Southern California Regional Watershed Monitoring Program

Bioassessment Quality Assurance Project Plan

Version 1.0

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PROJECT: Southern California Regional Watershed Monitoring Program

PREPARED BY: Southern California Coastal Water Research Project
3535 Harbor Boulevard Suite 110
Costa Mesa, CA 92626

GROUP A. PROJECT MANAGEMENT

1. Approval Sheet

Grant Organization

_____ _____
Ken Schiff, Project Director Date
Southern California Coastal Water Research Project

_____ _____
Raphael Mazor, Project QA Officer Date
Southern California Coastal Water Research Project

Funding Organization (SWRCB, Surface Water Ambient Monitoring Program)

_____ _____
Pete Ode, Contract Manager Date
SWAMP Bioassessment Coordinator

_____ _____
Beverly van Buuren, SWAMP QA Officer Date
Moss Landing Marine Laboratories

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3. Distribution List

The final QAPP will be kept on file at SCCWRP. The following individuals will receive copies of the approved QAPP and any subsequent revisions:

Kenneth Schiff
Southern California Coastal Water Research Project
3535 Harbor Blvd., Suite 110
Costa Mesa, CA 92626
kens@sccwrp.org
(714) 755-3202

Raphael Mazor
Southern California Coastal Water Research Project
3535 Harbor Blvd., Suite 110
Costa Mesa, CA 92626
raphaelm@sccwrp.org
(714) 755-32xx

Peter Ode
SWAMP Bioassessment Coordinator
California Department of Fish and Game
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-0316
pode@OSPR.DFG.CA.GOV

Beverly H. van Buuren
SWAMP QA Officer
Moss Landing Marine Laboratories
P.O. Box 46425
Seattle, WA 98146
(206) 297-1378
bvanbuuren@mlml.calstate.edu

4. Project/Task Organization

4.1 Involved Parties and Roles.

The Surface Water Ambient Monitoring Program (SWAMP) is a statewide receiving water monitoring program administered by the Sate Water Resources Control Board (SWRCB). SWAMP's mission is to monitor the health of wadeable streams in California.

The Stormwater Monitoring Coalition (SMC) is a coalition of stormwater management agencies and Regional Water Quality Control Boards (RWQCBs) from Ventura to San Diego. The SMC has undertaken a collaborative program to monitor the health of coastal watersheds in Southern California. The SMC's mission is to cooperatively answer the technical questions that enable better environmental decision-making regarding stormwater management. Member agencies include SWRCB; the RWQCBs of Los Angeles, Santa Ana, and San Diego regions; Caltrans; the cities of Long Beach and Los Angeles, the Counties of Orange, San Diego, Los Angeles, Riverside, San Bernardino, and Ventura; and the US Environmental Protection Agency.

Southern California Coastal Water Research Project (SCCWRP) is a joint powers authority formed by the largest regulated and regulatory agencies in southern California. SCCWRP's mission is to provide unbiased scientific information to these environmental decision makers for creating informed environmental policy. As the lead agency in this project, SCCWRP will organize the sample collection, coordinate analysis of samples, compile data, and lead report preparation.

Ken Schiff will be the SCCWRP Study Director for this study and will establish a project team for planning and conducting the study (Table 1, Figure 1).

The Surface Water Ambient Monitoring Program (SWAMP) is a statewide monitoring program designed to assess the chemical, physical, and biological integrity of the state's receiving waters. Since SCCWRP and SWAMP have overlapping missions, they have formed a partnership to implement a regional monitoring program that will assess the health of perennial wadeable streams in the southern California region.

Pete Ode will be the SWAMP contract manager for this study and will provide overview of the study (Table 1, Figure 1).

4.2 Officer Roles

4.2.1 Project Director

Kenneth Schiff is the Project Director. His role is to supervise and coordinate all lab analysis and field sampling activities, including overseeing training of crews, conduct of sampling events, and analysis by lab technicians. He will work with the Project and the SWAMP Quality Assurance Officers to ensure that all aspects of the program comply with the QAPP. The Project Director may stop all actions if there are significant deviations from required practices, or if there is evidence of a systematic failure.

4.2.2 Project Quality Assurance Officer

Raphael Mazor will be the Project Quality Assurance Officer. His role is to establish the quality assurance and quality control procedures found in this QAPP as part of the sampling and analysis procedures. The Project QAO will work with field and laboratory personnel by communicating all quality assurance and quality control issues contained in this QAPP. The Project QAO will report all findings to the Project Director (Ken Schiff), including all requests for corrective action. The Project QAO may stop all actions if there are significant deviations from required practices, or if there is evidence of a systematic failure.

4.2.3 SWAMP Quality Assurance Officer

Beverly van Buuren will be the SWAMP Quality Assurance Officer. Her role is to review quality assurance and quality control procedures found in this QAPP as part of the program's design and supervision. She will work with the Project Director and Project Quality Assurance Officer to ensure that the program comply with this QAPP and with state guidelines.

4.3 Persons Responsible for QAPP Update and Maintenance.

Changes and updates to this QAPP may be made after a review of the evidence for change by the Project Director and Quality Assurance Officer, and with the concurrence of the both Contract Manager and Contract Quality Assurance Officer. The Project Director will be responsible for making the changes, submitting drafts for review, preparing a final copy, and submitting the final for signature.

This document will serve as the QAPP for the SMC until the statewide QAPP for SWAMP is developed. At that point, the SMC QAPP will be updated to conform with the guidelines in the SWAMP QAPRP.

Table 1. (Element 4) Personnel responsibilities.

Name	Organizational Affiliation	Title	Contact Information (Telephone number, fax number, email address)
Ken Schiff	SCCWRP	Project Director	Tel: (714) 755-3202 Fax: (714) 755-3299 kens@sccwrp.org
Raphael Mazor	SCCWRP	Project QA Officer	Tel: (714) 755-3235 Fax: (714) 755-3299 raphaelm@sccwrp.org
Peter Ode	CDFG	Contract Manager	Tel: (916) 358-0316 Fax: (916) 985-4301 pode@ospr.dfg.ca.gov
Beverly van Buuren	Moss Landing Marine Laboratories	SWAMP QA Officer	Tel: (206) 297-1378

4.4 Organizational Chart and Responsibilities

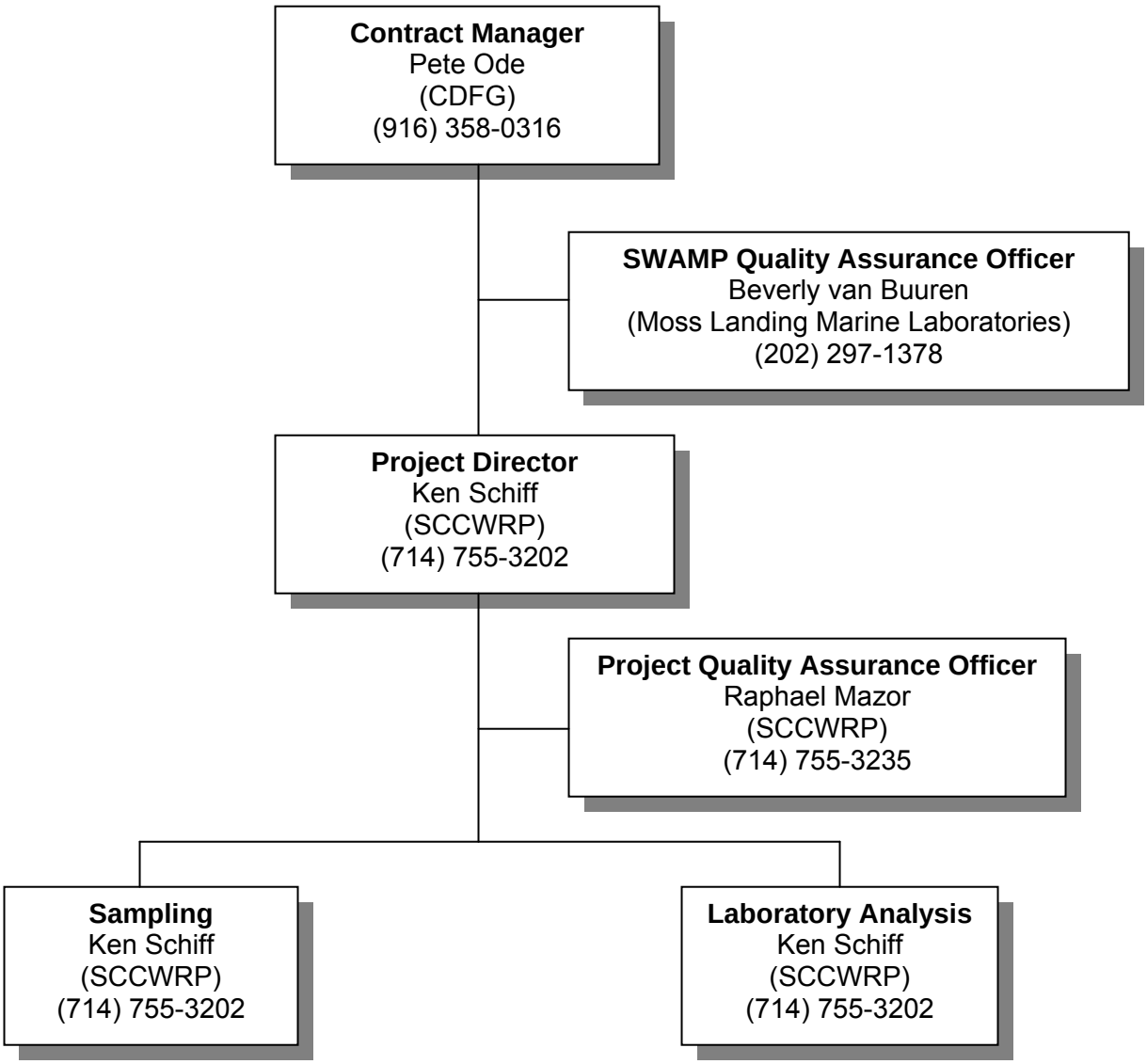

Figure 1. Organization chart

5. Problem Definition / Background

5.1 Problem Statement

5.1.1 Bioassessment in California

Bioassessments that focus on benthic macroinvertebrates (BMIs) in freshwater streams are a powerful tool for evaluating the ecological integrity of the State's waterbodies. The utility of BMIs is based on at least six factors: 1) BMIs have low mobility so they cannot escape water quality stressors; 2) BMIs integrate stressors over time; 3) BMIs respond to cumulative stressors; 4) BMIs have relatively short lifespans (typically weeks to months) so they respond to recent stressors; 5) BMIs have a diverse community structure with individual species having differential sensitivity to stressors, allowing discrimination of gradients in magnitude of impact can be ascertained; and 6) BMIs provide a direct measure of the aquatic life beneficial use that is to be protected rather than surrogate measures of water quality such as chemistry or toxicity.

The State of California, recognizing the value of bioassessment, has been developing and testing protocols for sampling and assessing BMIs for the last 15 years (CSBP 1999). As a result, bioassessment monitoring has become a more widespread and frequently utilized monitoring tool. For example, the state has implemented the SWAMP, which assesses the ecological condition of more than 211,500 stream miles annually (CSBP 1999). In addition, bioassessments are becoming more frequently added to National Pollutant Discharge Elimination (NPDES) permits. These NPDES permits mandate bioassessment to assess the impacts from in-stream discharges such as those from Water Reclamation Plants, Industrial facilities, and urban runoff/stormwater.

The goal of this QAPP is to compile the minimum data quality standards necessary for measurement of BMIs. Ideally, both regulated and regulatory water quality managers will want to integrate bioassessment data across many programs. For this to occur, data collection methods and data quality measurements must be standardized. Standard Operating Procedures for BMI field collection has already been developed (Ode 2007, Appendix B). However, minimum data standards for laboratory identification of these organisms have not been standardized. These data standards are a critical component of data comparability.

5.1.2 Quality assurance of biological data

This QAPP was developed under a set of principles designed to support data quality as a primary objective. In many cases, this objective is fulfilled in ways identical to approaches used for water chemistry, as described in the SWAMP QAPrP (SWAMP 2008). These approaches include measurement quality objectives (MQOs) to assess completeness and representativeness of data, as

well as requirements for auditing, training, and documentation of errors. However, many approaches used for data quality assurance for water chemistry have no valid analog for biological data. Instead of using the repeatable physical and chemical properties of target constituents to assess accuracy and precision, biological data are quantified using trained taxonomists relying on organism morphological features. Even for highly trained and experienced taxonomists, if organisms are immature, damaged, or otherwise indistinct, accurate identification can be difficult. Moreover, phylogenies can and do change over time based on increases in taxonomic understanding. Compounding the challenge between chemistry and biology is the inherent small-scale spatial and temporal variability in biological data. Unlike chemical data where replicate sampling and analysis of samples are expected to be similar, no such expectation exists for biological data. Hence, MQOs in this QAPP have a strong emphasis on training and oversight. As a corollary to this concept, chemical approaches that focus on accuracy do not apply to biological samples. For example, matrix spikes used for chemistry have no parallel in biological samples. Thus, a new approach using independent third party verification through a reference laboratory becomes the primary mechanism for assuring accuracy.

In order to bridge the gap between chemical and biological MQOs, a survey of bioassessment programs from California (e.g., Southern Californa Bight Monitoring Program, San Gabriel River Watershed Monitoring Program, the SWAMP Perennial Stream Assessment, and the Sierra Nevada Aquatic Research Lab), other states in the US (e.g., the Maryland Biological Stream Survey, the Flordia Department of Environmental Protection, and the Oregon Department of Environmental Quality), and from other countries (e.g., the Australian Capital Territory) identified an initial set of MQOs to include in this QAPP. Subsequently, taxonomists with many years of experience in the western US verified the MQOs, focusing on the data generation and verification process. Key to this process were the biologists of the SMC and the Southwest Association of Freshwater Invertebrate Taxonomists (www.SAFIT.org). SAFIT is the premier trade organization for freshwater taxonomists and it is their mission to promote education, training, and standardization of freshwater invertebrate identifications.

5.2 Decisions or Outcomes

The data will be used to identify the magnitude and extent of ecological disturbance in California streams.

In southern California, the bioassessment data will be evaluated using two assessment tools developed for use in the region: the Southern California Index of Biological Integrity (IBI, Ode *et al.* 2005) and the California River Invertebrate Prediction and Classification System (RIVPACS) model (described in Ode *et al.*

2008). Both of these assessment tools evaluate the existing biotic community by comparison with expected biological communities at undisturbed reference sites.

5.3 Water Quality Regulatory Criteria

No narrative numerical water quality criteria exist for bioassessment in California. Regulatory criteria for water chemistry data are specified in the SWAMP QAPrP (SWAMP 2008).

6. Project/Task Description

6.1 Work Statement and Produced Products

One of the goals of the SWAMP program is to assess aquatic life beneficial uses and to use this information for protection of rivers and streams of the State. The SWAMP program accomplishes this goal by using biological information to:

1) Estimate the current status, extent and trends of biological indicators;
2) Evaluate the associations between observed biological effects and physical and chemical stressors;
3) Prioritize stressors;
4) Develop and refine indices of biotic integrity;
5) Maintain a reference condition program to help develop regional indices of biotic integrity; and
6) Evaluate the status and trends of aquatic life use (ALU) in wadeable streams and to establish context for interpreting ALU condition in other statewide and regional programs.

This goal is accomplished by producing periodic statistical summaries and interpretive reports on ecological status and trends relative to statewide conditions and land use reporting units. (SMC Bioassessment Working Group 2007)

The goal of the SMC's Southern California Regional Watershed Monitoring Program complements SWAMP by integrating SWAMP and NPDES monitoring programs to assess the condition of perennial wadeable streams from Ventura to San Diego in a cost-effective manner. Specifically, the SMC seeks to answer three questions:

1) What is the condition of streams in Southern California?
2) What are the major stressors to aquatic life?
3) Are conditions in locations of special interest getting better or worse?

The final product will be a state-of-the-watershed report that will determine the extent and magnitude of impact to freshwater BMIs. The extent and magnitude will be compared among various southern California watersheds, land uses, and jurisdictional areas.

This document will serve as the QAPP for the SMC until the statewide QAPP for SWAMP is developed. At that point, the SMC QAPP will be updated to conform with the guidelines in the SWAMP QAPRP.

6.2 Study Design

The sampling frame includes 15 management units located from Ventura to San Diego and as far east as San Bernardino and Riverside Counties (Figure 2). These management units equate to combinations of hydrologic units utilized by the RWQCBs or ecosystem managers. Altogether, these 15 management units comprise roughly 28,051 km^2. The streamlines used to define the sampling frame were derived from the National Hydrography Dataset (NHD Plus) (US EPA and USGS 2005). Cumulatively, there are over 7,500 stream-kilometers of Strahler order 2 and greater in the sampling frame. Sample sites were selected using a probabilistic approach, stratifying by management unit and weighting by land use, and stream order (Stevens and Olsen 2004). This approach ensures that a predetermined number (i.e., 30) of sites will be sampled in each management unit, and that the overall sample will reflect approximately equal numbers of sites representing each land use and stream order. Land use was defined as either urban, agriculture, or open based on the National Oceanic and Atomspheric Administration's (NOAA's) Coastal Change Analysis Program (CCAP) remote imaging algorithms (NOAA 1995) (Figure 3). CCAP defines 35 different land use classes that have been aggregated into the three categories for this study (i.e., open, agriculture, urban, and water). The dominant land use within a 500-m buffer was assigned to each stream reach.

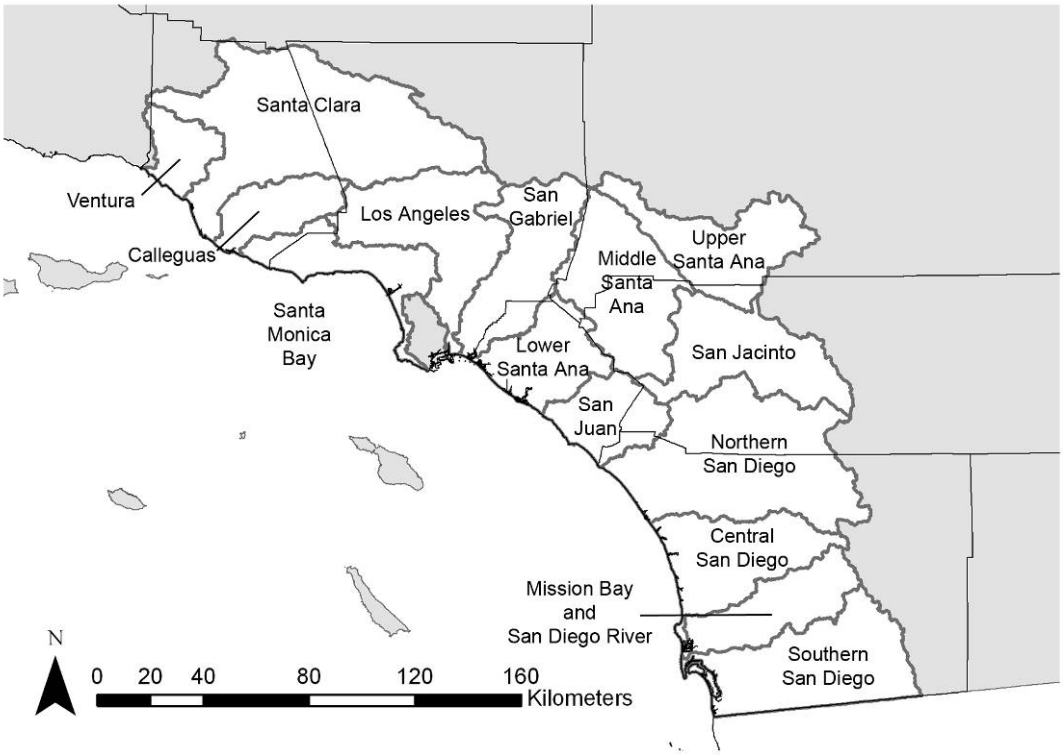

Figure 2. Management units monitored by the Stormwater Monitoring Coalition.

A

B

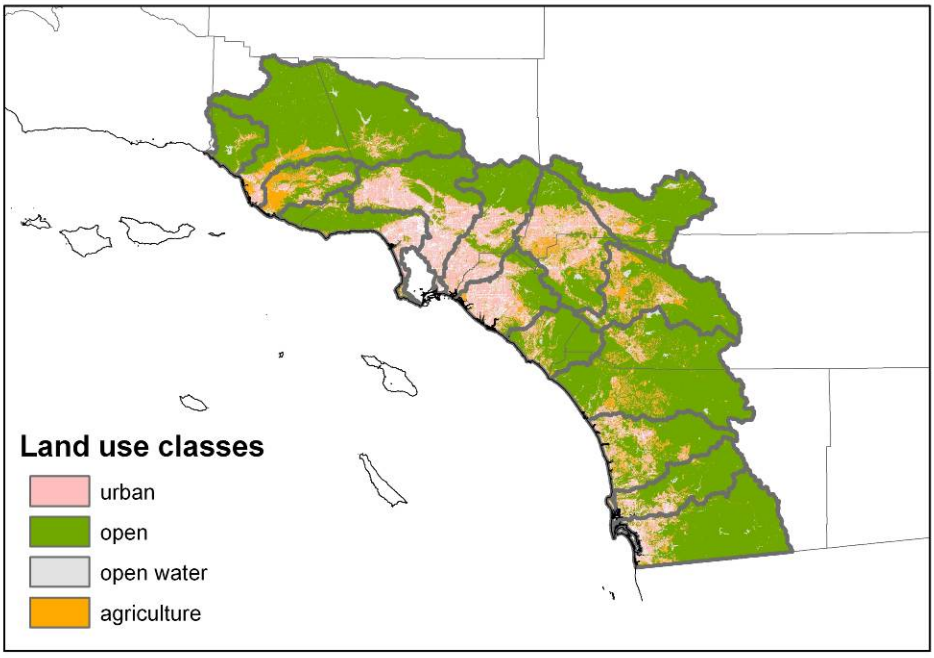

Figure 3. Land use in the SMC Region. A. CCAP remote imaging of land use in the southern California region. B. Land use assignments for the management units included in the study.

A total of 30 sites will be sampled in each management unit over 5 years, creating a total of 450 samples in the Southern California region. Sites will be sampled once during the index period, which is defined as lasting 4 to 16 weeks since the last significant rainfall. Without prior knowledge of rainfall, the default index period will occur May 15 to July 15. SWAMP is currently conducted a study on index periods throughout the state, and information provided by that study may alter these dates.

6.3 Constituents to be Monitored and Measurement Techniques

Bioassessments will sample BMI communities and assess physical habitat. Existing SWAMP standard operating procedures (SOPs) will be used to sample BMIs (Ode et al. 2007, Appendix B). See Table 2.

Table 2. (Element 6) Analytical constituents and method requirements.

Analyte	Method
Biological communities – Benthic macroinvertebrates	SWAMP SOP for benthic macroinvertebrates and physical habitat (Ode et al. 2007, Appendix B)

6.4 Project Schedule

The project schedule for the first year of the program is described in Table 3. Subsequent years will follow similar schedules.

Table 3. (Element 6) Project schedule.

Activity	Anticipated date of completion	Deliverable	Deliverable due date
Monitoring preparation	4/30/2009	Workplan, QAPP	5/15/2009
Sampling	7/15/2009	Sample event summary	8/31/2009
Laboratory Identifications	2/28/2010	Analytical Database	2/28/2010
Draft Report	8/31/2010	Draft Report	8/31/2010
Final Report	10/31/2010	Final report	10/31/2010

6.5 Geographic Setting

The SMC's Southern California Regional Watershed Monitoring program applies to all the coastal watersheds from the Mexican border to (and including) the Ventura River watershed. It is coincident with the areas encompassed by the Los Angeles, Santa Ana, and San Diego Regional Water Quality Control Boards. Streams on the Channel Islands and in the Dominguez Channel watershed are excluded (Figure 2).

6.5 Constraints

The primary constraint in southern California is the lack of streams with perennial flow. Southern California has a semi-arid, Mediterranean climate that is naturally dry for the majority of the year. This condition becomes exacerbated during years of low rainfall. This constraint can be overcome by two factors: 1) extensive site reconnaissance; and 2) limiting the sampling index period to late spring/early summer, which excludes streams with short-duration (i.e., ephemeral) flows.

7. Quality Objectives and Criteria

Measurement Quality Objectives (MQOs) are quantitative and qualitative statements that specify the tolerable levels of potential errors in the data (SWAMP 2008) and ensure that the data generated meet the quantity and quality of data required to support the study objectives.

The MQOs focused on five aspects of data quality: completeness, precision, accuracy, representativeness, and sensitivity. These MQOs address the sampling, sorting, and identification phases for producing biological data. Quality objectives for non-biological data is not addressed in this document, and will be covered by the forthcoming Quality Assurance Plan for statewide bioassessments conducted by SWAMP. Quality objectives for benthic algae and for riparian wetlands will also be addressed by other forthcoming plans. Each measurement quality category is described below. Numerical MQOs are listed in Table 4. A diagram of the data production process is provided in Figure 4. Corrective actions are described in Section 13.3.

The overarching objectives of these MQOs is to first validate the taxonomic data and ensure that the final data have an overall error ≤10%, and to provide constructive feedback concerning errors that occurred during identification to the taxonomist with the purpose of allowing them to prevent the errors from occurring in the data in the future.

In general, MQOs were set at levels found in the survey of other bioassessment programs. MQOs were set at 99% for objectives where perfect compliance was a reasonable expectation (e.g., most completeness MQOs). Where perfect compliance was not a reasonable expectation, the MQOs were set at 90%. However, where available data supported more stringent thresholds, MQOs were set at 95%. It is expected that, as data become available, these MQOs will change to reflect the most stringent threshold that can be reasonably attained.

Table 4 and Figures 4A-4C summarize the MQOs and data production processes.

Table 4. (Element 7) Measurement quality objectives for biological measurements.

Analyte	Completeness	Accuracy	Precision	Sensitivity	Representativeness
Sampling	• ≥95% successful collection at all sites for probabilistic designs	• NA	• Record coefficient of variation of biological measures	• 1.0 seconds or 1/10,000th of a degree	• Probabilistic sites are evaluated in order within each panel and management unit. • ≤10 seconds of

			for duplicate samples (no MQO), frequency of 10% or at least one per project each year.	Lat/Long	nominal Lat/Long (300 m radius)
Sorting	• Sorting efficiency ≥95%, 100 % frequency (internal) • Processing efficiency ≥99%, 100% frequency	• Recount accuracy ≥95%. 10% frequency (external reference lab)	• At least three grids or 25% of the total sample volume must be sorted.	• N/A	• ≥ 3 grids or ≥ 25% of the total sample volume is sorted
Taxonomic ID	• ≥99% successful analysis of all sorted samples	• Taxa count error ≤10%. 10% frequency (external reference lab) • Taxa ID error ≤10%. 10% frequency (external reference lab) • Individual ID error ≤10%. 10% frequency (external reference lab)	• Random errors ≤ 10% of taxa, 10% frequency (ref lab) • Systemic errors ≤ 10% of common taxa. 10% frequency (external reference lab) • Taxonomic resolution error rate ≤10%.	• SAFIT Level 2	• All sorted organisms are identified

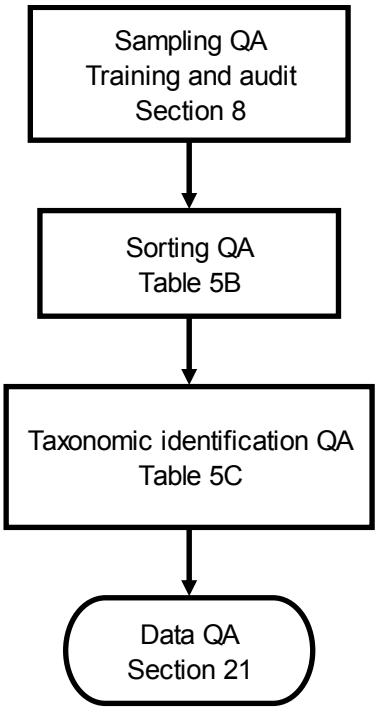

Figure 4A (Element 7). Overall data production process diagram.

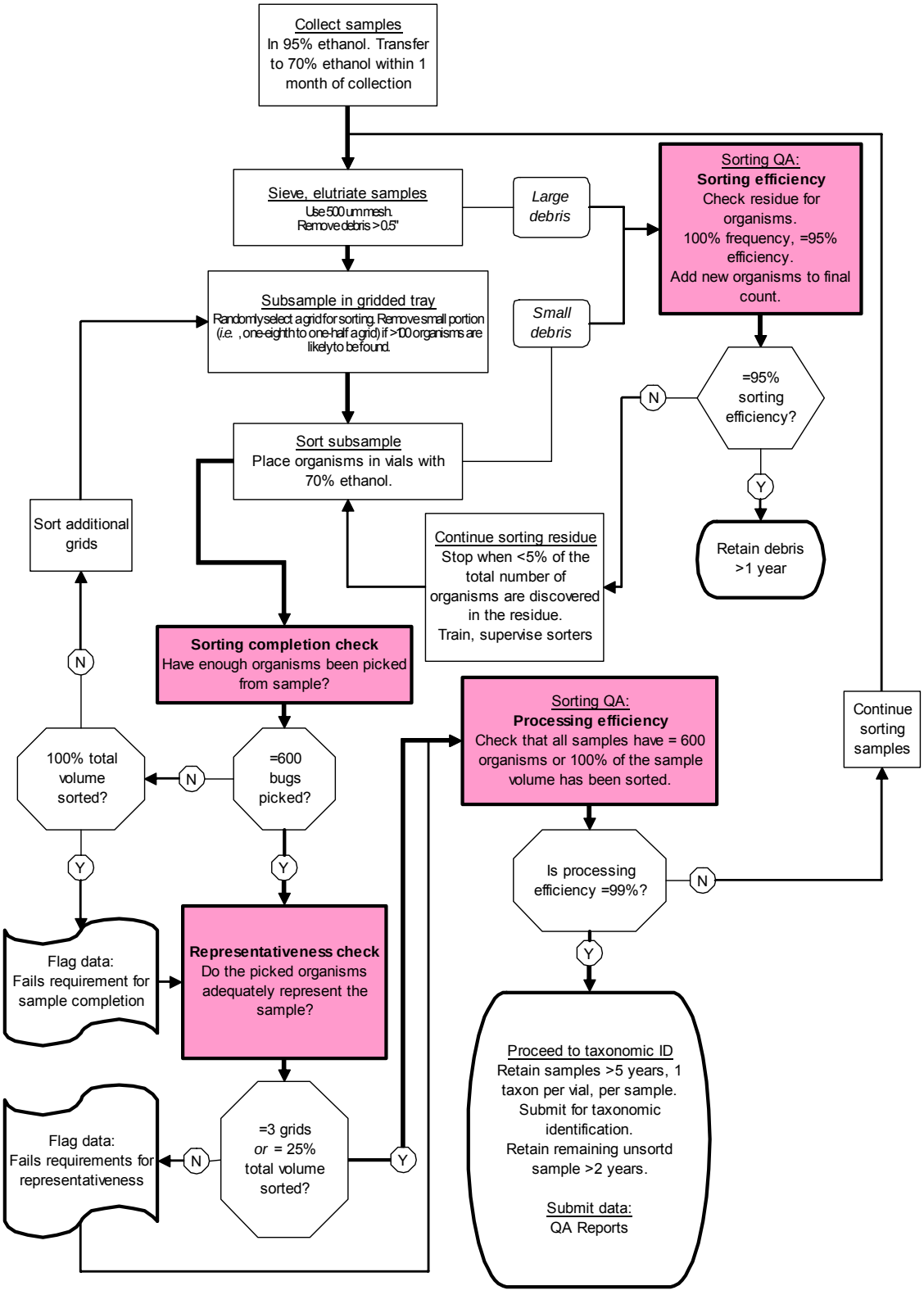

Figure 4B (Element 7). Sorting process diagram for sorting.

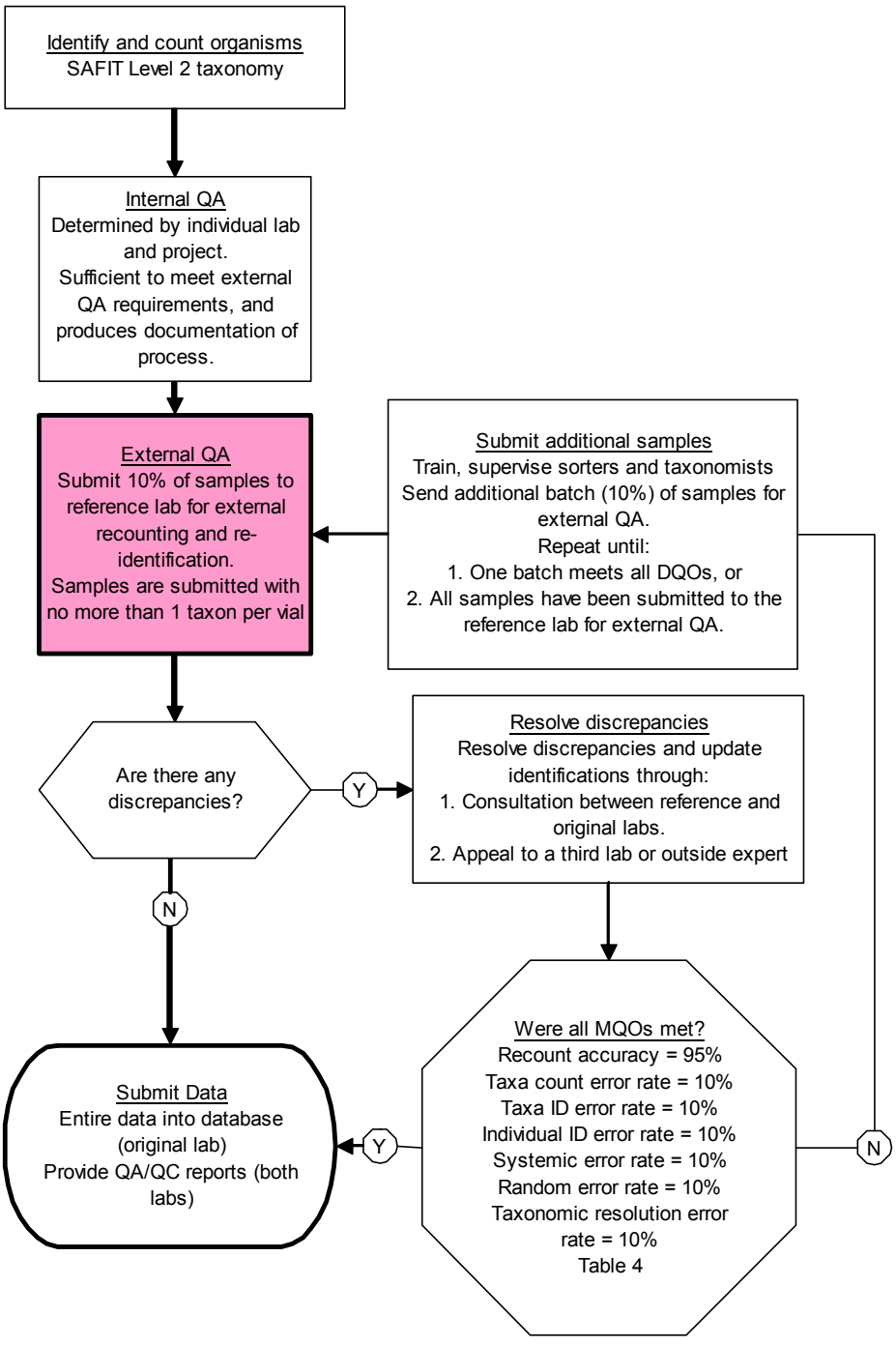

Figure 4C (Element 7). Taxonomic identification process diagram.

7.1 Completeness

Completeness describes the success of sample collection and laboratory analysis (both sorting and taxonomic identification), which should be sufficient to fulfill the statistical criteria of the project (Table 4).

7.1.1 Sampling Completeness

Completeness of sampling is measured as the **percent of sites sampled** and **percent of variables measured** (See Section 10).

7.1.1.1 Percent of Sites Sampled

In all biological surveys, all sites selected for sampling must be evaluated in order to achieve the intended statistical power. Therefore, this MQO measures how completely a program fulfills its sampling goals.

7.1.1.1.1 Sampling Completeness MQO

It is expected that 95% of all sites will be sampled. This MQO accounts for adverse weather conditions, safety concerns, and equipment problems. A loss of 5% of the samples in this study would represent a minimal loss in statistical power to address the study objectives.

7.1.1.1.2 Sampling Completeness Corrective Actions

Corrective action for this MQO is to collect additional samples within the index period, if possible.

7.1.1.2 Percent of Variables Measured

All variables must be measured at each site. This MQO ensures that a complete suite of indicators and supporting data are collected at each site in the survey.

7.1.1.2.1 Percent of Variables Measured MQO

It is expected that 95% of all variables will be sampled. This MQO applies to biological samples (including macroinvertebrates, benthic algae, and CRAM assessments), all components of physical habitat (e.g., gradient, pebble counts, etc.), water chemistry, and toxicity samples.

This MQO accounts for adverse weather conditions, safety concerns, and equipment problems. A loss of 5% of the samples in this study would represent a minimal loss in statistical power to address the study objectives.

7.1.1.2.2 Percent of Variables Measured Corrective Actions

Corrective action for this MQO is to revisit sites and measure missing variables within the index period, if possible. In certain cases, the Project QAO may require that additional variables be remeasured if

synoptic data are required (e.g., resampling water chemistry if toxicity samples are required).

7.1.2 Sorting Completeness

There are two MQOs for completeness of sorting activities**: sorting efficiency** and **processing efficiency**.

7.1.2.1 Sorting—Sorting Efficiency

Sorting efficiency measures how complete the sorting of a sample is, and it is evaluated by resorting the residue of sample aliquots to ensure that no benthic macroinvertebrates remain.

7.1.2.1.1 Sorting Efficiency MQO

Sorted residue is checked by a person different from the original sorter for any remaining organisms, which are then added to the final, sorted sample. Sorting efficiency is calculated as follows:

$$\frac{\textit{Total number of organisms in initial sort}}{\textit{Total number of organisms after resort}}$$

The frequency of sorting efficiency evaluation shall be 100%, and shall be equal to or greater than 95%.

7.1.2.2 Sorting Efficiency Corrective Actions

Corrective action for this MQO is to train and supervise sorters, and to continue sorting residue until the MQO is achieved (that is, ≤5% of the total number organisms are discovered in the sorted residue).

7.1.3 Sorting—Processing Efficiency

Processing efficiency is the ability of a taxonomy lab to sort all samples to completion.

7.1.3.1 Processing Efficiency MQO

Processing efficiency is measured as the ability of a lab to obtain adequate numbers of organisms (i.e. ≥600) from all samples or, if <600 organisms are in a sample, that 100% of sample volume has been sorted. Processing efficiency is calculated as follows:

$$\frac{\textit{Total number of completely sorted samples}}{\textit{Total number of samples}}$$

The number of completely sorted samples include all samples containing ≥600 organisms, or samples for which 100% of the material has been sorted.

The frequency of processing efficiency evaluation shall be 100%, and shall be equal to or greater than 99%.

7.1.3.2 Processing Efficiency Corrective Actions
Corrective action for this MQO is to locate missing samples and document failures.

7.1.3 Taxonomic Identification Completeness
There is one MQO for **taxonomic identification completeness**, which ensures that all sorted samples are identified by a taxonomist.

7.1.3.1 Taxonomic Identification Completeness MQO
The MQO for completeness of taxonomic identifications is greater than or equal to 99% of all samples submitted to the taxonomist. This MQO accounts for loss of samples during shipping and processing.

7.1.3.2 Taxonomic Identification Corrective Actions
Corrective action for this MQO is to locate missing samples and document failures.

Example lab benchsheets for sorting and identification are provided in Appendix C.

7.2 Accuracy

7.2.1 Sampling Accuracy
Sampling accuracy measures how close field measurements are to the true value. For bioassessment sampling, it is not possible to assess accuracy because the true value is not known. However, the accuracy of several components of field sampling can be assessed, as described below.

7.2.1.1 Water Quality Sampling Accuracy
Water quality accuracy is assessed by calibration and **comparison with standards** of known concentration. Specifically, these MQOs apply to measurements of pH, temperature, dissolved oxygen, specific conductance, and alkalinity (when measured in the field). MQOs for lab-based measurements are included in the SWAMP QAPrP (SWAMP 2008).

All calibration and maintenance procedures for field data measurement devices must comply with the SWAMP Quality Assurance Management Plan (QAMP, SWAMP 2002). Detailed guidelines on these procedures is provided in the QAMP Appendix E (SWAMP 2002) and in the SWAMP Standard

Operating Procedures for Field Measurements and Sample Collection (SWAMP 2007).

7.2.1.2 Accuracy of other physical habitat measurements
There is no direct way to assess the accuracy of other components of physical habitat assessments that accompany bioassessment because true values are typically not known. Instead, data quality is assured through **assessments** (described in Section 20) conducted by the Project QAO at least once per crew per sampling season. According to his or her professional judgment, the Project QAO may require additional assessments or trainings of crews whose performance does not comply with established protocols.

7.2.2 Sorting Accuracy—Recount Accuracy
Sorting accuracy shall also be assessed as **recount accuracy**. Recount accuracy is evaluated by an independent recount of the number of organisms in a sample. The frequency of recount accuracy shall be at least 10% of all samples or one sample per lab per project (whichever is greater) each year. Recount accuracy shall be conducted at a designated reference laboratory.

For the SMC, the designated reference laboratory is the Aquatic Bioassessment Lab (ABL).

7.2.2.1 Recount Accuracy MQO
Recount accuracy is calculated as follows:

$$\frac{\textit{Number of identified organisms in the smaller of the two counts}}{\textit{Number of identified organisms in the larger of the two counts}}$$

Recount accuracy shall be equal to or greater than 95%.

Examples of calculations of this MQO are provided in Appendix D.

7.2.2.2 Recount Accuracy Corrective Actions
Corrective action for this MQO is to train and supervise sorters.

7.2.3 Taxonomic Identification Accuracy

Taxonomic identification accuracy shall be assessed through the independent **re-identification** of samples by expert taxonomists at a reference laboratory. The frequency of re-identification shall be at least 10% of all samples or one sample per lab per project (whichever is greater) each year. It is expected that the same lab and samples used to assess sorting accuracy will be used to assess identification accuracy.

The designated reference laboratory is the Aquatic Bioassessment Lab (ABL) of the California Department of Fish and Game.

7.2.3.1 Taxonomic Identification Accuracy MQO
Identification accuracy shall be assessed as error rate using the following three calculations:

Taxa count error rate:

$$\frac{|(\#\ Taxa\ in\ Final\ ID - \#\ Taxa\ in\ Initial\ ID)|}{\#\ Taxa\ in\ Final\ ID}$$

Taxa ID error rate:

$$\frac{\#\ Taxa\ misidentified}{\#\ Taxa\ in\ Final\ ID}$$

Individual ID error rate:

$$\frac{\#\ Individuals\ misidentified}{\#\ Individuals}$$

These three MQOs were selected because each provides different sensitivities to different types of errors.

Taxa count error rate measures the accuracy of richness estimates provided by the original lab. Richness metrics are the basis of many metrics used in IBIS, as well as RIVPACS-type O/E scores, and this MQO is a broad-stroke measure of the impact of taxonomic identification errors on bioassessment indices. This MQO is robust to errors that do not affect richness (e.g., multiple errors that balance each other out, or do not affect all the individuals within a taxon).

Taxonomic ID error rate provides greater sensitivity than taxa count error rate by measuring the number of misidentified taxa as a portion of the total number of taxa in a sample. Thus, errors that do not affect total richness can be assessed by this MQO. However, it does not differentiate between errors affecting common taxa and those affecting rare taxa.

Individual ID error rate is a measure of the number of incorrectly identified individuals in a sample, and is the most sensitive of these three MQOs. Unlike taxa count error rate and taxa ID error rate, it is based on the number of misidentified individuals, and is therefore more sensitive to errors affecting common taxa than to those affecting rare taxa.

The re-identification error rate will be less than 10% by any of these measures. (Table 4).

Example lab benchsheets for sorting and identification are provided in Appendix C.

Examples of calculations of these MQOs are provided in Appendix D.

7.2.3.2 Taxonomic Identification Accuracy Corrective Actions

Corrective action for these MQOs is to train and supervise taxonomists, and to update data for analysis.

This quality control check will be repeated until a sample lot has acceptable error rates or all samples have been checked by the reference lab.

Identifications determined by the reference lab shall be used to substitute identifications made by the original lab.

In the case that the original lab disputes the identifications made by reference labs, specimens may be sent to designated third lab or outside experts.

If the reference lab encounters labeling errors (e.g., labels for two taxa are switched), the errors are noted in the QA report, but the reference lab can, at their discretion, contact the original lab to verify the error, and proceed with the QA check with correct labeling.

7.3 Precision

Although conventional approaches to quality assurance assess precision using replicate measurements, biological data require a different approach. Replicate field samples are of little use to assessing precision because there is no reasonable expectation that replicates will produce identical data. Several classic papers in benthic ecology has shown that even within very small spatial scales (e.g., <1 m), habitats and benthic communities can vary significantly (e.g., Needham and Usinger 1956, Chutter 1972). This variability in community structure can affect assessment indices, such as IBIs. Therefore, it is not possible to determine whether differences in BMI communities are attributable to natural variability or sampling error. Unlike replicates of water chemistry samples, replicate biological samples do not provide a valid estimate of precision in the sampling method,

7.3.1 Estimates of variability

Field replicates can be evaluated to assess the intrinsic variability arising from small scale spatial and temporal heterogeneity. These evaluations will be reported as **standard deviations** and **coefficients of variation** for quantitative data (e.g., species richness, IBI, Coleoptera richness, EPT

richness, predator taxa, % collector individuals, % intolerant individuals, % non-insect taxa, and % tolerant taxa).

7.3.2 Random Error Rate

Random errors are defined as misidentifications that are made inconsistently within a taxon, and decrease the precision of bioassessments. They are usually indicative of sub-optimal working conditions for the taxonomist, rather than the lack of taxonomic expertise.

7.3.2.1 Random Error Rate MQO

Random errors occur in two ways: 1) the original lab mistakenly identifies a single taxon as multiple taxa; and 2) the original lab mistakenly identifies multiple taxa as a single taxon The first precision MQO for taxonomic identification is the number of random errors in identifications determined by a re-identification of samples by expert taxonomists at a reference laboratory. The frequency of re-identification shall be at least 10% of all samples or one sample per lab per project, whichever is greater. It is expected that the same reference lab and samples used for quality assurance checks of taxonomic identification accuracy will be used to assess identification precision. The error rates shall be calculated as follows:

[(# of taxa identified as multiple taxa by original lab) + (# taxa identified by original lab consisting of multiple taxa)]/(# of taxa identified by the reference lab).

This MQO is calculated for an entire batch of samples submitted for quality assurance check, and not for individual samples.

Examples of calculations of this MQO are provided in Appendix D.

7.3.2.2 Random Error Rate Corrective Actions

All random errors are corrected before data are submitted to the database. An error rate <10% is considered acceptable. If a higher error rate is observed, an additional 10% of all samples shall be submitted for external re-identification. This quality control check will be repeated until a sample lot has acceptable error rates or all samples have been checked by the reference lab.

Additional corrective actions for this MQO include training and supervision of the taxonomist, and an internal re-identification of samples not submitted for external review.

7.3.3 Systemic Error Rate

The second precision MQO will be assessed shall be **systemic errors**, which occurs when a specific taxon is consistently misidentified. Systemic errors are

the result of errors that are made consistently, and are usually indicative of a taxonomist lacking up-to-date knowledge of particular taxa.

7.3.3.1 Systemic Error Rate MQO
Systemic errors are calculated as the number of common taxa (i.e., those occurring at least 5 times in a batch of samples submitted for quality assurance checks) consistently misidentified as the incorrect taxon (i.e., all individuals were given the same, but incorrect, identification), as a proportion of all the common taxa identified in a batch.

(# of common taxa consistently misidentified)/(# of common taxa identified by the reference lab).

This MQO is calculated for an entire batch of samples submitted for quality assurance check, and not for individual samples.

Examples of calculations of this MQO are provided in Appendix D.

7.3.3.2 Systemic Error Rate Corrective Actions.
All systemic errors are corrected before data are submitted to the database. An error rate <10% is considered acceptable. If a higher error rate is observed, an additional 10% of all samples shall be submitted for external re-identification. This quality control check will be repeated until a sample lot has acceptable error rates or all samples have been checked by the reference lab.

The original lab is expected to correct systemic errors in all samples prior to submitting data.

Additional corrective actions for this MQO include training and supervision of the taxonomist, and an internal re-identification of all samples containing the erroneously identified taxa.

7.3.4 Taxonomic Resolution Error Rate
Taxonomic resolution errors occur when the original lab does not identify taxa to the correct taxonomic level. Poor taxonomic resolution reduces precision of bioassessments. Taxonomic resolution errors may occur in two ways: 1) **Low resolution errors**, where the lab may leave the identification at too coarse a level when a more fine determination is possible; and 2) **High resolution errors**, where the lab makes an identification at a finer level than the condition of the specimens or the STE will support.

7.3.4.1 Taxonomic Resolution Error Rate MQO
Error rates for low resolution errors and high resolution errors are calculated separately, and added to estimate the overall error rate for taxonomic resolution.

The low resolution error rate is calculated as follows:

$$\frac{\text{\# of individuals with lower than appropriate resolution}}{\text{Total \# of individuals}}$$

The high resolution error rate is calculated as follows:

$$\frac{\text{\# of individuals with higher than appropriate resolution}}{\text{Total \# of individuals}}$$

The total taxonomic resolution error rate is the sum of the high and low resolution error rates:

Low resolution error rate + High resolution error rate

Examples of calculations of this MQO are provided in Appendix D.

7.3.4.2 Taxonomic Resolution Error Rate Corrective Action
All taxonomic resolution errors are corrected before data are submitted to the database. A total error rate <10% is considered acceptable. If a higher error rate is observed, an additional 10% of all samples shall be submitted for external re-identification. This quality control check will be repeated until a sample lot has acceptable error rates or all samples have been checked by the reference lab.

This quality control check will be repeated until a sample lot has acceptable error rates or all samples have been checked by the reference lab.

The original lab is expected to correct taxonomic resolution errors in all samples prior to submitting data.

Additional corrective actions for this MQO include training and supervision of the taxonomist, and an internal re-identification of all samples containing the erroneously identified taxa.

7.3.5 Water Quality Sampling Precision
Precision of water quality measurements shall be assessed by repeat sampling during the same sampling event. Repeat samples will occur at 10% of sites sampled by each crew, but no less than one site per crew.

All calibration and maintenance procedures for field data measurement devices must comply with the SWAMP Quality Assurance Management Plan (QAMP, SWAMP 2002). Detailed guidelines on these procedures is provided in the QAMP Appendix E (SWAMP 2002) and in the SWAMP Standard

Operating Procedures for Field Measurements and Sample Collection (SWAMP 2007).

7.4 Representativeness

Representativeness describes the ability of a sample to be characteristic of the population of interest. There are three scales of representativeness for biological sampling including watershed, reach, and sample scales. In probabilistic studies, representativeness is ensured at the watershed scale by a spatially-balanced random sampling design, where there is a known probability of inclusion for all sites in the study. This representativeness is ensured by evaluating random sites in order for sampling or rejection. For the SMC, sites are evaluated in order within each panel and management unit. For targeted site designs, representativeness at the watershed scale is ensured by selecting sites that represent the range of natural and anthropogenic variability of interest.

Representativeness of the sampling event is ensured by sampling within the **nominal targets**—that is, sampling occurs at the intended place and time.

The MQOs for sampling event representativeness are measured by proximity to the nominal coordinates (i.e., within 300 m or 10 seconds latitude and longitude, as determined by a global positioning system), within the nominal index period (i.e., 4 to 12 weeks after the last major rainfall, or May 15 to July 15), and within the nominal stratum (i.e., the correct stream order and land use).

Corrective action for this MQO is to flag samples that are collected more than 10 seconds from the nominal coordinates, and to reject samples collected outside the index period or nominal stratum.

At the reach scale, representativeness is ensured through the use of reach-wide sampling, which is assumed to sample microhabitats in proportion to their abundance at a reach.

At the sample scale, representativeness is ensured through the sample **homogenization** and **subsampling** procedures that give each individual organism an equal probability of selection during the sorting phase. Samples are subsampled into aliquots by evenly spreading the sample onto gridded trays, and grids are randomly assigned a picking order. Sample depth should be no greater than 0.5 inches. For the first subsample, one-eighth of the grid is transferred to a tray or Petri dish for sorting under a dissecting microscope. Organisms overlapping multiple grids (or portions of grids) are selected if the majority (i.e., >50%) of their body is within the grid to be sorted. If <20 organisms are taken from the first grid, then larger portions (i.e., one-quarter, one-half, or a whole grid) of subsequent grids are to be sorted. A minimum of three grids or 25% of the

total sample volume must be selected for sorting, and all selected grids are sorted to completion. Sorting is completed when both of the following conditions are met: 1) At least 600 organisms are picked from a sample; and 2) At least three grids are sorted *or* at least 25% of the total sample volume is sorted. For samples with very high densities of organisms, it is possible to pick more than 600 individuals before processing the minimum three grids or 25% of the total sample volume. In these cases, data are flagged, but are still considered valid for analysis and assessment.

Corrective action for this MQO include flagging data as potentially not representative.

Representativeness of taxonomic identifications is ensured by identifying all the organisms that were sorted.

Example lab benchsheets for sorting and identification are provided in Appendix C.

7.5 Sensitivity

Sensitivity represents the reporting level that can be expected for each measurement. For field sampling, sensitivity should be to the nearest second for latitude and longitude. For taxonomic identification, taxonomists shall use Level II of the standard taxonomic effort (STE) established by the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT). SAFIT is a regional, professional, not for profit organization of bioassessment taxonomists. Level II identifications represent the highest level of taxonomic resolution consistently attainable using the most current scientific knowledge. Level II identifications include species-level for most families, and genus-level for Chironomidae. The STE can be found at http://www.safit.org/ste.html, or Appendix E.

8. Special Training Needs/Certification

8.1 Specialized Training or Certifications

Both sampling and laboratory analysis require specialized training. The Project QA Officer is responsible for ensuring that training requirements are met by participating field crews and laboratories. Field sampling training can be provided during short courses offered by the California Department of Fish and Game (CDFG) or similar agency. Laboratory analysis requires years of experience and mentoring by a qualified taxonomist.

All field crews must consist of at least two adults qualified to work in the State of California. However, it is strongly recommended that crews contain no fewer than four members because the SMC measures several indicators at each site (i.e., physical habitat, BMI and benthic algae communities, water chemistry, toxicity, and CRAM). If smaller crews are used, conducting CRAM assessments on a separate day, independent of sampling other indicators, may be acceptable. Inadequate staffing of field crews is one of the most common sources of data errors, and may result in costly corrective actions or data deficiencies.

At least one member of each crea crew must have received training in sampling procedures described in the Bioassessment SOP. Training in basic first aid is also required. Crew chiefs are responsible for ensuring the safety of the crew and must use his or her discretion to end sampling if conditions become unsafe. At least one person per crew must have experience with the Bioassessment SOP at a minimum of 20 sites in California.

It is strongly recommended that all taxonomists become a member of a taxonomist group for benthic macroinvertebrates, such as the Southwest Association of Freshwater Invertebrate Taxonomists (www.SAFIT.org). Although membership is not required, participation in a trade organization for freshwater taxonomists promotes taxonomic education, training, and communication. Membership in organizations like SAFIT offers several benefits to project participants, such as opportunities for continuing education, taxonomic workshops, reviews of current literature, and intercalibration exercises. Taxonomists are expected to participate in at least one taxonomic workshop focusing on benthic macroinvertebrates per year.

8.2 Training and Certification Documentation

All agencies, contractors, and participating laboratories shall maintain records of their training. These records shall be made available upon request from the Project QA Officer or Project Director.

8.3 Training Personnel

All agencies, contractors, and participating laboratories must maintain rigorous field and laboratory training programs based on written, oral and performance-based guidelines. Training and performance are also evaluated on an ongoing basis based, in part, on the QA parameters defined in this plan. Standard Operating Procedures (SOPs) for field (Appendix B), laboratory, and data management tasks have been developed and shall be updated on a regular basis in order to maintain procedural consistency. The maintenance of an SOP Manual will provide project personnel with a reference guide for training new personnel as well as a standardized information source that personnel can access.

To ensure consistent and comparable field techniques, this project shall include presurvey field training and *in-situ* field assessments. The presurvey training will focus on sampling methods and field logistics including compositing and netting patterns. *In-situ* assessments will consist of equipment checks, good sampling practices, record-keeping, and health and safety. Assessments are conducted annually, once for each crew, although more frequent assessments may be conducted at the Project QAO's discretion.

9. Documents and Records

All documents generated by this project will be stored at the agency that conducted the pertinent activities (Table 5). For example, sampling records will be stored and maintained at the offices of the sampling teams. Laboratory analysis records pertinent to this study will be maintained at the laboratory. Copies of all records held by pertinent agencies shall be provided to the Project QA Officer or Project Director upon request.

All field results will be recorded at the time of completion, using standardized field data sheets (provided in Appendix F). Data sheets will be reviewed for outliers and omissions before leaving the sample site. Chain of custody forms will be completed for all samples prior to shipment to labs (Appendix G). Data sheets and chains of custody will be stored in hard copy form for five years from the time the study is completed. Both chain of custody forms and data sheets may be stored as hard-copy paper forms, or soft-copy electronic forms. Regardless of whether hard- or soft-copy forms are used, the retention times in Table 5 apply. The directory where electronic files are stored will be backed up nightly on a second hard drive, and backed up monthly off-site.

All data from this project will be made publicly available. Release of data will include comprehensive documentation. This documentation will include database table structures (including table relationships) and lookup tables used to populate specific fields in specific tables. Release of the data to the public will also include quality assurance classifications of the data (i.e. flags, as appropriate) and documentation of the methods by which the data were collected (metadata). Data will be released to the general public once a final report documenting the study has been prepared. Final deposition of databases and reports will be passed to the Contract Manger electronically.

Table 5. (Element 9) Document and record retention, archival, and disposition information.

	Identify Type Needed	Retention	Archival	Disposition
Station Occupation Log	Notebook	Paper	Notebook	5 years
	Field data sheet	Paper or electronic	Notebook/Access	5 years
Sample Collection Records	Chain of Custody	Paper or electronic	Notebook/Electronic	5 years
Analytical Records	Lab notebooks, bench sheets, and sorting forms	Paper	Notebook	3 years
	Lab Results QA/QC	Paper and electronic	Notebook/Excel	3 years
	Electronic data file	Electronic	Database	3 years
Data Records	Data Entry	Electronic	Database	Indefinite
Assessment Records	QA/QC assessment	Paper and electronic	Document	Indefinite
	Final Report	Paper and electronic	Document	Indefinite

GROUP B DATA GENERATION AND ACQUISITION

10. Sampling Process Design

10.1 Sampling Sites

The Southern California Regional Watershed Monitoring Program will sample 6 sites in each of 15 management units per year (Table 6). Data from the most recent 5 years will be used for assessments. Sites were stratified across three land uses (i.e., urban, agricultural, and open) and five stream orders (2^{nd}, 3^{rd}, 4^{th}, and $\geq 5^{th}$) so that approximately equal numbers of each land use and stream orders are represented. The target sample sizes are described in Table 7. This program will continue in a similar fashion after Year 5; however, because of the probabilistic design, the distribution of sites among strata may vary from the numbers shown in Table 7. All sites in the initial sample draw are shown in Appendix A. The length of stream represented varies from site to site, but on average each site will represent approximately 17 kilometers.

All data will be collected within the index period, which is defined as 4 to 12 weeks following the last major rainstorm (i.e., large enough to mobilize the stream bed). Although the precise dates vary from year to year and region to region, typically, this index period starts on May 15 and ends on July 15 (Table 3).

Table 6. (Element 10). Number and frequency of sample sites by management unit.

Management unit	Year 1	Year 2	Year 3	Year 4	Year 5	Total after 5 years
Ventura	6	6	6	6	6	30
Santa Clara	6	6	6	6	6	30
Calleguas	6	6	6	6	6	30
Santa Monica Bay	6	6	6	6	6	30
Los Angeles River	6	6	6	6	6	30
San Gabriel River	6	6	6	6	6	30
Lower Santa Ana	6	6	6	6	6	30
Middle Santa Ana	6	6	6	6	6	30
Upper Santa Ana	6	6	6	6	6	30
San Jacinto	6	6	6	6	6	30
San Juan	6	6	6	6	6	30
Northern San Diego	6	6	6	6	6	30
Central San Diego	6	6	6	6	6	30

Mission Bay and San Diego River	6	6	6	6	6	30
Southern San Diego	6	6	6	6	6	30

Table 7. (Element 10). Number of sample sites by land use.

	Stream Order				
Land use	2	3	4	5	Total
Agricultural	28	30	46	36	140
Open	63	54	41	11	169
Urban	44	40	32	25	141
Total	135	124	119	72	450

10.2 Site Reconnaissance

Each site is evaluated prior to sampling through a reconnaissance process that determines site access and suitability.

Criteria for rejecting sites include:

Safety: Crews may reject a site if it is unsafe to access

Accessibility: Crews must be able to access a site from the nearest road and sample it within a single day. This timeframe is based on holding times for water chemistry and toxicity samples, which must be analyzed within 48 hours of sample collection.

Landowner permission: Crews may not enter private property without express permission of the landowner. At a minimum, crews should make two attempts to contact non-responsive landowners, after which permission is considered denied.

Target status: Crews must reject sites that do not fit the definition of target status, i.e., perennial, wadeable streams. In the SMC region, perennial streams are defined as those that flow until the onset of the next rainy season in years with typical rainfall (i.e., September). All other definitions of target streams are defined in Ode 2007.

All reasons for rejection are documented and submitted to the Project QAO using Recon Reporting Forms. When a site is rejected, crews must sample the next lowest numbered site within the same panel and management unit. If no sites remain in the panel, sites from the next panel may be used.

10.3 Bias and Representativeness in Sampling Design

The use of a probabilistic sampling design minimizes bias by giving all sites in the region the opportunity to be represented in the sample. However, biases may arise from errors in the sampling frame. For example, the land use may have changed from the time satellite imagery was gathered. These biases can be minimized by correcting the sampling frame using data gathered during the sampling and reconnaissance process, and using the corrected frame for analyses.

11. Sampling Methods

Sampling will follow the methods described by SWAMP (Ode 2007). Sampling requires the collection of benthic macroinvertebrate samples using a D-shaped kick net at each of the monitoring locations. See Appendix B for the sampling SOP. The SMC program will only use the reachwide method (or its modification for low-gradient streams), and not the targeted riffle method described in the SOP.

Sample containers and preservatives are identified in Table 8. Appropriate pre-cleaned sample containers will be used. Preservative must be added in the field.

Failure to collect a sample shall be promptly reported to the Project Director, who will determine if any corrective action is needed and make arrangements to collect a replacement sample (if possible). The Project QAO will document sampling failures and the effectiveness of corrective actions.

Table 8. (Element 11) Sample handling.

Analyte	Bottle Type/Size	Preservative	Maximum Holding Time
Benthic macroinvertebrate field samples	0.5 L (minimum) Plastic wide mouth with screw top lids. Additional containers can be used as needed.	95% Ethanol for ≤ I month, Transfer to 70% Ethanol	5 years from date of sample
Sorted specimens	Glass containers, Variable size depending on volume	70% Ethanol	5 years from date of sample
Sorted subsample residue	Plastic wide mouth with screw top lids. Variable size depending on volume	70% Ethanol	1 year from date of sorting
Unsorted sample	Plastic wide mouth with screw top lids. Variable size depending on volume	70% Ethanol	2 years from date of sample

12. Sample Handling and Custody

Samples will be kept in 70% ethanol and will be transferred to the analytical laboratories within the holding times specified in Table 8. To provide for proper tracking and handling of the samples, documentation will accompany the samples from the initial collection to the final identification and analysis.

All bottles will be labeled according to the SOP in Appendix B. Field data sheets and chains of custody will accompany the collection of samples. An example of the Chain-of-Custody form is shown in Appendix G. Example sample labels are shown in Appendix H.

All samples will be marked with a station code, date, time, and replicate number (if applicable) to track their analysis. These identification labels will also be entered directly on to field and laboratory data sheets. All observations recorded in the field as well as information recorded in processing all field samples in the laboratory will be tracked using these identification labels.

Sorted and identified samples must be stored with each taxon in a separate vial. For very abundant taxa, it is recommended that no more than 100 individuals be stored in a single vial. It is expected that participating labs will remove specimens from the sample to include as part of a reference collection. In these cases, the number of removed specimens must be recorded on the sample vial.

13. Analytical Methods

13.1 Analysis Methods

The samples will be analyzed for biological identification according to the SWAMP SOP (Ode 2007). Specific details regarding analysis are provided in Appendix B. These details include subsampling, sorting, and identification. See section 7 for additional details regarding analysis.

Table 9. (Element 13). Analytical methods. NA = not applicable.

Analyte	Method	Modifications to Method	Method Detection Limit
Biological sampling, identification and enumeration	Ode 2007 (Appendix B)	NA	SAFIT Standard Taxonomic Effort Level 2

13.2 Sample Disposal

After analysis, including QA/QC procedures, sample disposal will follow laboratory protocols (Ode 2007). The retention of samples shall include unsorted sample, sorted remnants, and identified specimens (Table 8). All material shall be retained by the lab performing the taxonomic identifications for the durations specified in Table 8. Samples sent to the reference lab shall be returned to the original lab for storage following QA procedures.

13.3 Corrective Action

Corrective action is taken when an analysis is deemed suspect for some reason. These reasons include exceeding accuracy ranges and/or problems with sorting and identification. The corrective action will vary on a case-by-case basis, but at a minimum involves the following:

- A check of procedures.
- A review of documents and calculations to identify possible errors.
- Correction of errors based on discussions among taxonomists.
- A complete re-identification of the sample.

The field and laboratory coordinators shall have systems in place to document problems and make corrective actions. All corrective actions will be documented to the Project Director.

When specific MQOs are not met, the following corrective actions are required (See Section 7 for additional details):

13.3.1 Completeness

Reasons for failure to complete sampling should be documented, and plans to ensure future success shall be made. When possible, efforts should be made to resample. For example, additional sites could be visited if there is time remaining within the index period. Incomplete site evaluations should either be resampled or a new site selected.

If sorting efficiency or processing efficiency does not meet specified MQOs, then training and supervision of that sorter shall increase according to laboratory protocols. The corrected data shall be confirmed in the project database. Because 100% of samples are subjected to these MQOs, data do not need to be qualified.

All organisms recovered during the sorting completeness check (i.e., sorting efficiency) are added to the final count and identified.

13.3.2 Precision

If a sample does not meet the MQOs for taxonomic identifications (i.e., random or systemic error rates), then corrective actions shall include submitting additional sample lots (10% of all samples processed by a lab for a particular project) for further quality assurance checks by a reference lab. Additional lots shall be submitted until a lot passes quality assurance checks or until all samples have been submitted to a reference lab for quality assurance checks. The taxonomist should gain additional training for problematic taxa.

Corrective actions for field-based measurements, such as water chemistry probes, are described in the SWAMP QAMP (SWAMP 2002).

13.3.3 Accuracy

If a sample does not meet MQOs for recount accuracy or poor accuracy in taxonomic identifications (i.e., excessive taxa count error rate, taxa ID error rate, individual ID error rate), then corrective actions shall include submitting additional sample lots (10% of all samples processed by a lab for each project) for further quality assurance checks by a reference lab. Additional lots shall be submitted until a lot passes quality assurance checks or until all samples have been

submitted to a reference lab for quality assurance checks. The taxonomist should gain additional training for problematic taxa.

All taxonomic errors, whether they are above or below the thresholds established in Table 4, shall be resolved through the following process:

1) Reference labs will inform the original lab of errors. The original lab is responsible for correcting the data set with the revised taxonomic identification from the reference lab
2) If the original lab disputes the reference lab identification, then taxa can be sent to a third lab for verification. The original lab is responsible for correcting the data set with the revised taxonomic identification from the third lab.

Corrective actions for field-based measurements, such as water chemistry probes, are described in the SWAMP QAMP (SWAMP 2002).

13.3.4 Representativeness

If a site is sampled more than 10 seconds (~ 300 m) from nominal coordinates, the data from this site shall be flagged in the project database. However, samples collected outside the nominal stratum or outside the index period shall be rejected.

14. Quality Control

Samples for QC will be collected both in the field and in the lab. Field QC samples, which include duplicates, are used to evaluate precision due to sampling bias or field variability. Lab QC samples are used to evaluate the analytical process for precision and accuracy. Internal laboratory quality control checks will include sample re-sorts and re-identification. These QC activities are discussed below. See Section 7 for additional details.

14.1 Field Duplicates

Field duplicates help quantify intrinsic variability associated with sampling activities. Field duplicates are comprised of a second sample taken at 10% of all sampling sites. There are no specific criteria for field duplicate variability, but these data are evaluated in the data analysis/assessment process for small-scale spatial variability.

14.2 Sampling representativeness

Sampling accuracy is ensured by evaluating if the sample event occurred at the nominal coordinates, within the index period, and within the nominal stratum. Site location shall be measured by global positioning system and must be within 10 seconds (~300 m) of the nominal latitude and longitude. All samples must be collected within the established index period and within the nominal stratum.

14.3 Sorting efficiency

Sorting efficiency is used to quantify the sorting accuracy of the laboratory. Once samples are sorted, a second technician will re-sort the remnants of sorted aliquots to ensure that all organisms have been removed. The acceptable accuracy limit is 95% (Table 4).

14.4 Processing efficiency

Precision of sorting shall be assessed as processing efficiency. Processing efficiency is the ability to obtain adequate numbers of organisms (i.e. ≥600) from all samples, or to sort 100% of sample volume. Samples with fewer than 600 organisms removed shall be sorted until this number has been achieved, or there is no sample left to sort.

14.5 Recount accuracy

Recount accuracy is used to quantify the sorting accuracy of the laboratory. A subset of samples (10%, or one per lab per project each year, whichever is greater) that have been sorted and identified are sent to a reference laboratory. At the reference lab, the number of benthic macroinvertebrates is enumerated by new sorters or taxonomists. The acceptable recount accuracy limit is 95% (Table 4).

14.6 Sample identification

Sample re-identification is used to quantify the identification accuracy of the laboratory. A subset of samples (10%, or one sample per lab per project each year, whichever is greater) analyzed by a second taxonomist at the reference lab will re-identify the sample to ensure that all organisms have been accurately identified and enumerated. The acceptable accuracy limits are shown in Table 4. Identification accuracy is calculated using the following metrics: Acceptable error rates for taxa count error, taxa ID error, and individual ID error are less than or equal to 10%.

Precision will also be assessed as bias through the re-identification process. Bias is defined as systemic errors, arising when a specific taxon is consistently misidentified. Only common taxa (i.e., those appearing at least 5 times in all the samples submitted for quality assurance checks) will count towards the calculation of systemic errors. Acceptable systemic error rates are ≤10% of all common taxa in a batch submitted for QA check.

Precision of identifications will also be assessed through the re-identification process. Random errors are inconsistent misidentifications in which different specimens of a single taxon are identified as belonging to multiple taxa or specimens of multiple taxa are identified as the same taxon. Acceptable random error rates are ≤10% of all taxa in a batch submitted for QA check.

Precision of identifications will also be assessed as taxonomic resolution errors. Taxonomic resolution errors occur when specimens are not identified to a taxonomic level supported by the condition of the specimen, or by the STE. Acceptable taxonomic resolution error rates are ≤10% of all individuals in a sample.

15. Instrument/Equipment Testing, Inspection, and Maintenance

15.1 Sampling Equipment and Analytical Instruments

SWAMP has established standard operating procedures for each piece of field equipment (Table 10). See Table 2 in Appendix B for a complete listing of equipment and maintenance schedule. Field sampling teams shall have spare equipment, as needed, to ensure successful sampling while in the field. The field supervisor shall be responsible for testing, inspecting and maintaining equipment.

In order to avoid problems with malfunctioning instruments, field supervisors are strongly encouraged to have back-up instruments, batteries, and parts (e.g., probe membranes) in the field with them at all times.

All procedures for field data measurement devices must comply with the SWAMP Quality Assurance Management Plan (QAMP, SWAMP 2002). Detailed guidelines on these procedures is provided in the QAMP Appendix E (SWAMP 2002) and in the SWAMP Standard Operating Procedures for Field Measurements and Sample Collection (SWAMP 2007).

Table 10. (Element 15). Testing, inspection and maintenance of sampling equipment and analytical instruments.

Equipment Item	Inspection Schedule
D-shaped Kick Net (0.5mm mesh)	Each sampling event
Standard Size 35 Sieve (0.5 mm)	Each sampling event
Wide-mouth Plastic Jars	Each sampling event
Measuring Tape (100 meter)	Each sampling event
Pencils/Permanent Markers	Each sampling event
Flagging	Each sampling event
Forceps	Each sampling event
Water-proof Paper	Each sampling event
Gridded White Enameled Pan	Each sampling event
Dissolved oxygen probe	Each sampling event
Conductivity probe	Each sampling event
Salinity probe	Each sampling event
pH Meter	Each sampling event
Thermometer	Each sampling event
Alkalinity kit	Each sampling event
Densiometer	Each sampling event
Flow Meter	Each sampling event
Auto level or clinometer	Each sampling event
Compass	Each sampling event

GPS Unit	Each sampling event
Digital Camera	Each sampling event
Stadia Rod	Each sampling event
Ruler	Each sampling event
Range finder	Each sampling event

15.2 Analytical Instruments

The field supervisor is responsible for maintaining equipment in accordance with its SOPs, which include those specified by the manufacturer and those specified by the method.

15.3 Corrective Actions

All instruments found to be malfunctioning shall be repaired and recalibrated before being used again. If repair is not possible, comparable instruments may be substituted. If comparable instruments are not available, water samples may be analyzed in a lab for certain analytes (i.e., pH, alkalinity, turbidity, dissolved oxygen, and specific conductance), provided that samples are collected and analyzed according to the procedures specified in the SWAMP QAPrP (SWAMP 2008). If the velocity meter is malfunctioning, the buoyant object method may be substituted for discharge measurements.

If an instrument is found be malfunctioning after data have already been collected, the data must be flagged in the database.

Corrective actions for field-based measurements, such as water chemistry probes, are described in the SWAMP QAMP (SWAMP 2002).

16. Instrument/Equipment Calibration and Frequency

All laboratory and field equipment shall be calibrated based on manufacturer recommendations and accepted laboratory protocol. The lab and field supervisors are responsible for maintenance and calibration of all equipment. The supervisors shall also maintain all records of equipment calibration and maintenance.

All procedures for field data measurement devices, including probes for pH, dissolved oxygen, specific conductivity, temperature, and water velocity, must comply with the SWAMP Quality Assurance Management Plan (QAMP, SWAMP 2002). Detailed guidelines on these procedures is provided in the QAMP Appendix E (SWAMP 2002) and in the SWAMP Standard Operating Procedures for Field Measurements and Sample Collection (SWAMP 2007).

Field supervisors must record all calibration failures, and have instruments recalibrated, repaired, or replaced as needed. If an instrument is found be out of calibration after data have already been collected, the data must be flagged in the database.

17. Inspection/Acceptance for Supplies and Consumables

Glassware, sample bottles, and collection equipment will all be inspected prior to their use for chips, cracks, leaks, contamination, and other deformities that can affect the outcome of the study results. The field supervisor will be responsible for examining supplies for damage as they are received.

Particular care must be taken for decontamination of sampling gear for invasive species such as the zebra mussel and New Zealand mudsnail. Decontamination of sampling gear should follow prescribed SOP guidelines (Ode 2007). Gear that has not been decontaminated shall not be used. Guidelines and resources are provided in Appendix I.

18. Non-direct Measurements

The current study will not use any non-direct measurements.

19. Data Management

Bioassessment data management shall be initiated with the use of field and laboratory data sheets. Data are generated by field sampling agencies, and by taxonomy labs. Field and laboratory results shall be electronically sent to the Project Director following the completion of quality control checks by each laboratory or sampling agency. Data shall be entered and screened by the laboratory or field sampling agency for the following major items:

- A 100% percent check between electronic data provided by the laboratory or field sampling agency and the hard copy reports
- Conformity check between the Chain-of-Custody Forms and laboratory reports
- A check for laboratory data report completeness
- A check for typographical errors on the laboratory reports
- A check for suspect values

The laboratories and sampling agencies shall provide data in electronic format. The required form of electronic submittals will be consistent with the SWAMP database.

Following the initial screening, a more complete QA/QC review process will be performed by the Project QAO, which will include an evaluation of analytical accuracy and precision. Accuracy will be evaluated by reviewing re-sort and re-identification; precision will be evaluated by reviewing field duplicates, and sample completeness will be evaluated by comparing results to chain-of-custody forms (see Section 7 and 14).

GROUP C ASSESSMENT AND OVERSIGHT

20. Assessments and Response Actions

The Project Director shall be responsible for the day-to-day oversight of the project. The Project QAO will conduct reviews of the data with each data delivery and relay any problems to the Project Director. The Project QA Officer has the power to halt all sampling and analytical work if the deviation(s) noted are considered detrimental to data quality.

20.1 Assessments of labs and field crews

The Project QAO may perform periodic quality system assessments of the project's contract laboratories and field crews to ensure compliance with SOPs.

20.2 Communication

For field assessments, the Project QAO will notify the field crew at least one week before the sampling date. The assessment may occur at any point in the index period (approximately May 15 to July 15).

For lab assessments, the Project QAO will notify the lab at least one month prior to the assessment date. The assessment may occur at any point before data are delivered to the Project Director (February 28 the year following sampling).

Both assessments involve evaluation of procedures , personnel, equipment, and facilities requirements of this QAPP. Field assessment forms are attached in Appendix J. Lab assessment procedures are not currently available, but will be developed, in conjunction with identification SOPs, by SAFIT.

20.3 Assessment Summary

Following an assessment, the Project QAO compiles notes and checklists into a single document. This summary details findings, observations, and recommendations; supporting evidence for each; and references to this QAPP or other applicable requirements. It is acceptable for the assessment report to include recommendations for corrective actions and their associated due dates.

The Project QAO may require additional assessments, or stop a field crew or lab from continuing work if major problems are found.

20.4 Assessment Response

The assessed organization must comply with the corrective actions recommended by the Project QAO. The assessed organization must then produce a report documenting major corrective actions required by the Project QAO, including trainings, facility upgrades, or instrument improvements.

Completed documents will be electronically archived by the Project QAO for a minimum of 3 years (see Element 9: Documents and Records).

21. Reports to Management

The status of data collection during this project will be reported by the Project Director to the Contract Manager on a quarterly basis beginning July 15, 2009 and continuing quarterly until the completion of the project in October 2010. A draft final project report will be filed no later than August 2010. Subsequent years of the project will follow similar schedules. The Project QA Officer has complete access to the Project Director on an ongoing basis. Any QA deviations will be detailed in the sample event summary report and draft/final report.

Table 11. (Element 21) QA management report

Report	Due by
Quarterly progress reports	July 15, 2009 and quarterly thereafter
Sample event summary	August 31, 2009
Draft final report for review	August 31, 2010
Final Report	October 31, 2010

GROUP D DATA VALIDATION AND USABLILITY

22. Data Review, Verification, and Validation

Laboratory validation and verification of the data generated is the responsibility of the laboratory. The laboratory manager will maintain analytical reports in a database format as well as all QA/QC documentation for the laboratory.

The procedure for verification and validation of field data is specified in the SWAMP Standard Operating Procedure for Field Data Verification of the SWAMP Database (SWAMP 2004).

The Project QA Officer shall review all data packages received for adherence to guidelines set forth in this QAPP. The Project QA officer will review Chain of Custody (COC) forms to ensure adherence to collection, transport, and receipt requirements.

Laboratories will conduct a 100% raw data versus electronic data audit before delivering results to the Project Director, and all errors will be corrected. .

23. Verification and Validation Methods

Data collected in the field shall be validated and verified by the field supervisor.

Laboratory validation and verification of the data generated is the responsibility of the laboratory supervisor. The laboratory supervisor shall maintain analytical reports in a database format as well as all QA/QC documentation for the laboratory.

The Project Director is responsible for oversight of data collection and the initial analysis of the raw data obtained from the field and the laboratory. The Project Director responsibilities also include the generation of rough drafts of quarterly and final reports. The Project Director has final oversight on the submission of quarterly and final reports.

24. Reconciliation with User Requirements

For data that do not meet MQOs, the Project Director has two options:

1. Retain the data for analytical purposes, but flag these data for QA deviations.
2. Do not retain the data and exclude them from all calculations and interpretations.

The choice of option is the decision of the Project Director. These decisions will be based upon the MQOs listed in Section 7. If qualified data are to be used, then it must be made clear in the final report that these deviations do not alter the conclusions of the study.

Uncertainty of validated project data will be evaluated using standard univariate and multivariate statistical procedures, including the calculation of confidence intervals for estimates of the extent and magnitude of impacts to streams, as described in the SMC Workplan (SMC Bioassessment Working Group 2007).

Validated project data collected for the SMC is compatible with SWAMP database requirements. The Project Director will submit these data to the SWAMP database, as described in the SMC Workplan (SMC Bioassessment Working Group 2007).

25. Glossary

Term	Definition
Accuracy	The closeness or agreement of the observed and a true value, or a test response and a valid reference method. It is influenced by both random error (precision) and systematic error (bias).
Assessment	A general evaluation process used to evaluate the performance, effectiveness and processes of a management and/or technical system.
Assessment tool	A model or index that converts biological data into an indicator of ecosystem health and integrity.
Batch	The collection of samples of the same group which is to be analyzed in one test run or inspected together within a specific time limit and traceable as a unit.
Benthic macroinvertebrates (BMI)	Aquatic organisms that dwell at the bottom of waterbodies, lack backbones and can be seen without the aid of magnification.
Bias	The constant or systematic distortion of a measurement process that manifests itself as a consistent positive or negative deviation from the known or true value. Bias can result from improper data collection, poorly calibrated analytical or sampling equipment, or limitations or errors in analytical methods and techniques.
Bioassessment	The use of living organisms (such as benthic macroinvertebrates, algae, bacteria, or wetland plants) to assess the health of an ecosystem. Used interchangeably with biomonitoring.
Biological community	All the organisms living at the same time and area.
Calibration	A comparison of a measurement standard, instrument, or item with one having higher accuracy to detect, quantify, and record any inaccuracy or variation; the process by which an instrument setting is adjusted based on response to a standard to eliminate the inaccuracy.
Calibration standard	Reference solution of known value used to correct an instrument reading.
Certified reference material	A substance whose property values are certified by a procedure which establishes its traceability and uncertainty at a stated level of confidence.
Coefficient of variation (CV)	The standard deviation divided by the mean, expressed as a percentage. The CV of repeated measurements is related to method precision.
Comparability	A measure of the confidence with which one data set,

	element, or method can be considered as similar to another.
Completeness	A measure of the amount of valid data obtained from a measurement system.
Corrective action	Any measures taken to rectify conditions adverse to quality and/or to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent reoccurrence.
Data validation	An analyte- and sample-specific process that evaluates the information after the verification process (i.e., determination of method, procedural, or contractual compliance) to determine analytical quality and any limitations.
Data verification	The process of evaluating the completeness, correctness, and conformance/compliance of a specific information set against the method, procedural, or contractual specifications for that activity.
External QA	A quality assurance process conducted by an independent reference lab, which did not generate the original data.
Field duplicate	An independent sample or measurement collected from approximately the same point in time and space as the previous sample.
Homogenization	The process of mixing benthic macroinvertebrates and debris collected in a sample so that representative subsamples may be drawn.
Index of biotic integrity (IBI)	A sum of scores derived from multiple metrics that provides a comprehensive measure of ecosystem health. Synonymous with multimetric index.
Index period	The time during which samples must be collected for data to be considered valid.
Indicators	Items, elements, or measures used to determine or identify a basic condition or how well a process or program is meeting its objectives.
Internal QA	A quality assurance process that occurs within a single lab that generated the original data.
Management unit	A single watershed or collection of watersheds, treated as a single unit for analysis and assessment.
Measurement quality objective (MQO)	The individual performance or acceptance goals for the individual Data Quality Indicators such as precision or bias
Metric	A summary measure of benthic macroinvertebrate community structure that is related to ecosystem health.
Method	A procedure, technique, or tool for performing a scientific

	activity.
Method detection limit (MDL)	The minimum concentration of an analyte that undergoes the entire measurement process and can be reported with a stated level of confidence that the analyte concentration is greater than zero.
Nominal targets	The intended type of site designated for sampling by the sample draw. The nominal targets are defined by coordinates of latitude and longitude, by stream order, and land use class.
Non-direct measurements	Data obtained from existing sources rather than measured or generated directly.
Original lab	The taxonomy lab that generates original data.
Parameter	A statistical quantity, usually unknown, such as a mean or a standard deviation, which characterizes a population or defines a system.
Population	The entire aggregate of items that comprise the universe of interest of a study or experiment. In the case of the SMC project, the population is defined as all the wadeable perennial streams, second order and higher, in the coastal watersheds of Southern California.
Precision	A measure of agreement between two or more individual measurements of the same property, obtained under similar conditions.
Probabilistic sample	A process of drawing a random sample in which each data measurement has a known probability of inclusion in the sample.
Processing efficiency	A measure of a lab's ability to completely sort all the samples it receives for a project.
Quality assurance (QA)	An integrated system of management activities (planning, implementation, assessment, reporting, and quality improvement) that focuses on providing confidence in the data or product by ensuring that it is of the type and worth needed and expected by the client.
Quality assurance officer (QAO)	The individual designated within an organization having management oversight and responsibilities for planning, documenting, coordinating, and assessing the system effectiveness for ensuring the value of the work.
Quality assurance project plan (QAPP)	A document that describes the intended technical activities and project procedures that will be implemented to ensure that the results of the work to be performed will satisfy the stated performance or acceptance criteria. The amount of information presented and the planned activities to ensure the value of the work will vary according he type of study and the intended use of the data.
Quality assurance	A document describing in comprehensive detail the

program plan (QAPrP)	necessary decisions and decision criteria to be used by an overall regulatory program.
Quality Management Plan (QAMP)	A document that describes an organization's system in terms of its organizational structure, policy and procedures, staff functional responsibilities, lines of authority, and interfaces for those planning, implementing, documenting, and assessing all activities conducted.
Random error	An error in taxonomic identification that is not made consistently, in which one taxon is identified as multiple taxa, or multiple taxa are given the same identification.
Reconnaissance	The process of verifying a site's sampleability for a project.
Recount accuracy	A measure of a lab's ability to count the correct number of organisms in a sample.
Reference collection	A collection of benthic macroinvertebrates with known identifications maintained by a taxonomy lab.
Reference lab	The taxonomy lab that performs quality assurance checks of data produced by the original lab, but does not generate original data.
Reidentification	A second process of taxonomic identification carried out by a reference lab.
Reporting limit (RL)	The minimum value below which data are documented as nondetected.
Representativeness	The degree to which a sample represents a population, or a subsample represents the sample from which it was drawn.
Sample (biological)	Material gathered in the field for lab analysis.
Sample (statistical)	A collection of data that represents the population of interest. In this project, all the data gathered from every site in the study is the sample.
Sampling frame	A representation of the population, used to draw a statistical sample.
Sensitivity	The capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest.
Sorted sample residue	The remnant organic and inorganic debris left in a sample after biological organisms are removed.
Sorting	The process of removing benthic macroinvertebrates from organic and inorganic debris collected during the sampling process.
Sorting efficiency	A measure of a lab's ability to completely sort a single sample and remove the target number of organisms.
Standard deviation (SD)	The measure of the dispersion or imprecision of a series of accepted results around the average, equal to the

	square root of the variance.
Standard operating procedure (SOP)	A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps and that is officially approved as the method for performing certain routine or repetitive tasks.
Standard Taxonomic Effort (STE)	The level of taxonomic resolution to which benthic macroinvertebrates can be identified using standard procedures for analyzing morphology based on the most current literature available.
Stratum	A discrete subpopulation of sites that are sampled and analyzed independently.
Stream order	A measure of position within a stream network, starting at one 1 in headwater streams, and increasing as position progresses through the watershed towards the mouth. When two stream reaches of the same order join, the subsequent reach has a stream order increased by one. Synonymous with Strahler order.
Stressor	An environmental disturbance (either acute or constitutive) known to degrade ecosystem health.
Systemic error	An error in taxonomic identification in which one taxon is consistently misidentified.
Taxonomic count error	An error that results in an inaccurate count of the number of taxa in a sample.
Taxonomic identification	The process of identifying organisms.
Taxonomic identification error	An error in taxonomic identification produced when an organism is identified as the incorrect taxon.
Taxonomic resolution error	An error in taxonomic identification in which an organism is identified to an inappropriate level of taxonomic resolution. A high taxonomic resolution error occur when an organism is identified to a higher level than the condition of the specimen (or the STE) can support. A low taxonomic resolution error occurs when an organism can be identified to a greater level than the level provided by the original lab.
Taxonomist	A professional scientist who has been trained to identify benthic macroinvertebrates.
Validity	The degree to which a method actually measures the parameter it purports to measure.
Voucher	A representative specimen of an individual taxon retained to verify the data produced by taxonomic identification for a particular project.

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APPENDIX A

Probabilistic sites sampled by the SMC

Ventura Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00463	2	Open	-119.29418	34.52005
SMC00911	2	Open	-119.29855	34.50797
SMC01119	3	Open	-119.40317	34.44259
SMC01423	3	Open	-119.33916	34.41219
SMC01487	2	Open	-119.26005	34.51221
SMC01531	2	Agricultural	-119.21444	34.47277
SMC01567	3	Open	-119.38374	34.50959
SMC01723	2	Agricultural	-119.16195	34.45244
SMC02127	4	Agricultural	-119.26475	34.42319
SMC02831	5	Urban	-119.30139	34.42874
SMC03023	4	Open	-119.29156	34.45442
SMC03791	5	Agricultural	-119.29680	34.44310
SMC03919	4	Open	-119.31862	34.36177
SMC04047	5	Agricultural	-119.29171	34.45833
SMC04127	5	Urban	-119.29096	34.44578
SMC04175	4	Urban	-119.27642	34.40835
SMC04239	6	Urban	-119.31114	34.36080
SMC04383	4	Open	-119.35603	34.50224
SMC04399	6	Urban	-119.30063	34.30796
SMC05423	6	Urban	-119.30791	34.28650
SMC05883	3	Agricultural	-119.22521	34.44381
SMC06927	4	Urban	-119.30229	34.43182
SMC08335	6	Urban	-119.29948	34.34584
SMC10079	4	Agricultural	-119.25254	34.43136
SMC10959	5	Agricultural	-119.29976	34.48521
SMC11215	5	Agricultural	-119.28858	34.45682
SMC11727	5	Agricultural	-119.29339	34.47858
SMC16079	6	Agricultural	-119.30039	34.43900
SMC16409	5	Agricultural	-119.29526	34.44618
SMC19145	5	Agricultural	-119.28953	34.46478

Santa Clara Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00175	2	Open	-119.00484	34.51777
SMC00204	2	Open	-118.70947	34.48069
SMC00271	3	Open	-119.16547	34.54850
SMC00283	2	Open	-119.03309	34.55930
SMC00299	2	Open	-118.93862	34.59778
SMC00315	2	Open	-119.16957	34.57281
SMC00319	3	Open	-118.90185	34.51206
SMC00324	6	Agricultural	-119.10970	34.30064
SMC00348	2	Open	-118.57797	34.50262
SMC00456	4	Open	-118.23419	34.43528
SMC00475	3	Open	-119.09713	34.73026
SMC00495	4	Open	-118.93968	34.47887
SMC00511	6	Agricultural	-118.86425	34.38668
SMC00536	4	Open	-118.34351	34.43388
SMC00604	2	Agricultural	-118.60785	34.48489
SMC00619	3	Open	-118.85114	34.56729
SMC00671	3	Agricultural	-119.14791	34.32516
SMC00772	4	Agricultural	-118.93222	34.40976
SMC00827	4	Open	-119.18833	34.55735
SMC01039	4	Open	-119.20388	34.55491
SMC01136	5	Open	-118.74403	34.62762
SMC01151	6	Agricultural	-118.97196	34.37230
SMC01163	5	Open	-118.86529	34.69943
SMC01272	5	Agricultural	-118.69051	34.40303
SMC01279	6	Agricultural	-118.82171	34.38525
SMC01372	5	Agricultural	-118.61387	34.43437
SMC01676	5	Agricultural	-118.62962	34.41932
SMC01784	5	Agricultural	-118.74715	34.40228
SMC05708	4	Urban	-118.54122	34.41027
SMC09564	5	Urban	-118.59398	34.43220

Calleguas Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC01023	2	Open	-118.81565	34.30527
SMC01044	2	Open	-119.02818	34.15932
SMC01092	2	Agricultural	-119.05912	34.27315
SMC01236	3	Urban	-118.89450	34.18534
SMC01256	3	Urban	-118.79596	34.26756
SMC01412	2	Agricultural	-119.00627	34.28551
SMC01512	2	Urban	-118.67252	34.27641
SMC01684	2	Agricultural	-118.91592	34.27907
SMC01732	5	Agricultural	-119.09079	34.11248
SMC01748	4	Urban	-118.82745	34.28747
SMC01860	4	Urban	-118.97912	34.22400
SMC01960	4	Urban	-118.75916	34.26555
SMC02047	2	Agricultural	-118.83136	34.31092
SMC02280	2	Urban	-118.80949	34.24981
SMC02436	4	Agricultural	-118.97200	34.26280
SMC02628	4	Urban	-119.00404	34.23316
SMC02884	3	Agricultural	-118.98534	34.21750
SMC02948	3	Agricultural	-119.08495	34.13724
SMC02984	4	Urban	-118.75053	34.26528
SMC03268	5	Agricultural	-119.06302	34.16256
SMC03476	4	Agricultural	-118.95043	34.26730
SMC03988	3	Open	-118.89767	34.21323
SMC04308	4	Open	-118.90831	34.19349
SMC04328	3	Agricultural	-118.81187	34.29363
SMC04500	3	Agricultural	-118.93566	34.28889
SMC04756	4	Agricultural	-118.92691	34.27092
SMC04932	4	Agricultural	-119.00116	34.20139
SMC05252	4	Agricultural	-119.00078	34.24680
SMC07556	4	Agricultural	-118.99110	34.25615
SMC11668	4	Agricultural	-118.95421	34.26559

Santa Monica Bay Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC01172	2	Open	-118.85827	34.08160
SMC01364	2	Urban	-118.83101	34.13913
SMC01384	4	Open	-118.70092	34.06461
SMC01550	2	Open	-118.84901	34.05627
SMC01592	3	Open	-118.59230	34.11131
SMC01640	3	Urban	-118.69679	34.15336
SMC01812	2	Open	-118.94831	34.08930
SMC01988	2	Open	-119.00119	34.12066
SMC02152	4	Open	-118.72171	34.09802
SMC02408	2	Open	-118.73840	34.16462
SMC02446	2	Open	-118.63889	34.04769
SMC02548	2	Open	-118.50674	34.06379
SMC02574	2	Open	-118.84172	34.03182
SMC02756	3	Open	-119.01324	34.09217
SMC02920	2	Urban	-118.76695	34.17748
SMC03048	2	Urban	-118.79089	34.18426
SMC03896	3	Open	-118.60226	34.09220
SMC03944	2	Urban	-118.75016	34.14272
SMC04200	4	Open	-118.73315	34.09950
SMC04264	3	Urban	-118.75481	34.13000
SMC04692	2	Agricultural	-118.88777	34.14317
SMC04750	3	Open	-118.58150	34.04100
SMC05060	4	Open	-119.01176	34.08717
SMC05460	3	Open	-118.82519	34.13609
SMC05480	4	Open	-118.69207	34.05998
SMC05902	2	Urban	-118.51219	34.03432
SMC11880	3	Urban	-118.70828	34.12529
SMC13416	3	Urban	-118.71595	34.09875
SMC14952	3	Urban	-118.70090	34.14268
SMC16232	3	Urban	-118.75317	34.12550

Los Angeles Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00436	5	Urban	-118.27864	34.14900
SMC00440	2	Urban	-118.52966	34.28659
SMC00472	3	Open	-118.27577	34.37406
SMC00520	4	Open	-118.28253	34.29626
SMC00528	2	Open	-118.11052	34.33508
SMC00732	2	Open	-118.08666	34.20705
SMC00756	4	Urban	-118.39156	34.14957
SMC00924	3	Open	-118.18053	34.22395
SMC00984	2	Open	-118.33716	34.32723
SMC00988	3	Open	-118.14413	34.26610
SMC01004	3	Urban	-118.16579	34.15016
SMC01040	4	Open	-118.15792	34.30553
SMC01096	4	Open	-118.29344	34.28465
SMC01196	2	Open	-118.02952	34.27836
SMC01208	4	Urban	-118.53651	34.19016
SMC01320	4	Open	-118.25082	34.29856
SMC01400	2	Urban	-118.53735	34.14725
SMC01432	3	Open	-118.39935	34.33306
SMC01452	2	Urban	-118.06675	34.09095
SMC01464	2	Urban	-118.52666	34.27517
SMC01544	4	Open	-118.24844	34.29729
SMC01656	2	Urban	-118.53627	34.15633
SMC01692	3	Urban	-118.16973	34.19799
SMC01716	2	Urban	-118.49728	34.20731
SMC01780	4	Urban	-118.42307	34.14979
SMC01972	2	Urban	-118.49564	34.24018
SMC01976	3	Urban	-118.59092	34.27243
SMC03646	5	Urban	-118.16911	33.97840
SMC03902	5	Urban	-118.21959	34.01076
SMC06216	4	Agricultural	-118.31519	34.27407

San Gabriel Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00464	4	Open	-117.86684	34.24152
SMC00480	3	Open	-117.73156	34.23435
SMC00620	2	Open	-117.97154	34.27014
SMC00638	2	Urban	-118.01413	33.95751
SMC00670	2	Urban	-117.90916	33.86926
SMC00894	2	Urban	-117.96668	33.94455
SMC00926	2	Urban	-117.88297	33.90740
SMC01184	3	Urban	-117.80201	34.12409
SMC01278	4	Urban	-118.06646	33.82099
SMC01324	2	Open	-117.94112	34.20137
SMC01340	3	Open	-117.74976	34.30002
SMC01424	2	Open	-117.81586	34.24075
SMC01488	3	Open	-117.88862	34.27566
SMC01504	2	Open	-117.71385	34.25327
SMC01646	2	Open	-117.84238	33.94575
SMC01964	5	Urban	-117.95058	34.12730
SMC02096	3	Open	-117.76906	34.16617
SMC02348	3	Open	-117.93618	34.19753
SMC02400	5	Open	-117.90050	34.16003
SMC02656	3	Urban	-117.87216	34.07499
SMC02848	3	Urban	-117.81479	34.09642
SMC02976	4	Open	-117.75661	34.25791
SMC03774	3	Urban	-117.93627	33.84298
SMC05036	4	Urban	-117.93771	34.14187
SMC05246	5	Urban	-118.07745	33.98362
SMC05472	5	Urban	-117.91784	34.15651
SMC05968	4	Open	-117.80555	34.23490
SMC06368	4	Open	-117.75382	34.27868
SMC06496	5	Open	-117.89110	34.16554
SMC06864	5	Open	-117.85828	34.20283

Lower Santa Ana Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00067	2	Urban	-117.68783	33.67280
SMC00105	2	Open	-117.58423	33.74651
SMC00414	3	Urban	-117.84618	33.90342
SMC00814	2	Open	-117.70897	33.85996
SMC01155	3	Open	-117.67949	33.76061
SMC01219	5	Urban	-117.83016	33.78543
SMC01246	5	Urban	-117.79477	33.81020
SMC01475	5	Urban	-117.87728	33.77009
SMC01795	3	Open	-117.65149	33.72643
SMC01838	5	Urban	-117.73315	33.87498
SMC02270	5	Urban	-117.77242	33.79574
SMC02371	2	Agricultural	-117.71998	33.79143
SMC02563	2	Urban	-117.67294	33.68193
SMC03091	3	Urban	-117.70363	33.66512
SMC03294	3	Agricultural	-117.74823	33.79544
SMC03550	5	Agricultural	-117.73608	33.79613
SMC03998	5	Urban	-117.83897	33.82650
SMC06019	4	Urban	-117.81236	33.68262
SMC06467	2	Agricultural	-117.71782	33.79119
SMC08275	4	Urban	-117.76864	33.66197
SMC08531	3	Agricultural	-117.74964	33.64048
SMC10718	5	Agricultural	-117.74582	33.79461
SMC23039	4	Agricultural	-117.73081	33.79340
SMC26288	4	Agricultural	-117.69453	33.77433
SMC27958	4	Agricultural	-117.73181	33.79457
SMC30222	5	Agricultural	-117.64442	33.88736
SMC34888	4	Agricultural	-117.68432	33.77387
SMC37561	5	Agricultural	-117.73963	33.79485
SMC39841	5	Agricultural	-117.72839	33.79199
SMC40561	5	Agricultural	-117.75752	33.79507

Middle Santa Ana Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00011	2	Urban	-117.28995	34.04934
SMC00029	2	Open	-117.30796	33.92526
SMC00032	3	Urban	-117.63367	34.14454
SMC00103	4	Urban	-117.56372	34.13708
SMC00185	2	Open	-117.44727	33.74997
SMC00215	2	Open	-117.51636	34.16906
SMC00413	2	Urban	-117.30302	33.72223
SMC00493	2	Urban	-117.59438	33.85532
SMC00807	3	Open	-117.54286	34.14215
SMC00889	3	Open	-117.46787	33.77310
SMC01165	3	Agricultural	-117.33512	33.83615
SMC01191	3	Urban	-117.37298	34.15167
SMC01261	4	Agricultural	-117.62698	33.90018
SMC01303	3	Agricultural	-117.42372	34.18248
SMC01341	3	Urban	-117.56211	33.94615
SMC01383	3	Urban	-117.54181	34.06636
SMC01533	4	Urban	-117.41245	33.92107
SMC01559	4	Open	-117.45726	34.20984
SMC01639	4	Urban	-117.60047	34.05360
SMC01913	3	Open	-117.47196	33.77438
SMC02059	5	Urban	-117.30727	34.06182
SMC02350	5	Agricultural	-117.64400	33.90334
SMC02798	4	Agricultural	-117.64355	33.92522
SMC03133	4	Agricultural	-117.59960	34.00169
SMC03389	4	Agricultural	-117.61732	33.94428
SMC04333	3	Agricultural	-117.63045	33.90493
SMC05261	3	Agricultural	-117.32484	33.83654
SMC06269	2	Agricultural	-117.42096	33.89439
SMC06423	2	Agricultural	-117.40453	34.17351
SMC06446	2	Agricultural	-117.64106	33.90226

Upper Santa Ana Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00119	3	Agricultural	-117.14031	34.09075
SMC00135	2	Open	-116.87858	34.07819
SMC00146	2	Open	-117.00386	33.94737
SMC00263	3	Open	-116.98426	34.16203
SMC00331	3	Agricultural	-117.18959	34.10372
SMC00375	2	Urban	-117.15272	34.10902
SMC00435	2	Open	-116.98910	34.05870
SMC00439	4	Open	-117.03351	34.14781
SMC00503	3	Open	-117.18594	34.17967
SMC00519	3	Open	-116.94261	34.17639
SMC00523	2	Urban	-117.24742	34.07279
SMC00779	5	Urban	-117.30036	34.09470
SMC01015	3	Urban	-117.26665	34.15878
SMC01099	4	Urban	-117.22608	34.09387
SMC01355	4	Agricultural	-117.19256	34.10338
SMC01399	3	Agricultural	-117.17274	34.10318
SMC01719	4	Agricultural	-117.14497	34.08654
SMC02167	4	Agricultural	-117.15956	34.10450
SMC02571	4	Urban	-117.27427	34.10642
SMC02573	4	Agricultural	-117.17765	34.01345
SMC02647	4	Agricultural	-117.37808	34.16536
SMC03191	3	Agricultural	-117.15424	34.09137
SMC04215	3	Agricultural	-117.13267	34.09178
SMC05143	4	Agricultural	-117.42219	34.19215
SMC05495	4	Agricultural	-117.16853	34.09762
SMC06263	4	Agricultural	-117.14676	34.09311
SMC07287	4	Agricultural	-117.15411	34.09458
SMC09047	2	Agricultural	-117.40081	34.17573
SMC09399	4	Agricultural	-117.10556	34.10398
SMC20677	5	Agricultural	-117.16991	34.09803

San Jacinto Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00077	2	Agricultural	-117.16551	33.94510
SMC00226	4	Open	-116.71323	33.66104
SMC00285	2	Urban	-117.21802	33.91637
SMC00290	2	Open	-116.94045	33.86073
SMC00338	3	Open	-116.78492	33.63182
SMC00354	3	Open	-116.99219	33.84901
SMC00386	3	Open	-116.79277	33.74187
SMC00466	2	Open	-116.83192	33.78715
SMC00505	4	Agricultural	-117.18716	33.78800
SMC00562	2	Open	-116.74412	33.60690
SMC00610	2	Open	-116.91382	33.79323
SMC00653	3	Agricultural	-117.21317	33.85022
SMC00802	4	Agricultural	-117.00086	33.83562
SMC00962	2	Urban	-116.91337	33.74481
SMC01309	2	Agricultural	-117.19303	33.93473
SMC01490	3	Open	-116.83769	33.79021
SMC01954	4	Open	-116.72524	33.66269
SMC01977	4	Urban	-117.39674	33.67699
SMC02178	4	Open	-116.77521	33.69993
SMC02205	4	Urban	-117.28464	33.66626
SMC02370	2	Agricultural	-116.89368	33.72809
SMC02461	2	Agricultural	-117.26742	33.77423
SMC02589	3	Urban	-117.23413	33.93186
SMC02946	3	Agricultural	-116.85235	33.69700
SMC03357	3	Urban	-117.23883	33.94260
SMC03421	4	Agricultural	-117.24263	33.73906
SMC04601	4	Agricultural	-117.16326	33.80506
SMC04706	3	Agricultural	-116.90049	33.77817
SMC04749	3	Agricultural	-117.21322	33.85827
SMC08697	4	Agricultural	-117.17012	33.79801

San Juan Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00206	3	Urban	-117.65964	33.54359
SMC00213	3	Open	-117.49069	33.46172
SMC00229	4	Open	-117.54708	33.41933
SMC00313	3	Open	-117.44624	33.60643
SMC00469	3	Open	-117.40855	33.52999
SMC00485	3	Open	-117.57005	33.45641
SMC00531	2	Open	-117.77201	33.55975
SMC00661	3	Open	-117.45780	33.48302
SMC00741	3	Open	-117.49927	33.45730
SMC00873	2	Urban	-117.62668	33.59849
SMC00910	4	Open	-117.74427	33.51384
SMC00963	3	Urban	-117.65140	33.56402
SMC00981	4	Urban	-117.58498	33.40187
SMC01189	2	Open	-117.53394	33.48763
SMC01193	2	Open	-117.55190	33.64233
SMC01245	2	Open	-117.34627	33.56365
SMC01257	2	Urban	-117.61860	33.60842
SMC01678	4	Urban	-117.68227	33.46643
SMC01701	4	Urban	-117.61084	33.52643
SMC02005	4	Agricultural	-117.58173	33.40645
SMC03465	2	Agricultural	-117.33238	33.52393
SMC03493	4	Agricultural	-117.56197	33.51874
SMC05029	4	Agricultural	-117.60079	33.52380
SMC13269	4	Agricultural	-117.57949	33.41228
SMC14245	4	Agricultural	-117.58117	33.51498
SMC14757	4	Agricultural	-117.55932	33.52310
SMC16085	3	Agricultural	-117.58809	33.39784
SMC17113	3	Agricultural	-117.59027	33.51761
SMC19113	4	Agricultural	-117.56441	33.51741
SMC21515	4	Agricultural	-117.55526	33.53176

Northern San Diego Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00033	3	Open	-116.71307	33.28013
SMC00101	2	Open	-117.49226	33.32862
SMC00109	4	Urban	-117.14825	33.58234
SMC00117	5	Open	-117.33194	33.34095
SMC00129	2	Open	-116.56385	33.21168
SMC00137	3	Agricultural	-117.25322	33.46819
SMC00153	5	Urban	-117.34612	33.22193
SMC00173	2	Open	-117.07142	33.62273
SMC00181	2	Open	-117.07215	33.34756
SMC00197	4	Open	-116.96476	33.48467
SMC00341	3	Open	-116.83128	33.46334
SMC00353	3	Agricultural	-117.04169	33.24049
SMC00373	2	Urban	-117.23525	33.29381
SMC00457	2	Agricultural	-117.09392	33.23370
SMC00517	2	Agricultural	-117.00516	33.31907
SMC00561	5	Open	-116.89747	33.25961
SMC00585	2	Agricultural	-117.29619	33.43762
SMC00665	5	Urban	-117.23159	33.27401
SMC00693	2	Agricultural	-117.08556	33.29641
SMC00753	5	Agricultural	-116.98761	33.30224
SMC00757	5	Urban	-117.17420	33.51806
SMC01097	3	Agricultural	-117.25538	33.48724
SMC01133	3	Urban	-117.13425	33.53875
SMC01161	3	Agricultural	-117.25532	33.44662
SMC01717	5	Agricultural	-117.13233	33.34015
SMC01909	4	Agricultural	-117.13885	33.31129
SMC02101	6	Agricultural	-117.32450	33.36036
SMC02457	5	Agricultural	-117.25006	33.25578
SMC02501	5	Agricultural	-117.04549	33.48853
SMC02933	5	Agricultural	-117.16562	33.31956

Central San Diego Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00001	2	Open	-116.72734	33.14405
SMC00177	4	Urban	-117.05158	33.05295
SMC00198	3	Urban	-117.13851	32.93710
SMC00257	2	Open	-116.77104	33.12559
SMC00433	4	Agricultural	-117.01620	33.08340
SMC00473	4	Urban	-117.15803	33.03917
SMC00481	3	Open	-116.80988	33.05113
SMC00625	2	Open	-117.00273	33.14575
SMC00710	3	Urban	-117.20028	32.88934
SMC00729	2	Urban	-117.17489	33.13525
SMC00921	3	Urban	-117.11574	33.10624
SMC01049	2	Urban	-117.20403	33.17734
SMC01158	2	Agricultural	-117.16676	32.96281
SMC01174	2	Urban	-117.01646	33.01678
SMC01201	2	Urban	-117.05528	33.08585
SMC01222	3	Urban	-117.11509	32.94308
SMC01414	3	Urban	-117.17043	32.92968
SMC01441	3	Open	-116.85296	33.13849
SMC01561	2	Urban	-117.22808	33.10140
SMC01622	2	Urban	-117.04842	32.92835
SMC01638	3	Open	-116.91228	33.02957
SMC01814	4	Urban	-117.22540	33.02298
SMC01862	4	Urban	-117.18087	33.03234
SMC01953	4	Open	-116.90321	33.08959
SMC02694	2	Agricultural	-117.11597	33.00240
SMC03654	4	Urban	-117.20067	33.03966
SMC05745	4	Agricultural	-116.93710	33.08928
SMC05958	5	Urban	-117.20227	33.00349
SMC06361	3	Agricultural	-117.15180	33.08555
SMC07537	3	Agricultural	-117.01624	33.10549

Mission Bay and San Diego River Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00102	2	Open	-116.80116	33.00372
SMC00214	3	Open	-116.99266	32.89287
SMC00321	3	Open	-116.69458	33.05258
SMC00458	4	Open	-116.75479	32.89163
SMC00513	2	Open	-116.64514	33.08937
SMC00577	2	Open	-116.67502	33.07673
SMC00586	2	Open	-116.65097	32.96716
SMC00598	2	Open	-116.98656	32.92344
SMC00966	2	Urban	-117.10144	32.83284
SMC01046	2	Urban	-117.18495	32.79510
SMC01098	3	Open	-116.63808	32.90276
SMC01302	3	Urban	-117.18222	32.84640
SMC01418	3	Open	-116.71771	32.99255
SMC01434	3	Open	-116.62488	32.90424
SMC01446	5	Agricultural	-116.84989	32.89244
SMC01606	2	Urban	-117.23481	32.84199
SMC01990	2	Urban	-117.11327	32.79654
SMC02006	2	Urban	-116.98486	32.83083
SMC02214	4	Agricultural	-116.86362	32.88010
SMC02442	4	Open	-116.74364	32.98100
SMC02822	3	Urban	-117.15909	32.76822
SMC03094	3	Urban	-117.18848	32.84533
SMC04054	3	Urban	-117.01875	32.83698
SMC04774	3	Urban	-116.80702	32.84589
SMC05702	3	Urban	-117.22954	32.83210
SMC09638	5	Agricultural	-116.81509	32.88420
SMC09750	2	Agricultural	-117.08711	32.86372
SMC10406	4	Urban	-116.92115	32.87291
SMC13478	5	Agricultural	-116.87326	32.88188
SMC16714	5	Agricultural	-116.83366	32.88853

Southern San Diego Management Unit

Site Code	Stream order	Land use	Longitude	Latitude
SMC00010	2	Open	-116.61990	32.65835
SMC00106	3	Open	-116.92625	32.58677
SMC00182	5	Open	-116.68581	32.62912
SMC00202	3	Open	-116.74631	32.80563
SMC00262	2	Open	-116.48674	32.90899
SMC00282	3	Open	-116.61358	32.87181
SMC00326	2	Urban	-117.11830	32.71748
SMC00434	2	Open	-116.49235	32.76817
SMC00474	2	Open	-116.87299	32.66322
SMC00498	2	Open	-116.49464	32.80828
SMC00538	4	Open	-116.63207	32.78123
SMC00618	2	Open	-116.85860	32.61642
SMC00682	2	Urban	-117.01425	32.54404
SMC00694	2	Open	-116.77989	32.57078
SMC00742	3	Open	-116.77250	32.66797
SMC01066	4	Open	-116.81875	32.77188
SMC01242	2	Urban	-116.86137	32.69866
SMC01258	3	Urban	-117.05887	32.64950
SMC01350	3	Urban	-117.12137	32.70066
SMC01802	4	Open	-116.55047	32.68328
SMC01818	4	Open	-116.52038	32.86216
SMC02058	4	Open	-116.64257	32.76142
SMC02230	5	Open	-116.71996	32.60050
SMC02474	5	Open	-116.88420	32.63687
SMC02618	2	Agricultural	-116.98590	32.68170
SMC03302	2	Agricultural	-116.84530	32.79510
SMC03354	4	Open	-116.61677	32.79112
SMC03434	4	Open	-116.80673	32.65586
SMC03766	5	Open	-116.75202	32.57553
SMC04058	3	Agricultural	-116.83715	32.78053

APPENDIX B

SWAMP BIOASSESSMENT SOP

Download from

http://swamp.mpsl.mlml.calstate.edu/wp-content/uploads/2009/04/swamp_sop_bioassessment_collection_020107.pdf

APPENDIX C

Sorting benchsheets and subsampling worksheets

Subsampling Worksheet

BENTHIC MACROINVERTEBRATE SUBSAMPLING WORKSHEET

Project Name: ________________________ Project Code: _______________ Object Code: _______________

Lab Sample ID #:				**Date:**					**Technician Name:**										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
random grid #																				
half /whole grid																				
# per grid																				
cumulative #																				
Grids Picked: Total Grids: Count:							QC #: QC%:				Total Count:					Time: QC Initials:				

Lab Sample ID #:				**Date:**					**Technician Name:**										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
random grid #																				
half /whole grid																				
# per grid																				
cumulative #																				
Grids Picked: Total Grids: Count:							QC #: QC%:				Total Count:					Time: QC Initials:				

Lab Sample ID #:				**Date:**					**Technician Name:**										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
random grid #																				
half /whole grid																				
# per grid																				
cumulative #																				
Grids Picked: Total Grids: Count:							QC #: QC%:				Total Count:					Time: QC Initials:				

Sorting Bench Sheets

Benthic Macroinvertebrate Sorting Worksheet					
Project Code:		**Project Name:**			
Technician Name:		**Object Code:**		**Project Date:**	
	Lab Sample ID #	**Lab Sample ID #**	**Lab Sample ID #**	**Lab Sample ID #**	**Lab Sample ID #**
Taxon:	***#bugs***	***#bugs***	***#bugs***	***#bugs***	***#bugs***
Annelida(Hirudinea)					
Annelida(Oligochaeta)					
Annelida(Polychaeta)					
Chelicerata(Hydracarina)					
Coleoptera					
Crustacea(Amphipoda)					
Crustacea(Isopoda)					
Crustacea(Mysidacea)					
Crustacea(Ostracoda)					
Decapoda					
Diptera					
Diptera(Chironomidae)					
Ephemeroptera					
Hydra					
Hemiptera					
Lepidoptera					
Megaloptera					
Mollusca(Gastropoda)					
Mollusca(Pelecypoda)					
Nemertea					
Odonata					
Plecoptera					
Platyhelminthes					
Tardigrada					
Trichoptera					
Total Bugs Sorted:					
***Total Bugs Discarded:**					
Total:					
Bugs Picked:					
Time:					
Date:					

***Discards include exuvia, small (<0.5 mm), fragmented, decomposed, non-aquatic/benthic**

APPENDIX D

Example of MQO calculations for biological data

Below are results from two hypothetical samples submitted to a reference lab as a batch for quality assurance checks. Calculations of the MQOs described in Section 7 are provided. Relevant MQOs are summarized in Table D1.

Table D1. Summary of MQOs

Sample-based MQO	Objective
Recount accuracy	≥95%
Taxa count error rate	≤10%
Taxa ID error rate	≤10%
Individual ID error rate	≤10%
Taxonomic resolution error rate	≤10%
Batch-based MQO	
Random error rate	≤10%
Systemic error rate	≤10%

Table D2 shows the results from Sample 1. Sample 1 contains several errors in counting as well as identification. For example, in Vial 1, *Diphetor hageni* is incorrectly identified as *Fallceon quilleri*, and the vial contains two specimens instead of one. Vial 6 and Vial 10 both show errors of taxonomic resolution, in which the original lab made an inappropriate determination than the specimens (and, in fact, the STE) could support.

Table D2. Results from Sample 1

Vial #	Original ID	Original count	Reference ID	Reference count	ID error	Count error
1	*Fallceon quilleri*	1	*Diphetor hageni*	2	Yes	Yes
2	*Baetis*	129	*Baetis*	129	No	No
3	*Hydroptila*	12	*Hydroptila*	12	No	No
4	*Hydropsyche*	67	*Hydropsyche*	67	No	No
			Prostoma	1	Yes	Yes
5	*Simulium*	46	*Simulium*	45	No	Yes
6	*Caloparyphus*	20	*Caloparyphus / Euparyphus*	20	Yes	No
7	*Sperchon*	5	*Sperchon*	5	No	No
8	*Argia*	12	*Argia*	12	No	No
9	*Hyalella*	3	*Hyalella*	3	No	No
10	*Corbicula fluminea*	6	*Corbicula*	6	Yes	No

Table D3 summarizes the count of individuals and taxa for Sample 1. These numbers are used in the calculation of several MQOs.

Table D3. Summary of Sample 1

	Original	Reference
Total richness	10	11
Total # individuals	301	302

Table D4 shows the calculation of MQOs for Sample 1. Although most objectives were met, the Taxa ID error rate exceeded the MQO because four of the 11 taxa (36.4%) were identified incorrectly.

Table D4. MQOs for Sample 1.

Sample-based MQOs	Calculation	Result	Meets objective?
Recount accuracy	=301/302*100	99.7%	Yes (≥95%)
Taxa count error rate	=|(11-10)|/11*100	9.1%	Yes (≤10%)
Taxa ID error rate	*Diphetor hageni* *Prostoma* *Caloparyphus/Euparyphus* *Corbicula* =4/11*100	36.4%	No (>10%)
Individual ID error rate	2 *Diphetor hageni* 1 *Prostoma* 20 *Caloparyphus/Euparyphus* 6 *Corbicula* =29/302*100	9.6%	Yes (≤10%)
High taxonomic resolution error rate	6 *Corbicula* 20 *Caloparyphus/Euparyphus* =26/302*100	8.6%	NA
Low taxonomic resolution error rate	None	0%	NA
Taxonomic resolution error rate	8.6% + 0%	8.6%	Yes (≤10%)

Table D5 shows the results from the second sample included in the QA batch. Table D6 shows its summary, and Table D7 shows the MQO calculations.

Table D5. Results for Sample 2.

Vial #	Original ID	Original count	Reference ID	Reference count	ID error	Count error
1	*Fallceon quilleri*	13	*Fallceon quilleri*	12	No	Yes
2	*Caenis*	2	*Caenis*	2	No	No

3	*Cheumatopsyche*	1	*Cheumatopsyche*	1	No	No
4	*Hydroptila*	1	*Hydroptila*	1	No	No
5	*Simulium*	128	*Simulium*	127	No	No
			Cheumatopsyche	1	Yes	No
6	Chironomidae	29	Chironomidae	28	No	Yes
			Mycetophilidae	1	Yes	No
7	*Trichocorixa*	1	*Trichocorixa*	1	No	No
8	Corixidae	2	Corixidae	2	No	No
9	*Sperchon*	2	*Sperchon*	2	No	No
10	*Argia*	24	*Argia*	22	No	Yes
11	Oligochaeta	35	Oligochaeta	9	No	Yes
12	Ostracoda	1	Ostracoda	1	No	No
13	*Hyalella*	41	*Hyalella*	41	No	No
14	*Corbicula fluminea*	6	*Corbicula*	6	Yes	No
15	*Pisidium*	11	*Pisidium*	11	No	No
16	*Turbellaria*	2	*Turbellaria*	2	No	No

Table D6. Summary of Sample 2

	Original	Reference
Total richness	16	17
Total # individuals	299	270

Table D7. MQOs for Sample 2

Sample-based MQOs	Calculation	Result	Meets objective?
Recount accuracy	=270/299*100	90.3%	No (≤95%)
Taxa count error rate	=|(17-16)|/17*100	5.9%	Yes (≤10%)
Taxa ID error rate	*Cheumatopsyche* Mycetophilidae *Corbicula* =3/17*100	17.6%	No (≥10%)
Individual ID error rate	1 *Cheumatopsyche* 1 Mycetophilidae 6 *Corbicula* =8/270*100	3.0%	Yes (≤10%)
High taxonomic resolution error rate	6 *Corbicula* =6/270*100	2.2%	NA
Low taxonomic resolution error rate	None	0%	NA
Taxonomic resolution error rate	=2.2% + 0%	2.2%	Yes (≤10%)

Sample 2 shows several additional errors. For example, the original lab counted a higher number of Oligochaeta than the reference lab found, presumably because the original lab counted organism fragments as individual specimens.

However, this discrepancy was not so large as to cause a failure of the recount accuracy MQO.

Table D8 shows the summary of the entire QA batch, and Table D9 shows the calculation of batch-based MQOs. Table D9 shows that random and systemic error rates exceeded objectives.

Table D8. Summary of batch

	Original	Reference
Total richness	19	22
Total number of common taxa	13	13
Total # individuals	600	572

Table D9. Batch-based MQOs

MQO	Calculation	Result	Meets objective?
Random error rate	*Hydropsyche* identified as *Hydropsyche* and *Prostoma* (Sample 1, Vial 4) *Simulium* identified as *Simulium* and *Cheumatopsyche* (Sample 2, Vial 5 *Cheumatopsyche* identified as *Cheumatopsyche* and *Simulium* (Sample 2, Vials 3 and 5) Mycetophilidae identified as Chironomidae (Sample 2, Vial 6) =4/22*100	18.2%	No (≥10%)
Systemic error rate	*Caloparyphus/Euparyphus* identified as *Caloparyphus* *Corbicula* identified as *Corbicula fluminea* =2/13*100	15.4%	No (≥10%)

Note that some identification errors did not count towards the systemic error rate because the taxa appeared fewer than 5 times in the batch (e.g., *Diphetor hageni* identified as *Fallceon quilleri* in Sample 1 Vial 1, or *Prostoma* identified as *Hydropsyche* in Sample 1 Vial 4). Furthermore, some identification errors did not count towards the systemic error rate because the error was not made consistently (e.g., *Cheumatopsyche* identified as *Simulium* in Sample 2 Vial 5, but as *Cheumatopsyche* in Sample 2 Vial 3).

Sample 1 failed to meet one MQO, and Sample 2 failed to meet two. The batch failed both applicable MQOs. Therefore, the original lab would be required to submit an additional two samples for quality assurance checks.

APPENDIX E

SAFIT Standard Taxonomic Effort

APPENDIX F

SWAMP Bioassessment Data Forms

Download from:

http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/database-management-systems/swamp-25-database/templates-25/field-data-sheets/#BAFieldData

APPENDIX G

Example Chain of Custody Forms

Chain of Custody

Date: _____

Page: _____ of _____

Sample collection by:_____ Project name:_____ Project number: _____

Sample ID	Date	Time	Matrix	Container type	Number of containers	Comments	Analysis

Relinquished by		Relinquished by		Relinquished by	
(signature)	(date)	(signature)	(date)	(signature)	(date)
(printed name)	(time)	(printed name)	(time)	(printed name)	(time)
(company)		(company)		(company)	

Relinquished by		Relinquished by		Relinquished by	
(signature)	(date)	(signature)	(date)	(signature)	(date)
(printed name)	(time)	(printed name)	(time)	(printed name)	(time)
(company)		(company)		(company)	

APPENDIX H

Example Sample Labels

SiteID Stream name County Lat (N) Long (E) Datum (circle one) NAD83 NAD27 Jar # _____ of _____ Date Time Collector Method: RWB ~~TRC~~	SiteID Stream name County Lat (N) Long (E) Datum (circle one) NAD83 NAD27 Jar # _____ of _____ Date Time Collector Method: RWB ~~TRC~~
SiteID Stream name County Lat (N) Long (E) Datum (circle one) NAD83 NAD27 Jar # _____ of _____ Date Time Collector Method: RWB ~~TRC~~	SiteID Stream name County Lat (N) Long (E) Datum (circle one) NAD83 NAD27 Jar # _____ of _____ Date Time Collector Method: RWB ~~TRC~~
SiteID Stream name County Lat (N) Long (E) Datum (circle one) NAD83 NAD27 Jar # _____ of _____ Date Time Collector Method: RWB ~~TRC~~	SiteID Stream name County Lat (N) Long (E) Datum (circle one) NAD83 NAD27 Jar # _____ of _____ Date Time Collector Method: RWB ~~TRC~~

APPENDIX I

Guidelines for the prevention of introducing invasive species and pathogens into streams

The following is an adaptation of an excerpt taken from an EMAP-based Quality Assurance Project Plan developed by the California Department of Fish and Game Aquatic Bioassessment Laboratory (2008).

Organisms of concern in the U.S. include, but may not be limited to, Eurasian watermillefoil (*Myriophyllum spicatum*), New Zealand mud snail (*Potamopyrgus antipodarum*), zebra mussel (*Dreissena polymorpha*), whirling disease (*Myxobolus cerebralis*), chytrid fungus (*Batrachochytrium dendrobatidis*).

Field crews must be aware of regional species of concern, and take appropriate precautions to avoid transfer of these species. Crews should make every attempt to be apprised of the most up-to-date information regarding the emergence of new species of concern, as well as new advances in approaches to hygiene and decontamination to prevent the spread of all such organisms (e.g., Schisler et al., 2008).

There are several online sources of information regarding invasive species, including information on cleaning and disinfecting gear, such as the Whirling Disease Foundation (www.whirling-disease.org), the USDA Forest Service (Preventing Accidental Introductions of Freshwater Invasive Species, available from http://www.fs.fed.us/invasivespecies/documents/Aquatic_is_prevention.pdf, and the California Department of Fish and Game (Hosea and Finlayson 2005). General information about freshwater invasive species is available from the U.S. Geological Survey Nonindigenous Aquatic Species website (http://nas.er.usgs.gov) and the Protect Your Waters website (http://www.protectyourwaters.net/hitchhikers) that is co-sponsored by the U.S. Fish and Wildlife Service. The California State Water Resources Control Board Aquatic Invasive Species website (http://www.swrcb.ca.gov/water_issues/programs/swamp/ais/) should also be consulted regularly for updates.

References

Hosea, R.C. and B. Finlayson. 2005. Controlling the spread of New Zealand mudsnails of wading gear. California Department of Fish and Game, Office of Spill Prevention and Response, Administrative Report 2005-02, Sacramento.

Schisler, G.J., N.K.M. Vieira, and P.G. Walker. 2008. Application of Household Disinfectants to Control New Zealand Mudsnails. North American Journal of Fisheries Management 28:1171-1176.

APPENDIX J

Sampling assessment forms

2009 SMC SWAMP Bioassessment Procedure
Biological and Physical Habitat Field Assessment

Field Team:_____

Field Location:_____

Date of Assessment:_____

Background of Group and Assessment Objectives:

Preliminary Sampling Site QA/QC Measures	
Procedure	Comments
Sampling Team Briefing – insure that all field personnel are aware of the site requirements and SWAMP Bioassessment Procedures and specific project SOP. (NZMS procedures)	
Equipment Inspection – insure that all the equipment is present and in working order	
Equipment Calibration – insure that all equipment is calibrated as described in 2007 SWAMP SOP	
Initial Sample Site Delineation – insure that the sampling site is surveyed for access, hazards and special concerns	
Sampling Site Description – insure that all the requirements of the SWAMP field form are measured	

and recorded	
Transect Layout – insure that the 11 transect and 10 intertransect are located and adequately marked	

Biological Sampling QA/QC Measures	
Procedure	Comments
Determine Collection Locations – insure that the collection locations are determined according to high or low gradient procedures	
Assemble Equipment – insure that all equipment identified in the 2007 SWAMP SOP is assembled before approaching collection location	
Net Placement – insure that the sampling net is correctly placed in the substrate and perpendicular to flow	
Substrate Excavation Adequacy – insure that the substrate is adequately scrubbed of all BMIs	
Substrate Excavation Duration – insure that the substrate is scrubbed for a consistent duration (1-3 minutes) and in accordance with the type of substrate	
Substrate Excavation Depth – insure that the substrate is excavated to a depth (4-6 inches) adequate to collect all BMIs	
Excavated Material Cleaning – insure that no BMIs are lost when large material is cleaned from the net	
Handling of Excavated Material – insure that no BMIs are lost when transporting the net between collection locations	
Compositing of Excavated Material – insure that no excavated material is lost when compositing and placing material in jars	
Labeling of Samples – insure that all jars are labeled according to the 2007 SWAMP SOP	
Collection of Duplicates – insure that all procedures required for collecting duplicate samples are followed according to 2007 SWAMP SOP	

Physical Habitat QA/QC Measures	
Procedure	Comments
Substrate Cross-Sectional and Inter-Transect Information – insure that the width, depth, substrate size and embeddedness measures are collected in	

accordance with the 2007 SWAMP SOP	
Habitat Complexity – insure that all components are properly rated in accordance with the 2007 SWAMP SOP	
Visual Riparian Estimates – insure that all components are properly rated in accordance with the 2007 SWAMP SOP	
Human Influence – insure that all components are properly rated in accordance with the 2007 SWAMP SOP	
Densiometer – insure that the densiometer is placed and used in accordance with the 2007 SWAMP SOP	
Field Data Sheets– insure that all field data sheets are filled out completely and correctly	
Field Personnel Communication– insure that all personnel communicate constantly during the rating procedure	

EPA/RBP Physical Habitat QA/QC Measures	
Procedure	Comments
1. Epifaunal Substrate/ Available Cover – insure that this component of the procedure is rated according to procedures described in the EPA RBP procedure	
2. Sediment Deposition – insure that this component of the procedure is rated according to procedures described in EPA RBP procedure	
3. Channel Alteration – insure that this component of the procedure is rated according to procedures described in EPA RBP procedure	
Field Data Sheets – insure that all field data sheets are filled out completely and correctly	
Field Personnel Communication – insure that all personnel communicated constantly during the rating procedure	
Field Personnel Verification and Agreement – insure that all personnel are in agreement on the rating procedure and verify what is recorded on the field data sheets	

Sampling Event Conclusion QA/QC Measures	
Procedure	Comments
Sampling Equipment – insure that all equipment is	

accounted for and in operating condition	
Biological Sample COC – insure that all information is provided on the Chain-of-Custody form	
Field Paperwork – insure that all paperwork is accounted for and inspected for completion	
Water Chemistry Measures – insure that all parameters of water chemistry are measured in according to procedure described in the SOP	
Stream Gradient – insure that the percent slope of the stream reach is measured according to procedures described in the SOP	
GPS Coordinates – insure that the latitude and longitude of the sampling location is measured as described in the SOP	
Substrate Delineation of Reach – insure that percent substrate types are measured in accordance with the 2007 SWAMP SOP	
Stream Flow Determination – insure that stream flow is measured in accordance with the 2007 SWAMP SOP	
Sampling Reach Photo-documentation – insure that digital photos are taken at the transects and in the direction described in the SOP	
Sampling Event Comments – insure that at the end of the sampling events comments specific to the event are recorded on the field form	

Water chemistry	
Procedure	Comments
Equipment Inspection – insure that all the equipment is present and in working order	
Supplies – insure that crews have appropriate bottles to sample constituents (conventionals, nutrients, major ions, metals in plastic and pyrethroids in amber glass; separate bottle for total and dissolved metals)	
Sample collection – insure that samples are collected appropriately, avoiding contamination and sediment, and that samples are placed on ice soon after collection.	

Water toxicity	
Procedure	Comments
Equipment Inspection – insure that all the equipment is present and in working order	
Supplies – insure that crews have appropriate bottles	

for toxicity samples	
Sample collection – insure that samples are collected appropriately, avoiding contamination and sediment, and that samples are placed on ice soon after collection.	

I CERTIFY THAT THIS FIELD TEAM HAS ADEQUATELY FULLFILLED ALL REQUIRMENTS OF THE FIELD ASSESSSMENT FOR THE CALIFORNIA STREAM BIOASSESSMENT PROCEDURE

_____

Raphael D. Mazor
Project Quality Assurance Officer
Stormwater Monitoring Coalition
Southern California Coastal Water Research Project

COMMENTS:

2009 SWAMP Algae Bioassessment Procedure Biological and Algae-Specific Physical Habitat Field Assessment

Field Team:

Field Location:

Date of Assessment:

Background of Group and Assessment Objectives:

Biological Sampling QA/QC Measures	
Procedure	Comments
Familiarity with SOP – Has read SOP and demonstrates thorough understanding of procedures and refers to SOP (which is on hand in the field) if uncertain about something	
Avoidance of cross-contamination – Has scrubbed and rinsed all equipment that touches algae since previous site	
Determine Collection Locations – Sample collection locations are determined correctly, and according to procedures for high vs. low gradient	
Sampling spot – Substrate to be sampled at each point is correctly identified (and has not been recently disturbed by bug sampling or otherwise)	
Recording sampling area – Device (area) used for sampling at each transect is tallied on data sheet	
Protection of sample integrity – Specimens are kept out of direct sunlight, away from heat, and protected from desiccation during sampling and sample processing	
Cobble/wood/macrophyte substrates – Substrate is placed in tub such that sampling spot (upper surface) is kept track of; non-target material cannot slough off	

substrate into tub; target material is not lost from the substrate/sample	

Silt/sand/fine gravel substrates –PVC delimiter is filed to make bottom edge "sharp" and clearly marked with a 1cm depth indicator; delimiter is inserted into substrate to a depth of 1 cm; no target material is lost in collecting; excess material is cleared off spatula prior to adding material to tub	
Macroalgal substrates – PVC delimiter is used; entire thickness of clump is collected within the delimiter; macroalgal mat is not unnaturally stretched nor bunched up prior to isolating the area to be sampled; excess material (outside of the PVC) is cleanly cut away (not pulled) prior to adding the specimen to the tub; no target material is lost in the process of collecting	
Isolation of specimen from substrates: Cobble/wood/macrophyte – Rubber delimiter is used on the appropriate spot on the substrate; specimen collection (i.e., scrubbing, rinsing) occurs only on the area within the delimiter; the sampler checks to make sure area sampled is rough, possibly different color, and apparently free of algae after sampling	
Isolation of specimen from substrates: Silt/sand/fine gravel – Substrate is thoroughly massaged and rinsed well (to the color of very weak tea or clearer) before separating the cleaned substrate from liquid and dumping substrate; microalgal suspension (including any rinse water used) is agitated well and transferred to a clean graduated cylinder in a manner that leaves most silt, etc. behind	
Isolation of specimen from substrates: Bedrock/boulders/concrete – a properly constructed syringe scrubber is used; a new scrubber pad is used for each sampling (or at least between sites); scrubber is rotated at least 3x flush against substrate, while maintaining a good seal with the barrel, and carefully removed from stream so as to minimize potential for loss of material; scrubber pad is rinsed thoroughly into dish tub and squeezed to remove material; the scrubbed spot on substrate is checked to ensure adequate removal of sample material	
Composite sample preparation –total volume of composite liquid is measured, including rinse water, and recorded on data sheets and sample labels	
Aliquotting samples – sample is always adequately agitated immediately before pouring	

Macroalgal clump processing: soft-bodied sample – ¼ of the clump is measured and isolated and placed in soft-bodied sample tube; the remainder is properly stored in cooler on wet ice	
Macroalgal clump processing: other samples – composite sample is agitated prior to pouring off properly calculated amount to restore ratio; ¾ remaining macroalgal clump is chopped into sufficiently fine pieces and homogenized adequately into liquid	
Taxonomic ID sample fixing and storage – diatom sample is fixed immediately with formalin for final concentration of 2%; soft-bodied sample, if unfixed, is stored immediately on wet ice and in the dark; all sample tubes properly labeled and taped; fixative is stored in an appropriate container; tubes are kept on a centrifuge rack to free up hands.	
Biomass samples, general – Filter tower apparatus is always cleaned before use and between uses, and rubber rings are confirmed to be in place; 25mL is measured in a small grad. cylinder (or a smaller volume is used, only if necessary); maximum allowable psi is not exceeded during filtering; proper pore size, glass-fiber filters used; filters are folded with sides containing material folded inward and are wrapped carefully in Whirlpak, labeled, and shoved into wet ice; final volumes that were filtered are recorded, for each filter, on the data sheet and sample labels	
Chlorophyll a – non-algal leaves are removed from filter; filter is placed in Petri dish and wrapped in foil	
AFDM – a precombusted filter used; non-algal organic material (e.g., leaves, twigs, bugs) is removed from filter	
Algal PHab – proper procedures are followed for determining micro- and macro-algal cover during the pebble count (correct assessment of point-interception of attached and unattached macroalgae; correct assignment of micralgal thickness and distinguishing from silt slime; always assesses microalgal cover on the substrate that is highest up in the water column… i.e., exposed to the sun; correct recording of dry sampling points vs. moist points with zero surface water depth)	
Collection of qualitative soft-bodied algae sample	

– Qualitative algal sample was collected and properly labeled and kept in the dark on wet ice; stream was examined with sufficient rigor to collect a reasonably exhaustive sample	

I CERTIFY THAT THIS FIELD TEAM HAS ADEQUATELY FULLFILLED ALL REQUIRMENTS OF THE FIELD ASSESSSMENT FOR THE *DRAFT* SWAMP ALGAE FIELD SOP

_____

Betty Fetscher
Biologist
Southern California Coastal Water Research Project

COMMENTS: