SWAMP
Surface Water Ambient Monitoring Program

Monitoring Plan	**2008**

SWAMP Statewide Stream Contaminant Trend Monitoring at Integrator Sites

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California Water Boards

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MONITORING PLAN

SWAMP Statewide Stream Contaminant Trend Monitoring at Integrator Sites

SUMMARY SHEET

1. This program addresses aquatic life beneficial uses in California streams.

2. Assessment questions:
   The overall goal of this long-term trends component of the SWAMP statewide assessment of California streams is to detect meaningful change in the concentrations of stream-borne contaminants and their effects in large watersheds at time scales appropriate to management decision making. The 5 assessment questions are:
   Q1. Which contaminants are detected in depositional stream sediments, and in which large California watersheds are they detected?
   Q2. In which large California watersheds is sediment toxicity observed?
   Q3. What is the relationship between contaminant concentrations and watershed land use characteristics?
   Q4. What is the relationship between contaminant concentrations and the level of management activity?
   Q5. What is the direction and magnitude of change in contaminant concentrations and toxicity over multi-year time periods?

3. Link to the statewide monitoring framework components:
   This program is an essential component of the statewide monitoring framework. It provides data to assess whether human activities on the scale of hydrologic units (large watersheds) is leading to increases or decreases in the loading of toxic compounds to streams throughout California. It compliments that SWAMP probabilistic bioassessment component that assesses the overall status of aquatic life in perennial streams.

4. The integrated 305(b)/303(d) report cycle for which project data will be available:
   Toxicity data will be available in the fall of each year, with chemistry data available approximately one year later. The first complete report covering toxicity and chemistry data will be available February 2010, in time for the 2010 integrated 305(b)/303(d) report cycle.

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I. Title of the program:

SWAMP Statewide Stream Contaminant Trend Monitoring at Integrator Sites

II. Background

The following is a summary of key aspects of this SWAMP program to monitor long-term pollution trends in California streams, and to relate these to changes in human activity in large watersheds throughout the State.

Clients and Information Needs

Assessments of trends in contaminant concentrations and effects in California streams support a number of agency priorities and statutory requirements, as well as general purpose assessment goals. Specific clients that will benefit from this trend monitoring program include:

1. Regional Board staff: tracking effectiveness of TMDL and management actions
2. State and Regional Board staff: program coordination and broad management context
3. Stormwater, agricultural waiver, and NPDES programs: broad context for management
4. State Board and EPA staff: CWA §305(b) reporting
5. State Board and EPA Non-point source programs: evaluating changes in water quality
6. State and Regional Board staff: identifying emerging contaminants
7. Public constituencies: prioritizing policy needs

In addition, trend monitoring at integrator sites provides context for contaminant measurements at local and regional scales.

Assessment Questions

This program addresses the information needs of the clients listed above by answering the following assessment questions:

1. Which contaminants are detected in depositional stream sediments, and in which large California watersheds are they detected?
2. In which large California watersheds is sediment toxicity observed?
3. What is the relationship between contaminant concentrations and watershed land use characteristics?
4. What is the relationship between contaminant concentrations and the level of management activity?
5. What is the direction and magnitude of change in contaminant concentrations and toxicity over multi-year time periods?

Monitoring Goals

The overall goal of this long-term trends component of the SWAMP statewide assessment of California streams is to detect meaningful change in the concentrations of stream-borne contaminants and their effects in large watersheds at time scales appropriate to management decision making. Three specific goals are:

1. Determine long-term trends in stream contaminant concentrations and effects statewide.
2. Relate water quality indicators to land-use characteristics and management effort.
3. Establish a network of sites throughout the state to serve as a backbone for collaboration with local, regional, & federal monitoring.

Ecological Attributes of Concern

The ecological attributes of concern are aquatic communities that may be affected by the transport of contaminants from watershed areas into streams and downstream habitats. This program is designed primarily to assess support for aquatic life beneficial uses of California streams.

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III. Study Methods and Materials

Monitoring Objectives

The following monitoring objectives are intended to address program goals and assessment questions:

1. Determine concentrations of a suitable suite of contaminants in depositional sediment collected near the base of large California watersheds;
2. Determine whether these depositional sediments are toxic to representative organisms;
3. Measure additional parameters as requested and funded by program collaborators;
4. Quantify parameters such as land use, precipitation, population density, and management activity, using foundational data from other sources;
5. Conduct surveys once per year on a continuing basis;
6. Analyze data to evaluate relationships between the above measured parameters and foundational data (e.g., contaminant concentration vs. management effort);
7. Conduct trends analyses to detect the direction, magnitude, and significance of change in the above parameters over time.

Monitoring Design

1. Review previous monitoring, geographic, and hydrologic information to select 100 long-term trend monitoring sites near the bases of large heterogeneous watersheds.
2. Sample depositional sediments from each of these sites once per year (spring into summer).
3. At all sites, measure concentrations of the chemicals in the Tier 1 suite: trace metals, pesticides, PCBs, total phosphorus, TOC and sediment grain size.
4. At a subset of approximately 30 sites, also measure the Tier 2 chemicals: PAHs and PBDEs.
5. Measure sediment toxicity in each sample, using a representative benthic invertebrate (the amphipod *Hyalella azteca*).
6. Coordinate with cooperating programs to facilitate monitoring of additional parameters that enhance the information value of each survey.
7. Produce an annual interpretive report and fact sheet describing trends in contaminant concentrations and biological effects in large watersheds throughout California, and contribute to 305[b] reporting and 303[d] listing.
8. Provide data through the SWAMP data base to the public and collaborating programs, including Regional monitoring, TMDL, Nonpoint-Source, Sediment Quality Objectives, agricultural waiver, and stormwater monitoring programs.

Indicators and Measurement Parameters

The criteria for indicator selection include:

1. Stability over intermediate time scales (weeks to months) to minimize the effects of intra-annual variability on the evaluation of long-term trends;
2. Sensitivity to contaminants;
3. Feasibility;
4. Reasonable cost;
5. Use of established methods comparable to SWAMP indicators and widely accepted in the scientific and regulatory communities;
6. Usefulness for investigating relationships between contaminants and effects;
7. Coverage of analyte lists that are sufficient for statewide application in order to detect relevant trends in different regions.
8. Usefulness for investigating sources and causes of impairment; and
9. Feasibility and cost effectiveness.

Based on these criteria, the selected indicators are:

1. Sediment chemical analysis, including, at all sites, trace metals, organophosphate, organochlorine, and pyrethroid pesticides, PCBs, total phosphorus, total organic carbon, and sediment grain size. At a subset of approximately 30 sites, also measure the Tier 2 chemicals: polycyclic aromatic hydrocarbons (PAHs) and polybrominated diphenyl ethers (PBDEs).
2. Sediment toxicity, using the 10-d growth and survival test with the representative freshwater amphipod *Hyalella azteca*, to estimate biological effects of contaminants; and
3. Additional indicators as appropriate for addressing the needs of partner programs, including NPS, stormwater, agricultural, or Regional monitoring enhancements. These enhancement indicators are not included in the program budget, and it is expected that funding for, or measurement of, additional indicators would be provided by cooperating entities. Enhancement indicators could be measured in water, sediment, or biota; and could include additional chemical analytes (nutrients, selenium, carbamate pesticides, new use pesticides, etc.), or additional biological effects measures (benthic macroinvertebrates, periphyton, endocrine disrupters, biomarkers, additional toxicity tests, eutrophication indicators, etc.).

Because trend monitoring will focus on contaminant concentrations, the biological effects to be measured are the responses of a contaminant-sensitive, representative, benthic invertebrate species (*Hyalella azteca*) that has been the subject of numerous studies linking its response to the composition of *in situ* benthic communities (e.g., Anderson et al. 2003a, 2003b, 2006; Kedwards et al. 1999; Phillips et al. 2004; Schulz 2004; Tucker and Burton 1999).

Data Analysis and Assessment:

Two key products will provide data and information to program clients, including a number of State and Regional programs. These are described in Section VI, below. Data analysis and assessment will be statistically based, focusing on correlations with land use parameters and testing the significance of changes in parameter values over time. Thresholds (e.g., sediment quality objectives) can be applied to the data in separate 303(d) listings or other assessments. No assessment thresholds are proposed specifically for this program.

Data Collection and Frequency of Sampling:

All sites will be sampled annually for at least five years, unless the number of sites is reduced due to budget restrictions. After five years, the data will be analyzed for statistical power and sources of variation, and the program will be reviewed to determine whether annual sampling should continue, or whether trend detection can be accomplished by greater temporal spacing.

The spatial aspects of sample collection are essential to this program. As recommended by the external scientific reviewers, sediment at each site will be collected from 5 to 10 depositional areas within a 100 meter reach of the stream. This approach is considered necessary to adequately characterize the quality of sediments delivered to the stream by runoff throughout the watershed. Deviations from this practice at specific sites will be noted by the sampling team, and sites that do not allow this sampling pattern may be discontinued. Spatial aspects of site selection are described below.

Collection of fine-grained sediment is also essential to characterizing contaminant dynamics. Most contaminants associate with fine-grained sediment, and this is the sediment fraction most affected by annual transport processes. The field team has been trained to identify depositional areas in the stream bed, and to differentiate these deposits from bank sediments that likely represent older depositional features. The field test for grain size is to rub the sediment between the fingers: sediments that feel smooth are generally fine enough for analysis, sediments that feel gritty have too much sand and are rejected. A 2-mm screen is available for sites at which fine-grained sediment is found interspersed with gravel. Otherwise, sediment for toxicity and organic chemistry analysis is unsieved. A 10-gram subsample of collected sediment is field sieved to 63 um, and this sieved sample is used for trace metal analysis, according to USGS NAWQA protocol. Trace metals are also analyzed on unsieved sediment.

Spatial Scale

The scale of this assessment is the State of California. Within this area, trend monitoring sites in streams will be established using statewide, consistent criteria (discussed in Section III, below, under Site Selection). Site selection is critical for evaluating trends in contaminant concentrations and effects. Site selection will be targeted, in order to place sites in locations most likely to characterize accumulation of contaminants from the watersheds. Site selection criteria include:

- availability of fine-grained depositional sediment (this is a mandatory criterion);

- location in a large watershed, in most cases on the order of a hydrologic unit (this criterion should be flexible to include watersheds in hydrologic units without a single dominant watershed, etc.);
- one site per large watershed;
- location at or near the base of a watershed, defined as the confluence with either an ocean, lake, or another stream of equal or greater stream order;
- availability of previous data on sediment contaminant concentrations, biological impacts, or other relevant water quality data;
- location where site-specific conditions are appropriate for the indicators selected (e.g., depositional areas, sufficient flow, appropriate channel morphology, substrate, etc.);
- availability of safe access, either by boat or wading; and
- location near stream gauges where possible.
- collaboration potential: who else is interested in or working at or near this site?
- ranking assigned by SWAMP Regional Monitoring Coordinator.
- contamination potential: is the site amenable to seeing changes in contaminant concentration and effects over time and in relation to human activity?
- preference given to large tributaries rather than multiple main stem sites on multi-HUC rivers.

Sites will be selected in waterbodies at points where contaminants released throughout large watersheds are likely to accumulate. These sites will be similar to the “integrator” sites used in the USGS NAWQA program; that is, sites located near discharge points of large watersheds characterized by heterogeneous land uses. The design envisions trend monitoring at 100 sites in a state divided into approximately 200 major hydrologic units. Ideally, monitoring at these sites should characterize the cumulative contribution of contaminants from the target watersheds.

Temporal Scale

Sites would be sampled once each year during base flow or near-base flow conditions following annual peak flows. The intent is to collect depositional sediment that has been recently transported from watershed surfaces, but is not subject to extreme variation due to storm events. Sampling should occur before significant contaminant breakdown occurs via hydrolysis or photolysis (assumed half-lives on the order of a few months). Surveys will be scheduled based on regional hydrologic cycles, with Southern California coastal streams sampled in early spring, and other regions sampled progressively later in the year as stream flows recede. This survey schedule will be replicated in subsequent years to minimize the effects of inter-annual variation on trend analysis.

Four types of temporal variation must be taken into consideration for trend analysis: 1) secular trend, which is the change in mean condition over time, the detection of which is generally the objective of trend monitoring; 2) cyclical or seasonal variation, which in some cases could occur on daily, weekly, monthly, or seasonal scales (as with irrigation pulse flows or storm events); 3) random error in parameter measurement; and 4) serial correlation, which is the autocorrelation involved when surveys closer in time tend to produce more similar results (Barnett, 2004). Autocorrelation will be addressed by conducting surveys at regular annual intervals. Seasonal variation will be partly addressed by measuring chemistry and toxicity of depositional sediment, rather than measuring water column parameters that vary more greatly over short time scales. Past studies will be used to provide perspective regarding the effects of short term variations in sediment parameters on the ability to detect long-term trends; and future special studies, funded by SWAMP or otherwise, may be considered in trend interpretation as well.

Data Management.

All data will be submitted in SWAMP format by laboratories that have extensive experience with the SWAMP data management system. Data will be managed by the SWAMP Data Management Team.

IV. Coordination and Review Strategy

This program is designed to provide a statewide network of sites at the bases of large watersheds to encourage collaboration with watershed-based monitoring programs throughout the state. During first-year planning, discussions have taken place with Regional monitoring coordinators and stormwater agencies, and these groups currently serve as the program's primary collaborators. The southern California Stormwater Monitoring Coalition participated in site selection for the southern California integrator sites. A representative from the Bay Area Stormwater Management Agencies Association served on the SWAMP committee that designed the program, and all sites in Region 2 were selected with the intent of fostering collaboration with stormwater agencies.

This strategy was reviewed by a formal external scientific committee on February 27, 2008. Notes from that meeting have been circulated to the SWAMP Roundtable. Suggestions from the committee have been incorporated into this version of the workplan.

V. Quality Assurance:

This program will be consistent with the SWAMP Quality Assurance Management Plan. A program-specific quality assurance document is forthcoming, which will describe quality assurance elements specific to the program.

VI. Reporting

This program will generate two key products that provide data and information to program clients, including a number of State and Regional programs:

1. An annual interpretive report will be produced that describes monitoring methods, results, and statistical analysis of trends in contaminant concentrations and biological effects over time, and relationships between water quality parameters and land use change and management, in streams draining roughly half of the large watersheds in the State of California.
2. All monitoring data will be entered into the SWAMP data base, where they will be available for a number of uses, including the following:
    - statewide 305[b] reporting and 303[d] listing as required by the Clean Water Act;
    - enhancing Regional monitoring programs;
    - evaluating the success of TMDL, Regional, and statewide management programs;
    - determining relationships between stressors and effects for NPS programs;
    - providing perspective for and enhancing agricultural waiver monitoring;
    - providing perspective for and enhancing urban stormwater monitoring;
    - assisting with sediment quality objective development;
    - examining trends related to particular stressors of concern;
    - providing a framework for prioritizing individual issues for further investigation.
3. Additional products, including newsletters, fact sheets, and website links, will be integrated into the SWAMP communication strategy.

Annual interpretive reports will be delivered within 4 months of receipt of all program data from participating laboratories. Because the turn-around time for organic chemical analysis is one-year, and sample collection extends into October, the report will be completed by the end of February, 16 months after data collection. A fact sheet describing field sampling and toxicity testing will be available within four months of sample collection. John Hunt, of the University of California at Davis, will be responsible for completing program reports. Data will be available in the SWAMP data base as soon as it is received from the laboratories and is processed by the data management team.

VII. Project schedule

The field sampling schedule is determined by general hydrologic conditions in each Region. On an annual basis, field sampling will begin in Regions 9, 8, and 4 in April of each year. Regions 3 and 2 will be sampled in May and June. Region 5 will be sampled, from south to north, from May through August. Regions 1, 6, and 7 will be sampled from August to October. Toxicity testing and analysis of grain size and total organic carbon will be completed within 7 weeks of sample collection. Trace metal analysis will be completed within 9 months of sample collection, and trace organics analysis will be completed within 12 months of sample collection. Reports will be available within 4 months of data availability, as described, in Section VI, above.