SWAMP
Surface Water Ambient Monitoring Program

Monitoring Plan	2009

Seasonal Trend Monitoring at Central Valley Integrator Sites

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Water Boards

www.waterboards.ca.gov/swamp

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Background

The Central Valley Regional Water Quality Control Board (Central Valley Water Board) covers 60,000 square miles, or 40% of the land in California. This includes approximately 75% of California's irrigated land. The Central Valley includes three major basins. From north to south, these are the Sacramento River, the San Joaquin River, and the Tulare Lake Basins.

The Central Valley Water Board's Surface Water Ambient Monitoring Program (SWAMP) is tasked with assessing water quality in all Central Valley waterbodies. When the SWAMP began in 2000, staff built off of existing monitoring frameworks in each basin. This approach allowed priorities in each basin to be addressed, but did not facilitate Region-wide assessments of water quality. This study is designed to help build a framework to fill that need through seasonal trend monitoring at a Region-wide network of lower watershed integrator sites. This monitoring is designed to answer the following questions:

1. What is the spatial variability of ambient water quality in the Central Valley?
2. What is the seasonal variability of ambient water quality in the Central Valley?
3. Is there evidence beneficial uses are not being protected?

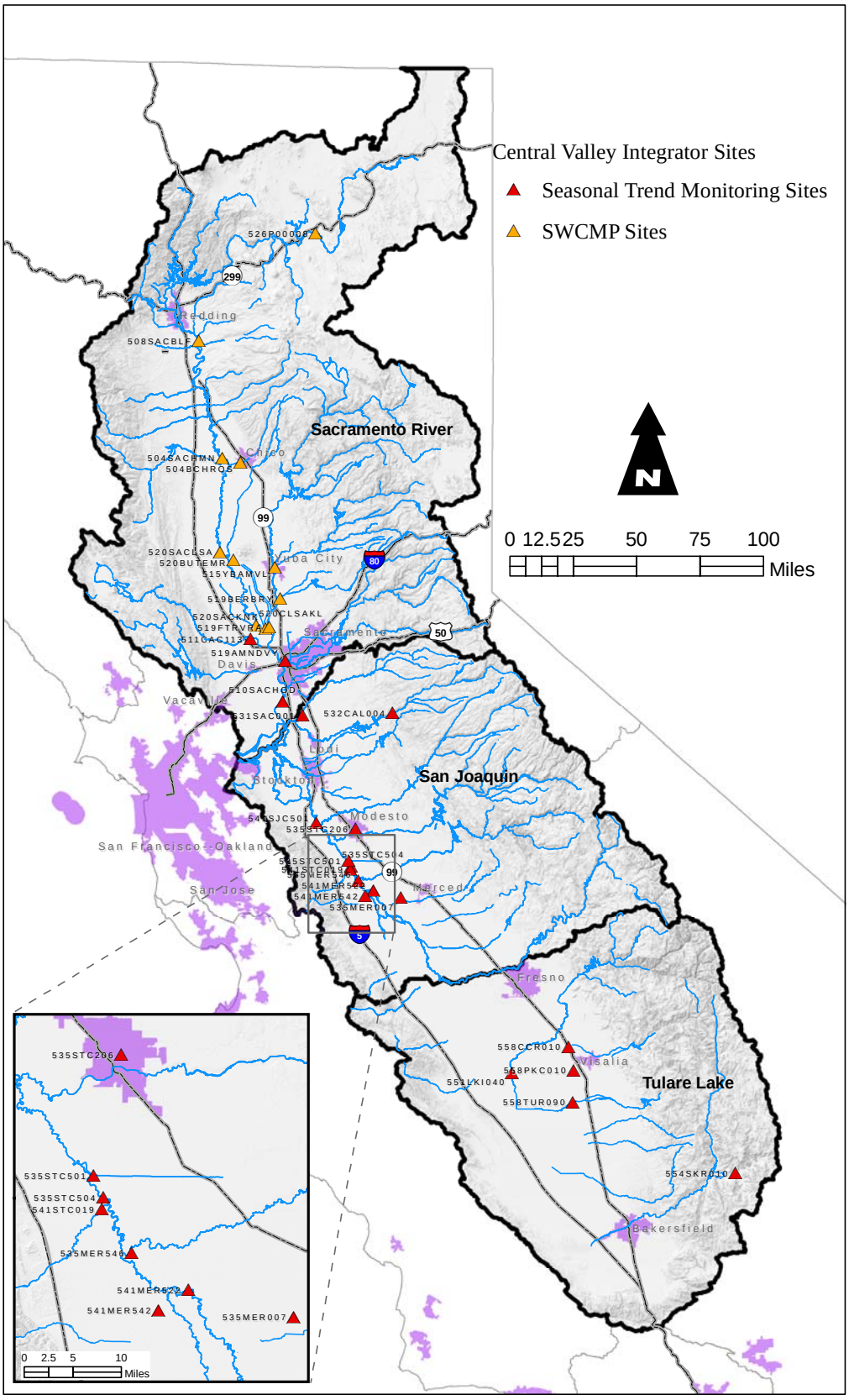
The assessment of these questions will benefit the general public by providing information on overall water quality in the Central Valley and will help inform the Sate and Regional Water Boards about specific water quality concerns and the effectiveness of management activities within targeted watersheds. The selected sites match those utilized by the SWAMP Statewide Stream Contaminant Trend Monitoring at Integrator Sites (Statewide Contaminant Monitoring). Water quality data assessed as part of this Regional study will add value to the annual sediment toxicity and chemistry data gathered as part of the Statewide Contaminant Monitoring.

Study Methods and Materials

Monitoring Design

The monitoring sites for this study are Central Valley sites selected for the Statewide Contaminant Monitoring. The Statewide Contaminant Monitoring annually or biannually monitors sediment toxicity and sediment chemistry at approximately 80 sites distributed across California (SWAMP, 2008b). Central Valley Water Board SWAMP staff selected integrator sites to represent discharge points at the base of large watersheds, as well as main stem sites on large rivers above or below major tributary inputs. Sites were selected to represent a range of land uses and priority was given to sites with potential for collaboration with both internal programs (e.g. Irrigated Lands Regulatory Program, TMDL, and Grants) and external stakeholders (e.g. Department of Water Resources).

Figure 1: Map of Central Valley Integrator Sites



Thirty of the statewide integrator sites are within the Central Valley. Eleven of these are being monitored as part of the Sacramento Watershed Coordinated Monitoring Program (McReynolds et al., 2009), a coordinated monitoring effort between the Central Valley Water Board SWAMP and the Department of Water Resources, Northern District. This study described in this document will monitor the remaining 19 integrator sites shown in red on Figure 1. Table 1 lists the monitoring sites for this study by basin.

Table 1: Site List

Basin	Station Code	Station Name
Sacramento River	511CAC113	Cache Creek at Highway 113
	519AMNDVY	American River at Discovery Park
	510SACHOD	Sacramento River at Hood
San Joaquin River	531SAC001	Cosumnes River at Twin Cities Road
	532CAL004	Mokelumne River at Highway 49
	535MER007	Bear Creek near Bert Crane Road
	535MER546	Merced River at River Road
	535STC206	Dry Creek at La Loma Road
	535STC501	TID 5 Harding Drain at Carpenter Road(1)
	535STC504	San Joaquin River at Crows Landing(2)
	541MER522	San Joaquin River at Lander Avenue(2)
	541MER542	Mud Slough at San Luis Drain
	541SJC501	San Joaquin River at Airport Way
	541STC019	Orestimba Creek at River Road
Tulare Lake	551LKI040	Kings River at Jackson Avenue
	554SKR010	South Fork Kern River at Fay Ranch Road
	558CCR010	Cross Creek at Highway 99
	558PKC010	Packwood Creek at Road 68
	558TUR090	Tule River at Road 64

(1) Site was not sampled in first year of the Statewide Contaminant Monitoring, but will be sampled in subsequent years.
(2) Site was sampled in first year of the Statewide Contaminant Monitoring, but will not be sampled in subsequent years.

The 30 sites that comprise this project are intended to serve as a long-term framework for a Central Valley trend monitoring program. As funding permits, seasonal trend monitoring will continue at all 30 sites. Data collected at the integrator sites will provide comparison between water year types and long-term trend information.

Indicator and Measurement Parameters

Parameters for this study were selected based on potential to add value to existing monitoring programs and fill information gaps. It is also an opportunity to get a Region-wide assessment of ambient water quality conditions and preliminary review of beneficial use protection based on the indicators listed in Table 2. Study parameters include: field parameters, *E. coli*, organic carbon, toxicity, and bioassessment.

Field parameters will include temperature, dissolved oxygen, pH, specific conductivity, and turbidity. Collection of field parameters is cost effective and provides information on the protection of multiple beneficial uses (Table 2). Additionally, these field parameters

link to large efforts including the Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS) and TMDL development and implementation.

Table 2: Parameters as Indicators for Beneficial Use Protection

Parameter	*Recreation*	*Drinking Water*	*Aquatic Life*	*Agriculture*
Temperature			x	
Dissolved Oxygen			x	
pH	x	x	x	x
Conductivity		x	x	x
Turbidity	x	x	x	
TOC		x	(1)	
DOC		x		
E. coli	x	x		
Toxicity (Water)			x	
Toxicity (Sediment)			x	
BMI			x	

(1) While TOC is an essential component of a functioning ecosystem, more study is needed to determine the levels of organic carbon needed before it can reliably be used as an indicator.

The Central Valley Water Board is able to analyze for total coliform and *E. coli* in-house using the IDEXX Colilert® QuantiTray system. *E. coli* is an important indicator for the protection of recreational beneficial uses.

Organic carbon is an important indicator for drinking water because it forms hazardous byproducts upon disinfection with chlorine or chloramine. A multi-year effort is currently underway to develop a drinking water policy for surface waters in the Central Valley. Visit http://www.waterboards.ca.gov/centralvalley/water_issues/drinking_water_policy/ for more information. The Conceptual Model for Organic Carbon in the Central Valley and Sacramento-San Joaquin Delta (Roy et al., 2006) identifies better characterization of organic carbon loads in subwatersheds as a need for future work. The report also concludes that organic carbon in the dissolved form (DOC) is more likely to react during chlorination to form disinfectant byproduct compounds and is generally less bioavailable. For this reason both TOC and DOC are included as parameters in this study.

Water column toxicity and limited bioassessments were selected as parameters because of the opportunity to add value to the sediment data being collected by the SWAMP Statewide Contaminant Monitoring. The combined data on observed toxicity in the water column and bed sediments will provide information on the transport and age of toxicants. Limited funding has also been allocated for follow-up sediment toxicity and Toxicity Identification and Evaluation (TIE) tests to help identify the general class of the toxicants.

Benthic macroinvertebrates (BMIs) are the most common basis for bioassessment. BMIs assemblages are indicators of aquatic health. Different species of invertebrates

respond differently to water pollution and habitat degradation and provide information on biologic integrity. SWAMP has developed or is in the process of developing tools for bioassessment, including SOPs and indices of biologic integrity (IBI) for California eco-regions. This sampling effort is an opportunity to train Central Valley Water Board staff on sample collection procedures and to collect data that can be compared to the statewide SWAMP bioassessment monitoring programs.

All samples and field measurements will be collected in accordance with the Procedures Manual for the San Joaquin River Water Quality Monitoring Program (Central Valley Water Board, 2008) and the Standard Operating Procedures (SOP) for Conducting Field Measurements and Field Collections of Water and Bed Sediment Samples in the Surface Water Ambient Monitoring Program (MPSL-DFG, 2007). Both documents have been reviewed and approved by the SWAMP Quality Assurance Team. More specific information on field and laboratory procedures for each parameter follows.

Field Parameters

The Central Valley Water Board measures several parameters in the field. A YSI 650MDS with a 600XLM multiparameter sonde is used to collect data for dissolved oxygen, pH, water temperature, and specific conductivity. A Hach 2100P Turbidimeter is used to collect data for turbidity. All field equipment is calibrated using certified calibration standards and following manufacturer specifications and the Procedures Manual for the San Joaquin River Water Quality Monitoring Program (Central Valley Water Board, 2008). Calibration records are maintained at the Region 5 laboratory and are used to determine instrument accuracy. Field probe measurements are recorded on the field sheets. In the field, observations of air temperature, algal growth, scum, odor, and other indications of water and habitat conditions are also recorded on the field sheets.

Bacteria

Bacteria samples are collected and analyzed for total coliform and *E. coli* in accordance with the procedures in the San Joaquin River Basin Bacteria Monitoring Program (Central Valley Water Board, 2007). Samples are analyzed in-house at the Central Valley Water Board laboratory using the IDEXX Colilert® QuantiTray system.

Organic Carbon

Total organic carbon (TOC) and dissolved organic carbon (DOC) are analyzed at the Department of Fish and Game (DFG) Water Pollution Control Laboratory according to EPA method 415.3. Samples are collected in 125 mL amber glass bottles. TOC sample bottles are pre-acidified with H_2SO_4. DOC samples are filtered and acidified by the laboratory within 48 hours of sample collection.

Toxicity

Water samples for toxicity analysis are collected in two 2.5L amber glass bottles. 96-hour acute toxicity tests are conducted following standard EPA procedures (EPA-821-R-02-012).Two test species are used for each sampling event: *Hyallella azteca* and *Ceriodaphnia dubia* (water fleas). More specific information on toxicity testing using

Hyallella azteca can be found in EPA-600-R-99-064. Samples collected in the first year of the study will be tested at UC Davis Marine Pollution Studies Laboratory at Granite Canyon. Subsequent samples will be tested at UC Davis Aquatic Toxicology Laboratory.

Sediment samples for toxicity analysis are collected in accordance with the MPSL-DFG SOP. Ten-day toxicity tests will be conducted by UC Davis Marine Pollution Studies Laboratory at Granite Canyon using standard EPA procedures (EPA-600-R-99-064) for *Hyalella azteca*.

Limited funds are available to conduct TIE tests on samples demonstrating toxicity. Observed survival during toxicity tests of 50% or less will be used as the trigger for TIE tests, with priority given to the most toxic samples. Phase I TIE procedures will be used to try to determine the general category of toxicant involved (i.e. metals, organics, volatiles, ammonia). Phase II TIE procedures may be used to narrow down the class of chemical implicated in Phase I. No funding is available for chemical analyses to identify specific toxicants.

Bioassessment

Benthic macroinvertebrate samples and physical habitat data will be collected in accordance with the Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California (Ode, 2007). Sample collection will use the multi-habitat approach. Samples will be identified to SAFIT level 2 by the DFG Aquatic Bioassessment Laboratory.

Data Analysis and Assessment

All data from this study will be assessed in the 2012 cycle of the Clean Water Act Section 305(b) and 303(d) Integrated Report. Data will be assessed based the listing criteria for the current Integrated Report cycle and on the criteria in the Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River Basin (Central Valley Water Board, 2007), the Water Quality Control Plan for the Tulare Lake Basin (Central Valley Water Board, 2004).

Statistical analyses will be conducted to test the significance of changes in parameter values over time. These and other findings will be presented in Fact Sheets.

Where potential water quality problems are identified, this information will be provided to the appropriate Central Valley Water Board program for follow-up study. Source identification is not an objective of this study except in broad terms such as problematic watersheds or general classes of contaminants identified in a TIE. As funding permits, information from this study will also be used to direct more intensive SWAMP monitoring that will rotate through each of the three Central Valley basins. This intensive monitoring will focus on watershed with identified impairments or information needs.

Data Collection and Frequency of Sampling

All sites will be sampled four times during the first year of the study, with the exception of sediment toxicity and BMI samples (Table 3). Each sample event will occur over an approximately one week period. Sample collections will be timed as best as possible to represent the spring snowmelt, irrigation, dry season, and winter runoff. It will not be possible to capture runoff events because of the large geographic extent of the study area. It is expected that some of the sites may go dry during the summer and fall months.

Table 3: Sample Frequency and Sites Sampled for Each Parameter

Parameter	***Sample Frequency***		***Sites Sampled***	
	4/year	***1/year***	***All***	***Selected***
Field Parameters	x		x	
Total Organic Carbon	x		x	
Dissolved Organic Carbon	x		x	
E. coli / Total Coliform	x		x	
Toxicity (Water Column)	x		x	
Toxicity (Sediment)		x		x
Benthic Macroinvertebrates		x		x

Sediment toxicity and BMI samples will be collected at a subset of sites during the spring or summer months. Sediment toxicity sites will be selected based on the results of the Statewide Contaminant Monitoring, with priority given to sites that display toxicity. BMI sampling will be limited to sites that are wadeable. Other site selection criteria will include accessibility, known water quality concerns, and historic BMI data.

It is the goal of the Central Valley Water Board to continue this monitoring program long-term, however, continued monitoring is funding dependent. Current funding only allows for a subset of the sites to be monitored during the second year. Unless additional funding becomes available, approximately 15 sites will be selected for continued monitoring during the second year of the study. Sampling frequency at these sites will be the same as in the first year of the study.

Spatial and Temporal Scale

This study samples integrator sites geographically distributed across the Central Valley Region. Each site is situated at the base of a large watershed and provides information on the quality of the water leaving the watershed. The eleven northernmost sites are not sampled under this monitoring plan, but are sampled by DWR as part of the Sacramento Watershed Coordinated Monitoring Program. Data from all 30 sites will be combined for a Region-wide assessment.

Sites will be sampled seasonally for one or two years with current funding allocations, with the exception of sediment toxicity and BMI samples. Continued seasonal trend monitoring at these sites is planned as funding stabilizes. This sampling schedule will allow for assessment of intra-annual and inter-annual variations in ambient water

quality. Due to their cost and longer-time scales for change, sediment toxicity and BMI samples will be collected once or twice at selected sites under this monitoring plan, with frequencies re-evaluated in the future.

Data Management

All data from this study will be managed in accordance with the SWAMP Data Management Plan (2009) and SWAMP Standard Operating Procedures (SOPs). Data will be entered and stored in the SWAMP v2.5 Database. The Central Valley Water Board will load field sheet, field parameter, and bacteria data into the database. The SWAMP contract laboratories will submit the remaining data in SWAMP-comparable format to the SWAMP Data Management Team for entry to the database.

Data in the SWAMP Database will be made available to the public through the California Environmental Data Exchange Network (CEDEN). CEDEN is currently in development and is expected to be operational in 2009. Information on CEDEN is available at www.ceden.org.

Coordination and Review Strategy

Central Valley Water Board SWAMP staff will complete all work associated with this study, however, considerable effort was made to coordinate with ongoing monitoring and management efforts in the Central Valley. The sites monitored for this study are a subset of the network of sites selected for the SWAMP Statewide Contaminant Monitoring. Assessments will benefit from having both sets of data at Central Valley integrator sites. All of the parameters selected for this study are also being monitored at the 41 sites in the Sacramento Watershed Coordinated Monitoring Program (see Appendix 1), which includes eleven integrator sites. This coordination will expand the network of sites and the parameters available for assessments.

In addition to review by program staff from both the Central Valley Regional Board and the DWR Northern Districts, this document will be reviewed by two external reviewers, in accordance with SWAMP procedures.

Quality Assurance

All aspects of this study will be conducted in accordance with the SWAMP Quality Assurance Project Plan (QAPrP) (SWAMP, 2008a). Data verification and validation will follow SWAMP SOPs. Additional information on quality assurance procedures for bacteria is found in the San Joaquin River Basin Bacteria Monitoring Program (Central Valley Water Board, 2007).

Reporting

The Central Valley Water Board will prepare fact sheets highlighting analytical results and findings. All field sheet and bacteria data will also be posted annually. Both Fact Sheets and field and bacteria data will be made available to the public on the Central Valley Water Board's SWAMP webpage at:

http://www.waterboards.ca.gov/centralvalley/water_issues/water_quality_studies/surface_water_ambient_monitoring/index.shtml. Target completion dates can be found in Table 4.

Project Schedule

A timeline for project activities and target completion dates are provided in Table 4.

Table 4: Target Completion Dates for Products

Product	*Target Completion Date*
Year 1 Sampling:	
Spring Snowmelt	May 2009
Irrigation	August 2009
Dry Season	November 2009
Wet Runoff	February 2010
Fact Sheets/Data Posted	August 2010
Year 2 Sampling:	
Spring Snowmelt	May 2010
Irrigation	August 2010
Dry Season	November 2010
Wet Runoff	February 2011
Fact Sheets/Data Posted	August 2011

References

California Regional Water Quality Control Board, Central Valley Region. Procedures Manual for the San Joaquin River Water Quality Monitoring Program. 2008 (Draft).

California Regional Water Quality Control Board, Central Valley Region. San Joaquin River Basin Bacteria Monitoring Program. 2007.

California Regional Water Quality Control Board, Central Valley Region. Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River Basin, Fourth Edition. 2007. (http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr.pdf)

California Regional Water Quality Control Board, Central Valley Region. Water Quality Control Plan for the Tulare Lake Basin, Second Edition. 2004. (http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/tlbp.pdf)

Marine Pollution Studies Laboratory, Department of Fish and Game. Standard Operating Procedures for Conducting Field Measurements and Field Collections of Water and Bed Sediment Samples in the Surface Water Ambient Monitoring Program. 2007. (http://swamp.mpsl.mlml.calstate.edu/wp-content/uploads/2009/04/swamp_sop_field_measures_water_sediment_collection_v1_0.pdf)

McReynolds, Scott, Coombe, Peter, and Sime, Fraser. Monitoring Plan: Sacramento Watershed Coordinated Monitoring Program. 2009. (http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/workplans/regionalworkplan2.pdf)

Ode, Peter. SWAMP Bioassessment Procedures: Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California. 2007. (http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/phab_sopr6.pdf)

Roy, Sujoy, Heidel, Katherine, Creager, Clayton, Chung, Chih-fang, and Grieb, Tom. Prepared for USEPA, Region IX and the Central Valley Drinking Water Policy Workgroup. Conceptual Model for Organic Carbon in the Central Valley and Sacramento-San Joaquin Delta. 2006. (http://www.waterboards.ca.gov/centralvalley/water_issues/drinking_water_policy/organic_carbon/cover_toc_es.pdf)

Surface Water Ambient Monitoring Program, Data Management Team. Data Management Plan. 2009 (Draft). (http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/database-management-systems/swamp-25-database/documentation-25/swamp-data-management-plan)

Surface Water Ambient Monitoring Program, Quality Assurance Team. Quality Assurance Program Plan. 2008a. (http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/swamp_qapp_master090108a.pdf)

Surface Water Ambient Monitoring Program. Monitoring Plan: Statewide Stream Contaminant Trend Monitoring at Integrator Sites. 2008b. (http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/workplans/statewide_stream_contaminants_trend_montoring_plan.pdf)

Appendix 1: SWCMP Monitoring Sites

Table A-1 lists the station names for the Sacramento Watershed Coordinated Monitoring Program Sites shown on Figure A-1.

Table A-1: SWCMP Station Names

Map #	Station Name
1	North Fork Pit River at Alturas
2	South Fork Pit River near Alturas
3	Pit River near Canby
4	Fall River at Glenburn
5	Pit River at Pittville*
6	McCloud River above Shasta Lake
7	Sacramento River at Delta
8	Pit River near Montogomery Creek
9	Cow Creek near Millville
10	Clear Creek near mouth near Redding
11	Churn Creek near Anderson
12	Stillwater Creek near Anderson
13	Bear Creek near Anderson
14	Sacramento River at Balls Ferry*
15	Battle Creek at Jelly's Ferry Road Bridge
16	Cottonwood Creek at Cottonwood
17	Paynes Creek near Red Bluff
18	Sacramento River at Bend Bridge
19	Sacramento River below Red Bluff
20	Red Bank Creek at Highway 99W near Red Bluff
21	Antelope Creek near mouth near Red Bluff
22	Elder Creek at Gerber
23	Mill Creek near mouth near Los Molinos
24	Thomes Creek at Hall Road
25	Deer Creek at Hwy 99E near Vina
26	Sacramento River at Vina bridge
27	Sacramento River at Hamilton City*
28	Big Chico Creek at Chico*
29	Butte Creek below Western Canal Siphon
30	Stony Creek at The Nature Conservancy
31	Honcut Creek at Highway 70
32	Sacramento River at Colusa*
33	Butte Slough near Meridian*
34	Yuba River at Marysville*
35	Bear River near mouth*
36	Sacramento River above CBD near Knights Landing
37	Colusa Basin Drain near Knights Landing*
38	Feather River near Verona*
39	Sutter Bypass at RD-1500 Powerplant*
40	Sacramento River at Verona
41	Sacramento River below Knights Landing

*Indicates integrator sites

Figure A-1: Map of SWCMP Monitoring Sites