Appendix C

Water Quality Monitoring Guidelines for the Petaluma Watershed

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Water Quality Monitoring Guidelines for the Petaluma Watershed

Prepared By:
Southern Sonoma County Resource Conservation District

June 1998

This Project has been funded wholly or in part by the United States Environmental Protection Agency Agreement No. C6999482-97-0 to the State Water Resources Control Board and by Contract No. 6-048-250-0 in the amount of $144,115. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency or the State Water Resources Control Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

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I. Introduction

The Petaluma River and its tributaries encompass a watershed of about 146 square miles and flows into the northwestern portion of San Pablo Bay. The pear-shaped basin located in both Sonoma and Marin Counties is approximately 19 miles long and about 13 miles wide. Normal annual rainfall over the watershed ranges from about 20 inches at the mouth of the Petaluma River to about 50 inches at the highest elevations, with the basin averaging about 26 inches (see attached Normal Annual Precipitation Map). Land use outside the City and rural residential areas is predominantly agriculture and open space.

Fifty-six percent of the watershed is mountainous and hilly, 33 percent is valley and 11 percent is salt marsh located along the lower 11 miles of the Petaluma River. The mountainous and hilly areas are covered with grass, shrubs, and groves of oak and California bay laurel. They are used for grazing and pasture with tracts of cultivated haylands scattered throughout. The marshlands are used for haylands and provide habitat to many plants and animals including rare and endangered species.

Sedimentation, high nutrient levels and animal waste, causing exceedance of water quality standards, have been identified as the main pollutants in the River. The receiving waters of San Pablo Bay are listed on the State's Impaired Waterbody 303(d) List. It is suspected that a combination of land use activities both urban and rural contributes to these impacts.

For purposes of the watershed enhancement plan, which focuses primarily on rural and rural residential areas, urban water quality impacts will not be addressed. It is important to note however, that urban areas impact water quality in a number of ways which include the contribution of sediments, nutrients, bacteria, and toxic heavy metals. Water runoff carries these pollutants over impervious areas which results in increased water volumes and velocities entering nearby streams.

The following monitoring guidelines are designed to provide landowners and residents with an introduction to existing monitoring data, data gaps, and recommendations for the Petaluma River Watershed. This report also includes a section addressing non-point source monitoring for private landowners, which may be used to steer future monitoring projects.

II. Summary of Existing Data

The Federal Clean Water Act requires the state to adopt water quality objectives for toxic pollutants. *California's Inland Surface Waters Plan* and the *Enclosed Bays and Estuaries Plan* were created in order to comply with federal water quality objectives. Both plans pertain to the Petaluma River and include objectives for 37 toxic substances or classes of pollutants and ambient toxicity for these waters. (Whyte, 1996)

Water quality objectives, which govern the concentration of pollutants in water, are outlined in the San Francisco Bay Regional Water Quality Control Board (RWQCB) Basin Plan and are designed "to protect present and potential beneficial uses...and to protect existing high quality waters of the state" (San Francisco Bay RWQCB, 1986). The Basin Plan outlines a variety of beneficial uses for the Petaluma River watershed, which include:

- cold fresh-water habitat
- warm fresh-water habitat
- preservation of areas of special biological significance
- marine habitat
- fish spawning habitat
- fish migration
- wildlife habitat
- preservation of rare & endangered species
- water contact recreation
- non-water contact recreation

Water quality impairments occur when the identified beneficial uses are threatened resulting in violations of prescribed water quality objectives. Pollutants and their effects on beneficial uses of water are exhibited in Table 1. The Regional Board has classified the Petaluma River as an impaired water body due to such violations based on past monitoring activities.

Past monitoring activities have been undertaken cooperatively with the Department of Water Resources, State Water Resources Control Board, and the San Francisco Bay Regional Water Quality Control Board. According to Bill Hurley, RWQCB, water samples were collected primarily in the mid 1970's at various locations and most recently in 1993 (see attached monitoring sites map). Their efforts were focused primarily on nutrients, dissolved oxygen, and coliform bacteria. In the upper portions of the watershed, tests revealed slightly elevated nutrient concentrations and high coliform counts. In the lower reaches, unacceptable levels of dissolved oxygen, turbidity, sedimentation, ammonia, coliform, algal blooms, eutrophication, and foul odors have been noted as problems (Questa, 1992). Mr. Hurley suggests the focus of additional sampling activities should be aimed at sediment

Table 1: Major Pollutants, Their Sources and Effects on Beneficial Uses of Water

Major Pollutant	Description	Common Sources or Causes of Pollutants	Some Effects of Pollutants
Organic Material	(Oxygen consuming substances)	Lumber, pulp, paper, and food processing waste discharges, animal and ag wastes; runoff from waste disposal sites	Produce foaming in industrial process waters; consume oxygen in water by decomposition
Dissolved Salts and Minerals	(chloride, carbonate, sulfate salts, and other chemical compounds)	Natural and man-induced soil erosion, sewage treatment plant and industrial waste discharges; storm sewer runoff; ag drainage water; sea water intrusion; and runoff from waste disposal sites	Cause disagreeable odor and taste; affect vital organs of humans, livestock, and fish; cause corrosion scaling, and foaming in industrial processes; toxic to many plants
Floating Debris	(paper, cans, bottles, plastic, lumber, and other materials)	Storm sewer runoff, runoff from waste disposal sites; ships, pleasure boats, picnickers, and campers	Interferes with the esthetic and recreational enjoyment of water; clogs ship channels, water supply intakes, and storm sewer intakes
Heat		Sewage treatment plant and industrial waste discharges, industrial cooling water discharges	Makes drinking water less palatable; reduces oxygen needed for fish; makes water less desirable for industrial processes; increases evaporation which tends to concentrate other pollutants
Nutrients	(compounds of nitrogen and phosphorous)	Sewage treatment plant and industrial waste discharges, runoff from waste disposal sites, ag drainage water; decomposition of organic matter; and detergents	Interfere with human digestive processes, and can be toxic to vital organs; toxic to some livestock and some wildlife species; promote growth of algae and other secondary pollutants
Oils & Greases	(animal, and vegetable oils, and petroleum products)	Storm sewer runoff, ships and pleasure boats; animal and ag wastes, and industrial waste discharges	Cause disagreeable odor and taste; clog water supply intakes and water distribution systems; interfere with the esthetic and recreational enjoyment of water; interfere with repiration in many forms of aquatic life; consume oxygen in water by decomposition
Pathogenic Organisms	(viruses, toxic bacteria, and parasites)	Human and animal wastes; seepage from septic tanks; runoff from waste disposal sites	Cause illnesses such as amoebiasis, hepatitis, poliomyelitis, and botulism in humans; toxic to many forms of life
Pesticides	(arsenicals, mercuricals, chlorinated hydrocarbons, organic phosphates, polychlorinated biophenyls)	Storm sewer runoff and ag drainage water	Cause illness of death in humans who consume contaminated water or food (fish and shellfish are known to concentrate certain pesticides in their flesh); toxic to fish and wildlife

Table 1: Major Pollutants, Their Sources and Effects on Beneficial Uses of Water- *Continued*

Major Pollutant	Description	Common Sources or Causes of Pollutants	Some Effects of Pollutants
Secondary Pollutants	(algae, barnacles, aquatic weeds, and other organic growths)	Combined effect of nutrient materials present, warm temperatures, and sunshine	Cause disagreeable taste and odor; clog ship channels, and water supply intakes; consume excessive quantities or water; reduce oxygen in water when organisms and plants die and decompose; cause flooding by clogging drainage facilities
Suspended Sediment	(clay, silt, sand, and other inorganic matter)	Natural and man-induced soil erosion	Cause objectionable color in water, clog ship channels, and water supply intakes; cause flooding by clogging drainage facilities; interfere with penetration of light and decrease production of fish-food organisms
Toxic Heavy Metals	(cadmium, lead, mercury, selenium, and others)	Sewage treatment plant and industrial waste discharges; storm sewer runoff; and mining and refining heavy metals	Highly toxic to many forms of life with serious sublethal effects (some are cumulative poisons)
Toxic Chemical Materials	(acids, caustics, fluorides, borates, sulfides, and others)	Industrial and sewage treatment plant waste discharges; and decomposition of organic material	Toxic to many forms of life; interfere with industrial processes; corrode or attack wood and metal surfaces (wharves and ship hulls)
Toxic Organic Materials	(cyanides, alcohols, chloroform, organic acids, formaldehyde, and phenol)	Sewage treatment plant and industrial waste discharges; runoff from waste disposal sites; and citrus crop wastes	Toxic to many forms of life; interfere with industrial processes, especially processing of food products

Source: USGS, 1972.

contamination studies as well as pesticide and herbicide use. Water contaminants will adhere to sand, silt, and clay particles based on their surface to volume ratio and geochemistry. Samples are withdrawn from the stream channel, usually where sediment deposition occurs. Table 2 shows identified parameters of concern for the Petaluma River and associated land uses and/or activities of concern as identified by the Regional Board.

The RWQCB will be analyzing baseline water quality data in an effort to establish water quality standards specific to the Petaluma River. The Total Maximum Daily Load (TMDL) and Attainment Strategy for the Petaluma River watershed will also identify sources of contamination by land use, establish target dates for water quality improvements, and make recommendations for corrective action. The TMDL process is slated to begin by the year 2000.

Table 2: Identified Water quality impairments for the Petaluma River and associated land uses/ activities of concern.

Water Quality Impairments	Land Use / Activites of Concern
Temperature	Dredging, agriculture, habitat alteration
Ammonia	Agriculture
Dissolved Oxygen	Dredging, habitat alteration, agriculture
Sediment	Construction, dredging, habitat alteration, agriculture
Coliforms	Agriculture, Boat vessel discharges
Debris	Boat vessel discharges, industrial
Petroleum Distillates	Boat vessel discharges, industrial, urban runoff
Habitat	Construction activities, industrial
Herbicides	Urban runoff

Source: San Francisco Bay Regional Water Quality Control Board, 1989.

The California Department of Fish and Game (DFG) acts to protect water quality through management and enforcement of water quality laws. DFG Code 5650 states that "it is unlawful to deposit in, permit to pass into, or place where it can pass into the waters of this State ... any substance or material deleterious to fish, plant life, or bird life." DFG has been monitoring for agricultural runoff within the watershed since 1971, however a systematic program was not established until 1991 (Mike Rugg, Calif. Dept. Fish & Game, Pers. Comm.). During this time, eight stations have been monitored in the San Antonio Creek drainage followed by a more recent addition of two sites within the Ellis Creek watershed. All sites are monitored for pH, temperature, ammonia, percent saturation, electrical conductivity, dissolved oxygen, biochemical oxygen demand, and total dissolved solids.

Test results have consistently been distributed to the Sonoma Marin Animal Waste Committee, which acts to address animal waste issues. According to Mike Rugg, DFG Water Quality Biologist, water quality at the San Antonio Creek locations has improved considerably over the years with the exception of one

station. In addition to the current monitoring program, Mr. Rugg suggests two additional stations as potential monitoring sites be included: 1) Old Adobe Rd. at Adobe Creek and 2) King Road at Wiggin's Creek.

The *Petaluma General Plan* and the *Petaluma River Access and Enhancement Plan* both direct the need to "improve the quality of the water in the Petaluma River." and to "protect and preserve streams and the river in their natural state." The City also has published reports concerning the *Ellis Creek Watershed Enhancement and Wetland Mitigation Plan and Monitoring Program for the Petaluma Wastewater Treatment and Storage Facilities Project* and an *Analysis of Historic and Current Hydrologic Conditions in the Petaluma River.*

The City is presently monitoring discharge effluent on a monthly basis during the non-discharge period from May 1 through October 20. Monitoring parameters include biochemical oxygen demand, total suspended solids, conductivity, pH, temperature, dissolved oxygen, and bacteria. Metals and pesticides are tested less frequently. Monitoring results are inconclusive at this time. Chris McAuliffe, EOS Environmental Inc., water quality consulting firm, has been working with the city's wastewater treatment program and recommends monitoring associated with nutrient and pesticide use adjacent to agricultural lands and diazinon and chlorpyrifos adjacent to residential properties.

The Army Corps of Engineers has recorded information on stream flows within the Petaluma River from 1941 to 1946 from a station located one mile upstream from the center of town (COE, 1971). In 1948, the US Geological Survey (USGS) relocated the gauge about 1,000 feet further upstream north of Corona Road, encompassing a 30.9 square mile area of the watershed. USGS continued to record data until 1963 at which time the gauge was removed (FEMA, 1991). During the period the gauge was active, flows ranged from 0-3,500 cubic feet per second and annual runoff was recorded between 1,600-32,800 acre feet (COE, 1971). Water temperatures were also recorded periodically at this station and ranged between 4 - 17 degrees Celsius (Blodgett, 1971).

Local schools, community groups, and organizations are also pursuing monitoring programs. They are listed as follows:

- **Grant Elementary School -** Third, fifth, and sixth graders at Grant School have been working with AmeriCorps members in order to establish a monitoring program for Thompson Creek. Preliminary samples have been collected, analyzed, and recorded for future reference. In addition to classroom activities related to wildlife populations and vegetation, students are monitoring for pH, temperature, ammonia, and dissolved oxygen (H. Jensen, Watershed Steward Project, personal communication).

- **Casa Grande High School** - The United Anglers of Casa Grande High School have been monitoring stream conditions within the watershed since 1983. Seven tributaries are monitored for water quality, fish conditions, and population studies (T. Furr, Casa Grande High School, personal communication). Students have restored stream reaches through the use of their fish hatchery, revegetation program, and debris clean up activities. Their efforts have proven successful with the presence of year around stream flows and increasing numbers of steelhead migrations.

- **Petaluma Tree Planters (PTP)** - PTP is a non-profit corporation founded in 1990 to "provide opportunities for citizens of southern Sonoma County to learn about and improve environmental conditions in the Petaluma River Watershed." The group has completed urban forestry, environmental education, and riparian restoration projects throughout the watershed. This year the Rose Foundation has granted the group funding to pursue diazinon testing at a minimum of eight major tributary confluences along the river and around the city of Petaluma (B. Abelli-Amen, Pet. Tree Planters, pers. comm.). Samples will be collected, analyzed and distributed for public information by July, 1999.

- **Sonoma and Marin County Farm Bureaus** - The Sonoma and Marin County Farm Bureaus have followed animal waste issues for the past twenty years through the development of the Sonoma Marin Animal Waste Committee. The committee is an informal group of agriculturalists, federal and state agency staff that meet on a regular basis to discuss waste management issues and solutions. Throughout the years, the committee has established informational materials and guidelines relating to animal waste in the form of Animal Waste Management Guidelines, Compliant Investigation Resolution Procedures, a Dairy Waste Pond Size Estimation Worksheet, Runoff and Pond Areas Calculation Worksheet, and Nutrient Budgeting Program. This year the committee established its first water monitoring program. The program includes monitoring at four sites within the watershed. Monitoring Parameters include pH, temperature, ammonia, and dissolved oxygen.

- **San Francisco Estuary Institute (SFEI)** - SFEI has been instrumental in creating a Regional Monitoring Program (RMP) for the San Francisco Bay. The RMP has been in effect since 1991, monitoring for trace elements such as arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. Trace organics such as diazinon, PAH's, DDT, Chlordane, PCBs, and chlorpyrifos are also examined (SFEI, 1997). The program includes one station located at the mouth of the Petaluma River. This station has consistently revealed elevated concentrations of trace elements and organics above water quality criteria. In comparison to other sites around the Bay, the

Petaluma station has the second highest number of water quality exceedences. One reason for the unusually high concentrations may be the location of the station at the opposite end of the Bay, and downstream of a major tributary, where contamination might expect to accumulate. The Petaluma station also has a shallow water depth which may result in a re-suspension of sediments. According to Dr. Rainer Hoenicke, SFEI Environmental Scientist, monitoring within the watershed could be enhanced through studies indicating the presence or absence of PCBs and mercury concentrations. An additional study examining sediment contamination and affiliated land use patterns would also enhance Petaluma's monitoring program.

III. Data Gaps

Baseline data will be essential in determining a Total Maximum Daily Load (TMDL) and Attainment Strategy for the watershed slated to begin in the year 2000. All existing data will be examined as well as data generated from current monitoring programs. Although existing programs may provide excellent data for baseline information, they cover limited portions of the watershed. An expansion of these programs could provide deeper insight into baseline conditions of the watershed as a whole.

Additional data pertaining to sediment contamination studies and associated land use practices would be of benefit although such studies are deemed costly. Participants of the Petaluma River watershed advisory group and water quality professionals have suggested pesticide, herbicide, and fungicide testing for urban, rural residential, and agricultural land uses. The watershed advisory group meetings held throughout the watershed have also revealed the need for information pertaining to sedimentation, water diversions and stream flows (SSCRCD, 1998).

IV. Water Quality Monitoring Plan

Previously identified non-point source pollutants associated with rural and rural residential areas include temperature, ammonia, dissolved oxygen, sediment, and coliform. Current rural water quality monitoring programs consistently monitor for these parameters with the exception of sediment and coliform levels. However, both of these parameters are being evaluated at this time to determine monitoring feasibility.

The USDA Natural Resources Conservation Service is now exploring coliform testing methods that may be utilized by landowners, and has recently published *Fecal Flash News.* The purpose of the newsletter is to inform and educate landowners and the general public about fecal coliforms and their associated

impacts. A study of the watershed's sedimentation has also recently been completed entitled *Erosion and Sedimentation in the Petaluma Watershed*, appendix E. The information derived from both of these efforts should provide good baseline information that could expand current monitoring programs.

The current water quality monitoring program includes a monitoring plan developed by the University of California Cooperative Extension Service and the Sonoma and Marin County Farm Bureaus. The plan was developed for the Sonoma Marin Animal Waste Committee in order to address excessive nutrient loading in local streams. The following monitoring plan is now being used to curtail water quality impacts associated with animal waste.

Description of the Flow Chart

A. The flow chart will be initiated based on water testing results from Department of Fish & Game, Region,1 Water Quality Laguna Stations and Point Reyes National Seashore Stations. Trigger levels have been set that, if reached, initiate the process.

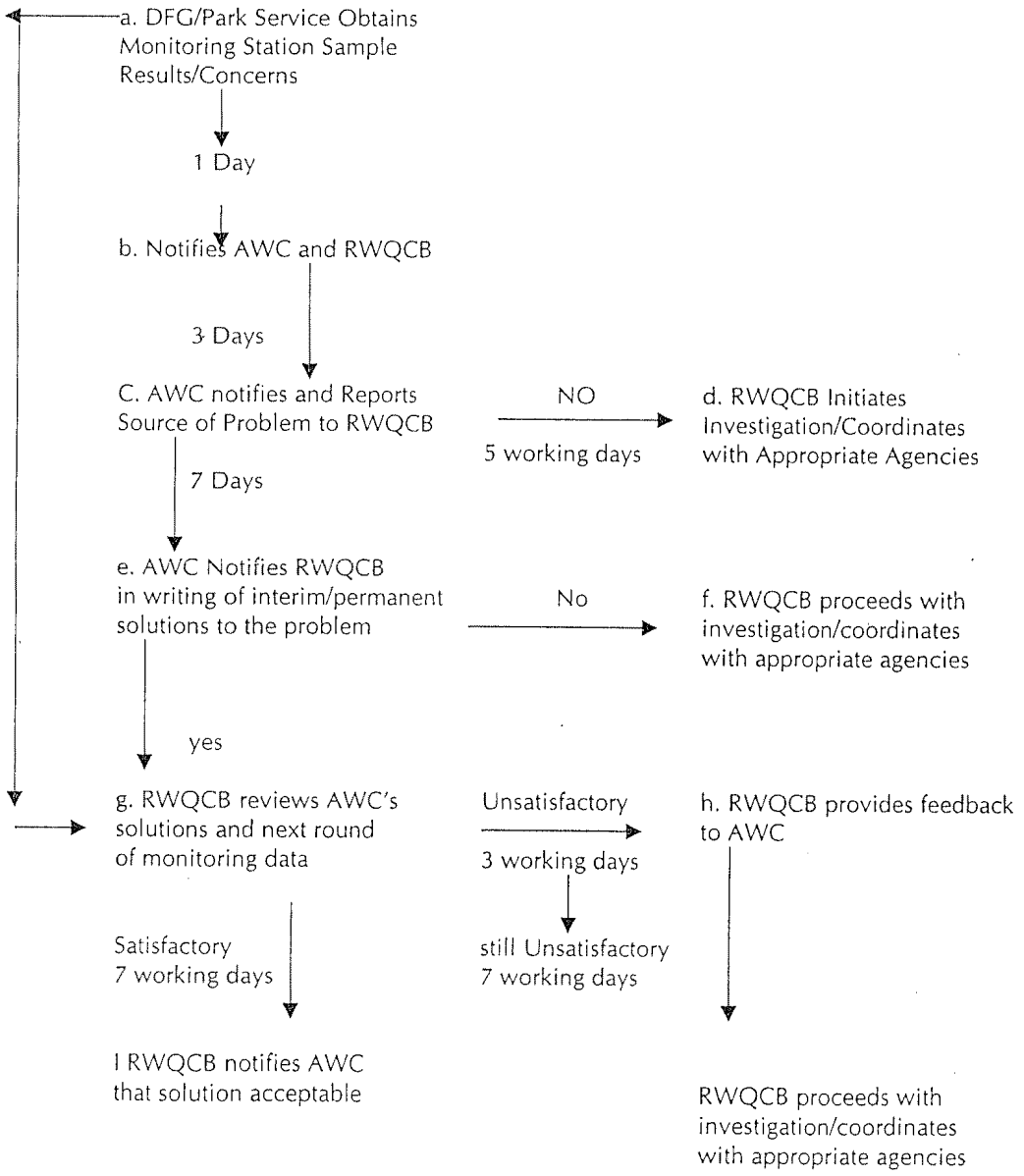
Levels	Standard Levels	Trigger
Total Ammonia	1.0 ppm	5.0 ppm
Unionized Ammonia	0.025 ppm	0.10 ppm
Dissolved Oxygen	>5.0	<5.0

The standard levels are those that reflect, on average, good water quality conditions. The trigger levels are those that are dangerous to aquatic life. Levels above the standards are not necessarily acceptable, but they are not as serous as the trigger levels. Test results between these two levels are an indication of a potential problem, and are also an indication to producers to identify possible sources before water quality reaches a toxic level. Once trigger levels are obtained, the response process begins. The monitoring party has one day to notify the Animal Waste Committee (AWC) (Judy James or Dayna Girardelli) and the respective regional water quality agency.

B. The AWC is notified and has three days to identify the source
C. No later than three days, the AWC is to contract the regional agency to report the source of the problem
D. If the AWC fails to report, water quality initiates its own investigation and the rest of the process is void
E. Seven days following the notification a written report is due to the regional agency, describing actions taken to reduce/eliminate the source
F. If a written report is not submitted, water quality initiates its own investigation and the remaining process is void
G. Water quality reviews the written report and takes into consideration the results of the next monitoring tests to determine if these actions are satisfactory
H. If actions are not deemed satisfactory the AWC is notified to take additional steps
I. The water quality board will notify the AWC that actions taken are satisfactory and the solution is acceptable
J. The AWC has seven days to make additional improvements. If they fail to do so, water quality will proceed with their own agenda

This process is initiated by using the trigger levels. There are, however, instances where regulatory agency involvement supercedes this process, such as deliberate discharge and or visually unacceptable circumstances. For the most part, regulating agencies will refer to this process to deal with poor water quality and concerns. With this process in place and regulatory cooperation, it is imperative that all landowners, regardless of industry, work together within each watershed to make the process work.

Agency Response Flow Chart



Source: University of California Cooperative Extension Service – Sonoma County, 1999

Recommendations

The water quality monitoring plan that is being implemented by the Animal Waste Committee has proven successful in its attempts to curtail water quality impacts associated with the dairy and livestock industries in the watershed. Monitoring programs such as these should continue and could be expanded to include additional monitoring parameters or monitoring sites. In addition to the continuation and expansion of existing programs, the establishment of a watershed science team, and the support of landowner water quality self-monitoring programs are recommended.

- **Continue and expand current monitoring efforts.** Current monitoring groups have done an exceptional job to date. Local schools, the Farm Bureau, Bay Area scientists, environmental organizations, and public agencies are all participating in an effort to determine water quality conditions for the Petaluma River. Efforts such as these have the ability to educate all facets of the community with an interest in water quality. These programs should continue and should be enhanced by funding opportunities whenever possible. Monitoring programs for the river could also be enhanced through the expansion of existing programs to include additional monitoring sites and parameters. Furthering these programs to include other areas of the watershed will aide in detecting the presence or absence of pollutants.

- **Establish a watershed science team consisting of local community groups and organizations, and local, state, and federal agency representatives focused on evaluating ongoing monitoring activities for the Petaluma River.** The creation of a watershed science team would help collectively organize groups and agencies to evaluate and refine ongoing monitoring activities by identifying gaps in data, making recommendations for improvement, and preventing duplication of studies. The riparian vegetation and erosion and sedimentation maps could be evaluated to determine additional monitoring sites. The watershed science team could also act to make this data available to the general public and provide direction for the purpose of furthering water quality improvement projects.

- **Support landowners to monitor water quality themselves** (*Recommendation of Landowner Advisory Committee).* Landowners have stressed the need for more outreach to let them know that monitoring kits/training/protocols are available (such as through the current Farm Bureau monitoring program). Monitoring workshops put on through the U.C. Cooperative Extension Service are encouraged. These workshops should stress standardized protocols to ensure that monitoring is done accurately. Landowners have also expressed the need for technical expertise, possibly through a local water monitoring coordinator.

V. Non-point Source Monitoring for Rural Landowners

Monitoring may be as simple as a visual observation or as complicated as performing a detailed laboratory analysis. It is often confusing to know which parameters may be of concern for a specific project or purpose. The following pages offer a set of guidelines to non-point source monitoring followed by a summary of water quality concerns and associated water quality parameters related to land use within the Petaluma River watershed. For purposes of the Petaluma River watershed study, these guidelines are focused on rural residential and agricultural areas of the watershed.

Non-point Source Monitoring. Sources of water pollution that require monitoring are divided into two categories: 1) point source and 2) non-point source pollution. The Regional Water Quality Control Board regulates both sources. Point source pollution is best described as any type of pollution that is released from a pipe such as wastewater and in certain cases, agricultural runoff. These are regulated by requiring National Pollution Discharge Elimination System (NPDES) permits for all point source discharges to waters of the state. In terms of agricultural practices, a NPDES permit is needed for dairies containing greater than 1000 animal units (the equivalent of 750 cows). Non-point source pollution is regulated in a different manner since it is difficult to assess an exact location that is contributing to a pollution problem. Polluted runoff from stormwater and agriculture are two examples of non-point source pollution. For purposes of the watershed study, these guidelines will focus on non-point source pollution.

Non-point source pollution can be addressed most effectively by instituting the following types of monitoring programs defined as:

> **Baseline monitoring** - Existing water quality conditions are characterized to establish a database for planning or future comparisons.
>
> **Effectiveness monitoring** - Evaluation is made to determine whether the specified activities (e.g., Best Management Practices, BMPs) have the desired effect (MacDonald, 1991).

The type of monitoring a project will adopt depends on the purpose of the project. Baseline monitoring can be used on a watershed basis and will reveal any existing concerns related to non-point or point source pollution. Once the watershed's problem areas are identified, the monitoring program can be refined to include trend monitoring which will evaluate any long term changes that are occurring in the watershed. This can be done on a regular basis of public access points.

Effectiveness monitoring would help evaluate a particular practice such as the effectiveness of planting a cover crop with a vineyard. This can be as simple as a visual observation but may include additional water quality monitoring measures. It is important to note that effective monitoring sites would most likely be located on private property and should be implemented by landowners unless permission for other monitors has been granted.

Monitoring programs can prove to be valuable for their desired purpose. The most important element to consider when developing a monitoring program is that the program produces quality data. Quality assurance and control will allow for better comparison and interpretation and ensure the data's validity for future endeavors. Once you have chosen the type of monitoring program you would like to pursue, the next step is identifying parameters of concern. Monitoring parameters outside urban areas can be identified most effectively through types of land use such as rural residential, animal agriculture, or vineyards and croplands.

Rural Residential Areas. Rural residential areas are often referred to as ranchettes and are found throughout the Petaluma River watershed. Ranchettes range from one to 20 acres and are usually not part of development tracts. These areas provide a direct impact on nearby stream systems carrying storm runoff and dry weather flows which include irrigation water and wash waters from impervious areas such as roads. The result is a lack of water infiltration into the soil (ground water recharge) and an increase in runoff. Compounding the effect is not only an increase in the volume of water but an added increase in the water velocity over impervious surfaces. Once the accelerated flow reaches the stream channel, the morphology of the stream may change, resulting in increased flooding, increased temperature, erosion, sedimentation, and habitat loss.

Aside from these factors, water quality is further degraded as runoff carries sediment, nutrients, bacteria, and toxic heavy metals into the stream. The sources of these pollutants are varied and can be traced to septic systems, residential and commercial landscaping, construction sites, motor vehicles (brake pads, tires, and oils), paints, cleaning products, fertilizers, pesticides, and herbicides. Ranchettes also harbor small-scale animal agriculture or crop operations. Please refer to the appropriate land use for monitoring parameters associated with such operations.

Rural residential areas within the Petaluma River watershed which may provide an impact to the river include the area on the eastern side of the watershed surrounding Penngrove extending into Lichau and Lynch Creeks. On the western side of the watershed, the rural residential areas impacting the river outside Petaluma are Liberty Road, Rainsville Road, Skillman Lane, Middle Two

Rock Road, and Eastman Lane. The following are water quality parameters that may be associated with rural residential areas (University of California, 1995:

- Visual evaluations/foam/color/odor
- Conductivity
- Flow
- Acute toxicity (visible mortality, odor, turbidity)
- Dissolved Oxygen (DO)
- Septic system failures (Coliform bacteria)
- Biomonitoring (monitoring instream fauna)
- Sediment/gravel
- Metals
- Ammonia/pH/temperature
- Biological oxygen demand (BOD)
- Habitat assessment
- Fertilizers/nutrients
- Pesticides
- Road oil, soap, surfactants, (visual)
- Paint/construction materials
- Garbage, (visual)

Animal Agriculture. Animal wastes such as those associated with horse, dairy, beef, sheep, poultry, and any other animal facility will contribute non-point source polluted runoff to nearby surface waters if managed incorrectly. Animals may contribute to non-point source pollution in a number of ways. The most direct effect is the presence of animals within the stream corridor. When managed incorrectly, these areas can become denuded of vegetation due to over grazing and/or hoof traffic. The result is the sloughing of streambanks, erosion, increased water temperature, sedimentation, and loss of wildlife habitat.

Animals will also contribute to non-point source pollution in the way of nutrients and bacteria from manure. This is caused by animals defecating in the stream or by runoff from manured areas such as confinement areas, feeding areas, watering areas, manure storage areas, silage pits, hoof trails, and manure application areas. The following are water quality parameters associated with confined animal facilities (University of California, 1995):

- Ammonia/pH/Temperature
- Conductivity
- Flow
- Dissolved Oxygen, (DO)
- Foam/color visual evaluation, odor turbidity
- Sediment/gravel
- Biological oxygen demand (BOD)

- Habitat assessment
- Pesticides

Agriculture - Vineyards/Croplands. The primary water quality concern related to vineyards and cropland is erosion and sedimentation. Sedimentation can be the result of new vineyard development and/or hillside vineyards that do not take the necessary precautionary steps for erosion control. The mismanagement of such sites can result in gullies, sheet and rill erosion, increased runoff, and increased water velocities. All of these factors ultimately affect the nearby streams by downcutting the stream channel, destroying wildlife habitat, increasing water temperatures, and/or destroying spawning beds.

Additionally, vineyards and croplands may contribute to non-point source pollution through the mismanaged use of pesticides, herbicides, fungicides, fertilizers, and pomace disposal. The following are water quality parameters associated with such practices (US Department of Agriculture, 1996):

- Sedimentation
- Flow
- Habitat assessment
- Pesticides
- Temperature
- Dissolved Oxygen
- Biological Oxygen Demand
- Fertilizers/nutrients

Other Considerations:
It may not be necessary to monitor for each of the parameters that is listed and to do so can prove to be expensive. For example, it is recommended that agricultural producers concerned with dairy waste monitor for pH, temperature, and ammonia. The cost to purchase test equipment for these parameters is substantially lower than if one were to purchase test kits for all parameters listed. Other considerations include identification of sites, and monitoring frequency. All these factors are important questions that should be answered by a local professional. Table 3 lists resource personnel available who can help answer these questions.

Table 3: List of Resources

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Agency	**Address**	**Phone Number**
Mike Rugg Department of Fish and Game	P.O.Box Yountville, CA 94599	(707) 944-5525
Bill Hurley Regional Water Quality Control Board	1515 Clay Street, Suite 1400 Oakland, CA 94612	(510)-622-2364
Dayna Ghirardelli / Paul Olin Univ.of California Cooperative Extension	2604 Ventura Ave., Rm. 100 Santa Rosa, CA	(707)-527-2621
Sonoma and Marin County Farm Bureau	970 Piner Road Santa Rosa, CA	(707) 544-5575
Josh Collins San Francisco Estuary Institute	1325 South 46th St. Richmond, CA 94804	(510) 231-9539
Paul Jones Environmental Protection Agency	75 Hawthorne Street San Francisco, CA 94105	(415) 744-1976
Mike Ban City of Petaluma	22 Bassett Street Petaluma, CA 94952-2610	(707) 778-4304
Southern Sonoma County Resource Conservation District	1301 Redwood Way Suite 170 Petaluma, CA 94954	(707) 794-1242x3
Natural Resources Conservation Service	1301 Redwood Way Suite 170 Petaluma, CA 94954	(707) 794-1242x3
Bruce Osterlye Trout Unlimited	727 Paula Lane Petaluma, CA 94952	(707) 765-9775
Paul Martin Western United Dairyman	5154 Linda Lane Santa Rosa, CA 95404	(209) 527-6453

VI. List of References

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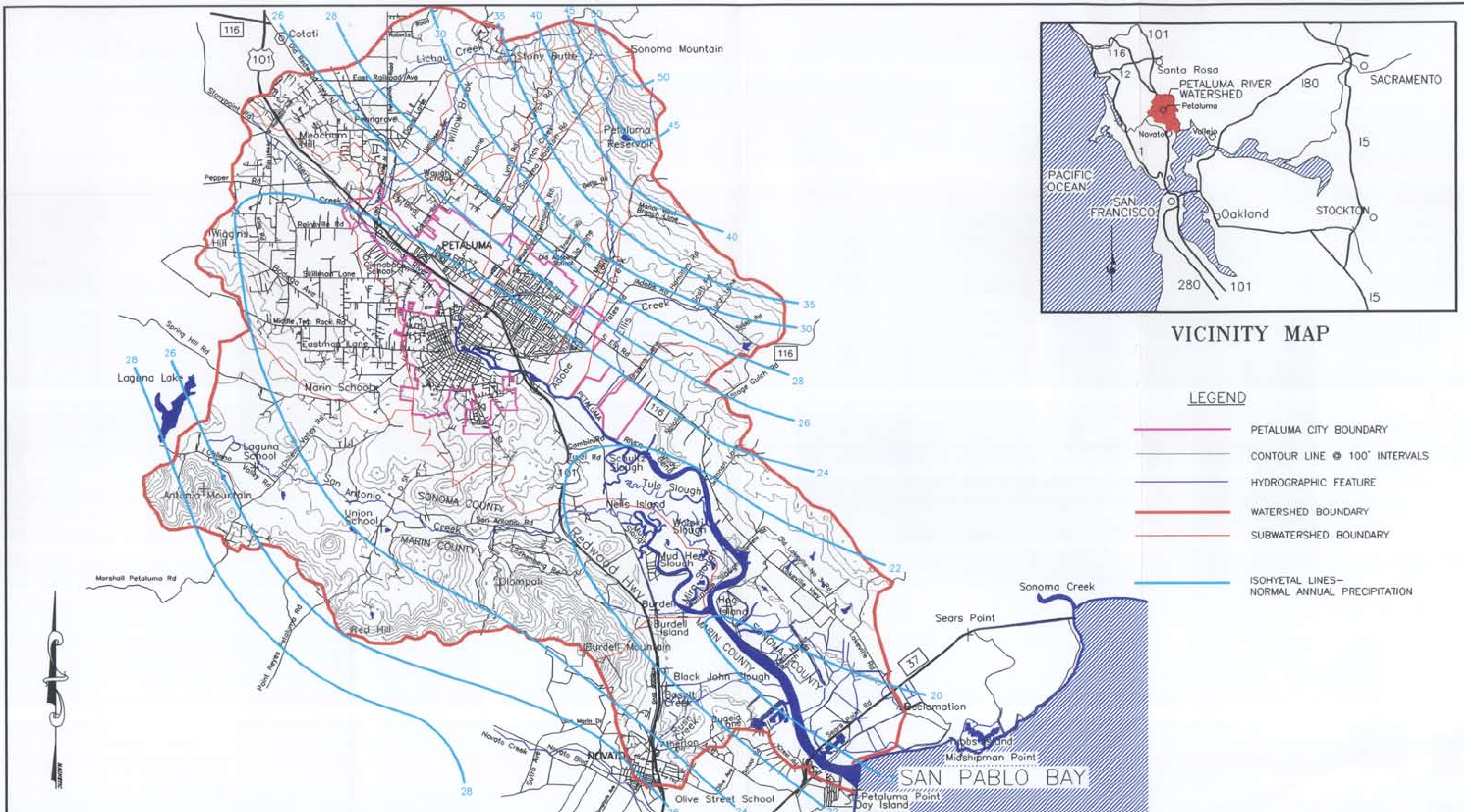
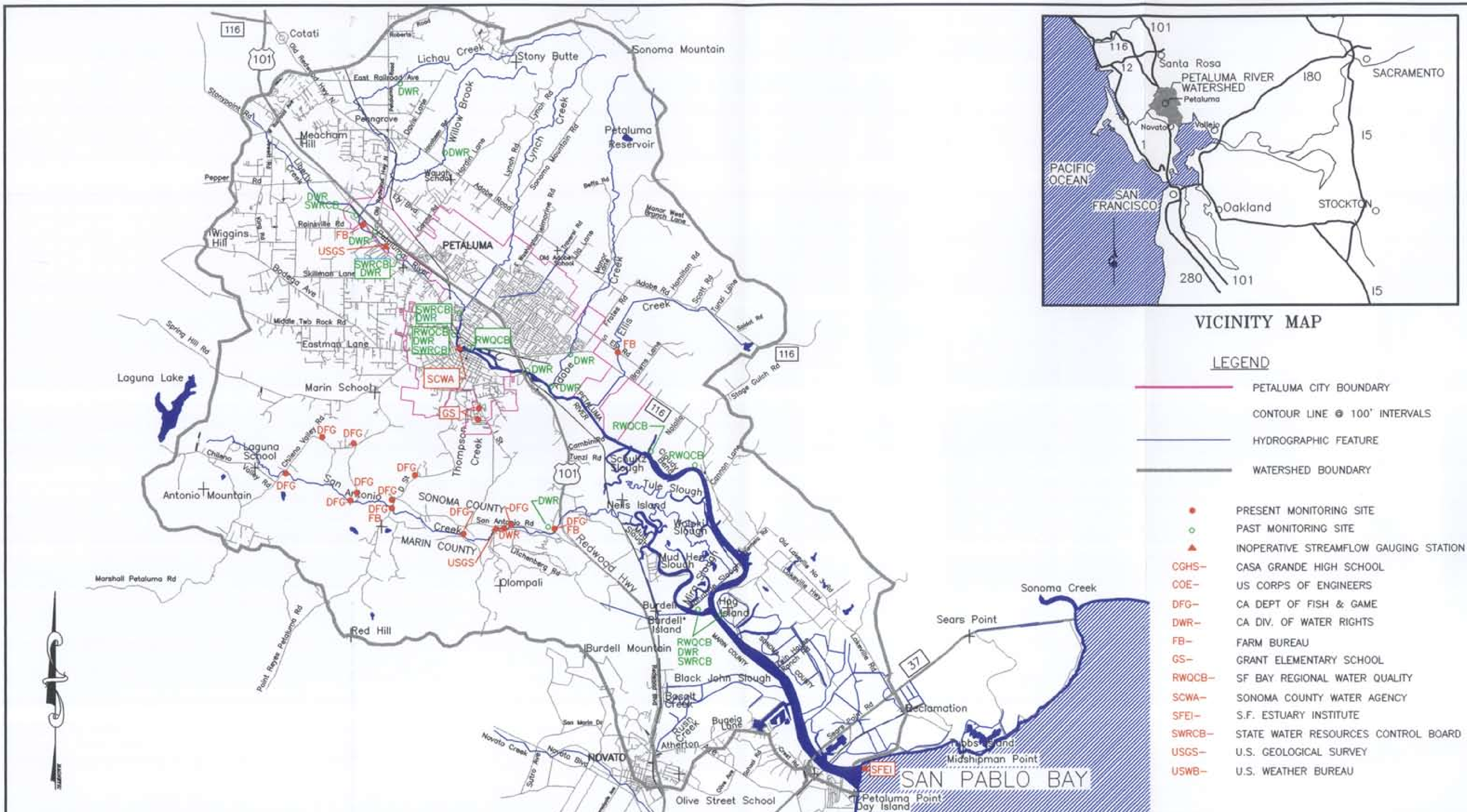


PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: March, 1998 SCALE: 1" = 10,000' CHECKED BY: MN DRAFTED BY: EA	REVISIONS	BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	NORMAL ANNUAL PRECIPITATION FOR PETALUMA RIVER WATERSHED	SHEET 1 OF 1



PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874–0100	DATE: July 1, 1998 SCALE: 1" = 10,000' CHECKED BY: MN DRAFTED BY: EA	REVISIONS	BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	WATER QUALITY MONITORING IN THE PETALUMA RIVER WATERSHED	SHEET 1 OF 1