QUALITY ASSURANCE PROJECT PLAN

TUOLUMNE COUNTY WATER QUALITY PLAN PROJECT

Final – Version 1.0

Prepared for

Tuolumne County
2 South Green Street
Sonora, CA 95678

By

Environmental Science Associates

September 21, 2005

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TITLE AND APPROVAL SIGNATURES

TUOLUMNE COUNTY WATER QUALITY PLAN PROJECT

State Water Resources Control Board Agreement No. 03-240-55-0

September 21, 2005

GRANT ORGANIZATION: Tuolumne County

Title:	Name:	Signature:	Signature Date:
County Project Manager	Amy Augustine	___________________________________	
County QA Officer	Mark Houghton	___________________________________	
Contractor Project Manager	Clint Meyer	___________________________________	
Contractor QA Manager	Michele Stern	___________________________________	

STATE WATER RESOURCES CONTROL BOARD

Title:	Name:	Signature:	Signature Date:
Contract Manager	Catherine Graham	___________________________________	
QA Officer	William Ray	___________________________________	

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ACRONYMS

BMPs	best management practices
CALFED	California Bay-Delta Authority
CAMMR	California's Management Measures for Polluted Runoff
CGS	California Geological Survey
CGU	Channel Geomorphic Unit
CLS	California Laboratory Services
COC	Chain of Custody forms
CT-1	Curtis Creek Monitoring Location 1
CVRWQCB	Central Valley Regional Water Quality Control Board

DEM	Digital Elevation Model
DOQQ	digital ortho quarter quadrangle
ELAP	Environmental Laboratory Accreditation Program
ESA	Environmental Science Associates
GIS	Geographic Information System
GV-1	Garrotte Creek Monitoring Location 1
HA	Hydrologic Area
HGU	Hillslope Geomorphic Unit
HU	Hydrologic Unit
MEP	maximum extent practicable
mg/L	milligram per liter
mL	milliliter
MM-1	Mormon Creek Monitoring Location 1
MPN	most probable number
MRP	Monitoring and Reporting Plan
NA	Not Applicable
NAD 83	North American Datum 1983
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
QA/QC	Quality Assurance / Quality Control
QAPP	Quality Assurance Project Plan
RL / IAL	Reporting Limit / Instrument Accuracy Level
RPD	Relative Percent Difference
SNEP	Sierra Nevada Ecosystem Project
SV-1	Sullivan Creek Monitoring Location 1
SV-2	Sullivan Creek Monitoring Location 2
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TB-1	Turnback Creek Monitoring Location 1
TDS	total dissolved solids
TMDL	Total Maximum Daily Load
TSS	total suspended solids
UCCE	University of California Cooperative Extension
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
WD-1	Woods Creek Monitoring Location 1
WQC	Water Quality Committee
WQP	Water Quality Plan
μg/L	microgram per liter
μS/cm	microSiemen per centimeter

SECTION A

PROJECT MANAGEMENT

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) for the Tuolumne County Water Quality Plan (WQP) Project (State Water Resources Control Board Agreement No. 03-240-555-0) was prepared using U.S. Environmental Protection Agency (USEPA) and State Water Resources Control Board (SWRCB) publications QA/G-5 and QA/R-5 as guidance. These sources were used in conjunction with the SWRCB's Guide for preparing SWAMP-Compatible Quality Assurance Project Plans (Version 1.0). This document sets standards and provides guidance for ensuring that the development, use, and interpretation of data are consistent with the project's goals and objectives.

2.0 PROJECT STAFF ORGANIZATION AND DISTRIBUTION LIST

2.1 INVOLVED PARTIES AND ROLES

Tuolumne County (County) is interested in the assessment and improvement of the Upper Stanislaus and Upper Tuolumne River Hydrologic Units. As the lead agency, the County will organize the sample collection, field and laboratory analysis of samples, and the initiation and maintenance of a contract with Environmental Science Associates (ESA).

Ms. Amy Augustine, Augustine Planning Associates, Inc., is under contract with the County to perform project management duties on behalf of the County and will be the County Project Manager for this project. Ms. Augustine will be responsible for all aspects of the project including the organization of field staff, scheduling of sampling, management of the project contract, and interactions with the contractor and SWRCB staff. All project deliverables will be reviewed by the County's Water Quality Committee (WQC), composed of staff representing various County departments and the University of California Cooperative Extension, to ensure document consistency with project objectives. The County Project Manager will be responsible for coordinating review and project meetings with the WQC.

ESA is under contract to develop the Water Quality Plan (WQP) and those studies leading to its development. Mr. Clint Meyer will be the ESA Project Manager and the primary point of contact. ESA and its laboratory sub-contractor, California Laboratory Services (CLS), will analyze submitted samples in accordance with all method and quality assurance requirements found in this QAPP. ESA will also act as a technical resource to County staff and management.

2.2 QUALITY ASSURANCE OFFICER ROLE

Mr. Mark Houghton, the County's Quality Assurance (QA) Officer, will establish the quality assurance and quality control procedures found in this QAPP as part of the sampling, and field and laboratory analysis procedures. Mr. Houghton will also work with Michele Stern, the ESA QA Manager by communicating all quality assurance and control issues contained in this QAPP to ESA.

Mr. Houghton will also review and assess all procedures during the life of the contract against QAPP requirements. He will report all findings to Mr. Meyer, including all requests for corrective action. Mr. Houghton has the authority to stop all actions, including those conducted by ESA, if there are significant deviations from required practices or there is evidence of a systematic failure.

2.3 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 County Project Manager and the QA Officer, and with the concurrence of both the SWRCB's Contract Manager and QA Officer. The County QA Officer will be responsible for making the changes or updates, submitting drafts for review, preparing a final copy, and submitting the final change or update for signature.

2.4 ORGANIZATIONAL CHART AND RESPONSIBILITIES

Figure A-1 illustrates the relationships and lines of communication among project personnel. The following key project personnel shall receive copies of the approved QAPP for the project:

State Water Resources Control Board

Catherine Graham, Contract Manager
Central Valley Regional Water Quality Control Board
San Joaquin Watershed Unit
(916) 964-4714
cgraham@waterboards.ca.gov

Bill Ray, QA Officer
State Water Resources Control Board
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Tuolumne County Water Quality Committee

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(Project Management, GIS, Hydrology, and Water Quality)

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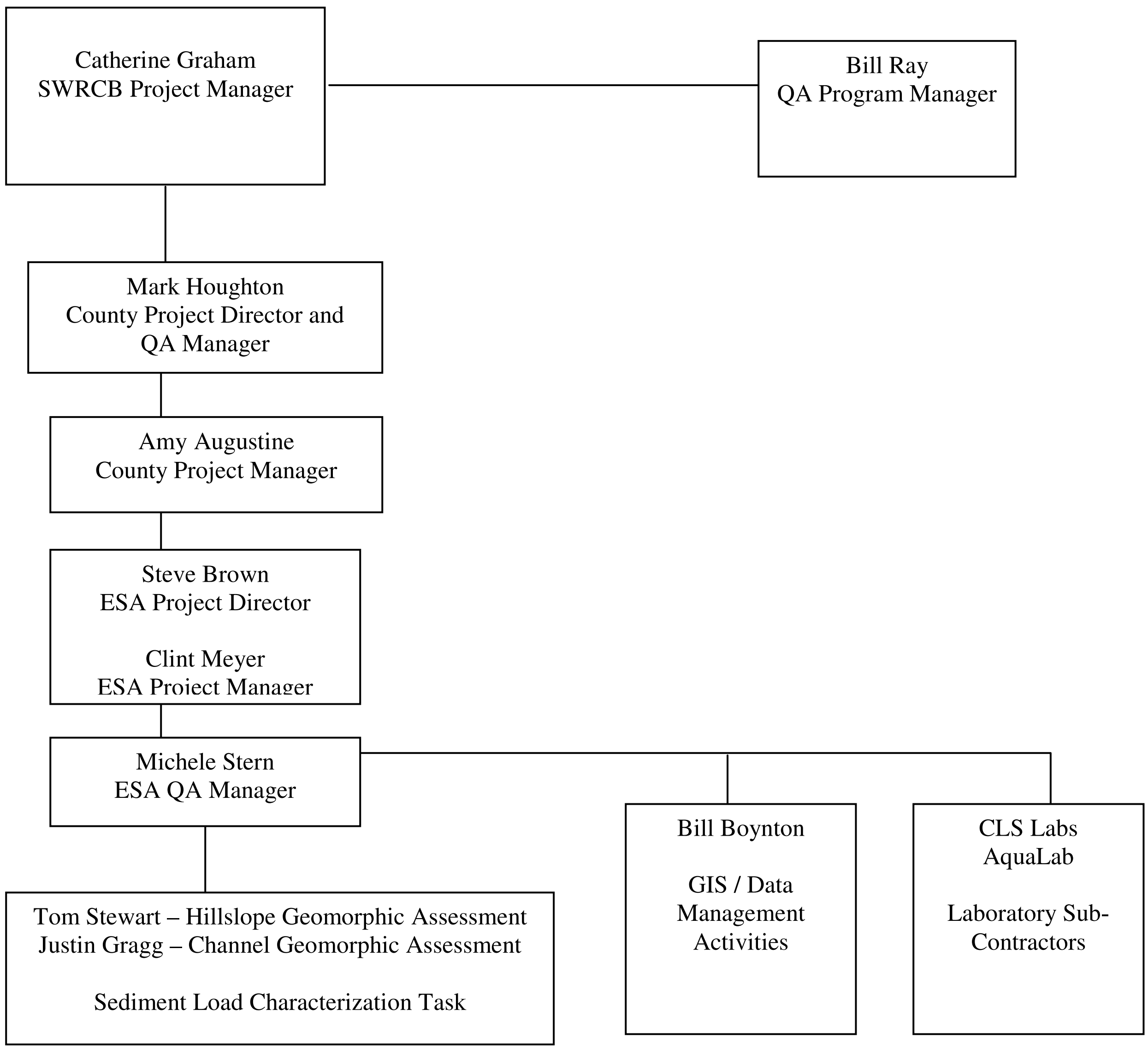
FIGURE A-1 – PROJECT ORGANIZATIONAL CHART



3.0 PROBLEM DEFINITION AND BACKGROUND

3.1 PROBLEM STATEMENT

Developed portions of Tuolumne County are mainly centralized along the Table Mountain Ridgeline that divides the Stanislaus and Tuolumne River basins in the lower foothill region of the Sierra Nevada. These urban and rural centers drain into several water supply reservoirs that provide water supplies to various locations locally and throughout the State. In the upper foothill reaches, reservoirs such as Phoenix Lake in the Phoenix basin near Sonora, have experienced heavy sediment loading. Similar observations have been documented in waterways that drain into Don Pedro and New Melones Reservoirs (e.g., Sullivan and Mormon Creeks, respectively).

In addition to sedimentation issues, Tuolumne County is traversed from north to south by the Mother Lode ore belt. Mining activities, although generally inactive since the 1980s, have resulted in the accumulation of heavy metals near historic sites, which threaten nearby waterbodies. Don Pedro Reservoir is listed on the 2002 California Section 303(d) list and Total Maximum Daily Load (TMDL) Priority Schedule for mercury contamination associated with historic resource extraction (mining) activities. In addition to mercury other heavy metals, such as arsenic, may also be currently discharged in storm water runoff from these old mine sites; thereby causing water quality degradation.

Except for Don Pedro Reservoir, no waterbodies within the Upper Stanislaus and Tuolumne River Watersheds are identified as impaired on the 303(d) List and TMDL (SWRCB, 2003). However, the County's grant application notes other issues concerning septic system failures, urban and agricultural runoff, land management practices, and hydromodification, and their potential effects on local water quality.

The lower reaches of the Stanislaus and Tuolumne Rivers are listed under the federal Clean Water Act as impaired water bodies for diazinon, Group A pesticides (aldrin, dieldrin, endrin, chlordane, heptachlor expoxid, hexachlorocyclohexane, endosulfan, and toxaphene), and unknown toxicity. The Lower Stanislaus River is also listed for mercury. Currently, the upper portions of these two river systems are not listed for any TMDLs.

3.2 DECISIONS AND OUTCOMES

Watershed baseline studies are most needed for watershed tributaries impacted by development, mining, and/or other County land uses. Both County officials and the public have suggested that Sullivan Creek, Woods Creek, Turnback Creek, Curtis Creek, Garrotte Creek (all tributaries of the Tuolumne River, draining into Don Pedro Reservoir); as well as Mormon Creek (a tributary of the Stanislaus River, draining into New Melones Reservoir); may be the most impacted or affected tributaries in the two watersheds. The central focus of the project will include collecting data for these tributaries to determine if a problem exists.

Two phases of monitoring will be completed to identify existing baseline conditions and track potential changes in water quality over time.

Phase 1: ESA will conduct baseline water quality monitoring to identify constituents of concern within each waterway. During the first phase a wide range of constituents associated with upstream land usage will be monitored. This monitoring phase will provide a baseline for the local foothill creeks that drain urban and rural centers within the unincorporated portions of the County.

Phase 2: The second phase of the monitoring program will include on-going field measurements for flow, temperature, turbidity and other identified constituents of concern. The second phase data will be integrated with the baseline data to analyze trends. If the baseline data and trend analysis show a substantial threat to impaired water quality, the data will be made available to the Central Valley Regional Water Quality Control Board (CVRWQCB) for consideration for 303(d) listing and TMDL development.

3.3 WATER QUALITY OR REGULATORY CRITERIA

The CVRWQCB has set water quality objectives for all surface waters in the Central Valley. These water quality objectives include bacteria, biostimulatory substances, chemical constituents, color, dissolved oxygen, floating material, oil and grease, pH, pesticides, radioactivity, salinity, sediment, settleable material, suspended material, sulfide, tastes and odors, temperature, toxicity, and turbidity (CVRWQCB, 1998). In addition, objectives for specific chemical constituents have been set depending on the beneficial uses designated for each waterbody (CVRWQCB, 1998). Specific water quality objectives for the Tuolumne and Stanislaus Rivers are presented in **Appendix A**. (CVRWQCB, 1998). Constituent limits identified in CVRWQCB (1998) will be used to determine the magnitude of any impact within each of the monitored waterways.

4.0 PROJECT/TASK DESCRIPTION

4.1 WORK STATEMENT AND PRODUCED PRODUCTS

The project will include an assessment of existing conditions in the Upper Stanislaus-Tuolumne River Watersheds. Specific emphasis will be placed on the surface water quality and those factors affecting it in areas where the County maintains land use jurisdiction. The overall goal of the project is to develop a better understanding of the surface water quality conditions in the County, prepare a WQP that responds to those conditions, and maximize community involvement and education during the process. The specific project objectives are as follows:

1. Identify the current water quality conditions of local waterways in terms of mass loading and categorize the level of risk to their watersheds at a sub-unit level;

2. Identify the various factors and processes limiting the quality of local surface waters, in general. It is assumed that the primary processes are accelerated erosion and sedimentation of the stream system, resulting from past and current land use. The project will attempt to answer the question of whether portions of the two watersheds are experiencing accelerated erosion and sedimentation.

3. Identify water quality constituents of concern, cost-effective treatments to reduce those constituents, and the parameters for when these treatments should be employed.

The Upper Stanislaus-Tuolumne Rivers have been the subject of several past studies, as well as actions and efforts by local residents to investigate and solve problems associated with the river systems, including impaired water quality. The Stanislaus-Tuolumne Watershed Assessment (Assessment) in support of the County's WQP will build on past studies, and will include an assessment of hillslope and channel geomorphology, local riparian conditions, and historical land use review. The Assessment will synthesize the results of these studies by prioritizing the watershed areas for future water quality improvement projects. In addition, the Assessment will serve as the initial foundation for the development of the County-wide WQP by prioritizing specific reaches within each watershed. Based on this prioritization and the assessment of watershed conditions, the WQP will include a general overview of potential treatment options for high and moderate priority areas, and various best management practices (BMPs) to apply at identified locations within (or throughout) each watershed.

Throughout the project the County will provide quarterly progress reports, including collected data. At the end of the project, the County will provide a full listing and summary of the collected data, including a trend analysis. This listing and summary will provide an indication of those tributary subbasins and mainstem reaches that are currently impacted by degraded water quality (high priority areas), and those areas that present the best opportunities for cost-effective treatments.

4.2 CONSTITUENTS TO BE MONITORED AND MEASUREMENT TECHNIQUES

This section outlines procedures for monitoring the water quality of urban runoff generated at specific discharge points within the County. Due to the expansive area involved and the range of constituents covered by the Monitoring and Reporting Plan (MRP), the project design consists of a two-phased approach. The first phase will involve the establishment of a water quality baseline by ESA staff. The second phase of the MRP will consist of monitoring and tracking those constituents identified as "constituents of concern" during the first phase as well as other water quality parameters including flow, specific conductance, turbidity, and temperature. A volunteer monitoring group under the County's oversight will conduct this second monitoring phase. The University of California Cooperative Extension (UCCE) will specifically provide management oversight for the second monitoring phase (Note: Should the County proceed with the formation of the Tuolumne County Resource Conservation District, that agency will provide management oversight). The MRP will be subject to future amendments based on data interpretation.

The first phase of monitoring will include two components:

1. Grab samples will be collected and analyzed from three runoff events. Specific criteria for the selection of storm events are provided below. The following parameters will be sampled and analyzed at targeted locations: flow, pH, total suspended solids (TSS), specific

conductance, oil and grease, temperature, hardness, priority pollutant metals[1], turbidity, and nitrate + nitrite as N. Other, more site-specific tests may include EPA 8151A herbicides, EPA 8260B volatile organics, and total and fecal coliform bacteria.

2. Concurrent with collection of the above grab samples, visual observations for the presence of floating and suspended materials, films or sheens, discoloration, turbidity, potential nuisance conditions (e.g., odor), and aquatic life will also be recorded. These conditions will be photo-documented using a digital camera to allow for real-time download and viewing.

No acute or chronic toxicity monitoring is proposed under the MRP.

Chemical constituents and physical measurements to be analyzed in the MRP are included in **Table A-1**. Sample containers, preservatives, laboratory methods, and detection limits for each constituent are provided in the MRP contained in **Appendix B**. The timing of each sampling event will generally coincide with low to moderate rainfall events that produce sufficient runoff to enable sampling within each of the identified stream reaches. However, in efforts to characterize the range of potential conditions, winter and/or summer base flows will be sampled to the extent feasible. The first phase of monitoring will commence in the fall of 2005.

TABLE A-1
SURFACE WATER SAMPLING PARAMETERS

Analysis	Method	Unit	RL / IAL
pH	Field	standard unit	+/- 0.5
Specific Conductance	Field	•S/cm	+/- 0.5%
Temperature	Field	°C	+/- 0.5 °C
Dissolved Oxygen	Field	mg/L	+/- 2%
Turbidity	Field	NTU	+/- 2%
Hardness	SM-2340B	mg. eq. CaCO3/L	1.0
Oil and Grease	EPA 1664	mg/L	5.0
Total Suspended Solids	EPA 160.2	mg/L	5.0
Priority Pollutant Metals	EPA 200.8[(1)]	•g/L	variable
Low-Level Mercury	EPA 1631	ng/L	0.5
Total and Fecal Coliform Bacteria	STDM 9221	MPN/100 mL	2.0
Nitrate + Nitrite as N	EPA 300.0	mg/L	0.500
Volatile Organics	EPA 8260B	•g/L	variable
Herbicides	EPA 8151A	•g/L	variable

[1] EPA Methods 200.8, 8260B, and 8151A are designed to obtain analytical results for various constituents with differing detection limits.

mg/L = milligram per liter
•g/L = microgram per liter
•S/cm = microSiemen per centimeter
mL = milliliter
MPN = most probable number
NTU= nephelometric turbidity unit
RL / IAL – Reporting Limit / Instrument Accuracy Level

1 Priority pollutant metals include silver, arsenic, beryllium, cadmium, chromium, copper, mercury, nickel, lead, antimony, selenium, thallium, and zinc.

The implementation of the MRP and completion of field work will be coordinated to avoid duplication of effort and to focus the overall effort on the project objectives. Further details on the sediment load characterization task are presented in **Section B** of this document. Initial monitoring data collected during the MRP will be integrated with other data sources to provide a holistic view of watershed processes and conditions consistent with the project objectives. This will be accomplished as follows:

- Narrating an illustrated history of land use in the watershed to provide the context for current conditions (e.g., land alteration, timber harvesting, mining, development);
- Mapping of major findings, including erosion rates, rates of sediment production to stream channels based on existing literature (e.g., SNEP, 1996; MacDonald et al., 2004; and others), observations of channel conditions, and general riparian habitat quality. This information will also be presented in tabular and narrative format, as appropriate;
- Ranking of sub-basins within the County's jurisdiction, using a scale of high, medium, and low, indicating the priority that should be given for water quality improvement projects and potential restoration sites. The ranking will be based on a synthesis of the information available for each sub-basin. The results of the sub-basin prioritization will be mapped. This map will be one of the more useful products of the project.

4.3 PROJECT SCHEDULE

A shown on Table A-2, the project schedule is as follows:

TABLE A-2 – PROJECT SCHEDULE

	Date			
Task	Initiation Date	Completion Date /a/	Deliverable	Deliverable Due Date
Start Project	12/1/04	3/31/07	None	--
Quarterly Progress Reporting	9/10/04	1/10/07	Progress Reports	By the 10th of the month following the quarter.
Phase 1 – MRP Implementation	9/1/05	1/10/07	COCs	--
Phase 2 – MRP Implementation	12/30/05	1/10/07	COCs	--
Draft Watershed Assessment Report	3/10/05	4/10/06	Draft Assessment Report	4/10/06
Final Watershed Assessment Report	--	7/10/06	Final Assessment Report	7/10/06
Sediment Characterization Task	3/10/05	4/10/06	Hillslope and Channel Geomorphic Assessments / supporting documentation	4/10/06
Draft WQP	4/10/05	4/10/06	Draft WQP	4/10/06
Final WQP	--	7/10/06	Final WQP	7/10/06
Draft Project Report	12/10/06	1/10/07	Draft Final Project Report	1/10/07
Final Project Report	--	3/31/07	Complete Data Set and Project Summary Report	3/10/07

Note:
/a/ Submittal to State
MRP – Monitoring and Reporting Plan
WQP – Water Quality Plan
COC – Chain of Custody forms

4.4 GEOGRAPHIC SETTING

Tuolumne County is almost exclusively contained within the Upper Stanislaus-Tuolumne River Hydrologic Units [Catalog No. 1804009 (Upper Tuolumne River) and 1804010 (Upper Stanislaus River)] located in the central Sierra Nevada. The County comprises just less than 1.5 million acres. Several dam systems regulate flows within the middle and lower reaches of both river systems. Don Pedro Reservoir along the Tuolumne River and New Melones Reservoir along the Stanislaus River are the largest impoundments within each watershed. These two impoundments disconnect each waterway from its lower reaches within the Central Valley. Much of the two watersheds, especially the upper portions, are located within the Stanislaus National Forest. For this reason, the primary geographic scope of the project is limited to the foothill regions of the two watersheds where urban and rural growth is actively occurring under County jurisdiction.

4.4.1 WATERSHED DESCRIPTIONS

Upper Stanislaus River Hydrologic Unit

The Upper Stanislaus River Hydrologic Unit (HU; U.S. Geological Survey [USGS] Cataloging Unit 18040010) is comprised of 1,660 miles of waterways, with approximately 85 percent of the watershed unobstructed by impoundments. There are 32 dams within the watershed and an estimated 1,215 stream crossings (ICE, 1997). Approximately 35 percent of the watershed is situated on slopes in excess of 15 percent slope (ICE, 1997). All flows within the watershed ultimately drain into the federally-owned New Melones Reservoir. The Tuolumne Utilities District (TUD) delivers domestic water supplies to much of the unincorporated County from Lyons Reservoir, below Pinecrest Lake on the South Fork. Lyons Reservoir is generally characterized by excellent water quality (TUD, 2004).

Vegetation within the watershed is highly variable and influenced by factors including elevation, soil type, and slope aspect. Vegetative communities generally consist of oak/grey pine, ponderosa pine, mixed conifer and fir. Upper portions of the watershed are generally comprised of deep, U-shaped, and glacially carved canyons and broad glaciated plains composed of granitic rocks. Lower sections of the river system, above New Melones Reservoir, flow through V-shaped gorges comprised of meta-sedimentary rocks. Gold mining still occurs in lower sections of the South Fork. The deepest mudflow in the Sierra Nevada occurs within the Middle Fork near Nightcap Peak (3,000 feet).

Upper Tuolumne River Hydrologic Unit

The Upper Tuolumne River HU (USGS Cataloging Unit 18040009) is comprised of 1,944 miles of waterways with 80 percent of the watershed unobstructed by impoundments. Almost 50 percent of the total watershed land is under protected status (e.g., Wilderness Area.). There are 30 dams and approximately 1,197 stream crossings (ICE, 1997). Approximately 35 percent of the watershed is located on slopes in excess of 15 percent (ICE, 1997). The geologic structure of the Tuolumne River HU is similar to that described for the Upper Stanislaus River; with vegetation communities consisting of oak/grey pine, ponderosa pine, mixed conifer, and fir.

All flows within the watershed drain into the federally owned New Don Pedro Reservoir. The Tuolumne River begins in Tuolumne Meadows at the confluence of streams descending from the slopes of Mt. Lyell (13,100 feet) and Mt. Dana (13,155 feet). From Tuolumne Meadows the river descends through the steep Yosemite wilderness, before its flow is impounded by the O'Shaughnessy Dam in Hetch Hetchy Valley (3,500 feet). A portion of the water from O'Shaughnessy Dam is diverted towards the Kirkwood Powerhouse. Just below Yosemite National Park, Cherry Creek enters the river. Further downstream, the Tuolumne's South and North Forks, as well as the Clavey River, join the main stem above Don Pedro Reservoir.

4.5 CONSTRAINTS

The primary constraints to this project are attributed to the expansive geographic area under consideration in conjunction with limits on available funding and time to acquire baseline data. Baseline data acquisition will be limited to less than one year of field inventory. Therefore, it will be impossible to capture the variability in surface water quality over multiple water years. Following the baseline assessment, field data acquisition will be limited in scope to general field parameters including flow, specific conductance, temperature, and turbidity. As a consequence, trends in other constituents (e.g., heavy metals) will be difficult to assess over the long-term without additional funding to enable expanded analytical and, if necessary, toxicity testing. It is noted, however, that recommendations contained in the WQP are expected to include pursuit of future funding to assist in ongoing monitoring to gauge trends.

By virtue of the large land area and diverse history included within the Tuolumne and Stanislaus River Basins, it is not practical to conduct comprehensive field studies of the entire watersheds. For this reason, the assessment will require segregating the two watersheds based upon physical attributes and jurisdictional considerations. Much of the watershed characterization will be based on information gleaned from past studies and existing reports. Field studies will be limited to the foothill region where much of the current development is occurring. As the primary study area is limited to just a few selected sub-watersheds, those assessment findings will acknowledge a continued need for baseline data for other foothill watersheds (e.g., Sixbit Gulch Creek, Priest Creek). Nonetheless, information acquired from these studies will be applied, where appropriate, to the remainder of the foothill watersheds to characterize the range of possibilities.

5.0 QUALITY OBJECTIVES AND CRITERIA

The data quality objectives for the project are relative to the intended use of the project's outcome. This outcome, which will be contained in the WQP, can be described primarily as responsive: the Assessment Report will characterize existing conditions within the primary and secondary study areas. The WQP will be developed in response to those identified conditions. Therefore, the foremost data quality objective will be to achieve a high level of internal consistency by following specified quality assurance/quality control (QA/QC) criteria. The basic questions to be answered are the following:

- Which portions of the watershed are most impacted by urban development and other County land uses and, more importantly, what and how are the impacts from non-point sources manifested within the watershed?
- What level of monitoring is necessary to assess the level of impacts from non-point sources and where should sampling occur to determine the extent of impairment, if any?
- Are current County codes, land use designations, and management practices used by the County adequate to limit cumulative impacts to surface water quality from non-point sources of pollution?
- What methods or BMPs could the County utilize to reduce the impacts to surface water quality; and how will the County evaluate the effectiveness of the WQP, consistent with the objectives of CALFED and the SWRCB?

Site specific, repeatable measurements will be taken in the field using methods that have become standard for assessing water quality along streams in California. Field sites will be selected that represent a range of conditions, but which will concentrate on areas within each watershed that are within the County's jurisdiction and influenced by a variety of land uses. These same sites may in the future be used as monitoring sites to assess the effectiveness of restoration treatments, or to obtain long-term data trends.

More specific data quality objectives are presented in the discussion of particular methods in **Table A-3** and **Section B** of this document.

6.0 SPECIAL TRAINING/CERTIFICATIONS

All team members identified in Figure A-1 are professionals, who have received training in their areas of expertise at various academic institutions and training programs. Their fields of expertise include geomorphology, hydrology, limnology, and riparian and aquatic ecology. All team members are experienced in the methods for data collection and analyses that they will be undertaking. Project personnel resumes are included in the original Statement of Qualifications and Proposal for the project, which are incorporated by reference. CLS Laboratories is a California-certified laboratory.

ESA will coordinate informational transfer with County staff and volunteer monitors during the transition to phase two of the MRP. The County and the SWRCB will provide the proper education and necessary training for volunteer personal.

7.0 DOCUMENTATION AND RECORDS

All field results will be recorded at the time of completion in the field, using data sheets designed for the purpose. Data sheets will be reviewed for outliers and omissions before leaving the sample site at the completion of each data collection. The team leader will review and sign data sheets. Field personnel will turn in data sheets to their home office within one week of actual data collection. Copies of all data sheets will be made immediately available upon receipt at the home office.

Original copies will be stored in an “original binder.” One copy will be placed in a “working binder,” and a second copy will be forwarded to the ESA Project Manager for inclusion in the main project file in Sacramento. Copies of all information in field logbooks will be made and inserted into the working binder and the project file. All data entries and other tasks involving the data sheets will utilize the working binder. The original binder shall be used for reference only.

Entry of all data will be made into a computer database or spreadsheet within three weeks of data collection. Electronic copies of all data will be forwarded within one week of entry to the ESA Project Manager, who will maintain the data in the main project file. The ESA computer library system is backed up daily.

Team members will also maintain instrument maintenance and calibration logs for field equipment. Instrument logs will detail the dates of equipment inspection, calibrations, reagent replacement, and repair. Instrument logs will be turned in with data sheets. Photocopies will be placed in the working binder and the main project file.

Electronic copies of existing data used in the study, such as GIS layers, will be maintained in the main project file in their original form, along with any associated metadata.

TABLE A-3
MEASUREMENT QUALITY OBJECTIVES

Group	Parameter	Accuracy Objectives			
		Accuracy	**Precision**	**Recovery**	**Completeness**
Field Analyses	Dissolved Oxygen	± 0.5 mg/L or 2%	± 0.5 or 10%, whichever is greater	NA	90%
	Temperature	± 0.5^{o} C	± 0.5 or 5%, whichever is greater	NA	90%
	Conductivity	± 2%	± 5%, whichever is greater	NA	90%
	pH by meter	± 0.5 unit	± 0.5 or 5%, whichever is greater	NA	90%
	Depth	± 0.2 meter	NA	NA	NA
	Turbidity	± 10% or 0.1, whichever is greater	± 10% or 0.1, whichever is greater	NA	90%
Laboratory Analyses	Conventional Constituents in Water	80% to 120% of true value	Laboratory duplicate, ± 25 % RPD	Matrix spike 80% to 120%	90%
	Volatile Organic Analytes (including VOCs, MTBE, BTEX) in Water	50% to 150% of true value	Field replicate, ± 25 % RPD	Matrix spike 50% to 150%	90%
	Synthetic Organic Analytes (including herbicides)	50% to 150% of true value	Field replicate, ± 25 % RPD	Matrix spike 50% to 150%	90%
	Trace metals, including mercury	Standard Reference Materials 75% to 125%.	Laboratory duplicate, ± 25 % RPD	Matrix spike 75% to 125%.	90%
	Bacteria / Pathogens	Laboratory positive and negative cultures – proper positive or negative response. Bacteria / Pathogen sample -–within the stated acceptance criteria.	R_{log} within 3.27*mean R_{log} (reference is Section 9020B in 20th edition of *Standard Methods*	NA	90%

NA – Not Applicable
RPD – Relative Percent Difference

Source: SWRCB, 2004, CLS, Labs, 2005

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SECTION B

DATA GENERATION AND ACQUISITION

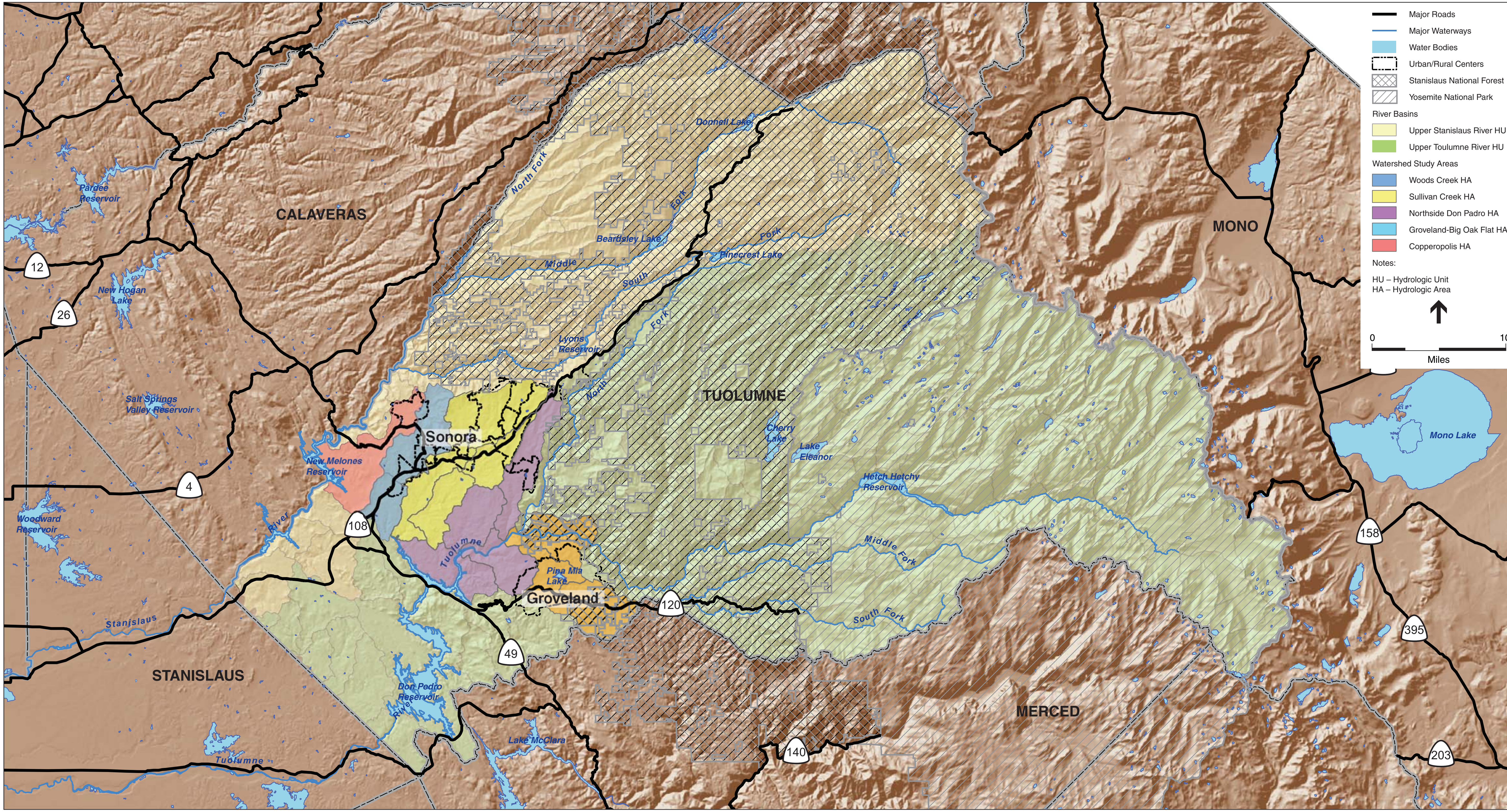
1.0 SAMPLING PROCESS DESIGN

Developing consistent data for a large watershed-scale assessment requires both a synthesis and interpretation of pre-existing informational sources to avoid duplication of effort. In addition, a focused set of objectives is necessary to guide the acquisition of project data. In the context of the County's stated objectives, the focus of the project will be on those hydrologic areas within the Upper Stanislaus and Tuolumne River Watersheds that are largely within the County's jurisdiction. This focus will allow for a more effective evaluation of water quality in locations where the County maintains both land use and permitting authority.

To accomplish this, ESA completed a jurisdictional overlay for the two watersheds and reviewed land use patterns to identify representative units. Using CalWater 2.2, five watershed planning units were delineated to be assessed at a greater level of detail. These units include the Sullivan Creek, Woods Creek, North Don Pedro, and Groveland-Big Oak Flat hydrologic areas (HA) within the Upper Tuolumne hydrologic unit (HU) and the Copperopolis HA within the Upper Stanislaus HU. These hydrologic areas are depicted in **Figure B-1**.

Data acquired for the project will consist of a combination of GIS layers, aerial photography (USGS digital ortho quarter quadrangle or DOQQs), stream gauging records, and various written reports. Based on this initial consolidation and interpretation of exiting data, water quality monitoring will be initiated within each sub-unit. The Sullivan Creek HA has been chosen to undergo further analysis to allow for stratification of the unit into areas with shared attributes for assessment of sediment production and transport. This process of stratification is further described under the Sediment Load Characterization Task. The field study design will be developed so that each stratum is sufficiently sampled to develop a characteristic profile. All field studies will be concentrated in these representative hydrologic areas.

Baseline field studies for this project will be performed by ESA staff in coordination with the County, the SWRCB, and other local contributing agencies.



SOURCE: CalSIL, 2004; and ESA, 2005

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Figure B-1
Hydrologic Study Areas

2.0 SAMPLING METHODS

This section describes the methods that will be used by field staff to sample data, handle samples, analyze data, and control data quality.

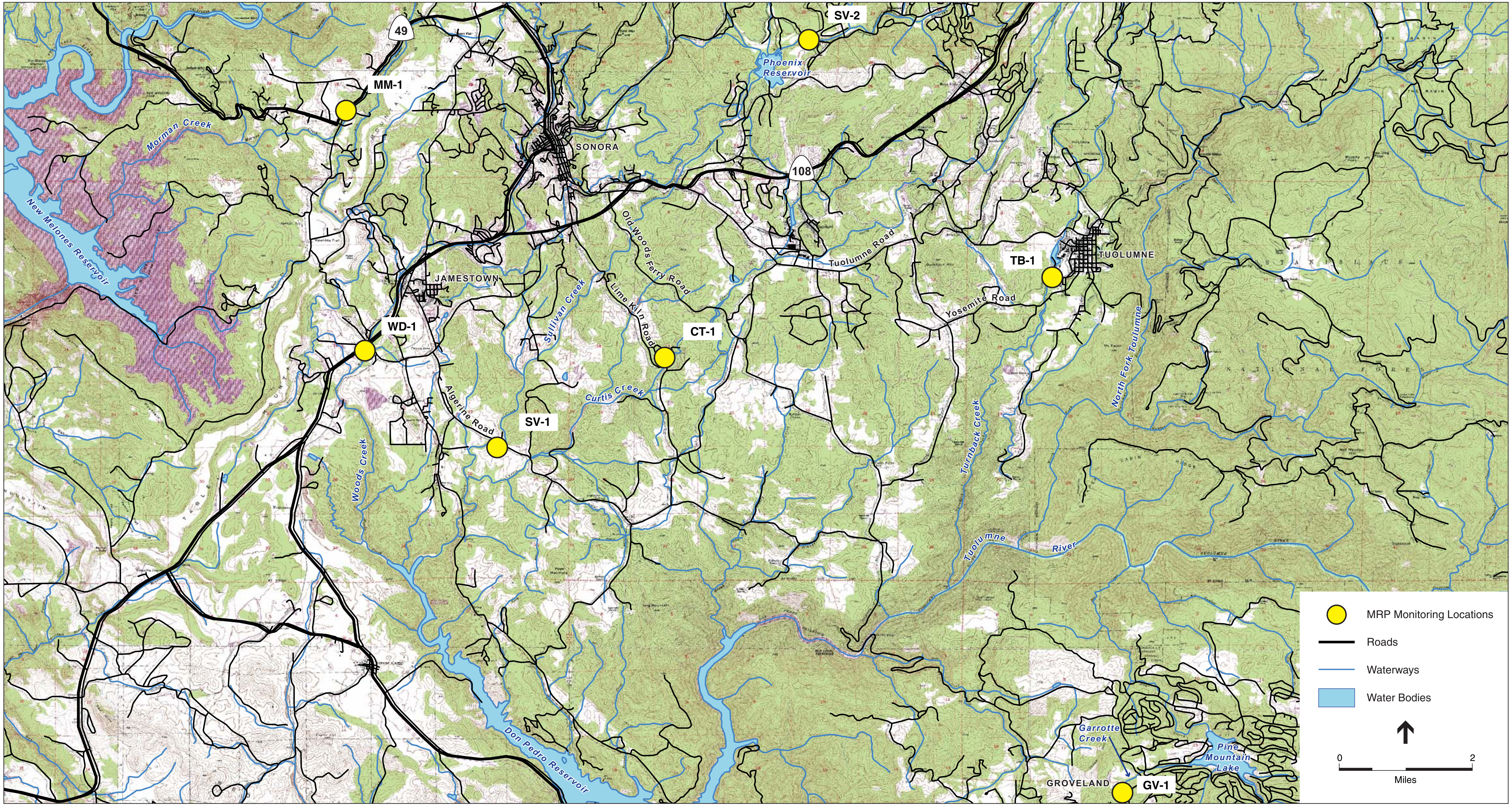
2.1 SURFACE WATER QUALITY MONITORING

This section provides an overview of the QAPP for the MRP. The MRP describes all aspects of the monitoring program including sampling locations, water quality sampling parameters, field procedures, and reporting protocols (refer to Appendix B). The objective of the MRP is to establish a monitoring and reporting framework to track and assess the water quality of streams in the unincorporated portions of the Upper Tuolumne and Stanislaus River Hydrologic Units.

At this time, sampling will be limited to the North Don Pedro, Sullivan Creek, Woods Creek, Groveland-Big Oak Flat, and Copperopolis Hydrologic Areas (HA). Seven monitoring locations were identified as the most cost-effective to characterize the quality of surface water generated from various land uses within the County's jurisdiction. Six of the monitoring locations are located within the Upper Tuolumne River Watershed; the seventh is located in the Upper Stanislaus River Watershed. These watershed sub-units receive a majority of the runoff generated from urban and rural centers within the County's jurisdiction. The monitoring locations along each reach were chosen to provide an indication of cumulative runoff within each sub-watershed unit. These monitoring locations are shown in **Figure B-2**.

All of the creeks within the Upper Tuolumne River watershed slated for sampling drain directly to Don Pedro Reservoir, with the exception of Garrotte Creek, which drains into Big Creek and then in to the mainstem of the Tuolumne River. Two monitoring locations are proposed along Sullivan Creek with one situated just above Phoenix Lake and the second above the confluence of Curtis Creek. Monitoring along Garrotte Creek will occur downstream of the town of Groveland and upstream of Pine Mountain Lake. Monitoring along Turnback Creek will occur below Tuolumne City. Monitoring along Woods Creek will occur downstream of Jamestown.

Monitoring within the Stanislaus River Watershed will be limited to the Copperopolis HA with monitoring focused on the lower reach of Mormon Creek. As illustrated in **Figure B-2**, this monitoring location is situated just upstream of New Melones Reservoir and below the Town of Columbia. Photographs and descriptions of the monitoring locations, as well as directions to each of the sampling sites, are provided in the MRP.



SOURCE: Tuolumne County, 2004; and ESA, 2005

Tuolumne County WQP Project . 204254

Figure B-2
Surface Water Monitoring Locations

APPROACH TO SURFACE WATER MONITORING

The locations of the seven monitoring sites were chosen to characterize the quality of surface water draining from existing urban and rural centers and areas currently experiencing increased growth pressures (e.g., construction). In addition, the identified waterways may or may not receive runoff from other uses such grazing, small vineyards, rural roadways, and private timber operations. In this context, the selection of the seven sites is primarily based on localized hydrology within each of the selected hydrologic areas and land use considerations upstream of the selected monitoring points based on field investigation, aerial photograph interpretation, and review of the County General Plan Land Use Map. Land use considerations were particularly important in developing the MRP to account for factors that could influence surface water quality within each hydrologic area. In addition, the selection process favored those locations where access is readily available, such as where a public road crosses or intersects the waterbody.

The two phases of the MRP initially utilize a mass (or cumulative) loading approach to determine surface water quality at the seven monitoring locations. This approach is designed to monitor large drainage areas with mixed land use characteristics. ESA, in conjunction with the Tuolumne County Water Quality Committee and consultation with the CVRWQCB, selected the mass loading monitoring site locations. The primary site selection factors included:

- Suitability of the site drainage area to monitor area-wide contributions of storm water pollutant loading;
- Suitability of the site's hydrological characteristics to enable practical measurement of flow and collection of representative storm water samples;
- Safety from traffic and other hazards;
- Potential for development under County jurisdiction within the HA (hence corresponding potential to implement BMPs and increased likelihood of for water quality benefits); and
- Access for retrieving samples and maintaining equipment during storm conditions.

The mass loading sites were selected to directly measure pollutant loads being discharged into receiving waters (i.e., New Melones and Don Pedro Reservoirs) within the five hydrologic areas under consideration. Monitoring sites are included where flow from up-gradient catchments pass through a single hydrologically ratable point, suitable for measurement and sampling. In most instances, these sites were located upstream of the drainage area discharge point for accessibility and/or to avoid reservoir water level influences.

After determining the locations to be sampled, it is necessary to define the constituents that are potentially present in the water column, especially those that could occur at sufficient concentrations to impair the beneficial uses. In this context, the MRP includes monitoring for a wide range of parameters that could be present in the runoff, based on those land uses present within each hydrologic area, to characterize baseline mass loading conditions. Table B-1 lists water quality parameters important to the applied beneficial uses that may be affected by the variety of the land uses present with the County.

SAMPLING PARAMETERS AND FREQUENCY

The MRP will be implemented in two phases with the first phase focused on establishing a water quality baseline. ESA will complete monitoring tasks under Phase One of the MRP. Data generated from this phase will help to direct the development of the County-wide WQP in conjunction with Phase Two monitoring activities. With direction from professionals trained and experienced in data collection methods and analyses, the second phase of the MRP will involve a volunteer-monitoring program to track those parameters identified as constituents of concern over the long-term implementation of the WQP.

Chemical and physical parameters to be analyzed at each monitoring location are summarized in **Table B-1**. Sample containers, preservatives, laboratory methods, and detection limits for each parameter are provided in Sub-Section 3. The timing of each sampling event will generally coincide with rainfall events that produce sufficient runoff to enable sampling within each of the identified stream reaches.

TABLE B-1 - SURFACE WATER SAMPLING PARAMETERS

				Monitoring Location(s)						
Analysis	**Method**	**Units**	**RL / IAL**	**SV-1**	**SV-2**	**GV-1**	**MM-1**	**TB-1**	**CT-1**	**WD-1**
Flow	Field	cfs	--	x	x	x	x	x	x	x
pH	Field	standard unit	pH Unit	x	x	x	x	x	x	x
Specific Conductance	Field	•S/cm	+/- 0.5%	x	x	x	x	x	x	x
Temperature	Field	°C	+/- 0.5 °C	x	x	x	x	x	x	x
Dissolved Oxygen	Field	mg/L	+/- 2%	x	x	x	x	x	x	x
Turbidity	Field	NTU	+/- 2%	x	x	x	x	x	x	x
Hardness	SM-2340B	mg. eq. $CaCO_3$/L	1.0	x	x	x	x	x	x	x
Oil and Grease	EPA 1664	mg/L	5.0	x		x	x	x	x	x
Total Suspended Solids	EPA 160.2	mg/L	5.0	x	x	x	x	x	x	x
Priority Pollutant Metals	EPA 200.8[(1)]	•g/L	variable	x	x	x	x	x	x	x
Low-Level Mercury	EPA 1631	ng/L	0.5	x	x	x	x	x	x	x
Total & Fecal Coliform	STDM 9221	MPN/100 mL	N/A	x	x	x	x	x	x	x
Nitrate + Nitrite as N	EPA 300.0	mg/L	0.500	x	x	x	x	x	x	x
Volatile Organics	EPA 8260B	•g/L	variable	x			x	x	x	x
Herbicides	EPA 8151A	•g/L	variable	x			x	x	x	x

Note: RL / IAL – Reporting Limit / Instrument Accuracy Level
[SV-1 (Sullivan Creek at Algerine Road); SV-2 (Sullivan Creek at Potato Ranch Road); GV-1 (Garrotte Creek at GCSD Driveway); MM-1 (Morman Creek at Mormon Creek Road); TB-1 (Turnback Creek at Box Factory Road); CT-1 (Curtis Creek at Lime Kiln Road); WD-1 (Woods Creek at Bell Mooney Road)].

[1] EPA Method 200.8 is designed to obtain analytical results for numerous metals with differing detection limits.

cfs = cubic feet per second
mg/L = milligram per liter
•g/L = microgram per liter
•S/cm = microSiemen per centimeter
mL = milliliter
MPN = most probable number
NTU= nephelometric turbidity unit

RAINFALL EVENT CRITERIA

Surface water sampling under both phases of the MRP will occur during the period marked by final approval of the MRP (anticipated for October 2005) through March 1, 2007. An effort will be made to collect samples within the first hours of runoff following a rainfall event. However, in recognition of the large sampling area and associated travel times, it is expected that each site will be sampled at differing periods during each of the sampled rainfall events. For this reason, it will be necessary for sampling personal to document those conditions present at the time of sampling (e.g. peak, residing, etc.)

It is preferable that each event be preceded by a minimum of three days of dry weather. An emphasis will be placed on sampling the first storm event of the season in the fall of 2005. However, if this is not possible; another storm event that meets the above criteria should be sampled shortly thereafter.

SAMPLING PROTOCOLS

Pre-Sampling Preparation

Long-term weather predictions must be carefully tracked to determine appropriate storm events for sampling. This is particularly important for the first storm event of the season. If it appears that the first storm event may commence outside of the County's regular business hours, the County should plan accordingly for the next anticipated rainfall event.

All field equipment will be stored at the County's Farm Advisor/UC Cooperative Extension main office at 52 North Washington Street in Sonora. Prior to departure, all necessary equipment will be gathered. A complete list of suggested equipment and monitoring worksheets are provided in the MRP. All field equipment shall be calibrated according to manufacturers' specifications prior to sampling.

Sample Collection

Field meters will be used to measure in-stream flow, dissolved oxygen, specific conductance, turbidity, pH, and temperature. To the extent feasible, staff will try to grab samples from the center rather the sides of the stream; while ensuring that the sampler is standing downstream of the sensors. Field meters will be submerged for approximately one minute to allow readings to stabilize. All field data will be logged electronically and on the hardcopy field worksheet to avoid accidental loss of data.

Flow velocity data shall be taken at a depth of two thirds of the actual water depth. If flows are less than one foot per second, obtain an accurate dissolved oxygen reading by moving the sensor rapidly through the water. Rinse sensors with deionized water and dry with Kimwipes between samples. If flows are too turbulent, use the sampling pole to acquire grab samples from the middle of the stream. Immediately immerse the probes within the sample container and follow the procedures above.

Grab samples may be obtained using a sampling pole or by hand, depending on the flow present. Attach the first sample container to the sampling pole, and remove the container lid. Dip the container into the surface flow making sure that the container draws flows from the suspended load near the center of the stream. Do not bring the sample container in contact with other objects Pre-rinse the sample container by collecting one grab sample and emptying the sample back into the surface flow (oil and grease samples do not receive a pre-rinse). Collect a second grab sample, replace lid, and remove from pole. Repeat until all samples have been collected. For samples placed in pre-preserved sample containers, attach a one-liter polyethylene container to the sample pole, and follow the protocol above to grab the sample. Once the sample has been grabbed, transfer it to the pre-preserved container. Do not pre-rinse the pre-preserved container. Make sure that the two containers do not touch during the transfer. Place collected samples in ice chest, containing ice. Sub-Section 3 provides the bottle and preservation requirements for each parameter to be collected. Sampling parameters for each monitoring location are provided in Table B-1.

Be sure to record visual observations downstream of the monitoring location. Observe any signs of water quality degradation including, but not necessary limited to: floating or suspended matter; discoloration; bottom deposits; aquatic life; visible films, sheens, or coatings; slimes or objectionable growths; and odors and other potential nuisance conditions.

Complete chain of custody forms.

Monitoring Locations

TB-1

The TB-1 monitoring location is accessed by parking on Box Factory Road at the Turnback Creek Bridge, within the southern section of Tuolumne City. The creek can be accessed at the upstream side of the bridge. Use caution while descending the bank below Box Factory Road. To the extent feasible, samples should be obtained upstream of the bridge.

SV-1

This monitoring location is accessed by parking on the shoulder of Algerine Road at either end of the bridge over Sullivan Creek and proceeding to the downstream side on either end of the bridge. Use caution descending the stream bank below Algerine Road. If necessary, tie a piece of static rope or webbing of sufficient length to the bridge to aid in carrying equipment and supplies down-slope. Use a square knot to avoid knot failure. Grab samples will need to be obtained downstream of the bridge.

SV-2

The SV-2 monitoring location is located just east of Phoenix Lake on Potato Ranch Road. SV-2 can be accessed by parking on the shoulder of Potato Ranch Road. If necessary, tie a piece of static rope or webbing of sufficient length to the bridge to aid in carrying equipment and supplies down-slope. Samples should be grabbed upstream of the bridge.

GV-1

GV-1 can be accessed by taking State Route 120 east past the town of Groveland. Just past the Groveland Wayside Park, proceed to the left on Ferretti Road. Continue on Ferretti Road for about one mile before taking a left on the Groveland Community Services District (CSD) access road. This access road proceeds over a bridge that crosses Garrotte Creek. Park at either end of the bridge and proceed to the upstream side at either end of the bridge.

MM-1

This monitoring location will be accessed by taking State Route 49 north towards New Melones Reservoir. Take a left onto Mormon Creek Road. Proceed to the first bridge and park on the shoulder. Sampling will take place upstream of the bridge along Mormon Creek. This location is readily accessible; however, use caution when descending down to the creek channel.

WD-1

The WD-1 monitoring location is accessed just south of Sonora Pass Road (Highway 108). At the intersection of Bell Money Road, proceed to the south approximately 700 feet to the Woods Creek Bridge and park on either side of the bridge. Sampling will take place upstream of the Woods Creek crossing. This location is readily accessible; however, use caution as the creek commonly flows over the roadway during significant rainfall events.

CT-1

The CT-1 monitoring location will be accessed from Lime Kiln Road. This location is approximately one mile south-southeast of Sonora. Sampling at this monitoring location will occur upstream of the bridge. This location is readily accessible; however, use caution when descending down to the creek channel.

2.2 SEDIMENT LOAD CHARACTERIZATION TASK

The following describes the QAPP for performing the Sediment Load Characterization Task of selected hillslopes and river channels in the Upper Stanislaus-Tuolumne River Hydrologic Units. Based on local drainage patterns, County land use patterns, and public comments, this work will be confined to the Sullivan Creek HA in the Upper Tuolumne River Hydrologic Unit (**Figure B-3**). To complete this task, ESA will complete a Hillslope and Channel Geomorphic Assessment to provide an indication of total sediment volume within the Sullivan Creek HA.

ESA's work will focus on broadly quantifying volume and extent of hillslope and streamside erosion and sediment delivery occurring in the watershed. This information will be used in estimating the relative proportion of sediment delivery from erosion, which is potentially controllable or preventable.

Data collection methods for this task primarily consist of (1) unit-wide, aerial photographic mapping and analysis; and (2) field mapping, data collection and analyses on selected portions of the hillslopes and stream channels in the Sullivan Creek HA. Both elements rely on sound professional judgment in identifying, measuring, and quantifying erosional features and sediment sources, and in determining whether the erosion is natural or associated with past land use activities in the watershed.

HILLSLOPE GEOMORPHIC UNITS

Hillslope Geomorphic Units (HGUs) are the basic unit for analysis of rates of erosion and sediment production rates to stream channels. The concept of HGUs assumes that hillslopes with similar characteristics will be dominated by similar erosional processes and similar mechanisms by which eroded material is delivered to stream channels. The development of HGUs serves as the basis for a sampling of hillslopes, to measure (through use of aerial photographs and field mapping) erosion and sediment production rates. Once determined, these rates can then be extrapolated to all areas in the larger watershed that fall within the same HGU. This work will be completed as additional grant funding becomes available.

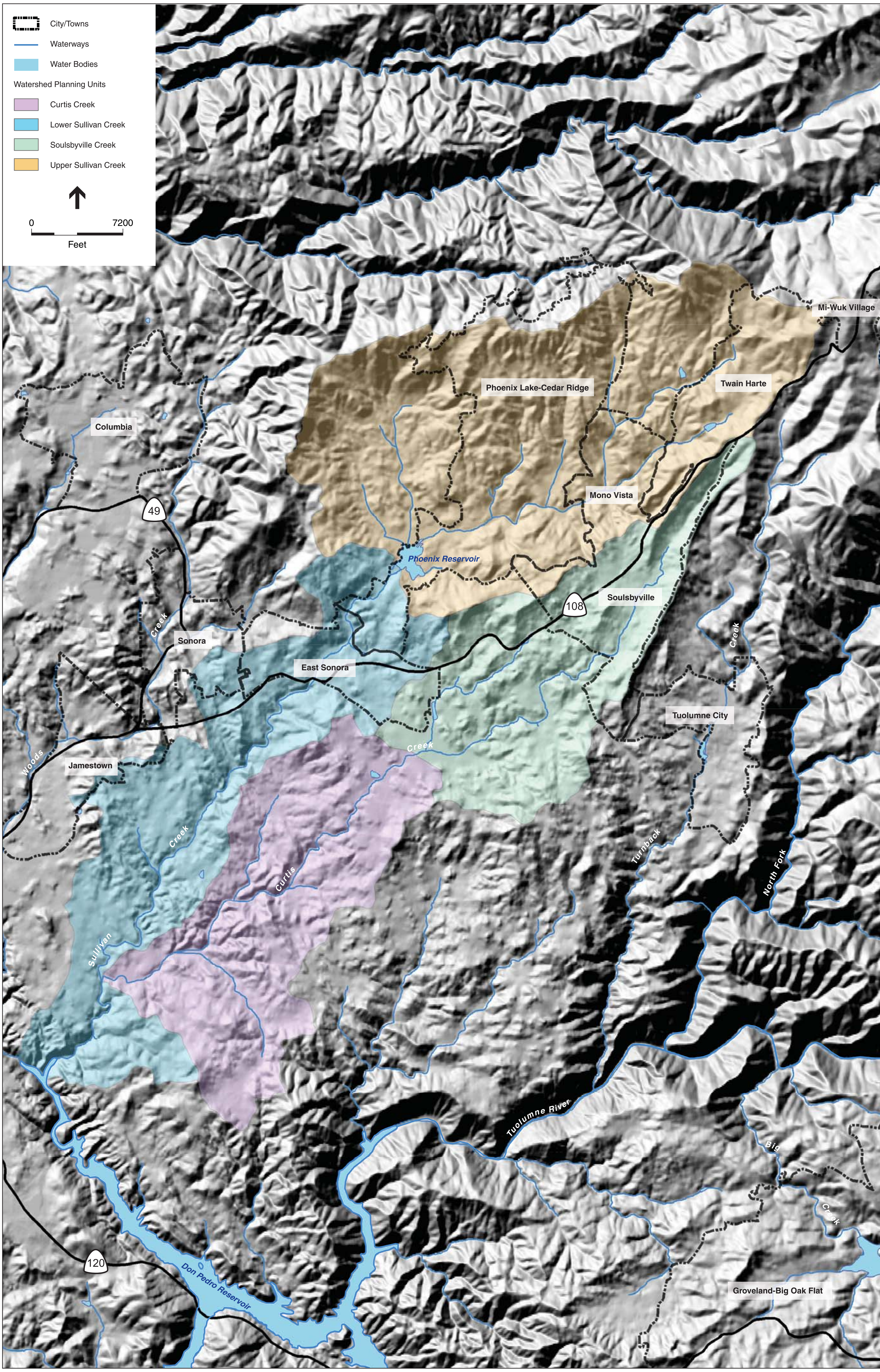
Development of the HGUs for the Sullivan Creek HA will be accomplished primarily through the use of existing GIS data. Possible data layers will include:

- Digital elevation model (DEM) (USGS)
- Soils (UC Cooperative Extension)
- Geology (California Geological Survey [CGS])
- Vegetation (NRCS, California Department of Forestry [CDF])
- Precipitation (National Oceanographic and Atmospheric Administration [NOAA])
- Land Use (County)

Because each HGU type will be defined as possessing a unique combination of attributes, it will be necessary to limit the number of layers that would be used in the definition. In addition, some "lumping" of attributes within a layer will be necessary to reduce the number of possible combinations. In the end, three primary layers will be used: the 10-meter DEM, geology (or soils)[2], and vegetation. The following describes how each of these layers will be used.

A 10-meter DEM will be used to calculate slope angles, expressed in terms of percent slope. The slope categories will then be generalized into areas of steeper and less steep terrain through the use of a "nearest neighbor" function of the GIS. With this function, the region (or "neighborhood") around each point on a 10-meter grid in the watershed will be examined to determine the steepness of all points in the neighborhood.

[2] The availability of a soils-vegetation layer for the project is uncertain. Soil/vegetation maps for Tuolumne County were produced by the Soil Conservation Service in 1968; and are currently being digitized and attributed for use in a GIS by the Tuolumne County Farm Advisor's Office.



SOURCE: USGS, 2003; and ESA, 2005

Figure B-3
Relief within the Sullivan Creek Sub-Watershed Unit

Several dozen geologic units are shown as polygons in geology maps prepared by the CGS for the County. These will be lumped into generalized categories with shared characteristics of resistance to erosion and grain size (e.g., quaternary deposits, etc.). This approach will be used unless soils data currently being developed by the UC Cooperative Extension becomes available for use in this project. The soil data are anticipated to provide a higher level of detail in terms of grain size and erodability. The vegetation layer includes many vegetation types converted into a grid file. These will be lumped into similar categories based on cover protection to reduce the number of possible HGUs.

Aerial Photograph Analysis

All aerial photograph interpretative work will be limited to digital aerial photography provided by the County. ESA will use this aerial coverage (ten-meter resolution) to identify larger sediment sources throughout the entire Sullivan Creek HA. Because this imagery is not available in stereo, its use in identifying small- to medium-sized features will be limited. A standard air photograph interpretation dataform will be used to record data on erosional or channel response (e.g., enlarged channels and open canopy reaches of stream) features. On each data form, included in Appendix C, the name of the analyst conducting the interpretation and the date will be indicated, as well as the reach name and the HGU unit where the feature is located. Each feature will then be transferred into an ArcGIS shape file (1:24,000 scale).

For each erosional feature, to the degree possible, the following information will be compiled:

1. Feature type: There are eight categories of features, including four types of landslides, as well as earthflows, rockfalls, and debris flows.

2. Feature certainty: This is the certainty of the analyst's interpretation of the feature type. It provides information necessary for field checking of sites.

3. Source dimensions: Average length, width, and depth of the feature on the aerial photo.

4. Deposition dimensions: Average length, width, and depth of the visible deposit area.

5. Hill slope gradient: Gradient (in percent) at the feature initiation point from topographic maps.

6. Aspect of the hillslope on which the feature is located.

7. Length of the stream affected by the feature, stream class, and stream type (e.g., perennial, ephemeral, etc.).

8. Delivery certainty: An interpretation of whether or not sediment was delivered to a stream.

9. Land use history at feature initiation point: A classification of the land use status at the point of failure and upslope of the point of failure, including a determination as to whether the feature is anthropogenic (i.e., whether it is road or management-related).

10. Approximate forest stand age: In forested areas, stand age classifications of less than 15 years old, 15 to 30 years, and greater than 30 years.

11. Activity: Estimation of the level of erosion activity for each feature (i.e., active, inactive, dormant).

For each channel response reach of stream, the following will be compiled:

1. Feature type that led to the channel response: There are five categories of features (rockfalls and topples are not included), including four types of landslides as well as debris flows.

2. Feature certainty: This is a subjective estimate of the certainty of interpretation of the feature type. It provides information necessary for field checking of sites.

3. Channel response dimensions: Average length, width, and depth of the disturbed reach of channel on the aerial photo.

4. Channel Geomorphic Unit (CGU) classification: Gradient and identification number.

Field Mapping and Analysis

Following the completion of the aerial photograph analysis of the Sullivan Creek HA, field work will begin (1) mapping of smaller sediment sources not readily identifiable on aerial photos; (2) allowing field verification of data collected on a portion of the features identified on air photographs (both erosional features and stream channel response reaches); and (3) sampling stream reaches by CGUs to quantify the volume of in-channel stored sediment by type. The procedures for identifying features, quantifying past erosion, sediment delivery and in-channel sediment storage volumes, and determining geomorphic and land-use associations are similar to those used for aerial photographs. However, for this approach, ESA will rely solely on field evidence, measurements, and interpretation.

The field mapping will be conducted in systematically selected plots; sampling size to be determined. Sample plots will then be selected within each HGU to serve as the representative plots for that HGU. Where access to a plot is not attainable, ESA will select another plot within the HGU. Within each plot, all sediment sources above 10 cubic meters will be cataloged, with the exception of larger features identified from the aerial photographs (to avoid double counting). This will include estimates for both road-related and non-road erosion including surface erosion, gullying, small mass wasting sites, stream bank erosion, and any other sources that are identified and measured during the field reconnaissance. Any larger features that occur within a sample HGU plot will be cross-checked to verify and refine data obtained from the aerial photographic interpretation.

Field measurements within each sample plot will focus on the following:

1. Feature type: In-stream channel stored sediment, landslides, gullies, bank erosion, and surface erosion.

2. Feature dimensions: Using a tape and/or rangefinder, dimensions will be quantified, and the depth of each feature will be estimated perpendicular to the hillslope.

3. Age of feature or deposit: Age will be estimated primarily utilizing vegetation as an indicator.

4. Hillslope gradient: Gradient will be measured with a clinometer.

5. Delivery percentage: The percent of eroded sediment delivered to the nearest stream channel will be estimated on the ground.

6. Land use and geomorphic associations: These will be determined using available physical evidence.

In addition to sampling plots, the team will complete limited field checking of the larger erosional features identified from aerial photographs. This field checking will be used to verify and refine information already gathered on feature type, dimensions, sediment delivery to stream channels, geomorphic association, and land use association. Field data collected will be recorded using datasheets contained in Appendix C.

Data Storage and Calculations

1. All data will be entered on a standard form using standardized abbreviations where appropriate.

2. Data on forms will be entered in an Excel spreadsheet. Data entry accuracy will be verified through random checks of entered forms.

3. All volume and sediment production calculations will be performed in Excel.

4. Volume of sediment delivered to streams per unit time will be calculated using the average length, width, and depth of each feature and the estimated sediment delivery percentage. Using GIS, volumes will be extrapolated over the area of the HGU to arrive at totals for the entire watershed for the time period examined. These results will be mapped. Data will also be presented in tabular format, by sub-HA, indicating erosion rates, land use association, and sediment delivery to stream channels for each feature type.

CHANNEL GEOMORPHIC ASSESSMENT

Valley segment morphology is useful for distinguishing dominant sediment transport processes (fluvial versus mass wasting), inferring general long-term sediment flux characteristics (transport- versus supply-limited), and providing insight into the spatial linkages that govern watershed response to disturbance (Montgomery and Buffington, 1998). However, depending on the extent of alluvial material, segments that appear functionally similar at the valley-scale may respond differently at the channel-scale to similar perturbations in sediment loading and discharge. Thus, to the extent possible, channel reach morphology will be used to verify or augment the description and characteristics of representative valley segments.

A protocol is presented here that will help to characterize the current status of channel and valley segments in terms of sediment movement (i.e., source area, transport area, response/accumulation area, etc.). Identification of response segments is of particular importance, as response segments are sensitive to increases in sediment supply and are thus excellent sites for monitoring the effects of upstream actions. The following definitions describe a channel survey protocol based on systematic quantitative and qualitative observations of channel conditions at a given survey reach. The survey data will be collected in homogenous reaches of not less than 5 bankfull width equivalents (i.e., if the channel has a bankfull width of five meters, the channel length surveyed will be at least 25 meters—see following page for a definition of bankfull). The CGU definitions will be based on average channel slope for drainage accumulation lines delineated on a 10-meter DEM (see Figure B-3). All field data for the Channel Geomorphic Assessment are contained in Appendix C.

Channel and Valley Characteristics

Floodplain characteristics, disturbance regimes, and obvious reach-scale sediment input processes will be characterized through observation and, where applicable, quantified to the degree feasible. Channel geometry will be characterized based on a scale cross-section sketch of a representative location in the channel, typically in a relatively straight portion of the channel with few obstructions (such as a run or riffle) where bankfull flow hydraulics are expected to be relatively uncomplicated.

Following is a description of the specific data to be collected and observations to be made. Except for channel slope and some floodplain characteristics and disturbance regimes distinguishable on aerial photographs, the data will be collected at the representative cross-section location as determined in the field. The term “bankfull flow” in this context corresponds to flow levels that occur at recurrence intervals of two years or less.

Floodplain Characteristics

Observations along a given channel reach or valley segment will be made to qualitatively assess (where applicable) the flood prone width, the characteristics of the floodplain, and the presence and extent of terrace formations. **Flood prone width** is typically defined as the width of the horizontal surface at an elevation twice the “bankfull” depth (Rosgen, 1994. Description of **floodplain** characteristics and extent will be based primarily on the observed distribution of vegetated floodplain that is occupied during periods of peak flows substantially greater than bankfull flow. Evidence indicating floodplain extent includes side-channels, strand lines, sediment deposits, and vegetation. The longitudinal continuity and presence or absence of an active flood plain will be assessed. In channels steeper than about four percent slope, the flood plain may consist of poorly sorted coarse sediment and debris laying in bars adjacent to the channel deposited during episodes of peak flow. Furthermore, the average **terrace height** (above the channel bottom) and longitudinal extent of terrace formations will be estimated and recorded. The relative positions of terraces are typically represented in a cross-section sketch of the valley in field notes.

Disturbance and Observed Sediment Input

The nature and extent of any observed **disturbance** and/or obvious sediment input processes will be recorded and, where possible, quantified to some extent (at the channel reach- or valley segment-scale). Sediment input to channels occurs either through discrete (episodic) processes, chronic processes, or the general process of soil creep (which may manifest in either a discrete or chronic manner). Significant anthropogenic disturbances could include logging, channel modification (i.e., rip-rap or levees), grading/excavation, vegetation modification, and road building. Fire, naturally or artificially induced, can also have a significant effect on sediment input and overall hillslope and channel condition. Such disturbances can significantly affect, or exacerbate, either discrete or chronic sediment input processes. Evidence of discrete sediment input processes (e.g., **mass wasting**) includes: landslide scars, debris flows, gullies, tree-throw, and bank erosion (driven primarily by gravitational forces); evidence of chronic sediment input processes includes: sheet erosion from hillslopes, ravel/road-cut erosion, and bank erosion (driven primarily by the shearing force of flow).

Cross Section and At-a-Station Geometry

Average Slope: Number is the average of field observations of channel slope expressed as a percent. Two slope observations will be collected using a clinometer for channels with slopes of two percent or more. In channels with slopes less than two percent, slope will be calculated as rise over run using a hand level and stadia rod to measure change in elevation, and a tape or hip chain to measure horizontal distance. One of the slope measurements will be collected at the cross-section location.

Maximum and Average Hillslope Angle: Number is the maximum and/or average observed hillslope angle measured in the field with a clinometer. The angle of both hillslopes will be recorded in a valley cross-section sketch in the field notes.

Channel Confinement: Confinement class is determined in the field using the "entrenchment ratio" (Rosgen, 1994). The ratio is calculated by dividing the flood prone width (defined as the horizontal surface at an elevation twice the "bankfull" depth as determined by field observations; not literally the top of the bank in most locations) by the bankfull channel width.

Bankfull Channel Width: Number is the measured width (in meters) of the "bankfull" channel, defined by high-water marks indicated by strand lines, fluvial sediment deposits, and the boundary formed by vegetation at the channel margin. This width is intended to approximate stream stage corresponding to "effective discharge" (Wolman and Miller, 1960). This width is often less than the width defined by a horizontal line connecting the tops of opposite banks. When a portion of the bankfull width of the channel contains riparian vegetation, the bankfull width is apportioned into "vegetated" and "active" components.

Bankfull Channel Depth: Number is the measured average depth (in meters) of flow at "bankfull" stage corresponding with field evidence defining bankfull width (i.e., "effective discharge") at the representative cross-section location. It is normally not equal to the top of the bank, which is often the elevation of the low terrace or flood plain.

Bedrock/Parent Material: Letters (and additional notes) represents the presence, absence, and extent of bedrock exposed in the channel bed and channel margins observed in the field. If other types of parent material are observed, this is noted. The key observation is exposure of nonalluvial material and the bedrock type, either a descriptive note (e.g., competent greenstone) or an abbreviation for the geologic formation, if known.

Channel Roughness Elements: Letters represent the channel elements that provide resistance to flow at bankfull stage in descending order of importance; the dominant element is listed first. If elements are equally influential, they are separated by a "/". These data are not ordinal.

Channel Type: Letters indicate the dominant and subdominant (or co-dominant) channel reach types (Montgomery and Buffington, 1997), and briefly described in the main text. Two types are often necessary to characterize the morphology of a given location.

Cross Section Stream Power Index

Indices of stream power are computed from field observations, and are used to help differentiate channels of like characteristics. Stream power indices to be used are defined below. These data are included in the protocol to emphasize that they are computed upon entry of field data.

SPI: The stream power index is the product of bankfull depth (in meters), bankfull width (in meters), and mean channel slope (percent), and is a quantitative index of total stream power.

Unit SPI: The unit stream power index is the product of bankfull depth (in meters) and mean channel slope (percent), and is a quantitative index of the average total shear stress for a given site.

Quantitative Survey Data-Gravel Bars and Sediment Size Distribution

Gravel Bars: Gravel bars will be counted to provide data on the abundance of sediment being actively routed and stored within the channel. Bars are recognized in the field by their topographic relief relative to the thalweg and the finer distribution of sediment on the bar surface relative to the framework sediment found in riffles and the thalweg. Bars represent an area of net sediment deposition over the long-term and are typically considered to be a response environment (i.e., good indicators of upstream changes or disturbance). Minimum bar size for this survey will be one horizontal dimension at least one bankfull width equivalent and the other horizontal dimension at least one-third bankfull width equivalent.

Surface Sediment Size Distribution: Surface sediment size will be characterized using systematic random methods (Bunte and Abt, 2001). Where maximum grain size is generally less than 128 millimeters (mm), a heel-toe sampling technique will be used. Where maximum grain size is generally greater than 128 mm, a grid system will be used with survey tapes to avoid sampling bias. One hundred point pebble counts will be conducted at two locations. One pebble count will be collected across the bankfull width at the cross-section survey site, and will span a distance of one bankfull width (one-half width above and below the cross-section site). The other pebble count will be collected on the surface of the downstream bar (subject to minimum size criteria as described above) nearest the cross-section site; an upstream bar may be utilized if no downstream bar is available. These pebble counts are expected to specify the median size for each location within 15 percent of the true median.

Sediment particles will be categorized according to the sieve mesh diameter upon which the particle would be captured by measuring the intermediate axis of the particle with a ruler. The minimum size discriminated for this survey will be eight mm; the diameter classes in millimeters will be 8, 11, 16, 22, 32, 45, 64, 90, 128, 180, 256, 360, 512, 720, 1024, etc.

QUALITY CONTROL

Quality control for the hillslope and channel geomorphic assessments will be achieved as follows:

1. A limited number of analysts will perform the assessment, ensuring consistency in applying methods, and in interpretation and judgment;

2. The field team will be led by a senior analyst with extensive experience;

3. All work will be supervised by a single individual, who will re-check approximately 10 percent of office and field measurements.

4. All completed work, both field and office, will be reviewed by the supervisor prior to entering data into the database.

DATA SYNTHESIS

The individual studies will be coordinated to avoid duplication, so that the results of one study may be related to another. For example, where sample HGU plots include stream channels, these channel reaches will also be sampled in the Channel Geomorphic Assessment. The data synthesis will also include overall trends and conditions in the Sullivan Creek HA. This information may be coupled with the examination of historic aerial photographs and the land use history to relate changes in land use and large storms to changes in stream conditions. This synthesis will be accomplished through discussions between team members on the results of their individual efforts, through the use of GIS and database analyses, and ultimately by the Project Manager, who will be responsible for the Final Project Report.

2.3 GEOGRAPHIC INFORMATION SYSTEMS

GIS technology is well-suited to support the assessment of the Upper Tuolumne-Stanislaus River Watersheds. In any project involving GIS, it is important to limit its use to those aspects of the project for which GIS adds value. For the County, there are three such areas:

- Obtaining and using data and findings that already exist in electronic form (e.g., USGS DEMs; digital orthophotos; land use);

- Planning field work, and recording field work findings; and

- Presenting results in the form of maps.

Obtaining existing data. ESA will obtain available data sets for the watershed from the USGS, NRCS, County, and other sources. Many of these are readily available in the public domain. ESA will use the State Plan (NAD 83), Zone 3 coordinate system for all GIS mapping; since the County currently maintains all of its data within this coordinate system.

Field work planning and data logging. ESA will review reports and electronic data as part of the process of focusing our field studies. The GIS will be used to print maps and overlays; detailed GIS analyses will not be part of this process. After field work is almost complete and data discrepancies have been corrected, the relevant data will be entered into the GIS in “shapefile” format for subsequent mapping and analysis.

Presenting results. GIS will be used to prepare several maps for the final report. ESA will plot maps of the entire watershed at scales of 1:24,000 and 1:62,500, providing good detail at a convenient size that is compatible with other resource maps. Detailed maps will be plotted at scales suitable for their subjects. All data used and/or generated during the project will be complied a on CD ROM of data layers, to the extent that the publishers of the data allow free distribution.

3.0 SAMPLING HANDLING AND CUSTODY

Once sample containers have been filled and labeled, they will be stored on blue ice for transport to CLS and AquaLab Laboratories. Table B-2 provides information on containers, volumes, initial preservation, and holding times for constituents to be sampled during Phase 1 of the MRP. Many of the constituents to be sampled cannot be kept in prolonged storage. Therefore, it is important that the samples are delivered to the laboratory on the same day that sampling occurs. Samples will be transported under chain-of-custody documentation (see Appendix B).

All samples will be handled, prepared, transported, and stored in a manner to minimize bulk loss, analyte loss, contamination, or biological degradation. Sample containers will be clearly labeled with an indelible marker. Where appropriate, samples may be frozen to prevent biological degradation. Water samples will be kept in Teflon™, glass, or polyethylene bottles; and kept cool at 4˚C until analyzed. Maximum holding times for specific analyses are listed in Table B-2.

TABLE B-2
SAMPLE HANDLING

Parameter	Container	Volume	Initial Preservation	Holding Time
Nitrate + Nitrite (NO_3 + NO_2)	polyethylene bottle	125 ml (one bottle)	Cool to 4°C, dark	48 hours at 4°C, dark
Total Suspended Solids (TSS)	1-Liter Poly	1,000 ml	Cool to 4°C, dark	7 days at 4°C, dark
Oil and Grease	1-liter glass jar with Teflon lid-liner	1,000 ml (one jar)	Add 2 ml concentrated sulfuric acid to pH <2; cool to 4°C, dark.	28 days at 4°C, dark

TABLE B-2
SAMPLE HANDLING

Parameter	Container	Volume	Initial Preservation	Holding Time
Dissolved Metals (except Dissolved Mercury)	500 ml Poly bottle		Cool to 4°C, dark. Acidify in lab after filtration w/ 0.45 micron filter, within 48 hrs, using pre-acidified container (ultra-pure nitric acid) for pH<2.	Once sample is acidified, can store up to 6 months at room temperature
Dissolved Mercury	250 ml glass bottle, pre-cleaned in lab using hydrochloric acid	250 ml (one bottle)	Acidify with pre-tested hydrochloric acid to 0.5%.	Once sample is acidified, can store up to 28 days at room temperature
Hardness	250 ml polyethylene	250 ml (one bottle)	Cool to 4°C, dark	Can store up to 6 months at room temperature
Volatile Organic Compounds (VOC's)	40 ml VOA vials	120 ml (three VOA vials)	All vials are pre-acidified (50% hydrochloric) at lab before sampling. Cool to 4°C, dark	14 days at 4°C, dark
Herbicides* (Chlorinated Herbicides)	1-L amber glass bottle, with Teflon lid-liner (per each sample type)	1,000 ml (one bottle) ***Each sample type requires 1,000 ml in a separate container**	Cool to 4°C, dark If chlorine is present, add 0.1g sodium thiosulfate	Keep at 4°C, dark, up to 7 days. Extraction must be performed within the 7 days
Fecal and Total Coliform Bacteria	Factory-sealed, pre-sterilized, disposable Whirl-Pak® bags or 125 ml sterile high density polyethylene or polypropylene bottle	100 ml volume sufficient for both fecal and total coliform analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4°C; dark.	STAT: 6 hours at 4°C, dark; lab must be notified well in advance

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

A sample is considered under custody if:

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

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

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

Sampling personnel will have the sample receiving clerk at the laboratory sign the chain- of-custody form with date and time of receipt. A copy will be kept to complete the chain of custody in the project files. Sample results will be requested with a 10-day turnaround. With the exception of bacteriological analysis, all samples requiring analytical analysis will be delivered to California Laboratory Services, Inc. (CLS), a California-certified facility. CLS's sample receiving address and telephone and fax numbers are provided below:

California Laboratory Services, Inc
3249 Fitzgerald Road
Rancho Cordova, CA 95742
Contact: Mark Smith
Telephone: (916) 638-7301,
Fax: (916) 638-4510

To ensure bacteria samples are delivered within the six-hour holding time, bacteriological analysis will be performed by AquaLab, located in the town of Twain Hart. AquaLab's sample receiving address and telephone and fax numbers are provided below:

AquaLab
1843 Fir Drive
Twain Harte, CA 95383.
Contact: Catherine Behee
Telephone: (209) 586-3400

It should also be noted that other analytical laboratories may be used throughout Phase 2 of the MRP. These laboratories will be required to satisfy the target reporting limits identified in Table B-3.

4.0 ANALYTICAL METHODS

This section provides reference to the analytical procedures, including field measurements and laboratory analyses that will be used for the project. Table B-3 provides analytical procedures for each sampling constituent proposed under the project in addition to target reporting limits for each analyte.

TABLE B-3
FIELD AND LABORATORY ANALYTICAL METHODS

Analyte	Matrix	Reporting Units	Analytical Method	Target Reporting Limit (TRL)
General Water Constituents				
Nitrate (as N)	water	mg/L	EPA 300.0A	0.500
Oil and Grease (HEM)	water	mg/L	EPA 1664A SM 5520 B	5.0
Fecal Coliforms	water	MPN/100 mL	SM 9221E (25-tube dilution)	2
Total Coliforms	water	MPN/100 mL	SM 9221B (25-tube dilution)	2
Total Hardness (as CaCO3)	water	mg/L	EPA 200.7 EPA 130.1-2 SM 2340C	1
Total Suspended Solids	water	mg/L	EPA 160.2 SM 2540D APHA 1997	5.0
Trace Metals				
Arsenic	water (salinity >0.5 ‰)	•g/L	EPA 200.8	1.0
Cadmium	water	•g/L	EPA 200.8	0.25
Chromium	water	•g/L	EPA 200.8	2.0
Copper	water	•g/L	EPA 200.8,	0.5
Lead	water	•g/L	EPA 200.8	0.5
Mercury	water (low level, parts per trillion)	ng/L (ppt)	EPA 1631	0.5
Nickel	water	µg/L	EPA 200.8	5.0
Selenium	water (salinity >0.5 ‰)	µg/L	EPA 200.8	5.0
Silver	Water	µg/L	EPA 200.8	1.0
Zinc	Water	µg/L	EPA 200.8	10.0
VOCs				
1,1-Dichloroethane	water	•g/L	EPA 8260B	1.0
1,1-Dichloroethene	water	•g/L	EPA 8260B	0.5
1,1,1-Trichloroethane	water	•g/L	EPA 8260B	2.0
1,1,2-Trichloroethane	water	•g/L	EPA 8260B	0.5
1,1,2,2-Tetrachloroethane	water	•g/L	EPA 8260B	0.5
1,2-Dichlorobenzene	water	•g/L	EPA 8260B	2.0
1,2-Dichloroethane	water	•g/L	EPA 8260B	0.5
cis-1,2-Dichloroethene	water	•g/L	EPA 8260B	0.5
1,2-Dichloropropane	water	•g/L	EPA 8260B	0.5
1,2,4-Trichlorobenzene	water	•g/L	EPA 8260B	5.0

TABLE B-3
FIELD AND LABORATORY ANALYTICAL METHODS

Analyte	Matrix	Reporting Units	Analytical Method	Target Reporting Limit (TRL)
1,3-Dichlorobenzene	water	•g/L	EPA 8260B	2.0
1,3-Dichloropropene	water	•g/L	EPA 8260B	0.5
1,4-Dichlorobenzene	water	•g/L	EPA 8260B	2.0
Benzene	water	•g/L	EPA 8260B	0.5
Bromoform	water	•g/L	EPA 8260B	2.0
Bromomethane	water	•g/L	EPA 8260B	2.0
Carbon tetrachloride	water	•g/L	EPA 8260B	0.5
Chlorobenzene (mono chlorobenzene)	water	•g/L	EPA 8260B	2.0
Chloroethane	water	•g/L	EPA 8260B	2.0
Chloroform	water	•g/L	EPA 8260B	0.5
Chloromethane	water	•g/L	EPA 8260B	2.0
Dibromochloromethane	water	•g/L	EPA 8260B	0.5
Dichlorobromomethane	water	•g/L	EPA 8260B	0.5
Dichloromethane	water	•g/L	EPA 8260B	2.0
Ethylbenzene	water	•g/L	EPA 8260B	2.0
Hexachlorobutadiene	water	•g/L	EPA 8260B	1.0
Naphthalene	water	•g/L	EPA 8260B	10.0
Tetrachloroethene	water	•g/L	EPA 8260B	0.5
Toluene	water	•g/L	EPA 8260B	2.0
trans-1,2-Dichloroethylene	water	•g/L	EPA 8260B	1.0
Trichloroethene	water	•g/L	EPA 8260B	2.0
Vinyl chloride	water	•g/L	EPA 8260B	0.5
Methyl-tert-butyl ether (MTBE)	water	•g/L	EPA 8260B	3.0
Trichlorofluoromethane	water	•g/L	EPA 8260B	5.0
1,1,2-Trichloro-1,2,2-Trifluoroethane	water	•g/L	EPA 8260B	10.0
Styrene	water	•g/L	EPA 8260B	0.5
Xylenes	water	•g/L	EPA 8260B	0.5
Herbicides				
Bentazon	water	•g/L	EPA 8151A	2.0
2,4-D	water	•g/L	EPA 8151A	10.0
Dalapon	water	•g/L	EPA 8151A	10.0
Dinoseb	water	•g/L	EPA 8151A	2.0
Picloram	water	•g/L	EPA 8151A	1.0
2,4,5-TP (Silvex)	water	•g/L	EPA 8151A	1.0
Pentachlorophenol	water	•g/L	EPA 8151A	1.0

(*) *Standard Methods for the Examination of Water and Wastewater*, 20th edition.

Source: SWAMP-Compatible Quality Assurance Project Plans, SWRCB, 2004., CLS, 2005

mg/L = milligram per liter
•g/L = microgram per liter
mL = milliliter
MPN = most probable number
ng/L = nanograms per liter
ppt = parts per trillion

5.0 QUALITY CONTROL

5.1 QUALITY CONTROL

The need for environmental data of known quality necessitates the implementation of stringent quality control protocols. The use of blanks and replicates, as well as strict attention to calibration and field procedures, are essential for producing meaningful data that have known uncertainties associated with them. In addition to the use of formal quality control measures, sampling personnel must be careful, methodical, and thoughtful when carrying out field and/or laboratory procedures. The quality of the data is more important than the speed with which the data are obtained. Specific quality control measures to be implemented include:

Sample Collection. During sample collection, sampling personnel will always wear clean rubber gloves. With the exception of oil and grease samples, sample containers that are not pre-preserved will be pre-rinsed with sample water prior to filling. Foreign matter will be kept out of sample container and off the sample lid.

Field Instruments. Field instruments used for measuring specific conductance, pH, dissolved oxygen, temperature, and turbidity will be kept clean and calibrated prior to field work. If the probes have already been used, they will be rinsed in copious amounts of deionized water and dried with clean Kimwipes or air dried. Field instruments will be tested upon return from the field to verify meter calibration. In the event of abnormal conditions or operational questions, equipment manuals will be consulted.

Field Duplicates. Field duplicates will be collected for all constituents at a minimum of one monitoring event per year. The duplicates will be collected in sequence as rapidly as possible. A duplicate sample will be denoted by "dup" at the end of the sample identification number (e.g., for a sample labeled R-1, the duplicate would be labeled R-1 dup). Both samples will be handled identically and transported to the laboratory under chain-of-custody documentation.

Results from field duplicates will be recorded and reported in quarterly progress reports.

In addition to the quality control measures taken by ESA, the County, and volunteer monitors, analytical laboratories utilized for this MRP also will implement quality control measures, such as laboratory duplicates. These quality control measures will measure the precision and accuracy of the analytical methods and instrumentation.

5.2 QUALITY ASSURANCE

Quality assurance ensures that quality control measures are properly implemented. The following quality assurance tasks will be completed:

- All staff involved with the project will familiarize themselves with the monitoring program and quality control practices in place, including this document.

- At least once every six months, the Project Manager will accompany field staff on monitoring runs to ensure that all quality control tasks are properly implemented.
- The Project Manager and/or Project Director will review reports prior to submission for accuracy and possible errors, including reviewing and assessing quality control data (e.g., field duplicates and laboratory quality assurance data).

6.0 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Each team member involved in the Assessment will be responsible for the equipment they will be using in the field. Equipment requiring maintenance will include the following:

- Sampling pole, flexible nylon measuring tape, spiral-bound Rite-in-the-Rain notebook, stopwatch for discharge measurements;
- Compass;
- Clinometer;
- Calculator;
- Hand-held global positioning system (GPS) unit;
- Digital camera;
- Fiberglass or steel tape;
- Yellow Springs Instrument (YSI) model 556 meter (dissolved oxygen, temperature, specific conductance, total dissolved solids [TDS], pH)
- YSI Model 62 (pH, conductivity, specific conductance, and temperature)
- Hach 2100P Turbidity meter;
- Lamotte 2020 turbidity meter;
- Global Water FP201 flow meter

All equipment will be visually inspected for broken or missing parts, and will be tested prior to commencement of fieldwork. Where applicable, batteries will be tested or replaced prior to commencement of fieldwork. Maintenance will be performed in accordance with manufacturers' recommendations or more frequently, if problems are identified.

7.0 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Immediately before use in the field, field instruments will be calibrated against known standards. Conductivity meters cannot be directly calibrated; however a calibration curve has been established by plotting known conductivity standards against device readings. Correction factors are then derived from a chart. The devices are checked by analyzing a conductivity standard and determining if, after correction, the reading agrees with the stated accuracy criteria cited in Table A-3.

There are no calibration procedures for bacterial testing.

CLS Labs and AquaLab are certified by the California Department of Health Services, and accredited by the Environmental Laboratory Accreditation Program (ELAP). The ESA QA Officer has reviewed both Labs' QA/QC procedures and finds them to be in conformance with project objectives.

8.0 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The inspection of equipment will occur as a pre-sampling check prior to use or as indicated by an exceeded QC limit. Maintenance will be performed in accordance with manufacturers' recommendations or more frequently, if problems are identified by QC checks.

9.0 NON-DIRECT MEASUREMENTS

9.1 PRODUCE ASSESSMENT REPORT

The Assessment report will include a section in which ESA's background research and field investigations (e.g., geomorphic and riparian habitat assessments, water quality monitoring) will be synthesized into a meaningful whole. This information is complied in **Table B-4**. The primary organizing principal for this synthesis will be the prioritization of the two watersheds for further study and, to the extent feasible, water quality and riparian habitat improvement projects.

TABLE B-4
PRELIMINARY LIST OF SOURCE MATERIALS

Source	Date	Prepared
Assessing Cumulative Watershed Effects in the Central Sierra Nevada: Hillslope Measurements and Catchment-scale Modeling	2004	Lee H. MacDonald, Drew Coe, and Sandra Litschert Department of Forest, Range, and Watershed Stewardship
Attributes of Bedrock Sierra Nevada River Ecosystems	January 2004	Stream Systems Technology Center Rocky Mountain Research Station by Scott McBain and Bill Trush
Pollutants Controlled Calculation and Documentation For Section 319 Watersheds Training Manual	Revised June 1999	Michigan Department of Environmental Quality Water Division Nonpoint Source Unit
Hazard Assessment of the Insecticide Diazinon to Aquatic Organism in the Sacramento – San Joaquin River Systems	1994	California Department of Fish and Game
Monitoring Landcover Changes in California Southern Sierra Nevada Project Area	March 1999	US Forest Service and California Department of Forestry Cooperative Change Detection Program
A Classification of Natural Rivers	1994.	D. L. Rosgen
Waste Discharge Requirements Order No. R5R5-2002-0142 Big Oak Flat (Groveland) Municipal Solid Waste Landfill Tuolumne County	2002	Central Valley Regional Water Quality Control Board

TABLE B-4
PRELIMINARY LIST OF SOURCE MATERIALS

Source	Date	Prepared
Monitoring and Reporting Program No. R5-2002-0202 Tuolumne Utilities District Wastewater Reclamation System Tuolumne County	2002	Central Valley Regional Water Quality Control Board
Best Management Practices Evaluation Program 1992–2002 Monitoring Results	November /2004	US Forest Service, Pacific Southwest Region
Stanislaus National Forest Fire Management Plan	January 2004	Stanislaus Forest Service
Urban Water Management Plan 2000 Update	July 2001	Kennedy/Jenks Consultants
Analytical Data for Waters of the Harvard Open Pit, Jamestown Mine, Tuolumne County, California,	March 1998 – September 1999	U.S Geological Survey by R.P. Ashley and K.S. Savage
2004 Annual Report and Update on Watershed Control Program and Sanitary Survey for the Hetch Hetch Water Supply	12/2004	San Francisco Public Utilities Commission
Central Stanislaus Watershed Analysis	June 2002	United States Department of Agriculture
Tuolumne County General Plan		Tuolumne County Community Development Department
Tuolumne Wild and Scenic River Management Plan	April 2002	United States Department of Agriculture Stanislaus National Forest
Tuolumne County Groundwater Protection Grant Final Report	1999	Tuolumne County
Sierra Nevada Ecosystem Project: Final Report to Congress, vol. II, Assessments and Scientific basis for management options	1996	University of California - Davis, Centers for Water and Wildland Resources
Tri-Dam Project Beardsley/Donnells Project FERC Project No. 2005	December 2002	Tri-Dam
Spring Gap Stanislaus Project FERC Project No. 2130	December 2002	Pacific Gas and Electric Company

The report will identify those tributary subbasins and mainstem reaches that currently exhibit impaired water quality (high priority) based on monitoring results and background research. This section of the report will also summarize conditions throughout the watershed, focusing on factors or conditions that are influencing water quality (e.g., high sediment).

ESA will prepare a single document and accompanying large format maps that include all of the report components. The report will include an executive summary and technical appendices. ESA anticipates one meeting with project management to discuss the draft report, and assumes that only one set of consolidated written comments will be received. ESA will respond to the written comments and comments received at the meeting, and produce the final watershed assessment report.

9.2 WATER QUALITY PLAN

The Water Quality Plan (WQP) will be developed to focus on water quality issues determined to be problematic in the Assessment report and provide guidance on sustaining higher quality surface waters. The WQP will include suggested BMPs and apply them to specific discretionary and ministerial actions utilized by the County to further reduce impacts to water quality throughout the County, consistent with the goals of the County's General Plan. The WQP will include an approach, adopted from the MRP, to monitor BMP effectiveness and modify where appropriate. The WQP will be tailored to the rural Sierra foothills for the control of nonpoint source pollution and will focus on storm water runoff from urbanized areas, septic systems, grading, vegetation modification, public works projects, marinas and recreational boating, hydromodification activities, mining runoff, certain agricultural practices, and County discretionary forestry practices. "California's Management Measures for Polluted Runoff (CAMMR)" will be used as the initial guide for developing best management practices to be included in the WQP. The measures to be included in the WQP must be cost-effective and developed with input from local stakeholders.

The WQP will also provide the initial framework for developing a County-wide Stormwater Management Plan, which is required to comply with USEPA's Phase II of the National Pollution Discharge Elimination System (NPDES) program. The Phase II regulations require municipalities and contiguous areas with smaller, but still urban, communities to develop and implement stormwater management programs. This process requires the County to implement BMPs that reduce pollutants in stormwater to the "maximum extent practicable" (MEP). The MEP is generally a result of emphasizing pollution prevention and source control BMPs as the first lines of defense in combination with treatment methods serving as additional lines of defense, where appropriate.

10.0 DATA MANAGEMENT

All data will be kept in electronic and hard copies that are readily available and easy to understand. To prevent accidental data loss, data will be entered into spreadsheets or databases as soon as feasible upon receipt of electronic submissions from the laboratory. However, all laboratory data will be treated as preliminary until the hard copy laboratory results have been received, and verified against these final results. Final data will be entered into a master database, which will be linked to a GIS, and maintained by ESA and, in the future, by the County following the conclusion of ESA's scope of services.

SECTION C

ASSESSMENT AND OVERSIGHT ELEMENTS

1.0 ASSESSMENT AND RESPONSE ACTIONS

Review and assessment of all field and data activities will be the responsibility of the task leaders and the Project Manager. All field crews will include or be supervised by senior project personnel. Any problems encountered with understanding or application of methods, data consistency, or data completeness will immediately be brought to the attention of the ESA and County Project Managers, and if necessary, the WQC. Any such problems will be resolved before continuing with data collection or analysis.

2.0 REPORTS

The ESA Project Manager will provide monthly correspondence to the County Project Manager on project progress, problems encountered, solutions to problems, and next steps. The SWRCB will review and ultimately approve this QAPP and the draft Assessment Report. Raw data, spreadsheets, etc., used in data collection and analyses will be made available to the SWRCB and the WQC upon their request.

SECTION D

DATA VALIDATION AND USABILITY ELEMENTS

1.0 DATA REVIEW, VALIDATION, AND VERIFICATION

Data sheets will be reviewed at the end of each field day by field crew leaders or supervisors and weekly by the County and/or ESA Project Managers, to determine if the data meet the QAPP objectives. Project and QA Managers will identify outliers, spurious results, or omissions to the field crews. They will also evaluate compliance with the data quality objectives, and if necessary implement corrective action. Any problems encountered, and solutions to the problems, will be reported in the Final Project Report.

2.0 VALIDATION AND VERIFICATION METHODS

Data will be validated and verified through review by the ESA Project and QA Managers, as described above. Any problems encountered may result in re-sampling or rejection of some samples.

3.0 RECONCILIATION WITH USER REQUIREMENTS

Ultimately, the determination of the consistency of the data with project objectives will be made by the County Project and QA Managers. This determination will be described in the Final Project Report, and will be reviewed by the WQC.

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APPENDIX A

Water Quality Objectives

Recommended Numerical Limits to Apply Water Quality Objectives

based on *A Compilation of Water Quality Goals*, California Regional Water Quality Control Board, Central Valley Region

(Numerical Objectives from the applicable Basin Plan also apply)

Constituent / Parameter (Synonym)	Water Quality Objective or Promulgated Criterion	Recommended Numerical Limit(s) Source / Averaging Period	Limit	Units	G = Groundwater IS = Inland Surface Water
Acenaphthene	Tastes and Odors	USEPA National Ambient W Q Criteria / taste & odor	20	ug/L	G & IS
	Toxicity - humans (a)	USEPA IRIS Reference Dose (c)	420	ug/L	G
	Toxicity - aquatic life	USEPA National Water Quality Aquatic Toxicity Information	520	ug/L	IS
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	1200	ug/L	IS
Acenaphthylene	No criteria in database. Toxicity and other properties should be similar to acenaphthene due to similar structure.				
Acetone	Tastes and Odors	Odor threshold (Amoore and Hautala)	20,000	ug/L	G & IS
	Toxicity - humans	USEPA IRIS Reference Dose (c)	6300	ug/L	G & IS
Acrolein	Tastes and Odors	Odor threshold (Amoore and Hautala)	110	ug/L	G & IS
	Toxicity - humans (a)	USEPA IRIS Reference Dose (c)	3.5	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	21	ug/L	IS
		USEPA National Ambient W Q Criteria / acute tox info	68	ug/L	IS
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	320	ug/L	IS
Alachlor	Chemical Constituents	California Primary MCL	2	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	4	ug/L	G & IS
	Toxicity - aquatic life	USEPA Water Quality Advisory / Instantandous maximum	76	ug/L	IS
Aldrin	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.0021	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.00013	ug/L	IS
	CTR - aquatic life	California Toxics Rule (USEPA) / instantaneous maximum	3	ug/L	IS
Aluminum	Chemical Constituents	California Primary MCL	1000	ug/L	G & IS
		California Secondary MCL	200	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	5000	ug/L	G & IS
	Tastes and Odors	California Secondary MCL	200	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	600	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Recomm. W Q Criteria / 4-day avg (total) (f)	87	ug/L	IS
		USEPA National Recomm. W Q Criteria / 1-hour avg (total) (f)	750	ug/L	IS
Ammonia (Ammonium)	Tastes and Odors	Odor threshold (Amoore and Hautala)	1500	ug/L	G & IS
	Toxicity - humans	USEPA Draft Health Advisory	30,000	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Ambient Water Quality Criteria	see Page 17 tab		IS
Anthracene	Toxicity - humans (a)	USEPA IRIS Reference Dose (c)	2100	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	9600	ug/L	IS
Antimony	Chemical Constituents	California Primary MCL	6	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	20	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	14	ug/L	IS
	Toxicity - aquatic life	USEPA National Water Quality Aquatic Toxicity Information	610	ug/L	IS
Arsenic	Chemical Constituents	California Primary MCL	50	ug/L	G & IS
		USEPA Primary MCL	10	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	100	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	0.004	ug/L	G & IS
	CTR - aquatic life	Californa Toxics Rule (USEPA) / 4-day average (dissolved)	150	ug/L	IS
		Californa Toxics Rule (USEPA) / 1-hour average (dissolved)	340	ug/L	IS
Asbestos	Chemical Constituents	California Primary MCL	7	MFL	G & IS
	Toxicity - humans (a)	USEPA Drinking Water Health Advisory	7	MFL	G
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	7	MFL	IS
Atrazine	Chemical Constituents	California Primary MCL	1	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	0.15	ug/L	G & IS
	Toxicity - aquatic life	USEPA Draft National Ambient Water Quality Criteria (h)	1500	ug/L	IS
Barium	Chemical Constituents	California Primary MCL	1000	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	2000	ug/L	G & IS
Benzene	Chemical Constituents	California Primary MCL	1	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	170	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.15	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	1.2	ug/L	IS
Benz(a)anthracene	Toxicity - humans (a)	California Public Health Goal for benzo(a)pyrene & OEHHA PEFs	0.04	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.0044	ug/L	IS
Benzo(a)pyrene	Chemical Constituents	California Primary MCL	0.2	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.004	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.0044	ug/L	IS
Benzo(b)fluoranthene	Toxicity - humans (a)	California Public Health Goal for benzo(a)pyrene & OEHHA PEFs	0.04	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.0044	ug/L	IS
Benzo(k)fluoranthene	Toxicity - humans (a)	California Public Health Goal for benzo(a)pyrene & OEHHA PEFs	0.04	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.0044	ug/L	IS
Benzo(g,h,i)perylene	No criteria in database.				
Beryllium	Chemical Constituents	California Primary MCL	4	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	100	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	1	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Water Quality Toxicity Information	5.3	ug/L	IS
alpha-BHC (alpha-Benzene hexachloride)	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.013	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.0039	ug/L	IS
beta-BHC (beta-Benzene hexachloride)	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.023	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.014	ug/L	IS

Recommended Numerical Limits to Apply Water Quality Objectives

based on *A Compilation of Water Quality Goals*, California Regional Water Quality Control Board, Central Valley Region

(Numerical Objectives from the applicable Basin Plan also apply)

Constituent / Parameter (Synonym)	Water Quality Objective or Promulgated Criterion	Recommended Numerical Limit(s) Source / Averaging Period	Limit	Units	G = Groundwater IS = Inland Surface Water
gamma-BHC	Chemical Constituents	California Primary MCL	0.2	ug/L	G & IS
(gamma-Benzene hexachloride)	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.032	ug/L	G
(Lindane)	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / 4-day average	0.08	ug/L	IS
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.019	ug/L	IS
	CTR - aquatic life	California Toxics Rule (USEPA) / 1-hour average (total)	0.95	ug/L	IS
technical-BHC (technical-Benzene hexachloride) (mixture of BHC isomers)	Toxicity - humans	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.0088	ug/L	G & IS
Boron	Chemical Constituents	Water Quality for Agriculture (Ayers & Westcot)	700	ug/L	G & IS
	Toxicity - humans	California DHS Action Level for drinking water	1000	ug/L	G & IS
Bromacil	Toxicity - humans	USEPA Drinking Water Health Advisory - non-cancer	90	ug/L	G & IS
Bromodichloromethane	Chemical Constituents	California Primary MCL (total trihalomethanes)	100	ug/L	G & IS
		USEPA Primary MCL (total trihalomethanes)	80	ug/L	G & IS
	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.27	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.56	ug/L	IS
Bromoform	Chemical Constituents	California Primary MCL (total trihalomethanes)	100	ug/L	G & IS
		USEPA Primary MCL (total trihalomethanes)	80	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	510	ug/L	G & IS
	Toxicity - humans (a)	USEPA IRIS Cancer Risk Level	4	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	4.3	ug/L	IS
tert-Butyl alcohol	Tastes and Odors	Odor threshold (Amoore and Hautala)	290,000	ug/L	G & IS
(TBA)	Toxicity - humans	California DHS Action Level for drinking water	12	ug/L	G & IS
n-Butylbenzene	Toxicity - humans	California DHS Action Level for drinking water	260	ug/L	G & IS
sec-Butylbenzene	Toxicity - humans	California DHS Action Level for drinking water	260	ug/L	G & IS
tert-Butylbenzene	Toxicity - humans	California DHS Action Level for drinking water	260	ug/L	G & IS
Cadmium	Chemical Constituents	California Primary MCL	5	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	10	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	0.07	ug/L	G & IS
	CTR - aquatic life	Californa Toxics Rule (USEPA)	see Page 19 tab		IS
Carbaryl	Toxicity - humans	California DHS Action Level for drinking water	700	ug/L	G & IS
(Sevin)	Toxicity - aquatic life	California Dept of Fish & Game W Q Criteria / 4-day average	2.53	ug/L	IS
		California Dept of Fish & Game W Q Criteria / 1-hour average	2.53	ug/L	IS
Carbon tetrachloride	Chemical Constituents	California Primary MCL	0.5	ug/L	G & IS
	Tastes and Odors	Taste & Odor Threshold (USEPA)	520	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.1	ug/L	G
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	0.25	ug/L	IS
Chlordane	Chemical Constituents	California Primary MCL	0.1	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.03	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.00057	ug/L	IS
	CTR - aquatic life	Californa Toxics Rule (USEPA) / 4-day average (total)	0.0043	ug/L	IS
		California Toxics Rule (USEPA) / instantaneous maximum	2.4	ug/L	IS
Chloride	Chemical Constituents	California Secondary MCL	250,000	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	106,000	ug/L	G & IS
	Tastes and Odors	California Secondary MCL	250,000	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / 4-day average	230,000	ug/L	IS
		USEPA National Ambient W Q Criteria / 1-hour average	860,000	ug/L	IS
Chlorobenzene	Chemical Constituents	California Primary MCL	70	ug/L	G & IS
	Tastes and Odors	USEPA National Ambient W Q Criteria / taste & odor	20	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	200	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / toxicity info	50	ug/L	IS
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	680	ug/L	IS
Chloroethane	Tastes and Odors	Odor threshold (Amoore and Hautala)	16	ug/L	G & IS
Chloroform	Chemical Constituents	California Primary MCL (total trihalomethanes)	100	ug/L	G & IS
		USEPA Primary MCL (total trihalomethanes)	80	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	2,400	ug/L	G & IS
	Toxicity - humans	Cal/EPA Cancer Potency Factor as a drinking water level (b)	1.1	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic toxicity info	1,240	ug/L	IS
Chloromethane	Toxicity - humans	USEPA Drinking Water Health Advisory - non-cancer	3	ug/L	G & IS
Chlorpyrifos	Toxicity - humans	USEPA IRIS Reference Dose (c)	21	ug/L	G & IS
	Toxicity - aquatic life	California Dept of Fish & Game W Q Criteria / 4-day average	0.014	ug/L	IS
		California Dept of Fish & Game W Q Criteria / 1-hour average	0.02	ug/L	IS
Chromium (III)	Chemical Constituents	California Primary MCL	see Cr (total)		G & IS
	Toxicity - humans	USEPA IRIS Reference Dose (c)	10,500	ug/L	G & IS
	NTR - aquatic life	National Toxics Rule (USEPA)	see Page 21 tab		IS
Chromium (VI)	Chemical Constituents	California Primary MCL	see Cr (total)		G & IS
		Water Quality for Agriculture (Ayers & Westcot)	100	ug/L	G & IS
	Toxicity - humans	USEPA IRIS Reference Dose (c)	21	ug/L	G & IS
	CTR - aquatic life	Californa Toxics Rule (USEPA) / 4-day average (dissolved)	11	ug/L	IS
		Californa Toxics Rule (USEPA) / 1-hour average (dissolved)	16	ug/L	IS
Chromium (total)	Chemical Constituents	California Primary MCL	50	ug/L	G & IS
Chrysene	Toxicity - humans (a)	California Public Health Goal for benzo(a)pyrene & OEHHA PEFs	0.4	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.0044	ug/L	IS
Cobalt	Chemical Constituents	Water Quality for Agriculture (Ayers & Westcot)	50	ug/L	G & IS

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(Numerical Objectives from the applicable Basin Plan also apply)

Constituent / Parameter (Synonym)	Water Quality Objective or Promulgated Criterion	Recommended Numerical Limit(s) Source / Averaging Period	Limit	Units	G = Groundwater IS = Inland Surface Water
Copper	Chemical Constituents	California Primary MCL	1300	ug/L	G & IS
		California Secondary MCL	1000	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	200	ug/L	G & IS
	Tastes and Odors	California Secondary MCL	1000	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	170	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	1300	ug/L	IS
	CTR - aquatic life	Californa Toxics Rule (USEPA)	see Page 23 tab		IS
Cumene (Isopropylbenzene)	Tastes and Odors	Odor threshold (Amoore and Hautala)	0.8	ug/L	G & IS
	Toxicity - humans	California DHS Action Level for drinking water	770	ug/L	G & IS
Cyanide	Chemical Constituents	California Primary MCL	150	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	170	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	150	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	700	ug/L	IS
	NTR - aquatic life	National Toxics Rule (USEPA) / 4-day average (total)	5.2	ug/L	IS
		National Toxics Rule (USEPA) / 1-hour average (total)	22	ug/L	IS
Dalapon	Chemical Constituents	California Primary MCL	200	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	790	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / Inst Maximum	110	ug/L	IS
DDD	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.15	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.00083	ug/L	IS
DDE	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.1	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.00059	ug/L	IS
DDT	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.1	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.00059	ug/L	IS
	CTR - aquatic life	California Toxics Rule (USEPA) / 4-day average (total)	0.001	ug/L	IS
		California Toxics Rule (USEPA) / instantaneous maximum	1.1	ug/L	IS
Diazinon	Toxicity - humans	California DHS Action Level for drinking water	6	ug/L	G & IS
	Toxicity - aquatic life	California Dept of Fish & Game W Q Criteria / 4-day average	0.05	ug/L	IS
		California Dept of Fish & Game W Q Criteria / 1-hour average	0.08	ug/L	IS
Dibenz(a,h)anthracene	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.0085	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.0044	ug/L	IS
Dibromochloromethane	Chemical Constituents	California Primary MCL (total trihalomethanes)	100	ug/L	G & IS
		USEPA Primary MCL (total trihalomethanes)	80	ug/L	G & IS
	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.37	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.41	ug/L	IS
1,2-Dibromo-3-chloropropane (DBCP)	Chemical Constituents	California Primary MCL	0.2	ug/L	G & IS
	Tastes and Odors	Taste & Odor Threshold (USEPA)	10	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	0.0017	ug/L	G & IS
Dicamba	Toxicity - humans	USEPA IRIS Reference Dose (c)	210	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / Inst Maximum	200	ug/L	IS
1,2-Dibromoethane (Ethylene dibromide (EDB))	Chemical Constituents	California Primary MCL	0.05	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	0.01	ug/L	G & IS
1,2-Dichlorobenzene	Chemical Constituents	California Primary MCL	600	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	24	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	600	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	763	ug/L	IS
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	2700	ug/L	IS
1,3-Dichlorobenzene	Toxicity - humans (a)	California DHS Action Level for drinking water	600	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	763	ug/L	IS
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	400	ug/L	IS
1,4-Dichlorobenzene	Chemical Constituents	California Primary MCL	5	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	11	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	6	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	763	ug/L	IS
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	400	ug/L	IS
Dichlorodifluoromethane	Toxicity - humans	California DHS Action Level for drinking water	1000	ug/L	G & IS
1,1-Dichloroethane	Chemical Constituents	California Primary MCL	5	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	3	ug/L	G & IS
1,2-Dichloroethane (Ethylene dichloride)	Chemical Constituents	California Primary MCL	0.5	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	7000	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.4	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	20,000	ug/L	IS
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	0.38	ug/L	IS
1,1-Dichloroethylene	Chemical Constituents	California Primary MCL	6	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	1500	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	10	ug/L	G
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	0.057	ug/L	IS
cis-1,2-Dichloroethylene	Chemical Constituents	California Primary MCL	6	ug/L	G & IS
	Toxicity - humans	USEPA MCL Goal	70	ug/L	G & IS
trans-1,2-Dichloroethylene	Chemical Constituents	California Primary MCL	10	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	260	ug/L	G & IS
	Toxicity - humans (a)	USEPA IRIS Reference Dose (c)	140	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	700	ug/L	IS

Recommended Numerical Limits to Apply Water Quality Objectives

based on *A Compilation of Water Quality Goals*, California Regional Water Quality Control Board, Central Valley Region

(Numerical Objectives from the applicable Basin Plan also apply)

Constituent / Parameter (Synonym)	Water Quality Objective or Promulgated Criterion	Recommended Numerical Limit(s) Source / Averaging Period	Limit	Units	G = Groundwater IS = Inland Surface Water
Dichloromethane	Chemical Constituents	California Primary MCL	5	ug/L	G & IS
(Methylene chloride)	Tastes and Odors	Odor threshold (Amoore and Hautala)	9,100	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	4	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	4.7	ug/L	IS
2,4-Dichlorophenoxyacetic acid	Chemical Constituents	California Primary MCL	70	ug/L	G & IS
(2,4-D)	Toxicity - humans	California Public Health Goal for Drinking Water	70	ug/L	G & IS
4-(2,4-Dichlorophenoxy)butyric acid (2,4-DB)	Toxicity - humans	USEPA IRIS Reference Dose (c)	56	ug/L	G & IS
1,2-Dichloropropane	Chemical Constituents	California Primary MCL	5	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	10	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.5	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	5,700	ug/L	IS
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.52	ug/L	IS
1,3-Dichloropropene	Chemical Constituents	California Primary MCL	0.5	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.2	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	244	ug/L	IS
		USEPA National Ambient W Q Criteria / acute tox info	6,060	ug/L	IS
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	10	ug/L	IS
Dieldrin	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.0022	ug/L	G
	CTR - humans	California Toxics Rule (USEPA) for sources of drinking water	0.00014	ug/L	IS
	CTR - aquatic life	California Toxics Rule (USEPA) / 4-day average (total)	0.056	ug/L	IS
		California Toxics Rule (USEPA) / 1-hour average (total)	0.24	ug/L	IS
Diesel	Tastes and Odors	Taste & odor threshold (USEPA Health Advisory)	100	ug/L	G & IS
(TPH-d)	Toxicity - humans	USEPA Superfund Provisional Reference Dose (c)	56 to 140	ug/L	G & IS
Di(2-ethylhexyl)phthalate	Chemical Constituents	California Primary MCL	4	ug/L	G & IS
(Bis(2-ethylhexyl)phthalate)	Toxicity - humans (a)	California Public Health Goal for Drinking Water	12	ug/L	G
(DEHP)	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	1.8	ug/L	IS
Di-isopropyl ether (Isopropyl ether) (DIPE)	Tastes and Odors	Odor threshold (Amoore and Hautala)	0.8	ug/L	G & IS
Dinoseb	Chemical Constituents	California Primary MCL	7	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	14	ug/L	G & IS
1,4-Dioxane	Tastes and Odors	Odor threshold (Amoore and Hautala)	230,000	ug/L	G & IS
	Toxicity - humans	Cal/EPA Cancer Potency Factor as a drinking water level (b)	1.3	ug/L	G & IS
Dioxin	Chemical Constituents	California Primary MCL	0.00003	ug/L	G & IS
(2,4,7,8-TCDD)	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	2.7E-07	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water (d)	1.3E-08	ug/L	IS
Disyston	Toxicity - humans	USEPA IRIS Reference Dose (c)	0.3	ug/L	G & IS
(Disulfoton)	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / inst maximum	0.05	ug/L	IS
Diuron	Toxicity - humans	USEPA IRIS Reference Dose (c)	14	ug/L	G & IS
Electrical conductivity (see Specific conductance)					
Endosulfan	Toxicity - humans (a)	USEPA IRIS Reference Dose (c)	42	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	110	ug/L	IS
	NTR - aquatic life	National Toxics Rule (USEPA) / 4-day average (total)	0.056	ug/L	IS
		National Toxics Rule (USEPA) / Instantaneous Maximum	0.22	ug/L	IS
Endrin	Chemical Constituents	California Primary MCL	2	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	1.8	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.76	ug/L	IS
	CTR - aquatic life	California Toxics Rule (USEPA) / 4-day average (total)	0.036	ug/L	IS
		California Toxics Rule (USEPA) / 1-hour average (total)	0.086	ug/L	IS
Ethanol	Tastes and Odors	Odor threshold (Amoore and Hautala)	760,000	ug/L	G & IS
Ethylbenzene	Chemical Constituents	California Primary MCL	300	ug/L	G & IS
	Tastes and Odors	Taste & Odor Threshold (USEPA)	29	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	300	ug/L	G
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	3,100	ug/L	IS
Ethyl bromide	Tastes and Odors	Odor threshold (Amoore and Hautala)	46	ug/L	G & IS
Fluoranthene	Toxicity - humans (a)	USEPA IRIS Reference Dose (c)	280	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA)	300	ug/L	IS
Fluorene	Toxicity - humans (a)	USEPA IRIS Reference Dose (c)	280	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	1300	ug/L	IS
Fluoride	Chemical Constituents	California Primary MCL	2000	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	1000	ug/L	G & IS
	Tastes and Odors	USEPA Secondary MCL	2000	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	1000	ug/L	G & IS
Gasoline	Toxicity - humans	USEPA Superfund Provisional Cancer Slope Factor (b)	21	ug/L	G & IS
(TPH-g)	Tastes and Odors	California SWRCB, *Water Quality Criteria* (McKee & Wolf)	5	ug/L	G & IS
Heptachlor	Chemical Constituents	California Primary MCL	0.01	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.008	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.00021	ug/L	IS
	CTR - aquatic life	California Toxics Rule (USEPA) / 4-day average (total)	0.0038	ug/L	IS
		California Toxics Rule (USEPA) / instantaneous maximum	0.52	ug/L	IS
Indeno(1,2,3-c,d)pyrene	Toxicity - humans (a)	California Public Health Goal for benzo(a)pyrene & OEHHA PEFs	0.04	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.0044	ug/L	IS

Recommended Numerical Limits to Apply Water Quality Objectives

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(Numerical Objectives from the applicable Basin Plan also apply)

Constituent / Parameter (Synonym)	Water Quality Objective or Promulgated Criterion	Recommended Numerical Limit(s) Source / Averaging Period	Limit	Units	G = Groundwater IS = Inland Surface Water
Iron	Chemical Constituents	California Secondary MCL	300	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	5000	ug/L	G & IS
	Tastes and Odors	California Secondary MCL	300	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / 4-day average	1000	ug/L	IS
Kepone	Toxicity - humans	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.0022	ug/L	G & IS
Lead	Chemical Constituents	California Primary MCL	15	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	5000	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	2	ug/L	G & IS
	CTR - aquatic life	California Toxics Rule (USEPA)	see Page 24 tab		IS
Lead compounds, organic	Chemical Constituents	California Primary MCL	15	ug/L	G & IS
(see also Lead acetate,		Water Quality for Agriculture (Ayers & Westcot)	5000	ug/L	G & IS
Lead subacetate, and	Toxicity - humans	California Public Health Goal for Drinking Water	2	ug/L	G & IS
Tetraethyl lead)	CTR - aquatic life	California Toxics Rule (USEPA) for sources of drinking water	see Page 24 tab		IS
Lead acetate	Toxicity - humans	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.13	ug/L	G & IS
Lead subacetate	Toxicity - humans	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.92	ug/L	G & IS
Lindane (see gamma-BHC)					
Linuron	Toxicity - humans	USEPA IRIS Reference Dose (c)	1.4	ug/L	G & IS
Manganese	Chemical Constituents	California Secondary MCL	50	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	200	ug/L	G & IS
	Tastes and Odors	California Secondary MCL	50	ug/L	G & IS
	Toxicity - humans	California DHS Action Level for drinking water	500	ug/L	G & IS
Mercury	Chemical Constituents	California Primary MCL	2	ug/L	G & IS
(see also Methylmercury)	Toxicity - humans (a)	California Public Health Goal for Drinking Water	1.2	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / 4-day average	0.77	ug/L	IS
		USEPA National Ambient W Q Criteria / 1-hour average	1.4	ug/L	IS
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.05	ug/L	IS
Methoxychlor	Chemical Constituents	California Primary MCL	30	ug/L	G & IS
	Tastes and Odors	Taste & Odor Threshold (USEPA)	4700	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	30	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / inst maximum	0.03	ug/L	IS
Methanol	Tastes and Odors	Odor threshold (Amoore and Hautala)	740,000	ug/L	G & IS
(Methyl alcohol)	Toxicity - humans	USEPA IRIS Reference Dose (c)	3500	ug/L	G & IS
Methyl t-butyl ether	Chemical Constituents	California Primary MCL	13	ug/L	G & IS
(MTBE)		California Secondary MCL	5	ug/L	G & IS
	Tastes and Odors	California Secondary MCL	5	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	13	ug/L	G & IS
Methyl ethyl ketone	Tastes and Odors	Odor threshold (Amoore and Hautala)	8,400	ug/L	G & IS
(MEK)	Toxicity - humans	USEPA IRIS Reference Dose (c)	4,200	ug/L	G & IS
Methylmercury	Toxicity - humans	USEPA IRIS Reference Dose (c)	0.07	ug/L	G & IS
		USEPA National Ambient W Q Criteria (fish tissue)	0.3	mg/kg	IS
2-Methylnaphthalene	Toxicity	USEPA IRIS Reference Dose (c)	28	ug/L	G & IS
Molybdenum	Chemical Constituents	Water Quality for Agriculture (Ayers & Westcot)	10	ug/L	G & IS
	Toxicity - humans	USEPA IRIS Reference Dose (c)	35	ug/L	G & IS
Naphthalene	Tastes and Odors	Odor threshold (Amoore and Hautala)	21	ug/L	G & IS
	Toxicity - humans	California DHS Action Level for drinking water	170	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	620	ug/L	IS
Nickel	Chemical Constituents	California Primary MCL	100	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	200	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	12	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	610	ug/L	IS
	CTR - aquatic life	Californa Toxics Rule (USEPA; dissolved)	see Page 25 tab		IS
Nitrate (expressed as nitrogen)	Chemical Constituents	California Primary MCL	10,000	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	10,000	ug/L	G & IS
N-Nitrosodimethylamine	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.0022	ug/L	G
(NDMA)	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	0.00069	ug/L	IS
Pendimethalin	Toxicity - humans	USEPA IRIS Reference Dose (c)	280	ug/L	G & IS
(Prowl)					
Pentachlorophenol	Chemical Constituents	California Primary MCL	1	ug/L	G & IS
	Tastes and Odors	Taste & Odor Threshold (USEPA)	30	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.4	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA)	0.28	ug/L	IS
	CTR - aquatic life	California Toxics Rule (USEPA)	see Page 27 tab		IS
pH	Chemical Constituents	USEPA Secondary MCL	6.5 to 8.5	units	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	6.5 to 8.4	units	G & IS
	Tastes and Odors	USEPA National Ambient W Q Criteria / taste & odor	5 to 9	units	G & IS
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / Inst Min & Max	6.5 to 9	units	IS
Phenanthrene	No criteria in database.				
Polychlorinated biphenyls	Chemical Constituents	California Primary MCL	0.5	ug/L	G & IS
(PCBs)	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.007	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.00017	ug/L	IS
	CTR - aquatic life	California Toxics Rule (USEPA) / 4-day average (total) (e)	0.014	ug/L	IS
Propham	Toxicity - humans	USEPA IRIS Reference Dose (c)	140	ug/L	G & IS
n-Propylbenzene	Toxicity - humans	California DHS Action Level for drinking water	260	ug/L	G & IS

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(Numerical Objectives from the applicable Basin Plan also apply)

Constituent / Parameter (Synonym)	Water Quality Objective or Promulgated Criterion	Recommended Numerical Limit(s) Source / Averaging Period	Limit	Units	G = Groundwater IS = Inland Surface Water
Pyrene	Toxicity - humans (a)	USEPA IRIS Reference Dose (c)	210	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	960	ug/L	IS
Selenium	Chemical Constituents	California Primary MCL	50	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	20	ug/L	G & IS
	Toxicity - humans	USEPA IRIS Reference Dose (c)	35	ug/L	G & IS
	NTR - aquatic life	National Toxics Rule (USEPA) / 4-day average (total)	5	ug/L	IS
		National Toxics Rule (USEPA) / 1-hour average (total)	20	ug/L	IS
Silver	Chemical Constituents	California Secondary MCL	100	ug/L	G & IS
	Tastes and Odors	California Secondary MCL	100	ug/L	G & IS
	Toxicity - humans	USEPA IRIS Reference Dose (c)	35	ug/L	G & IS
	CTR - aquatic life	Californa Toxics Rule (USEPA)	see Page 28 tab		IS
Simazine	Chemical Constituents	California Primary MCL	4	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	4	ug/L	G & IS
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / Inst Maximum	10	ug/L	IS
Sodium	Chemical Constituents	Water Quality for Agriculture (Ayers & Westcot)	69	mg/L	G & IS
	Tastes and Odors	Taste and odor threshold (USEPA Drinking Water Advisory)	30 to 60	mg/L	G & IS
	Toxicity - humans	USEPA Drinking Water Advisory for persons on restricted sodium	20	mg/L	G & IS
Specific conductance	Chemical Constituents	California Secondary MCL	900	umhos/cm	G & IS
(Electrical conductivity)		Water Quality for Agriculture (Ayers & Westcot)	700	umhos/cm	G & IS
(EC)	Tastes and Odors	California Secondary MCL	900	umhos/cm	G & IS
Sulfate	Chemical Constituents	California Secondary MCL (recommended level)	250	mg/L	G & IS
		California Secondary MCL (upper level)	500	mg/L	G & IS
	Tastes and Odors	California Secondary MCL (recommended level)	250	mg/L	G & IS
	Toxicity - humans	USEPA Drinking Water Advisory	500	mg/L	G & IS
Tebuthiuron	Toxicity - humans	USEPA IRIS Reference Dose (c)	490	ug/L	G & IS
1,1,2,2-Tetrachloroethane	Chemical Constituents	California Primary MCL	1	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	500	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.1	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	2400	ug/L	IS
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	0.17	ug/L	IS
Tetrachloroethylene	Chemical Constituents	California Primary MCL	5	ug/L	G & IS
(Tetrachloroethene)	Tastes and Odors	Odor threshold (Amoore and Hautala)	170	ug/L	G & IS
(PCE)	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.06	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	840	ug/L	IS
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	0.8	ug/L	IS
Tetraethyl lead	Toxicity - humans	USEPA IRIS Reference Dose (c)	0.0007	ug/L	G & IS
Thallium	Chemical Constituents	California Primary MCL	2	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.1	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / aquatic tox info	20	ug/L	IS
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	1.7	ug/L	IS
Toluene	Chemical Constituents	California Primary MCL	150	ug/L	G & IS
	Tastes and Odors	Taste & Odor Threshold (USEPA)	42	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	150	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	6,800	ug/L	IS
Total Dissolved Solids	Chemical Constituents	California Secondary MCL	500,000	ug/L	G & IS
(TDS)		Water Quality for Agriculture (Ayers & Westcot)	450,000	ug/L	G & IS
	Tastes and Odors	California Secondary MCL	500,000	ug/L	G & IS
Toxaphene	Chemical Constituents	California Primary MCL	3	ug/L	G & IS
	Tastes and Odors	Taste & Odor Threshold (USEPA)	140	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.03	ug/L	G
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	0.00073	ug/L	IS
	CTR - aquatic life	Californa Toxics Rule (USEPA) / 4-day average (total)	0.0002	ug/L	IS
		California Toxics Rule (USEPA) / 1-hour average (total)	0.73	ug/L	IS
2,4,5-TP	Chemical Constituents	California Primary MCL	50	ug/L	G & IS
(Silvex)	Toxicity - humans (a)	California Public Health Goal for Drinking Water	25	ug/L	G & IS
1,2,4-Trichlorobenzene	Chemical Constituents	California Primary MCL	5	ug/L	G & IS
	Tastes and Odors	USEPA, National Primary Drinking Water Regs., Contaminant Fac	3,000	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	5	ug/L	G & IS
	Toxicity - aquatic life (a)	USEPA National Ambient W Q Criteria / chronic tox info	50	ug/L	IS
		USEPA National Ambient W Q Criteria / acute tox info	250	ug/L	IS
1,1,1-Trichloroethane	Chemical Constituents	California Primary MCL	200	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	970	ug/L	G & IS
	Toxicity - humans	USEPA MCL Goal for drinking water & health advisory	200	ug/L	G & IS
1,1,2-Trichloroethane	Chemical Constituents	California Primary MCL	5	ug/L	G & IS
	Toxicity - humans (a)	Cal/EPA Cancer Potency Factor as a drinking water level (b)	0.49	ug/L	G
	Toxicity - aquatic life	USEPA National Ambient W Q Criteria / chronic tox info	9400	ug/L	IS
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	0.6	ug/L	IS
Trichloroethylene	Chemical Constituents	California Primary MCL	5	ug/L	G & IS
(TCE)	Tastes and Odors	Odor threshold (Amoore and Hautala)	310	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.8	ug/L	G
	Toxicity - aquatic life	USEPA National Water Quality Aquatic Toxicity Information	21,900	ug/L	IS
	CTR - humans	Californa Toxics Rule (USEPA) for sources of drinking water	2.7	ug/L	IS
Trichlorofluoromethane	Chemical Constituents	California Primary MCL	150	ug/L	G & IS
(Freon 11)	Toxicity - humans (a)	California Public Health Goal for Drinking Water	700	ug/L	G & IS
2,4,5-Trichlorophenoxyacetid acid	Toxicity - humans	USEPA IRIS Reference Dose (c)	70	ug/L	G & IS

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(2,4,5-T)					
2,4,5-Trichlorophenoxypropionic acid	Chemical Constituents	California Primary MCL	50	ug/L	G & IS
	Toxicity - humans	USEPA IRIS Reference Dose (c)	53	ug/L	G & IS
1,2,3-Trichloropropane	Toxicity - humans	California DHS Action Level for drinking water	0.005	ug/L	G & IS
1,1,2-Trichloro-1,2,2-trifluoroethane	Chemical Constituents	California Primary MCL	1200	ug/L	G & IS
(Freon 113)	Toxicity - humans (a)	California Public Health Goal for Drinking Water	4000	ug/L	G & IS
Trifluralin	Toxicity - humans	USEPA IRIS Cancer Risk Level	5	ug/L	G & IS
1,2,4-Trimethylbenzene	Toxicity - humans (a)	California DHS Action Level for drinking water	330	ug/L	G & IS
1,3,5-Trimethylbenzene	Tastes and Odors	Odor threshold (Amoore and Hautala)	15	ug/L	G & IS
	Toxicity - humans (a)	California DHS Action Level for drinking water	330	ug/L	G & IS
Vanadium	Chemical Constituents	Water Quality for Agriculture (Ayers & Westcot)	100	ug/L	G & IS
	Toxicity - humans	California DHS Action Level for drinking water	50	ug/L	G & IS
Vinyl choride	Chemical Constituents	California Primary MCL	0.5	ug/L	G & IS
	Tastes and Odors	Odor threshold (Amoore and Hautala)	3,400	ug/L	G & IS
	Toxicity - humans (a)	California Public Health Goal for Drinking Water	0.05	ug/L	G
	NTR - humans	National Toxics Rule (USEPA) for sources of drinking water	2	ug/L	IS
Xylene(s)	Chemical Constituents	California Primary MCL	1,750	ug/L	G & IS
	Tastes and Odors	Taste & Odor Threshold (USEPA)	17	ug/L	G & IS
	Toxicity - humans	California Public Health Goal for Drinking Water	1,800	ug/L	G & IS
Zinc	Chemical Constituents	California Secondary MCL	5000	ug/L	G & IS
		Water Quality for Agriculture (Ayers & Westcot)	2000	ug/L	G & IS
	Tastes and Odors	California Secondary MCL	5000	ug/L	G & IS
	Toxicity - humans	USEPA IRIS Reference Dose (c)	2100	ug/L	G & IS
	CTR - aquatic life	Californa Toxics Rule (USEPA)	see Page 30 tab		IS

Notes:

(a) For surface waters, this limit may be preempted by a Calfornia Toxics Rule or National Toxics Rule criterion.

(b) Assumes 70 kg body weight and 2 liters per day drinking water consumption.

(c) Assumes 70 kg body weight, 2 liters per day drinking water consumption, and 20 percent relative source contrubution. An additional undertainty factor of 10 is used for Class C carcinogens.

(d) Applies to "TCDD Equivalents" calculated from the concentrations of 2,3,7,8-chlorinated dibenzodioxins and 2,3,7,8-chlorinated dibenzofurans and their corresponding toxic equivalency factors (TEFs).

(e) Applies separately to Aroclors 1242, 1254, 1221, 1232, 1248, 1260, and 1016.

(f) USEPA, Region 9 has allowed acid soluble to account for suspended clay partices in receiving water.

(g) Potency Equivalency Factors, published by the Cal/EPA Office of Enviornmental Health Hazard Assessment, relate the relative cancer potencies of various polynuclear aromatic hydrocarbons to that of benzo(a)pyrene.

(h) In addition, the Average Primary Producer Steinhaus Similarity deviation for a site is less than 5% (as determined using Comprehensive Aquatic Systems Model (CASM) or appropriate model and index) and is not exceeded more than once every three years (or other appropriate return frequency sufficient to allow system recovery). The 5% i the protection of aquatic plant community should also be protective of most freshwater animals (chronic criterion).

CTR California Toxics Rule

MFL Million fibers per liter; limited to fibers longer than 10 um.

NTR National Toxics Rule

APPENDIX B

Monitoring and Reporting Plan

APPENDIX C

SEDIMENT CHARACTERIZATION DATASHEETS

SEDIMENT SOURCE FIELD DATASHEET

Watershed Name:______________________ **Sub Drainage Basin:______________ Sample Cell ID No. -Dom. Geol. - Plot #:______________________**

Analyst and Date Mapped:______________________ **Page: _____ of ______.**

Unique ID #	Site #	Air Photo #	Feature Type	Source Loc.	Slope Loc.	Eros. Dimens. (ft)			Sed. Del. (%)	Stream	Activity	Age	Land Use Link		Geomorp Assoc.		Geol Unit		Veg Clas	Slope in %	GPS # (Y/N)	EPE
						L	W	D					Pri.	Sec.	Pri.	Sec.	Map	Field				

AIR PHOTO INTERPRETATION DATASHEET

Watershed Name:______________________ **Sub-basin:____________________________**

Analyst and Date Mapped:________________________ **Photo Year:_______** **Photo Scale:______________**

PWA Air Photo Interpretation Sediment Source Inventory Form

GIS unique ID #	Feature ID #	Air Photo #	Feature Type	Feature Certainty	Photo Year	Feature Size (1/50s of inch)		Sed. Delivery % to nearest stream	Delivery Certainty	Aspect	Stream Class & Type	Land Use History	Geo-morph. Assoc.	Horiz. curv.	Activity	Initial % Veg. Cover	Final % Veg. Cover (2000)	Slope (%)	Comments
						L	W												

CHANNEL GEOMORPHOLOGY DATASHEET

Site Number	**River**	**Site**	**Observers**	**Date**	**Total reach length**	**Geology @ site**	**W'shed Geology Consistent w/ Site?**	**Drainage Area (km^2)**	**Map slope class**	**SPI**	**Unit SPI**	**FPW @ 2bfd**	**Bf width-active (m)**

LARGE WOODY DEBRIS DATASHEET

Site	CONIFER				DECIDUOUS				UNKNOWNS				Total	Pieces per Unit Length (BRW units)	Comments
	Live	Fresh	Sound	Decayed	Live	Fresh	Sound	Decayed	Live	Fresh	Sound	Decayed			

GRAVEL BAR DATASHEET

Site	Small	Medium	Large	Total	RATING	Bar Rating per Unit Length (BFW Units)

PEBBLE COUNT DATASHEET

Site	D16	D50	DS84	Sorting