SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP)

FINAL WORKPLAN 2001 –2002

SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD

AUGUST 2001
(Revised August 2002)

1. Introduction

In October 1999 the San Francisco Bay Regional Water Quality Control Board (Regional Board) developed a Regional Monitoring and Assessment Strategy (RMAS) in order to develop information for all waterbodies in the Region for the 305b report and for 303d listing. The Surface Water Ambient Monitoring Program (SWAMP) will be used in this Region to implement the RMAS. The three components that make up the SWAMP/RMAS include: 1) funding from the State Water Resources Control Board for Regional Board lead activities (these activities will concentrate on monitoring watersheds, lakes/reservoirs and bays and estuaries other than San Francisco Bay and will include other Regional Board programs such as State Mussel Watch, the Toxic Substances Monitoring Program and the Coastal Fish Contamination Program), 2) partner lead watershed monitoring programs that are being conducted by local agencies/groups and are of similar goals, structure and scope as the Regional Board lead activities and 3) the San Francisco Estuary Regional Monitoring Program (RMP). Specific waterbodies that will be monitored by the three components of the SWAMP/RMAS in 2001-2002 are listed in Appendix A.

The Regional Board has developed this workplan to describe the site-specific monitoring that will be conducted in our Region with funding from the 2000-2001 **and** 2001-2002 fiscal years. Monitoring will take place in the years 2001-2002 (year 1) and 2002-2003 (year 2). These activities are referred to above as Regional Board lead activities. The goal of the site-specific portion of the SWAMP program in this Region is to monitor and assess all of our waterbodies in order to identify reference sites (clean sites) and waterbodies or sites that are impaired. Data developed in this program will be used for evaluating waterbodies for the 305b report and the 303d list. Specific objectives of the monitoring program are to: 1) identify reference sites, 2) identify impacted sites or waterbodies in order to determine if beneficial uses are being protected, 3) identify the cause of impacts (i.e., sediment, specific chemical contaminants, temperature), 4) determine if these impacts are associated with specific land uses and 5) evaluate monitoring tools in watersheds in order to develop a program that uses the best environmental indicators to achieve the purposes of the program.

With funding from the 2000-2001 fiscal year (year 1) we will monitor and assess six “planning watersheds”: Walker, Lagunitas, Wildcat/San Pablo, San Leandro, Arroyo Las Positas, and Suisun creek watersheds. The larger Lagunitas watershed includes Olema Creek where the National Park Service has already initiated a multi-year watershed monitoring program of similar goals, structure and scope. Planning watersheds, defined in more detail below in Section 2, are both area- and drainage-based. Our sampling plan focuses on three sampling events based on three hydrologic cycles. The 3 hydrologic cycles are the wet season (January - March), decreasing hydrograph/spring (April - May) and the dry season (June - October). Sampling will take place early in the dry season (June - July) so that that all sites have water. Rapid bioassessments were conducted in the six planning watersheds in May 2001. However, due to contractual delays the rest of the monitoring that was planned had to be delayed until the dry season. Therefore, monitoring, other than bioassessments and qualitative physical habitat assessment, in these watersheds will take place in the dry season of 2001, the wet season of 2002 and the decreasing hydrograph in 2002. A complete description of these activities is contained in this document and in the 2000-2001 Task Order.

With funding from the 2001-2002 fiscal year three more planning watersheds will be monitored. These watersheds are Pescadero, San Gregorio and Stevens/Permanente creek watersheds. The same basic study design will be used in these watersheds. This monitoring will start in spring (decreasing hydrograph) of 2002.

2. Regional Identification of Problem and Clean Watersheds to Monitor

The 4000 square-mile San Francisco Bay Region was divided into 47 "planning watersheds" for the purpose of implementing a rotating basin approach for monitoring and assessment on a finer scale than the seven hydrologic basins. These planning watersheds are between 30 and 200 square miles in area, with most between 50 and 100 square miles. Some of these planning watersheds are self-contained hydrologic units that drain to an estuary or the ocean (e.g., Sonoma Creek), and others have been either combined with adjacent watersheds (e.g., North San Mateo Coastal Creeks) or are subwatersheds within a larger drainage basin (e.g., Arroyo Mocho within the larger Alameda Creek). All planning watersheds are fully contained within one of the seven Hydrologic Units of the San Francisco Bay Region.

Table 1, below, is a prioritized list of planning watersheds to be monitored under the SWAMP in this region, preceded by criteria used to set the priorities. It includes the area, county, and whether there may be potential reference "clean" sites in each planning watershed.

Criteria for prioritizing the planning watersheds for monitoring and assessment are pragmatic, and aim toward generating the most useful and current information with the least amount of new resources and investigations. The first watersheds to be analyzed at this new level of detail also consider time-sensitive issues such as imminent development plans (e.g., major housing or flood control projects), upcoming stream restoration projects, or declining sensitive aquatic resources. The prioritized order of planning watersheds achieves balance geographically, by eco-region, and includes both data-rich and data-poor watersheds as well as a balance of potentially clean and problem watersheds.

The seven selection criteria include:

1. EXISTING LOCAL EFFORTS. Build on existing watershed monitoring and assessment efforts, including citizen monitoring.
2. SENSITIVE AQUATIC RESOURCES. Focus in areas with sensitive aquatic resources or species, such as habitat for the federally-listed threatened species steelhead.
3. PRE-PROJECT INFORMATION. Collect pre-project ambient data in areas proposed for urbanization, stream restoration, or hydromodification.
4. WATERBODIES WITH LIMITED INFORMATION. Initiate monitoring in areas that have little or no current water quality and habitat information.
5. MONITOR IN ALL ECO-REGIONS. Fill information gaps in certain eco-regions, for instance with stream bioassessment data to support biocriteria development or geomorphic data to support physical criteria development.
6. PAIRED WATERSHEDS. Monitor paired watersheds, with similar drainage area, land use, geology, vegetation, and climate for cross-comparison and testing of the ability to extrapolate findings from one watershed to another.
7. GEOGRAPHIC BALANCE. The list of pilot watersheds should be balanced geographically and by eco-region, in order to capture the full range of stream types in the region and to recognize watershed management efforts in all parts of the region.

A thorough, but not exhaustive, list of waterbodies located within each of these planning watersheds is included in Appendix B.

TABLE 1

PLANNING WATERSHEDS
PRIORITY LISTING AND ORDER OF ROTATING BASIN MONITORING STRATEGY
SAN FRANCISCO BAY REGION

NO.	PLANNING WATERSHED	AREA (SQ. MI.)	COUNTY	PRIORITY	POTENTIAL REFERENCE SITES?
1	Walker Creek	73.9	Marin	High	Yes
2	Lagunitas Creek	107.1	Marin	High	Yes
3	Suisun Creek	56.6	Napa/ Solano	High	No
4	Arroyo de las Positas	76.7	Alameda/ Contra Costa	High	No
5	Wildcat/San Pablo Creeks	48.4	Contra Costa/ Alameda	High	Yes

No.	Planning Watershed	Area (Sq. mi.)	County	Priority	Potential Reference Sites?
6	San Leandro Creek	46.5	Alameda/ Contra Costa	High	Yes
7	San Gregorio Creek	52.0	San Mateo	High	Yes
8	Pescadero/ Butano Creeks	82.0	San Mateo	High	Yes
9	Stevens/ Permanente Creeks	46.0	Santa Clara	High	Yes
10	San Mateo Creek	32.8	San Mateo	High	Yes
11	Petaluma River	96.5	Sonoma/ Marin	High	No
12	Mt. Diablo/ Kirker Creeks	61	Contra Costa	High	Yes
13	Oakland Creeks	60.0	Alameda	High	No
14	San Tomas/ Calabazas Creeks	66.0	Santa Clara	High	Yes
15	Green Valley/ W. Suisun	88.9	Solano	High	Maybe
16	Arroyo Mocho	71.4	Alameda	High	Yes
17	Palo Alto Creeks	28.0	Santa Clara	High	Yes
18	South Marin Bayside	61.9	Marin	Medium	Yes
19	Napa River	297.9	Napa	Medium	Yes
20	Napa River Estuary	123.6	Napa	Medium	Maybe
21	Upper Walnut Creek	84.8	Contra Costa	Medium	Yes
22	Lower Walnut Creek	60	Contra Costa	Medium	No
23	Laguna Creek	74	Alameda	Medium	No
24	Point Reyes Coastal Creeks	53.6	Marin	Medium	Yes
25	Mid San Mateo Coastal Creeks	50.9	San Mateo	Medium	Yes

No.	Planning Watershed	Area (Sq. mi.)	County	Priority	Potential Reference Sites?
26	Ledgewood/ Laurel Creeks	29.1	Solano	Medium	No
27	Arroyo del Valle	172.7	Alameda	Medium	Yes
28	North San Mateo Bayside	22.3	San Mateo	Medium	No
29	Berkeley/ Richmond/ San Francisco Creeks	49.5	Alameda/ Contra Costa/ San Francisco	Medium	No
30	Pilarcitos Creek	28.3	San Mateo	Medium	Yes
31	South Marin Coastal Creeks	54.6	Marin	Medium	Yes
32	Lower Alameda Creek	119.1	Alameda	Medium	No
33	Upper Alameda Creek	137.3	Alameda/ Santa Clara	Medium	Yes
34	Arroyo de la Laguna	93.4	Alameda/ Contra Costa	Medium	Maybe
35	Northwest Contra Costa Creeks	42.5	Contra Costa	Medium	Yes
36	Sonoma Creek	104.5	Sonoma	Low	Yes
37	San Francisquito Creek	47.6	Santa Clara/ San Mateo	Low	Yes
38	Tomales Bay Creeks	37.7	Marin	Low	Yes
39	North San Mateo Coastal Creeks	43.7	San Mateo/ San Francisco	Low	Yes
40	South San Mateo Bayside	24.2	San Mateo	Low	No
41	San Lorenzo Creek	52.1	Alameda	Low	Yes
42	Alhambra Creek	50	Contra Costa	Low	Yes
43	North Marin Bayside	55.2	Marin	Low	Yes

No.	Planning Watershed	Area (Sq. mi.)	County	Priority	Potential Reference Sites?
44	Upper Coyote Creek	195	Santa Clara	Low	Yes
45	Lower Coyote Creek	155	Santa Clara	Low	Maybe
46	Guadalupe River	112.1	Santa Clara	Low	Maybe
47	Los Gatos Creek	57.9	Santa Clara	Low	Maybe

* Priority in this table is based on the selection criteria above, including geographic balance, but also considers factors such as existing monitoring and assessment efforts in "Partner-lead" pilot watersheds, which include San Francisquito, Sonoma, San Lorenzo, Alhambra, San Pedro (in North San Mateo Coastal Creeks), North Marin Bayside, Coyote, and Guadalupe/Los Gatos watersheds. We plan to monitor the first six planning watersheds from Spring 2001-Spring 2002, and the next three beginning in Spring 2002.

3. Objectives and Related Beneficial Uses for Watersheds Being Monitored in 2001-2002

The first six planning watersheds to be monitored using FY 2000-2001 funding are indicated in Table 2, below. Each planning watershed has its own unique set of potential problems, based on land uses and beneficial uses (and related legislative objectives) located in these areas of the San Francisco Bay Region. Table 2 describes the general areas of potential water quality impacts pertaining to land uses, water management, and beneficial uses, and also contains summaries of potential reference or "clean" portions of those planning watersheds.

Generally in this region, reference sites may be located in areas of restricted or limited public access such as regional parks, wilderness areas, and drinking water source watershed areas (e.g., Marin Municipal Water District and East Bay Municipal Utility District in watersheds 1-4). In addition, watershed areas that are mostly in private ownership can potentially yield reference conditions if the land use is of low intensity, such as the lower Walker Creek watershed where slopes are too steep and wooded for intensive grazing. Such conditions will be noted as monitoring and assessment efforts rotate into different planning watersheds of the San Francisco Bay Region as available funding and staffing allow. Access to the areas of potential reference conditions is a priority of the Regional Monitoring and Assessment Strategy, and will be carefully negotiated with private and public landowners on a case-by-case basis. Ultimately, the data that are collected will determine whether specific stations can be used as reference conditions for bioassessment or physical/chemical assessment. Until monitoring results are available, one cannot confirm whether a site qualifies as a reference site, due to the exploratory nature of ambient monitoring and the discoveries of unknown factors and water quality impairments that inevitably arise.

TABLE 2

PLANNING WATERSHEDS TO BE MONITORED IN FY 2001-2002

No.	Planning Watershed	Area (Sq. mi.)	County	Potential Problems	Potential Reference Conditions	Legislative Objectives and associated beneficial uses
1	Walker Creek	73.9	Marin	Rangeland Mgt., Dairy Waste Mgt., Mercury Mine Runoff, Dams and Water Releases, Erosion and Sedimentation, Community Septic Systems, Shellfish Harvesting, Recreational Uses, Sensitive Species	Lower watershed, higher order main channel, just above tidal influence, where upper watershed impacts may be ameliorated by long, steep riparian canyon.	Is aquatic life protected? (COLD), (WARM), (SPAWN), (RARE) Is it safe to eat fish and shellfish? (COMM) Is it safe to swim? (REC1) Is it safe to drink? (MUN)
2	Lagunitas Creek	107.1	Marin	Dams and Water Releases, Erosion and Sedimentation, Rangeland Mgt., Dairy Waste Mgt., Community Septic Systems, Shellfish Harvesting, Recreational Uses, Drinking Water Source, Sensitive Species	Limited Public Access on Marin Municipal Drinking Water Reservoir Watershed Lands.	Is aquatic life protected? (COLD), (WARM), (SPAWN), (RARE) Is it safe to eat fish and shellfish? (COMM) Is it safe to swim? (REC1) Is it safe to drink? (MUN)
3	San Leandro Creek	46.5	Alameda/ Contra Costa	Dams and Water Releases, Water Transfers, Drinking Water Source, Recreational Uses, Grazing, Urban Runoff, Sensitive Species	Limited Public Access on East Bay MUD Drinking Water Reservoir Watershed Lands, East Bay Regional Park District Open Space	Is aquatic life protected? (COLD), (WARM), (SPAWN), (RARE) Is it safe to eat fish and shellfish? ? (COMM) Is it safe to swim? (REC1) Is it safe to drink? (MUN)

No.	Planning Watershed	Area (Sq. mi.)	County	Potential Problems	Potential Reference Conditions	Legislative Objectives and associated beneficial uses
4	Wildcat/San Pablo Creeks	48.4	Contra Costa/ Alameda	Dams and Water Releases, Flood Control Projects, Recreational Uses, Urban Runoff, Rangeland Mgt., Proposed Housing Development., Erosion and Sedimentation, Drinking Water Source, Sensitive Species	Upper Bear Creek (in San Pablo watershed) and Wildcat Creek are located in East Bay Regional Park District lands, some of which may be undisturbed enough for reference conditions.	Is aquatic life protected? (COLD), (WARM), (SPAWN), (RARE) Is it safe to eat fish and shellfish? (COMM) Is it safe to swim? (REC1) Is it safe to drink? (MUN)
5	Suisun Creek	56.6	Napa/ Solano	Dams and Water Releases, Water Transfers, Flood Control, Irrigation Canal Discharges, Erosion and Sedimentation, Agricultural Return Water, Rangeland Mgt., Sensitive Species	Not likely, due to rangeland and agricultural uses in upper watershed, and intensive land use throughout watershed.	Is aquatic life protected? (COLD), (WARM), (SPAWN), (RARE) Is it safe to drink? (MUN)
6	Arroyo de las Positas	76.7	Alameda/ Contra Costa	Salt Management In Groundwater Basin, Runoff from Dept. of Energy Site, Urban Runoff, Rangeland Mgt., Proposed Housing Developments, Flood Control Projects	Not likely, due to rangeland uses in upper watershed, and intensive land use throughout watershed.	Is aquatic life protected? ? (COLD), (WARM), (SPAWN), (RARE) Is it safe to drink? (MUN)

Beneficial Uses Listed in Basin Plan
COLD – COLD FRESHWATER HABITAT
WARM – WARM FRESHWATER HABITAT
SPAWN – FISH SPAWNING
RARE – PRESERVATION OF RARE AND ENDANGERED SPECIES
COMM – OCEAN, COMMERCIAL AND SPORTFISHING
REC1 – WATER CONTACT RECREATION
MUN – MUNICIPAL AND DOMESTIC WATER SUPPLY

3.1 General Study Design

3.1.1 Overview of General Approach

In general, the technical approach for Regional Board lead activities under SWAMP includes: 1) monitoring fish for contaminant levels in reservoirs and coastal areas where people catch and consume fish and 2) watershed monitoring to assess water quality impacts and establish regional sites of reference (i.e., high quality or “clean”) conditions. The part of the program to measure contaminants in fish will be implemented through the Toxic Substances Monitoring Program and the Coastal Fish Contamination Program. The Regional Board will implement most of the watershed monitoring portion of SWAMP through the Fish and Game master contract, although additional monitoring will be conducted by Regional Board staff using the Regional Board’s laboratory contract for laboratory services. Regional Board staff will be conducting continuous water quality monitoring in each of the watersheds using continuous monitoring probes and collecting samples for bacteriological analysis in areas where there is water contact recreation. Continuous monitoring parameters include temperature, electrical conductivity, dissolved oxygen and pH. These field measurements, as well as measurement of flow, a more quantitative physical habitat assessment and a trash assessment will be conducted whenever possible, as available labor and equipment allow. Paired watersheds were chosen for monitoring, which are close geographically, and have similar land use and geology.

Conducting rapid bioassessments with concurrent measurement of basic water quality parameters, visual physical habitat assessments and continuous monitoring of basic water quality parameters is the framework of our watershed monitoring program and considered Tier 1 of the program. In the six planning watersheds, 88 of 89 stations were evaluated using macroinvertebrate bioassessments and visual, qualitative physical habitat assessments. These samples were collected during Spring 2001 through a variety of contractual mechanisms and interagency agreements. In addition, continuous monitoring devices, measuring basic water quality parameters, will be deployed in all watersheds. Not all measurements were directly funded under SWAMP, but will be directly comparable. For instance, ten of the 89 stations are part of a three-year monitoring program in Wildcat and San Leandro watersheds, funded by a grant from the California Coastal Conservancy, and six are stations monitored over several years by the National Park Service in Olema Creek watershed. Some additional bioassessment and physical assessment work was funded by a separate contract, so that the actual number of samples funded under FY 2000-01 SWAMP funds was approximately 45.

Tier 2 of the design was developed to answer basic questions concerning protection of beneficial uses and potential impacts of land use and water management. There are 33 tier 2 stations that are a subset of the tier 1 stations. At tier 2 stations samples will be collected during three hydrologic cycles. The 3 hydrologic cycles are the wet season (January - March), decreasing hydrograph /spring (April - May) and the dry season (June - October). November and December months may be monitored as well. Regardless of calendar month, the prevailing seasonal conditions will determine monitoring events. Additional samples and parameters to be evaluated will depend on the beneficial uses or land uses at or above a site. Additional parameters that will be monitored include conventional water quality parameters including chlorophyll, ammonia, nitrate/nitrite, total nitrogen (by TKN), phosphate, alkalinity, hardness, total and dissolved organic carbon (TOC/DOC), total suspended solids (TSS) and total dissolved solids (TDS-salinity). At 16 of the 33 tier 2 stations samples will be collected for toxicity, using the U.S. EPA three species tests, and water column chemistry for toxic metal and organic pollutants. In year 1 toxicity/chemistry samples will be collected during 2 hydrologic cycles (changed to all 3 hydrologic cycles in year 2). These samples will be collected during the spring and dry season at the same time the conventional water quality samples are collected. At the bottom of each watershed in the non-tidal area we will have one station, the integrator station, that will integrate the contaminant conditions in the waterbody and determine which contaminants from that waterbody flow into the receiving waters. At these stations, *Corbicula* will be deployed for bioaccumulation measurements and sediment samples will be collected for toxicity analysis, using *Hyalella*, grain size analysis and sediment chemistry. Clams will be deployed and collected during the period of April-July. Sediment and any other samples will be collected when the clams are collected. Regional Board staff will collect samples for total and fecal coliforms and E.coli at 14 of the tier 2 stations where there is water contact recreation and/or there are potential sewage inputs.

3.1.2 Water Quality Indicators

Water quality indicators that we plan to use in the SWAMP and the beneficial uses they are designed to evaluate include:

Beneficial Use	Indicators
Water Contact and Noncontact Recreation	Total coliform bacteria Fecal coliform bacteria E.coli
Ocean, Commercial and Sportfishing	Fish chemistry Lipid concentration
Warm/Cold Freshwater Habitat, Preservation Rare and Endangered Species and Fish Spawning	Macroinvertebrate bioassessments Water chemistry (metals, organics) ELIZA for diazinon and chlorpyrifos Continuous water temperature, dissolved oxygen, pH, conductivity Hardness TSS, TDS TOC, DOC Turbidity Flow Nutrients Chlorophyll

Physical habitat assessment
Water toxicity tests
Sediment chemistry (metals, organics)
Grain size
Sediment toxicity test
Bivalve bioaccumulation

Indicators may be added to the program as necessary. Additional beneficial uses will be evaluated through other programs. Through the San Francisco Estuary Regional Monitoring Program (RMP), Estuarine Habitat, Marine Habitat and Wildlife Habitat are evaluated. The Department of Health Services, as well as water purveyors, monitor for Municipal and Domestic Water Supply, although some of the indicators above such as TDS, nutrients, and bacteria can help evaluate sources of municipal drinking water supply. The Department of Health Services monitors for Shellfish Harvesting. Counties conduct additional monitoring for Water Contact Recreation.

4. Specific Activities Planned for 2001-2002: Specific technical approach and scope of work to be performed

4.1 List of Watersheds to be Sampled in 2001-2002 (See Maps – Appendix C and Station Descriptions - Appendix D)

Planning Watersheds where sampling started in spring 2001:

?? Walker Creek (Marin County)
?? Lagunitas Creek (Marin County)
?? San Leandro Creek (Alameda/Contra Costa Counties)
?? Wildcat/San Pablo Creeks (Contra Costa County)
?? Suisun Creek (Solano/Napa Counties)
?? Arroyo de las Positas (Alameda/Contra Costa Counties)

Planning Watersheds where sampling will start in spring 2002:

?? Pescadero Creek (San Mateo County)
?? San Gregorio Creek (San Mateo County)
?? Stevens/Permanente Creeks (Santa Clara County)

4.2 Review of Available Information

WATERSHEDS WHERE SAMPLING STARTED IN SPRING 2001:

1. Walker Creek Watershed

Background

Physical Setting

The Walker Creek watershed is 73 square miles, mostly in northwestern Marin County, with a small portion in Sonoma County. The northern landscape of the lower watershed has open, low rolling hills, while the upper watershed has rugged canyons toward the southeastern headwaters. Significant tributaries of Walker Creek include Keys Creek, which flows through gentle hills east of Tomales; Chileno Creek, which flows through Chileno Valley; and, in the upper watershed, Salmon and Arroyo Sausal Creeks, which flow through Hicks Valley. Keys Creek joins Walker Creek barely one mile upstream of the outlet at Tomales Bay. Frink and Verde Canyons each support ephemeral streams that join Walker Creek upstream from Chileno Creek. Soulejoule Reservoir impounds the 15 square mile drainage of Arroyo Sausal [Rich 1989].

Annual rainfall varies from 24 to 32 inches [Nolte 1965]. Chileno Valley is notably hotter and drier than the coastal areas. Vegetation is over 60% open grassland and nearly 40% shrub and woodland (mixed hardwood and a few conifers) [Zumwalt 1972]. The San Andreas Fault, an active strike-slip fault, runs through Tomales Bay. The bedrock in this watershed northeast of the fault is Franciscan Formation, a mélange of Jurassic-Cretaceous conglomerate, sandstone, mudstone and chert, which is susceptible to debris flows and landslides on steep slopes. The Wilson Hill formation around Hicks Valley north of Walker Creek, composed of soft sands, silt and clay, is less susceptible to landslides, but more likely to erode and gully [Bush 1995]. Greywacke, greenstone, and volcanics are also evident within the watershed.

Land Uses

Ranching - Grazing is the major land use impact in the Walker Creek watershed. Much of the watershed is in a few large parcels of privately owned livestock ranches. Dairies concentrate in the valleys of Keys Creek near Tomales and Chileno Valley, while the rest of the watershed is predominantly beef cattle ranches and some sheep ranches [Bush 1995]. Walker Creek Ranch, a project of the Marin County Office of Education on the land parcel just downstream from the confluence with Salmon Creek, has excluded cattle grazing for the last ten years and revegetated the riparian corridor. The Marin County Resource Conservation District supports similar restoration projects like the riparian exclusion fencing and tree planting on a stretch of Chileno Creek. Comparative testing for nutrients, pathogens, and sediments at creek sites within or close to ranches should reveal an improvement in water quality in the cattle-excluded areas.

Farming - Keys Creek and the Walker Creek delta still show evidence of sediment deposition from historic potato farming that peaked in the 1860s around Tomales [Bush 1995]. Privately owned Laguna Lake at the headwaters of Chileno Creek is a large (about 200 acres) shallow water body, which until 1991 was been drained and planted with corn; it may still show high ammonia levels from fertilizer and pesticide residues, as well as coliform bacteria from the Reichardt duck farm which drains to the northern tip of the lake.

Residential - The only residential community is the small town of Tomales (69 homes and a school in 1990) and Blue Mountain, a spiritual community near Keys Creek, both in the lower watershed. The sewage treatment pond for the town is adjacent to Keys Creek. Sampling sites downstream from the pond should test for nutrients, if only for a baseline to compare to if there is a leak or overflow.

Mining - The Gambonini Mine operated as a large open pit cinnabar mine for mercury from 1964 to 1970. Since remediation in 1998, it has been monitored for mercury transport to Salmon Creek, just before the confluence with Walker Creek. A smaller mercury mine operated at the same time nearby in upper Chileno Valley, and two more inactive mercury mines are listed for Walker Creek in the Basin Plan [1995]. For a while in the 1960s, Marin County public works extracted gravel from Walker Creek just downstream of the confluence with Chileno Creek [Bush 1995].

Diversions - Soulejoule Reservoir was initially dammed in 1968 and later enlarged to 10,570 acre feet by the Marin Municipal District in 1980 for domestic water supply, which is pumped as needed to Nicasio Reservoir in the Lagunitas watershed. Since 1980, releases from the reservoir have increased the summer and fall flows in an effort to improve the downstream fishery. The fishery has continued to decline, while a smelly algal build up below the dam has been attributed to the summer releases from the reservoir [Bratovitch 1994]. Soulejoule is open for warm water fishing. Ranches often have small, dammed ponds used for watering livestock.

Commercial fishing - Oyster farms in Tomales Bay are closed during rainfall events due to high concentrations of fecal coliforms. Potential sources include dairies and other confined animal facilities, grazing animals, septic systems, recreational use and wildlife. In May 1997 there was an outbreak of Norwalk virus, a human pathogen, transmitted by the consumption of oysters. A TMDL is currently being developed for pathogens in Tomales Bay. Oyster farming in Tomales Bay has also been impacted by sediment build up at the mouth of Walker Creek. The herring population declines in years with low freshwater input to the bay. The halibut harvest fluctuates with temperature because Tomales Bay is the northern limit of the range in non-El Niño years. [Bush 1995]

Beneficial Uses

Walker Creek is protected habitat for coho salmon, steelhead trout, and California freshwater shrimp [US Fish and Wildlife Service 1997]. The beneficial uses listed in the California Regional Water Quality Control Board, San Francisco Bay Region's Water Quality Control Plan (Basin Plan) [1995] that cover their habitat are: Cold Freshwater Habitat, Preservation of Rare or Endangered Species, Fish Migration, Fish Spawning, and Wildlife Habitat (COLD, RARE, MIGR, SPAWN, and WILD). Soulejoule Reservoir is a municipal water supply (MUN) and supports a warm water fishery, which covers Warm Freshwater Habitat, Water Contact Recreation, and Non-contact Water Recreation (WARM, REC1, and REC2). Despite the numerous dairy, cattle, and sheep ranches, no surface waters are listed for agricultural supply (AGR) as they are for the adjacent Lagunitas Creek watershed. Tomales Bay, to which Walker Creek drains, supports commercial aquaculture of oysters, as well as halibut, herring, ghost shrimp, and rock crab (COMM and SHELL). The Department of Fish and Game leases the oyster parcels and the Dept. of Health Services regulates the shellfish harvest.

Overview of Available Information

Previous Studies

General - The earliest comprehensive study of the watershed, *Master Drainage and Sediment Control Plan: Lagunitas and Walker Creek Watersheds* [1965], provides a basis of data for the watershed with an excellent, though general, series of maps for rainfall, geology (sedimentary and intrusive), vegetation (three classes), urban areas, slope (three classes), and stream profiles for mainstem and tributaries with several channel cross sections. *The Final Report of the Marin Coastal Watershed Enhancement Project* [1995] presents a thorough overview of water quality problems for agriculture and natural resources in West Marin featuring Walker Creek as one of three watersheds profiled in detail. The narrative summarizes description, land use history, research, and restoration in the watershed.

Geomorphic - Will Haible [1976] documents the dramatic geomorphic changes to the watershed above Keys Creek over the preceding 60 years, noting the change from perennial to seasonal flow, five feet of incision in the upstream reaches of Walker Creek, and downstream sedimentation which have decreased the stream gradient, widened channels, and caused a decline in riparian habitat.

Listed Species - Don Kelley's [1976] report implicates overgrazing as the primary cause of decline in the salmonid fishery. Among grazing impacts he lists a vegetative shift from native perennials to introduced annuals, compacted soil, increased runoff, reduced percolation, loss of soil moisture leading to flashy erosion of the streambed with consequent loss of riparian vegetation for shade, filling of pools with sand, vertical incision, groundwater drop, and loss of summer flows. Since grazing will remain, Kelley advised restoring summer and fall flows with releases from Soulejoule Reservoir. Alice Rich's 1989 survey of Walker Creek below Soulejoule cites sedimentation that reduces fish habitat and high summer temperatures as primary limiting factors for salmonids. Bratovitch [1984] found the highly embedded streambed to be the dominant culprit. The debate continues, and the fishery declines. The report on California freshwater shrimp [US Fish and

Wildlife Service 1997] establishes their expected range on short stretches of Keys and Walker Creeks, lists species requirements to restore a healthy population, and advocates plantings, exclusionary fencing, soil stabilization, and repair of roads and culverts. There is no current data on the distribution or health of the freshwater shrimp in the watershed.

Water Quality - Walker Creek was a sampling site in the Toxic Substances Monitoring Program from 1991-1993 [Basin Plan 1995]. Dyan Whyte's 1998 study verifies that mercury from the abandoned Gambonini Mine continued to leach from the site and recommended remediation. Whyte and Kirchner [2000] found that mercury discharges are highly correlated with suspended sediment, and that both are episodic, limited to brief, intense rainstorms, and thus likely to be overlooked by monitoring designs which neglect such episodic events. *Controlling Pathogens in Tomales Bay* [Taberski 2000] reviews studies from1974 to 1996 that tested for fecal coliform in the waters of and those that drain to Tomales Bay and forms the basis of the TMDL for pathogens in Tomales Bay. The highest fecal coliform loadings were found in Chileno Creek.

<u>Current and Future Studies</u>

Water Quality and Geomorphic - The Gambonini Mine Post-Remediation Monitoring is a five-year study through the San Francisco Regional Water Quality Control Board begun in winter 1998-99. Dissolved oxygen, salinity, conductivity, pH, temperature, total suspended sediments, and mercury are monitored at eight sites near the mine. Since December 1997, the California Department of Fish and Game has been sampling five sites near the mouth on Walker and Keys Creeks for ammonia (total and toxic), conductivity, dissolved oxygen, percent saturation, pH, temperature, and turbidity biweekly for six months. For the 2000-2001 Tomales Bay Pathogen Study, the San Francisco Bay Regional Water Quality Control Board, in conjunction with other agencies, tested surface waters for coliform bacteria at five sites within the Walker Creek watershed during storm events to determine loadings as a follow-up to the previous studies [Taberski 2000]. A geomorphic study including the Walker Creek watershed is being planned through the Tomales Bay Watershed Council habitat and geomorphology group.

General and Restoration - The University of California Extension Service works with ranchers in the watershed to improve ranching practices and mitigate grazing impacts. The Marin County Resources Conservation District has been working with landowners on restoration projects (mostly revegetation and riparian exclusion) to control erosion within the watershed since 1986 [Rich 1989]. The Point Reyes Bird Observatory has been conducting a migratory songbird count on Chileno and Walker Creeks for a few years, although recent lack of funding threatens the study's future. An active USGS gauging station remains at Walker Creek Ranch (Walker Creek # 11460750) collecting flow data.

Conclusions and Recommendations

The Walker Creek watershed is free of urban and industrial impacts, but overgrazing, water diversions, and extraction have resulted in water quality problems. Walker Creek is listed by the RWQCB as an impaired water body for sediment, nutrients, and mercury. Whyte's studies [1998, 2000] provide data on mining discharge, and some of the studies for pathogens in Tomales Bay give data on coliform bacteria [Taberski 2000], but there are no current data referenced for sediment. The few passable roads, as well as the need for permission from private landowners, limit access to large sections of Walker Creek. Water quality sampling for SWAMP should include:

?? Nutrient, pathogens, and sediments in Keys, Chileno, Arroyo Sausal, Salmon, and Walker Creeks to monitor for the effects from grazing, the major land use impact. Comparison with the Walker Creek Ranch site should give evidence of effectiveness of riparian cattle exclusion and revegetation efforts.

?? Pathogens and nutrients at Laguna Lake to monitor levels of input at the headwaters of Chileno Creek.

?? Pathogens and nutrients to monitor septic system leaks below Tomales on Keys Creek.

?? Flow, temperature, dissolved oxygen, and sediment below Soulejoule Reservoir to monitor conditions for the salmonid fishery.

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2. Lagunitas Creek Watershed

Background

Physical Setting

Topography and Tributaries—Lagunitas Creek watershed, the largest in the county, drains 103 square miles of west central Marin. From the headwaters on the north slope of Mount Tamalpais, Lagunitas Creek flows about 25 miles before reaching the southern tip of Tomales Bay. In the upper watershed where the slopes are steepest, the rainfall heaviest, and the woods thickest, the first eight miles of Lagunitas Creek are dammed for municipal drinking water (21.5 sq. mi. of watershed) by the Marin Municipal Water District (MMWD). Peters Dam holds 32,900 acre-feet in Kent Lake, about a mile downstream from three smaller reservoirs near the headwaters—Lake Lagunitas, Bon Tempe Lake, and Alpine Lake.

San Geronimo Creek drains San Geronimo Valley and joins Lagunitas Creek at Shafter Bridge, about a mile below Peters Dam. Devils Gulch drains the western slope of Barnabe Mountain and joins Lagunitas Creek about 2.5 miles downstream. The reach between San Geronimo and Tocaloma, especially in Samuel P. Taylor State Park, is prime habitat for coho salmon, steelhead, and California freshwater shrimp. By Tocaloma, the slope has relaxed and the creek starts to aggrade. Halleck and Nicasio Creeks drain 35.9 square miles of the gentle grassland hills of Nicasio Valley, joining in Nicasio Reservoir. About a mile below Seeger Dam, what remains of Nicasio Creek joins Lagunitas Creek.

Olema Creek, which flows in a two mile-wide and nine mile-long linear watershed within the San Andreas Fault Zone, drains 14.5 square miles of Inverness and Bolinas Ridges on either side. It joins Lagunitas southwest of Point Reyes Station, where tidal influence affects the flow. Bear Valley Creek, which also runs in the fault zone and drains Mt.

Wittenberg in the Inverness Ridge, joins Lagunitas just downstream in Olema Marsh, and is soon followed by steep Haggerty Gulch. Finally, at the southern end of Tomales Bay, Tomasini Creek joins the drainage from the low hills to the east.

Climate and Vegetation—Annual rainfall varies from 30 to 52 inches, with the most intense rain over Kent Lake and the upper watershed, and the driest portion in Nicasio Valley and the drainage of Tomasini Creek. The upper watershed supports a dense forest of redwood, Douglas fir, coast live oak, bay, and alder. The northern uplands of Nicasio and San Geronimo Valleys are grassland, with bay, coast live oak, and Douglas fir on the steeper slopes to the south. The gentle slopes on the east side of Olema Creek and the lower watershed are predominantly grassland and chaparral.

Geology and Soils—The Franciscan mélange underlying the watershed east of the San Andreas Fault includes greywacke, sandstone, shale, greenstone, and serpentine rocks. On steep slopes, it is susceptible to landslides and debris flows. Because Inverness Ridge (west of the fault) is granitic rock overlain by sandstone and shale which retain water for a year round base flow, the steep tributaries (15-20% slope) on the west side of Olema Creek are perennial. The east side, however, drains Bolinas Ridge, which is fractured Franciscan mélange, resulting in intermittent tributaries of lower gradient (4-8% slope). The San Andreas Fault crosses Olema Creek at Five Brooks, resulting in bank instability and erosion. The State Park reach of Lagunitas is underlain with greenstones, a source of cool, clear water for good fish habitat. On the steep southern side of San Geronimo Creek, a few large areas of serpentine are suspect for higher susceptibility to erosion and landslides. Basalt underlies both Barnabe Mountain near the confluence of San Geronimo and Lagunitas Creeks, and Black Mountain at the confluence of Nicasio and Lagunitas Creeks. Nicasio Valley soils have more clay, which is more susceptible to gullying and produces lower water quality.

Land Uses and Water Quality Issues

Water Diversions—The reduced flow from five reservoirs has dramatically altered stream flows, thereby affecting aquatic habitat. The lack of flushing flows means that sand and fine gravels are not transported, so excess bed sedimentation impairs fish habitat. Temperature, dissolved oxygen, and bed composition are all affected by reduced flow.

Open Space and Recreation—Most of the watershed is publicly owned and protected land. MMWD owns about 30% of the watershed, mostly in the southern portion near the headwaters. MMWD land is restricted to non-contact water recreation, although fishing is permitted at Nicasio Reservoir and grazing is allowed in a small area near Nicasio. The National Park Service (NPS) owns 21% of the watershed as Point Reyes National Seashore (PRNS) and Golden Gate National Recreation Area (GGNRA); Marin County Open Space District (MCOSD) has 3.5%; and Samuel P. Taylor State Park accounts for 3%. Each has trails for hikers, bikes, and horses. The State Park operates an active campground throughout the year, with swimming permitted. Outside the park, swimming is also popular at "Big Bend," a site downstream from Devils Gulch, and at "Inkwells," at the bottom of San Geronimo Creek. The old logging railroad bed along the creek from

San Geronimo to Point Reyes is now a recreational trail. The grassland hills on the north side of San Geronimo Valley that were once grazed are now mostly incorporated into a golf course. Surrounded by MMWD land in the upper watershed, a golf course drains to Bon Tempe Lake. Horse riding and swimming suggest testing for pathogens and nutrients; golf suggests testing for nutrients, herbicides, and pesticides.

Residential—Residential communities include Woodacre, San Geronimo, Forest Knolls, and Lagunitas along San Geronimo Creek; Nicasio on Nicasio Creek; Olema on Olema Creek; and, near the mouth of Lagunitas Creek, Point Reyes Station. French Ranch and Skye Ranch are recent developments upslope from San Geronimo Creek on the north and south sides respectively, and Big Rock Ranch is being developed at the headwaters of Nicasio Creek. All residential areas use septic systems, many of which have been known to leak, especially those along San Geronimo Creek. Pathogen testing there would provide data to encourage repair and maintenance of the septic systems.

Ranching—Nicasio Valley has three dairies, and several landowners in the valley keep horses. MMWD allows grazing only in small areas of their Nicasio Valley holdings. PRNS leases land to some beef cattle ranches along Olema Creek. There are three horse stables in Olema Valley, one on Devils Gulch, and two on San Geronimo Creek. A few more beef ranches operate in the lower watershed. Grazing effects to test for include stream bank erosion, turbidity, temperature (from reduced vegetative cover), and nutrients.

Farming—Olema Creek in the lowland between Olema and Point Reyes Station was channelized in 1922, with the meanders removed to make way for fields planted in feed crops and vegetables. The fields have been grazed for about forty years.

Mining—Gravel extraction from a quarry in the Halleck Creek sub-watershed is long-standing and the operation has applied to enlarge. The MMWD annually removes gravel to prevent flooding near Nicasio School. A cement plant near the confluence of Nicasio and Lagunitas Creeks ceased removing gravel and sands from the creek bed soon after Nicasio dam was built in 1961 and the supply dwindled. Downstream on Lagunitas Creek at the Genazzi ranch, gravel is commonly extracted for ranch use.

Logging and Fire—The upper watershed has a history of logging from 1860 through 1900. The south sides of Nicasio and San Geronimo Valleys have been logged from 1850 through 1960. Olema Valley was logged intermittently from 1880 until 1964. The Kent Lake area was clear-cut in the 1940s and early 1950s for the reservoir. Large fires raged through the watershed in 1904 and 1945, and smaller fires are common. Excess sedimentation is an expected watershed response to logging and fire; however, there is no recent history of these activities.

Commercial Fishing—Oyster farms in Tomales Bay are closed during rainfall events due to high concentrations of fecal coliforms. Potential sources include dairies and other confined animal facilities, grazing animals, septic systems, recreational use and wildlife.

In May 1997 there was an outbreak of Norwalk virus, a human pathogen, transmitted by the consumption of oysters. A TMDL is currently being developed for pathogens in Tomales Bay. The herring population declines in years with low freshwater input to the bay. The California halibut harvest fluctuates with temperature because Tomales Bay is the northern limit of the fishery range in non-El Niño years. Sediment discharge, flow, and temperature from Lagunitas Creek thus affect the bay.

Beneficial Uses

Lagunitas Creek is protected habitat for coho salmon, steelhead, and California freshwater shrimp. It supports 10% of California's coho run. The beneficial uses listed in the Basin Plan [1995] that cover their habitat are: Cold Freshwater Habitat, Warm freshwater habitat, Preservation of Rare or Endangered Species, Fish Migration, Fish Spawning, and Wildlife Habitat (COLD, WARM, RARE, MIGR, SPAWN, and WILD). Contact Water Recreation (REC-1) includes warm water fishing at Nicasio Reservoir and swimming at the State Park. The MMWD reservoirs are each a municipal water supply (MUN), with open trails for Non-contact Water Recreation (REC-2).

The watershed is listed for agricultural supply (AGR), although ranching is far less extensive than in the unlisted Walker Creek watershed. Olema Creek is listed for navigation (NAV), although that is an unlikely supported use. Nicasio Creek is listed as supporting spawning and migratory species (SPAWN and MIGR), although only for the mile between Seeger Dam and the confluence with Lagunitas Creek. Tomales Bay, to which Lagunitas Creek drains, supports a commercial aquaculture of oysters, as well as halibut, herring, ghost shrimp, and rock crab (COMM and SHELL).

Overview of Available Information

Previous Studies

General—The earliest comprehensive study of the watershed, *Master Drainage and Sediment Control Plan: Lagunitas and Walker Creek Watersheds* [1965], provides a basis of data for the watershed with an excellent, though general, series of maps for rainfall, geology, vegetation, urban areas, slope, and stream profiles for mainstem and tributaries with several channel cross sections. *The Final Report of the Marin Coastal Watershed Enhancement Project* [1995] presents a thorough overview of water quality problems for agriculture and natural resources in West Marin including the Lagunitas Creek watershed and includes reviews of previous studies. Most studies cite inadequate instream flows and sand deposition as the primary problems in the watershed.

Olema Creek—Although the detailed erosion and sediment study of Olema Creek from 1986-89 by Questa Engineering [Bush 1995] is limited by monitoring stream flow and sediment discharge during dry years, still it confirms the general good to fair watershed conditions of Olema Valley. Their investigation of aerial photographs from 1943 to 1985 determined that, aside from heavy logging before 1964, land use changed very little. Erosion features on the eastern side of the valley date back to sheep grazing at the turn of the century. Most erosion is attributed to the 1982-83 winter storms, most sediment is from channel bank erosion, the most significant slides (at Five Brooks where the creek crosses the San Andreas Fault) are due to faulting, and none is attributed to roads. Questa's study questions Hecht's 1980 study, which found that Olema Creek contributed more sediment to Tomales Bay than the rest of Lagunitas Creek watershed.

Lagunitas Creek, lower watershed—The North Marin Water District's (NMWD) *Summer Dam* report has salinity, temperature and dissolved oxygen data [Nelson *et al.* 1987].

Lagunitas and San Geronimo Creeks, mid watershed—Chatham's 1987 report on San Geronimo Creek is concerned with stream bank erosion and coarse sediment yield (particles from 0.5 to 45 mm), which is degrading the anadromous fishery in Lagunitas Creek. Prunuske and Chatham's 1990 report on bedload reduction in San Geronimo Creek determined that most of the coarse sediment yield is from natural, background erosion processes. Their study estimates that the 4000 tons per year of coarse sediment from San Geronimo Creek could be reduced by 15% (600 tons) using off-site control sediment traps on intermittent tributaries upstream of Woodacre to avoid harming fish habitat. According to their interpretation, because San Geronimo Creek is emerging from a period of heavy erosion into comparative equilibrium, sediment traps could induce headcutting and downstream channel scour and should be monitored.

Barry Hecht [1983, 1992] has produced several studies on Lagunitas Creek geomorphology since 1979. Like many coastal streams, Lagunitas has incised in the upper watershed (above Tocaloma) and filled in below, but the five dams have altered its sediment transport. Hecht concluded that the sand and fine gravels that impair aquatic habitat originate in San Geronimo Valley and accumulate because of reduced flow from the dams. He has monitored several sites long-term for bed composition, suspended sediment and bedload transport, imbeddedness, bed scour, pool and bar sedimentation, and stream bank erosion. Effects of the recommended erosion control on San Geronimo Creek are best monitored on Lagunitas Creek at the confluence just below Shafter Bridge. However, Hecht recommends against active monitoring of bed conditions below Tocaloma because they will vary with storm intensities, log jams, and factors not associated with upstream management.

Order: WR 95-17: Lagunitas Creek from the State Water Resources Control Board [1995] required MMWD to produce and implement a sediment and riparian management plan for the reach between Peters Dam and Tocaloma as mitigation for the 1982 Kent Lake enlargement. The order delineates provisions to protect coho salmon, steelhead, and California freshwater shrimp, including flow and sediment requirements, woody debris placement, and monitoring of turbidity, dissolved oxygen, and water temperature.

In response to this order, MMWD's sediment and riparian management plan [Prunuske Chatham, Inc. 1997] surveyed seven sites in the reach of prime fish habitat on Lagunitas Creek, monumented cross-sections, and identified pool, riffle, and glide habitat sequences. They found the upper reach had less embeddedness, less sand, and more exposed bedrock, whereas the lower reach had more sand and lower mean particle size than Hecht's studies of earlier years. They detail 34 of over 300 sediment sources, with photos, descriptions, and ratings. The study recommends sites for revegetation and placement of woody debris structures to improve fish habitat.

Fishery—Bratovich *et al.* [1982] provide a summary of streamflows and bed conditions needed to maintain and improve the fishery in San Geronimo and Lagunitas Creeks, along with extensive data on life cycle characteristics and distributions. Prunuske and Chatham's 1994 report on fish habitat enhancement recommended: (1) maintaining instream flow, water temperature, and turbidity standards, (2) reducing sedimentation (especially of sands), and (3) increasing woody debris. They identified 17 sites for placement of woody debris structures between Irving and Shafter Bridges. A few structures have been emplaced and are currently monitored for fish recruitment by MMWD. Trihey and Associates [1996] provide background on salmonid and freshwater shrimp habitat requirements, past monitoring efforts, and recommendations for surveys through 2007 to determine distribution and population trends, and monitoring for habitat typing, flow, and temperature. Larry Serpa monitors the California freshwater shrimp in Lagunitas Creek for MMWD [Serpa 1992, 1996].

<u>Current and Future Studies</u>

In compliance with *Order WR 95-17* MMWD regularly samples turbidity, temperature, dissolved oxygen, and total suspended solids at Peters Dam, Shafter Bridge, Irving Bridge, Tocaloma, Gallagher's Ranch, and Seeger Dam; they monitor 34 erosion sites, woody debris structures, and salmonid redds in Lagunitas Creek; and they are currently sponsoring a study of sedimentation and erosion in San Geronimo Valley as a follow-up to the Prunuske Chatham, Inc. study [1990].

Since December 1997, the California Department of Fish and Game (DFG) has been sampling sites on Lagunitas and San Geronimo Creeks for ammonia (total and unionized), conductivity, dissolved oxygen, percent saturation, pH, temperature, and turbidity biweekly for six months as part of the Marin and Sonoma Counties Agricultural Runoff Investigation (MSCARI).

The 2000-2001 Tomales Bay Pathogen Study by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), which tested surface waters for coliform bacteria, included nine sites within the Lagunitas Creek watershed. The study is a follow-up to a 1995-96 study [Taberski 2000], with preliminary results indicating high pathogen loadings for San Geronimo Creek.

Leslie Ferguson, graduate student and staff of the SFBRWQCB, has been sampling juvenile fish in Lagunitas Creek from below Peters Dam to Jewell (above Tocaloma) during the summers of 2000 and 2001. At ten sites, she has measured chlorophyll A, MBAS, temperature, dissolved oxygen, nitrates, and phosphates. She used the V* method to assess pool sediment depth.

For a three-year water quality study starting in fall of 1999, PRNS monitored un-ionized ammonia, nitrate, nitrite, and orthophosphorus at sixteen sites along Olema Creek, but stopped after finding values for the nutrients mostly undetectable. At the same sites, they also measure flow, pH, temperature, dissolved oxygen, total suspended solids, turbidity and fecal and total coliform bacteria during five wet and one dry event each year. They have been monitoring benthic macroinvertebrates at six sites along the mainstem of Olema during the spring and fall of 2000 and 2001.

For the Septic Tank Advisory Committee (SepTAC—a county government entity), the Marin County Community Development Agency will be mapping septic tanks throughout the county within the next two years. Because land within 100 feet of a stream has priority, the San Geronimo Valley parcels should be identified soon.

Active USGS gauging stations on Lagunitas remain at Gallagher's Ranch (daily discharge in cubic feet per second since 1975, temperature and sediment data records from October 1989 to September 1990), and Samuel P. Taylor Park (daily water stage and crest stage since December 1982).

The North Marin Water District (NMWD) has plans to install a pipeline below Gallagher's Ranch, with a possible treatment plant for iron and manganese removal and chlorination.

Conclusions and Recommendations

The Lagunitas Creek watershed represents some of the finest pristine stretches of protected creek in its upper watershed, providing rare reference sites. Urban and industrial impacts are insignificant. However, substantial effects from reduced flow and stream network availability due to the five reservoirs are a concern, especially for the salmonid fishery. Grazing impacts, while not as severe as in the Walker Creek watershed, are nonetheless present. The watershed is listed as an impacted water body because of coarse sediment yield, with a focus on San Geronimo Creek.

Water quality sampling for SWAMP should include:

?? Flow, temperature, dissolved oxygen, and biological indicators at reference sites in the protected upper watershed above Peters Dam.

?? Flow, temperature, dissolved oxygen, and sediments in Lagunitas Creek below Peters Dam, in Nicasio Creek below Seeger Dam, and San Geronimo and Olema Creeks to monitor conditions for the salmonid fishery and the freshwater shrimp.

?? Sediment monitoring up and downstream from the confluence of Lagunitas and San Geronimo Creeks to monitor for erosion control.

?? Pathogens and nutrients to monitor septic system leaks on San Geronimo Creek.

?? Nutrient and pesticide testing below the golf courses at Bon Tempe Lake and on San Geronimo Creek.

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3. San Leandro Creek Watershed

Background

Physical Setting

San Leandro Creek watershed is a 46.5 square mile drainage basin in Alameda and Contra Costa Counties. From the headwaters near Round Top Peak in Rocky Ridge of Sibley Park, the creek drains to Arrowhead Marsh in San Leandro Bay, just north of the Oakland airport. Redwood, Indian, Moraga, Buckhorn, and Kaiser Creeks drain into the Upper San Leandro Reservoir; downstream, Grass Valley Creek drains into Lake Chabot. Lower San Leandro Creek, from below Chabot dam to Arrowhead Marsh, runs for about six miles through residential and urban industrial areas of Oakland and San Leandro. Although it is channelized and concrete lined in portions of the lower reach, San Leandro Creek is one of the few East Bay creeks still entirely above ground.

The landscape varies from gently rolling hills to steep canyons. Ridges trend from northwest to southeast, the same as the faults. The Hayward Fault crosses the creek below Chabot dam. The bedrock is nearly all sandstone and shale, with some volcanics in Sibley Park and serpentine outcrops along and beneath Lake Chabot. Soils are mostly loam and loam/clay loam; they rate as a moderate to high erosion hazard. Grassland is the dominant vegetation type, with scattered oak woodlands, and coastal chaparral throughout the undeveloped areas. Redwood Creek runs through a second and third growth redwood forest in Redwood Park. The common eucalyptus and Monterey pine trees were planted intentionally, although now considered for removal, and remnants of fruit orchards remain. Average annual rainfall is about 26 inches, but it ranges from 11-48 inches per year, most of it falling between October and May. About 18 acres of freshwater marsh near Upper San Leandro Reservoir support wetland species.

The drainage of upper San Leandro Creek above Chabot dam is protected watershed of the East Bay Municipal Utility District (EBMUD) and undeveloped parkland for recreational use held by the East Bay Regional Park District (EBRPD). The towns of Moraga and Rheem Valley are in the upper drainage above Upper San Leandro Reservoir.

Water Quality Issues

a. Water Diversion: Upper San Leandro Reservoir provides water for domestic supply, which must meet drinking water standards. The Mokelumne Aqueduct delivers water from the Sierras to the reservoir at Moraga Creek. The water in Lake Chabot is for emergency supply, recreation, and golf course irrigation; only occasionally in the winter is excess water released. Summer flow in the lower watershed has been attributed to seepage from Lake Chabot [URS 1999]. Lack of summer flow in the lower watershed because of the water detained by the dams leads to high water temperatures and low dissolved oxygen in the remaining stagnant pools.
b. Pathogens and Toxicity. Recreational land uses in the upper watershed such as horse stables and golf courses suggest testing for coliform, nutrients, pesticides, and herbicides.
c. Urban Runoff. In the lower San Leandro watershed, runoff from storm drains is the major source of summer flow. Consequently, the water quality of the lower creek is more subject to pollutants during the dry season.

Beneficial Uses

The San Francisco Bay Basin Water Quality Control Plan (Basin Plan) of 1995 identifies 8 beneficial uses in the surface waters of the San Leandro Creek Watershed:

COLD	Cold Freshwater Habitat
FRSH	Freshwater Replenishment
MUN	Municipal and Domestic Water Supply
REC-1	Water Contact Recreation
REC-2	Non-contact Water Recreation
SPWN	Fish Spawning
WARM	Warm Freshwater Habitat
WILD	Wildlife Habitat

The rainbow trout was first described in 1855 from a specimen in San Leandro Creek.

Overview of Available Information

Previous Studies

East Bay Municipal Utility District (EBMUD) has a management plan for the upper watershed above Lake Chabot Dam [Montgomery Watson 1995]. The study presents detailed descriptions of the watershed and water supply system, an analysis of water quality conditions and potential sources of water quality impairment, and current management practices. The survey refers to a 1993 report, “Stormwater Quality Impacts on San Pablo Reservoir and Upper San Leandro Reservoir”, which investigated nutrient levels to determine the limiting factor for algal blooms.

Re-envisioning San Leandro Creek [1994] includes an inventory of vegetation and land uses with 25 cross-sections and pebble counts for the stretch from Chabot Dam to Interstate 880.

The *San Leandro Creek Coordinated Resource Management Planning Process Draft* [URS 2000] addresses the lower watershed. The report includes several maps documenting a 1998 creek walk from Lake Chabot to Arrowhead Marsh, noting left and right bank conditions, vegetation, and problem areas. The data is also available as an ArcView layer.

Genetic studies reveal the trout in Redwood Creek to be descendants of the native steelhead, thereby representing a unique, landlocked, non-hybridized coastal population [Gall *et al.*] In San Leandro Creek above Chabot dam, trout population counts have ranged above 10,000 [Holsinger *et al.* 1991]. While steelhead once spawned above the dams, lower San Leandro Creek is frequently dry in the summer and fall and has never supported a year-round fish population.

In the urban reach of the watershed, Friends of San Leandro Creek has done routine volunteer monitoring from 1995-1998, summarized in a report [URS 1999]. Their survey included water quality (dissolved oxygen, temperature, pH, conductivity, and turbidity), fisheries habitat assessment, bird counts, diazinon and toxicity testing at a limited number of stations. Results suggested that despite lack of summer flow in the lower watershed, still some adequate aquatic habitat may persist.

<u>Current and Future Studies</u>
In the upper watershed, EBMUD continues its monitoring and water quality testing for its municipal drinking water reservoirs. The East Bay Regional Park District monitors the use of herbicide and pesticide at Willow Park Golf Course, Moraga Country Club, and Orinda Country Club. The California Department of Fish and Game continually monitors a leak from an underground petroleum tank removed about ten years ago in the east fork of Redwood Creek.

Six stations on San Leandro Creek included in Breaux's study [2001] were tested for pH, conductivity, turbidity, dissolved oxygen, temperature, and salinity, as well as sediment (percent fines, total organic carbon, metals, pesticides, and PCBs) and for benthic macroinvertebrates. This study, funded by the California Coastal Conservancy, will continue for at least two more years. In the fall of 2000, the Regional Water Quality Control Board tested for diazinon at the Clarke St. footbridge.

Conclusion and Recommendations

Upper watershed issues are concerned with municipal drinking water, grazing, and recreational uses. The protected EBMUD watershed lands with restricted access provide good reference sites. In the lower watershed below Chabot dam, urban water quality issues are pesticides, toxicity, and urban and industrial runoff. The seasonal variation in flow leads to degradation of water quality in the lower reaches in the dry months. The sampling for SWAMP should include:

?? Flow, pH, conductivity, turbidity, dissolved oxygen, temperature, and sediment chemistry in the upper watershed to monitor the stream for health of the rainbow trout.
?? Pathogen monitoring near Canyon School and horse stables in the upper watershed.
?? Flow, pH, conductivity, turbidity, dissolved oxygen, temperature, and sediment chemistry in the lower watershed to monitor stream health and compare with the upper watershed.
?? Chemistry and toxicity in the lower reaches of San Leandro creek that is more heavily urbanized.

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4. Wildcat/San Pablo Creek Watersheds

Background

Physical Setting

Wildcat and San Pablo Creeks are contiguous watersheds in Contra Costa County, together draining 48 square miles to San Pablo Bay, just north of Point Richmond. In its linear, nine square mile watershed, Wildcat Creek drains the western slopes of Vollmer Peak (1913 feet) in the Berkeley Hills, flows north through Wildcat Canyon, turns west through San Pablo, Richmond, and North Richmond, and runs through Wildcat Marsh before entering San Pablo Bay. Wildcat Creek has a major tributary, Havey Creek, and two small impoundments, Lake Anza and Jewel Lake. The first four miles of its headwaters are within East Bay Regional Park District (EBRPD). The remaining seven miles of creek are mostly open, even through urban areas. According to the California Department of Fish and Game, it is one of the last San Francisco Bay streams with a nearly continuously vegetated riparian channel.

Adjoining the narrow Wildcat Creek watershed on the north is the wider 39 square mile watershed of San Pablo Creek. Perennial tributaries of San Pablo Creek include Bear Creek, which drains into San Pablo Reservoir, and Lauterwasser Creek, which drains into Briones Reservoir. Much of the upper watershed is in protected East Bay Municipal Utility District (EBMUD) land or EBRPD land. In the lower watershed below San Pablo Dam, San Pablo Creek runs through suburban El Sobrante and San Pablo before entering the bay at Wildcat Marsh. Until 1895, San Pablo Creeks meander in Wildcat Marsh where it connects to Wildcat Creek.

The Wildcat/San Pablo Creek watershed landscape varies from gently rolling to steeply sloping hills. The steepest slopes, from 30 to 70%, are on San Pablo Ridge to the west of San Pablo Reservoir. Sandstone and shale underlie most of the watershed, except for igneous bedrock of volcanic origin along San Pablo Ridge. Soils are over half clay loam, with clay and loam making up the rest. Most of the soil is moderately to highly susceptible to erosion. There are several landslides in the upper watershed. The ridges trend northwest to southeast, as do the Moraga Fault, which runs parallel to San Pablo Creek, and the Hayward Fault two miles west. Wildcat Creek crosses the Hayward Fault at Alvarado Park.

Grasslands dominate the upper watershed, with patches of northern coastal scrub and chaparral and woodlands of oak, bay, and buckeye on the south-facing slopes. Monterey pine and eucalyptus were planted in the hills. Average annual rainfall is 23 inches, with a range from 5 to 49 inches, mostly falling between October and May.

Water Quality Issues

a) Water Diversion. The Mokelumne Aqueduct system imports municipal drinking water from the central Sierra Nevada Mountains for storage in Briones and San Pablo Reservoirs. The Lake Anza and Jewel Lake impoundments are minimal and for recreational purposes only; however, their dams do impede fish migration.
b) Sediment. The highly erodible sandstone of the hills is prone to downcutting. The Hayward Fault crosses Wildcat Creek at Alvarado Park, a site of a damaged creek restoration project. Landslide areas are evident in the hills to the east. Grazing impacts in Havey Canyon of the upper watershed may cause excess sedimentation. Wildcat Creek has been shown to be eroding in the upper watershed and transporting excess sedimentation downstream [Collins *et al.* 2001].
c) Pathogens. Both lakes on Wildcat Creek are used for swimming and monitored for coliform bacteria from April through October.
d) Toxicity. The Orinda water treatment plant discharges its filter backwash to San Pablo Creek after holding it in a settling basin for a few hours. Unintended chemical spills from the Orinda filter plant could impair aquatic life downstream.
e) Urban Runoff. Urban communities within the watersheds include Orinda, El Sobrante, San Pablo, Richmond, and North Richmond. The latter three include heavily industrialized portions, with the potential for toxic runoff. The 300 acre salt marsh at the mouth of the watershed is bordered by a landfill, a sewage treatment plant, and Chevron's industrial holding ponds and refineries. A new development just north of San Pablo Dam is likely to deliver additional sediment and runoff to the lower reaches of San Pablo Creek.

Beneficial Uses

The San Francisco Bay Basin Water Quality Control Plan (Basin Plan) of 1995 identifies 8 beneficial uses in the surface waters of the Wildcat/San Pablo Creek Watershed:

COLD	Cold Freshwater Habitat
MUN	Municipal and Domestic Water Supply
MIGR	Fish Migration
REC-1	Water Contact Recreation
REC-2	Non-contact Water Recreation
SPWN	Fish Spawning
WARM	Warm Freshwater Habitat
WILD	Wildlife Habitat

Two endangered species live in Wildcat Marsh, at the outlet of both creeks: the salt marsh harvest mouse and the clapper rail. Native rainbow trout were re-introduced to Wildcat Creek in 1983 and are still resident.

Overview of Available Information

<u>Previous Studies</u>

East Bay Municipal Utility District (EBMUD) has a management plan for the upper watershed above San Pablo Dam [Montgomery Watson 1995]. The survey presents detailed descriptions of the watershed and water supply system, an analysis of water quality conditions and potential sources of water quality impairment, and current management practices. The survey refers to a 1993 report, "Stormwater Quality Impacts on San Pablo Reservoir and Upper San Leandro Reservoir", which investigated nutrient levels to determine the limiting factor for algal blooms. They also document sampling of Briones and San Pablo Reservoirs in 1988-89 and 1990-91 for stormwater runoff.

The long-awaited flood control project in the lower reaches of Wildcat/San Pablo Creek watershed, accomplished by joint efforts of the U.S. Army Corps of Engineers and local community groups, was followed by an environmental mitigation plan to improve the riparian habitat and include a creekside trail.

During seven months of 1997-1998, ten sites in Upper San Pablo Creek were monitored for flow, temperature, pH, total dissolved solids, turbidity, and dissolved oxygen [Barrett and Barrett 1998]. All parameters indicated a relatively healthy urban watershed, although trash was a notable problem in the creek.

Wildcat Creek Watershed: a Scientific Study of Physical Processes and Land Use Effects [Collins *et al.* 2001] includes a detailed creek profile with stream bank and bed conditions from below Jewel Lake (8.9 miles upstream) to the upper alluvial plain above Interstate 80 (over a mile from the mouth). The graph is invaluable for tracking erosion and sediment changes along the stream.

The 1992 Alvarado Park Restoration Project designed by Dave Rosgen for the EBRPD restored bank and channel stability to 1660 feet of Wildcat to improve water quality and replaced a concrete dam with a Denil fish ladder to improve fish migration. In the spring of 1995, a ten-year flood of about 900 cfs damaged the project. The fish ladder has proven poorly sited and ineffective; a by-pass is planned [Urban Creeks Council 1996].

From October 1995 to May 1996, the Wildcat Creek Monitoring Project sampled water quality every two weeks at four sites in the upper watershed and four in the urbanized lower watershed. They measured temperature, pH, dissolved oxygen, turbidity, conductivity, and ammonia. Temperature, conductivity, and dissolved oxygen were within acceptable ranges except at Verde School; pH was generally alkaline; and turbidity was high at downstream sites. In spring 1994, an Environmental Chemistry class from UC Berkeley studied total and fecal coliform bacteria, pH, dissolved oxygen, and conductivity at Lake Anza. EPA Flood Protection Project on Wildcat Creek studied ways to improve anadromous fish migration and riparian habitat. The Denil fish ladder was poorly sited and thus does not help fish migration, but a by-pass is planned [Urban Creeks Council 1996].

The Department of Fish and Game and Pete Alexander from EBRPD have sampled Wildcat for rainbow trout since the re-introduction in 1983. They have found the population fluctuations to be dependent on rainfall, indicating that flow is the limiting factor.

Urban Creeks Council (UCC) and Waterways Restoration Institute (WRI), together with the U.S. Army Corps of Engineers and Contra Costa County, finished a creek bank stabilization and reshaping project on the reach between Verde School and Richmond Parkway, and at Davis Park.

<u>Current and Future Studies</u>

Five stations on Wildcat Creek included in Breaux's study for the Regional Water Quality Control Board [2001] were tested for pH, conductivity, turbidity, dissolved oxygen, temperature, and salinity, as well as sediment (percent fines, total organic carbon, metals, pesticides, and PCBs) and for benthic macroinvertebrates. This study, funded by California Coastal Conservancy, will continue for at least two more years. In the fall of 2000, Davis Park on Wildcat Creek and Kennedy Park Footbridge on San Pablo Creek were tested for diazinon.

Contra Costa County has been training volunteers to use GPS units and to collect detailed information about physical stream characteristics, especially bank condition, vegetative cover, and physical obstructions. San Pablo Creek will be included in their survey. U.C. Berkeley graduate student Jeff Opperman is studying large woody debris and channel complexity in Wildcat Creek.

Urban Creeks Council will be using Proposition 13 funds to study the upper watershed of Wildcat Creek to determine restoration approaches. Two sites of interest are the culvert beneath the city of San Pablo playing fields and the culvert above Alvarado Park. The City of San Pablo and Urban Creeks Council are sponsoring a bank stabilization project for a small stretch near the intersection of San Pablo Ave. and Road 20.

The Friends of Orinda Creeks is proposing a restoration project for 1,400 feet of San Pablo Creek through downtown Orinda [Leventhal 2001]. The plan includes restoration of a more natural sinuosity while providing flood control and bank stabilization, and revegetation of the riparian corridor.

The San Pablo Watershed Neighbors Education and Restoration Society (SPAWNERS) is funded by CalFed for a cleanup and revegetation project at a site on Appian Creek, a tributary to lower San Pablo Creek, in El Sobrante. SPAWNERS has been monitoring water quality monthly since May 2000 (temperature, pH, dissolved oxygen, turbidity, and conductivity) at two sites in the lower watershed in El Sobrante. In August 2001, with Save the Bay, they will add an oyster-monitoring site at the mouth in North Richmond.

Conclusion and Recommendations

The upper watershed water quality issues include drinking water standards for water in the reservoirs, landslides and erosion leading to excess sediment delivery to the hydrological network, grazing impacts, and contamination in runoff from major transportation corridors and recreational facilities. The lower watershed issues are more directly related to pollution from urbanization and restoring stream functions to reduce excess sedimentation. Restoring clear fish passage for the trout is a goal on Wildcat. Sampling for SWAMP should include:

- ?? Physical habitat measurements and special sediment studies to evaluate the effect of erosion and sedimentation in the upper watershed.
- ?? Bacteriological indicators in areas used for water recreation.
- ?? Basic water quality parameters for aquatic life assessment.
- ?? Toxicity and chemistry to evaluate the effects of urbanization and industrialization in the lower watershed.

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Shanna Anderson at Aquatic Outreach Institute
Jill Marshall and Andrée Breaux at the San Francisco Regional Water Quality Control Board

5. Suisun Creek Watershed

Background

Location and Hydrology - The Suisun Creek watershed is a 57 square mile drainage basin in Solano and Napa Counties. Suisun Creek originates in the Vaca Mountains of the central California Coast Range and empties into Suisun Marsh and Suisun Bay in the San Francisco Estuary.

The major tributary to Suisun Creek is Wooden Valley Creek, which flows through Wooden Valley before its confluence with Suisun Creek three miles below Lake Curry. Suisun Creek and Wooden Valley Creek are perennial streams, while many of the smaller tributaries, such as White's Creek, dry up in mid-summer.

There are two reservoirs in the watershed, Lake Curry and Suisun Reservoir. Susan reservoir is a small, dammed lake on a minor tributary to Suisun Creek. Lake Curry is a much larger reservoir on the main stem of Suisun Creek, on the southern end of Gordon Valley. Lake Curry has been owned and operated by the city of Vallejo since the 1920's. During the droughts of the late 1980's and early 1990's the water level in the reservoir dropped to such a low level that the treatment plant was no longer able to adequately purify the water. The City of Vallejo allowed the treatment plant to fall into disrepair, and has not drawn water from Lake Curry since the early 1990's. A recent proposal from House Representative George Miller (D-Martinez) would allow the City of Vallejo to transport water from Lake Curry to the Green Valley treatment plant via Suisun Creek and the Putah South Canal. Working with members of the Save Suisun Creek Alliance, the City of Vallejo has promised to provide adequate water for aquatic resources, especially steelhead fisheries.

Geologic and Geomorphic Setting - Suisun Creek and Wooden Valley Creek flow through broad alluvial valleys. The hills of the central California Coast Range are highly erosive, with large amounts of sediment being transported to streams during severe winter rain events.

Land Uses and Associated Water Quality Issues - The Suisun Valley is predominantly agricultural, with numerous vineyards and orchards spread throughout Suisun Valley, Gordon Valley, and Wooden Valley. Population centers include the small communities of Rockville, Wooden Valley, and Gordon Valley. Specific land uses of concern in the Suisun Creek watershed include:

- Runoff and erosion from agricultural and grazed land, especially vineyards
- Runoff and discharge from residential houses, including Rockville
- Illegal water discharges from the Putah South Canal
- Water release and retention from Lake Curry Dam

Potential pollutants include:

- Agricultural and household pesticides, such as diazanon
- Excessive erosion and sedimentation

?? Excessive nutrients and low dissolved oxygen

Beneficial Uses - The two major water bodies of the Suisun Creek Watershed support the following beneficial uses, as described in the San Francisco Bay Basin Water Quality Control Plan (1995 Basin Plan):

Beneficial Uses		**Suisun Creek**	**Lake Curry**
COLD	Cold Freshwater Habitat	**E**	
FRSH	Freshwater Replenishment	E	
MIGR	Fish Migration	E	
MUN	Municipal and Domestic Supply		E
REC-1	Water Contact Recreation	P	E
REC-2	Noncontact Water Recreation	P	E
SPWN	Fish Spawning	E	E
WARM	Warm Freshwater Habitat	E	E
WILD	Wildlife Habitat	E	**E**

(Note: E = existing beneficial use and P = potential beneficial use):

Overview of Available Information

There is little information available on water quality in the Suisun Creek watershed. The Department of Fish and Game did an Aquatic Bioassessment study on Suisun Creek following an illegal discharge of water from the Putah South Canal. Currently, Laurel Marshall and Associates, a Bay Area environmental consulting firm, is initiating a water quality study in the Suisun Creek watershed. Regional Board staff are collaborating with Laurel Marshall and Associates to insure that our data collection efforts are complementary.

6. Arroyo de las Positas Watershed[1]

Background

Location and Hydrology - The Arroyo de las Positas watershed, a 77 square mile watershed in eastern Alameda County, is one of the main tributaries to Alameda Creek in the Livermore Valley basin. Arroyo de las Positas originates at the confluence of its two major tributaries, Altamont Creek and Arroyo Seco, just north of Interstate 580 near Springtown Boulevard in the city of Livermore. From the confluence, Arroyo de Las Positas flows west for 7 miles, roughly parallel to Interstate 580, until it meets Arroyo Mocho just east of the city of Pleasanton. Other tributaries to Arroyo de Las Positas include Cottonwood Creek, Colier Canyon, and Cayetano Creek, which drain north-south trending valleys north of the city of Livermore. Arroyo de las Positas, Arroyo Mocho,

[1] In the San Francisco Bay Basin Water Quality Control Plan (Basin Plan), this watershed is identified as "Arroyo de las Positas." In other maps and studies it is called "Arroyo Las Positas."

Arroyo Valle, Tassajara Creek, and Alamo Creek together drain the Livermore Valley watershed before entering Arroyo Laguna and Alameda Creek west of San Antonio reservoir.

Altamont Creek drains the Altamont Hills in the easternmost area of the San Francisco Bay region. In the Altamont hills, the mainstem of Altamont Creek is flanked by Altamont Pass Road and railroad tracks from Altamont Pass to the floor of the Livermore Valley. In the valley floor, the creek meanders north and west through the Springtown residential developments prior to the confluence with Arroyo Seco. Several unnamed, second- and third-order tributaries drain Brushy Peak and other hills to the north, joining Altamont Creek just east of the Springtown developments.

The 31 square-mile Arroyo Seco watershed drains the south-eastern mountains of the Livermore Valley, from Interstate 580 in the north to Crane Ridge in the south. The mainstem of Arroyo Seco follows Tesla Road for much of its length, before it crosses the South Bay Aquaduct. Arroyo Seco flows through recent residential developments and the south-west corner of the Lawrence Livermore National Laboratory before crossing under Interstate 580 and meeting Altamont Creek. Numerous smaller, unnamed tributaries feed Arroyo Seco, including a Zone 7 Water Agency flood control channel (P-1) that drains the central part of eastern Livermore Valley.

The average rainfall in the Arroyo de las Positas watershed ranges from 12 to 16 inches per year (Zone 7). Arroyo de las Positas, and the lower portions of both Altamont Creek and Arroyo Seco, are perennial streams. Cottonwood Creek, Colier Canyon, and Cayetano Creek are believed to be intermittent, with groundwater-fed base flow occurring from December through May (Zone 7). The upper portions of all of the creeks in the Arroyo de Las Positas watershed are dry for much of the year. During the dry season the primary source of water in Arroyo Seco is wastewater from the Lawrence Livermore National Laboratory, which is drained by the Zone 7 Water Agency P-1 flood-control channel. Upstream of the confluence with this channel, Arroyo Seco is dry for much of the year, beginning soon after the last winter storm.

<u>Geologic and Geomorphic Setting -</u> The lower portions of Arroyo Seco and Altamont Creek, and the entire length of Arroyo de las Positas, flow through the Livermore Valley, a structural basin filled with Quaternary alluvial deposits (Herd, 1977). The southern end of the Livermore Valley is formed by the Las Positas fault, a high-angle, northeast trending fault system. The upper watershed areas are also primarily quaternary alluvial deposits, poorly consolidated and highly erodable rocks uplifted by the Las Positas fault and Greenville fault systems. Streams in the Livermore Valley are believed to be still evolving in response to late Quaternary folding and associated uplift.

<u>Land Uses and Associated Water Quality Issues</u> - Historic and current land use practices have undoubtedly resulted in detrimental impacts to the water quality of the Arroyo de las Positas watershed. The Livermore Valley is one of the fastest-growing regions of the Bay Area. The continued rapid construction of residential communities, golf courses, and

commercial areas in previously undeveloped open space threaten water quality by increasing the quantity of poor quality urban runoff. Much of the upper portion of the watershed is rangeland or open space, although substantial land development is predicted in the future. Specific land uses of concern in the Arroyo de las Positas watershed include:

- ?? Runoff and discharge from urban areas, including the City of Livermore, Lawrence Livermore National Laboratory, Springtown Golf Course and Los Positas Golf Course, Livermore sewage disposal site, and new and recent residential developments, such as the Springtown residential developments.
- ?? Runoff and erosion from agricultural and grazed land

Potential pollutants include:

- ?? Pesticides, such as diazanon
- ?? Excessive erosion and sedimentation, compounded by grazing and land use effects
- ?? Excessive nutrients and low dissolved oxygen

Beneficial Uses - The Basin Plan does not differentiate beneficial uses between the tributaries of the Alameda Creek watershed. Therefore, the existing beneficial uses in the Arroyo de las Positas watershed are taken to be those listed for Alameda Creek:

AGR	Agricultural Supply
COLD	Cold Freshwater Habitat
GWR	Groundwater Recharge
MIGR	Fish Migration
REC-1	Water Contact Recreation
REC-2	Noncontact Water Recreation
SPWN	Fish Spawning
WARM	Warm Freshwater Habitat
WILD	Wildlife Habitat

Overview of Available Information

The Zone 7 Water Agency conducts monitoring of ground water quality and distribution, but no surface water quality monitoring. There is no known data or research on surface water quality in the watershed.

WATERSHEDS WHERE SAMPLING WILL START IN SPRING 2002:

1. Pescadero Creek Watershed

Background

Physical Setting

The watershed of Pescadero and Butano Creeks is an 82 square mile drainage basin in western San Mateo County. The headwaters of both Pescadero Creek and Butano

Creek are in the Santa Cruz Mountains. Pescadero and Butano Creeks converge in the Pescadero Marsh on the Pacific Ocean. Numerous tributaries feed Pescadero Creek including Honsinger, Hoffman, McCormick, Lambert, Slate, and Oil Creeks. Butano Creek tributaries include Little Butano and South Fork Butano Creeks.

Beneficial Uses

The San Francisco Bay Basin Water Quality Control Plan (Basin Plan) of 1995 identifies 10 beneficial uses in the surface waters of the Pescadero-Butano Watershed.

AGR	Agricultural Supply
COLD	Cold Freshwater Habitat
MIGR	Fish Migration
MUN	Municipal and Domestic Supply: drinking water
RARE	Preservation of Rare or Endangered Species
REC-1	Water Contact Recreation
REC-2	Non-contact Water Recreation
SPWN	Fish Spawning
WARM	Warm Freshwater Habitat
WILD	Wildlife Habitat

In addition to these uses, Pescadero Marsh serves as estuarine habitat (EST).

Water Quality Issues

Sediment - The Pescadero watershed is prone to very high sediment yields, caused by the combination of very unstable rock types and soils, high relief and steep slopes, high-intensity rainfall events, and human land use changes such as logging, road building, agriculture, and urbanism. The accumulation of excess fine sediment in gravel-bedded creeks reduces the quality of fish habitat for spawning. Pescadero Creek is listed on the 303(d) list of impaired water bodies as medium priority for excessive sedimentation and siltation resulting in impairment of steelhead habitat. According to the RWQCB San Francisco Bay Region TMDL Time Schedule of October 2000, a TMDL for siltation will be completed by 2005.

Flooding - Pescadero Creek is historically prone to flooding. The main access route to the town of Pescadero is routinely flooded during heavy winter storms. Although not a traditional water quality issue, flooding is nonetheless an important issue to community members. The magnitude and frequency of flooding which affects humans and their property is dependent on the location of human habitations, as well as on land use decisions that may affect storm flow. Recent large log-jams have developed in the creek, which divert water to the flood plain during high flows.

Urban and Agricultural Runoff - Agriculture occurs along much of the length of the main channel of Pescadero Creek. Runoff from agricultural areas is often high in suspended sediment, nutrients, and pesticides. The primary urban center is the town of Pescadero, near the mouth of the creek.

Overview of Available Information

Previous Studies

Between 1994 and 1996 the Pescadero-Butano Creek Coordinated Resource Management and Planning (CRMP) project was completed with the purpose of reducing non-point source pollution. The BMP demonstration projects focused on grazing operations, agriculture, roadside management, recreation, and timber harvesting. A volunteer monitoring program consisted of suspended sediment, bacteria, and photo monitoring. As part of the education component of the demonstration project sponsored by the Farm Bureau, Laurel Graham-Holsman, the project coordinator, devised a Creek Maintenance Certification Workshop. Local farmers and ranchers were aided in developing stream management projects such as removing log-jams causing flooding, restoring riparian vegetation, diverting runoff, removing garbage from streams, and seeding farm roads adjacent to streams. Five large agricultural organizations were involved in the pilot workshop, representing over 4 miles of creek-side land ownership in the lower watershed.

A project funded by the Department of Water Resources Urban Streams Restoration Program was designed to clear and modify creek obstructions and stabilize eroded streambanks along Pescadero Creek at the town of Pescadero. After the 1955 flood, fifteen cars and several tons of rip-rap were placed along the streambank in an attempt to stabilize the bank and reduce flooding. Over time the cars became unearthed and corroded, causing debris and toxic substances to be released downstream. In addition, organic debris and sediment had accumulated behind the cars and rip-rap. Much of the debris and original bank stabilizers were removed between 1994-and 1996. In its place, boulders, cobble, and soil was added and stabilized with fabric and willow plantings.

Current and Future Studies

The San Mateo County Resource Conservation District has designed a Pescadero-Butano Watershed Assessment plan with the help of consulting groups and the SFBRWQCB. The assessment will involve an analysis of the watershed with respect to its ecology, geomorphology, hydrology, and land use. Methods proposed for the first phase include research of relevant scientific and historical literature, oral history interviews, field reconnaissance of hillslopes and stream channels for geomorphic assessment, GIS and remote analysis of sediment sources, the construction of stream profiles for the entire stream network, rapid bioassessment of macroinvertebrates (15 sites), and endangered species surveys. No chemical water quality data will be collected, however. The second phase of assessment will include more focused analyses based on questions raised during Phase 1. Phase 1 is scheduled to be completed by the summer of 2001, while Phase 2 will commence in Fall 2001 and be completed by Summer 2002.

The Farm Bureau, with help from the SFBRWQCB, has proposed a watershed monitoring program with the objective of establishing baseline water quality information and agricultural BMPs for the Pescadero Creek watershed. Watershed scale water quality monitoring, Level 1 of the program, would obtain pesticide, nutrient, and coliform data both upstream and downstream of the pilot project area. Level 2, farm scale monitoring, would be initiated by landowners and would establish which management practices are effective at reducing pollutant inputs into the water bodies.

Conclusions and Recommendations

1. Pescadero Creek is listed as impaired by excessive sedimentation on the 303(d) list. A detailed geomorphic analysis of Pescadero Creek Watershed is beyond the scope of SWAMP, but is scheduled to be completed by the San Mateo RCD Watershed Assessment. Hopefully, this information can be used by SWAMP for analysis of possible sediment impairment. In addition, the RCD study will produce a detailed assessment of the physical habitat and hydrology of Pescadero Creek. The preliminary Phase 1 results of the study should be useful in designing the SWAMP monitoring plan. The San Mateo RCD study will produce rapid bioassessment data from 15 sites, as well as temperature data, although no other water quality data will be collected. SWAMP should design its monitoring program to provide a comprehensive assessment of chemical and biological parameters.

2. Rapid bioassessment monitoring upstream and downstream of reaches where recent restoration efforts have been completed would provide data on the effects of restoration on the ecological integrity of the stream.

3. The limiting factors affecting salmonid survival in Pescadero Creek should be investigated. Although sediment has been listed as the primary impairment, water quality parameters such as dissolved oxygen and temperature, which also may affect fish survival, should be comprehensively monitored.

4. Urban and agricultural runoff along the main channel of Pescadero Creek may cause water quality impairment. Once the Farm Bureau monitoring plan is formalized it can serve to complement SWAMP monitoring in this area.

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2. San Gregorio Creek Watershed

Background

Physical Setting

San Gregorio Creek Watershed is a 52 square mile drainage basin in western San Mateo County. San Gregorio Creek has its headwaters in the Santa Cruz Mountains, and drains into the Pacific Ocean. Numerous tributaries feed San Gregorio Creek including El Corte de Madera, Clear, Coyote, Bogess, Harrington, La Honda, Woodruff, Alpine, and Mindego Creeks.

Beneficial Uses

The San Francisco Bay Basin Water Quality Control Plan (Basin Plan) of 1995 identifies 9 beneficial uses in the surface waters of the San Gregorio Creek Watershed:

AGR	Agricultural Supply
COLD	Cold Freshwater Habitat
MIGR	Fish Migration
MUN	Drinking Water
RARE	Preservation of Rare or Endangered Species
REC-1	Water Contact Recreation
REC-2	Non-contact Water Recreation
SPWN	Fish Spawning
WARM	Warm Freshwater Habitat
WILD	Wildlife Habitat

In addition to these uses, San Gregorio Creek serves as a source of drinking water for residents (MUN) and as a source for agricultural use (AGR).

Water Quality Issues

Water Diversions - Numerous water diversions have reduced base flows in San Gregorio Creek to potentially detrimental levels. The 1993 San Gregorio Creek Adjudication Decree by the San Mateo Superior Court required that minimum bypass flows be maintained, based on data from the USGS flow gage at San Gregorio. A Draft Water Availability Analysis (1999) completed by the SWRCB Division of Water Rights found that "some water may be available for appropriation during limited portions of average and wet years… however, in dry years, water may not be available for appropriation." Since 1994, however, the flow gage has been out of service, and no data has been available with which to judge the attainment of the minimum flow decree. Currently there are efforts by several groups to re-institute the San Gregorio flow gage.

Sediment - The San Gregorio watershed is prone to very high sediment yields, caused by the combination of very unstable rock types and soils, high relief and steep slopes, high-intensity rainfall events, and human land use changes such as logging, road building, agriculture, and urbanism. The accumulation of excess fine sediment in gravel-bedded creeks reduces the quality of fish habitat for spawning. San Gregorio Creek is listed on the 303(d) list of impaired water bodies as medium priority for excessive sedimentation and siltation resulting in impairment of steelhead habitat. According to the RWQCB San Francisco Bay Region TMDL Time Schedule of October 2000, a TMDL for siltation will be completed by 2005.

Pathogens - The failure of septic tanks and leach fields, especially in La Honda and Alpine creeks, is cause for concern, although there is no information available on the extent of the problem (Napolitano, 2001).

Urban and Agricultural Runoff - Agriculture is concentrated along the floodplains and main channel of San Gregorio Creek, from the mouth at the Pacific Ocean to the confluence of Harrington Creek. Approximately 400 acres of farmland is irrigated along the main channel, and an unknown amount of land is dry farmed or grazed (SWRCB, 1990). Approximately 260 acres and 60 acres of farmland are irrigated along the Corte de Madera and La Honda Creek tributaries, respectively. Runoff from farms can cause water quality problems such as excess nutrients, sediment, and pesticides. In general, San Gregorio Creek Watershed is very sparsely populated. The largest urban center in the watershed is the town of La Honda, situated at the confluence of La Honda Creek with the main channel of San Gregorio Creek. Other communities and residences include the town of San Gregorio, residences along the entire length of Alpine Creek east of La Honda, and residences along the length of San Gregorio Creek.

Overview of Available Information

Previous Studies

San Gregorio Creek was identified as a priority watershed for the recovery of Coho salmon populations in the Draft Strategic Plan for Restoration of Endangered Coho Salmon South of San Francisco Bay (CDFG, 1998). The plan identifies the following primary factors limiting the successful recovery and survival of fish populations:

?? Insufficient stream flows
?? Excessive streambed sedimentation
?? Inadequate refuge from natural and man-made events
?? Impediments to up- and down-stream migration
?? Insufficient recruitment and maintenance of large, woody debris
?? Poor water quality
?? Excess water diversions
?? Threats to riparian vegetation

In addition, the Plan makes the following recommendations for future research:

?? Monitor compliance of fish bypass flows

- ?? Conduct a survey of existing and potential sediment sources
- ?? Document habitat conditions detrimental to aquatic insects
- ?? Map existing and potential Coho habitat
- ?? Inventory barriers to migration
- ?? Minimize sediment input and restore vegetation along State Highway 84

The California Department of Fish and Game conducted stream surveys and inventories of salmon spawning and rearing habitat for many of the tributaries of San Gregorio Creek during 1996 and 1997. The project consisted of a physical habitat survey, including an inventory of pool-riffle flow regimes, water temperature, and tree cover, as well as a biological survey of fish populations in selected reaches. Tributaries surveyed include Mindego Creek, Alpine Creek, Harrington Creek, and La Honda Creek. The survey concludes that beneficial uses such as fish migration, spawning, and cold freshwater habitat may be impaired as a result of poor water quality. Potential water quality problems include sub-optimal water temperatures, excess fine sediment in the creek bed, reduced flows, lack of in-stream cover, and habitat destruction. Excess fine sediment may result from erosion associated with roads, landslides and hill slope erosion, stream bank failures, and land use activity such as grazing, agriculture, logging, and urbanization. The report includes general recommendations for fish habitat restoration, including assuring adequate stream flows, retaining woody debris in pools, enhancing riparian corridors, removing exotic vegetation, and reducing sediment inputs generated from human activity.

<u>Current and Future Studies</u>

The San Gregorio-La Honda Creeks and State Highway 84 Transportation/ Stream Corridor Assessment Plan, proposed by Roland Brady (PI) and Mark Somma (CSU Fresno), Joseph Peterson and David Yam (Caltrans), and Kris Vyverberg (DFG); is designed to develop a protocol for assessing the impacts of transportation infrastructure on stream corridor environmental health and quality (Vyverberg, 2001). The proposed work would follow a three-year plan beginning in the spring of 2002. Year 1 would involve the establishment of relationships with watershed stakeholders, the formation of a technical advisory committee, and the compilation and review of existing watershed data and studies. Year 2 focuses on field studies of geology, geomorphology, hydrology, habitat, sediment, and riparian vegetation, as well as data analysis and opportunities for mitigation. Year 3 involves an assessment of the monitoring project and a summary of findings.

Conclusions and Recommendations

In general, the San Gregorio Creek Watershed appears to be free of many of the water quality problems associated with urban creeks in the San Francisco Bay Area, such as urban runoff and channel modifications. Water diversions and land use activities, however, have the potential to severely impact water quality and beneficial uses. Two priorities for water quality assessment are:

1. Establish a water quality monitoring program
2. Re-establish the flow gage in San Gregorio Creek for the purpose of assuring minimum bypass flows are maintained.

Areas of emphasis within SWAMP should include:

- ?? Monitoring of turbidity and other indicators of sediment impairment. Although San Gregorio Creek is listed on the 303(d) list as impaired for excessive sedimentation, very little information is known on the magnitude or sources of the problem. Although a complete geomorphic evaluation of sediment sources is beyond the scope of SWAMP, a rapid analysis of geologic maps and air photos, combined with field observations, would yield evidence for the susceptibility of sub-basins or reaches to increased sediment loads that may cause impairment of beneficial uses. Continuous turbidity measurements or runoff-based sampling efforts could confirm these hypotheses.

- ?? In addition to sediment, other water quality parameters may be limiting fish habitat quality. Extensive monitoring of temperature, dissolved oxygen, and physical habitat should be completed to determine the limiting factor(s) affecting salmonid survival. Sites should be selected in the main channel of San Gregorio Creek as well as in tributaries at potential spawning sites.

- ?? Comparison of agricultural-related water quality parameters (nutrients, pesticides, toxicity) between heavy agricultural areas (El Corte de Madrea Creek, lower San Gregorio Creek) and possible reference sites (upper Mindego Creek, upper Harrington Creek).

- ?? Pathogen testing in La Honda, San Gregorio, and Alpine creeks for possible leaky septic systems.

- ?? Rapid Bioassessment monitoring in all tributaries and along the length of San Gregorio Creek. Bioassessment monitoring can reveal water quality impairment in areas of physical disturbance or poor habitat, where other water quality parameters may not detect problems.

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3. Stevens Creek/ Permanente Creek Watersheds

Background

Physical Setting

The Stevens Creek and Permanente Creek watersheds are neighboring drainage basins in the western Santa Clara Basin. The Stevens Creek and Permanente Creek watersheds have been grouped together for the purposes of the SFBRWQCB SWAMP study because of their proximity, physical similarities, and relatively small sizes. The upper portions of both watersheds drain upland, mountainous or hilly landscapes where human development is largely absent. The lower portions of the streams flow through western Santa Clara Valley, a large flat alluvial valley draining into South San Francisco Bay. Peak flows from Permanente Creek are diverted, via the Permanente Creek Diversion, to Stevens Creek at rates up to 1500 cubic feet per second.

The watershed of Stevens Creek is a 38 square mile drainage basin, with its headwaters high in the Santa Cruz Mountains. Upper Stevens Creek flows through the San Andreas Rift Zone, a southeast trending valley along the San Andreas Fault. To the east of the fault, bedrock is of the Franciscan Formation, including serpentine. Groundwater draining serpentine bedrock, such as the numerous springs at the heads of tributaries along Monte Bello Ridge, is often rich in magnesium and nickel. To the west of the fault, marine sedimentary rocks such as sandstone and shale are common.

Stevens Creek Reservoir was constructed in 1935 for the purpose of storing winter runoff for the recharge of the Santa Clara Groundwater Basin during the summer months (SCBWMI, 2001). The dam is located southwest of the city of Cupertino, at the point where Stevens Creek emerges from a deep canyon between Monte Bello Ridge and Table Mountain. Swiss Creek, the largest tributary of Stevens Creek, enters the reservoir from the west. The capacity of the reservoir is 3,465 acre-feet; the upstream drainage area is approximately 17 miles.

Permanente Creek, just north of Stevens Creek, has its headwaters in the Los Altos Hills, a relatively sparsely developed area of chaparral and oak woodland. The creek flows through the cities of Los Altos and Mountain View, where the channels have been heavily modified, and drains into South San Francisco Bay at Mountain View Slough.

Beneficial Uses

The San Francisco Bay Basin Water Quality Control Plan (Basin Plan) of 1995 identifies 10 total beneficial uses in the three surface water bodies of the Stevens/Permanente Creeks Watershed:

	Beneficial Uses E=Existing P=Potential	Stevens Creek	Stevens Creek Reservoir	Stevens/ Permanente Creek
COLD	Cold Freshwater Habitat	E	E	E
FRSH	Freshwater Replenishment	E		
GWR	Groundwater Recharge		E	
MIGR	Fish Migration	E	E	
MUN	Municipal and Domestic Supply		E	
REC-1	Water Contact Recreation	E		E
REC-2	Non-contact Water Recreation	E	E	E
SPWN	Fish Spawning	P	E	E
WARM	Warm Freshwater Habitat	E	E	
WILD	Wildlife Habitat	E	E	E

Water Quality Issues

Mining - A cement plant and rock quarry, owned by Hanson Permanente Cement Company (formerly Kaiser Permanente), occupies a large segment of land along much of the length of upper Permanente Creek. The SFRWQCB issued a violation to the company in September 1998 for discharges of sediment-laden storm water into Permanente Creek. The Hanson Company has since submitted reports to the Regional board detailing its efforts to reduce erosion and sediment discharges, such as stabilizing disturbed slopes and intercepting runoff in sedimentation basins.

Stevens Creek Quarry, at the base of Stevens Creek Reservoir on Stevens Canyon Road, has been in operation since 1932, producing crushed rock for the building industry.

Channel modifications - The Water District has seriously modified a significant amount of the channels of Permanente and Stevens Creeks in an attempt to reduce flooding and transfer water (see table below). Channelization results in the direct loss of habitat diversity and quality (Mount, 1995). Physically diverse substrate is no longer available as habitat for benthic organisms, resulting in the elimination of species from many trophic levels. The removal of riparian vegetation reduces habitat, increases water temperatures and decreases dissolved oxygen levels.

Linear Feet of Modified and Unmodified Channels

Creek	Natural Unmodified (feet)	Concrete Channel (feet)	Other Modified (feet)	% Modified
Permanente Creek Watershed				
Permanente Creek	35,662	15533	278	30.7%
Hale Creek	5419	7874	3458	67.6%
Loyola Creek	3867	0	0	0.0%
Magdalena Creek	0	2350	776	100.0%
Ohlone Creek	5226	0	0	0.0%
Permanente Diversion	0	6282	200	100.0%
West Branch Permanente	10408	0	0	0.0%
Totals	**60,582**	**32039**	**4712**	**37.8%**
Stevens Creek Watershed				
Stevens Creek	75925	4355	21582	25.5%
Heney Creek	0	6776	0	100.0%
Montebello Creek	8350	0	0	0.0%
Permanente Diversion	0	614	0	100.0%
Swiss Creek	8857	0	0	0.0%
Totals	**93132**	**11745**	**21582**	**26.4%**

Urban Runoff - The lower portions of both Permanente and Stevens Creek Watersheds are both heavily urbanized (see table below). Residential zones account for 25% and 45% of the total land area in Stevens Creek and Permanente Creek watersheds, respectively. Forested and parkland areas are also large, but are restricted to the upper portions of each watershed. Industrial and commercial areas are also significant. Urban runoff poses numerous water quality problems, including abundant metals, fecal coliform, nutrients, pesticides, organics, and other toxic substances.

Land Use in Stevens Creek and Permanente Creek Watersheds

Land Uses	Stevens Creek Acres	Percent	Rank	Permanente Creek Acres	Percent	Rank
Residential	4580	24.5%	2	5140	45.4%	1
Commercial	393	2.1%	6	181	1.6%	8
Public	202	1.1%	7	406	3.6%	5
Industrial	732	3.9%	4	501	4.4%	4
Trans./Communication	180	1.0%	9	78	0.7%	9t
Utilities	121	0.6%	10	0	0.0%	-
Mines/Quarries	62	0.3%	12	529	4.7%	3
Agriculture	92	0.5%	11	0	0.0%	-
Forest	9202	49.2%	1	3888	34.3%	2
Rangeland	2333	12.5%	3	305	2.7%	6
Urban Recreation	566	3.0%	5	227	2.0%	7
Undeveloped	44	0.2%	13	78	0.7%	9t
Lakes/Reservoirs	183	1.0%	8	0	0.0%	-
Total	18690	100.0%		11333	100.0%	

Overview of Available Information

Previous Studies

The U.S. EPA, the State WRCB, and the SFBRWQCB established the Santa Clara Basin Watershed Management Initiative (WMI) in 1996. The purpose of the WMI is to “develop and implement a comprehensive watershed management program…” for the Santa Clara Basin (SCBWMI, 2001). The WMI will produce a watershed management plan in four volumes. The Watershed Characteristics Report, the first of these volumes to be completed, details the cultural, organizational, regulatory, and natural settings of the Basin, as well as land use and water management issues. This report summarizes the most relevant sources of information on the watersheds of the Santa Clara Basin.

Iwamura (1999), as discussed in the Santa Clara Basin Watershed Characteristics Report (SCBWMI, 2001), studied the geology and water chemistry of Santa Clara Basin Reservoirs. The water of upper Stevens Creek is rich in calcium bicarbonate during periods of high runoff, and magnesium bicarbonate during base flows. Limited sampling of reservoir water did not indicate excessively high nutrient levels (Iwamura, 1999).

Current and Future Studies

As discussed above, the WMI is developing a comprehensive watershed management program based on existing information. No water quality data is anticipated to be collected, however.

Conclusions and Recommendations

1. Monitoring in the lower watersheds should emphasize parameters associated with urban runoff. In addition, rapid bioassessment monitoring above and in modified channels will provide data on the effects of channel simplification on the ecological integrity of the streams.

2. Much of the upper Permanente Creek watershed is in very close proximity to large-scale mining operations. Monitoring in these areas should assess the effects of runoff from the mine sites on water quality. Turbidity after storms and rapid bioassessment monitoring may provide useful data.

3. Upper Stevens Creek, based on all available data, should provide reference conditions for water quality assessment. Rapid bioassessment monitoring in this area may provide reference data to which other water bodies may be compared. Sites should be selected to reflect a diversity of channel conditions such as high and low gradient streams and different assemblages of surrounding terrestrial vegetation. The lack of access roads in much of upper Stevens and upper Permanente Creeks may be an important consideration in choosing monitoring sites. In order to select an array of sites in the upper watershed, some sites may only be reached by hiking considerable distances.

Bibliography

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4.3 Specific Sampling Design/Sampling Collection

Sampling Design

Macroinvertebrate bioassessments will be conducted at all tier 1 sampling sites to provide an environmental measurement that integrates impacts on aquatic life. In the spring of 2001, in the first six planning watersheds, 88 of 89 sites were sampled using the California protocol for rapid bioassessments, which includes triplicate macroinvertebrate collections at each site, a qualitative physical habitat assessment and basic water quality measurements (DO, temperature, pH and conductivity. This work will be performed by Jim Harrington at Fish and Game.

The tier 2 phase of the monitoring program is mainly designed to determine if beneficial uses are being protected and if certain land uses or management practices are having an impact on water quality. In the first six planning watersheds there will be 33 tier 2 stations, which are a subset of the tier 1 stations. These stations will include an integrator station at the bottom of each watershed, in the nontidal area, where sediment chemistry and toxicity and bioaccumulation will be measured along with other tier 2 parameters. Sampling and analysis for tier 2 parameters will be performed through the Fish and Game master contract and by Regional Board staff. The suite of nutrients and chlorophyll are planned to be monitored at all 33 tier 2 sites, with water chemistry and toxicity screening occurring at 16 of these sites, based on potential impacts from land uses, or to measure at reference sites. The sampling and analysis to be performed through the Fish and Game contract for the first six planning watersheds is described in the table below.

TABLE 3

NUMBER OF SITES IN EACH PLANNING WATERSHED FOR TIER 1 AND TIER 2 MONITORING

CHEMICAL AND BIOLOGICAL MONITORING

Pilot Watershed	Area (Sq. Mi.)	TIER 1	Nutrients	Water Toxics and Toxicity	Integrator Station
Walker	74	13	4	0	1
Lagunitas	107	18 (+ 6)*	8	3	2
San Leandro	47	6 (+ 5)*	4	2	1
San Pablo/Wildcat	48	18 (+ 5)*	7	5	2
Suisun	57	10	6	3	1
Arroyo de las Positas	77	7	4	3	1
TOTAL	**410**	**88**	**33**	**16**	**8**

* Tier 1 monitoring includes rapid bioassessment, visual or qualitative physical assessment, and continuous water quality monitoring for DO, pH, temperature, and conductivity (and turbidity if available). Tier 1 monitoring is augmented by National Park Service monitoring in Olema Creek (Lagunitas Cr. planning watershed), and by the three-year Coastal Conservancy-funded Regional Board monitoring project in Wildcat and San Leandro creek watersheds.

TABLE 4

NUMBER OF SITES IN EACH PLANNING WATERSHED FOR TIER 2 MONITORING

PHYSICAL AND BACTERIOLOGICAL MONITORING

Pilot Watershed	Area (Sq. Mi.)	Pathogens	Sediment	Flow and Phys. Meas.
Walker	74	1	6	5
Lagunitas	107	4	10	4
San Leandro	47	5	2	2
San Pablo/Wildcat	48	4	7	4
Suisun	57	0	7	5
Arroyo de las Positas	77	0	6	3
TOTAL	**410**	**14**	**38**	**23**

In addition, Regional Board staff will be monitoring 14 tier 2 stations where there is water contact and/or there is potential sewage input. Samples will be collected 5 times in 30 days, using total and fecal coliform and E.coli. Sequoia Laboratories will conduct the analyses. Regional Board staff is also planning to deploy continuous monitoring probes in each watershed to measure DO, temperature, pH and conductivity. Also, sites have been selected for periodic field measurements of flow and dry season measurement of other physical attributes such as sinuosity, width-to-depth ratio of the channel and floodprone area, and slope. Trash assessments are also planned. The extent of this work will depend on available resources.

Starting in the spring of 2002 we will start monitoring stations in Pescadero, San Gregorio and Stevens/Permanente planning watersheds. In year 2 there will be 33 Tier 1 stations and 15 tier 2 stations. The same sampling design will be used for these watersheds except that toxicity/chemistry will be sampled during all 3 hydrologic cycles rather. Maps of the monitoring planned for all watersheds are included in Appendix C.

Through the Toxic Substances Monitoring Program, Fish and Game has collected fish in Soulejoule (in the Walker Creek watershed), Lake Chabot (in the San Leandro watershed), Stevens Creek Reservoir (in the Stevens/Permanente creek watershed) and Del Valle Reservoir. The filet of all fish will be analyzed for mercury. Some fish will also be analyzed for organic contaminants. Fish in three additional waterbodies will be monitored in the 2001-2002 fiscal year. These waterbodies will be Bon Tempe Lake (Marin), Anderson Reservoir (Santa Clara) and Nicasio Reservoir (Marin). These studies are conducted in consultation with the State Office of Environmental Health Hazard Assessment (OEHHA).

Sample Collection

The field crew will collect the samples at the latitude and longitude previously recorded during reconnaissance of stations. If a new station is being sampled the GPS coordinates and digital cross-referenced photographs will be provided for the site for future reference. If there is confusion about locating a site, it will be resolved in consultation with the RWQCB staff member present in the field or by phone. Flow, temperature, electrical conductivity, dissolved oxygen, pH and turbidity will be measured at every station where a sample is collected. Various physical assessments may be conducted on a site-specific basis as requested. Sufficient volume of water and/or sediment will be collected in order to perform the analyses to be conducted at each station. Tissue and sediment samples will be archived for future analysis. Sample collection and subsequent processing and testing will be performed according to the most recent version of the SWAMP Quality Assurance Project Plan (QAPP) and SWAMP Laboratory SOPs.

RWQCB staff will be sampling for bacteriological analysis, conducting continuous monitoring of basic water quality parameters in all 6 watersheds and performing quantitative physical habitat assessments at selected sites in each watershed.

4.4 Laboratory Analysis (Year 1)

Laboratory Analysis or Service Performed	**Total**	**Funding**
SJSUF: Sampling water/sediment	99	SWAMP
Cruise Reports	3	
Mussel Deploy and Collect	8	SWAMP
TSMP: Collect Freshwater Fish	48 composites	TSMP
Tissue chemistry (Hg)	48 fish composites	TSMP
Tissue Chemistry (metals)	8 clams	SWAMP
Tissue Chem (Pest, PCB, PAH)	8 clams 16 fish comp.	SWAMP/TSMP
Water Chemistry (total metals)	32	SWAMP
Water Chemistry (dissolved metals)	32	SWAMP
Water Chemistry (total mercury)	16	SWAMP
Water Chem (Pest, PCB, PAH)	14	SWAMP
Sediment Chemistry (metals)-no Se	8	SWAMP
Sediment Chem (Pest, PCB, PAH)	8	SWAMP
Conventional Chemistry		

	Total	Funding
Laboratory Analysis or Service Performed		
(All nutrient and conv chemistry parameters except grain size)	99	SWAMP
Grain Size (full analysis)	8	SWAMP
Rapid Bioassessment collection and analysis (3 samples per site)	88	½ SWAMP and ½ others
UCD: Toxicity Lab		
Sediment toxicity *Hyalella*	8	SWAMP
Freshwater Toxicity 7-d *Cerio*	32	SWAMP
Freshwater Toxicity Minnows	32	SWAMP
Freshwater Toxicity Alga	32	SWAMP
ELISA Diazinon or Chlorpyrifos	32	SWAMP
Total Coliforms	70	RWQCB
Fecal Coliforms	70	RWQCB
E.coli	70	RWQCB
Continuous monitoring	6 watersheds	RWQCB
Physical Habitat measurements	6 watersheds	RWQCB
Trash Assessments	6 watersheds	RWQCB

4.5 Data Quality Evaluation and Data Reporting

Bioassessment data will be generated using the California Stream Bioassessment Procedure and will include the species counts and calculated metrics for each of the three replicate 100 counts conducted at each site. The bioassessment data will be accompanied by the exact location of each reach. Latitude/longitude coordinates and datum will be recorded at the top and bottom of the reach. Digital photographs will be taken on the left and right banks on the top and bottom of the reach. The length of the reach will also be recorded. Physical habitat assessments will be completed at each site and water quality measurements at the time of macroinvertebrate sampling (i.e., dissolved oxygen, pH, temperature and conductivity) will be recorded. Toxicity bioassay data will include test mean, standard deviation, and a determination of whether or not a sample is toxic at a statistically significant level of difference from the laboratory control samples and a value less than 80% of the lab control value. Chemistry data will include the analytical result, method detection limit, reporting limit, and relevant quality assurance (QA) information on surrogate recovery, duplicate relative percent difference (RPD), matrix spike percent recovery and RPD, and blank spike percent recovery and RPD. Any deviations from QA goals established in the QAPP will be noted. Data will be made available in electronic format unless otherwise requested.

4.6 Deliverable Products

Sampling Event Report - For the Fish and Game contract a report will be prepared for each sampling event. This report will be provided to the Regional Board, with an additional copy provided to the State Board (one copy to each). The report will include GPS coordinates, a brief description of each station, all field measurements and data collected during the sampling event including flow, temperature, electrical conductivity, dissolved oxygen, pH, turbidity, any physical assessments completed and any unusual circumstances or deviations from protocols or task order.

Final Data Report - A final data report will be prepared for the first year's work on the first six planning watersheds and for the second years work. All data will be reported in an electronic file in an agreed upon format, as well as in hard copy (three one-sided originals for copying, and three bound copies). One of each type, electronic file and one-sided hardcopy original, and bound hardcopy shall go to the State Board and the Regional Board and DFG. QA/QC evaluation reports and verification that data met QA criteria set forth in QA Project Plan must be provided with the hardcopy data report. The final data report will include the following items, where applicable, but shall not necessarily be limited to the following items: All station data including project number, station number and sample number, sample collection date, sample station longitude and latitude, sample GPS coordinates, sample station flow and water quality data, sample location characteristics. Specific QA/QC data may be included in the QA/QC report or appendices.

QA/QC evaluation ranking by each analytical laboratory will be provided in the database. In addition, appendices will include replicate data for toxicity tests, a database description and file structure description. A QA/QC report will also be included in the final data report, containing an evaluation of how the data complied with actual QA/QC parameters.

Interpretative Report - An interpretive report will be prepared at the end of the first 2 years of monitoring. This report will analyze, synthesize and interpret the data for all nine watersheds.

4.7 Desired Milestone Schedule

All samples will be collected within the 3 hydrologic cycles specified in the sample design. We would like the field report within a month of finishing the collection. We would like to have the data from the analyses of the samples within 6 months of collection. We would like to have the final data report 6 months after the final sample collection. Exact dates are currently be negotiated between the Regional Board and Dept. of Fish and Game.

4.8 Desired “sample throughput schedule”

See above. Exact dates are being negotiated between Fish and Game and the Regional Board.

4.9 Budget

The first table is a budget for the 2000-2001 task order, which spans the sampling period from spring 2001 to spring 2002. The SWAMP budget totals $310,000. Since $38,600 was set aside for student resources and the development of a QAPP for SWAMP, $271,400 is left for SWAMP contractual services. SWAMP studies for year 1 will be supplemented with other contracts.

The projected allocation for 2001-2002 totals $289,787. This budget is available in the 2001-2002 task order. Task orders for both years are available through the State Board.

Task Order Station by Analysis Worksheet for RWQCB 2 for FY00-01 funds

Analysis or Service Performed	Unit Cost (per sample)	ALP010	ALP100	ALP110	ALP140	LAG040	LAG130	LAG150	LAG160	LAG190	LAG210	LAG270	LAG320	SLE030	SLE190	SLE210	SLE230	SPA020	SPA070	SPA150	SPA200	SPA220	SUI010	SUI060	SUI110	SUI130	SUI180	SUI210	WIL020	WIL180	WLK030	WLK090	WLK100	WLK140	TOTAL UNITS	TOTAL COST (Total Units X Cost/Unit)
SJSUF: Sample collection lab																																				
Generic Sampling Event (a)	$300	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	99	$29,700
See footnote "a" below																																				
Cruise Reports	$550																																		3	$1,650
Mussel Watch and TSM Lab																																				
Mussel Deploy and Collect	$1,155	1				1	1							1				1					1						1			1			8	$9,240
Tissue Chemistry (metals)	$324	1				1	1							1				1					1						1			1			8	$2,592
Tissue Chem (Pest, PCB, PAH)	$1,423	1				1	1							1				1					1						1			1			8	$11,384
Water Chemistry (total metals)	$199	2	2	2		2	2					2		2			2	2	2		2	2	2	2	2				2						32	$6,368
Water Chemistry (dissolved metals)	$219	2	2	2		2	2					2		2			2	2	2		2	2	2	2	2				2						32	$7,008
Water Chemistry (total mercury)	$91	2				2	2							2				2					2						2			2			16	$1,456
Water Chem (Pest, PCB, PAH)	$798	2				2	2							2				2					2						2						14	$11,172
Sediment Chemistry (metals)-no Se	$234	1				1	1							1				1					1						1			1			8	$1,872
Sediment Chem (Pest, PCB, PAH)	$1,423	1				1	1							1				1					1						1			1			8	$11,384
Conventional Chemistry																																				
See footnote "b" below																																				
for list of analytes	$503	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	99	$49,797
Sediment Characterization																																				
Sediment TOC	$58	1				1	1							1				1					1						1			1			8	$464
Sediment grain size (full analysis)	$125	1				1	1							1				1					1						1			1			8	$1,000
Rapid Bioassessment																																				
(3 samples per site)	$1,221																																		44	$55,000
See footnote "c" below																																				
UCD Granite Canyon: Toxicity Lab																																				
Sediment toxicity *Hyalella*	$840	1				1	1							1				1					1						1			1			8	$6,720
Freshwater Toxicity 7-d *Cerio*	$575	2	2	2		2	2					2		2			2	2	2		2	2	2	2	2				2						32	$18,400
Freshwater Toxicity Minnows	$575	2	2	2		2	2					2		2			2	2	2		2	2	2	2	2				2						32	$18,400
Freshwater Toxicity Alga	$575	2	2	2		2	2					2		2			2	2	2		2	2	2	2	2				2						32	$18,400
ELISA Diazinon or Chlorpyrifos	$32	2	2	2		2	2					2		2			2	2	2		2	2	2	2	2				2						32	$1,024
Field QA/QC--5% Field Duplicates	$4,726																																			$4,726
See footnote "d" below																																				
Total cost of field and analytical services																																				**$267,757**
R2 share DFG pass-thru subcontract fee																																				$3,643
GRAND TOTAL all costs for Task Order																																				**$271,400**

PLEASE SEE NEXT PAGE FOR SCHEDULE NOTES AND FOR EXPLANATION OF FOOTNOTES

SCHEDULE NOTES:

For Nutrients/Conventional Chemistry Measurements, 3 samples, sampling once during the three periods of Jan-Mar, April-June, and July-Oct. (Wet, Spring, Dry Seasons)

For Toxicity and Chemistry in Water, 2 samples, sampling once during the two periods of April-June and July-Oct. (Spring, Dry Seasons)

For Toxicity and Chemistry in Sediment and Tissue Chemistry, sample once during the period of April-Oct. (Spring or Dry Season)

FOOTNOTES:

a) $300 sample collection cost should be $360 (sediment and water), but R2 will allocate the difference from FY 01-02 funds, since student contract funding fell thru that was to be used for sample collection costs. Also we are waiving cost of YSI probe measures (normally $140, with centroid flow), as R2 is lending us their YSI for probe measurements, & has done extensive field reconnaissance prior to sampling. Thus, R2 will "owe" $60 x 99 stations for sample collection = $5,940.

b) Analytes at each station to be analyzed for conventional constituents and nutrients **IN WATER** include: Chloride, sulfate, ortho-phosphate, nitrate, nitrite (all $27 each--$135 total); total Phosphate ($37); TKN ($45); total ammonia ($30); alkalinity ($25); TOC ($58); DOC ($58); TDS ($20); TSS ($30); chlorophyll-a ($40); hardness ($25) = $503 total

c) $55,000 swamp funding is placed in Rapid Bioassessment to augment the original $45,000 separate (non-swamp funds) contract up to $100,000.

d) R2 has only $4,726 allocated to 5% field duplicates, due to not knowing in advance how much to allocate for this. R2 agrees to make up the cost difference in FY 01-02 task order. True cost is $10,374 and R2 has $4,726 available, thus R2 will "owe" $5,648 out of FY01-02 task order allocation to make-up this 5% field dupe qa/qc shortfall.

5.0 Working Relationships

Task	SWRCB	RWQCB	Contractors
Identify waterbodies or sites of concern and clean sites to be monitored		??	
Gather information on watersheds, investigate land uses, beneficial uses and previous data.		??	
Make contacts with all groups working in watersheds and coordinate efforts.		??	
Prepare site-specific study design based on monitoring objectives, an assessment of available information, indicators and available resources.	?? (review role)	??	?? (in consultation)
Task	**SWRCB**	**RWQCB**	**Contractors**
Conduct reconnaissance and gain access to sampling sites.		??	
Develop contracts for contractor services	??		??
Develop task orders for sampling and analysis		??	?? (in consultation)
Implement study design (collect and analyze samples)		??	??
Track study progress. Review quality assurance information and make assessments on data quality. Adapt study as needed.	?? (review role)	??	??
Report data through SWRCB web site	??	?? (coordinat-ion role)	??
Prepare written report and presentations of data	??	??	??

6.0 Appendices:

Appendix A - SWAMP Monitoring Components for 2001-2002
Appendix B - Inland Surface Waterbodies According to Watershed
Appendix C - Maps of RWQCB SWAMP Stations for 2001-2002
Appendix D – Descriptions of RWQCB SWAMP Stations for 2001-2001