB's needs for 303(d) listing, TMDL development, and other core regulatory programs. Some of the monitoring activities under SWAMP for FY 2002-03 are conducted through contracts and interagency agreements with a number of organizations, such as DFG and USGS.

Another major component of SWAMP– the overall status and trends of the state's surface water quality–will be implemented in the future as additional funds are made available. Until then, RWQCB's will continue to use SWAMP resources to address high priority water quality issues in each region, while following SWAMP protocols to ensure statewide data comparability.

Because there is not currently a consistent statewide routine monitoring program for SWAMP, there is no one single monitoring and analysis approach that can be described in this QAMP. However, **Appendix B** (RWQCB SWAMP Work Plans for FY02-03) outlines overall goals for SWAMP for each RWQCB, with details of specific monitoring objectives for the year, a summary description of existing and known information regarding waterbodies to be sampled during the year, site-specific lists of all planned monitoring site locations, with specific planned measurement parameters for monitoring at each site, as well as a summary of planned sampling frequencies for each site for the year. A summary of the guidance for preparing the annual SWAMP Work Plan is provided at the beginning of **Appendix B.**

Through the preparation of annual SWAMP Regional Work Plans, the SWAMP Program is planning to develop and maintain a web-based SWAMP Monitoring Schedule each year, although this is still under development. The website address for the SWAMP calendar (for field sampling, for lab analyses, and for SWAMP programmatic events) is: http://crete.mlml.calstate.edu/cgi-bin/publish/webevent.pl.

This monitoring schedule will ultimately be made available to all SWAMP participating entities each year on the SWRCB=s SWAMP web page. This schedule will contain links to the specific site locations, sampling frequencies, and measurement parameters for the fiscal year, to the extent they are provided in an appropriate format, as provided by the RWQCB's in their annual SWAMP Work Plans.

A schedule of tasks for state Fiscal Years 2002/2003 and 2003/2004 is found in Table 3.

TABLE 3. ANTICIPATED SWAMP WORK SCHEDULE - FY 2002/2003

TASKS	Jl '02	Au '02	Se '02	Oc '02	No '02	De '02	Ja '03	Fe '03	Mr '03	Ap '03	My '03	Jn '03
Prepare & submit SWAMP FY02-03 RWQCB Work Plans	*	*	*									
Prepare Contracts, Task Orders 02-03	*	*	*	*	*	*						
Water Quality Monitoring Coord. Committee Meetings	*	*	*	*	*	*	*	*	*	*	*	*
Surface Water Quality Monitoring	*	*	*	*	*	*	*	*	*	*	*	*
Qtrly Progress Rpts	*			*			*			*		
Annual SWAMP Scientific Summit											*	
SWAMP Annual External Scientific Review Committee Meeting(s)											*	
Incorp. comments, revise QAMP; submit Final QAMP					*	*	*					
QA visits to labs & RWQCB offices; start field audits												*
Prepare & submit SWAMP FY03-04 RWQCB Work Plans										*	*	*
Prepare Contracts, Task Orders 03-04											*	*

TABLE 3 (Continued). ANTICIPATED SWAMP WORK SCHEDULE - FY 2003/2004

TASKS	Jl '03	Au '03	Se '03	Oc '03	No '03	De '03	Ja '04	Fe '04	Mr '04	Ap '04	My '04	Jn '04
Finalize SWAMP FY03-04 RWQCB Work Plans	*	*										
Prepare Contracts, Task Orders 03/04	*	*	*	*	*							
Water Quality Monitoring Coord. Committee Meetings	*	*	*	*	*	*	*	*	*	*	*	*
Surface Water Quality Monitoring	*	*	*	*	*	*	*	*	*	*	*	*
Qtrly Progress Rpts	*			*			*			*		
Annual SWAMP Scientific Summit											*	
SWAMP Annual External Scientific Review Committee Meeting											*	
Submit Draft of 1st revision SWAMP QAMP to SWRCB; 60-day intern. review											*	*
Incorp. comments & revise 1st revision QAMP												*
QA visits to labs & regional offices/field audits	*			*				*				*
Prepare & submit SWAMP FY04-05 RWQCB Work Plans									*	*	*	*
Prepare Contracts, Task Orders 04/05											*	*

Section A7. Data Quality Objectives and Acceptability Criteria for Measurement Data

The SWAMP Program deals with characterizing the ambient conditions of the surface waters of California. For this reason, few enforcement, regulatory, or policy decisions will be made directly as a part of this project, although there may certainly be some regulatory actions taken as a direct result of SWAMP information. This is not, however, the focus of most of the RWQCB's for this program. The results of this project will be used, however, to support rulemaking, enforcement, regulatory, or policy decisions. SWAMP data which are collected following the requirements of this QAMP, and more specifically data which are produced by following the Data Quality Objectives (DQO's) as outlined in **Appendix C (Data Acceptability Criteria--DQO Tables, including QA sample types, frequencies, and corrective actions--for all types of analyses done in SWAMP, in all media)**, will be put into the SWAMP database and may be used by the SWRCB, the RWQCB's, other state agencies, federal and local agencies, public organizations and entities, and the general public to support and enhance:

* establishment of baseline (ambient) water quality conditions;
* analysis of trends in water quality and comparison to water quality standards;
* maintenance of surveillance on sensitive aquatic ecosystems and water bodies of high public use and interest;
* determination of the effectiveness of the implementation of water quality controls;
* alerting RWRCB personnel to potential water quality violations and, in the case of documented violations, showing whether or not permit violations have contributed to water quality degradation;
* water quality assessments in the biennial water quality inventory report (the 305(b) report) to the USEPA;
* establishment of stream segment ranking (303(d) listing); and
* numerous other region-specific objectives as outlined in their respective SWAMP Work Plans.

GOALS FOR ACHIEVING DATA QUALITY OBJECTIVES (DQO's)

Establishing DQO's is of little value if the proper quality assurance activities are not undertaken to ensure that such objectives will be met. Quality assurance in the SWAMP Program will be achieved by a number of measures, but with emphasis on the following:

- Developing a SWAMP Field Procedures Manual, or FPM (goal during FY02-03), with standardized methods, but using agreed-upon, documented standardized field methods to the extent currently practical and applicable until such time that the SWAMP FPM is developed;

- Implementing a 3rd party, external QA Program which will provide for the oversight of an Interlaboratory Calibration Exercise Program mandatory for all participating SWAMP labs, as well as providing for 3rd party (referee) oversight of SWAMP lab and field performance audits and other QA checks; and providing for QA/QC training and consultations for SWAMP staff as needed to ensure that they are familiar with the methods and able to achieve the DQO's;
- Forming and convening a SWAMP External Scientific Planning and Review Committee (SPARC), which will serve to bring together scientists that are "external" to the SWAMP Program to provide on-going peer review of all SWAMP activities, with QA oversight being one of the primary focuses; and last but certainly not least
- Documenting the comparability of laboratory and field methods that are consistent with the DQO's.

As with all other aspects of this SWAMP QAMP, the intent is to provide for minimum standards and guidelines that all participants should utilize, with strong encouragement to use more stringent criteria and to adopt methodologies that improve upon these minimum standards. The major goal that this SWAMP QAMP can accomplish, if all SWAMP participants abide by the stipulations put forth in this document, is to have representative, comparable, accurate and precise data that can be shared statewide, to the extent possible under the given limitations.

Until such time that a SWAMP Field Procedures Manual is prepared (over the next 12-15 months), **Appendix D** provides a collection of recommended minimum Standard Operating Procedures (SOP's) for Field Sample Collection (except for Bioassessment Procedures, which are documented in **Appendix G**), and **Appendix E** provides SOP's for Field Data Measurement Activities currently being conducted within SWAMP. These two appendices also provide reference citation and documentation of field methods being employed by SWAMP participants currently using alternate, but acceptable, standard methodologies. At the SWAMP Workshop held in July 2001 in Moss Landing, CA, sample collection and processing issues, as well as field data measurement issues, were discussed at length by all SWAMP participants in an attempt to reach consensus on as many points as possible for the use of standardized minimum methods for sample collection/processing activities, as well as field data measurement activities. What was agreed upon for the first several years of the "start-up" of the SWAMP Program was an approach to ***"standardize where possible; document otherwise"***. The need for flexibility to accommodate region-specific sample collection needs was acknowledged, but the need for striving for moving towards using standard methods to the extent possible was also agreed upon, as practical and appropriate.

Likewise, a single laboratory procedures manual has not been developed for SWAMP, since each of the participating laboratories have their own internal operating procedures and documented protocols which are available for review. The compilation and centralization of these analytical laboratory protocols (in electronic format) is still underway to ensure that the

SWAMP QA Program does have a copy of any protocol being employed by SWAMP labs, and that, at a minimum, if a standard method is used and is not modified, that this method citation is documented for the SWAMP QA Program.

Laboratory SOP's for Toxicity Testing are provided in **Appendix F**. Field Sample Collection and Field Data Measurement and Habitat Assessment SOP's, as well as Laboratory SOP's (taxonomy, sorting, counting, reporting, QA), for biological/ecological assessment, and for benthic infaunal community assessment of bottom sediment are detailed in **Appendix G**, with QAPP's from the primary entities conducting these services provided therein.

Data quality will be attained by maximizing and documenting the accuracy and precision of the methods used. Any changes in procedures due to equipment changes or to improved precision and accuracy will be documented. Analyses and determinations must be performed by qualified personnel in conformance with the United States Environmental Protection Agency (EPA) or DHS approved test procedures described in the current Code of Federal Regulations (CFR) (Title 40, Part 136); "Test Methods for Evaluating Solid Waste," SW-846; or Title 22, CFR, Article 11, as appropriate. The test procedures may be modified subject to the application and approval of alternate test procedures under the CFR (Title 40, Part 136.4). The SWAMP Program strongly encourages the use of "performance-based methodology" (PBM) for conducting analytical procedures and therefore recognized the use of modified standard procedures, as appropriately documented following CFR 40, Part 136.4. The use of PBM allows for approved procedures to be modified according to these guidelines, which provide results that are equal to or better than (more stringent than) the standard protocol that was modified.

Any project undertaken by SWAMP-participating entities will employ only methods and techniques which have been determined to produce measurement data of a known and verifiable quality and which are of quality sufficient to meet the overall objectives of the water quality monitoring investigation.

Representativeness

The representativeness of the data is mainly dependent on the sampling locations and the sampling procedures adequately representing the true condition of the sample site. Requirements for selecting sample sites are discussed in more detail in the SWAMP PM. Sample siting, sampling of relevant media (water, sediment and biota), and use of only approved/documented analytical methods will determine that the measurement data does represent the conditions at the investigation site, to the extent possible. The goal for meeting total representation of the site will be tempered by the types and number of potential sampling points and media as well as the potential funding required for meeting complete representativeness.

It is well known that water flowing past a given location on land is constantly changing in response to inflow, tidal cycle, weather, etc. Sampling schedules will be designed with respect to frequency, locations and methodology in order to maximize representativeness, where

possible and applicable. Likewise, however, for the collection of bed sediment samples, for instance, a built-in bias occurs due to focusing on collecting fine, recently deposited sediment, which may or may not be representative of specific sampling sites. Therefore, the samples collected from bed sediment may not be as thoroughly representative of the typical bed sediment within a particular sampling site, in many cases, since this program is focusing sediment collections on fine, recently-deposited bed sediment.

Comparability

The comparability of data produced by and for SWAMP is predetermined by the commitment of its staff and contracted laboratories to use standardized methods, where possible, including EPA-approved analytical methods, or documented modifications thereof which provide equal or better results. These methods have specified units in which the results are to be reported.

Measurements are made according to standard procedure, or documented modifications thereof which provide equal or better results, using common units such as Celsius, feet, feet/sec, mg/L, Φg/L, mg/kg, etc. Analytical procedures are set by the USEPA approval list published in 40 CFR 136.

Completeness

The completeness of data is basically a relationship of how much of the data are available for use compared to the total potential data before any conclusion is reached. Ideally, 100% of the data should be available. However, the possibility of data becoming unavailable due to laboratory error, insufficient sample volume, or samples broken in shipping must be expected. Also, unexpected situations may arise where field conditions do not allow for 100% data completeness.

- Therefore, 90% data completeness is required by SWAMP for data usage in most cases; for tissue studies involving deployment and retrieval of bagged bivalves, and involving the collection of finfish for contaminant analysis, an 85% data completeness level is required.

Precision and Accuracy

The precision and accuracy of data are determined by particular actions of the analytical laboratory and field staff. The precision of data is a measure of the reproducibility of the measurement when an analysis is repeated. It is reported in Relative Percent Difference (RPD) or Relative Standard Deviation (RSD). The accuracy of an analysis is a measure of how much of the constituent actually present is determined. It is measured, where applicable, by adding a known amount of the constituent to a portion of the sample and determining how much of this spike is then measured. It is reported as Percent Recovery. The acceptable percent deviations and the acceptable percent recoveries are dependent on many factors including: analytical method used, laboratory used, media of sample, and constituent being measured.

It is the responsibility of the program manager to verify that the data are representative while the analytical data's precision, accuracy, and comparability are mainly the responsibility of the laboratory supervisor. The program manager also has prime responsibility for determining that the 90% data completeness criteria (85% for tissue analyses as outlined previously) are met or for justifying acceptance of a lesser percentage.

Laboratories performing the analysis of samples for this project have developed precision and accuracy limits for acceptability of data. For parameters and matrices which have USEPA established criteria, the limits are either equal to, or more stringent than, the established limit.

For matrices without USEPA established criteria, the laboratories have developed control limits following the procedures published in the USEPA Handbook for Analytical Quality Control in Water and Wastewater Laboratories. These DQO's are used to evaluate the acceptability of each set of results. If the objectives are not passed for a particular analysis, the lab will immediately determine the cause of the discrepancy and resolve the problem.

Data Acceptability Criteria , QC sample purposes, QC sample frequencies, and resulting corrective actions for specific QC sample types, for each type of media, and for each analytical group (such as trace metals, organics, conventional constituents, etc.), are provided in ***Appendix C*****,** rather than in the body of this QAMP, due to the length of the tables.

Appendix C also contains Target Reporting Limit Tables (for all analytical groups in all media), and contains the Sample Handling Requirements Tables (for all analytical groups in all media). This was done so that these QA/QC measures could be utilized in a stand-alone fashion, if desired, since those elements are "the meat" of the analytical and field criteria that flow from a QAMP, in large part.

Section A8. Special Training Requirements/Safety

Recommended Training for SWAMP Field Personnel

Proper training of field personnel represents a critical aspect of quality control. Field technicians are trained to conduct a wide variety of activities using standardized protocols to ensure comparability in data collection among crews and across geographic areas.

At a minimum, it is recommended that each field crew should consist of a Chief Scientist and a minimum of one technician. Minimum recommended qualifications for Chief Scientists should include an M.S. degree in biological/ecological sciences or similar related field, and at least three years of experience in field sampling/field data collection activities, or a B.S. degree and at least five years experience. The remaining crew members generally are recommended to hold B.S. degrees in the appropriate disciplines as just described, and preferably, at least one year's experience in field sampling/field data collection activities.

When a boat is required for sample collection activities, the vessel operator should be an experienced boat handler, and should be certified as having completed at least minimal U.S. Coast Guard boating safety training for the appropriate respective vessel, as well as well-versed in the safe and correct operation of on-board sample collection equipment and processes, including navigation skills and the use of GPS equipement. The vessel itself shall contain all proper U.S. Coast Guard-required personal floatation devices and other safety gear, have current state registration, and be in good operation and maintenance condition.

Likewise, documentation of completion of a driver safety training course is highly recommended for all SWAMP field staff, including the safe use and operation of a vehicle, boat/trailer towing and maneuvering to back-up, 4-wheel drive operation, etc. All vehicles shall have current registration and be in good operation and maintenance condition.

For training of SWAMP field staff, all sampling equipment (*e.g.,* boats, field instruments and field data equipment, grabs, nets, etc.), and all pertinent sample collection protocols will be used extensively during "hands-on" training sessions (actual field sample collection trips). By the end of the sampling training trip(s), all crew members must demonstrate proficiency in all the required sampling activities, as certified by the Chief Scientist for the training session(s), as documented in training records developed and maintained for all SWAMP field and lab personnel.

In addition to in-field training and certification/documentation of such training, all crews will be evaluated on their field performance during field QA audits conducted by SWAMP QA Program staff, when staffing and funding shall become available for the QA Program. The conducting of such field performance audits is recommended to be conducted every two years, or more often if necessary. If any deficiencies within a crew are noted during this QA audit, they will be

documented and remedied prior to continued field sampling. This can be accomplished by additional training or by changing crew composition, but verification of correction of any deficiencies must be documented in writing prior to the resumption of further sample collection activities. It is the responsibility of any and all SWAMP entities conducting field sample collection and field data measurements to develop and implement internal training and QA audit "checklists". Copies must be maintained in a central file by each SWAMP entity of all internal training and QA audit reports completed, as well as documentation of any deficiencies and corrective actions necessary to remedy such deficiencies. When requested, these records must be accessible to, or copies provided to, the SWAMP QA Program.

Safety Guidelines for Field Activities

Personnel conducting any field activities for SWAMP will be well-versed in standard safety procedures for such activities. It is the responsibility of the QA officer or Safety Officer or Supervisor, or designee, of the particular participating SWAMP entity conducting field activities to ensure that safety training is mandatory for all field personnel, and that such training is documented in training certifications/records maintained and updated for all participating SWAMP field staff. Each SWAMP entity conducting field activities is responsible for preparing and maintaining a current Field Safety Manual (FSM) in compliance with the Occupational Safety and Health Administration (OSHA), or equivalent state or local regulations. The FSM will be readily available to field personnel, including all appropriate Material Safety Data Sheets (MSDS) information for chemicals that may need to be used while in the field. Proper procedures for safe storage, handling, shipping, transport, and disposal of chemicals and other materials will be followed at all times in the field; each chemical or field sample will be treated as a potential health hazard and good field safety practices will be implemented accordingly. A thorough description of recommended "Recommended Minimum Safety Guidelines for SWAMP Field Activities" is provided in **Appendix H** of this SWAMP QAMP, which can serve as the FSM in most cases for entities in need of such a document.

Recommended Training and Proficiency Documentation for SWAMP Laboratory Personnel

To ensure samples are analyzed in a consistent manner, it is recommended that all SWAMP laboratories implement the measures which follow in the paragraphs below.

It is recommended that key laboratory personnel participate in an orientation session conducted during an initial site visit or via communications with appropriate SWAMP staff, either from the RWQCB's, or from SWAMP QA Program officials, or other designated staff as appropriate. The purpose of such a recommended orientation session is to familiarize key laboratory personnel with the SWAMP QAMP and the specific QA/QC program for the analyses being conducted by the respective laboratory for SWAMP. Participation in an Annual SWAMP Scientific Forum is another recommended venue for the exchange of data and ideas that can help to improve the SWAMP Program methodology and resulting information and strengthen the SWAMP QA/QC program.

Meetings, whether by phone or in person, shall be held with all participating laboratories at regular intervals to continually review QA/QC procedures, and to make recommendations for future revisions to update the SWAMP QAMP. The more frequent interactions possible with respective laboratory staff, the better the understanding of, and communication of, any key issues or correction of problems will be in the long run.

Minimum proficiency requirements that SWAMP analytical lab staff must meet shall be established and documented, and updated as necessary. Documentation of required expertise and on-going training for SWAMP laboratory staff is required for all participating laboratory entities. Documentation of each analyst or technician must be provided regarding their proficiency to use analytical equipment and conduct analytical protocols, as well as being documented as being proficient in-house for conducting any general lab processes, such as glassware cleaning, sample preparation and processing, hazardous materials handling, storage, disposal, etc. All lab staff must demonstrate proficiency in all the required laboratory activities that they conduct, as certified by the Laboratory QA Officer, or designee, as documented in training records developed and maintained for all SWAMP lab personnel.

Laboratory Health and Safety Requirements

All SWAMP laboratories shall be operated and maintained in a safe manner, and provide a working environment for staff that has as its top priority the implementation of any and all measures necessary for the highest level of protection of employee health and safety. Personnel in any laboratory performing analyses for SWAMP will be well-versed in good laboratory practices, including standard safety procedures. It is the responsibility of the particular participating laboratory QA Officer, laboratory manager and/or supervisor to ensure that safety training is mandatory for all laboratory personnel, and that such training is documented in training certifications/records maintained and updated for all participating SWAMP laboratory staff. Each laboratory is responsible for maintaining a current Laboratory Safety Manual (LSM) in compliance with Occupational Safety and Health Administration (OSHA), or equivalent state or local regulations. The LSM will be readily available to, and readily understood by, all laboratory personnel, including all appropriate Material Safety Data Sheets (MSDS) information. Proper procedures for safe storage, handling and disposal of chemicals will be followed at all times; each chemical will be treated as a potential health hazard and good laboratory practices will be implemented accordingly.

Section A9. Documentation and Records

All field data gathered by SWAMP entities are recorded in field notebooks and additionally on standardized field data entry forms for Station Occupation (all sites must have this form completed), for Water Quality (sites which require any analyses to be conducted on water samples), for Sediment (sites which require any analyses to be conducted on sediment samples), and for Bioaccumulation (sites which require any analyses to be conducted on tissue samples). These forms and this process is described in more detail in the Interim SWAMP Information Management System Plan (**Appendix J**).

- These data records are recommended to be maintained for at least an eight year period in files at the specific SWAMP entities.
- Field data are required to be reported to the appropriate SWAMP Regional Information Management Coordinator (RIMC) at least once per quarter, or more frequently as appropriate.
- Data are reported to the SWAMP Program data manager electronically in a format as specified in the SWAMP Information Management System Plan.
- All hard copies of data are kept on file at the respective SWAMP entity conducting the field data collection (or appropriate contract managers as appropriate) and are reviewed by the SWAMP Program QA staff during annual performance reviews. QA evaluation procedures are further described in Section B5 of this QAMP, and in the SWAMP Recommended Lab/Field QA Evaluation Guidance (**Appendix I**).

Data Reporting/Submission Format

In addition to the laboratory's standard reporting format, all results meeting data quality objectives and results having satisfactory explanations for deviations from objectives shall be reported in tabular format on electronic media, as outlined in the Interim SWAMP Information System Management Plan.

As they become available, and after preliminary internal laboratory QA/QC review, DRAFT data produced from laboratory analyses are sent in electronic format from the respective SWAMP entity conducting the analysis to the specific RWQCB requesting the analyses for a preliminary review by SWAMP RWQCB staff. These DRAFT data are not for distribution or application/utilization in any manner whatsoever, other than for the RWQCB initial review. Upon completion of their preliminary review of the DRAFT data, the RWQCB SWAMP staff will provide any concerns/comments either in writing to the respective laboratory, as well as to the SWAMP QA Program staff and the SWAMP Data Management Program (as appropriate, including others, as appropriate), and let the lab know if it approves of this DRAFT data in its current format. If any concerns are presented by the RWQCB SWAMP staff regarding this

DRAFT data, the concerns must be addressed in writing also, to the extent that the responses from the analytical lab are addressed sufficiently to allow the RWQCB to consider their concerns having been alleviated. Once the RWQCB deems the DRAFT data as meeting all their needs, and having all their concerns addressed to the extent practical and applicable ("RWQCB verification"), the DRAFT data is then finalized by the originating laboratory and officially submitted to the SWAMP RIMC in the electronic format and manner as directed.

The SWAMP Information Management System, and many of the requirements for reporting, is undergoing final review, and the Interim SWAMP Information Management System Plan provided in **Appendix J** is therefore considered Interim. Upon completion of a Final SWAMP Information Management System Plan, this QAMP will replace the Interim document currently in **Appendix J** with the Final document, and inform all recipients of this initial QAMP of the availability of the Final version of the SWAMP Information Management System. The SWAMP Data Management Program, based out of Moss Landing Marine Laboratory, shall be the recipient and custodian of all SWAMP data files and records.

Documentation for analytical data is kept on file at the laboratories. These are always available and are reviewed during external audits by the SWAMP QA Program. These records include the analyst's comments on the condition of the sample and progress of the analysis, raw data, instrument printouts, and results of calibration and QC checks.

The final disposition of documents is consistent with agency record-keeping procedures. Paper copies of all analytical data, field data forms and field notebooks, raw and condensed data for analysis performed on-site, and field instrument calibration notebooks are part of the permanent archives in the respective SWAMP entity offices and serve as a more readily accessible backup than agency archives.

Section B1. Sampling Process Design (Experimental Design)

This section provides detailed background on the monitoring objectives that are designed to address the protection and enhancement of beneficial uses of the state's surface waters. These objectives are utilized by RWQCB's in the specific designing of their monitoring approach and rationale each year in their annual RWQCB SWAMP Work Plans **(Appendix B)**. The lengthy detail provided in this section is necessary in order to provide the basis for the sampling process design used by the RWQCB's in their Work Plans, since there is no one unified, routine type of monitoring design that occurs in SWAMP, as it is currently designed.

NOTE: Because of the budget constraints during 2001-02, and continuing with the 2002-03 budget, the SWRCB and RWQCB's began implementing SWAMP by primarily focusing on **site-specific monitoring** to better characterize problem sites or clean locations (reference sites) to meet each RWQCB's needs for 303(d) listing, TMDL development, and other core regulatory programs. Another major component of SWAMP– the overall status and trends of the state's surface water quality–will be implemented in the future as additional funds are made available. Until then, RWQCB's will continue to use SWAMP resources to address high priority water quality issues in each region, while following SWAMP protocols to ensure statewide data comparability. But, currently, the need for "site-specific" studies in each region is the highest priority for use of SWAMP funds. The sections which follow below provide a summary of both programmatic components--**site specific monitoring** currently being done in SWAMP focusing on regional priorities, questions, and needs; and **regional status and trends monitoring** of all of the state's waters, which may be implemented in future years if funding allows.

Summary/Overview of the Overall Experimental Design Approach Used in the Surface Water Ambient Monitoring Program

The 11/2000 Legislative Report proposal calls for a combination of (1) regional monitoring to provide a picture of the status and trends in water quality and (2) site-specific monitoring to better characterize problem and clean locations. This approach balances these two important monitoring needs of the SWRCB and serves as a unifying framework for the monitoring activities being conducted by the SWRCB and RWQCB'. The coordinated SWRCB and RWQCB involvement in study design and sampling is critical to providing a comprehensive, effective monitoring program that results in identifying degrading and improving conditions in waterways.

The regional component with the rotating basin design and, for some water bodies, the probability-based design will allow the SWRCB and RWQCB's to complete comprehensive monitoring required to satisfy CWA Section 305(b) requirements and will contribute to the

achievement of the State's various water quality programs. These types of programs allow the State and USEPA to track trends in water quality. This in turn could be used as measures to track the effectiveness of the SWRCB and RWQCB water quality control programs.
The regional monitoring component complements the site-specific monitoring effort in two ways. It provides additional data that can be used to put the data from targeted sites into a broader regional context. Equally important, the regional component would serve as a periodic screening mechanism for identifying new problem areas that were not previously known.

The site-specific monitoring provides flexibility for RWQCB's to focus monitoring resources toward specific problems and waters that may be clean. This might involve verifying problems identified in the statewide surveys, other areas suspected of having water quality problems, or locations that

represent background or clean conditions. This documentation and verification of a site's water quality status should be a key component of the Section 303(d) listing process.

Regional Monitoring (not currently being conducted; implementing in the future is a goal)
The overall goal of this activity of SWAMP is to develop a statewide and region-wide picture of the status and trends of the quality of California's surface water resources. It is intended that this portion of SWAMP will be implemented in each hydrologic unit (including coastal waters) of the State at least once every five years. This portion of SWAMP is focused on collecting information on water bodies for which the State presently has little information and to determine the effects of diffuse sources of pollution, and the baseline conditions of potentially clean areas. For inland waters (watersheds), the program will implement a rotating basin framework where each Region will be divided into five areas consisting of one or more hydrologic units. The major watercourses and tributaries in one of these areas would be monitored for a one-year period at least once every five years. In coastal waters, a smaller amount of probabilistic monitoring will be completed. See Regional Monitoring section below for further details.

Site-Specific Monitoring (this is the focus of all current SWAMP-funded work)
The overall goal of this activity of SWAMP is to develop site-specific information on sites that are (1) known or suspected to have water quality problems and (2) known or suspected to be clean. It is intended that this portion of SWAMP will be targeted at specific locations in each region. The RWQCB's are given significant flexibility to select the specific locations to be monitored. The
RWQCB's may, at their discretion, perform monitoring at clean sites to determine baseline conditions (for assessments related to anti-degradation requirements) or if this information is needed to place problem sites into perspective with cleaner sites in the Region. See Site-Specific Monitoring section below for further details.

REGIONAL MONITORING (future programmatic goal; not currently done)

The overall goal of this activity of SWAMP will be to develop statewide and region-wide picture of the status and trends of the quality of California's surface water resources. It is intended that this portion of SWAMP, once funded, will be implemented in each hydrologic unit (including coastal waters) of the State at least one time every five years. This portion of SWAMP would focus on collecting information on water bodies for which the State presently has little information and to determine the effects of diffuse sources of pollution and the baseline conditions of potentially clean areas.

For inland waters (watersheds), the program would implement a rotating basin framework where each Region will be divided into five areas consisting of one or more hydrologic units. The major watercourses and tributaries in one of these areas would be monitored for a one-year period at least once every five years. In coastal waters, a smaller amount of probabilistic monitoring would be completed.

Need for Regional Monitoring

Monitoring is needed that defines the larger scale condition of beneficial uses. This regional monitoring can determine if known local impacts can be observed over large distances and allows the assessment of region-wide or statewide water resource conditions. The results of regional monitoring will help the SWRCB and RWQCB's to determine clearly the effectiveness of the State's water quality control program.

The California Legislature is also very interested in establishing a closer link between budgeted water quality program activities and the impact those activities have on protecting and improving water quality. The Supplemental Report Language to the 1999 Budget Act directed the SWRCB to "… develop performance measures for its core regulatory programs …. that relate directly to water quality outcomes ….". While the SWRCB and RWQCBs have established performance measures to manage many activities, the ability to relate directly the performance of their programs to water quality outcomes has been hampered by limited data management capabilities and fragmented and incomplete water quality monitoring data collection, evaluation, and management.

Since 1995, the SWRCB has used several performance objectives and measures for its programs. The measures are generally output related and designed to measure program efficiency and timeliness (such as percent of total inspections completed versus the number of permitted sites, number of Cleanup and Abatement Orders (CAO's); median time required to issue new NPDES permits and WDR's).

Regional monitoring, when funded and implemented, will provide the SWRCB and RWQCB's with a better picture of the water quality outcome of their programs. The information needed to assess program performance and support CWA Section 305(b) reporting focuses on the area or

percentages of the area of the State's surface water that fully or partially support the associated beneficial uses.

Monitoring Objectives

In developing the SWAMP monitoring objectives, the SWRCB used a modified version of the model proposed by Bernstein et al. (1993) for developing clear monitoring objectives. The model makes explicit the assumptions and/or expectations that are often embedded in less detailed statements of objectives such as those presented in the SWRCB Report to the Legislature on comprehensive monitoring submitted in February 2000 (SWRCB, 2000). This section is organized by each major question posed in the January 2000 report.

o Is it safe to swim?

Beneficial Use: Water Contact Recreation

1. Throughout water bodies that are used for swimming, estimate the concentration of pathogenic contaminants above and below screening values, health standards, or adopted water quality objectives.
2. Estimate the percent of beach area that poses potential health risks of exposure to pathogens in streams, rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of potential human impact (pathogen indicators).
3. Throughout water bodies that are used for swimming, estimate the concentration of bacterial contaminants from month-to-month above and below screening values, health standards, or adopted water quality objectives.

o Is it safe to drink the water?

Beneficial Use: Municipal and Domestic Water Supply

4. Throughout water bodies, estimate the area of lakes, rivers, and streams that are sources of drinking water where the concentration of microbial or chemical contaminants are above and below screening values, drinking water standards, or adopted water quality objectives used to protect drinking water quality.
5. Throughout water bodies that are used as a source of drinking water, estimate the concentration of microbial or chemical contaminants from month-to-month above and below screening values, drinking water standards, or adopted water quality objectives used to protect drinking water quality.

o Is it safe to eat fish and other aquatic resources?

Beneficial Uses: Commercial and Sport Fishing, Shellfish Harvesting

6. Estimate the area of streams, rivers, lakes, nearshore waters, enclosed bays, and estuaries where the concentration of chemical contaminants in edible fish or shellfish tissue exceeds several critical threshold values of potential human impact (screening values or action levels).
7. Assess the geographic extent of chemical contaminants in selected size classes of commonly consumed target species that exceed several critical threshold values of potential human impact (screening values or action levels) (Adapted from USEPA, 1995).
8. Throughout water bodies (streams, rivers, lakes, nearshore waters, enclosed bays, and estuaries), estimate the concentration of chemical contaminants in fish and aquatic resources from year to year using several critical threshold values of potential human impact (advisory or action levels).
9. Throughout water bodies that are used for shellfish harvesting, estimate the concentration of bacterial contaminants from month to month above and below health standards or adopted water quality objectives.
10. Throughout water bodies that are used for shellfish harvesting, estimate the concentration of bacterial contaminants above and below health standards or adopted water quality objectives.

o Are aquatic populations, communities, and habitats protected?

Beneficial Uses: Cold Freshwater Habitat; Estuarine Habitat; Inland Saline Water Habitats; Marine Habitat; Preservation of Biological Habitats; Rare, Threatened or Endangered Species; Warm Freshwater Habitat; Wildlife Habitat
11. Estimate the percent of degraded water area in lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, water or benthic community analysis, habitat condition, and chemical concentration.
12. Estimate the percent of degraded sediment area in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.
13. Identify the areal extent of degraded sediment locations in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.
14. Estimate the percent of degraded sediment area from year to year in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.
15. Estimate the percent of degraded water area from year to year in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, water column or benthic community analysis, habitat condition, and chemical concentration.

Beneficial Use: Spawning, Reproduction and/or Early Development
16. Estimate the area of degraded spawning locations and water or sediment toxicity associated with toxic pollutants in rivers, lakes, nearshore waters, enclosed bays, and estuaries using critical threshold values of early life-stage toxicity, chemical concentration, and physical characteristics

17. Estimate the area degraded spawning locations and water or sediment toxicity associated with toxic pollutants from year to year in rivers, lakes, nearshore waters, enclosed bays, and estuaries using critical threshold values of early lifestage toxicity, chemical concentration, and physical characteristics.

o Is water flow sufficient to protect fisheries?

Beneficial Use: Migration of Aquatic Organisms; Rare, Threatened or Endangered Species; Wildlife Habitat

18. Throughout water bodies, estimate the area with the conditions necessary for the migration of aquatic organisms, such as anadromous fish, using measures of habitat condition including water flow, watercourse geomorphology, sedimentation, temperature, and biological communities.
19. Throughout water bodies, estimate the area with the conditions from month to month necessary for the migration of aquatic organisms, such as anadromous fish, using measures of habitat condition including water flow, watercourse geomorphology, sedimentation, temperature, and biological communities.

o Is water safe for agricultural use?

Beneficial Use: Agricultural supply

20. Throughout water bodies, estimate the area of lakes, rivers and streams that are used for agricultural purposes where the concentration of chemical pollutants are above or below screening values or adopted water quality objectives used to protect agricultural uses.
21. Throughout waterbodies that are used for agricultural purposes, estimate the concentration of chemical pollutants from year-to-year above or below screening values or adopted water quality objectives used to protect agricultural uses.

o Is water safe for industrial use?

Beneficial Use: Industrial Process Supply; Industrial Service Supply

22. Throughout water bodies, estimate the area of coastal waters, enclosed bays, estuaries, lakes, rivers and streams that are used for industrial purposes where the concentration of chemical pollutants are above or below screening values or adopted water quality objectives used to protect industrial uses.
23. Throughout water bodies that are used for industrial purposes, estimate the concentration of chemical pollutants from year to year above or below screening values or adopted water quality objectives used to protect industrial uses.

o Are aesthetic conditions of the water protected?

Beneficial Use: Non-Contact Water Recreation
24. Throughout water bodies, estimate the area of coastal waters, enclosed bays, estuaries, lakes, rivers and streams where the aesthetic conditions are above or below screening values or adopted water quality objectives used to protect noncontact water recreation.
25. Throughout water bodies, estimate the aesthetic condition from year-to-year above or below screening values or adopted water quality objectives used to protect non-contact water recreation.

Overall Sampling Design for Regional Monitoring, when funded and implemented
As discussed elsewhere, each year the SWRCB, in coordination with the RWQCBs, would prepare a detailed Work Plan that is consistent with the SWAMP goals, objectives, study design, indicators, and quality assurance requirements. The specific study design would be incorporated into contracts or task orders to implement the monitoring program.

While this effort will be coordinated by the SWRCB, the RWQCBs will make any needed region-specific decisions. The steps to establish the specific sampling design are:

1. RWQCBs will divide the Region into five areas consisting of one or more hydrologic units.

2. Identify all major watercourses, tributaries and lakes to sample. Monitoring will be completed in all hydrologic units without bias to known impairments.

3. Select monitoring objectives based on applicable beneficial uses of the water bodies selected. Applicable beneficial uses are uses that are listed in the RWQCB's basin plan, or potential beneficial uses for the water body that are included in the scope of SWAMP.

4. Review available information. The RWQCB will compile all available information including data reports as part of compliance monitoring programs, State monitoring efforts, other agency monitoring, citizen monitoring efforts, or research efforts. Depending on the water body, the RWQCBs and SWRCB will include information produced by the Southern California Bight Projects; the San Francisco Regional Monitoring Program; the USEPA Environmental Monitoring and Assessment Program (EMAP) efforts in the State's enclosed bays, estuaries, coastal streams, and rivers; U.S. Forest Service efforts (Harrington, personal communication, October 2000); NOAA's Status and Trends Program; any information produced as a result of the Unified Federal
Policy for a Watershed Approach to Federal Land and Resource Management (U.S. Department of Agriculture et al., 2000); and other federal, State, or local programs that would augment the State's monitoring efforts.

5. Evaluate quality and applicability of available information and then make a determination on the need for new monitoring. Considerations in this evaluation include temporal variability, spatial variability, and critical conditions (such as drought, flood, stream flow, and El Nino).

6. For inland waters (watersheds), the RWQCBs will select long-term, fixed/permanent sites in each perennial lake, major watercourse and tributary.

It is assumed that each of these sites will represent upstream water quality conditions or, for lakes, the water body condition. In selecting sites to monitor, the RWQCBs will consider the existing information or model predictions for the following characteristics:

- Seasonal variation in the water bodies or watersheds including precipitation information;
- Spatial variation in the watershed (the range of physical characteristics in the watersheds) including, but not limited to, land use patterns, topography, and soil characteristics;
- The release of water to support groundwater recharge or surface water diversions;
- Sample representativeness under different flow conditions.

7. For enclosed bays, estuaries, and ocean waters, the SWRCB and RWQCB's, will select sites using probability-based approach. The approach may be either random or stratified random (i.e., strata can correspond to a subpopulation of interest such as land use patterns) with a mechanism for systematically separating samples (Stevens, 1997; SCCWRP, 1998). It is necessary that an adequate number of samples is selected to represent the stratum with adequate precision. Thirty sites should be allocated to each stratum to provide a 90 percent confidence interval of no larger than roughly ±10 percent of the area in the subpopulation (this assumes a binomial probability distribution and p=0.2). Fewer or more sites may be selected if smaller or larger confidence intervals are needed.

8. Select necessary water quality indicators and target species. RWQCB's will select indicators based on the beneficial uses of the water body. For example, if a water body is not a source of drinking water, it is not necessary to implement monitoring focused on drinking water uses. RWQCB's may select alternative indicators if they meet the selection criteria presented in Table 4 at the end of this section.

In all monitoring efforts, the indicators will be selected from the biological response, pollutant, and habitat indicator categories presented in Table 5 at the end of this section. Further, indicators representing each category should be collected synoptically. For biological resources, it is important that a triad of measurements (biological, pollutant, and habitat) be collected concurrently. If more than one medium is being monitored, all samples should be synoptically collected, to the extent possible. The most sensitive and waterbody appropriate indicators should be selected for use.

SITE-SPECIFIC MONITORING (this is what is being conducted currently)

The overall goal of this activity of SWAMP is to develop site-specific information on sites that are (1) known or suspected to have water quality problems and (2) known or suspected to be clean. It is intended that this portion of SWAMP will be targeted at specific locations in each region. This portion of SWAMP is focused on collecting information from sites in water bodies of the State that could be potentially listed or de-listed under CWA Section 303(d). The RWQCB's are given significant flexibility to select the specific locations to be monitored.

The RWQCBs at their discretion may perform monitoring at clean sites to determine baseline conditions (for assessments related to antidegradation requirements) or if this information is needed to place problem sites into perspective with cleaner sites in the Region.

Objectives for Site-Specific Monitoring

In developing the SWAMP monitoring objectives, the SWRCB used a modified version of the model for developing clear monitoring objectives proposed by Bernstein et al. (1993). The model makes explicit the assumptions and/or expectations that are often embedded in less detailed statements of objectives (as presented in SWRCB, 2000). This section is organized by each major question posed in the SWRCB report to the Legislature on comprehensive monitoring (SWRCB, 2000).

o Is it safe to swim?

Beneficial Use: Water Contact Recreation

1. At sites influenced by point sources (e.g., storm drains, publicly owned treatment works, etc.) or nonpoint sources of pathogenic contaminants, estimate the concentration of bacteria or pathogens above screening values, health standards, or adopted water quality objectives.

o Is it safe to drink the water?

Beneficial Use: Municipal and Domestic Water Supply

2. At specific locations in lakes, rivers and streams that are sources of drinking water and suspected to be contaminated, estimate the concentration of microbial and chemical contaminants above screening values, drinking water standards, or adopted water quality objectives used to protect drinking water quality.
3. At specific locations in lakes, rivers and streams that are sources of drinking water and suspected to be contaminated, verify previous estimates of the concentration of microbial and chemical contaminants above screening values, drinking water standards, or adopted water quality objectives used to protect drinking water quality.

o Is it safe to eat fish and other aquatic resources?

Beneficial Uses: Commercial and Sport Fishing, Shellfish Harvesting
4. At specific sites influenced by sources of bacterial contaminants, estimate the concentration of bacterial contaminants above health standards or adopted water quality objectives to protect shellfish harvesting areas.
5. At specific sites influenced by sources of chemical contaminants, estimate the concentration of chemical contaminants in edible aquatic life tissues above advisory levels and critical thresholds of potential human health risk.
6. At frequently fished sites, estimate the concentration of chemical contaminants in commonly consumed fish and shellfish target species above advisory levels and critical thresholds of potential human health risk (Adapted from USEPA, 1995).
7. At frequently fished sites, verify previous estimates of the concentration of chemical contaminants in commonly consumed fish and shellfish target species above advisory levels and critical thresholds of potential human health risk (Adapted from USEPA, 1995).
8. Throughout water bodies (streams, rivers, lakes, nearshore waters, enclosed bays and estuaries), estimate the concentration of chemical contaminants in fish and aquatic resources from year to year using several critical threshold values of potential human impact (advisory or action levels).

- **Are aquatic populations, communities, and habitats protected?**

Beneficial Uses: Cold Freshwater Habitat; Estuarine Habitat; Inland Saline Water Habitats; Marine Habitat; Preservation of Biological Habitats; Rare, Threatened or Endangered Species; Warm Freshwater Habitat; Wildlife Habitat
9. At sites influenced by point sources (e.g., storm drains, publicly owned treatment works, etc.) or nonpoint sources of pollutants, identify specific locations of degraded water or sediments in rivers, lakes, nearshore waters, enclosed bays, or estuaries using several critical threshold values of toxicity, water column or epibenthic community analysis, habitat condition, and chemical concentration.
10. At sites influenced by point sources (e.g., storm drains, publicly owned treatment works, etc.) or nonpoint sources of pollutants, identify specific locations of degraded sediment in rivers, lakes, nearshore waters, enclosed bays, or estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.
11. Identify the areal extent of degraded sediment locations in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.

- **Beneficial Use: Spawning, Reproduction and/or Early Development**

12. At sites influenced by point sources (e.g., storm drains, publicly owned treatment works, etc.) or nonpoint sources of pollutants, identify specific locations of degraded water or sediment in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of early life-stage toxicity, chemical concentration, and physical characteristics.
13. At sites influenced by point sources (e.g., storm drains, publicly owned treatment works, etc.) or nonpoint sources of pollutants, verify previous measurements identifying specific locations of degraded water or sediment in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of early life-stage toxicity, chemical concentration, and physical characteristics.

o Is water flow sufficient to protect fisheries?

Beneficial Use: Migration of Aquatic Organisms; Rare, Threatened or Endangered Species; Wildlife Habitat
14. At specific sites influenced by pollution, estimate the presence of conditions necessary for the migration and survival of aquatic organisms, such as anadromous fish, using measures of habitat condition including water flow, watercourse geomorphology, sedimentation, temperature, and biological communities.
15. At specific sites influenced by pollution, verify previous estimates of the presence of conditions necessary for the migration and survival of aquatic organisms, such as anadromous fish, using measures of habitat condition including water flow, watercourse geomorphology, sedimentation, temperature, and biological communities.

o Is water safe for agricultural use?

Beneficial Use: Agricultural supply
16. At specific locations in lakes, rivers and streams that are used for agricultural purposes, estimate the concentration of chemical pollutants above screening values or adopted water quality objectives used to protect agricultural use.
17. At specific locations in lakes, rivers and streams that are used for agricultural purposes, verify previous estimates of the concentration of chemical pollutants above screening values or adopted water quality objectives used to protect agricultural uses.

o Is water safe for industrial use?

Beneficial Use: Industrial Source Supply; Industrial Process Supply
18. At specific locations in coastal waters, enclosed bays, estuaries, lakes, rivers and streams that are used for industrial purposes, estimate the concentration of chemical pollutants above screening values or adopted water quality objectives used to protect industrial use.
19. At specific locations in coastal waters, enclosed bays, estuaries, lakes, rivers and streams that are used for industrial purposes, verify previous estimates of the concentration of chemical

pollutants above screening values or adopted water quality objectives used to protect industrial uses.

o Are aesthetic conditions of the water protected?

Beneficial Use: Non-Contact Water Recreation
20. At specific locations in coastal waters, enclosed bays, estuaries, lakes, rivers and streams, estimate the aesthetic condition above screening values or adopted water quality objectives used to protect non-contact water recreation.
21. At specific locations in coastal waters, enclosed bays, estuaries, lakes, rivers and streams, verify previous estimates of the aesthetic condition above screening values or adopted water quality objectives used to protect non-contact water recreation.

Overall Sampling Design for Site-Specific Monitoring
As discussed elsewhere, each year the RWQCB's will prepare a detailed SWAMP Work Plan for ambient surface water monitoring which is consistent with the SWAMP goals, objectives, overall study design, indicators, and quality assurance requirements. Specific study design will be incorporated into contracts or task orders to implement the monitoring program.

While this effort will be coordinated by SWRCB, the RWQCB's will make the region-specific decisions. The steps to establish the specific sampling design are:

1. Identify site-specific problem(s), potential problem(s), or clean water locations to be monitored.
2. Select monitoring objective(s).
3. Review available information. The RWQCB shall consider all available information including data reported as part of compliance monitoring programs, State monitoring efforts, other agency monitoring, citizen monitoring efforts, and research efforts. To the extent possible, the RWQCB's will solicit new information from interested parties.
4. Evaluate the quality and applicability of available information and then make determination on the need for new monitoring. Considerations in this evaluation include temporal variability, spatial variability, and critical conditions (such as drought, flood, stream flow, and El Nino).
5. Select sites using investigator pre-selection (i.e., point estimates) or a probability-based approach. The approach depends on the RWQCB's needs. If a stratified random sampling approach is used, ensure adequate numbers of samples are selected to represent the stratum with adequate precision (specific guidance is available to determine the discussion of the number of samples needed).

The RWQCB's may select monitoring sites in water bodies considered to be clean (unpolluted or unimpacted). These sites may be needed to assess baseline conditions or, if the sites are needed

as reference sites, to place other monitoring efforts into perspective, or to make assessments related to anti-degradation requirements.

In developing the design of the site-specific monitoring efforts, the RWQCB's will consider the existing information or model predictions for the following characteristics:
- Seasonal variation in the water body or watershed including precipitation information;
- Spatial variation in the watershed (the range of physical characteristics in the watershed) including, but not limited to, land use patterns, topography, and soil characteristics;
- The release of water to support groundwater recharge and surface water diversions;
- Sample representativeness under different flow conditions; and
- Variation in the magnitude, duration, and frequency of the suspected water quality problem or unpolluted baseline conditions.

6. Select appropriate water quality indicators and target species, if appropriate. RWQCB's will select indicators based on the potential for impacts on specific beneficial uses of the water body. For example, if a suspected problem is related to potential aquatic life impacts near or at storm drains, the RWQCB's should focus on this specific concern.

In all monitoring efforts, the indicators will be selected from each of the biological response, pollutant, and habitat indicator categories described in Tables 4 and 5 at the end of this section. RWQCB's may select fewer indicators if the needed monitoring information is available and comparable to the data to be collected.

Further, indicators representing each category should be synoptically collected. For biological resources, it is important that a triad of measurements (biological, pollutant, and habitat) be collected concurrently. If more than one medium is being monitored, all samples should be synoptically collected, to the extent possible. The most sensitive and water body-appropriate indicators should be selected for use.

WATER QUALITY INDICATORS

One of the most important steps in the development of an ambient monitoring program is the selection and use of indicators of water quality. Indicators are the tools used to assess and measure water quality. This section describes the characteristics of indicators, provides supporting rationale for their use, and lists some of the indicators that will be used in SWAMP.

What is an indicator?

An indicator is a "... measurable feature or features that provide managerially and scientifically useful evidence of environmental and ecosystem quality or reliable evidence of trends in quality" (ITFM, 1995). Indicators must be measurable with available technology, scientifically valid for assessing or documenting ecosystem quality, and useful for providing information for

management decision making. Environmental indicators include tools for assessment of chemical, physical, and biological conditions and processes.

Selection of Appropriate Indicators

One of the hardest tasks for development of an ambient monitoring program is the selection of meaningful indicators of water quality. General criteria are needed to help shape the monitoring efforts so the results are useful in the decision making process. The use of criteria streamlines the indicator selection process, potentially reduces costs, prevents the use of indicators that will not allow program effectiveness to be assessed, and provides consistency.

Table 4 lists several criteria for selecting environmental indicators based on scientific, practical, and programmatic considerations. Scientific validity is the foundation for determining whether data can be compared with reference conditions or other sites. An indicator must not only be scientifically valid, but its application must be practical (i.e., not too costly or too technically complex) when placed within the constraints of a monitoring program. Of primary importance is that the indicator must be able to address the questions posed by the ambient monitoring program.

Scientific Validity

Measurements of environmental indicators should produce data that allow comparisons on temporal and spatial levels. This is particularly important for comparisons with the reference conditions. Indicators should be sensitive and provide resolution sufficient to detect important environmental change and to indicate the presence of a problem. The indicator methodology should be reproducible and provide the same level of sensitivity regardless of geographic location.

Practical Considerations

The success of a monitoring program is dependent on the ability to collect consistent data. The practical considerations include monitoring costs, availability of experienced personnel, and the practical application of the technology.

A cost-effective procedure should provide a large amount of information in comparison to cost and effort. It is significant to acknowledge that not every quantitative characteristic needs to be measured unless it is required to answer specific questions.

Cost effectiveness may be dependent on the availability of experienced personnel and the ability to find or detect the indicating parameters at all locations, as well as overall geographic extent.

Water Quality Programmatic Considerations

Stated objectives of a monitoring program are an important factor in selecting indicators. Sampling and analysis programs should be structured around questions to be addressed. The term "programmatic considerations" simply means that the program should be evaluated to confirm that the original objectives would be met once the data have come together. If the design and the data being produced by a monitoring program do not meet the questions posed by the monitoring objective(s) within the context of scientific validity and resource availability, then the selected indicators should be reevaluated.

Another important consideration is the ease with which the information obtained can be communicated to the public. Although it is essential to present information for the SWRCB and RWQCB's, scientists, or other specialized audiences, information should also be responsive to public interests and needs.

Table 4. Environmental Indicator Selection Criteria (ITFM, 1995).

Criteria	Definition(s)
	Scientific validity (technical considerations)
Measurable/quantitative	Feature of environmental measurable over time; has defined numerical scale and can be quantified simply.
Sensitivity	Responds to broad range of conditions or perturbations within an appropriate time frame and geographic scale; sensitive to potential impacts being evaluated.
Resolution/discriminatory power	Ability to discriminate meaningful differences in environmental condition with a high degree of resolution.
Integrates effects/exposure	Integrates effects or exposure over time and space.
Validity/accuracy	Parameter is true measure of some environmental conditions within constraints of existing science.
	Related or linked unambiguously to an endpoint in an assessment process.
Reproducible	Reproducible within defined and acceptable limits for data collection over time and space.
Representative	Changes in parameter/species indicate trends in other parameters they are selected to represent.
Scope/applicability	Responds to changes on a geographic and temporal scale appropriate to the goal or issue.
Reference value	Has reference condition or benchmark against which to measure progress.
Data comparability	Can be compared to existing data sets/past conditions.
Anticipatory	Provides an early warning of changes.
	Practical considerations
Cost/cost effective	Information is available or can be obtained with reasonable cost/effort. Must consider geographic scale when examining cost effectiveness. High information return (of good quality data) per cost.
Level of difficulty	Ability to obtain expertise to monitor.
	Ability to find, identify, and interpret chemical parameters, biological species, or habitat parameter.
	Easily detected.
	Generally accepted method available.
	Sampling produces minimal environmental impact.
	Programmatic considerations
Relevance	Relevant to desired goal, issue, or agency mission; for example, fish fillets for consumption advisories; species of recreational or commercial value.
Program coverage	Program uses suite of indicators that encompass major components of the ecosystem over the range of environmental conditions that can be expected.
Understandable	Indicator is or can be transformed into a format that target audience can understand; for example, non-technical for public.

List of Indicators

Monitoring programs sponsored by the SWRCB and the RWQCBs have used a variety of environmental indicators. Indicators that have been used in ambient monitoring efforts and meet the requirements of the general criteria are presented in Table 5. These indicators are considered a starting point for the indicators which should be used in the State's ambient monitoring efforts.

Table 5: List of Indicators for Site-Specific and Regional Monitoring

Beneficial Use	Monitoring Objectives[1]		Category	Indicator
	Site-Specific	Regional		
Water Contact	1	1, 2, and 3	Contaminant exposure	Total coliform bacteria Fecal coliform bacteria Enterococcus bacteria Enteric viruses
Drinking Water	2 and 3	4 and 5	Contaminant exposure	Inorganic water chemistry Nutrients Organic water chemistry Total coliform bacteria Cryptosporidum Giardia
Fish and Shellfish Contamin-ation	4, 5, 6, 7, and 8	6, 7, 8, 9 and 10	Contaminant exposure	Fish tissue chemistry Shellfish tissue chemistry Coliform bacteria in shellfish Fecal coliform bacteria in water

1 The number refers to the monitoring objective discussed previously under site-specific and regional monitoring approaches.

Beneficial Use	Monitoring Objectives[1]		Category	Indicator
	Site-Specific	Regional		
Aquatic Life	9, 10, 11, 12, and 13	11, 12, 13, 14, 15, 16, and 17	Biological response[2]	Phytoplankton Chlorophyll-a Benthic infauna (Animals that live in sediment.) Fish assemblage Fish pathology Recruitment of sensitive life stages Interstitial water toxicity Macroinvertebrate assemblage Periphyton Sediment toxicity Water toxicity
			Pollutant exposure	Acid volatile sulfides/simultaneously extracted metals Debris Interstitial water metal chemistry Reporter Gene System (RGS 450) Organic and inorganic sediment chemistry Total organic carbon Shellfish or fish tissue chemistry Nutrients Turbidity Inorganic and organic water chemistry

2 While the assessment of invasive species is not a focus of SWAMP, these organisms will very likely be identified when biological community measurements are made.

Beneficial Use	Monitoring Objectives[1]		Category	Indicator
	Site-Specific	Regional		
			Habitat	Dissolved oxygen Sediment grain size Sediment organic carbon Water flow Water temperature Channel morphology Residual pool volume Instream structure Substrate composition Wetland vegetation Riparian vegetation Electrical conductivity Salinity Hydrogen sulfide Ammonia
Sufficient Flow	14 and 15	18 and 19	Habitat	Water flow Suspended solids Channel morphology Water temperature
			Biological response	Fish assemblage and populations Macroinvertebrate assemblage and populations Periphyton Wetland habitat Riparian habitat
Agricultural Supply	16 and 17	20 and 21	Pollutant Exposure	Organic and inorganic chemistry
Industrial Supply	18 and 19	22 and 23	Pollutant Exposure	Organic and inorganic chemistry Total organic carbon Temperature Electrical conductivity
Aesthetic Condition	20 and 21	24 and 25	Pollutant Exposure	Taste and odor Debris and trash

Adapted from: SWRCB, 1993; SPARC, 1997; SCCWRP, 1998; Stephenson et al., 1994; CalEPA, 1998; CABW, 1998; CDFG, 1998; Noble et al., 1999; AB 982 Scientific Advisory Group, personal communication, August, 2000.

SWAMP includes sample collection at numerous and varied locations in each RWQCB region throughout the state, with varying goals, objectives, and designs for monitoring and analysis. Due to the specific and varied nature of each of the RWQCB SWAMP Work Plans within this program, repetitive and routine monitoring of the same type (and for the same indicators, and of the same frequency of monitoring) is not the objective for data collection for the current SWAMP program. Thus, monitoring sites, monitoring objectives, monitoring parameters, monitoring schedules, and other information specific to each RWQCB region in SWAMP will not be described in detail in this Main Body of the QAMP, but rather are located in annual RWQCB Work Plans for FY02-03 in **Appendix B.**

A General Description of Field Measurements, Routine Water Chemistry, Sediment Samples, Biological and Bacteriological Analyses Commonly Conducted for SWAMP

Basic sampling which is common to many sites includes field measurements, in most cases utilizing a multiparameter probe or continuous monitoring equipment (measuring dissolved oxygen, specific conductance, pH, and temperature), collection of samples for routine water chemistry ("conventional constituents in water", such as nitrate, nitrite, ammonia, sulfate, ortho-phosphate, total phosphate, TKN, TOC/DOC, TSS/SSC, varying minerals, and others), collection of samples for a suite of indicator bacterial analyses (total and fecal coliform densities, *E. Coli*, and *Enterococcus* primarily), and where bed sediment samples are collected, sediment grain size and sediment TOC are routinely conducted.

The objectives of monitoring these parameters are to detect and describe spatial and temporal changes, determine impacts of point and nonpoint sources, and assess compliance with water quality standards. DO, water temperature, and pH are field measurements for which water quality criteria are established for each classified water body. Specific conductance is used as an indirect measure of another established water quality criteria, total dissolved solids. Secchi disk measurements are used in some cases to determine the transparency of the water column. Conductivity and salinity are monitored to estimate the total concentration of dissolved ionic matter, evaluate mixing of fresh and salt water in estuaries (and other saline waterbodies), determine density stratification, and document impact and dispersion of pollutants. The field-measured parameters are key indicators of the status of many chemical and biological processes. Monitoring of field measurements also provides complementary information necessary in evaluating chemical and biological data.

In order to relate chemical concentrations and flow, instantaneous flow measurements (or in many cases, velocity measurements only) are made at many stream sites concurrently with the collection of water samples. In some cases, stream flow is obtained at the time of sampling from a United States Geological Survey (USGS) gage if one is located nearby.

Water samples are collected, preserved, and sent to a contract laboratory, where analyses are

performed. Due to the difficulty in culturing specific pathogens, fecal coliform bacteria are commonly monitored as indicators of human pathogen densities in order to assess the recreational potential of water bodies (and to evaluate compliance of the oyster waters use in estuarine segments). Water samples for fecal coliform analysis require immediate transport to the analytical laboratory, since they have a very short hold time.

Other variables are added to the RWQCB-specific SWAMP monitoring program as information needs arise, and as specified in Work Plans each year. The following paragraphs provide an outlined of additional analyses which are typically conducted for RWQCB SWAMP monitoring programs.

Organic substances (pesticides, PCB's, PAH's, semi-volatiles, and volatiles) and trace metals are commonly monitored in water, sediment, and fish/bivalve tissue at selected RWQCB monitoring sites. In most cases, these parameters are used to establish current condition (presence and/or magnitude) and then where possible from previous measurements, to detect change.

The SWAMP Program focuses toxic substances monitoring on those sites deemed to have a likelihood of being impacted and selects sample stations on criteria which include: sites near dischargers that have shown receiving water or effluent toxicity, sites that have shown recurrent ambient water and/or sediment toxicity, sites near large industrial or domestic discharges, areas that receive high nonpoint source loads, areas with exceptional recreational uses, sites near hazardous waste facilities, sites downstream of major metropolitan areas, areas adjacent to Superfund sites, and sites which exhibit biological impairment. Toxic substances in water, sediment, and fish tissue are monitored at these sites to determine their prevalence and magnitude, to detect and describe spatial and temporal changes, and to evaluate compliance with applicable water quality standards.

The results of monitoring sediment chemistry may be used to evaluate the condition of the benthic habitat, determine point and nonpoint source impacts, and to monitor rates of recovery following establishment of pollution controls or improved wastewater treatment. In addition to monitoring toxic chemical contaminants in sediments, conventional parameters in sediment are also useful to measure, if sediment samples are collected: total phosphorus and Kjeldahl nitrogen are used for evaluation of nutrient status; volatile solids for organic content; percent solids for determination of water content; oil and grease for petrochemical influences; sediment grain size for availability of contaminants and habitat availability; total organic carbon for bioavailability of organic contaminants that adsorb to particulates; and acid volatile sulfide for bioavailability of metal contaminants. Sediment grain size analysis and sediment TOC are the two most common analytical procedures conducted on sediment samples collected for SWAMP.

Biological communities (fish and benthic macroinvertebrate) are useful in assessing water

quality for a variety of reasons, including their sensitivities to low-level disturbances and their functioning as continuous monitors. Monitoring of resident biota, thus, increases the possibility of detecting episodic spills and dumping of pollutants, wastewater treatment plant malfunctions, toxic nonpoint source pollution, or other impacts that periodic chemical sampling is unlikely to detect. Perturbations of the physical habitat such as sedimentation from stormwater runoff, dredging, channelization, and erosion may also be detected through biological monitoring in combination with habitat assessment.

The objectives of monitoring fish and benthic macroinvertebrate communities are to detect and describe spatial and temporal changes in the structure and function of these communities. These results can be used to assess impacts of point and nonpoint sources, assess community condition or "health", determine appropriate aquatic life uses, monitor rates of recovery following implementation of improved wastewater treatment, and provide early warning of potential impacts.

Section B2. Sampling Methods Requirements

Field personnel will adhere to recommended SWAMP sample collection protocols or approved and documented alternative protocols, in order to insure the collection of representative, uncontaminated (contaminants not introduced by the sample handling procedure itself) water, sediment, tissue, and biological samples for laboratory analyses. If protocols are revised or altered, the deviations from the standard protocols must be documented.

Appendix D provides a collection of recommended minimum Standard Operating Procedures (SOP's) for Field Sample Collection methods (except for sample collection for Bioassessment and for Benthic Infaunal Community Assessment, which are provided in **Appendix G**), while Field Data Measurement procedures, including probe calibrations and maintenance, are provided in **Appendix E. Appendix D** describes those sampling methods currently being conducted within SWAMP. At the SWAMP Workshop held in July 2001 in Moss Landing, CA, sample collection and processing issues, as well as field data measurement issues, were discussed at length by all SWAMP participants in an attempt to reach consensus on as many points as possible for the use of standardized minimum methods for sample collection/processing activities, as well as field data measurement activities. What was agreed upon for the first several years of the "start-up" of the SWAMP Program was an approach to ***"standardize where possible; document otherwise"***. The need for flexibility to accommodate region-specific sample collection priorities was acknowledged, but the need for striving for moving towards using standard methods to the extent possible was also agreed upon, as practical and appropriate.

Briefly, the key aspects of quality control associated with sample collection for eventual chemical analyses are as follows: 1) field personnel will be thoroughly trained in the proper use of sample collection gear and will be able to distinguish acceptable versus unacceptable water, sediment, or biological specimen samples in accordance with pre-established criteria; 2) field personnel will be thoroughly trained to recognize and avoid potential sources of sample contamination (e.g., engine exhaust, winch wires, deck surfaces, ice used for cooling); 3) sample gear and utensils which come in direct contact with the sample will be made of non-contaminating materials (e.g., glass, high-quality stainless steel and/or Teflon™, according to protocol) and will be thoroughly cleaned between sampling stations according to appropriate cleaning protocol; 4) sample containers will be of the recommended type and will be free of contaminants (i.e., pre-cleaned); and 5) conditions for sample collection, preservation and holding times will be followed.

Corrective Actions for Field Activities

The field sampling staff have primary responsibility for responding to failures in the sampling or measurement systems. Deviations from SWAMP protocols and the SWAMP QAMP are documented in the comment section of field notes. Data problem resolution is discussed in detail

in Section B10 of this document. If monitoring equipment fails, SWAMP personnel will report the problem in the comment section of their field notes and will not record data values for the variables in question. Actions will be taken to replace or repair broken equipment prior to the next field use. No data will be entered into the SWAMP database that were known to be collected with any faulty equipment.

Samples will be collected from four environmental media: water, sediment, tissue, and biota (biological assessment and benthic infaunal community assessment). Sampling of tissue will include methods specific for fish and for deployment/retrieval of mussels, clams, and other bivalves; sampling for biota will include methods for benthic macroinvertebrates and periphyton. For each of these methods described or referenced, it is the combined responsibility of all members of the sampling crew to determine if the performance requirements of the specific sampling method have been met, and to collect an additional sample if required. Summary descriptions of specific sampling methods and requirements are provided below.

COLLECTION OF WATER SAMPLES

Summary of Typical Procedure for Collection of Water Samples for Analyzing Trace Metals, Organics, Conventional Constituents, and for Toxicity Testing

All water samples collected for analyzing trace metals, organics, conventional constituents, and for toxicity testing in water will be collected using clean techniques that minimize sample contamination. Sampling methods will generally conform to EPA "clean" sampling methodology described in *Method 1669: Sampling Ambient Water for Trace Metals* (USEPA 1995a). Specific methods are also documented in **Appendix D**. Samples will generally be collected from shore or in-stream in wadeable waters, or by boat in non-wadeable waters (such as larger rivers, lakes, estuaries, and open coastal waters), in most cases by using a near-surface grab sample, but in those cases where depth-integrated sample collection is desired for water samples, a peristaltic pump and acid-cleaned polyethylene or Teflon™ tubing is used. Grab samples will be collected into appropriate pre-cleaned containers and aliquoted into glass, polyethylene, or Teflon™ sample containers appropriate for the analyses to be performed (see Sample Handling Requirements Tables in Section B3), *or* will be collected directly into the sample containers, if appropriate. Samples to be analyzed for dissolved (filtered) trace metals (including mercury) will be filtered to 0.45 µm in the field using Gelman in-line filtration capsules (in the case of pumped samples) or syringe filters (in the case of grab samples).

After collection, field-collected samples will be stored at 4˚C until arrival at the contract laboratory. Samples to be analyzed for mercury will be preserved at the contract laboratory, immediately on arrival. Samples to be analyzed for other constituents will be preserved in the

lab (in most cases) or field, as appropriate and as described in the SWAMP Sample Handling Summary Tables (Tables 6 and 7, Section B3).

This sample collection method requires that the sample collection tubing, and the sample bottle and lid come into contact only with surfaces known to be clean, or with the water sample. Additionally, mercury samples must have no air bubbles or head space present in the bottle immediately following sample collection. If air is present in the sample container for mercury analyses, additional sample will be aliquoted into the same sample bottle. If the performance requirements for specific samples are not met, the sample will be re-collected. If contamination of the sample container is suspected, a fresh sample container will be used.

Collection of Water Samples for Analyzing Bacteria

Pathogen monitoring in SWAMP will typically include sampling for pathogen indicator organisms (fecal and total coliform bacteria, *E. coli*, and *Enterococcus* bacteria). *Note*: Samplers must wear gloves when collecting any pathogen samples in order to prevent introduced bacterial contamination. In addition, please refer to **Appendix H** (Recommended Minimum Health and Safety Guidance for SWAMP Field Activities), which provides a summary of protective measures that should be employed when sampling areas where there is potential exposure to biohazards (e.g., in some areas with known high levels of bacteria and pathogenic activity). In addition, a detailed protocol specifically dealing with health and safety measures for field and laboratory personnel is in the process of being developed for just such situations. This will be distributed upon completion in the near future.

Samples analyzed for bacteria will be collected as near-surface grab samples. Sampling for bacteria will in most cases be performed according to the sampling procedures detailed for Standard Methods 9221B and 9221E (APHA *et al*. 1998). In brief, the sampling procedures are summarized as follows:

- Sample containers should be cleaned and sterilized using procedures described in Standard Methods 9030 and 9040 (APHA *et al.* 1998). In most cases, these containers are provided by the laboratories conducting the analyses. Alternatively, Whirl-pak bags may also be used, per protocol
- For waters suspected to contain a chlorine residual, sample bottles should contain a small amount of sodium thiosulfate ($Na_2S_2O_3$) sufficient to neutralize bactericidal activity. In most cases, bottles provided by contract laboratories already contain the sodium thiosulfate as a precautionary measure. For water containing high concentrations of copper or zinc, sample bottles should contain sufficient EDTA solution to reduce metal toxicity. *Note*: These conditions are rare in surface waters.

- Sample bottles may be glass or plastic (e.g. polypropylene) with a capacity of at least 100 ml., or again, Whirl-pak bags. After sterilization, sample bottles should be kept closed until they are to be filled.
- When removing caps from sample bottles, be careful to avoid contaminating inner surface of caps or bottles.
- Using aseptic techniques, fill sample bottles (or Whirl-pak bags), leaving sufficient air space to facilitate mixing by shaking. Do not rinse bottles.
- Recap bottles tightly.

If at any time the sampling crew suspects that the sample or sampling container has been contaminated, the sample should be re-collected into a new sample container.

If bacteriological samples are to be used for regulatory compliance purposes, then samples must be kept at 4˚C (dark) and transported to the laboratory so that the analysis begins within 6 hours of collection.

If bacteriological samples are non-regulatory in nature (ie, non-drinking water samples analyzed for non-compliance purposes), after collection, store samples at 4˚C (dark) until analysis, which must begin within 24 hours of collection. The 20th edition of Standard Methods (APHA et al. 1998) recommends analysis of samples as soon as possible, but specifies that non-drinking water samples analyzed for non-compliance purposes may be held for up to 24 hours (below 10˚C) until time of analysis. For this reason, data from these samples should not be used for assessment of regulatory compliance.

Summary of Bioassessment Field Procedures

Bioassessment monitoring includes sampling of benthic invertebrates and periphyton for bioassessment evaluations. The procedure for collecting samples of benthic invertebrates from wadable streams is based on the method detailed in *California Stream Bioassessment Procedures (Habitat Assessment and Biological Sampling)* (CDFG 1996a). Specific procedures are documented in **Appendix G**. Please note that Biological Assessment procedures utilized for RWQCB 6, in the Lahontan Region, are conducted by U.C.'s Sierra-Nevada Aquatic Resources Laboratory (SNARL), and vary in several significant ways from the methods outlined below (number of replicates, level of taxa identified down to, sampling gear mesh sizes, etc. The SNARL procedures for bioassessment are provided in detail in **Appendix G**.

The method used throughout most of the state for SWAMP RWQCB biological assessment (*California Stream Bioassessment Procedures--Habitat Assessment and Biological Sampling;* CDFG 1996a), can be briefly summarized as follows:

1. Reaches for benthic invertebrate sampling are selected after an initial reconnaissance of the section or stream. The overall goal is to select homogenous wadable reaches that best typify a riffle or run condition. Avoid walking in the stream when conducting a reconnaissance survey. Each riffle used for biological assessment must be approached from downstream and no portion of the riffle disturbed until all sampling is complete. Habitat assessment should be conducted after macroinvertebrates have been collected.
2. Fill out a field log sheet for each riffle section. Enter watershed name, station name, sample identification number, date, time and names of crew members.
3. To select a transect, place the measuring tape along the bank of the entire riffle section. Each meter (3 ft) mark represents a possible transect location. Select the transects from all possible meter marks along the measuring tape using the provided table of random numbers. If only one transect is to be sampled, then select one meter mark in the top one-third of the riffle. Record the meter mark in the field log for each transect.
4. Once transects have been selected, benthic macroinvertebrates are collected from several locations along the transect and combine them into one sample. If possible, choose three locations; the two side margins and the center of the stream. If the riffle is not ideal, then make adjustments to accommodate prevailing conditions. When making adjustments, such as increasing or reducing the number of locations for collecting organisms or sampling substrate that is not gravel/cobble, try to sample similar conditions at each reach. Record the number of locations per transect in the field log.
5. Starting from the transect furthest downstream, collect macroinvertebrates with a sampling device appropriate for stream conditions. Appropriate devices for wadable reaches include the D-shaped kick-net, Needham-type kick-screen, Surber bottom samplers, and the Hess bottom sampler. Appropriate devices for non-wadable reaches include Eckman and Ponar dredges, and drift nets. Combine the three collections. Measure and record stream temperature.
6. For wadable reaches, place the combined contents from the transect in a standard size 30 or 35 (0.6 or 0.5 mm, respectively) testing sieve. Large organic material is removed by hand while carefully inspecting for clinging organisms. All remaining material is placed with forceps in a 95% ethanol filled jar. If there is considerable debris in the net, inspect the sample in a white enameled pan and rinse material from the pan through the sieve before placing it in the jar.
7. Using a pencil, record the following information for each sample on a piece of water-proof paper and place in the jar:
    - sample identification number followed by -01, -02 (to identify each transect)
    - collection date and time
    - sampler type

- sample area
- habitat type
- collectors name
- comments

If the sample collection requirements above are not met, the sample will be re-collected, if it is possible to do so without compromising sample quality.

The procedures for collecting biological samples of benthic invertebrates from non-wadable streams generally follow *Methods For Collecting Benthic Invertebrate Samples As Part Of The National Water Quality Assessment Program* (USGS 1993a). Specific procedures and any modifications are documented in **Appendix G.**

COLLECTION OF BED SEDIMENT SAMPLES

NOTE: The summary procedures outlined below for Van veen grab sediment collection are thanks in large part to procedures outlined in "Field Sampling Manual for the San Francisco Bay Regional Monitoring Program for Trace Substances, Version 1, January 1999 (AMS 1999)". The use of this information, with relatively minor modifications, is greatly appreciated.

Collecting sediment samples is problematic. Samples of surficial sediments (top 2-3 cm) for analysis of chemical constituents, and for toxicity testing, must be collected in a manner such that surface layers are not disrupted when removed from the bottom of the sample for processing. Disruption may cause mixing of surficial layers with lower layers in the sample, and may lead to dilution or concentration of the contaminants of concern, depending upon the chemical content of the various layers of sediment.

Bed sediment samples are collected for many RWQCB's for SWAMP, although usually much less frequent. At this point, with the exception of RWQCB 5 and 8, all sediment sample collection is conducted by field staff of DFG and SJSUF/MLML.

The procedure summarized below can be used for collecting bed sediment samples for all types of sediment analyses typically conducted for SWAMP (trace metals, synthetic organic compounds, sediment TOC, and sediment grain size, amongst others). All equipment described is pre-cleaned according to the procedures outlined in specific SOP's (**Appendix D**).

It is critical that sample contamination be avoided during collection. All sampling equipment (i.e., Van Veen grab, compositing containers, and scoops) are composed of a non-contaminating material and are thoroughly cleaned before each use (all scoops are individually pre-cleaned and

bagged at the lab, and a new "pre-cleaned scoop used at each station). Sampling personnel wear polyethylene gloves whenever taking or processing samples to avoid contact contamination. Airborne contamination is avoided by keeping sample containers, sample scoops and compositing container inside bags or coolers with door closed or appropriately covered when not in use.

Sediment Sampling Equipment Preparation

Sediment sampling equipment is prepared in the laboratory by a minimum of four days prior to the start of a cruise. The sediment sampling equipment that is pre-cleaned includes:

- Van Veen Grab (excluding frame and stand)
- Sample scoops (equal to the number of stations where sediment collection is to occur, plus an extra five scoops)
- Compositing container
- Wash bottles

The following procedures are used for cleaning sediment sampling equipment:

1. Soak equipment (fully immersed) for three days in a 0.5 % solution of Alconox™ detergent and deionized water; alternatively, Micro™ detergent may be used.
2. Rinse equipment three times with deionized water and let dry in a clean place.
3. Rinse equipment with 1.0 % solution of hydrochloric acid, followed by a rinse with petroleum ether, followed by another set of three rinses with deionized water. All equipment is then allowed dry in a clean place.

All other equipment is stored in clean Ziploc™ bags until used in the field.

Summary of Wadeable Stream Bed Sediment Sample Collection Process: Using Scoop

The guidelines for obtaining grab samples of bed sediment (using a scoop) at most wadeable stream sites are as follows:

1. Randomly select an area of unconsolidated, recently-deposited fine-grain sediment. Unconsolidated sediments lack a usually visible diatom covering and are very easily penetrated. Typical locations are the side slope or surface of recent slump blocks and the surface of actively accreting point bars on the inside of meander bends. To the extent possible, given the volume of sediment necessary to collect for specific analyses, randomly select a location at least 10 meters from any channel or ditch (if possible), and at least 5 meters from the upland edge of any tidal marsh. If at all possilble, do not select

spots in ponds or channel pans.

2. Insert a cleaned scoop into the sediments to a depth of 2-3 centimeters. Remove sediments from an area in the streambed of approximately 0.1 square meter. The total amount of sediment sampled is proportional to the amount of sediments removed when using the Van Veen grab at non-wadeable sites, or sites where scooping or coring are not possible.

3. Place sediment into a pre-cleaned compositing container. Thoroughly stir (using pre-cleaned polycarbonate stir rod) the combined material into one homogeneous mixture.

4. Place the appropriate amounts of the sediment into pre-cleaned containers with appropriate labels, and place the containers on ice in a cooler, in the dark, for short-term storage at 4°C.

5. To avoid cross-contamination between stations, all utensils, compositing containers must be rinsed between stations with ambient water, then scrubbed thoroughly with Alconox™ or Micro™ detergent, followed successively by one rinse with deionized water, one rinse with 1% HCl, one rinse with methanol, and a final rinse with deionized water. All scoops used to collect sediment are pre-cleaned and bagged at the laboratory, and a "new" pre-cleaned scoop is used for each station.

6. The samples on wet ice in coolers should be checked periodically to ensure that samples are appropriately protected and ice should be added as required. Additionally, coolers containing wet ice should be drained periodically to remove melt water.

7. Grab samples may also be collected using a box core, diver core, or other coring device, and SOP's are available for these procedures; typically in SWAMP to date, the scoop has been sufficient to collect the required bed sediment samples in wadeable stream settings.

Summary of Non-wadeable Bed Sediment Sample Collection Process: Using Young-modified Van Veen Grab

In non-wadeable waters, such as lakes, deeper rivers, reservoirs, estuaries, and open coastal waters, bed sediment samples are collected using a Young-modified Van Veen Grab, following the procedure summarized below:

Sediment sampling is performed using a Young-modified, Van Veen grab with a surface area of 0.1 m^2. The grab is constructed entirely of stainless steel and the jaws and doors are coated with Tefzel™ to improve chemical inertness. A scoop and container used to remove and composite sediments are also constructed of pre-cleaned stainless steel or polycarbonate.

When the vessel reaches a sampling station and the anchor has been deployed, the captain notifies personnel that the vessel is on site and switches on a bilge pump used for rinsing the sampling equipment. Sampling equipment is cleaned at each station in the field using the following methods:

1. Fill the compositing container with ambient water from the raw water pump and add approximately 1/8 cup of Alconox™ or Micro™ detergent to the bucket.

2. Place all sampling scoops into the compositing container and wash thoroughly with the Alconox™ or Micro™ detergent solution. Wash all Tefzel™-coated parts of the Van Veen grab with Alconox™ or Micro™ detergent solution.

3. Completely rinse the grab, compositing container, and sample scoops with ambient water.

4. Rinse the grab, bucket, sample scoops and coring tubes with 1.0 % HCl , followed with a rinse of methanol.

5. Completely rinse the grab, compositing container, and sample scoops with deionized water and let air dry. Cover all cleaned parts with aluminum foil until use.

Two grabs are taken at each site. If sediments at a station are considerably fine, plastic floats may be attached to the grab frame and secured so they do not interfere with grab operation. Likewise, if sediments are considerably coarse, weights are added to the grab frame to assist penetration of sediments. The quality of grab samples is ensured by requiring each sample to satisfy acceptance criteria concerning depth of penetration and disturbance of sediment within grab.

Samples contain only the top 2-3 cm of sediment within the area of the grab jaws. Samples are rejected under the following conditions:

1. There is a rock or shell fragment wedged between the jaws of the grab allowing the sample to wash out.

2. The sample surface is significantly disturbed.

3. The sample is uneven from side to side, indicating that the grab was tilted when it penetrated the sediment.

4. The surface of the sample is in contact with the doors of the grab, indicating over-penetration of the grab and possible loss of material around the doors.

After determining a grab meets acceptance criteria, overlying water is drained off. The remaining

top 2-3 cm of sediment is scooped from each of two (or more if necessary to collect required sediment volume) replicate grabs and mixed in the compositing container to provide a single composite sample from each site. Portions of the composited sample are placed into clean containers provided by each laboratory. In cases where an "archive" sediment sample has been requested by a RWQCB for possible future chemical analysis, a duplicate sediment chemistry sample is collected from the composite for archiving and is labeled as an "archive".

Summary of Recommended Sample Collection Process for Benthic Infauna in Estuarine, Open Coastal, and Non-wadeable Waterbodies*)--currently only RWQCB 8 uses this protocol*

Benthic infauna primarily comprises sedentary, invertebrate organisms that burrow in or live on the surface of sediments. Benthic infaunal communities fluctuate in response to natural and human induced environmental perturbations and therefore can be important indicators of environmental health. For this reason they often are an important component of many ecological monitoring programs. Benthic infauna is sampled with a Ponar grab with a surface area of 0.05 square meters. The grab is equipped with hinged stainless steel mesh lids with rubber flaps to allow flow-through of water during decent and thus minimize disturbance of surface sediments. The rubber flaps close upon retrieval and prevent winnowing of the sample. The Young-modified Van Veen grab may also be used, but is not used by RWQCB 8. The Van Veen grab does not have rubber flaps, and has a larger surface area, although that can be modified.

Sampling procedures will insure that samples are collected from a localized area at each station to reduce uncontrolled temporal and spatial variations. Lead weights are added to or removed from the outside of the grab as appropriate for sediment type to control depth of penetration.

After deployment and retrieval, the grab is placed on a stand for processing. The grab lids are opened and the sample is examined for suitability using the following criteria:

- Complete closure of the grab jaws.
- No evidence of sediment washout through the grab doors.
- An even distribution of the sediment in the grab.
- Minimum disturbance of the sediment surface.
- Minimum overall sediment depth appropriate for the sediment type: 4 cm in coarse sands and gravel, 5 cm in medium sands, 7 cm in fine sands, and 10 cm in silty sands, silts, and clay.

If the sample passes all of the criteria, the grab jaws are opened and the sample is dumped into a five gallon plastic bucket placed beneath the grab stand. Estuary water is used to wash all sediment from the grab and grab stand into the bucket. Care is exercised not to lose sediment by overfilling the bucket. The sample bucket is then moved to a wash table for sample sieving.

When a sample bucket arrives at the sieving station, it is lifted to the sieve table and poured slowly onto the nested sieve screens. The sea water hose with a flow control nozzle is used to slowly wash sediment from the sample bucket onto the sieve screens. The sieving process is aided by keeping sediment in suspension as it reaches the screen. The sample is washed from the sample bucket until the bucket is empty and well rinsed. Sediment is washed through the nested sieve screens by gently running seawater over the top screen. Use of high water pressure damages organisms impinged on the sieve screen mesh.

When all material smaller than 1.0 mm has passed through the top screen, the process is repeated with the finer screen until all material smaller than 0.5 mm has passed through. The material retained on each screen is gently washed into one corner of the screen and with the aid of a canning funnel, washed into separate appropriately labeled sample jars. A wash bottle with seawater is used to rinse any material on the inside screen frame and canning funnel into the sample jar. Any organisms remaining on the screens are carefully removed with forceps and placed in the appropriate sample jars. The sample jars are then capped with dome lids and bands, labeled with indelible ink inside and out, and delivered to the on-board formalin station. Great care is exercised to avoid creating fragments when removing organisms from the sieve screens. The sieve screens are rinsed with high-pressure seawater and scrubbed clean with a stiff-bristle brush between samples.

If the sample contains many shell fragments and/or worm tubes, the sediment sample is added to the top (1.0 mm) screen in stages so that the screen does not become too full. If the bottom screen (0.5 mm) begins to clog with sediment, the field crew ceases adding sample and gently runs the hose nozzle with low flow along the outside bottom of the 0.5 mm screen being careful not to lose sample by allowing water to escape over the top of the sieve. The material retained on a sieve screen is not allowed to fill the sample jar more than half full. In such a case, the material is divided among two or more jars and each jar is labeled as jar 1 of 2, jar 2 of 2, etc., as required.

At the formalin station, each sample jar lid is replaced with screen lids fitted with 0.25 mm Nitex (tm) mesh and the estuary water is decanted from the sample jars through the screen lids. Relaxant (isotonic $MgCl_2$) is added to the sample through the screen lid to a level approximately one-third higher than the sample level. A wash bottle of relaxant is used to wash down the screen lid and sides of the sample jar. The sample jar is recapped with the sample jar lid and gently rotated several times in a tilted position to ensure mixing of the relaxant throughout the sample. The sample is allowed to sit in the relaxant for 15-30 minutes. After this period, the sample jar lid is replaced with a screen lid and the $MgCl_2$ is decanted out of the sample jar in preparation for fixing the sample.

At the formalin station, relaxant is decanted out and fixative (10% buffered formalin in seawater) is added to the sample through the screen lid. Fixative is added to a level approximately one third

higher than the sample level. A wash bottle of fixative is used to wash down the screen lid and sides of the sample jar. The screen lid is removed, 2 or 3 drops of stain (rose bengal solution) are added to the sample and the sample jar is recapped with the sample jar lid. The jar is gently rotated several times in a tilted position to ensure mixing of the fixative and stain with the sample. Safety glasses and nitrile gloves are worn when working with fixative.

While onboard the survey vessel, benthic infauna samples are stored in plastic trays with dividers, then transferred to cardboard cartons with dividers for travel to the laboratory for sample sorting. Benthic infauna samples fixed in formalin are washed in tap water and transferred to 70% ethyl alcohol between 24 and 72 hours after fixation. Samples can then be held indefinitely in 70% ethyl alcohol.

A sample collection log records sample date, station, depth of grab penetration, number of grabs, number of bottles per sample, and any problems encountered.

COLLECTION OF SAMPLES FOR CONTAMINANT ANALYSIS IN TISSUES (FISH, CRABS, BIVALVES, ETC.)

Fish Tissue Collection Procedures for Contaminant Analysis

Fish tissue samples will be collected by DFG and SJSUF contract field crew staff, using protocols detailed in **Appendix D**. Details of the protocols are summarized below.

Collection of fish for analysis of contaminants in tissue may be accomplished by a variety of methods, including hook and line, seines, gill nets, and electroshocking. Species collected will, in most cases, be non-migratory species that are most representative of a given location. Efforts will be made to collect fish of a similar (medium) size for each composite. Fish will be wrapped in trace metal- and organic-free Teflon™ sheets and frozen for transportation to the laboratory. The tissue samples are prepared in the laboratory using non-contaminating techniques in a clean room environment.

Collection, handling and storage of tissue samples will be performed in a manner consistent with other large scale tissue contaminant monitoring programs, such as the Regional Monitoring Program (RMP) protocols (SFEI 1999, SFRWQCB 1995), CALFED DFG protocols, and toxic substances monitoring protocols (see **Appendix D**), to assure the collection of representative, uncontaminated tissue chemistry samples. Field crews must rigorously follow sampling procedures and complete all necessary documentation according to the SOPs.
As a general rule, five fish of medium size or three fish of larger size are collected as composites for analysis. The smallest fish length cannot be any smaller than 75% of the largest fish length. Five fish provides sufficient quantities of tissue for the dissection of 100 grams of fish flesh for

organic and inorganic analysis. The medium size is more desirable to enable similar samples to be collected in succeeding collections.

When only small fish are available, sufficient numbers are collected to provide 100 grams of fish flesh for analysis. If the fish are too small to excise flesh, the whole fish, minus the head, tail, and guts are analyzed as composites.

Fish collected that are too large to fit in our clean bags (>500 mm) are initially dissected in the field. At the dock, the fish are laid out on a clean plastic bag and a large cross section from behind the pectoral fins to the gut is cut with a cleaned bone saw. The bone saw is cleaned (Micro™, DI, methanol) between fish and a new plastic bag is used. The internal organs are not cut into, to prevent contamination. For bat rays, a section of the wing is cut and saved. These sections are wrapped in Teflon™, double bagged and packed in dry ice before transfer to the freezer. During lab dissection, a subsection of the cross section is removed, discarding any tissue exposed by field dissection.

Field data recorded include, but are not limited to site name, sample identification number, site location (GPS), date of collection, time of collection, names of collectors, method of collection, type of sample, water depth, water and atmospheric conditions, fish total lengths (fork lengths where appropriate), photo number and a note of other fish caught.

The fish are then wrapped in cleaned Teflon™ sheets. The wrapped fish are then double-bagged in Ziploc™ bags with the inner bag labeled. The fish are put on dry ice and transported to the laboratory where they are kept frozen until they are processed for chemical analysis.

All samples, once returned to the laboratory for processing, are prepared in a clean room to avoid airborne contamination.

Bivalve Deployment and Retrieval Summary (for bagged bivalve bioaccumulation studies)
Sample collection - mussels and clams

The mussels to be transplanted (*Mytilus californianus*) are collected from Trinidad Head (Humboldt Bay Intensive Survey), Montana de Oro (Diablo Canyon Intensive Survey), and Bodega head (all other statewide transplants). The freshwater clam (*Corbicula fluminea*) source is Lake Isabella or the Sacramento River. Mussel and clam samples are analyzed for background contaminates prior to transplanting (see State Mussel Watch Program staff for more details).

Polyethylene gloves are worn while prying mussels off rocks with stainless steel dive knives. Note: polyethylene gloves should always be worn when handling sample. Mussels of 55mm to 65mm in length are recommended. Fifty mussels are collected for each TM and each SO

sample.

Collected mussels are carried out of collection site in cleaned nylon daypacks. For the collection of resident samples where only one or two samples are being collected the mussels are placed directly into a labeled Ziploc™ or cleaned aluminum foil (SO) and an additional Ziploc™.

Clams (*Corbicula fluminea*) measuring 20 to 30mm are collected by dragging the clam dredge along the bottom of the lake or river. The clams are poured out of the dredge into a 30 gallon plastic bag. 25-50 clams are needed for each TM and each SO sample.

Transplanted sample deployment

With polyethylene gloves, fifty transplant mussels are placed in each 76mm X 13mm polypropylene mesh bag. Each bag represents one TM or one SO sample. A knot is tied at each end of mesh bag and reinforced with a cable tie. On one end another cable tie is placed under the cable tie which will be used to secure the bag to the line for transplant deployment. The mussels in the mesh bag are divided into three groups of approximately equal size and sectioned with two more cable ties.

Once bagged, the mussels are placed in a 30 gallon plastic bag and stored in a cooler (cooled with ice) for no more than 48 hours. The ice is double bagged in Ziploc™ bags to avoid contamination.

If samples are held for longer than 48 hours they are placed in holding tanks with running seawater at the Fish and Game Granite Canyon Lab. Control samples for both SO and TM are also held in the tank.

For freshwater clams: clams (25-50) are placed in 50mm X 7mm polypropylene mesh bags using identical procedures to those used with mussels (section 7.2.1). If clams need to be stored for more than 48 hours, the mesh bags are deployed in Lake San Antonio or another clean source until actual sample deployment.

The mussels are attached to an open water transplant system that consists of a buoy system constructed with a heavy weight anchor (about 100lbs) or screw-in earth anchor, 13mm polypropylene line, and a 30cm diameter subsurface buoy. The sample bags are attached with cable ties to the buoy line about 15 feet below the water surface. In some cases the sample is hung on suspended polypropylene lines about 15 feet below the water surface between pier pilings or other surface structures. Creosote-coated wooden piers are avoided because they are a potential source of contamination. In some cases the mussels are hung below a floating dock. In shallow waters a wooden or PVC stake is hammered into the substrate and the mussel bags are

attached by cable ties to the stake.

The clams are deployed by attaching with cable ties the mesh bag to wooden or PVC stakes hammered into substrate or screw in earth anchors. The bags containing clams are typically deployed 15cm or more off the bottom. In areas of swift water, polypropylene line is also attached to the staked bags and a permanent object (piling, tree or rock).

Transplants are usually deployed for 1-4 months. Ideally mussels are transplanted in early September and retrieved in late December and early January. Clams are usually transplanted in March or April and retrieved in May or June, although this is variable in some cases.

Data is recorded for each site samples are transplanted to or collected from. Data includes, but is not limited to station name, date collected or transplanted, collectors names, water depth, GPS readings, photo, ocean/atmospheric conditions (if appropriate), description of site, and drawing in necessary.

Sample Retrieval

The transplanted or resident and control mussels analyzed for metals are placed into two labeled Ziploc™ polyethylene bags (4mm thickness).

All mussels to be analyzed for organics are placed in an aluminum foil bag. The bags are constructed of two layers of "heavy duty" aluminum foil. Prior to use these bags are cleaned by heating to 500°c or by rinsing in petroleum ether or methanol. The sample is first wrapped in a foil bag, hen placed in two labeled polyethylene Ziploc™ bags. Note: samples should only contact the dull side of the foil.
The bags containing samples are clearly and uniquely identified using a water-proof marking pen or pre-made label. Information items include ID number, station name, depth (if from a multiple sample buoy), program identification, date of collection, species and type of analysis to be performed.

The samples are placed in non-metallic ice chests and frozen using dry ice or regular ice. (Dry ice is used when the collecting trip takes more than two days.) At the lab, samples should be stored at or below -20°c until processed.

Section B3. Sample Handling and Custody Requirements

Proper sample handling procedures for water, sediment, and biological samples are provided in Tables 6 and 7 (on the following pages), as well as in SOP's for Field Sample Collection provided in **Appendix D** (for all sample types except for biological assessment and benthic infaunal community assessment) and **Appendix G** (biological assessment and benthic infaunal community assessment QAPP's). Table 6 provides a summary of recommended sample containers, sample volumes, initial preservation, and maximum storage times for water samples. Table 7 provides the same information for bed sediment, tissue, and biota samples.

In the field, all samples will be packed in wet ice or frozen ice packs during shipment, so that they will be kept at approximately 4˚C. Samples will be shipped in insulated containers. All caps and lids will be checked for tightness prior to shipping. All samples will be handled, prepared, transported and stored in a manner so as to minimize bulk loss, analyte loss, contamination or biological degradation. Sample containers will be clearly labeled with an indelible marker. Where appropriate, samples may be frozen to prevent biological degradation. Water samples will be kept in Teflon™, glass, or polyethylene bottles and kept cool at a temperature of 4˚C until analyzed. Maximum holding times for specific analyses are listed in Tables 6 and 7 on the following pages.

Ice chests are sealed with tape before shipping. Samples are placed in the ice chest with enough ice to completely fill the ice chest. COC forms (as well as "Authorization/Instruction for Analysis forms") are placed in an envelope and taped to the top of the ice chest or they may be placed in a plastic bag and taped to the inside of the ice chest lid. It is assumed that samples in tape-sealed ice chests are secure whether being transported by staff vehicle, by common carrier, or by commercial package delivery. The receiving laboratory has a sample custodian who examines the samples for correct documentation, proper preservation and holding times.

Contract laboratories will follow sample custody procedures outlined in their QA plans. Contract laboratory QA plans are on file with the respective laboratory.

All samples remaining after successful completion of analyses will be disposed of properly. It is the responsibility of the personnel of each analytical laboratory to ensure that all applicable regulations are followed in the disposal of samples or related chemicals.

Chain-of-custody procedures require that possession of samples be traceable from the time the samples are collected until completion and submittal of analytical results. A complete chain-of-custody form is to accompany the transfer of samples to the analyzing laboratory.

Table 6. Summary of Sample Container, Volume, Initial Preservation, and Holding Time Recommendations for Water Samples

Parameters for Analysis	Recommended Containers (all containers pre-cleaned)	Typical Sample Volume (ml)	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
Conventional Constituents in Water				
Alkalinity	Polyethylene bottles (see **NOTE(1)** below)	100 ml	Cool to 4°C, dark	14 days at 4°C, dark
Chloride (Cl), Sulfate (SO_4) and Fluoride (F)	Polyethylene bottles (see **NOTE(1)** below)	300 ml	Cool to 4°C. dark	28 days at 4°C, dark
Ortho-phosphate (OPO_4)	Polyethylene bottles (see **NOTE(1)** below)	150 ml	Cool to 4°C, dark	48 hours at 4°C, dark
Nitrate + Nitrite ($NO_3 + NO_2$)	Polyethylene bottles (see **NOTE(1)** below)	150 ml	Cool to 4°C, dark	48 hours at 4°C, dark
Total Keldjahl Nitrogen (TKN)	Polyethylene bottles (see **NOTE(1)** below)	600 ml	Cool to 4°C, dark	Recommend: 7 days Maximum: 28 days Either one at 4°C, dark
Total Dissolved Solids (TDS)	Polyethylene bottles (see **NOTE(1)** below)	1000 ml	Cool to 4°C, dark	7 days at 4°C, dark
Ammonia (NH_3)	Polyethylene bottles (see **NOTE(1)** below)	500 ml	Cool to 4°C, dark	28 days at 4°C, dark
Total Phosphorus (TPO_4)	Polyethylene bottles (see **NOTE(1)** below)	300 ml	Cool to 4°C, dark	28 days at 4°C, dark
(1)NOTE: The volume of water necessary to collect in order to analyze for the above constituents is typically combined in four 1-liter polyethylene bottles, which also allows enough volume for possible re-analysis and for conducting lab spike duplicates. This is possible since the same laboratory is conducting all of the above analyses; otherwise, individual volumes apply.				
Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC)	40 ml glass vial	40 ml (one vial)	Cool to 4°C, dark	28 days at 4°C, dark
Total Suspended Solids (TSS)	500 ml amber glass jar	1000 ml (two jars)	Cool to 4°C, dark	7 days at 4°C, dark
Suspended Sediment Concentration (SSC)	500 ml amber glass jar	500 ml (one jar)	Cool to 4°C, dark	7 days at 4°C, dark
Chlorophyll *a* Pheophytin *a*	1-L amber polyethylene bottle	1000 ml (one bottle)	Cool to 4°C, dark	Keep at 4°C, dark, but must filter within 48 hours. Filters may be stored frozen up to 30 days.

Parameters for Analysis	Recommended Containers (all containers pre-cleaned)	Typical Sample Volume (ml)	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
Non-Routine Compounds in Water Samples				
OIL AND GREASE	1-L glass jar with Teflon lid-liner, rinsed with hexane or methylene chloride	1000 ml (one jar)	Add 2 ml conc. H_2SO_4 to pH <2; cool to 4°C, dark.	28 days at 4°C, dark
PHENOLS	1-L glass jar with Teflon lid-liner	1000 ml (one jar)	Add 2 ml conc. H_2SO_4 to pH <2; cool to 4°C, dark.	28 days at 4°C, dark
CYANIDE	1-L cubitainer	1000 ml (one cubitainer)	Add 2 ml 1:1 NaOH to make pH > 12; Add 0.6 g ascorbic acid if residual Cl present. Cool to 4°C, dark.	14 days at 4°C, dark
BIOCHEMICAL OXYGEN DEMAND (BOD)	4-L cubitainer	4000 ml (one cubitainer)	Cool to 4°C, dark. Add 1g FAS crystals per liter, if residual Cl present.	48 hours at 4°C, dark
CHEMICAL OXYGEN DEMAND (COD)	500-ml cubitainer	110 ml (one cubitainer)	Add 2 ml conc. H_2SO_4 to make pH <2. Cool to 4°C, dark.	28 days at 4°C, dark
Trace Metals in Water Samples				
DISSOLVED METALS (except Dissolved Mercury)	60 ml polyethylene bottle, pre-cleaned in lab using HNO_3	60 ml (one bottle) if salinity <0.5 ppt 180 ml (three bottles) if salinity >0.5 ppt	Filter at sample site using 0.45 micron in-line filter, or syringe filter. Cool to 4°C, dark. Acidify in lab, within 48 hrs, using pre-acidified container (ultra-pure HNO_3) for pH<2.	Once sample is filtered and acidified, can store up to 6 months at room temperature
DISSOLVED MERCURY	250 ml glass or Teflon bottle, pre-cleaned in lab using HNO_3	250 ml (one bottle)	Cool to 4°C, dark. Filter in lab within 48 hours, using bench top Hg filtration apparatus. Acidify in lab within 48 hrs, with pre-tested HCL to 0.5%.	Once sample is filtered and acidified, can store up to 6 months at room temperature
TOTAL METALS (except Total Mercury)	60 ml polyethylene bottle, pre-cleaned in lab using HNO_3	60 ml (one bottle) if salinity <0.5 ppt 180 ml (three bottles) if salinity >0.5 ppt	Cool to 4°C, dark. Acidify in lab within 48 hrs, with pre-acidified container (ultra-pure HNO_3), for pH<2.	Once sample is acidified, can store up to 6 months at room temperature
Trace Metals in Water Samples (continued)				

Parameters for Analysis	Recommended Containers (all containers pre-cleaned)	Typical Sample Volume (ml)	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
TOTAL MERCURY	250 ml glass or Teflon bottle, pre-cleaned in lab using HNO_3	250 ml (one bottle)	Cool to 4°C, dark. Acidify in lab within 48 hrs, with pre-tested HCL to 0.5%.	Once sample is acidified, can store up to 6 months at room temperature.
HEXAVALENT CHROMIUM (filtered)	600 ml plastic or glass bottle	600 ml (one bottle)	Cool to 4°C, dark No acid	Keep at 4°C, dark for up to 24 hours; must notify lab in advance.
HARDNESS	200 ml polyethylene or glass bottle	200 ml (one bottle)	Cool to 4°C, dark OR Filter and add 2 ml conc. H_2SO_4 or HNO_3 to pH < 2; Cool to 4°C, dark.	48 hours at 4°C, dark 6 months at 4°C, dark
Synthetic Organic Compounds in Water Samples				
VOLATILE ORGANIC ANALYTES (VOA's) including VOC, MTBE and BTEX	40 ml VOA vials	120 ml (three VOA vials)	All vials are pre-acidified (50% HCl or H_2SO_4) at lab before sampling. Cool to 4°C, dark	14 days at 4°C, dark
PESTICIDES & HERBICIDES* □Organophosphate Pesticides □Organochlorine Pesticides □Chlorinated Herbicides **SEMI-VOLATILE ORGANICS*** **POLYCHLORINATED* BIPHEYNYL AND AROCHLOR COMPOUNDS** **TPH, PAH, PCP/TCP***	1-L I-Chem 200-series amber glass bottle, with Teflon lid-liner (per each sample type)	1000 ml (one container) ***Each sample type requires 1000 ml in a separate container**	Cool to 4°C, dark If chlorine is present, add 0.1g sodium thiosulfate	Keep at 4°C, dark, up to 7 days. Extraction must be performed within the 7 days; analysis must be conducted within 40 days.
Toxicity Testing Water Samples				
TOXICITY IN WATER	Four 2.25 L amber glass bottles	9000 ml	Cool to 4°C, dark	48 hours at 4°C, dark
Bacteria and Pathogens in Water Samples				
E. Coli	Factory-sealed, pre-	100 ml volume	Sodium thiosulfate is pre-	STAT: 6 hours at 4°C, dark

Parameters for Analysis	Recommended Containers (all containers pre-cleaned)	Typical Sample Volume (ml)	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
	sterilized, disposable Whirl-pak® bags or 125 ml sterile plastic (high density polyethylene or polypropylene) container	sufficient for both E. coli and Enterococcus analyses	added to the containers in the laboratory (chlorine elimination). Cool to 4°C; dark.	for regulatory data use; lab must be notified well in advance. Possibly 24hr hold time at 4C dark, if non-regulatory data use.
Enterococcus	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 ml sterile plastic (high density polyethylene or polypropylene) container	100 ml volume sufficient for both E. coli and Enterococcus analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4°C; dark.	STAT: 6 hours at 4°C, dark for regulatory data use; lab must be notified well in advance. Possibly 24hr hold time at 4C dark, if non-regulatory data use.
FECAL COLIFORM	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 ml sterile plastic (high density polyethylene or polypropylene) container	100 ml volume sufficient for both fecal and total coliform analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4°C; dark.	STAT: 6 hours at 4°C, dark for regulatory data use; lab must be notified well in advance. Possibly 24hr hold time at 4C dark, if non-regulatory data use.
TOTAL COLIFORM	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 ml sterile plastic (high density polyethylene or polypropylene) container	100 ml volume sufficient for both fecal and total coliform analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4°C; dark.	STAT: 6 hours at 4°C, dark for regulatory data use; lab must be notified well in advance. Possibly 24hr hold time at 4C dark, if non-regulatory data use.

Table 7. Summary of Sample Container, Volume, Preservation, and Storage Requirements for SWAMP Bed Sediment, Biota, and Tissue Samples (for contaminant analysis)

Parameters for Analysis	Recommended Containers	Typical Sample Volume (ml)	Initial Field Preservation	Maximum Holding Time
Bed Sediment Samples				
Trace Metals, including Hg and As (except for Se--see below)	60 ml I-Chem 300-series clear glass jar with Teflon lid-liner; Pre-cleaned	60 ml (one jar)	Cool to 4°C, dark, up to 14 days	12 months(1) (-20°C)
Selenium (separate container required)	60 ml I-Chem 300-series clear glass jar with Teflon lid-liner; Pre-cleaned	60 ml (one jar)	Cool to 4°C, dark, up to 14 days	12 months(1) (-20°C)
Synthetic Organic Compounds	250 ml I-Chem 300-series amber glass jar with Teflon lid-liner; Pre-cleaned	500 ml (two jars)	Cool to 4°C, dark, up to 14 days	12 months(1) (-20°C)
Sediment TOC	125 ml(3) clear glass jar; Pre-cleaned	125 ml (one jar)	Cool to 4°C, dark, up to 28 days	12 months(2) (-20°C)
Sediment Grain Size	125 ml(3) clear glass jar; Pre-cleaned	125 ml (one jar)	Cool to 4°C, dark, up to 6 months	28 days (4°C) ***Do not freeze***
Sediment Toxicity Testing	1-Liter I-Chem wide-mouth polyethylene jar with Teflon lid-liner; Pre-cleaned	2-Liters (two jars filled completely)	Cool to 4°C, dark, up to 14 days	14 days (4°C) ***Do not freeze***

(1) Sediment samples for parameters noted with one asterisk (*) may be refrigerated at 4°C for up to 14-days maximum, but analysis must start within the 14-day period, or the sediment sample must be stored frozen at minus (-) 20°C for up to 12 months maximum.

(2) Sediment samples for sediment TOC analysis can be held at 4°C for up to 28 days, and should be analyzed within this 28 day period, but can be frozen at any time during the initial 28 days, for up to 12 months maximum at minus (-) 20°C.

(3) Sediment samples for TOC AND grain size analysis can be combined in one 250 ml clear glass jar, and sub-sampled at the laboratory in order to utilize holding time differences for the two analyses. If this is done, the 250 ml combined sediment sample must be refrigerated only (not frozen) at 4°C for up to 28 days, during which time the sub-samples must be aliquoted in order to comply with separate storage requirements (as shown above).

Table 7 (continued). Summary of Sample Container, Volume, Preservation, and Storage Requirements for SWAMP Bed Sediment, Tissue (for contaminant analysis), and Biota Samples

Parameters for Analysis	Recommended Containers	Typical Sample Volume (ml)	Initial Field Preservation	Maximum Holding Time
Tissue samples				
Fish, crab, and shellfish tissue (for contaminant analysis)	Polyethylene bags (Teflon™ sheets in Ziplock™ bags); or glass (with Teflon™ lid); or polyethylene jar for trace metals sample only.	200g	Freeze until processing	12 months (-20°C)
Biota--Benthic Macroinvertebrates				
FRESHWATER	plastic or glass	variable	70% ethyl alcohol OR 70% isopropyl alcohol OR Add formalin to produce a 5-10% formalin solution Store in dark and away from extremes of hot and cold	5 years
MARINE	plastic or glass	variable	Add formalin buffered with borax to create a 10% formalin solution. After 2 weeks, sort sample and preserve with 70% ethanol.	5 years

Parameters for Analysis	Recommended Containers	Typical Sample Volume (ml)	Initial Field Preservation	Maximum Holding Time
Netplankton	amber plastic or glass (Lugol's solution will permeate plastic cubitainers and stain materials in contact with cubitainer)	variable	Rinse net bucket with 3-5% buffered formalin OR If net bucket rinsed with tap water, preserve sample with 1 ml of modified Lugol's solution per 100 ml of sample. Store in dark and away from extremes of hot and cold.	5 years
Nannoplankton	amber plastic or glass (Lugol's solution will permeate plastic cubitainers and stain materials in contact with cubitainer)	500 g	1 ml of modified Lugol's solution per 100 ml of sample. Store in dark and away from extremes of hot and cold.	5 years
Nekton	plastic or glass	variable	Fix in a 10% formalin solution. After about 1 week thoroughly wash and preserve in 40 % ethyl alcohol Store in dark and away from extremes of hot and cold.	5 years

Laboratory Custody Log

Laboratories shall maintain custody logs sufficient to track each sample submitted and to analyze or preserve each sample within specified holding times. A sample is considered under custody if:

- it is in actual possession;
- it is in view after in physical possession;
- it is placed in a secure area (accessible by or under the scrutiny of authorized personnel only after in possession)

Field Log

Field crews shall be required to keep a field log for each sampling event. The following items should be recorded in the field log for each sampling event:

- time of sample collection;
- sample ID numbers, including etched bottle ID numbers for Teflon™ mercury sample containers and unique IDs for any replicate or blank samples;
- the results of any field measurements (temperature, D.O., pH, conductivity, turbidity) and the time that measurements were made;
- qualitative descriptions of relevant water conditions (e.g. color, flow level, clarity) or weather (e.g. wind, rain) at the time of sample collection;
- a description of any unusual occurrences associated with the sampling event, particularly those that may affect sample or data quality.

The field crews shall have custody of samples during field sampling. Chain of custody forms will accompany all samples during shipment to contract laboratories. All water quality samples will be
transported to the analytical laboratory directly by the field crew or by overnight courier.

Section B4. Analytical Methods Requirements

The SWRCB contracts for SWAMP Program laboratory services for itself, as well as for all of the Regional Water Quality Control Boards, through utilization of the central contracting office at the SWRCB. The SWRCB currently utilizes two "master contracts" for providing analytical, field, technical/scientific consulting, and other assistance to the SWRCB and any/all RWQCB's desiring to utilize these master contracts. Currently, the two master contracts are with: 1) California Department of Fish and Game (DFG); and 2) U.S. Geological Survey (USGS). In addition, RWQCB's may negotiate and establish contracts for SWAMP services with any number of other qualified agencies, organizations, or commercial laboratories through the SWRCB central contracting office. The Organization Charts provided earlier in the QAMP (Figures 2, 3, 4, and 5), as well as in **Appendix A**, outline these relationships and contracts in more detail.

All contract laboratories must document the methods they use, the SOPs, and the data acceptability criteria of their analytical capabilities in their QA Program Plan and QA Manual respectively, also. The laboratory analytical procedures used by particular SWAMP laboratories are on file with the respective laboratory, and the acceptability criteria within which analytical procedures must be performed within are outlined in **Appendix C**.

The laboratory supervisor of each contracted lab has primary responsibility for responding to a failure of analytical systems. Solutions which are consistent with the measurement objectives will be reached in consultation with the project manager.

The method numbers used by each contract laboratory for each analytical procedure they perform for SWAMP is available in each laboratory=s respective QA Plan on file with that laboratory.

Corrective Action for Laboratory Activities:
Failures in field and laboratory measurement systems involve, but are not limited to such things as, instrument malfunctions, failures in calibration, sample jar breakage, blank contamination, quality control samples outside of the defined limits (Data Acceptability Criteria) listed in **Appendix C**. In many cases, the field technician or lab analyst will be able to correct the problem. If the problem is resolvable by the field technician or lab analyst, then they will document the problem in their field notes or laboratory record and complete the analysis. If the problem is not resolvable, then it is conveyed to the respective supervisor, who will make the determination if the analytical system failure compromised the sample results and should not be reported. The nature and disposition of the problem is documented in the data report that is sent to the SWAMP Project Manager.

Detection limits may be affected by instrument sensitivity or by bias due to contamination or matrix interferences. Common laboratory practice is to adjust detection limits upward in cases where high instrument precision (i.e., low variability) results in calculated detection limits that are lower than the absolute sensitivity of the analytical instrument. In these cases, best professional judgment is used to adjust detection limits upward to reduce false positives and values below the detection limit are not reported. In all cases, results cannot be reported for values less than the Method Detection Limit (MDL--see definitions below).

For SWAMP, the recommended applications of detection and quantification limits should follow:

- Values below the Method Detection Limit (MDL, per 40 CFR Part 136) are to be reported as a negative ("-") sign followed by the actual MDL value, and flagged with an ND = not detected.
- Values between the MDL and the Reporting Limit (RL, aka quantification limit, which is the MDL multiplied by a factor of 1-10, as determined by the lab to provide acceptable precision values among replicated measurements) should be reported as the actual measured value (not negative), with a flag that is carried all the way through data storage, handling, and reporting. The flag is DNQ = detected, not quantifiable.
- Values above the RL (or quantification limit) are deemed as acceptable values without reservation, and are shown as the actual measured value, and assigned a QA code of A (Acceptable without reservation).
- Other QA qualification codes may occur if QC criteria are not met or qualification is deemed appropriate during subsequent QA review.

The SWAMP Program has had numerous planning discussions and workshops regarding a variety of technical and scientific issues. One of the topics that led to lengthy and useful discussions was on the use and designation of Method Detection Limits, Minimum Detection Limits, Method Quantification Limits, Target Reporting Limits, and other such terminology used to apply to chemical concentration analytical quantification limits. Discussions centered on methodology limitations, matrix or other interference limitations, "cleanup" limitations, dilution limitations, and most important, discussions regarding the specific objectives for which the respective analyses are being conducted illuminated the large variety of regional goals and objectives for the current SWAMP work being conducted. At this time, RWQCB priorities and objectives for monitoring needs within their respective regions will drive the analytical needs of the program, and will therefore drive the data quality objectives for SWAMP. Therefore, there is a need and rationale for flexibility in analytical techniques, reporting limits, even sample collection protocols as properly driven at this point by RWQCB SWAMP Work Plan objectives.

To make recommendations, and in fact to make <u>requirements</u> for the reporting limits for chemical analyses for a program such as the California SWAMP Program, as it currently exists in its start-up phase, is very complex and difficult, given the issues pointed out above. This is due in large part to the variety of different objectives (including Basin Plan objectives) each RWQCB has in their

current Work Plans, as well as the variety of resulting experimental designs in different regions, the variety of differing media being collected in different regions, and the variety of differing analyses being conducted in different regions.

As with all other aspects of this SWAMP QAMP, therefore, the intent is to provide for minimum standards and guidelines that all participants should utilize, with strong encouragement to use more stringent criteria and to adopt methodologies that improve upon these minimum standards. The major goal that this SWAMP QAMP can accomplish, if all SWAMP participants abide by the stipulations put forth in this document, is to have representative, comparable, accurate and precise data that can be shared statewide, to the extent possible under the given limitations.

Given the issues stated above, it is the intent to provide guidance for recommended **Target Reporting Limits (TRL's) for SWAMP** analytical procedures. Target Reporting Limit Tables for SWAMP are provided in **Appendix C**, for all analytical groups in all media. These are "recommended" reporting limits at this time, and participating laboratories will provide their actual MDL's and RL's, as described above, in the submission of their data.

In general, laboratories should strive to meet target reporting limit recommendations for undetected analytes. In those cases where high concentrations of some analytes require analysis of a diluted sample and the dilution results in non-detects for other analytes, analysis of the sample at several different dilutions may be required to meet program detection limits as fully as practical.

When using the SWAMP Target Reporting Limits, it is clear that if any SWAMP entity desires to use analytical reporting limits that are more stringent than those in this SWAMP QAMP, this is highly encouraged. However, if any SWAMP entity desires to use analytical reporting limits that are LESS stringent than those within this SWAMP QAMP, then documentation of the rationale for such a variation, as well as any methodological variance, should be provided in writing.

Section B5. Quality Control Requirements

LABORATORY QUALITY CONTROL REQUIREMENTS

SWAMP will require all participating laboratories to demonstrate capability continuously through:

1. Strict adherence to common QA/QC procedures.
2. Routine analysis of certified reference materials (CRMs).
3. Regular participation in an on-going series of interlaboratory comparison exercises.

Because SWAMP is specifically designed to provide information on "ambient" conditions in the state's surface waters, the ability to provide low-level contaminant analysis is critical. This is a "performance-based" approach for measurements of low-level contaminant analyses, involving continuous laboratory evaluation through the use of accuracy-based materials (e.g., CRMs), laboratory matrix spikes, laboratory method blanks, calibration standards, laboratory- and field-duplicated samples, and others as appropriate. The definition and use of each of these types of quality control samples are explained further below.

Quality control operates to make sure that data produced are satisfactory, consistent, and dependable. Under SWAMP's performance-based chemistry QA program, laboratories are not required to use a single, standard analytical method for each type of analysis, but rather are free to choose the best or most feasible method within the constraints of cost and equipment that is suitable for meeting the data quality objectives (DQO's), as outlined in **Appendix C** (Data Acceptability Criteria tables). SWAMP has developed specific guidelines for measurement precision, accuracy, and levels of detection that are reflected in sampling, handling, and analysis requirements to satisfy a large spectrum of potential management questions. Each laboratory will continuously demonstrate proficiency and data comparability through routine analysis of accuracy-based performance evaluation samples, split samples, and reference materials representing actual sample matrices. No single analytical method has been officially approved for low-level analysis of organic and inorganic contaminants in water or sediments. Recommended methods are available and are provided in **Appendix C's** Target Reporting Limits section (listing of recommended methods).

All laboratories providing analytical support for chemical or biological analyses will have the appropriate facilities to store, prepare, and process samples, and appropriate instrumentation and staff to provide data of the required quality within the time period dictated by the project. Laboratories are expected to conduct operations in a way that includes:

1. A program of scheduled maintenance of analytical balances, microscopes, and other laboratory equipment and instrumentation.
2. Routine checking of analytical balances using a set of standard reference weights (American Society of Testing and Materials (ASTM) Class 3, NIST Class S-1, or equivalents).
3. Checking and recording the composition of fresh calibration standards against the previous lot. Acceptable comparisons are <5 percent difference from previous value.

4. Recording all analytical data in bound (where possible) logbooks, with all entries in ink, or electronic format.
5. Monitoring and documenting the temperatures of cold storage areas and freezer units once per week.
6. Verifying the efficiency of fume hoods.
7. Having a source of reagent water meeting ASTM Type I specifications (ASTM, 1984) available in sufficient quantity to support analytical operations. The resistivity of the reagent water will not exceed 18 megaohm at 25°C. Alternately, the conductivity of the reagent water will exceed 10 μmhos/cm.
8. Labeling all containers used in the laboratory with date prepared, contents, initials of the individual who prepared the contents, and other information as appropriate.
9. Dating and safely storing all chemicals upon receipt. Proper disposal of chemicals when the expiration date has passed.
10. Having QAPP, SOPs, analytical methods manuals, and safety plans readily available to staff.
11. Having raw analytical data, such as chromatograms, accessible so that they are available upon request.

Laboratories will be able to provide information documenting their ability to conduct the analyses with the required level of data quality. Such information might include results from interlaboratory calibration studies, control charts and summary data of internal QA/QC checks, and results from certified reference material analyses.

QA/QC Documentation

All laboratories will have the latest revision of the SWAMP QAMP. In addition, the following documents and information will be current, and they will be available to all laboratory personnel participating in the processing of SWAMP samples, as well as to SWAMP project officials:

1. Laboratory QA Plan: Clearly defined policies and protocols specific to a particular laboratory, including personnel responsibilities, laboratory acceptance criteria and corrective actions to be applied to the affected analytical batches, qualification of data, and procedures for determining the acceptability of results.
2. Laboratory Standard Operating Procedures (SOPs): Containing instructions for performing routine laboratory procedures.
3. Laboratory Analytical Methods Manual: Step-by-step instructions describing exactly how a method is implemented in the laboratory for a particular analytical procedure. Contains all analytical methods utilized in the particular laboratory for SWAMP.
4. Instrument Performance Information: Information on instrument baseline noise, calibration standard response, analytical precision and bias data, detection limits, etc. This information is usually recorded in logbooks or laboratory notebooks.

5. Control Charts: Control charts are useful in evaluating internal laboratory procedures and are helpful in identifying and correcting systematic error sources. Contract laboratories are encouraged to develop and maintain control charts whenever they may serve in determining sources of analytical problems.

Recommended Typical Laboratory Performance Measurements

Typical laboratory performance measurements included in the analysis stream and designed to check if data quality criteria are met are recommended and briefly defined below. SWAMP **Data Acceptability Criteria are provided for all analytical groups for all media in Appendix C. Note that not all media may have all of these performance measurements (See App C).**

1. Method Blanks (also called extraction blanks or preparation blanks): These account for contaminants present in the preservative and analytical solutions and equipment used during the preparation and quantification of the parameter.
2. Injection Internal Standards and/or Surrogates: These account for error introduced by the analytical instrument or extraction process.
3. Matrix Spike Samples: These are field samples to which a known amount of contaminant is added and used to measure potential analytical interferences present in the field sample.
4. Replicate Samples: These are replicates of extracted material that measure the instrumental precision.

   a. Laboratory Replicate Samples: These are replicates of the raw material that are extracted and analyzed to measure laboratory precision.

   b. Matrix Spike Replicate Samples: These are used to assess both laboratory precision and accuracy. They are particularly useful when the field samples analyzed do not contain many of the target compounds (measuring non-detects in replicate does not allow the data reviewer to measure the precision or the accuracy of the data in an analytical batch).
5. Certified Reference Materials (CRM): Analysis of CRMs is another way of determining accuracy of the analysis by comparing a certified value of material with similar concentrations as those expected in the samples to be analyzed.

These types of samples serve to check if errors were introduced during the analysis process and if so, at what step(s) and at what magnitude. The remainder of this document will provide RMP guidance for general laboratory requirements and protocols for checking and tracking possible sources of errors (outlined above) in the analytical process.

Laboratory Quality Control Procedures

The performance-based protocols utilized in SWAMP for analytical chemistry laboratories consist of two basic elements: initial demonstration of laboratory capability for new laboratories (e.g., documentation that the analyses of samples are within the data quality criteria), and

ongoing demonstration of capability. Prior to the initial analysis of samples, each new laboratory will demonstrate capability and proficiency.

INITIAL DEMONSTRATION OF CAPABILITY

Instrument Calibration

Upon initiation of an analytical run, after each major equipment disruption, and whenever on-going calibration checks do not meet recommended DQOs (see **Appendix C**), the system will be calibrated with a full range of analytical standards. Immediately after this procedure, the initial calibration must be verified through the analysis of a standard obtained from a different source than the standards used to calibrate the instrumentation, prepared in an independent manner, and ideally having certified concentrations of target analytes of a certified reference material (CRM) or certified solution. Frequently, calibration standards are included as part of an analytical run, interspersed with actual samples. However, this practice does not document the stability of the calibration and is incapable of detecting degradation of individual components, particularly pesticides, in standard solutions used to calibrate the instrument. The calibration curve is acceptable if it has a r^2 of 0.990 or greater for all analytes present in the calibration mixtures. If not, the calibration standards, as well as all the samples in the batch must be re-analyzed. All calibration standards will be traceable to a recognized organization for the preparation and certification of QA/QC materials (e.g., NIST, National Research Council Canada (NRCC), US EPA, etc.).

Calibration curves will be established for each analyte and batch analysis from a calibration blank and a minimum of three analytical standards of increasing concentration, covering the range of expected sample concentrations. Only data which result from quantification within the demonstrated working calibration range may be reported by the laboratory (i.e., quantification based on extrapolation is not acceptable). Alternatively, if the instrumentation is linear over the concentration ranges to be measured in the samples, the use of a calibration blank and one single standard that is higher in concentration than the samples may be appropriate. Samples outside the calibration range will be diluted or concentrated, as appropriate, and reanalyzed.

Initial Documentation of Method Detection Limits

Analytical chemists have coined a variety of terms to define "limits" of detectability; definitions for some of the more commonly used terms are provided in Keith *et al*. (1983) and in Keith (1991). In SWAMP, the method detection limit (MDL) is used to define the analytical limit of detectability. The MDL represents a quantitative estimate of low-level response detected at the maximum sensitivity of a method. The Code of Federal Regulations (40 CFR Part 136) gives the following rigorous definition:

> "The MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte."

The American Society of Testing and Materials (ASTM) defines the limit of detection as:

> "A concentration of twice the criterion of detection...when it has been decided that the risk of making a Type II error is to be equal to a Type I error."

In order to compare MDLs in quantitative terms by different laboratories participating in SWAMP analyses, MDLs will initially be determined according to 40 CFR 136.2 (f) and Appendix B of 40 CFR 136. Determining the MDL with this procedure is elaborate and need not be determined annually provided that:

1. No process or method changes have been made.
2. Check samples containing an analyte spike at about 2x MDL indicate that the sample is detected. The required frequency of check samples is quarterly.

The matrix and the amount of sample (i.e., dry weight of sediment or tissue) used in calculating the MDL will match as closely as possible the matrix of the actual field samples and the amount of sample typically used.

Limits of Quantification

In order to ensure comparability of results among different laboratories, recommended Reporting Limit (quantification) values have been established for SWAMP, termed **Target Reporting Limits, or TRL's (see Appendix C)**. These TRL's have been derived empirically. In most cases, they are 2-5 times the MDL as determined by the above process. Most are considerably lower than water quality objectives or sediment and tissue quality guidelines and provide the foundation for having a high level of certainty in the data.

The laboratory shall confirm the ability to analyze low-level samples with each batch. This shall be accomplished by analyzing a method blank spiked at 3 to 5 times the method detection limit or a reference material in the appropriate range. Recoveries for organic analyses shall be between 50 and 150% for at least 90% of the target analytes.

Taylor (1987) states that "a measured value becomes believable when it is larger than the uncertainty associated with it". The uncertainty associated with a measurement is calculated from the standard deviation of replicate measurements (s_0) of a low concentration standard or a blank. Normally, the MDL is set at three times the standard deviation of replicate measurements, as it is at this point that the uncertainty of a measurement is approximately ±100% at the 95% level of confidence. The limit of quantification (LOQ, which SWAMP is referring to as the Reporting Limit, or RL), as established by the American Chemical Society, is normally ten times the standard deviation of replicate measurements, which corresponds to a measurement uncertainty of ±30% (see Taylor, 1987). By these standard definitions, measurements below the MDL are not believable, measurements between the LOQ (RL) and the MDL are only semi-quantitative, and confidence in measurements above the LOQ is high.

Initial Blind Analysis of Representative Samples

As appropriate, representative sample matrices which are uncompromised, homogeneous, and contain the analytes of interest at concentrations of interest will be used to evaluate performance of analytical laboratories new to SWAMP prior to the analysis of field samples. The samples

used for this initial demonstration of laboratory capability typically will be distributed blind (i.e., the laboratory will not know the concentrations of the analytes of interest) as part of the SWAMP interlaboratory comparison exercises, with the SWAMP QA Program staff conducting and evaluating the exercise. Based on results that have typically been attained by experienced laboratories, a new laboratory's performance generally will be considered acceptable if its submitted values are within the DQO's **(outlined in Appendix C)** of the known concentration, or the consensus value, of each analyte of interest in the samples. These criteria apply only for analyte concentrations equal to or greater than three times the RL. If the results for the initial analysis fail to meet these criteria, the laboratory will be required to repeat the analysis until the performance criteria are met, prior to the analysis of SWAMP field samples.

Record of Certified Reference Material

As CRMs are routinely included in analysis of batches of reputable laboratories, the historical record of results may also serve as a suitable performance indicator.

ONGOING DEMONSTRATION OF CAPABILITY

Participation in Interlaboratory Comparison Exercises

Through an interagency agreement, NOAA's NIST Program and EPA's EMAP program jointly sponsor an on-going series of interlaboratory comparison exercises (round-robins). All SWAMP analytical laboratories are at this point encouraged to participate in these intercomparison exercises, which are conducted jointly by NIST and NRCC. In the near future, this most likely will become a mandatory participation, with approval from NOAA/NIST. SWAMP would then be conducting its own annual interlaboratory calibration exercise for media types not covered within the NOAA/NIST intercalibration (primarily water media), and it will be mandatory for all participating SWAMP labs. These exercises provide a tool for continuous improvement of laboratory measurements by helping analysts identify and resolve problems in methodology and/or QA/QC. The results of these exercises are also used to evaluate both the individual and collective performance of the participating analytical laboratories on a continuing basis and to insure that ongoing measurements are meeting Data Acceptability Criteria. The SWAMP laboratories will be required to initiate corrective actions if their performance in these comparison exercises falls below pre-determined minimal standards.

It is planned for there to be one exercise conducted over the course of a year. In a typical exercise as planned for SWAMP, the 3rd party (referee) contractor will distribute performance evaluation samples of an "unknown" and a certified reference material (CRM) to each laboratory, along with detailed instructions for analysis. A variety of performance evaluation samples could be utilized, including accuracy-based solutions, sample extracts, and representative matrices (e.g., sediment or tissue samples). Laboratories are required to analyze the sample(s) "blind" and will submit their results in a timely manner to the SWAMP interlaboratory calibration study coordinator (as instructed). Laboratories which fail to maintain acceptable performance may be required to provide an explanation and/or undertake appropriate corrective actions. At the end of each calendar year, coordinating personnel at the 3rd party

(referee) contract QA Program will participate in a QA workshop to present and discuss the comparison exercise results. Additionally, a written summary of the evaluation will be provided.

Routine Analysis of Certified Reference Materials or Laboratory Control Materials

Certified reference materials generally are considered the most useful QC samples for assessing the accuracy of a given analysis (i.e., the closeness of a measurement to the "true" value). CRMs can be used to assess accuracy because they have "certified" concentrations of the analytes of interest, as determined through replicate analyses by a reputable certifying agency using two independent measurement techniques for verification. In addition, the certifying agency may provide "non-certified or "informational" values for other analytes of interest. Such values are determined using a single measurement technique, which may introduce unrecognized bias. Therefore, non-certified values must be used with caution in evaluating the performance of a laboratory using a method which differs from the one used by the certifying agency.

A laboratory control material (LCM) is similar to a certified reference material in that it is a homogeneous matrix that closely matches the samples being analyzed. A "true" LCM is one that is prepared (i.e., collected, homogenized, and stored in a stable condition) strictly for use in-house by a single laboratory. Alternately, the material may be prepared by a central laboratory and distributed to others (so-called regional or program control materials). Unlike CRMs, concentrations of the analytes of interest in LCMs are not certified but are based upon a statistically valid number of replicate analyses by one or several laboratories. In practice, this material can be used to assess the precision (i.e., consistency) of a single laboratory, as well as to determine the degree of comparability among different laboratories. If available, LCMs may be preferred for routine (i.e., day to day) analysis because CRMs are relatively expensive.

Routine analysis of CRMs or, when available, LCMs represents a particularly vital aspect of the "performance-based" SWAMP QA philosophy. At least one CRM or LCM must be analyzed along with each batch of 20 or fewer samples (i.e., QA samples should comprise a minimum of 5% of each set of field samples). For CRMs, both the certified and non-certified concentrations of the target analytes will be known to the analyst(s) and will be used to provide an immediate check on performance before proceeding with a subsequent sample batch. Performance criteria for both precision and accuracy have been established for analysis of CRMs or LCMs **(Appendix C)**; these criteria are discussed in detail in the following paragraphs. If the laboratory fails to meet either the precision or accuracy control limit criteria for a given analysis of the CRM or LCM, the data for the entire batch of samples is suspect. Calculations and instruments will be checked; the CRM or LCM may have to be reanalyzed (i.e., reinjected) to confirm the results. If the values are still outside the control limits in the repeat analysis, the laboratory is required to find and eliminate the source(s) of the problem and repeat the analysis of that batch of samples until control limits are met, before final data are reported. The results of the CRM or LCM analysis will never be used by the laboratory to "correct" the data for a given sample batch.

Precision criteria: Precision is the reproducibility of an analytical method. Each laboratory is expected to maintain control charts for use by analysts in monitoring the overall precision of the CRM or LCM. Upper and lower control chart limits (e.g., warning limits and control limits) will

be continually updated; control limits based on 99% confidence intervals around the mean are recommended. The relative standard deviation (RSD) will be calculated for each analyte of interest in the CRM based on the last 7 CRM analyses. Acceptable precision targets for various analyses are listed in **Appendix C**.

Laboratory Replicates for Precision

A minimum of one field sample per batch of SWAMP samples submitted to the laboratory will be processed and analyzed in duplicate or more for precision. The relative percent difference among replicate samples (RPD expressed as percent) will be less than the DQO's listed in **Appendix C** for each analyte of interest. Following are the calculations:

Each measured value is compared against the known value of the standard, and accuracy is expressed as the relative percent difference.

$$RPD = \frac{[V_m - V_k]}{V_k} \times 100\%$$

Where: RPD = the relative percent difference
Vm = the measured value,
Vk = the known value.

If results for any analytes do not meet the DQO's for the RPD, calculations and instruments will be checked. A repeat analysis may be required to confirm the results. Results which repeatedly fail to meet the objectives indicate sample in-homogeneity, unusually high concentrations of analytes or poor laboratory precision. In this case, the laboratory is obligated to halt the analysis of samples and eliminate the source of the imprecision before proceeding.

Accuracy criteria: The "absolute" accuracy of an analytical method can be assessed using CRMs only when certified values are provided for the analytes of interest. However, the concentrations of many analytes of interest to SWAMP are provided only as non-certified values in some of the more commonly used CRMs. Therefore, control limit criteria are based on "relative accuracy", which is evaluated for each analysis of the CRM or LCM by comparison of a given laboratory's values relative to the "true" or "accepted" values in the LCM or CRM. In the case of CRMs, this includes both certified and noncertified values. The "true" values are defined as the 95% confidence intervals of the mean.

Based on typical results attained by experienced analysts in the past, accuracy control limits have been established both for groups of compounds (**Appendix C**).

Continuing Calibration Checks (CCC's)

Calibration check solutions traceable to a recognized organization must be inserted as part of the sample stream. The source of the calibration check solution shall be independent from the standards used for the calibration. Calibration check solutions used for the continuing calibration checks will contain all the analytes of interest. The frequency of these checks is

dependent on the type of instrumentation used and, therefore, requires considerable professional judgment. All organic analyses shall be bracketed by an acceptable calibration check. **Appendix C** provides specific frequencies and other criteria for CCC's. If the control limits for analysis of the calibration check solution (set by the laboratories) are not met, the initial calibration will have to be repeated. If possible, the samples analyzed before the calibration check solution that failed the DQO's in **Appendix C** will be reanalyzed following recalibration. The laboratory will begin by reanalyzing the last sample analyzed before the calibration check solution which failed. If the RPD between the results of this reanalysis and the original analysis exceeds precision DQO's (**Appendix C**), the instrument is assumed to have been out of control during the original analysis. If possible, reanalysis of samples will progress in reverse order until it is determined that the RPD between initial and reanalysis results are within DQO's (**Appendix C**). Only the re-analysis results will be reported by the laboratory. If it is not possible or feasible to perform reanalysis of samples, all earlier data (i.e., since the last successful calibration control check) are suspect. In this case, the laboratory will flag the data and prepare a narrative explanation to accompany the submitted data.

Laboratory Method Blank

Laboratory method blanks (also called extraction blanks, procedural blanks, or preparation blanks) are used to assess laboratory contamination during all stages of sample preparation and analysis. For both organic and inorganic analyses, one laboratory method blank will be run in every sample batch. The method blank will be processed through the entire analytical procedure in a manner identical to the samples. Method blank criteria are provided in **Appendix C**. If eliminating the blank contamination is not possible, all impacted analytes in the analytical batch shall be flagged. In addition, a detailed description of the contamination source and the steps taken to eliminate/minimize the contaminants shall be included in the transmittal letter. Subtracting method blank results from sample results is not permitted.

Completeness

Completeness is defined as “a measure of the amount of data collected from a measurement process compared to the amount that was expected to be obtained under the conditions of measurement” (Stanley and Verner, 1985). Field personnel will always strive to achieve or exceed the SWAMP completeness goals of 90% (85% for fish, clam, and mussel tissues) for water, sediment, or biota (biological assessment) samples.

Surrogates

The usage of the terms “surrogate”, “injection internal standard”, and “internal standard” varies considerably among laboratories and is clarified here.

Surrogates are compounds chosen to simulate the analytes of interest in organic analyses. Surrogates are used to estimate analyte losses during the extraction and clean-up process and must be added to each sample, including QA/QC samples, prior to extraction. The reported concentration of each analyte is adjusted to correct for the recovery of the surrogate compound, as done in the NOAA NS&T Program. The surrogate recovery data will be carefully monitored; each laboratory must report the percent recovery of the surrogate(s) along with the target analyte

data for each sample. If possible, isotopically-labeled analogs of the analytes will be used as surrogates.

Each laboratory will set its own warning limit criteria based on the experience and best professional judgment of the analyst(s). It is the responsibility of the analyst(s) to demonstrate that the analytical process is always "in control" (i.e., highly variable surrogate recoveries are not acceptable for repeat analyses of the same certified reference material and for the matrix spike/matrix spike duplicate). The warning limit criteria used by the laboratory will be provided in the standard operating procedures submitted to SWAMP.

Data will be reported as surrogate-corrected values.

Internal Standards (if they are used)

For gas chromatography (GC) analysis, internal standards (also referred to as "injection internal standards" by some analysts) may be added to each sample extract just prior to injection to enable optimal quantification, particularly of complex extracts subject to retention time shifts relative to the analysis of standards. Internal standards are recommended if the actual recovery of the surrogates added prior to extraction is to be calculated. The internal standards can also be used to detect and correct for problems in the GC injection port or other parts of the instrument. The compounds used as internal standards will be different from those already used as surrogates. The analyst(s) will monitor internal standard retention times and recoveries to determine if instrument maintenance or repair, or changes in analytical procedures, are indicated. Corrective action will be initiated based on the judgment of the analyst(s). Instrument problems that may have affected the data or resulted in the reanalysis of the sample will be documented properly in logbooks and internal data reports and used by the laboratory personnel to take appropriate corrective action.

Dual-Column Confirmation

Dual-column chromatography is required for analyses using GC-ECD due to the high probability of false positives arising from single-column analyses.

Matrix Spike and Matrix Spike Duplicate

A laboratory fortified sample matrix (commonly called a matrix spike, or MS) and a laboratory fortified sample matrix duplicate (commonly called a matrix spike duplicate, or MSD) will be used both to evaluate the effect of the sample matrix on the recovery of the compound(s) of interest and to provide an estimate of analytical precision. Frequencies and specifications for MS and MSD's are provided in **Appendix C**. A field sample is first homogenized and then split into three subsamples. Two of these subsamples are fortified with the matrix spike solution and the third subsample is analyzed to provide a background concentration for each analyte of interest. The matrix spike solution should contain as many representative analytes from the SWAMP analyte list as feasible. The final spiked concentration of each analyte in the sample will be at least 5 times the MDL for that analyte, as previously calculated by the laboratory. Additionally, the total number of spikes should cover the range of expected concentrations.

Recovery is the accuracy of an analytical test measured against a known analyte addition to a sample. Recovery is calculated as follows:

$$\text{Recovery} = \frac{(\text{Matrix plus spike result} - \text{Matrix result}) \times 100}{\text{Expected matrix plus spike result}}$$

Recovery data for the fortified compounds ultimately will provide a basis for determining the prevalence of matrix effects in the samples analyzed during the project. If the percent recovery for any analyte in the MS or MSD is less than the recommended warning limit, the chromatograms (in the case of trace organic analyses) and raw data quantitation reports will be reviewed. If an explanation for a low percent recovery value is not discovered, the instrument response may be checked using a calibration standard. Low matrix spike recoveries may be a result of matrix interferences and further instrument response checks may not be warranted, especially if the low recovery occurs in both the MS and MSD, and the other QC samples in the batch indicate that the analysis was "in control". An explanation for low percent recovery values for MS/MSD results will be discussed in a cover letter accompanying the data package. Corrective actions taken and verification of acceptable instrument response will be included. Analysis of the MS/MSD is also useful for assessing laboratory precision. The RPD between the MS and MSD results should be less than the target criterion listed in **Appendix C** for each analyte of interest.

FIELD QUALITY CONTROL REQUIREMENTS

Travel Blanks - The purpose of the travel blank is to determine if there is any cross-contamination of volatile constituents between sample containers. One VOA sample vial (volatile organic analytes= MTBE, BTEX, and VOC's), with deionized (DI) water free of volatile contaminants, is transported to the site, handled like a sample (but never opened up), and returned to the lab for analysis. One travel blank for each batch of VOA samples shipped to the laboratory is required. Travel blanks are not required for other analytes, but are encouraged to be utilized for other analytes as possible and appropriate.

Equipment Blanks (done in lab prior to field work) - To ensure that equipment used during sampling does not contaminate samples, the device is filled with DI water or DI water is pumped through the device, transferred to sample bottle(s), preserved (if appropriate) and analyzed by the lab. Equipment blanks are run when new equipment, equipment that has been cleaned after use at a contaminated site, or equipment that is not dedicated for surface water sampling, is used. An equipment blank is prepared for metals in water samples whenever a new lot of filters is used.

Field Duplicates - Duplicate samples will be collected for all parameters (including toxicity and bioassessment samples) at an annual rate of 5% of total samples to be collected within a given year's Work Plan. The duplicate sample will be collected in the same manner and as close in time as possible to the original sample. This effort is to attempt to examine field homogeneity as

well as sample handling, within the limits and constraints of the situation.

Field Blanks - A field blank is designed to assess potential sample contamination levels that could occur during field sampling and sample processing. Field Blanks (DI water) are taken to the field, transferred to the appropriate container, preserved (if appropriate), and otherwise treated the same as the corresponding sample type during the course of a sampling event. Field blanks are to be collected at a 5% rate for the following constituents: trace metals in water (including mercury), VOA samples in water and sediment, DOC samples in water, and bacteria samples. Field blanks for other media and analytes should be conducted upon initiation of sampling, and if field blank performance is acceptable, further collection and analysis of field blanks for these other media and analytes need only be performed on an as-needed basis, or during field performance audits.

Section B6. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

To minimize downtime of measurement systems, all field sampling and laboratory equipment must be maintained in working condition. Also, backup equipment or common spare parts will be available so that if any piece of equipment fails during use, repairs or replacement can be made as quickly as possible and the measurement tasks resumed.

Field Equipment - All field equipment which have manufacturer-recommended schedules of maintenance will receive preventive maintenance according to that schedule. Other equipment used only occasionally will be inspected for availability of spare parts, cleanliness, battery strength, etc. at least monthly and especially prior to being taken into the field. Common spare parts which should be available include, but are not limited to: batteries; tubes; light bulbs; rubber, Tygon™, polypropylene, or glass tubing; replacement probes; glassware. After use in the field, all equipment will be re-checked for needed maintenance.

Laboratory Equipment - Electronic laboratory equipment usually has recommended maintenance prescribed by the manufacturer. These instructions will be followed as a minimum requirement. Due to the cost of some laboratory equipment, back up capability may not be possible. But all commonly replaced parts will have spares available for rapid maintenance of failed equipment. Such parts include but are not limited to: batteries; tubes; light bulbs; tubing of all kinds; replacement specific ion electrodes; electrical conduits; glassware; pumps; etc.

A separate log book will be maintained for each type of equipment whether field or laboratory. All preventive or corrective maintenance will be recorded. The total history of maintenance performed will be available for inspection during a systems audit.

Section B7. Instrument Calibration and Frequency

An instrument or device used in obtaining an environmental measurement must be calibrated by the measurement of a standard. Every instrument or device has a specialized procedure for calibration and a special type of standard used to verify calibration. Laboratory and field equipment vary from location to location so that procedures for calibration may vary depending on the manufacturer. Therefore, a single format for calibration procedures and frequency is not possible for this program plan. The means and frequency of calibration recommended by the manufacturer of the equipment or devices as well as any instruction given in an analytical method will be followed. When such information is not specified by the method, continuing calibration will be performed on a 10 percent basis, except for analysis by gas chromatograph/mass spectrometer. It is also required that records of calibration be kept by the person performing the calibration and be accessible for verification during either a laboratory or field audit.

Field equipment needs periodic calibration. Calibration is required to be done within 24 hours before use and within 24 hours after measurement activities in the field are performed. Equipment to be calibrated includes, but is not limited to: titration equipment for chlorine analysis; thermometer; DO meter; pH meter; conductivity meter; multiparameter field meter (DO, pH, temperature, and specific conductance). Calibration log books should be issued to and maintained by each entity or agency conducting field data measurements using field equipment as listed. One calibration logbook is to be used per multiprobe instrument. These logbooks are to be kept in a safe place in the respective entity or agency laboratory and only taken to the field when instruments are to be used over a period of days requiring post-calibration or calibration in the field. All requirements for multiprobe instrumentation and calibration instructions are found in **Appendix E** of the SWAMP PM. A multiprobe sensor calibration and maintenance log recommended for use in the SWAMP Program (used in calibrating and maintaining these instruments) may also be found in **Appendix E**. If, after post-calibration checks, it is determined that the acceptable amount of drift has been exceeded for a multiprobe instrument, data collected by the probe out of compliance for that sampling event should in most cases not be submitted to the SWAMP Program for inclusion into the database, unless appropriately flagged and tracked as such. The investigator will resolve the problem with the instrument, either by conducting routine maintenance or by sending the instrument to the manufacturer for repair. The investigator will be encouraged to re-measure that field parameter as soon as possible. SOPs for laboratory equipment and devices needing calibration are referenced in the contract labs QA plans on file with each contracting laboratory. Electronic meters, analytical balances, thermometers, or temperature gauges will have verifiable calibration records. Laboratory reagents are standardized to verify that the percentage or normality is that which is prescribed for the analytical method. Reagent standardization is a form of calibration that is included in both field and laboratory quality control procedures.

Section B8. Inspection/Acceptance Requirements For Supplies And Consumables

The procurement of supplies, equipment, and services must be controlled to ensure that specifications are met for the high quality and reliability required for each field and laboratory function. All equipment and material specifications used by contract laboratories or SWRCB or RWQCB SWAMP personnel in surface water quality monitoring are outlined in the respective laboratories operating procedures and policies. Equipment and materials are purchased independently by each SWAMP contract laboratory, by the SWRCB, or by respective RWQCB SWAMP staff. It is the responsibility of each staff person doing the ordering to inspect the equipment and materials for quality.

Upon receipt of materials or equipment, a designated employee receives and signs for the materials. The items are reviewed to ensure the shipment is complete and they are then delivered to the proper storage location. All chemicals are dated upon receipt. All supplies are stored appropriately and are discarded upon expiration date.

Section B9. Data Acquisition Requirements (Non-direct Measurements)

Water quality monitoring data from sources other than directly from the SWAMP-funded monitoring activities will not be entered into the official SWAMP Information Management System (SIMS) at this time, unless otherwise determined and approved by the SWAMP IMS Data Manager, the SWAMP QA Program, and the SWRCB SWAMP Program Manager. Future programmatic funding and staffing provisions may allow for the inclusion of these non-direct measurement data, but these limitations preclude their inclusion in the official SIMS at this time.

However, the use of data obtained from these sources (non-direct measurements) is highly encouraged in the SWAMP planning efforts to produce annual Work Plans, and for SWAMP data assessment/data interpretation activities, provided that these data were collected in projects which were supported by an approved QAPjP, or at a minimum utilized approved and documented standard methods. RWQCB SWAMP staff must use their professional discretion for the use of such data for these purposes. These data are usually obtained in electronic format and should be inspected in their raw form by automated data editing procedures, where possible, as well as by RWQCB SWAMP water quality staff before data reduction and interpretation is undertaken for the uses described, or other uses as applicable.

Data collected from citizen monitoring efforts throughout California likewise at this time must be deemed non-direct measurements, and not allowed for entry into the official SIMS. The exceptions to this are those data that are collected by citizen monitors in conjunction with official SWRCB and RWQCB Clean Water Team protocols which prescribe similar, equivalent, or more stringent criteria for QA/QC than provided for in this SWAMP QAMP. Many citizen monitoring programs in California are now being coordinated in conjunction with the SWRCB's Clean Water Team's guidance, and in those cases, pending approval of RWQCB SWAMP staff and SWRCB Clean Water Team staff, citizen monitoring data would likely be appropriate for entry into the official SIMS, as a QAPjP would have been followed with requirements similar to, equivalent to, or more stringent than, this QAMP. Those citizen monitoring data which may meet the requirements of the SWAMP SIMS for entry, however, must still be submitted by appropriate RWQCB or SWRCB Clean Water Team staff, in the format as specified by the SIMS.

Section B10. Data Management

One major challenge in conducting a statewide monitoring effort is development of a unified data system. For instance, in many cases the participating SWAMP organizations have previously developed data management systems of their own, or for their own specific objectives. These systems vary in the types of data captured, the software systems in which they are stored, and the degree of data documentation. In order to meet the SWAMP Program goal of centralized data management, a cooperative information management system is necessary to ensure that the collected data can be shared effectively among participants.

Information management needs to occur on several levels. First, a process must be developed to ensure the quality, compatibility, and timeliness of the data each organization collects. Once collected and organized, it must be available in as timely a manner as possible to the Regional Board SWAMP staff and others for review, analysis and ultimately for interpretation. Ultimately, one of the major goals of the use of this information, once interpreted, is to make it available to other interested organizations and the general public. The SWRCB SWAMP Program is also in the process of creating and maintaining an official website for the SWAMP Program, upon which such reports and data and other information would become available.

Appendix J to this SWAMP QAMP, the Interim SWAMP Information Management System (SIMS) Plan, documents and describes in detail the information management system (IMS) in that will support data capture and reporting during the initiation of SWAMP, although several elements are still being documented and finalized. The Interim SIMS Plan focuses on four major functions of the SIMS:

- The standard protocols each participating agency or laboratory will use to transfer data from their internal date generators to the SWAMP IMS.
- The process by which data will be submitted to the SWAMP data managers, including the path and quality control procedures the data will follow until it has been accepted.
- The technical specification (guidelines) of how the data will be organized in the SWAMP database.
- The milestones and mechanisms by which the data will be made accessible to project participants, other organizations, and the general public.

APPROACH TO INFORMATION MANAGEMENT

The Information Management System has several purposes, most importantly to provide a mechanism for sharing data among project participants. Data sharing is required if the SWAMP goal of producing an integrated hydrologic unit assessment of the State's surface waters is to be achieved. While this is the primary focus, the IMS has been developed in recognition that SWAMP represents an initial effort toward data standardization among regions, agencies and laboratories and that protocols adopted here

may be later used for other data sharing purposes beyond this project. Thus, the system was designed to be flexible to future adaptation. In addition, the system was constructed primarily to serve the RBS and technical committees, but it has also been designed to supply data to non-project scientists and the interested public.

The IMS will be based on a centralized data storage model (see Figure 6). A centralized system was selected because SWAMP is an integrated project and the typical data user will be interested in obtaining synoptic data sets from discrete hydrologic units or large geographical regions of the state. The centralized system was also selected over the alternative of a distributed system linked through a server or series of FTP sites because sophisticated tools would need to be developed and implemented for users to access those sites. There is also valid concern over the difficulty of maintaining a linked-distributed system for an extended number of years. Current budget allocations make the centralized system a more achievable model for handling data in the SWAMP program

The centralized database will be developed using standardized data transfer protocols (SDTP) for data exchange and Data Entering/Editing Forms for field data and observations. The SDTP details the information to be submitted with each sample collection or processing element, the units and allowable values for each parameter, and the order in which that information will be submitted. They are necessary to ensure that data submitted by the participants are comparable and easily merged without significant effort or assumptions by the organization responsible for maintaining the centralized data system. Use of SDTP allows each participating organization to retain data they generate in their local data management system while providing a mechanism for data exchange among project participants and a means for populating a centralized database.

The SWAMP database will be organized through a relational structure. The central database will be called the Replicate Master and will contain a temporary and permanent side, which are further described in the Data Flow Section below (and in Figure 6). The relational structure involves use of multiple data tables linked through one or more common fields or primary keys. A relational structure allows data created at different times (e.g. lab data vs. field data) to be entered at the time of data production, minimizing the possibility of data loss. This relational structure also minimizes redundant data entry, by allowing data that are recorded only once (e.g. station location) to be entered into separate tables rather than to be repeated in every data record.

The data table structure of this database was designed around a sample driven model. One distinct feature of this database captures a “nominal” position of the station (lat/long) which is stored in the stations table while still capturing a “actual” position of each sample. This is important because many different organizations will be occupying a station at different times to collect different samples. An example would be one group collects water samples, another group would deploy and retrieve bivalves, while yet another would collect stream bioassessment information at a station. This database structure was also designed with surface water sampling in mind, however, it is also built to capture information collected at multiple depths in the water column more commonly observed in marine and freshwater

lake sampling systems.

It is imperative that station failures are documented in the sample table of the database to insure that a value is not missing from the database but was indeed documented as not being sampled. An example would be a station not being sample because it was "dry". This will be further described in the Master Table Structure in Appendix J of this QAMP.

ROLES AND RESPONSIBILITIES

SWAMP is a cooperative effort among eleven organizations (SWRCB, nine RWQCBs, CDFG) plus numerous additional subcontractor labs which have limited experience working together. Effective implementation of the SWAMP Information Management System Plan requires clearly defined roles for participants (Figure 6). For the purpose of defining roles, there will be four types of participants in SWAMP:

- Data generators - Field crew leaders (Key Data Entry) and laboratory supervisors who will be responsible for compiling data their organization generates and entering the data into the Data Entering/Editing Forms or the SDTP tables.
- SWAMP IM Coordinator (SIMC)- Responsible for working with Data Generators and leading the Data Management Team (DMT) at Moss Landing Marine Laboratories to develop SDTP, and for creation and management of the centralized SWAMP database.
- SWAMP Data QA Coordinator (SIMQA) - Responsible for overseeing quality assurance during migration of completed datasets to permanent data in the SWAMP database.
- SWIM IM Coordinator- Responsible for accepting data from SWAMP, placing it in the SWRCB SWIM database, and transferring it to other EPA databases, such as STORET.

Data Flow (still under development)

Official submission to the database can occur in two ways, 1) by form entry and 2) by batch loading (Figure 3) using SDTP. These data will reside in the temporary side of the Replicate Master. Data will be considered draft as it is loaded into the database (meets statewide comparability criteria) and compared with the task orders and found to be complete. Completeness checks will be accomplished with coordination between the SIMC and the Regional Board Staff requesting the work to be done as they have the best understanding of the study design. Data is considered complete when all results are entered in the database for a specific sample. Any SWAMP participants can have access to this draft data by requesting a replicate from the SIMC.

Once the draft data is certified complete, it will be transferred to the permanent side of the Replicate Master and sent to the SIMQA (QA Officer replica) for quality assurance checks. Once the data is validated by the SIMQA it will be considered final data.

Following certification of all portions of the data by the SIMQA, the SIMC will submit the integrated

across-state data set to be stored in a Manger's replica of the SWAMP database. The SIMC will be the point of contact for data requests about the integrated data set. The SIMC will also be responsible for making the SWAMP data available to other data centralization functions such as the SWRCB SWIM database. The SWIM IM Coordinator (SWIMC) will be responsible for maintaining the current version of the SWAMP database within SWIM, and transferring it to other databases, such as STORET.

General Structure of Database

The SWAMP database currently contains 20 data tables (Figures 7 and 8). There are 10 entry level data tables and 10 permanent level data tables, both containing similar content. The main table is the Sample table, which includes a single data record for sample taken. Samples created can be 1) laboratory samples (lab generated), 2) analytical samples (field generated), 3) field observations or 4) field results. The Sample table includes all fields necessary to uniquely describe a sample. This sample is linked in a one:one or one:many relationship with all subsequent data tables. It is imperative that the *StationCode, SampleDate*, and *SampleTime* remain the same for all the field-generated samples, observations and results in order to link the information.

The combination of the fields *StationCode, EventType, SampleDate, SampleTime, SampleTypeCode, Duplicate, DepthSampleCollected, DistanceFromBank*, and *AgencyCode* will ensure that each record in the Sample table is unique. Sample records need to be linked with all results data and thus become the foundation of the database. The chemistry and toxicity results tables, all laboratory and analytical data are captured at the level of individual replicate, rather than in a summarized form. It is essential that the laboratories receiving samples be supplied with the information in this table for each sample.

Form Entry/Editing Protocols

Key Data Entry people (limited number per RWQCB) will enter field data into a replicate of the central SWAMP database data entry/editing forms provided to them by the DMT. Limited analytical data can also be entered through the form entry system. The DMT will provide training and support for use of these forms. The individual replicates will be synchronized with the central SWAMP database (Replicate Master). Recommended QA for form-entered data include double checking of data, or at minimum 20%, and range checks of the Field Results table. Data will next be submitted to the SIMC for synchronization to the Replicate Master and QA of data types.

Standardized Data Transfer Protocols

The data formats for the SDTP table submissions are detailed in App J, Chapter V, Section C (SWAMP Data Formats). These data formats include Lookup lists that are required to use in order for the data to be loaded into the database. The DMT will work with analytical labs on an individual basis to make this process as seamless as possible. Fields for summary quality assurance information are also included. A detailed laboratory QA report will be required and addressed in detail in the SWAMP QAMP.

Upon receipt, the DMT will update a data submission log to document the data received from each submitting organization. The DMT will then initiate a series of error checks to ensure the data: 1) are

within specified ranges appropriate to each parameter measured, 2) contain all required fields, 3) have encoded valid values from constrained look-up lists where specified, and 4) are in correct format (text in text fields, values in numeric fields, etc.). If there are only a few, easily correctable errors, the DMT will make the changes. Changes will only be made with the consent of the data generator, with a list sent back to the data generator documenting the changes. If, there are numerous errors, or corrections difficult to implement, the DMT will send the data file back to the submitting organization with a list of necessary corrections. The submitting organization will make the corrections and resubmit the file to the DMT, who will subject the file to error checking once again. Each of these paths will be documented by the DMT as part of the submittal tracking process.

Data revisions (still under development)

Data can be revised in several ways depending on the stage of the data. When data is in the temporary side of the database, key data entry people will have the ability to revise data using the Data Entry/Editing Forms. When data is synchronized with the Replicate Master these edits will be committed to the database. It is important to note that the key data entry people or the DMT who make these edits bare the responsibility of making sure they are valid. Data deletions at this stage could have severe consequences to the database and should be used with care. Data being submitted using the SDTP can either be revised before or after it is submitted to the DMT. Once the data is transferred to the permanent side of the Replicate Master, only the DMT, Designated Regional Board Staff and SIMQA will be able to edit it.

Schedule

The schedule for data submission varies by data type. Data collected in the field will be due first, while data produced through extensive laboratory analysis will be produced on a schedule consistent with nominal laboratory processing times. Key data entry people should provide their data to the DMT so that there is sufficient time for the DMT to resolve any data discrepancies and to ensure the data are in the proper format for the addition of the batch input data.

Data Sheets

To assist organizations in meeting the data entry forms and improve the efficiency of data input, the DMT has created a series of data sheets. These sheets follow closely with the data entry forms, however data gatherers are not required to use them.

Figure 6: Flowchart of Statewide SWAMP Data Generators/Roles and Responsibilities

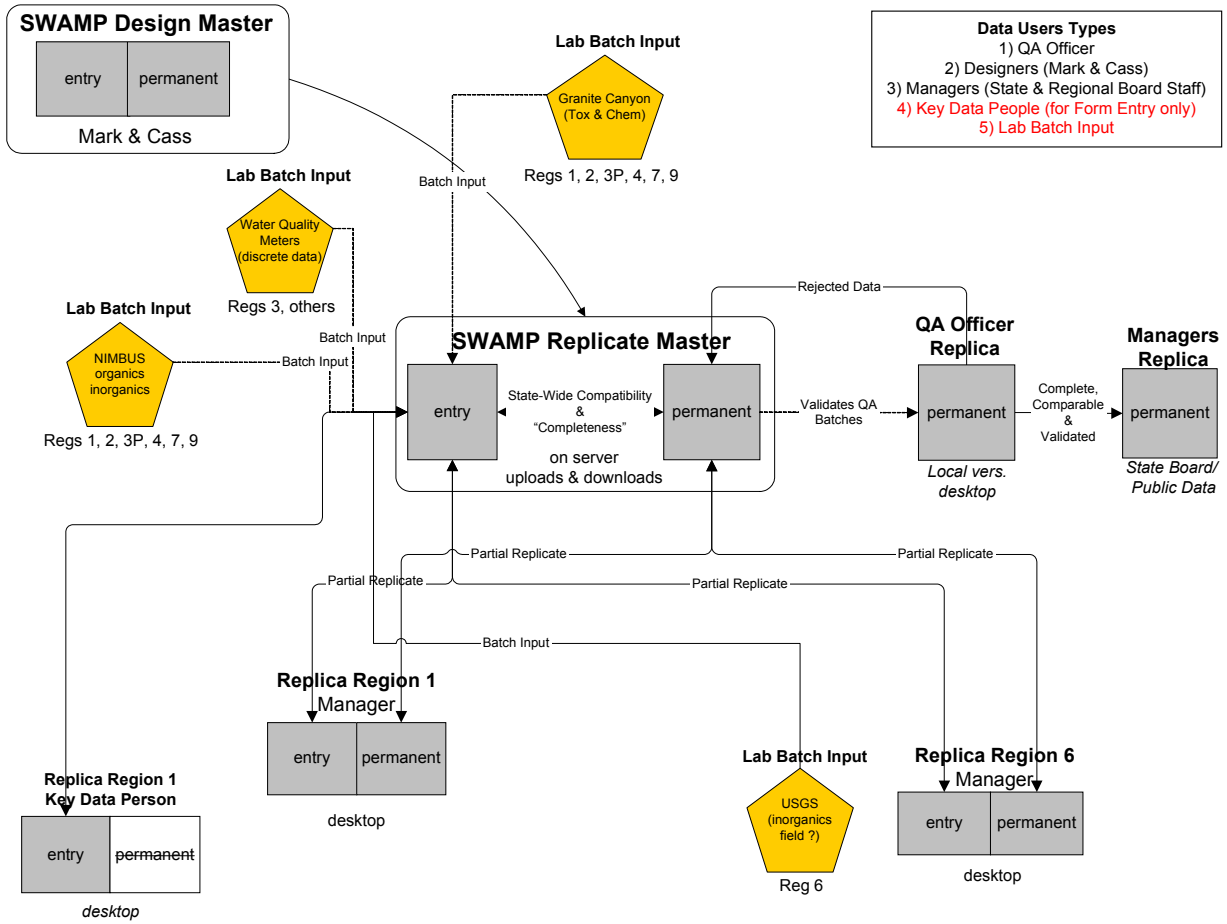


Figure 7: Outline of SWAMP Standardized Data Transfer Protocol Tables

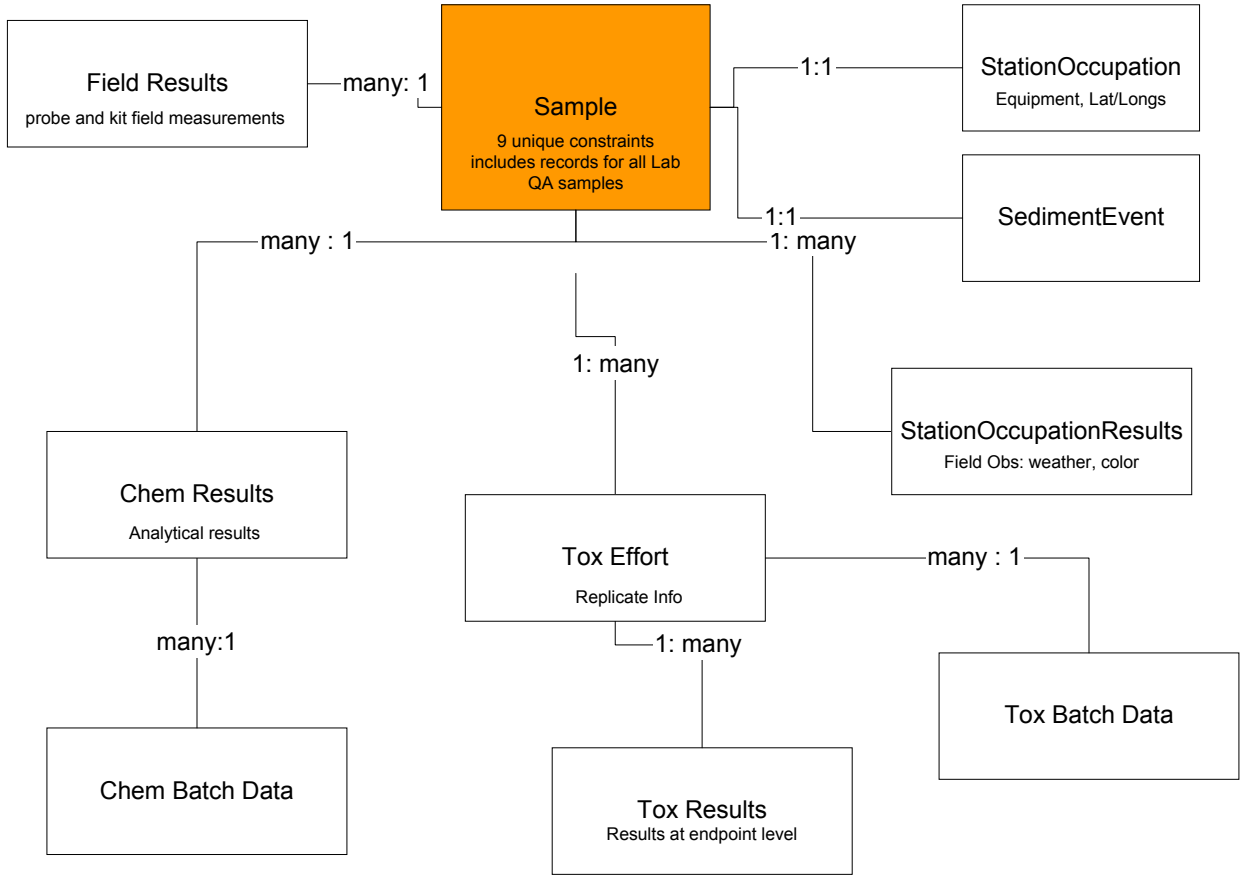
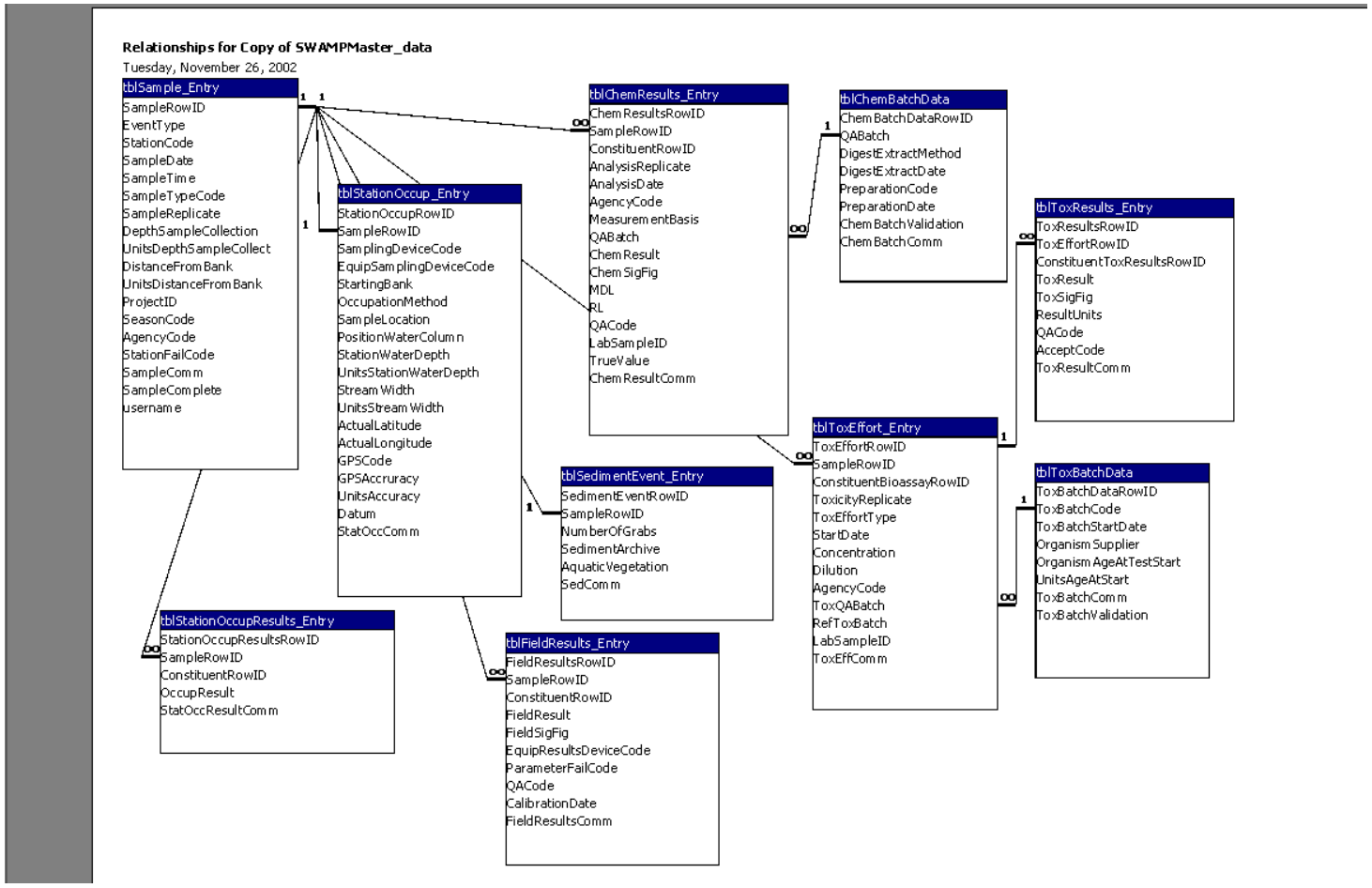


Figure 8: Contents of SWAMP Standardized Data Transfer Protocol Tables



DATA ACCESS (still under development)

All measurement and supporting data gathered during SWAMP will be made available to all participating organizations and to the general public, though the schedule of availability and point of contact will vary by user. The different schedules reflect the differing levels of quality assurance and data documentation that will have been completed at various stages in the project.

The first location of data availability will be the SIMC, who will be responsible for the SWAMP database generated within the state. The SIMC will be free to distribute SWAMP data collected within the state, at any point after the data has approved as complete by the SIMQA and submitted to the final SWAMP database. Data released prior to having been transmitted and accepted by the SIMC and SIMQA should be identified as DRAFT data, not SWAMP data, because SWAMP quality assurance procedures will not yet have been performed. If Draft data is released, all filenames will include the word "DRAFT". If hardcopies of Draft data are released, the pages must be stamped "Draft". It is highly recommended that data released prior to its submittal to the SIMC be limited to organizations directly participating in the SWAMP project, rather than to outside agencies or the general public. Releases to the general public are not recommended until quality assurance has been performed by the SIMQA and metadata documentation is completed.

Nodes (planned for future implementation, if funding allows)
The second location of data availability will be the SWIMC, who will be responsible for integrating SWAMP and other state program data sets into the SWIM database. These data sets may be made available through other centralized or distributed databases, as coordinated by the SWIMC. It is the responsibility of the SWIMC to obtain express permission of the individual Program Managers prior to distribution of their respective program's data outside of the SWIM database.

Metadata
Each release of data to the public will include comprehensive documentation about SWAMP and the accompanying data sets. Referred to as metadata, this documentation will include database table structures (including table relationships) and lookup tables used to populate the fields in each table. It will also include quality assurance classifications of the data and documentation of the methodologies by which the data were collected.

A second type of metadata will document changes made to the data over time. As the data are used, we anticipate that errors will be found. As changes to the data are made, they will be documented in a file organized by date and data table. Including this file with each data download will allow users to reconcile potential differences in analysis output that result from using different versions of the data.

Metadata will follow guidelines from the Federal Geographic Data Committee, Content standard for digital geospatial metadata, version 2.0. FGDC-STD-001-1998 (FGDC 1998), including the Biological Data Profile and the Biological Names and Taxonomy Data Standards developed by the National Biological Information Infrastructure (NBII 1999). For tabular data, metadata that meet the FGDC content standard are contained by a combination of the SWAMP Data Directory and the SWAMP Data Catalog. For Arc/Info coverages, the metadata are in the .DOC file embedded in the coverage. This file stays with the coverage. When the coverage is moved to a public web site, it will be duplicated to an ASCII text file.

Contact information for SWAMP information management:

SWAMP IM Coordinator (SIMC): Cassandra Roberts *Moss Landing Marine Laboratories* *Marine Pollution Studies Lab* 7544 Sandholdt Road Moss Landing, CA 95039 Ph. 831 771-4163 Fax 831 633-0128 roberts@mlml.calstate.edu Data Management Team (DMT) Mark Pranger *Moss Landing Marine Laboratories* *Marine Pollution Studies Lab* 7544 Sandholdt Road Moss Landing, CA 95039 Ph. 831 771-4176 Fax 831 633-0128 pranger@mlml.calstate.edu	SWAMP Data QA Coordinator (SIMQA) Not filled at this time--anticipated to be hired within 2003 if SWRCB funding allows.

For Future Implementation, if budget allows for development of nodes(these entities are currently providing extensive technical assistance into the database development):

Regional IM Coordinator (RIMC)- California Central Valley:
San Francisco Estuary Institute:Bruce Thompson
Department of Water Resources: Carl Jacobs

Regional IM Coordinator (RIMC)- - Southern California:
Larry Cooper
Southern California Coastal Water Research Project

Section C1. Assessments and Response Actions

The commitment to use approved equipment and approved methods when obtaining environmental samples and when producing field or laboratory measurements must have periodic verification that the equipment and methods are, in fact, being employed and being employed properly. The verification is accomplished by conducting performance and systems audits. The audits will be conducted by the SWAMP QA Program, as funding allows, with assistance from the 3rd party (referee) external QA Officers contracted by DFG to provide such services, and shall be independent of the actual duties of either the project management or laboratory management. These persons will be familiar with the field sampling requirements of the program and/or laboratory QA.

Before any investigation included in the water quality monitoring program begins, it will be verified that proper equipment is available for all field inspectors. This includes sampling equipment, safety equipment, and field measurement equipment (and calibration standards). It will also be verified that all personnel involved in field activities have received sufficient training and are able to properly use the equipment and procedures. The application of procedures and equipment will be verified periodically. This verification is made during periodic field performance audits. SWAMP field personnel will be observed during an actual field investigation to verify that equipment and procedures are properly applied. Details of the QC review are outlined in the SWAMP Recommended Lab/Field QA Evaluation Guidance (**Appendix I**) including review of records, field performance audit samples and corrective actions.

Those laboratories contracted to perform analytical measurements on samples collected during any water quality monitoring investigation are routinely monitored by the SWAMP QA Program, and by respective contract managers for those laboratories. During laboratory systems audits, it should be noted what equipment is available, what personnel are available, and what procedures are followed for data quality verification. Any inadequacy is noted in a response letter to the laboratory management. The laboratory management is then responsible for making any corrections needed and to report these corrective actions to the SWAMP QA Program. Follow-up inspections confirm that deficiencies have been addressed.

All of the performance and system audits described in this plan, including the annual workshop, training sessions and QC reviews are planned to be performed, if contractual and funding limitations allow. The activities included in the QC reviews, training sessions and annual workshop constitute routine performance and system audits.

Performance Evaluation Audits and Responses

Internal and External Performance Audits for SWAMP Analytical Labs

In addition to in-lab training and certification/documentation of lab analytical staff proficiencies, all lab staff will be evaluated on their performance during lab performance audits, both internal and external, conducted by respective Laboratory QA Officers (internal), or their designees, and by SWAMP QA Program staff (external), or their designees. The conducting of such lab performance audits, particularly internal audits, is recommended to be done every two years, depending on funding and QA needs, or more often if necessary. If any deficiencies are noted during this lab QA audit, they will be documented and remedied prior to continued lab operations. This can be accomplished by additional training or by changing the staff composition, but verification of correction of any deficiencies must be documented in writing prior to the resumption of further sample analysis activities. It is the responsibility of the any and all SWAMP entities conducting laboratory analytical activities to develop and implement internal proficiency, training, and QA audit "checklists". Copies must be maintained in a central file by each SWAMP entity of all internal training and QA audit reports completed, as well as documentation of any deficiencies and corrective actions necessary to remedy such deficiencies. When requested, these records must be accessible to, or copies provided to, the SWAMP QA Program or other designated officials. Further information and topics/issues to be reviewed and discussed during an external lab audit is provided in the SWAMP Recommended Lab/Field QA Evaluation Guidance (**Appendix I)**.

Section C2. Reports to Management

Quarterly progress reports (QPR's) are normally required to be produced by any contractors conducting work through the State of California, and are highly recommended for those participating in the SWAMP program. QPR's would be provided either in writing or orally to SWAMP Program Management in order to document project status, any significant field or laboratory issues, timeliness of scheduled field and analytical activities, any significant QA problems, or other issues, and provide recommended solutions, if applicable.

A Quality Assurance report will be prepared by the SWAMP Quality Assurance Program, if funding provides for the creation of this program, following each year of monitoring. The quality assurance report will summarize the results of QA/QC assessments and evaluations, including precision, accuracy, comparability, representativeness, and completeness of the monitoring data; will provide a summary of the annual interlaboratory calibration exercise findings; will provide a summary of the 5% field duplicate analyses; and will provide a summary of any lab and/or field performance audits that were conducted. The annual report will be distributed to the project managers, as well as to all other program participants and interested parties.

Section D1. Data Review, Validation, and Verification Requirements

Data verification and data validation are key steps in the transition from the implementation (sampling and analysis) phase to the assessment phase. EPA has recently provided a comprehensive guidance document (EPA 2001), entitled "*Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8)".* The purpose of this guidance is to explain how to implement data verification and data validation, and to provide practical advice and references. This guidance describes an array of data verification and data validation practices in order to promote common understanding and effective communication among environmental laboratories, field samplers, data validators, and data users.

Although data verification and data validation are commonly-used terms, they are defined and applied differently in various organizations and quality systems. Without attempting to preempt other meanings or approaches, the SWAMP Program will generally follow EPA's informal guidance on this topic, as provided in EPA 2001, and incorporates the following definitions:

Data Verification is confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements.

Data Validation is confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Data validation is an analyte-and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set.

Data meeting each of the applicable Data Acceptability Criteria contained in **Appendix C** are accepted for inclusion in the SIMS data base. Data which do not meet these requirements are excluded from being entered into the SIMS data base. Information on the data review, validation, and verification processes are provided in Section B10 of this document, and in more detail in the Interim SWAMP IMS Plan in **Appendix J**.

Section D2. Validation and Verification Methods

All data reported for the SWAMP Program will be subject to checks for errors in transcription, calculation, and computer input. Field data are initially validated by built in checks in the SIMS which alerts the person reporting the data immediately of outlier values for verification. These checks are described in Section B10 of this document and in more detail in **Appendix J**. For laboratory data, when the data are reported to the SWAMP data manager, if an outlier or other question arises with the data, the data manager refers the data in question to the appropriate SWAMP scientist who verifies the data. Usually, the individual who reported the data is contacted directly to resolve any discrepancies. When the SWAMP scientist is satisfied with the accuracy of the laboratory data in question, he or she signs the data form and forwards it to the data manager for data entry. The data manager will follow the SOP for data processing.

All laboratory data forms must be accurate and complete. Any changes to the data forms will be noted, initialed and dated on the form. Any actions taken as a result of the data review will also be noted on the data sheet.

Refer to Section B10 of this document for additional discussion of data problem resolutions.

Section B10 of this document also discusses the chain of custody of data throughout the life of the project.

Section D3. Reconciliation with User Requirements

There is not a specific decision which is made as a result of the data collected under this project. These data, and data collected by other organizations, will be subsequently analyzed and used by the SWRCB and RWQCB's for water quality assessments, TMDL development, stream standards modifications, permit decisions, and numerous other purposes. There are several ways SWAMP data may be evaluated and reported, as outlined below.

Establishing and Utilizing Screening Levels/Criteria/Guidelines

Typically, DQO's require the comparison of ambient measurements to established water quality standard criteria or screening levels. This allows regulators to identify waterbodies where pollution controls may be needed as well as to determine the effectiveness of controls already in place. These same data are useful for comparative analyses of data between stations and over time, and to characterize water quality conditions.

Established screening levels, standards, guidelines, and other criteria for water, sediment, and fish tissue are extensive, varied, and established for numerous purposes. John Marshak, of the Central Valley RWQCB (RWQCB 5), has produced a document which contains an extensive compendium of numerical water quality limits from the literature for over eight hundred chemical constituents and water quality parameters. An overview of this excellent reference document was provided by Jon Marshak to all SWAMP participants, and a thorough discussion held in terms of how these screening levels, critieria, and guidelines might be applied in the assessment of SWAMP program data. A summary of pertinent information regarding how to obtain this document, as well as the frequent updates to the document, is provided in **Appendix C**. The website URL address for more information on how to obtain this reference document is:

- http://www.swrcb.ca.gov/rwqcb5/available_documents/wq_goals/index.html

There are not established screening levels and standard criteria for all parameters of interest in all media. However, the screening levels that are established serve as a guideline for substances that involve similar methods of measurement. For measurement values to be directly compared to the screening levels or standard criteria, they must be reported with confidence at or below these levels. For some parameters, available technology or costs do not permit the program to achieve this minimum level of reporting. In these cases, the screening levels or standard criteria must be viewed only as a goal and adjustments of methods are made as measurement technology changes and costs allow.

It is the intent of the SWAMP Program to develop guidelines for producing interpretive technical reports for monitoring and analysis activities. At a minimum, these Reports will be produced once every other year, summarizing the prior two years of monitoring and analysis activities.

LIST OF ABBREVIATIONS

AB	Assembly Bill (California State Assembly)
ABL	Aquatic Bioassessment Laboratory (DFG)
ATL	Aquatic Toxicology Laboratory (UCD)
BPTCP	Bay Protection and Toxic Cleanup Program
CAL-EPA	California Environmental Protection Agency
CALFED	California Federal Bay Delta Program
CAO	Cleanup and abatement order
CERES	California Environmental Resources Evaluation System
CMARP	Comprehensive Monitoring, Assessment and Research Program
CWA	Clean Water Act
DFG	Department of Fish and Game
DHS	Department of Health Services
DPR	Department of Pesticide Regulation
DWR	Department of Water Resources
EMAP	Environmental Monitoring and Assessment Program
FED	Functional Equivalent Document
FY	Fiscal year
GIS	Geographic information system
IEP	Interagency Ecological Program
ITFM	Intergovernmental Task Force on Monitoring
ML	Minimum level
MDL	Method Detection Limit
MPSL	Marine Pollution Studies Laboratory
N/A	Not applicable
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
OEHHA	Office of Environmental Health Hazard Assessment
PAG	Public Advisory Group (for AB-982)
ppm	Parts per million (mg/kg sed and tissue; mg/l water)
ppb	Parts per billion (ug/kg or ng/g sed and tissue; ug/l water)
PY	Personnel year
QAMP	Quality Assurance Management Plan
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
QA/QC	Quality Assurance/Quality Control
RCD	Resource Conservation District
RL	Reporting Limit
RPD	Relative Percent Difference

RWQCB	Regional Water Quality Control Board
SAG	Scientific Advisory Group
SB	Senate Bill (California State Senate)
SCCWRP	Southern California Coastal Water Research Project
SD	Standard deviation
SFEI	San Francisco Estuary Institute
SIMS	SWAMP Information Management System
SMWP	State Mussel Watch Program
SNARL	Sierra Nevada Aquatic Resources Laboratory (UC)
SPARC	Scientific Planning and Review Committee
SWAMP	Surface Water Ambient Monitoring Program
SWIM	System for Water Information Management
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
TRL	Target Reporting Limit
TSMP	Toxic Substances Monitoring Program
TTP	Toxicity Testing Program
UC	University of California
UCD	University of California, Davis
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WDR	Waste Discharge Requirements
WMI	Watershed Management Initiative

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