

G-1091

May 1998 CALFED ECOSYSTEM RESTORATION PROPOSAL SOLICITATION

Proposal Title: Assessment of Water Quality from Agricultural Drains - Sutter Bypass and Butte Slough

Applicant Name: Gerald Boles - California Department of Water Resources

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Amount of funding requested: \$198,000 for two years

Indicate the Topic for which you are applying (check only one box). Note that this is an important decision: see page \_\_\_ of the Proposal Solicitation Package for more information.

- Fish Passage Assessment
- Floodplain and Habitat Restoration
- Fish Harvest
- Watershed Planning/Implementation
- Fish Screen Evaluations - Alternatives and Biological Priorities
- Fish Passage Improvements
- Gravel Restoration
- Species Life History Studies
- Education

Indicate the geographic area of your proposal (check only one box):

- Sacramento River Mainstem
- Delta
- Suisun Marsh and Bay
- San Joaquin River Mainstem
- Landscape (entire Bay-Delta watershed)
- Sacramento Tributary: Sutter Bypass/Butte Slough
- East Side Delta Tributary: \_\_\_\_\_
- San Joaquin Tributary: \_\_\_\_\_
- Other: \_\_\_\_\_
- North Bay: \_\_\_\_\_

Indicate the primary species which the proposal addresses (check no more than two boxes):

- San Joaquin and East-side Delta tributaries fall-run chinook salmon
- Winter-run chinook salmon
- Late-fall run chinook salmon
- Delta smelt
- Splittail
- Green sturgeon
- Migratory birds
- Spring-run chinook salmon
- Fall-run chinook salmon
- Longfin smelt
- Steelhead trout
- Striped bass

COVER SHEET (PAGE 2 of 2)

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Indicate the type of applicant (check only one box):

- |  |   |
|--|---|
| <input checked="" type="checkbox"/> State agency         | <input type="checkbox"/> Federal agency |
| <input type="checkbox"/> Public/Non-profit joint venture | <input type="checkbox"/> Non-profit     |
| <input type="checkbox"/> Local government/district       | <input type="checkbox"/> Private party  |
| <input type="checkbox"/> University                      | <input type="checkbox"/> Other: _____   |

Indicate the type of project (check only one box):

- |  |   |
|--|---|
| <input type="checkbox"/> Planning              | <input type="checkbox"/> Implementation |
| <input checked="" type="checkbox"/> Monitoring | <input type="checkbox"/> Education      |
| <input type="checkbox"/> Research              |   |

By signing below, the applicant declares the following:

- (1) the truthfulness of all representations in their proposal;
- (2) the individual signing the form is entitled to submit the application on behalf of the applicant (if applicant is an entity or organization); and
- (3) the person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section II.K) and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

Gerald Bole  
(Signature of Applicant)

## Executive Summary

**Project Title:** Assessment of Water Quality from Agricultural Drains — Sutter Bypass and Butte Slough

**Applicant:** Gerald Boles  
California Department of Water Resources  
2440 Main Street  
Red Bluff, California 96080

**Project Description:** The proposed project is a water quality assessment program for the Sutter Bypass and Butte Slough. The assessment program is needed to identify water quality parameters from the Sutter Bypass and Butte Slough that are contributing to the decline of anadromous fish in the Sacramento River. Information developed by the proposed project will be used to identify factors contributing to the decline of salmonid species and development of recommendations for corrective actions.

**Primary Biological and Ecological Objectives:** The primary biological and ecological objectives are to determine water quality factors that may be adversely affecting aquatic life and their habitats from discharges from the Sutter Bypass and Butte Slough agricultural drains, especially for spring-run salmon, fall-run salmon, and steelhead trout. This information will be used by the Regional Water Quality Control Board, Department of Pesticide Regulation, Western Canal Water District, Department of Fish and Game, and other groups to protect and improve habitat conditions for these important fish species and other aquatic life which are impacted by drain water.

**Approach:** Monitoring stations will be established in the Sutter Bypass (Sacramento Slough) and Butte Slough. Descriptive stream condition and habitat assessments will be conducted at each site. Basic water chemistry (minerals, nutrients, minor elements (metals), and physical parameters) will be assessed since these param-

eters determine the beneficial uses of water and become elevated due to pollution, which often results in deleterious effects to aquatic life and other beneficial uses. Water temperature will be assessed via continuous recorders since this parameter has often been significantly altered from stream management activities and is important for determining the suitability of a water body for survival and reproduction of anadromous fish. Coliform bacteria, Cryptosporidium, and Giardia levels will be assessed since these organisms are indicative of contamination which may impact health and are of concern to downstream drinking water purveyors. Aquatic macroinvertebrates, which form the basis of the aquatic food web and are excellent indicators of long-term water quality conditions, will be assessed throughout the watershed.

The direct measurement of toxicity to aquatic organisms will be used to determine the ability of the stream to support aquatic life. Toxicity assessment in stream bed sediments and the water column will identify potential impacts to fish and their food organisms from toxic substances. Fish tissues, which accumulate various toxic substances, will be analyzed to determine the presence of toxic substances which may not be identifiable through other means.

Organic chemicals (primarily pesticides) which are likely contained in the drain waters, will be sampled monthly from both the Sutter Bypass and Butte Slough.

**Justification:** The proposed project will provide information about system stressors in the Sutter Bypass and Butte Slough which affect priority aquatic species and their habitats. The draft Restoration Plan for the ARFP (May 1997) recommended monitoring long-term changes in water quality, among others. Monitoring water resources in the watershed is essential to detect and

document pollution. Water quality affects the beneficial uses of streams, including the beneficial use as fish habitat. Yet, very little water quality data are available for the Sutter Bypass and Butte Slough. Without water quality data, environmental effects to migrating, spawning, and rearing salmon and steelhead cannot be realistically determined, nor can mitigation be developed until the scope of the problem is defined. Data developed by the proposed project will be used by a variety of agencies and groups to implement mitigation activities to improve habitat conditions related to water quality. This project is important to water resource managers and will provide a strong basis for better decision making by federal, State, and local agencies and environmental groups.

**BudgetCosts:** The total annual cost for this project is \$99,000. The total cost for the two year project is \$198,000. There are no third party impacts associated with the conductance of this project.

**Applicant Qualifications:** The project manager and field staff have many years of experience with the Department of Water Resources conducting similar projects. The Department has all necessary equipment to conduct the project.

**Monitoring and Data Evaluation:** Data will be used to determine present effects from stressors to instream aquatic habitat and priority species, and to determine effectiveness of watershed management and mitigation activities. Data from the proposed project will be compared to the sparse historic data that are available to determine long-term changes that may have occurred. Data will also be compared with criteria established for protection of aquatic life and assessment results from the Sacramento River Watershed Program, which is assessing similar parameters in the mainstem of the Sacramento River.

A quality assurance project plan will be

developed to ensure that data are accurate. All staff will be familiar with the QA project plan and receive appropriate training in data collection techniques.

**Support/Coordination:** The Regional Water Quality Control Board, Western Canal Water District, Department of Fish and Game, and Sacramento River Watershed Program all support this project. This project was designed to offer data comparable to the mainstem data collection efforts of the SRWP.

**CompatibilitywithCALFEDOjectives:** This project addresses water quality problems which adversely impact high-risk aquatic species and their habitats, including spring-run and fall-run chinook salmon, steelhead trout, and instream aquatic habitat. The project also provides information necessary for actions to improve and increase aquatic habitats and improve ecological functions, consistent with the objectives in the Ecosystem Restoration Program Plan.

**Assessment  
of  
Water Quality from Agricultural Drains  
—  
Sutter Bypass and Butte Slough**

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Northern District  
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Type of Organization: State Government  
(Tax Exempt)

Implementation Participants and Collaborators  
Sacramento River Watershed Program

July 2, 1998

## Project Description

### Project Description and Approach:

The proposed project is a water quality assessment program for the Sutter Bypass and Butte Slough. The assessment program is needed to identify water quality parameters from the Sutter Bypass and Butte Slough that are contributing to the decline of anadromous fish in the Sacramento River. Information developed by the proposed project will be used to identify factors contributing to the decline of salmonid species and development of recommendations for corrective actions.

Basic water chemistry (minerals, nutrients, minor elements (metals), and physical parameters) will be assessed since these parameters determine the beneficial uses of water and become elevated due to pollution, which often results in deleterious effects to aquatic life and other beneficial uses. Water temperature will be assessed since this parameter controls the rate of chemical and biological processes, has often been significantly altered from stream management activities (such as dams and diversions), and is of utmost importance in determining the suitability of a water body for survival and reproduction of anadromous fish.

Coliform bacteria levels will be assessed since these organisms are indicative of fecal contamination and the possible presence of far more serious microorganisms which may impact health. Cryptosporidium and Giardia will also be monitored since these organisms affect drinking water supplies taken from downstream areas of the Sacramento River. Aquatic macroinvertebrates

form the basis of the aquatic food web and are excellent indicators of long-term water quality conditions since specific communities develop in response to specific stream conditions and perturbations. These organisms will also be assessed in the Sutter Bypass and Butte Slough.

The direct measurement of toxicity to aquatic organisms will determine the ability of the Sutter Bypass and Butte Slough discharges to support aquatic life. Toxicity assessment in Bypass and Slough bed sediments will identify impacts to the benthic community forming the basis of the food web. Water column toxicity assessment will identify direct impacts to fish from toxic substances dissolved or suspended in the water column. Fish tissues accumulate certain toxic substances, often in higher concentrations than found in the environment. Though these substances may not be directly lethal, bioaccumulation may result in death of the fish, impairment of life function such as reproduction, and adverse effects to higher trophic levels (including people) which ingest the fish. Analyses of fish tissues will determine the presence of toxic substances which may not be identifiable through other means.

Monitoring stations for general water quality characteristics will be established at the mouth of the Sutter Bypass (in the Sacramento Slough) and Butte Slough. Temperature recorders will be placed at each station. Descriptive stream condition/habitat assessments will be conducted at each site. Physical parameters will also be collected monthly at both of these stations, including pH, conductivity, dissolved oxygen, and turbidity.

Water samples will be collected monthly at the two water quality stations to assess chemical constituents, including minerals (calcium, sodium, potassium, magnesium, sulfate, chloride, boron, and alkalinity), nutrients (nitrate plus nitrite, ammonia, dissolved orthophosphate, and total phosphorus), and minor elements (aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, and zinc).

Monthly coliform bacterial analyses at the sampling locations will use the membrane filtration method. Biological sampling will include annual aquatic macroinvertebrate sampling at both locations.

Toxicity tests will include fish tissue sampling, bed sediments, and water column testing. Tissue samples will include resident species, such as sculpin or the Asiatic clam, *Corbicula*. Water column testing will use Ceriodaphnia and the fathead minnow. Bed sediment toxicity assessment will use the amphipod *Hyalella*.

The Sutter Bypass and Butte Slough transport drain water from agricultural fields to the Sacramento River. Drain waters often carry substantial loads of pesticides and other organic and inorganic chemical compounds associated with agricultural production. Organic chemicals (primarily pesticides) will be sampled monthly from both the Sutter Bypass and Butte Slough.

This monitoring schedule will continue for two years. Additional parameters may be added as data analyses identifies problems within the Bypass or Slough. Future assessment

proposals will use the data from this study to further identify sources of adverse effects and develop remedial actions.

**Proposed Scope of Work:** Field sample and data collection for water quality assessments will be conducted according to the schedule presented in Table 1. After collection, samples will be submitted to laboratories for analyses while field data and laboratory results will be entered into a database. The data will be reviewed monthly to insure the program is on schedule and that the data being collected are providing useful information.

Progress reports will be made to CALFED, the Sacramento River Watershed Program, and other interested parties at agreed upon intervals. The project is proposed to continue for two years. An annual report documenting the achievements of the project will be prepared at the end of the first year, while a final report will be prepared at the end of the second year of the program.

**Location of Project:** The proposed project will be conducted at two sites: Sutter Bypass and Butte Slough. Butte Slough, near the Sutter Buttes, carries Butte Creek flows to the Sutter Bypass, which empties to the Sacramento River at Knights Landing.

**Expected Benefit:** The proposed project will provide information about system stressors in the Sutter Bypass and Butte Slough which affect priority aquatic species and their habitats. The stressors for which this project will provide valuable information include: 1) alteration of flows and other effects of water management, including hydrograph

alterations, migration barriers and straying; 2) water quality; 3) water temperature; and 4) land use, including hydropower production, grazing, urbanization, and forestry and agricultural practices.

Adverse water quality conditions created by hydrograph modification, especially as related to water quality and temperature modification, result in delaying or blocking migration by anadromous fish, and mortality to juvenile fish. Contaminants from agricultural runoff and other pollution sources may lead to toxicity to aquatic organisms in the Sutter Bypass and Butte Slough. Water temperatures, especially during lower flows, adversely affect the ability of the Bypass and Slough to provide suitable migration for anadromous fish, as well as other aquatic species, which must pass through these drains for access to spawning areas in Butte Creek.

The habitat type affected by stressors in the Sutter Bypass and Butte Slough is primarily instream aquatic habitat. The priority species in this habitat type include spring-run, fall-run, and late-fall-run chinook salmon and steelhead trout. This project will provide primary benefits to this habitat type and these species by identifying water quality impairments that are limiting the quality of the habitat and reducing survival of these species. The project provides secondary benefits for adaptive management by establishing baseline conditions to evaluate the effects of other mitigation activities that occur in the watershed.

**Background and Biological/Technical Justification:** The proposed project conforms to the goals of the implementa-

tion strategy of the ERPP. This strategy focuses on indicators to determine effectiveness of the ERPP, and comprehensive monitoring to determine the status of the indicators (p. 3, Vol. 1). This proposed program will monitor water resource indicators to determine present ecological conditions and health, provide a benchmark to determine effectiveness of future restoration efforts, and identify ecosystem stressors.

An Implementation Objective of the ERPP for the Butte Basin Ecological Zone is to restore ecological processes in the upper watershed to maintain and improve the quality and quantity of water (p. 239, Vol. 2, ERPP). The ERPP vision for contaminants (p. 328, Vol. 1) is to ensure that all waters of mainstem rivers and tributaries entering the Bay-Delta are free of high concentrations of toxic substances. Furthermore, the process of ecosystem restoration would be initiated by implementing actions to prevent, control, and reduce contaminant sources that represent immediate or potential toxicological hazards to ecosystem processes.

The ERPP states that "an assessment of water quality and impacts from various other agricultural drainages to the Sacramento River is needed. Top priority should be given to the Sutter Bypass, which receives drainwater from rice growing areas and has outflows equivalent to those from the Colusa Basin drain. Assessments should also be conducted on Butte Slough," and others (p. 155, Vol. 2).

The CALFED Water Quality Program goal is to provide good water quality for environmental, agricultural, drinking water, industrial, and recreational

beneficial uses (p. 329, Vol. 1). "Monitoring programs that identify long-term trends in contaminants found in ecosystem biota have helped to guide restoration efforts" (p. 330, Vol. 1). Similarly, this proposed program to evaluate water quality conditions in the Sutter Bypass and Butte Slough will identify contaminants and guide restoration efforts by the Central Valley Regional Water Quality Control Board, Department of Pesticide Regulation, Department of Fish and Game, CVPIA, and others.

The May 1997 Draft AFRP identifies development of a watershed management plan as a high priority for the Butte Creek watershed, which includes the Sutter Bypass and Butte Slough. Paramount in the development of a watershed management plan is analysis of current conditions and data for determining baseline conditions against which future restoration activities can measure progress. The draft Restoration Plan for the ARFP recommended monitoring long-term changes in water quality, among others. The proposed program will provide information vital for inclusion in the watershed management plan being developed by the Butte Creek Watershed Conservancy.

Monitoring the water resources in a watershed is essential to detect and document pollution. Monitoring is also necessary to continually assess water quality and the health of the water resource. The most reliable way to determine if changes in land-based activities have affected water quality is to monitor the water resource before, during, and after a change in land management or restoration occurs. At a watershed scale, this relationship between changes in land management

and water quality can only be determined by following a strict experimental plan or monitoring protocol. Detailed tracking of water quality is essential to provide information to decision makers about the effectiveness of nonpoint source pollution control efforts.

Butte Creek supports fall, late-fall, and spring-run chinook salmon and steelhead trout, but numerous dams and diversions, inadequate spawning gravel, and poor water quality have contributed to the decline of fish populations. Adult fish migrating upstream to the spawning grounds and juvenile fish migrating downstream must pass through both Butte Slough and the Sutter Bypass. According to the Department of Fish and Game's report Restoring Central Valley Streams: A Plan for Action, many juvenile salmonids perish due to poor water quality, and attributed the decline of the chinook salmon and steelhead fisheries to poor water quality and other habitat issues. However, very little water quality data are available for the Sutter Bypass and Butte Slough. Without water quality data, environmental effects to migrating salmon and steelhead cannot be realistically determined, nor can mitigation be developed until the scope of the problem is defined.

Multi-agency efforts, including those of the Butte Creek Watershed Conservancy, Department of Fish and Game, Regional Water Quality Control Board, and Pacific Gas and Electric Company, are underway to address water quality issues, fisheries restoration, and stream flow management in the Butte Creek watershed, which includes the Sutter Bypass and Butte Slough. The Department of Fish and Game has identified a water quality study as a high priority

evaluation action to determine habitat needs for Butte Creek.

Water quality assessment and monitoring are necessary to characterize existing conditions within the watershed, determine contaminants and their origins, and understand the interactions of toxicants and biological components of the ecosystem. Data will be developed by the proposed program that identify current conditions of various resource issues related to water quality, and provide a baseline to determine the effectiveness of mitigation activities in the watershed. This assessment plan will address historic as well as current water quality conditions to define those factors that most affect the water quality conditions within the Sutter Bypass and Butte Slough.

Data developed by the proposed project will be used by a variety of agencies and groups to implement mitigation activities to improve habitat conditions related to water quality, including water temperatures and toxicants. This project is important to water resource managers and will provide a strong basis for better decision making by federal, State, and local agencies and environmental groups.

**Monitoring and Data Evaluation:** Data generated from this project will establish baseline water quality conditions for the Sutter Bypass and Butte Slough. These data will be used to determine present effects from stressors to instream aquatic habitat and priority species, and to determine effectiveness of watershed management and mitigation activities.

Data from the proposed project will be compared to the sparse historic data

that is available to determine long-term changes that may have occurred. Data will also be compared with criteria established for protection of aquatic life and assessment results from the Sacramento River Watershed Program, which is assessing similar parameters in the mainstem of the Sacramento River. Data from the proposed assessment program will be used by the Sacramento River Watershed Program to determine the contribution from the Sutter Bypass and Butte Slough to water quality impairment in the Sacramento River.

A quality assurance program plan will be developed prior to beginning of monitoring to assure that data are of high quality and suitable for intended uses. All staff working on the project will be familiarized with the quality assurance plan and program objectives.

**Implementability:** Department of Water Resources staff have current valid scientific collecting permits to enable completion of biological assessments for this project. No other environmental permits are required. The Department also has all necessary equipment to conduct this assessment, including vehicles, boats, and sampling equipment.

The Western Canal Water District has requested the Department of Water Resources to develop a water quality assessment program. The Department has also received endorsement for water quality monitoring from the Sacramento River Watershed Program. Monthly progress presentations to the Western Canal Water District and Sacramento River Watershed Program will insure that

information generated from the program is meeting the needs for assessment and mitigation efforts. All draft reports will be reviewed by these groups.

#### **Costs and Schedule to Implement Proposed Project**

**Budget Costs:** Costs for the project are distributed as indicated in Table 2. Estimated total cost for this work is \$99,000 per year, including field sample collection, laboratory analyses, data processing, and report preparation. The total requested allocation for the two year water quality assessment of the Sutter Bypass and Butte Slough is \$198,000.

**Schedule Milestones:** The Department of Water Resources will begin the monitoring program according to the schedule in Table 1 upon completion of a contract for funding. Data generated by the project will be reviewed monthly. The project may be modified following data review and consultation with CALFED staff and the Sacramento River Watershed Program.

**Third Party Impacts:** No direct third party impacts are associated with this project. However, third parties may be affected as the results of this watershed assessment project are used to mitigate sources of impairment. Third parties may bear some of the costs of mitigation, or additional grants will be needed to remediate impairment. The extent of costs for remediation of impairments cannot be determined until the proposed project is implemented and results are obtained.

#### **Applicant Qualifications**

The project will be conducted by staff

of the Northern District of the California Department of Water Resources. The project will be directed by Gerald Boles, who is Chief of the Water Quality and Biology Section in the Northern District. Gail Kuenster, an Environmental Specialist II in the Water Quality and Biology Section, will be the lead investigator responsible for field sample collection and data archiving and analyses under direction of the project director. Perry LeBeouf, an Environmental Specialist I in the same section, will be responsible for overseeing laboratory work for aquatic macroinvertebrate and coliform bacteria analyses. General administrative functions, such as accounting, billing, and contract administration, will be conducted by the Northern District's Administrative Officer, Barbara Polson.

The Sacramento River Watershed Program and Western Canal Water District are the primary participants that will help guide the program. The SRWP is comprised of representatives from the Department of Fish and Game, Regional Water Quality Control Board, California State University (Chico), landowners, environmental groups, and concerned citizens, while the WCWD is comprised of agricultural interests along the lower watershed. The SRWP and WCWD will review project progress and results, and make recommendations concerning direction for the project.

**Biosketches:** Gerald Boles has been the supervisor of the Water Quality and Biology Section in the Northern District of the Department of Water Resources since 1990, and has been conducting water quality studies for the Department since 1975. He has a B.A. degree in Microbiology (minor in Chemistry) and a

M.A. degree in Biological Sciences. In addition to years of experience with budgets and general supervisory functions, he has supervised and conducted numerous water quality investigations. He is responsible for both the Water Quantity and Quality Measurement Program and the Water Quality Evaluation Program in the Northern District. His duties have required him to develop and implement studies and research projects to determine environmental effects on water quality, wildlife, plants, and fisheries associated with future water supply projects, geothermal development, weather modification, water transfers, and other projects. Some of the projects for which he has been directly responsible include assessment of impacts to the aquatic macroinvertebrate community following the metam sodium chemical spill in the upper Sacramento River in 1991, development and implementation of a water quality assessment program at Lake Almanor in cooperation with Plumas County, long-term water quality monitoring at both Clear and Eagle lakes, evaluation of effects to aquatic resources from cloudseeding in the upper Feather River area, groundwater quality assessments in the Sacramento Valley, Eagle Lake, and Cady Springs areas, and assessment of factors affecting the water quality of a drinking water supply reservoir. References include Steve Turek, Department of Fish and Game, 2440 Athens Avenue, Redding, California; Lauri Zander, Lahontan Regional Water Quality Control Board, 2501 Lake Tahoe Boulevard, South Lake Tahoe, California; Laura Barnthouse, Plumas County Environmental Health Department, P.O. Box 545, Chester, California; and Dennis Heiman,

Central Valley Regional Water Quality Control Board, 415 Knollcrest Drive, Suite 100, Redding, California.

Perry LeBeouf earned a B.S. degree in Biology from California State University, Chico and has been employed since 1996 by the Department of Water Resources. He has been involved in all phases of the District's extensive aquatic macroinvertebrate program, including field sampling, taxonomy, program design, and QA/QC. He currently is responsible for the macroinvertebrate and coliform bacteria programs in the District. Some of his projects have involved identification and enumeration of macroinvertebrates from surface water quality monitoring sites, several lake water quality monitoring programs, and assisting other Environmental Specialists with water quality related projects. He also participates as a docent to local schools in conducting field trips in stream and vernal pool ecology. He is a member of the California Inland Invertebrate Working Group.

Gail Kuenster has been employed by the Department of Water Resources since 1995. With both a B.A. and M.S. degree, she has been extensively involved in the District's water quality monitoring program, as well as thermograph maintenance and data acquisition, aquatic macroinvertebrate collection, and database administration. She currently is responsible for the collection and processing of water quality, toxicological, and biological samples and data that the Department is collecting from the Sacramento River and its tributaries, including Big Chico Creek. She is the Water Quality and Biology Section's liaison to the Big Chico Creek Watershed Alliance. References include Linnea

Hanson, U. S. Forest Service, Oroville Ranger District, Oroville, California; Dr. Rob Schlising, Biology Department, California State University, Chico, California; and Lawrence Janeway, U. S. Forest Service, Oroville Ranger District, Oroville, California.

**Compliance with Standard Terms**

As a public agency, all standard terms and conditions will be approved at signing of the contract. No forms are necessary for submission with this proposal per Table D1 of the RFP.

Table 1. Proposed Monitoring Schedule for Butte Creek

Station	Temperature Recorder	Physical DO, pH, EC, Turbidity, Alkalinity	Chemical Minerals, Nutrients, Minor Elements, TSS	Aquatic	Coliform	Giardia	Toxicity Tests			Pesticides
				Macroinvertebrates	Bacteria	Cryptosporidium	Water Column Fathead minnow and Ceriodaphnia	Bed Sediment Hyalella	Fish Tissue Scudon	
Butter Bypass nr Knights Landing	c	m	m	September	m	m	m	biannually	S,F,W	m
Butte Slough	c	m	m	September	m	m	m	biannually	S,F,W	m

c - continuously temperature recorder; serviced monthly  
 m - monthly sampling and analysis  
 S,F,W - spring, fall, and winter

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Table 2. Annual Cost distribution for the Sutter Bypass and Butte Slough Assessment

Project Task	Direct Labor Hours	Direct Salary & Benefits	Overhead Labor	Service Contracts	Material & Acquisition	Miscellaneous	Total Cost
Thermographs	96	2,125	2,640	0	500	0	4,765
Water Sampling	included with costs of thermograph maintenance						0
Inorganic Analysis (1)	0	0	0	9,624	500	0	10,124
Aquatic Macroinvertebrates	48	1,063	1,320	0	500	0	2,931
Coliform bacteria (2)	16	355	440	0	1,000	0	1,811
Cryptosporidium/Giardia (3)	96	2,125	2,640	19,200	0	0	23,965
Water Column Toxicity (4)				20,640	0	0	20,640
Bed Sediment Toxicity (5)				3,200	0	0	3,200
Fish Tissue Analysis (6)	96	2,125	2,640	5,000	138	0	9,999
Pesticide Analysis (7)	0	0	0	16,800	0	0	16,800
Reports	96	2,125	2,640	0	0	0	4,765
Total Project Costs		7,793	9,680	74,464	2,638	0	99,000

1 - monthly analyses for minerals, nutrients, and minor elements at 2 sites

2 - total and fecal coliform analyses at 2 sites each month

3 - monthly sampling for these organisms at 2 sites

4 - monthly assessment at 2 sites

5 - twice per year at 2 sites

6 - spring, fall, and winter assessment at 2 sites

7 - monthly analysis at 2 sites