990-119

4.5 PSP Cover Sheet (Attach to the front of each proposal)

Proposal Title: **Determination of the Causes of Dissolved Oxygen Depletion in the San Joaquin River**

Applicant Name: Dr. P. Lehman
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Amount of funding requested: $ 866408 for 1 years

Indicate the Topic for which you are applying (check ~~only one box~~).

- ☐ Fish Passage/Fish Screens
- ☐ Habitat Restoration
- ☐ Local Watershed Stewardship
- ☑ Water Quality
- ☐ Introduced Species
- ☐ Fish Management/Hatchery
- ☐ Environmental Education

Does the proposal address a specified Focused Action? X yes _____ no

What county or counties is the project located in? San Joaquin, Stanislaus, Merced

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

- ☐ Sacramento River Mainstem
- ☐ Sacramento Trib: _____
- ☑ San Joaquin River Mainstem
- ☐ San Joaquin Trib: _____
- ☐ Delta: _____
- ☐ East Side Trib: _____
- ☐ Suisun Marsh and Bay
- ☐ North Bay/South Bay: _____
- ☐ Landscape (entire Bay-Delta watershed)
- ☐ Other: _____

Indicate the primary species which the proposal addresses (check all that apply):

- ☐ 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
- ☐ Other: _____
- ☐ Spring-run chinook salmon
- ☑ Fall-run chinook salmon
- ☐ Longfin smelt
- ☐ Steelhead trout
- ☐ Striped bass
- ☐ All chinook species
- ☐ All anadromous salmonids

Specify the ERP strategic objective and target (s) that the project addresses. Include page numbers from January 1999 version of ERP Volume I and II:

OBJECTIVES: Recovery of at-risk native species; restore fall-run Chinook salmon; rehabilitate natural processes, estuarine, hydraulic regime that favors native species and natural habitat; IMPROVE AND MAINTAIN WATER AND SEDIMENT QUALITY TO ELIMINATE TOXIC IMPACTS ON ORGANISMS IN THE ECOSYSTEM

TARGET: FALL-RUN CHINOOK SALMON

ERP: VOL I pp 32-37 ; VOL II page 273 and Table 1

I-019096

I-019096

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

- ☑ State agency
- ☐ Public/Non-profit joint venture
- ☐ Local government/district
- ☐ University
- ☐ Federal agency
- ☐ Non-profit
- ☐ Private party
- ☐ Other: _____

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

- ☐ Planning
- ☑ Monitoring
- ☐ Research
- ☐ Implementation
- ☐ Education

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 the 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 2.4) 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.

Peggy Lehman

Printed name of applicant

Peggy M Lehman

Signature of applicant

Executive Summary

Description of Project: This project will produce a management action plan to eliminate the oxygen depletion in the San Joaquin River during the fall.

Many point and non-point sources and physical factors have been attributed to cause of the oxygen depletion in the river, but available data and modeling tools have been inadequate to develop a reliable and efficient management action plan.

The management action plan will be developed over 3 years and will include: 1) development of a database containing new and historical data on source loads of oxygen depleting substances, 2) collection of supplemental field data on source loads and controlling mechanisms, 3) filling data gaps in the existing dissolved oxygen management model for verification and calibration of controlling factors, 4) evaluation of management alternatives and 5) development of a management action plan.

Problem: Dissolved oxygen depletion occurs over a 10 mile reach of the San Joaquin River near Stockton in the fall when concentrations decrease below 6 mg/l; concentrations below 2.5 mg/l are common (USBR 1968-1974; CDWR 1987-1995; Jones and Stokes 1998). Dissolved oxygen concentrations below 6 mg/l are ecologically damaging because they are a barrier to upstream migration of adult fall-run Chinook salmon that spawn in the Merced, Tuolumne and Stanislaus Rivers between September and December (CDFG 1970). The San Joaquin salmon population has severely declined and is considered a "species of concern" by the US FWS and was listed as a threatened species by NMFS. Low dissolved oxygen concentrations can also kill, stress or block migration of other fish and may negatively impact the health of the entire aquatic community (CVRWQCB 1997).

Compatibility with CALFED: Oxygen depletion in the San Joaquin River is considered a significant water quality problem in the CALFED Estuarine Restoration Program (ERP) and impedes the CALFED goals to: 1) recover at-risk species in order to establish self-sustaining populations and minimize the need for future endangered species listings, 2) rehabilitate natural processes that support natural aquatic communities and favor native communities and 3) improve and maintain water and sediment quality to eliminate toxic impacts on organisms in the ecosystem. Oxygen depletion in the San Joaquin River is a focused action for this proposal package.

This project is directed toward the ERP target species, fall-run Chinook salmon and will assist with CALFED Water Quality Program goals to: 1) eliminate occurrences of dissolved oxygen concentrations below 6 mg/l in the fall, 2) eliminate the impairment or blockage of fish migration, 3) eliminate stress to fish and other aquatic organisms due to oxygen depletion, and 4) eliminate fish kills near Stockton.

These goals also interface with Title 34 of the CVPIA and the program for restoring anadromous fish populations outlined in "Restoring Central Valley Streams: A Plan for Action" (CDFG).

Monitoring and Data evaluation – The primary objective of the project is to fully evaluate our current conceptual model of the causes of the dissolved oxygen depletion near Stockton in order to design a management action plan to eliminate the problem.

The current conceptual model is that algal biomass from the San Joaquin River upstream of Mossdale, sediment deposits and Stockton treated effluent are major sources of oxygen depleting substances in the San Joaquin River and that these sources become a problem in the fall when water

temperature is high and streamflow is low. Current information, however, is inadequate to fully evaluate this conceptual model and allocate the loads among potential sources for management. We will evaluate the conceptual model by direct field measurements and modeling results. Continuous fluorometry and simple mass balance calculations will directly measure the transport of algal biomass from Mossdale to the oxygen depletion zone. We will verify the relative contribution of both living and dead algal biomass from Mossdale to the oxygen demand in the oxygen depletion zone using biomarkers. The percent contribution of algal biomass to the total load of oxygen depleting substances will be determined from measurements of BOD, COD, chlorophyll *a* concentration, TOC, nutrients, biomarkers and flow from urban, industrial and agricultural sources throughout the upper and lower San Joaquin River. These surface water loads of oxygen depleting substances will be compared with direct measurements of organic and inorganic oxygen depleting substances in the sediment (sediment oxygen demand). Field sampling will begin at locations known to be important from historical data.

New and historic data on surface and sediment sources of oxygen depleting substances and associated physical and chemical data will be used to fill data gaps in the existing dissolved oxygen management model and enhance calibration and verification of controlling mechanisms. Comparison of new and historical field data with modelling results will provide insight for evaluation of alternatives and best management practices needed for development of a management action plan. Development of an IEP database and CD disk version of the model will make the model and data readily available to Stakeholders.

Field data collection and analyses will be done with the guidance of a statistician and field and laboratory analyses will be done using US EPA QA/QC guidelines.

Local support – This proposal was developed with the support of the SJR Dissolved Oxygen Steering and Technical Committees which represent these urban, agricultural, industrial and government stakeholders: 1) cities - Stockton, Manteca, Lathrop, Lodi, Merced, Turlock, Tracy and Modesto, 2) Farm Bureau, 3) government agencies - CDWR, CDFG, RWQCB, US EPA, USFWS and USDA, and 4) environmental groups represented by the Delta Keeper.

Coordination – Field sampling will coordinate with existing USBR/CDWR, CDFG, USGS, RWQCB and RWCF sampling programs. The project will also collect water quality data for the CALFED funded fish passage study (CDFG) and will collaborate with the CALFED funded program on sediment transport in the Delta (USGS).

Applicant qualifications –Project elements will be conducted by experts from academia, state and federal governments and consulting firms that have experience in the region. Investigators will be guided by local experts through the SJR Dissolved Oxygen Technical and Steering Committees, local peer review from IEP Project Work Teams, the Bay-Delta Modeling Forum and an outside review team.

Third party impacts - Third party benefits include a) improvement of water quality for south Delta agriculture and drinking water for southern California, accessibility of upstream habitat availability and reduction of mortality and stress of salmon and other aquatic organisms in the San Joaquin River and removal of impediments to growth in the San Joaquin River Basin.

Cost - Phase I (year1) - $871414 ; Phase II (year 2) - $750886; Phase III (year 3) - $750886
These costs include a 20% indirect cost to manage the contract through the CSUS Foundation. Advance billing instead of arrears billing would reduce this indirect cost to 15%.

Project Description

Description - This project will determine the relative importance of natural and anthropogenic oxygen depleting substances and physical processes to oxygen demand in the lower San Joaquin River below Stockton in the fall. This information will be used to develop a management action plan to eliminate the problem through an adaptive management framework.

The project will: 1) compile new and existing data on oxygen depleting substances in the San Joaquin River onto a relational data base, 2) measure the daily load of oxygen depleting substances from urban, agricultural, natural and industrial surface water sources to daily oxygen demand, 3) measure the contribution of sediment oxygen depleting substances to daily oxygen demand, 4) evaluate the relative importance of tide and associated physical and chemical factors on daily load and oxygen demand, 5) use new and historic data to improve daily predictions of oxygen concentrations using an existing dissolved oxygen model developed for the San Joaquin River, 6) use field data and modeling analyses to design and evaluate management alternatives and 7) develop a management action plan to eliminate oxygen depletion in the river.

Tasks and deliverables

Task 1. Project Management

Project Management will consist of three subtasks: 1) preparation of contracts, 2) tracking the project elements to ensure adherence to schedule and 3) ensuring completion of deliverables.

Task 2. Data collection

Subtask 1. Database development - Compile existing and new data on dissolved oxygen concentration and factors that affect dissolved oxygen concentration in the lower San Joaquin River including dissolved oxygen concentrations, point and nonpoint agricultural, urban and industrial sources of algal biomass, TOC, ammonia, nitrate, BOD and COD, water temperature, turbidity and flow. Available data include the USBR/DWR discrete and continuous monitoring programs, the DWR fall study of dissolved oxygen, USGS San Joaquin nutrient and sediment study, South Delta Program data and the Stockton RWCF monitoring program and discharge data for NPDES permits. Data will be organized into a relational database using MS Access for uploading to the IEP database. Data collection will include a literature survey of oxygen depletion in other estuaries. Database development will include preparation of a CD-ROM version of the oxygen model.

Subtask 2. Surface water sources of oxygen demand - Field surveys will determine the load of oxygen depleting substances in surface water to oxygen demand in the lower San Joaquin River and will include continuous and discrete monitoring components.

Item 1. Continuous monitoring – The load of upstream algal biomass to the oxygen demand will be determined from simple mass balance calculations using continuous measurements of streamflow (ADCP and UVM) and chlorophyll fluorescence combined with discrete measurements of net algal growth rate and grazing loss at Mossdale, Stockton, the Turning Basin and the depletion zone. Mechanisms that regulate the growth of algal biomass upstream will be determined the first year using a suite of physical and chemical variables including nutrient concentrations, water transparency and water temperature. This program will shift to a

baseline continuous monitoring program in years 2 and 3 and will be used to evaluate the alternative of using real-time monitoring to manage the dissolved oxygen problem.

Item 2. Discrete monitoring – The load of algal biomass to total oxygen depletion will be compared using measurements of flow, chlorophyll *a* concentration, BOD, COD, TOC, and nutrients from industrial, agricultural and urban point and non-point sources from tributaries upstream of Mossdale to the depletion zone. Physical measurements will also be used to assess the controlling mechanisms. An important element to this program is the use of mobile adcp flow measurements to calculate loads. We will sample at locations suspected to be a problem and shift sampling each year to pinpoint major sources and mechanisms.

Subtask 3. Biomarker verification of sources - The sources of living and dead upstream algal biomass to the inorganic and organic oxygen demand will be verified using natural isotope ratios, fatty acid biomarkers and USGS schedule tests for domestic and dairy wastes. The fingerprint of each source will be included for both the continuous and discrete surface water and sediment load measurements. Biomarkers have been effective tools for distinguishing sources of contaminants in rivers.

Subtask 4. Sediment sources of oxygen demand – Field surveys will measure the organic and inorganic oxygen demand from sediments (SOD) at upstream, downstream and tributary locations using in situ benthic chambers. Because no measurements of SOD have been made, the first year will be a survey of 20 stations to identify major sources of sediment oxygen demand in the fall. Resources will be shifted in years 2 and 3 to sample the major sources and determine their controlling mechanisms.

Subtask 5. The Influence of tidal variability – This task will determine the influence of tide on load and physical and chemical factors that control oxygen demand in the river. Water quality information from continuous monitors will be augmented with measurement of chlorophyll, BOD, COD, TOC and nutrients at each tidal stage at 9 selected locations.

Task 3. Data synthesis

Subtask 1. Determine relative contribution of sources to oxygen depletion – Determine the relative load of upstream river algae, RWCF effluent, major point and non-point sources and sediment to oxygen depletion and the influence of controlling mechanisms on the development and persistence of the depletion. We hope collection of field data over three years of the project will provide a sufficient range of conditions to characterize loads and controlling mechanisms. Data will also be evaluated in light of alternatives with the SJR DO Technical Committee.

Subtask 2. Calibrate and verify dissolved oxygen model – Use new and existing field data to calibrate, verify and enhance the existing dissolved oxygen model so that it provides reasonable predictions of daily oxygen concentration in the San Joaquin River near Stockton. Calibration and verification will include enhancement of model boundary flows using inputs from the DWR DSM2 model, adjustment of flows to real time ADCP and UVM flow measurements and expansion of the model to refine source load contributions from upstream of Mossdale. Comparison of model and empirical results will enable a thorough evaluation of the major factors controlling oxygen depletion in the river. Comparison of field data and model predictions will provide direction for a more focused study of the relative importance of sources of oxygen depleting substances and mechanisms that control dissolved oxygen concentration in years 2 and 3.

Task 4. Evaluate Alternatives and Develop Management Action Plan

Subtask 1. Evaluate alternatives - Evaluation of alternatives will begin in the first year with help from the SJR DO Steering and Technical Committees. More alternatives will be evaluated as suggested by field and modeling results in a consensus process. Evaluation of alternatives will include short and long-term measures. Long-term measures include the use of real-time monitoring and modeling to predict oxygen depletion and short-term measures include aeration and flow regulation through barrier management or water routing. Evaluation of alternatives will include the cost and feasibility of each measure to reduce or eliminate the oxygen demand.

Subtask 2. Develop a management action plan - Develop a management action plan that can be used in an adaptive management framework to efficiently eliminate oxygen depletion in the San Joaquin River. It is expected the management plan will include a combination of river management practices including (1) additional controls of RWCF effluent (2) reduction of upstream point and non-point loads of BOD, COD and nutrients, (3) changes in the San Joaquin River channel, (4) flow gate controls at the head of Old river, and (5) aeration devices in the river and that this will be evaluated using a continuous real-time monitoring network.

Task 5. Deliverables

Quarterly and Final Reports - All principal investigators will provide quarterly and final reports that summarize their findings. The Project Manager will compile the findings of principal investigators for the reports with the advise of the SJR Dissolved Oxygen Steering and Technical Committees. The Management Action Plan will be included in the final report.

Schedule - This is a three-year project (July 1999 to June 02). In year 1 (July 99 to June 00) we will compile existing data and conduct a field surveys to fill in missing data gaps. In year 2 (July 00 to June 01), we will conduct focused field and modeling studies based on year 1 results that pinpoint source loads and their controlling mechanisms. This effort would be intensified in year 3 (July 01-June 02). In all years, we will run a real-time monitoring program and use new and historic data to enhance a dissolved oxygen management model. Evaluation of alternatives will also proceed all years and will be developed into a management action plan in the last year.

Project management - The project manager is Dr. P. W. Lehman and each tasks of the project will be managed by principal investigators. CSUS Foundation will manage the contracts and funding.

Inseparable tasks – Elements of this project can be broken down into phases I through III that correspond to each year. Each year of the study is designed to further pinpoint and quantify source loads and controlling mechanisms and provide more refined input for the management action plan. Further separation would include splitting the field collection and data synthesis from the modeling work, which would reduce the cost by $120000 per year.

Location– The oxygen sag in the Stockton deepwater ship channel is downstream of the "turning basin" and along Rough and Ready Island in the San Joaquin River (Figure 1). It is located in San Joaquin County within the San Joaquin River Basin. Upstream sources, however, may be sampled in Stanislaus and Merced Counties (Figure 2). USGS quad map included.

Ecological/Biological benefits

Ecological and Biological Objectives

Need for project - Dissolved oxygen in the San Joaquin River near Stockton becomes depleted in the fall when concentrations decrease below 6 mg/l. Concentrations can reach as low as 2.5 mg/l and occurs over a 10-mile reach of the San Joaquin River. Eliminating these low dissolved oxygen concentrations is a goal of the CALFED water quality program, because oxygen depletion is a health threat to aquatic species and prevents upstream migration of fall-run Chinook salmon.

Research by Department of Fish and Game in the 1970s showed that dissolved oxygen concentrations below 6 mg/l was a barrier to upstream migration of adult San Joaquin fall-run Chinook salmon to spawning habitat in the Merced, Tuolumne, and Stanislaus Rivers between September and December. The San Joaquin salmon population has severely declined and is a listed threatened species by the US Fish and Wildlife Service. Low dissolved oxygen is a primary stsressor that kill, stress or block migration of other fish and aquatic organisms and may negatively impact the aquatic community as a whole.

The current management strategy attempts to reduce oxygen depletion in the San Joaquin River through NPDES permits that control local discharge and by diversion of water into the main channel by placement of a rock barrier at the Head of Old River. Many years of pre- and post-barrier measurements of dissolved oxygen concentration by DWR, however, indicate the barrier has little effect on oxygen concentrations in dry and critically-dry years (CDWR annual reports 1987-1995).

Oxygen depletion in the lower San Joaquin River during the fall has been attributed to many point and non-point sources including effluent from the Stockton RWCF, upstream algal biomass, high water temperature, low streamflow, ammonia from discharge agriculture, storm water runoff, sediment oxygen demand and oxygen depletion from tributaries. The current dissolved oxygen management model suggests the Stockton treated effluent is insufficient to cause the oxygen depletion in the San Joaquin River and that oxygen demand from upstream algal biomass and sediment are major sources of the problem (Chen 1997; Chen et al. In press). These findings need to be confirmed by new field data before reliable management alternatives can be developed.

There are many available data including periodic measurements of dissolved oxygen, nutrient concentrations and BOD collected by the USGS, USBR, DWR and Stockton RWCF since the 1970s. These provide valuable information on the dissolved oxygen problem in the mainstem and the extent of the oxygen depletion in the river. However, this information is insufficient to calculate load of oxygen depleting substances and the causal mechanisms associated with that load needed to accurately predict daily oxygen concentration in the river. For example, the current dissolved oxygen model suggests sediment oxygen demand is important, but measurements of sediment oxygen demand have not been made and although nutrient and sediment load is well quantified in the upper San Joaquin River, the influence of these substances on oxygen depletion is not quantified.

Approach – We will develop a management action plan to control oxygen depletion in the San Joaquin River in the fall based on new and historical data, enhanced modeling results and evaluation of potential management alternatives. Our initial approach will be to test the current conceptual model that oxygen depletion is primarily caused by oxygen demand from upstream

algal biomass and sediment during the fall when temperature is high and streamflow is low. In the first year, we will gather all existing information on source loads of oxygen depleting substances, develop an historic database and establish a baseline real-time monitoring program. Field measurements will consist of intensive surveys that supplement or fill in data gaps in our current knowledge on source loads and controlling mechanisms. Identifying the relative importance of algal biomass and sediment oxygen demand to the oxygen depletion will be an important goal of this first year. These surveys will cover both the main channel and lower and upstream tributaries that have been identified as important in historic surveys. The second year, we will focus our work on the primary sources and mechanisms identified in the first year, with the goal of pinpointing the worst locations and identifying key mechanisms. If necessary, we will continue focusing the work in a third year. We will conduct baseline monitoring of sources and mechanisms throughout the this project in order to get the maximum range of water-year type conditions, but will direct resources to key sources and mechanisms in years 2 and 3.

Enhancement of the existing dissolved oxygen model and will be done concurrently with data gathering. The dissolved oxygen management model is an important product of the study and will be a valuable management tool for evaluating the impact of future changes and management alternatives. Evaluation of potential management alternatives using field and modeling results will proceed throughout the project and will include real-time monitoring, changes in flow at Head of Old River, aeration, reducing BOD and algal biomass and NPDES discharge.

Review and guidance by the SJR Dissolved Oxygen Steering and Technical Committees will facilitate thorough evaluation of the field and modeling information and development of feasible and cost effective alternatives for the management action plan and future implementation of the plan through the adaptive management process.

The primary benefit of this information will be to restore ecosystem process and function to the estuary by eliminating oxygen depletion in the San Joaquin River channel that blocks salmon migration and threatens the health and survival of estuarine organisms in the river. Without this barrier to migration, Chinook salmon will have full access to CALFED funded restored upstream habitat in the San Joaquin River.

Linkages - The goals of the project are directly linked to ERP actions and goals (Table 1) and directly contributes to CALFED objectives to restore ecosystem process and function and removal of the oxygen depletion is a goal of the CALFED Water Quality Program. Further, the project is critical to success of CALFED funded upstream restoration because it provides access to these habitats.

The project also meets goals of CVPIA to restore anadromous fish populations and USFWS and NYMS to protect and restore threatened and endangered salmon populations.

This project will provide water quality data for the CALFED funded fish passage study (CDFG) and will collaborate with the CALFED funded studies of sediment transport and organic carbon (USGS). Sampling will be in conjunction with CDWR, Stockton RWCF, and NPDES routine monitoring and special studies by CDWR/USGS on flow and dissolved oxygen CDWR.

This proposal is a product of the development phase of the SJR Dissolved Oxygen Steering and Technical Committees that are funded by local urban, agricultural and industrial stakeholders and State and Federal agencies and are committed to eliminating the dissolved oxygen problem.

This proposal is the first stage of a process to eliminate oxygen depletion in the river. The first stage presented in this proposal will gather supplemental information, enhance a predictive modeling tool and develop a management action plan. The second stage will implement the management action plan through an adaptive management process. It is hoped CALFED will assist with the first stage through Category III funding and with the second stage through the CALFED Program.

Existing legal obligations – The project has no existing legal obligations.

System-wide ecosystem benefits – The primary benefit of the project will be to eliminate the oxygen depletion in the San Joaquin River and to remove oxygen depletion as a barrier to upstream spawning migration of fall-run Chinook salmon. This will restore natural ecosystem process and function to the estuary, particularly the growth and survival of salmon. Removing the oxygen depletion will also provide aquatic organisms access to restored upstream habitat and eliminate effects of low dissolved oxygen on the general health and survival of fish and other aquatic organisms.

Computability with non-ecosystem objectives – This project is compatible with non-ecosystem objectives because elimination of oxygen depletion in the river will increase the reliability of water supply, water quality and water use efficiency for beneficial uses in the San Joaquin River region and water exported to the southern portion of California. Elimination of oxygen depletion will allow urban, agricultural and industrial growth in the San Joaquin River Basin.

Third party benefits – Elimination of oxygen depletion in the San Joaquin River will: 1) improve water quality in the south Delta and drinking water exported to southern California and 2) allow growth in the San Joaquin River Basin.

Technical Feasibility and Timing

This project is technically feasible and fully implementable. It will not require any CEQA or NEPA documents. Access permits will be required to service and establish continuous monitoring stations, and collect discrete water quality samples of agricultural discharge, but these are not major impediments to the project, because of the broad local support.

There are no implementation issues that need to be resolved before beginning the project.

However, we recognized there is a problem in the management of CALFED contracts and funds that causes long delays, when they are run through state and federal agencies. Because we do not want to delay our efforts to solve this problem any longer than necessary, we followed recommendations to have a foundation manage the contract instead of a state or federal agency. We have received approval from the CSUS Foundation to use them for management of this project if it should be funded. This does increase the cost substantially (20%) because the funding is in arrears. This high cost could be reduced to 15% if funding was in advance.

Monitoring and Data Collection Methodology

Biological / Ecological Objectives -The focus of field data collection and modeling will be to test the current conceptual model that oxygen depletion in the San Joaquin River is primarily caused by upstream algal biomass and sediments. New and historic field data will be used to enhance the existing dissolved oxygen model for use as a management tool and both field and modeling results will be used to evaluate management alternatives needed to develop a management action plan.

Monitoring parameters and data collection - Data consist of historic and new continuous and discrete data. The contribution of upstream algal biomass to oxygen demand will be determined by mass balance calculations using continuous fluorometry, water temperature and flow and discrete measurements of algal growth rate, nutrients, water transparency and benthic biomass at 4 stations. The relative load of algal biomass in relation to other organic sources and sediment organic and inorganic sources will be determined by discrete measurements of surface point and non-point oxygen depleting substances (e.g. BOD, COD, nutrients) and sediment oxygen demand from upstream of Vernalis to Turner Cut and will be confirmed by natural isotope and fatty acid biomarkers. Baseline monitoring will continue for all 3 years in order to obtain a range of environmental conditions, but resources will be shifted each year to pinpoint major sources and mechanisms.

Discrete and continuous data collection will be conducted in conjunction with the DWR dissolved oxygen study and routine discrete and continuous monitoring programs, RWQCB Vernalis water quality sampling, Stockton RCWF and NPDES sampling and DWR/USGS Delta Circulation Monitoring Network. The study will provide water quality data for the CALFED study of fish passage in response to oxygen depletion (CDFG) and will collaborate with the CALFED study of sediment transport and carbon sources (USGS).

Data Evaluation - Field measurements, handling, preservation and analytical techniques for routine water quality measurements will follow Standard Methods or EPA methodology and QA/QC procedures of the DWR Bryte Laboratory. Analyses for biomarker and sediment oxygen demand elements will be done using state of the art procedures but current experts in their field. Modeling results will be evaluated by direct comparison with field measurements. Further, experimental design and statistical analyses for the project will be done with the guidance of Dr. R. Mahmood, a professor of statistics.

Deliverables - 1) quarterly and annual reports to CALFED and the San Joaquin River Dissolved Oxygen Steering Committee, 2) an access data base containing new and historic data on oxygen depleting substances, 3) an enhanced dissolved oxygen management model on a CD for use by Stakeholders and 4) a management action plan for eliminating the oxygen depletion.

Peer review – Peer review will be by local groups including the CALFED Water Quality Committee, IEP Project Work Teams such as the Water Quality and Contaminant Teams and by conducting a Bay Delta Modeling Forum Workshop. Continual review will be obtained by the San Joaquin River Dissolved Oxygen Steering and Technical Committees. In addition, an outside review panel will be developed with outside experts.

Local Involvement

Local groups that support this project include urban, agricultural and industrial stakeholders in the San Joaquin region and state and federal agencies. These stakeholders are members of the San Joaquin River Dissolved Oxygen Steering and Technical Committees and include: 1) cities - Stockton, Manteca, Lathrop, Lodi, Merced, Turlock, Tracy and Modesto, 2) Farm Bureau, 3) government agencies - CDWR, CDFG, RWQCB, US EPA, USFWS and USDA, and 4) environmental groups represented by the Delta Keeper

Third party impacts include improved water quality for the south Delta and drinking water exported to southern California and removal of impediments to growth in the San Joaquin Basin.

Budget

Attached tables include the total and quarterly budgets.

Overhead and indirect costs cover administrative and office costs that differ as follows:
Department of Water Resources: 1999/2000 - 41.8%; 2000/20001- 47.6 %
University of the Pacific: 52.3%
Systec, Inc.: 90%
Lawrence Berkeley Lab: 72%
Sacramento State University: 25%
University of Southern California: 63.5%
Moss Landing: 47%
Jones and Stokes Associates: 50%
CSUS Foundation 20%

Schedule

The project will begin July/August 1999 and be completed July/August 2002. Field sampling will be done between July and November each year and will be followed by data analyses and report preparation during the next 4 months (Dec-Mar). Review and evaluation of the current data and modeling results will be done April-June each year in preparation for sampling in July. In the final year of the project April-June will be used for development of the management action plan.

Payments to each collaborator will be based on monthly invoices.

Cost Share

Cost share aspects of this project include:

The Regional Water Quality Control Board pledges a direct contribution of $10-20,000 to assist with the project. In addition, it pledges to assist with collection and analysis of water quality samples at Vernalis (see attached letter).

EPA has provided $30,000 for review of the Stockton dissolved oxygen model developed by Carl Chen.

NPDES dischargers in the upper San Joaquin River from the cities of Stockton, Manteca, Lodi, Turlock, and Modesto have agreed to given in-kind services by paying for collection and analysis of water monthly quality samples needed for this project. These include new and existing variables: chlorophyll *a* concentration, BOD, COD, ammonia, nitrate, total phosphate, organic nitrogen and volatile solids. They will also do in-house evaluation of alternatives for discharge flexibility and enhanced treatment measures.

The City of Stockton will contribute at least $500,000 in direct and in-kind services (see attached letter). These services include purchasing and operating a Turner fluorometer at the RWCF outtake in 1999, current funding of the participation of Systech and Jones and Stokes in the development of the Stakeholder process, current funding of the services of a facilitator for the Stakeholder process. The City of Stockton also pledges $150,000 for consultants in 1999, $50,000 for management of the Stakeholder process over the life of the project and $150,000 direct contributions over the life of the project for any needed items.

DWR will contribute two mobile in situ fluormeter and one permanent fluorometer at Mossdale. DWR has already contributed at least two months staff time of P. Lehman in development of the program and preparation of this proposal.

Boats and equipment owned by DWR, Stockton RWCF and DFG will be used for continuous and discrete sampling during routine monitoring whenever possible and will be a significant cost share.

DWR and USGS will assist with maintenance of continuous chlorophyll fluorometers and assist with water quality data collection at real-time monitoring stations as part of the DWR/USGS Delta Circulation Monitoring Network.

Applicant Qualifications

Individual responsibilities are: 1) Project Management – CSUS Foundation and P. Lehman, 2) Continuous and discrete sources of oxygen Demand – P. Lehman, E. Dammel, J. Johnson, R. Mahmood, H. Mann, and R. Oltman, 3) Sediment oxygen demand – W. Berelson, K. Coale and C. Chen, 4) Tidal variability – G. Litton , 5) Biomarkers – T. Torok and M. Conrad, 6) Modeling – C. Chen, 7) Database and CD-Rom model development – R. Brown and C. Chen, 8) Evaluation of alternatives and development of management action plan – all collaborators and 9) Reporting – all collaborators.

Each principal investigator will be responsible for obtaining resources and organizing staff for their element of the project, but all collaborators will share boats, equipment and information as needed. Interpretation of the data will require full collaboration. Oversight of contract management, keeping the project on schedule and providing products and deliverables will be responsibility of the Project Manager and contract preparation and funding will be handled by the CSUS Foundation.

Conflict of interest - An apparent conflict of interest exists by the use of Systec Inc. and Jones and Stokes Inc. consulting firms because their client is the City of Stockton. However, their roles in data management will not bias the study. Bias in the Systec modeling work will be reduced by the use of independently collected empirical data. An extensive peer review will also reduce bias.

Another apparent conflict of interest is the participation of DWR and the City of Stockton in data collection and analysis. Oversight by professors Dr. R. Mahmood, Dr. E. Dammel and Dr. J. Johnson, an extensive peer review process and independent model results will reduce this bias in data analysis and interpretation.

Biosketches

Dr. W. Berelson and Dr. K. Coale from USC and Moss Landing are experts in the measurement and determination of mechanisms that control sediment oxygen demand. They are also experts on San Francisco Bay and just completed a 6-year research project on organic and inorganic sediment flux in San Francisco Bay. Their resumes are attached.

Dr. Brown is a consultant with Jones and Stokes and has worked on Delta water supply and water quality projects for over ten years, including water quality evaluations for the Delta Wetlands project. He wrote the report "Potential Solutions for Achieving the San Joaquin River Dissolved Oxygen Objectives" for the 1998 SWRCB Delta hearings. His expertise is in water quality measurements and water quality modeling.

Dr. Chen earned his M.S. and Ph.D. degrees in Environmental Engineering from UC Berkeley. He worked with Dr. G. Orlob to develop an hydrodynamic-water quality model of San Francisco Bay, the EPA Stormwater Management Model, and the eutrophication model of Lake Washington. As vice president of Tetra Tech, Inc., he conducted research on lake acidification and estuary pollution. As president of Systech since 1983, Dr. Chen developed the DO model for San Joaquin River, the graphical user interface for the real time water quality management of San Joaquin River, the model for transport and fate of suspended sediment and copper in San Francisco Bay. Dr. Chen has been involved in the TMDL process for the Truckee River Basin.

Dr. Mark Conrad, is a geological scientist with the Center for Isotope Geochemistry (CIG) at LBNL. He is in charge of CIG's facilities for analyzing the stable isotope ratios of low molecular weight elements (hydrogen, carbon, nitrogen, oxygen and chlorine). His research interests include using isotope measurements to monitor of subsurface biologic activity; stable isotopes as tracers in hydrologic studies, climate change and isotope geochemistry of clay minerals.

Dr. Dammel is a professor of Civil Engineering at Sacramento State University and has over ten years experience as an environmental engineer. His expertise is point and non-point source pollution in California surface waters. He has developed storm water management plans, negotiated for NPDES permits, and established monitoring studies to determine the extent and impact of non-point source pollution. Research projects include the removal of volatile organic compounds using granular activated carbon and the biological oxidation of trichloroethene using nitrifying bacteria.

Dr. Johnston, P.E. is a professor at Sacramento State University and has 20 years of experience as an environmental engineer. His professional experience includes design of water and wastewater treatment facilities, and investigations of technologies for sludge composting, PCE remediation, mercury removal, and water reclamation. Research projects include nitrogen removal in overland flow systems and slow sand filters, and DBCP volatilization. He was also responsible for solids and dissolved oxygen studies in the Lower Kings River for the RWQCB..

Dr. Litton is an associate professor in the Department of Civil Engineering at the University of the Pacific. Dr. Litton has twenty years of water quality experience; thirteen of these with RWQCB. As a researcher and professional engineer he has done water quality monitoring and modeling investigations, water quality planning, pollution impact studies, acid-mine drainage abatement projects, and subsurface remediation efforts. He is currently the principal investigator of water quality studies in the San Joaquin River that focus on urban stormwater and agricultural runoff and just completed a one-year dissolved oxygen study for the City of Lodi.

Dr. Lehman is a senior scientist at CDWR with expertise in water quality issues and algal ecology. She has published on physical and chemical mechanisms that control long-term changes in algal production and species composition in the San Joaquin River and has been principal investigator for many water quality investigations. During her 9 years with CDWR she has provided oversight for the CDWR fall dissolved oxygen and south Delta program data analysis and wrote the dissolved oxygen section for the CALFED Water Quality Program.

Dr. Mahmood, P.E. is a professor in Civil Engineering at Sacramento State University with over 13 years of experience. He has a Masters degree in applied mathematics and has done research on contaminated soils and ground water, risk assessment, design of sampling plans, characterization of unexploded ordinances, mobility of TCE in ground water, development of a water quality index for streams, and mobility of PAHs in soils. He was a consultant for USACE, California Department of Justice, Caltrans, Del Webb Corporation and Anderson Consulting Group.

Dr. T. Torok is staff scientist with Lawrence Berkeley National Laboratory with extensive experience in microbiology and fatty acid techniques. His resume is attached.

CALFED Goals and Objectives	ERP Volume	page
1. Recovery of at-risk native species in order to establish self-sustainin populations and minizmize the need for future endangered species listings	II	27
1.1. Restore fall run Chinook salmon to Central Valley and Bay-Delta	II	Table 5-1
1.1.1. Restore spawning and rearing habitat		
2. Rehabilitate natural processes that support natural aquatic communities and favor native communities	II	27
2.1. Establish hydraulic regime that favors native species and natural habitat	II	Table 5-1
3. Improve and maintain water and sediment quality to eliminate toxic impacts on organisms in the ecosystem	II	31
CALFED Target Species		
Chinook salmon	I	32
Fall-run Chinook salmon	I	33

I-019113

Table of Hypotheses

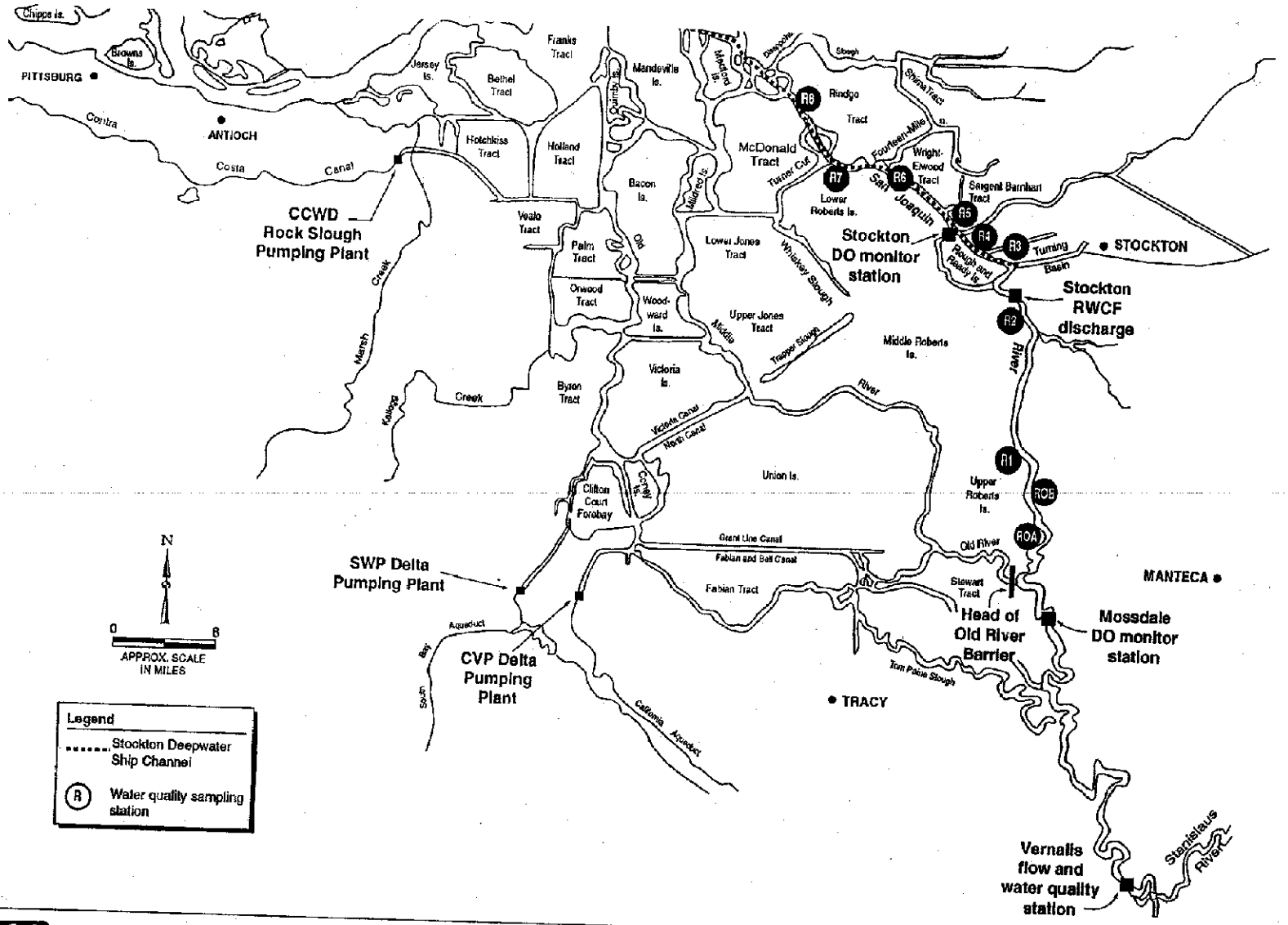
Project Element	Hypotheses	Type of data	Data Evaluation	Data Priority
Continuous sampling	The majority of the algal biomass in the depletion zone comes from the input and growth of algae from Mossdale and locations upstream	Continuous measurements of chlorophyll fluorescence and streamflow (adcp) between Mossdale and the depletion zone at 4 stations and discrete measurements of other algal inputs, algal growth rate and loss rate from sedimentation and grazing	Simple mass balance calculations for each segment of the river to determine the amount of upstream algal biomass that reaches the depletion zone as a function of input biomass, growth and loss ; Empirical results will be compared with model results	high
Biomarker	The majority of the algal biomass in the depletion zone comes from the input and growth of algae from Mossdale and locations upstream	Naturally occuring biomarkers including C and N isotope ratios, fatty acids, species composition and C:N nutrient ratios of algae at Mossdale and upstream and downstream sources	Numerical comparison of the biomarker values will determine if upstream algal biomass is the primary organic substance in the depletion zone	high
Discrete sampling program	Organic and inorganic oxygen depleting substances from surface water sources other than upstream algae are the primary cause of oxygen depletion in the depletion zone	Discrete measurement of BOD, COD, ammonia and algal biomass from major point and nonpoint surface sources of organic and inorganic oxygen depleting substances; loads will be calculated using mobile adcp and fixed flow measurements	The relative magniture of seasonal differences among source loads of oxygen depleting substances will be compared using analysis of variance; the potential contribution of each source to the depletion zone will also be calculated based on flow rate	high
Discrete sampling program	Stratification contributes to the development and persistence of the oxygen depletion	Vertical and horizontal profiles of fluorescence, dissolved oxygen, salinity and water temperature within and adjacent to the depletion zone	Graphical comparison of isopleths will determine the strength of the water column stratification throughout the season and how this prevents oxygenation and mixing	high

I-019114

Biomarker	Upstream water column algae deposited in the sediment is the primary source of oxygen depleting substances in the depletion zone	Deposition rates of algal biomass measured by sediment traps and measurements of biomarkers in source samples and sediment along the channel	Numerical comparison of algal sedimentation rates along the channel will be used to determine the location of maximum deposition and will be used in conjunction with graphical comparison of biomarkers (see Ho: 1) in upstream algal biomass, other point and non-point sources and sediment to determine the relative contribution of upstream algal biomass to sediment at selected stations along the river	high
Tidal variability	Tidal variation is a major factor controlling the development of the oxygen depletion zone	Tidal measurements of water temperature, EC, pH, do and fluorescence and discrete measurements of BOD, COD, TOC and nutrients at 9 stations	Differences between tides will be determined using the Kruskal-Wallis technique and further confirmation of the results will be done by comparison of model runs with the empirical data	high
Sediment oxygen demand	Sediment oxygen demand is a major contributor to oxygen depletion in the San Joaquin River	Direct measurements of surface benthic oxygen demand from organic and inorganic sources at locations suspected to have high oxygen depletion. The first year will be a broad survey and the second year will focus on specific locations and the primary mechanisms	Direct comparison of measured values of organic and inorganic oxygen depletion at the sediment surface and their relation to ancillary water quality and sediment variables.	high

I-019115

Modeling and empirical analysis	Dissolved oxygen in the lower San Joaquin River can be maintained at >6 mg/l by management actions including: aeration, reducing algal production at Vernalis, aeration at McCloud Lake, reducing point source loading from upstream, reducing or eliminating NPDES discharge	Historic and new field data and results of the enhanced dissolved oxygen model	Mass balance calculations and sequential model runs will be evaluated by the principal investigators and Technical Team in order to gain a consensus about feasible and effective alternatives	high



Jones & Stokes Associates, Inc.

Figure 1
Location of Water Quality Stations on the San Joaquin River in the Vicinity of Stockton

I-019117

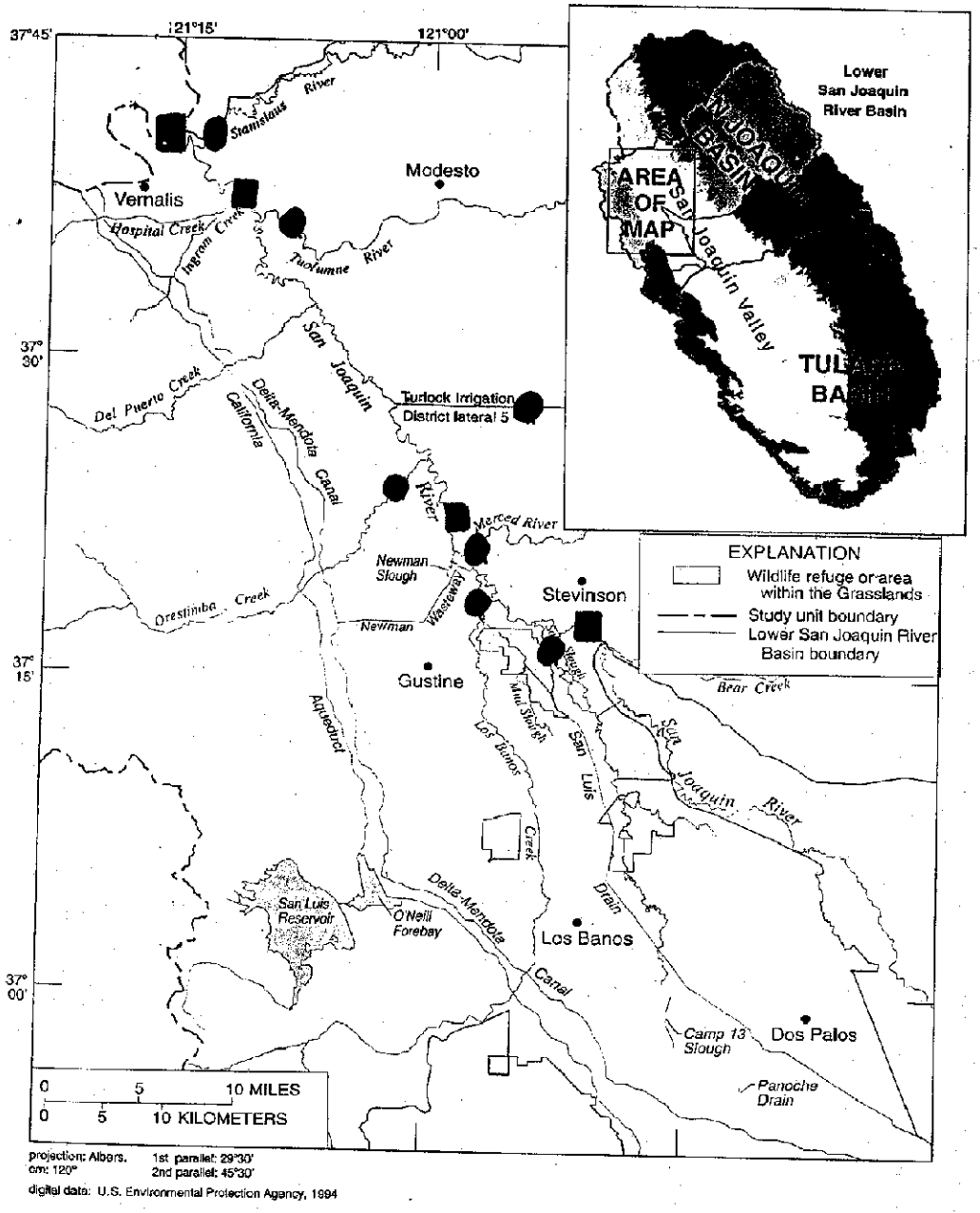


Figure 2. Proposed Upstream Sampling Stations for Source Identification

From USGS Professional Paper 1587

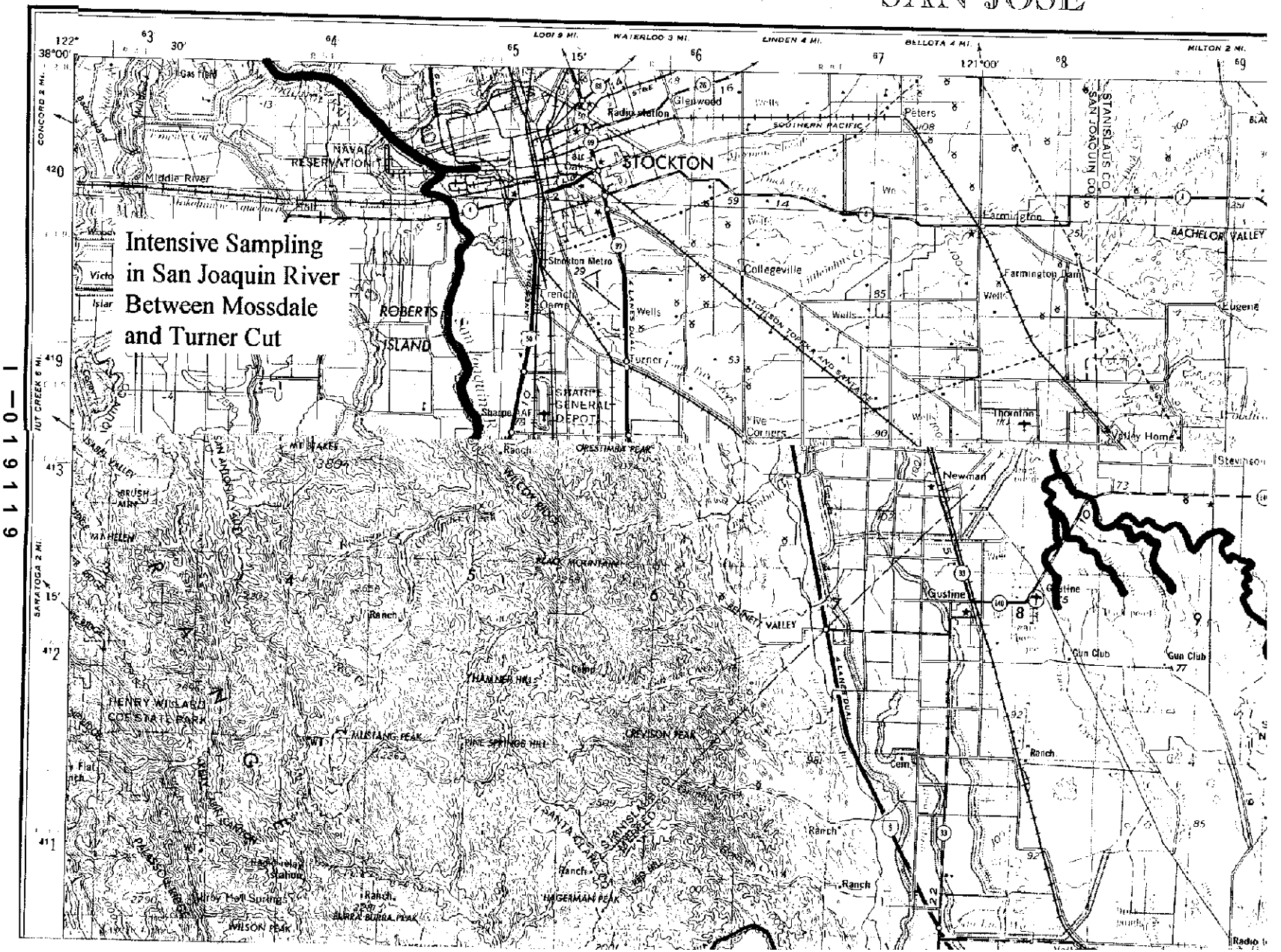
■ RWQB
● Initial stations

USGS

I-019118

WES

SAN JOSE



I—019119

I-019119

San Joaquin River Dissolved Oxygen TMDL Steering Committee
mailing address: 2500 Navy Drive, Stockton CA 95206

Project Oversight: Morris Allen <mallen@inreach.com> (209) 937-8700
Tom King <kingt@rb5s.swrcb.ca.gov> (916) 255-3105
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Glen Birdzell <stmwtr1@inreach.com> (209) 632-9900

Facilitation: Kevin Wolf <kjwolf@dcn.davis.ca.us> (530) 758-4211

April 12, 1999

Clerk of the Board of Supervisors
San Joaquin County
222 East Weber Street, Room 701
Stockton CA 95202

CALFED PROPOSAL; SAN JOAQUIN RIVER DISSOLVED OXYGEN ISSUE

This letter will serve to notify you that the San Joaquin River Dissolved Oxygen TMDL Steering Committee is intending to submit a grant application to CALFED for the purpose of study and evaluation of the dissolved oxygen levels in the lower San Joaquin River. The San Joaquin River Dissolved Oxygen TMDL Steering Committee is a group of stakeholders including the Cities of Stockton, Lathrop, Tracy, Manteca, Ripon, Modesto and Turlock; State and Federal resource agencies; local and State Farm Bureaus; the DeltaKeeper, and others interested in devising a total maximum daily load for oxygen in the San Joaquin River in accordance with EPA Guidlelines.

The lower San Joaquin River experiences episodes of very low dissolved oxygen concentrations in the summer and late fall of most years. The presents a very significant barrier to the migration of fall-run Chinook salmon, and this also represents an ecological stressor to resident fish and aquatic species. The goal of the study proposed by the San Joaquin River Dissolved Oxygen TMDL Steering Committee is to improve River quality, eliminate the oxygen sag in the River, and insure the passage of salmon to the headwaters for spawning.

The CALFED grant will allow for the mechanisms that result in the dissolved oxygen sag to be scientifically studied so that a series of solutions to resolve this problem may be facilitated. Our proposal has broad support, and will also assist San Joaquin County and the surrounding cities in dealing with a regional problem that must have a regional solution.

This notification is required as a part of the CALFED proposal process and is intended to inform the County of the proposed project and its general goals and objectives. If you have any questions or concerns regarding the grant proposal or this notification, please call Mr. Donald Dodge or me at the City of Stockton, at 937-8700.

MORRIS L. ALLEN
For the San Joaquin River Dissolved Oxygen TMDL Steering Committee

MLA:db

CITY OF STOCKTON

OFFICE OF THE CITY MANAGER
CITY HALL
425 N. EL DORADO STREET
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49ERS SUMMER HOME
UNIVERSITY OF THE PACIFIC

April 14, 1999

Peggy Lehman, Ph.D
Department of Water Resources
3251 S Street
Sacramento CA 95816

CALFED GRANT APPLICATION; SAN JOAQUIN RIVER DISSOLVED OXYGEN

This letter is to describe the cost sharing proposed by the City of Stockton for the CALFED grant proposal. The cost sharing by the City of Stockton discussed in my letter will include both in-kind services and direct financial contributions to the program.

As you will recall, the City of Stockton has already expended considerable funds for the development of the San Joaquin River Water Quality Model (the Chen Model). We have also funded the services of technical experts to participate in the Stakeholder Process, develop the CALFED proposal, and prepare the TMDL Program Master Plan. We have also provided funding for and retained Kevin Wolfe Associates to act as the Committee's interim meeting facilitator for the last four months.

On an ongoing basis, the City of Stockton is prepared to make the following additional commitments:

1. The City will fund the services of Systech Engineering and Jones and Stokes Associates to support the Stakeholder Process, Technical Committee, and related activities. The in-kind contribution of these services is expected to total up to $150,000 during calendar year 1999.

2. The City will also commit to funding of the management, administration, and facilitation of the Stakeholder process. While no budget for these activities has been established, the City is willing to pledge the sum of $50,000 per year for these services for the next three years. If this amount exceeds the amount needed, any unused funds may be reallocated to item 3.b. below.

CALFED GRANT APPLICATION: SAN JOAQUIN RIVER DISSOLVED OXYGEN

3. The City will also provide either services or funding for services related to the CALFED grant studies as follows:

   a. The City will purchase, install operate and maintain a Turner flourometer for monitoring chlorophyll levels in the San Joaquin River near Stockton. The cost of purchase and installation is expected to be $15,000. Operation and maintenance costs, including additional laboratory sampling and analysis, are estimated to be $10,000 per year. The cost for this item would therefore total $45,000 over three years.

   b. The City will provide approximately $150,000 over the life of the study in other direct financial contributions. I would anticipate that such expenditures could be for reaeration tests in the Deep Water Channel in cooperation with the Corps of Engineers, hydroacoutic stations to monitor fish populations and movement, or other items.

In total, this represents direct and in-kind contributions of nearly $500,000, exclusive of current staff support of the TMDL process and expected technical support beyond 1999.

The City of Stockton appreciates the effort you have already expended to supervise the development of the CALFED proposal, and looks forward to working with you on these issues. Please contact me should you have any questions or need additional information.

DWANE MILNES
CITY MANAGER

DM:PS:ma

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California Regional Water Quality Control Board

Central Valley Region

Steven T. Butler, Acting Chair

Winston H. Hickox
Secretary for Environmental Protection

Sacramento Main Office
Internet Address: http://www.swrcb.ca.gov/~rwqcb5
3443 Rottier Road, Suite A, Sacramento, California 95827-3003
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Gray Davis
Governor

TO: Dr. Peggy W. Lehman
Principal Investigator

FROM: Jerry Bruns
Sr. L&WU Analyst

DATE: April 13, 1999

SIGNATURE: Jerry Bruns

SUBJECT: REGIONAL BOARD COMMITTMENT OF RESOURCES TO PARTICIPATE IN THE CALFED PROPOSAL TITLED "DETERMINATION OF THE CAUSES OF DISSOLVED OXYGEN DEPLETION IN THE SAN JOAQUIN RIVER"

The Regional Board is committed to working with stakeholders to develop solutions to the dissolved oxygen problem in the San Joaquin River near Stockton. The Regional Board supports the proposal that is being developed and is willing to contribute to the effort by collecting weekly or bimonthly water samples from the San Joaquin River at Vernalis and have the samples analyzed for nutrients and BOD by the Regional Board's contract laboratory. Sampling and analysis has been initiated (as of March 1999) and will continue for two years but may be redirected to other locations at the request of the San Joaquin River TMDL Technical Advisory Committee. This contribution of resources is equivalent to $15,000 per year or $30,000 for the 2-year life of the proposal.

Oxygen Depletion Budget

			direct labor (hrs)	direct salary and benefits	service contracts	material acquisition	overhead	Total year 1	Total year 2	Total year 3	Grand Total
Task 1											
	Project Management	contracts, tracking and deliverables	478	20646			11987	32633	32633	32633	97899
		CSUS Foundation indirect cost (20%)						144401	125377	125377	395155
Task 2											
	Data Collection	Database development	280	13812		167	12788	26767	26767	26767	80301
		Continuous surface source monitoring	1262	11122	49880	36000	11122	108124	13000	13000	134124
		Tidal variation	600	11375	23000	700	5181	40256	40256	40256	120768
		Discrete surface source monitoring	208	2207	24200		2207	28814	28614	28614	85842
		Biomarker	1044	22745		10000	15921	48666	48666	48666	145998
		Sediment oxygen demand	830	27454	10660	37160	24125	99399	99399	99399	298197
Task 3	Data synthesis and modeling										
	Data synthesis	Continuous surface source monitoring	1044	24208			14802	39010	39010	39010	117030
		Tidal variation	75	1677		200	749	2626	2626	2626	7878
		Discrete surface source monitoring	1302	42327			18933	61260	61260	61260	183780
		Biomarker	348	7582			5307	12889	12889	12889	38667
		Sediment demand	561	19280			13024	32304	32304	32304	96912
	Modeling	modeling	673	33638		200	31662	65500	65500	65500	196500
Task 4	Evaluate alternatives and develop										
	Empirical analysis	Database	133	7000			7000	14000	14000	14000	42000
		Continuous sources	87	2600			2600	5200	5200	5200	15600
		Tidal variation	150	3354			1498	4852	4852	4852	14556
		Discrete surface source monitoring	87	2600			2600	5200	5200	5200	15600
		Sediment sources	87	4686			2975	7661	7661	7661	22983

I-019124

	Modeling	Modeling	170	8386		200	7784	16350	16350	16350	49050
Task 5	Reporting										
	Empirical analysis	Database	210	11052			11052	22104	22104	22104	66312
		Continuous sources	87	2600			2600	5200	5200	5200	15600
		Tidal variation	75	1677			749	2426	2426	2426	7278
		Discrete surface source monitoring	87	2600			2600	5200	5200	5200	15600
		Biomarker	174	3791			2653	6444	6444	6444	19332
		Sediment sources	174	9372			5950	15322	15322	15322	45966
	Modeling	Modeling	133	7000			7000	14000	14000	14000	42000
Total								866408	752260	752260	2370928
Grand Total											

I—019125

I-019125

Oxygen Depletion

YEAR 1

Task			Jly-Sep 99	Oct-Dec 99	Jan-Mar 00	Apr-Jun 00
Task 1	Project Management	Technical	8158	8158	8158	8158
		CSUS Foundation (20%)	36100	36100	36100	36100
Task 2	Data Collection					
		Database	6692	6692	6692	6692
		Continuous	54062	54062	0	0
		Discrete	14907	14907	0	0
		Tidal	20128	20128		
		Biomarker	23333	23333		
		Sediment demand	53793	53793		
Task 3	Data synthesis and modeling					
	Data synthesis					
		Conintuous			19505	19505
		Discrete			27022	27022
		Tidal			1313	1313
		Biomarker			7778	7778
		Sediment demand			16152	16152
	Modeling					
		Modeling	16375	16375	16375	16375
Task 4	Alternatives and Management Plan					
		Database	3500	3500	3500	3500
		Continuous			2600	2600
		Discrete			2600	2600
		Tidal			2426	2426
		Sediment demand			3830	3830
		Modeling	4087	4087	4087	4087
Task 5	Reporting					
		Database	5526	5526	5526	5526
		Continuous	1300	1300	1300	1300
		Discrete	1300	1300	1300	1300
		Tidal	607	607	607	607
		Biomarker	1944	1944	1944	1944
		Sediment demand	3831	3831	3831	3831
		Modeling	3500	3500	3500	3500
	Total		259143	259143	176146	176146

Oxygen Depletion

YEAR 2

Task			Jly-Sep 00	Oct-Dec 00	Jan-Mar 01	Apr-Jun 01
Task 1	Project Management	Technical	8158	8158	8158	8158
		CSUS Foundation (20%)	31344	31344	31344	31344
Task 2	Data Collection					
		Database	6692	6692	6692	6692
		Continuous	3842	3842	0	0
		Discrete	14907	14907	0	0
		Tidal	20128	20128		
		Biomarker	23333	23333		
		Sediment demand	53793	53793		
Task 3	Data synthesis and modeling					
	Data synthesis					
		Conintuous			19505	19505
		Discrete			27022	27022
		Tidal			1313	1313
		Biomarker			7778	7778
		Sediment demand			16152	16152
	Modeling					
		Modeling	16375	16375	16375	16375
Task 4	Alternatives and Management Plan					
		Database	3500	3500	3500	3500
		Continuous			2600	2600
		Discrete			2600	2600
		Tidal			2426	2426
		Sediment demand			3830	3830
		Modeling	4087	4087	4087	4087
Task 5	Reporting					
		Database	5526	5526	5526	5526
		Continuous	1300	1300	1300	1300
		Discrete	1300	1300	1300	1300
		Tidal	607	607	607	607
		Biomarker	1944	1944	1944	1944
		Sediment demand	3831	3831	3831	3831
		Modeling	3500	3500	3500	3500
	Total		204167	204167	171390	171390

Oxygen Depletion

YEAR 3

Task			Jly-Sep 01	Oct-Dec 01	Jan-Mar 02	Apr-Jun 02
Task 1	Project Management	Technical	8158	8158	8158	8158
		CSUS Foundation (20%)	31344	31344	31344	31344
Task 2	Data Collection					
		Database	6692	6692	6692	6692
		Continuous	3842	3842	0	0
		Discrete	14907	14907	0	0
		Tidal	20128	20128		
		Biomarker	23333	23333		
		Sediment demand	53793	53793		
Task 3	Data synthesis and modeling					
	Data synthesis					
		Conintuous			19505	19505
		Discrete			27022	27022
		Tidal			1313	1313
		Biomarker			7778	7778
		Sediment demand			16152	16152
	Modeling					
		Modeling	16375	16375	16375	16375
Task 4	Alternatives and Management Plan					
		Database	3500	3500	3500	3500
		Continuous			2600	2600
		Discrete			2600	2600
		Tidal			2426	2426
		Sediment demand			3830	3830
		Modeling	4087	4087	4087	4087
Task 5	Reporting					
		Database	5526	5526	5526	5526
		Continuous	1300	1300	1300	1300
		Discrete	1300	1300	1300	1300
		Tidal	607	607	607	607
		Biomarker	1944	1944	1944	1944
		Sediment demand	3831	3831	3831	3831
		Modeling	3500	3500	3500	3500
	Total		204167	204167	171390	171390

Oxygen Depletion

Task			Total Year 1	Total Year 2	Total Year 3
Task 1	Project Management	Technical	32632	32632	32632
		CSUS Foundation (20%)	144400	125376	125376
Task 2	Data Collection		0	0	0
		Database	26768	26768	26768
		Continuous	108124	7684	7684
		Discrete	29814	29814	29814
		Tidal	40256	40256	40256
		Biomarker	46666	46666	46666
		Sediment demand	107586	107586	107586
			0	0	0
Task 3	Data synthesis and modeling		0	0	0
	Data synthesis		0	0	0
		Conintuous	39010	39010	39010
		Discrete	54044	54044	54044
		Tidal	2626	2626	2626
		Biomarker	15556	15556	15556
		Sediment demand	32304	32304	32304
			0	0	0
	Modeling		0	0	0
		Modeling	65500	65500	65500
			0	0	0
Task 4	Alternatives and Management Plan		0	0	0
		Database	14000	14000	14000
		Continuous	5200	5200	5200
		Discrete	5200	5200	5200
		Tidal	4852	4852	4852
		Sediment demand	7660	7660	7660
		Modeling	16348	16348	16348
			0	0	0
Task 5	Reporting		0	0	0
		Database	22104	22104	22104
		Continuous	5200	5200	5200
		Discrete	5200	5200	5200
		Tidal	2428	2428	2428
		Biomarker	7776	7776	7776
		Sediment demand	15324	15324	15324
		Modeling	14000	14000	14000
			0	0	0
	Total		870578	751114	751114

Citations

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Chen, C. 1997. Evaluation of alternatives to meet the dissolved oxygen objectives of the lower San Joaquin River. Systech Engineering, Inc.

Chen, C. J. Herr, L. Ziemelis, R. Goldstein and L. Olmsted. In press. Decision support system for total maximum daily load.

Hallock, R., R. Elwell and D. Fry, Jr. 1970. Migration of adult King Salmon in the San Joaquin Delta - as demonstrated by the use of sonic tag. CDFG. Fish Bull. 151.

Kratzer, C. R. and J. L. Shelton. 1998. Water Quality Assessment of the San Joaquin-Tulare Basins, California: Analysis of Available Data on Nutrients and Suspended Sediment in Surface Water, 1972-1990.

Tamás Török

Education

B.S. (Food Sciences)	Humboldt University, Berlin, Germany; 1969
M.S. (Food Microbiology)	Humboldt University, Berlin, Germany; 1971
M.S. (Bioengineering)	Technical University, Budapest, Hungary; 1984
Ph.D. (Microbiology)	A. Jozsef University, Szeged, Hungary; 1982

Positions held

1997-present	Staff scientist, Life Science Division, Lawrence Berkeley National Laboratory
1995 -1997	Scientist, LSD, LBNL
1992 - 1995	Senior research associate, LSD, LBNL
1988 - 1992	Visiting scientist, USDA Western Regional Research Center, Albany, CA
1974 - 1988	Senior staff scientist, Department of Microbiology, University of Horticulture and Food Sciences, Budapest, Hungary
1971 - 1974	Microbiologist, Center for Food Control and Analysis, Budapest, Hungary

Research interests

- molecular microbial ecology;
- microbial physiology, microbial genetics;
- yeasts, taxonomy, identification, fine structure, genetics of *Saccharomyces cerevisiae;*
- fungi;
- culture collection, strain preservation, maintenance.

Administrative positions

1996 - present	Group Leader, Microbial Genomics, Department for Environmental Biology, LSD, LBNL
1995 - present	Associate Administrator, Center for Environmental Biotechnology, LBNL
1986	Acting head, Department of Microbiology, University of Horticulture and Food Sciences, Budapest, Hungary
1982 - 1988	Curator, National Collection of Industrial and Agricultural Microorganisms, Budapest, Hungary (from 1986 on international depositary authority under the Budapest Treaty)

Award and editorial activity

"Outstanding Performance Award" from Lawrence Berkeley National Laboratory (1996)
Member of the Editorial Board for the Journal of Industrial Microbiology and Biotechnology (1996- present)
Member of the DOE Review Panel for the Initiatives for Proliferation Prevention (IPP) program

Membership in scientific societies

American Society for Mcirobiology
American Society for Industrial Microbiology and Biotechnology
American Association for the Advancement of Science

Recent research publications and abstracts

Török, T., D. Rockhold, and A. D. King, Jr. 1993. Use of electrophoretic karyotyping and DNA- DNA hybridization in yeast identification. Int. J. Food Microbiol. 19:63-80.

Cheng, J.-F., Y. Zhu, T. Török, and D. Scott. 1993. Isolation and mapping of chromosome 21 cDNA clones. Abstr. Human Genome Program, Contractor-Grantee Workshop III, Santa Fe, NM, p. 22.

Rine, J., R. Blajez, J.-F. Cheng, J. C. Gingrich, S. R. Lowry, E. A. Ostrander, S. Scherer, D. Scott, F. Shadravan, T. Török, K. M. Wilson, and Y. Zhu. 1993. A physical and genetic map of human chromosome 21: A prelude. Abstr. Human Genome Program, Contractor-Grantee Workshop III, Santa Fe, NM, p. 42.

Gingrich, J. C., F. Shadravan, S. Scherer, J.-F. Cheng, Y. Zhu, T. Török, D. Scott, E. A. Ostrander, S. R. Lowry, K. M. Wilson, R. Blazej, and J. Rine. Integrated mapping of human chromosome 21: Characterization of YAC and P1 contigs on 21q22.3; 1993. Isolation and characterization of cDNAs and genetic markers on the chromosome. 4th Int. Workshop on Chromosome 21, Paris, France.

Cheng, J.-F., Y. Zhu, T. Török, D. Scott, J. Gingrich, F. Shadravan, S. Scherer, E. A. Ostrander, S. Lowry, K. M. Wilson, R. Blazej, and J. Rine. 1993. Integrated mapping of genetic markers, P1 clones and cDNA of human chromosome 21. Genome Mapping and Sequencing, Cold Spring Harbor, USA, p. 43.

Enigl, D. C., A. D. King, Jr., T. Török. 1993. *Talaromyces trachyspermus*, a new heat-resistant mold from fruit juice. J. Food Protec. 56:1039-1042.

Török, T., C. Royer, D. Rockhold, and A. D. King, Jr. 1995. Species-specific DNA-DNA hybridization probing lower eukaryotes using individual whole chromosomes for probe preparation. (US patent granted, Patent No. 5,401,530)

Mortimer, R. K., T.Török, P. Romano, G. Suzzi, and M. Polsinelli. 1995. *Saccharomyces cerevisiae* is present on the grapes and is introduced into the fermentation must at the time of crushing. 17th Int. Conf. Yeast Genet. Molec. Biol., Lisboa, Portugal, p.S574

Torok, T., R. K. Mortimer, P. Romano, G. Suzzi and M. Polsinelli. 1996. Quest for wine yeasts - An old story revisited. J. Ind. Microbiol., 17:303-313.

Torok, T., S. Goldman, and J. C. Hunter-Cevera. 1997. Who is out there? What is it doing? The *pros* and *cons* of polyphasic characterization of microbial communities. 8th European Congr. Biotechnol., Budapest, Hungary, p.144.

Torok, T., R. Mortimer, P. Romano, and G. Suzzi. 1997. Biodiversity of naturally-occurring *Saccharomyces cerevisiae* wine yeasts. 18th Int. Spec. Symp. Yeasts, Bled, Slovenia, p. P4-06.

Torok, T., S. Goldman, and J. C. Hunter-Cevera. 1997. Polyphasic characterization of microbial communities in contaminated environments. Spec. Symp. ACS "Emerging Technologies in Hazardous Waste Management", Pittsburgh, PA., p. 215.

McKinney, N., T. Torok, V. Repin, M. I Kuzmin, J. C. Hunter-Cevera. 1999. *Bacillus* spp. diversity in Lake Baikal and sediment samples based on the *SaspB* sequences. ASM International Subsurface Microbiology Meeting, Vail, CO, August, 1999.

Repin, V. T. Torok, M. I Kuzmin, and J. C. Hunter-Cevera. 1999. Unusual restriction enzyme profile of *Bacillus* spp. isolated from Lake Baikal water and sediment samples. ASM International Subsurface Microbiology Meeting, Vail, CO, August, 1999.

Torok, T. V. Repin, V. Gelatij, and J. C. Hunter-Cevera. **1999.** Microbial diversity in Lake Baikal water and sediment samples as determined by an extensive isolation program. ASM International Subsurface Microbiology Meeting, Vail, CO, August, 1999.

Curriculum Vitae: **WILLIAM M. BERELSON**

Work Address:
Department of Earth Sciences
University of Southern California
Los Angeles, CA 90089-0740
(213) 740-5828

Home Address:
840 S. Burnside Ave.
Los Angeles, CA 90036
(323) 934-9599

email:
berelson@usc.edu

Born: September 15, 1955, New York City

Employment

1996-present	Research Associate Professor, University of Southern California
1988-1995	Research Assistant Professor, University of Southern California
1985-1988	Research Associate of Geochemistry (Post-doc), U.S.C.

Education

Ph. D. Geological Sciences (Geochemistry), Studies of water column mixing and benthic exchange of nutrients, carbon and radon in the southern California borderland. December, 1985, *University of Southern California*, Los Angeles, CA

M.S. Geological Sciences (Sedimentology), Barrier island evolution and its effect on lagoonal sedimentation; Shackleford Banks, Back Sound, and Harkers Island: Cape Lookout National Seashore.September, 1979, *Duke University*, Durham, N.C

B.A. Geological Sciences, June, 1977, Cum Laude, *University of Rochester*, Rochester, N.Y.

PROFESSIONAL AFFILIATIONS, HONORS and SERVICES

American Geophysical Union
Geochemical Society
American Society of Limnologists and Oceanographers
The Oceanography Society

Chemical Oceanography NSF Panelist
US-JGOFS Steering Committee Member (1998-)
Session Organizer and Chair; AGU Meeting, San Francisco, 12/94
Gordon Conference on Chemical Oceanography, Invited Discussion Leader, 6/95
Australian Marine Science Association, Invited Lecture and Discussion Leader, 7/96

RESEARCH INTERESTS

*Factors that control the cycling of metals and nutrients in coastal and marine sediments, environmental implications.
*Global budgets of carbon, silica, nitrogen and phosphorus, the role of sediment diagenesis.
*Calcium carbonate dissolution kinetics and its impact on paleoceanographic reconstruction.
*In situ device technology.
*Use of radioisotopes and other tracers for mixing and advection in marine waters and sediments.
*Environmental applications of radon measurements in air, soil and groundwater.

Selected Publications of W. Berelson

10 Publications Relevant to the Proposed Work

Berelson, W. M. and D. E. Hammond (1986). The calibration of a new free vehicle benthic flux chamber for use in the deep sea, Deep Sea Research, v. 33, 1439-1454.

Berelson, W. M., D. E. Hammond, K. L. Smith, R. A. Jahnke, A. H. Devol, K. R. Hinga, G. T. Rowe and F. Sayles (1987). In situ benthic flux measurement devices: bottom lander technology. Invited contribution to Marine Technology Society Journal, v. 21, 26-32.

Berelson, W. M., D. E. Hammond and K. S. Johnson (1987). Benthic fluxes and the cycling of biogenic silica and carbon in two southern California borderland basins. Geochimica et Cosmochimica Acta, v. 51, 1345-1363.

Berelson, W. M., D. E. Hammond and P. Giordani (1989). Effect of sea floor disturbance on benthic flux measurements in the continental margin off Southern California, Catalina Basin. Giornale di Geologia, v. 51, 143-150.

Berelson, W. M. and K. Johnson (1991). Measurements of nutrient and metal fluxes from the seafloor in the area around the Whites Point Sewage Outfall, Los Angeles, CA. Seventh Symposium on Coastal and Ocean Management, Coastal Zone '91.

McManus, J., D. E. Hammond, W. Berelson, T. E. Kilgore, D. J. DeMaster, O. G. Ragueneau and R. W. Collier (1995). Early diagenesis of biogenic opal: Dissolution rates, kinetics, and paleoceanographic implications. Deep-Sea Research, v. 42, 871-903.

Berelson, W., J. McManus, K. Coale, K. Johnson, T. Kilgore, D. Burdige and C. Pilskaln (1996). Biogenic matter diagenesis on the sea floor: A comparison between two continental margin transects. Jour. Mar. Res., v. 54, 731-762.

Hammond, D. E., J. McManus, W. Berelson, T. Kilgore and R. Pope. (1996) Early diagenesis of organic carbon in the equatorial Pacific: Rates and kinetics. Deep-Sea Research, 43, 1365-1412.

Berelson, W., R. Anderson, J. Dymond, D. DeMaster, D. Hammond, R. Collier, S. Honjo, M. Leinen, J. McManus, R. Pope, C. Smith and M. Stephens (1997). Biogenic budgets of

particle rain, benthic remineralization and sediment accumulation in the Equatorial Pacific. Deep-Sea Res., v. 44, 2251-2282.

Berelson, W., D. Heggie, A. Longmore, T. Kilgore, G. Nicholson and G. Skyring (1998) Benthic nutrient recycling in Port Phillip Bay, Australia. Estuarine, Coastal and Shelf Science, v. 46, 917-934.

[Berelson, W., T. Townsend, D. Heggie, P. Ford, A. Longmore, G. Skyring, T. Kilgore and G. Nicholson. Modeling bio-irrigation rates in the sediments of Port Phillip Bay, accepted to Marine and Freshwater Research]

Collaborators

R. Anderson (L.D.E.O.), D. Burdige (O.D.U.), K. Johnson and K. Coale (M.L.M.L.), J. McManus, G. Klinkhammer, J. Dymond and R. Collier (O.S.U.), M. Leinen (U.R.I.), C. Smith (U.H.), D. Demaster (N.C.S.U.), C. Pilskaln (U. Maine), D. Heggie (AGSO, Aust.)
Ph.D. and Post-doc Advisor--D. Hammond (U.S.C.)

CURRICULUM VITAE

Kenneth H. Coale
Moss Landing Marine Laboratories
P.O. Box 450
Moss Landing, California 95039

(831) 755-8655 tel
(831) 753-2826 fax
coale@mlml.calstate.edu

Education:

Ph.D., Biology, University of California, Santa Cruz,	1988
B.A., Biology, University of California, Santa Cruz	1977

Professional Positions:

Acting Director, Moss Landing Marine Laboratories, 1998 to present
Adjunct Professor of Biogeochemistry, Moss Landing Marine Laboratories, 1992-1998.
Lecturer, Institute of Marine Sciences, University of California, Santa Cruz, 1994.
Senior Research Associate, Moss Landing Marine Laboratories, 1990 to 1992.
Postdoctoral Researcher, Moss Landing Marine Laboratories, 1988 to 1990.

Professional Experience:

Interests include a) Trace element biogeochemistry in the California Current; North, South and Equatorial Pacific and Southern Oceans. b) The use of naturally occurring U/Th series radionuclides in the study of biologically mediated chemical scavenging, removal and recycling processes. ^{226}Ra:^{210}Pb disequilibria to date rockfish otoliths. c) Trace metal speciation and the effect of metal speciation on trace metal limitation of phytoplankton productivity in open ocean and coastal systems. d) The distribution and cycling of trace metals in lacustrine systems. e) Trace metal cycling and removal in hydrothermal plumes. f) The role of continental margins in supplying trace metals to the ocean's interior.g) Lead-210 dating of marine sediments. h) Development of analytical methods for the determination of trace metals in seawater.

Public Service

Served on the National Science Foundation Advisory Panel in Chemical Oceanography. Co-conceived and implemented an aquatic public environmental education event (for the last five years) in Santa Cruz, California, and serves on the Board of Directors of the Land Trust of Santa Cruz County. Associate Editor, Marine Chemistry.

Professional Societies:

American Geophysical Union, The Oceanographic Society, American Chemical Society, American Society of Limnology and Oceanography, International Humic Substances Society, American Association for the Advancement of Science.

Personal: Born 1/24/55, Married 1979; 2 children

Selected Publications:

Coale, K. H. and K. W. Bruland, 1987. Oceanic Stratified Euphotic Zone as elucidated by ^{234}Th:^{238}U Disequilibria. Limnol. Oceanogr. 32 (1) 189-200.

Coale, K. H. and K. W. Bruland, 1988. Copper Complexation in the Northeast Pacific. Limnol. Oceanogr. 33: 1084-1101.

Flegal, A. R., J. O. Nriagu, S. Niemeyer and K. H. Coale, 1989. Isotopic Tracers of Lead Contamination in the Great Lakes. Nature, 339: 455-458.

Coale, K. H. and A. R. Flegal, 1989. Copper, Zinc, Cadmium and Lead in Surface Waters of Lakes Erie and Ontario. Science of the Total Environment, 87/88, 297-304.

Flegal, A. R. and K. H. Coale, 1989. Discussion: "Trends in Lead Concentrations in Major U. S. Rivers and Their Relation to Historical Changes in Gasoline-Lead Consumption," by R. B. Alexander and R. A. Smith. Water Resources Bulletin, Vol. 25,6, pg. 1-3.

Coale, K. H., 1990. Labyrinth of Doom: A Device to Minimize the "Swimmer Component" in Sediment Trap Collections. Limnol. Oceanogr. 35, 1376-1381.

Coale, K. H., 1991. The Effects of Iron, Manganese, Copper and Zinc on Primary Production and Biomass in Plankton of the Subarctic Pacific. Limnology and Oceanography, 36, 1851-1864.

Coale, K. H., C. S. Chin, G. J. Massoth, K. S. Johnson and E. T. Baker. 1991. In situ chemical mapping of dissolved iron and manganese in hydrothermal plumes. Nature, 352, 325-328.

Chin, C. S., K. S. Johnson and K. H. Coale, 1992. Spectrophotometric determination of dissolved manganese in natural waters with 1-(2-pyridylazo)-2-napthol: Application to analysis in situ in hydrothermal plumes. Marine Chemistry, 37, 65-82.

Johnson, K. S., W. M. Berelson, K. H. Coale, T. L. Coley, V. A. Elrod., W. R. Fairey, H. D. Iams, T. E. Kilgore and J. L. Nowicki, 1992. Manganese flux from continental margin sediments in a transect through the oxygen minimum. Science, 257, 1242-1245.

Coale, K. H., P. M. Stout, K. S. Johnson and C. M. Sakamoto. 1992. Shipboard Determination of Copper in Seawater using Flow Injection Analysis with Chemiluminescence Detection. Analytica Chimica Acta, vol. 266, issue 2, pp. 345-351.

Johnson, K. S., K. H. Coale and H. W. Jannasch, 1992. Analytical Chemistry in Oceanography. Analytical Chemistry, Vol. 64, No. 2 1065A-1075A.

Johnson, K. S., K. H. Coale, V. A. Elrod, and N. W. Tindale. 1994. Iron Photochemistry in seawater from the Equatorial Pacific. Marine Chemistry 46, 319-334.

Martin, J. H., K. H. Coale, K. S. Johnson, and 40 others. 1994. Testing the Iron Hypothesis in Ecosystems of the Equatorial Pacific Ocean. Nature, 371, 123-129.

Johnson, K. S., K. H. Coale, W. M. Berelson and R. M. Gordon. 1996. Formation of the Manganese Maximum in the Oxygen Minimum. Geochimica et Cosmochimica Acta, 60, 8, 1291-1299.

Coale, K. H., S. E. Fitzwater, R. M. Gordon and K. S. Johnson. 1996. Iron limits new production and community growth in the equatorial Pacific Ocean. Nature, 379, 621-624.

Coale, K. H., K. S. Johnson, S. E. Fitzwater, R. M. Gordon, S. Tanner, F. P. Chavez, L. Ferioli, C. Sakamoto, P. Rogers, F. Millero, P. Steinberg, P. Nightingale, D. Cooper, W. P. Cochlan, M. R. Landry, J. Constantinou, G. Rollwagen, A. Trasvina and R. Kudela. 1996. A massive phytoplankton bloom induced by an ecosystem-scale iron fertilization experiment in the equatorial Pacific Ocean. Nature, 383, 495-501.

Berelson, W. M., J. McManus, T. Kilgore, D. Hammond, K. Coale, K. Johnson and C. Pilskaln. 1996. Biogenic matter diagenesis on the sea floor: a comparison between two continental margin transects. Journal of Marine Research, 54, 731-762.

Johnson, K. S., R. M. Gordon and K. H. Coale. 1997. What controls dissolved iron concentrations in the world ocean? Marine Chemistry, 57, 137-162 and 181 Johnson, K. S., R. M. Gordon and K. H. Coale, 1997. What controls dissolved iron concentrations in the world ocean? Author's closing comments. Marine Chemistry,57, 181-186.

Coale, K. H. and K. S. Johnson, 1997. Recent advances in trace metal and nutrient analysis in seawater. In Advances in Environmental Science, N. K. Muraleedharan for Educational Book Publishers and Distributors, New Delhi. C.S.P. Iyer, Editor, p 63-81.

Coale, K. H. 1998. Preface to Topical Studies in Oceanography, The Galapagos Iron Experiments: A Tribute to John Martin. Deep-Sea Research, Part II, Vol 45, No 6, 915-918.

Gordon, R. M., K. S. Johnson and K. H. Coale. 1998. The behaviour of iron and other trace elements during the IronEx I and PlumEx experiments in the Equatorial Pacific. Deep-Sea Research, Part II, Vol 45, No 6, 995-1041.

Coale, K. H., K. S. Johnson, S. E. Fitzwater, S. P. G. Blain, T. P. Stanton and T. L. Coley. 1998. IronEx I, an in situ iron-enrichment experiment: Experimental design, implementation and results. Deep-Sea Research, Part II, Vol 45, No 6, 919-945.

Zamzow, H., K. H. Coale, K. S. Johnson and C. M. Sakamoto. 1998. Determination of copper complexation in seawater using flow injection analysis with chemiluminescence detection. Analytica Chimica Acta, 377, 133-144.

Colbert, D., K. S. Johnson and K. H. Coale. 1998. Determination of cadmium in seawater using automated on-line preconcentration and direct injection graphite furnace atomic absorption spectrometry. Analytica Chimica Acta, 377, 255-262.

Burton, E. J., A. H. Andrews, K. H. Coale and G. M. Cailliet. 1998. Appliecation of radiometric age determination to three long-lived fishes using 210Pb:226Ra disequilibria in calcified structures: A review. American Fisheries Society Special Publication, Ecology and Conservation of Long-Lived Marine Animals.

Andrews, A., K. H. Coale, J. Nowicki, C. Lundstrom, Z. Palacz, E. Burton and G. Cailliet. 1999. Application of a new ion-exchange separation technique and isotope dilution thermal ionization mass spectrometry to ^{226}Ra determination in otoliths for radiometric age determination of long-lived fishes. Canadian Journal of Fisheries and Aquatic Sciences, In Press.

Andrews, A. H., E. J. Burton, K. H. Coale, G. M. Cailliet and R. E. Crabtree. 1999. Application of radiometric age determination to the Atlantic tarpon, Megalops atlanticus. Fishery Bulletin. In Press.

Moore, J. K., M. R. Abbott, J. G. Richman, W. O. Smith, T. J. Cowles, K. H. Coale, W. D. Gardner and R. T. Barber. 1999. SeaWiFS Satellite Ocean Color Data from the Southern Ocean. Geophysical Research Letters. Submitted.

Coale, K. H., P. Worsfold and H. deBaar, 1999. Iron in Seawater and the Need for International Intercomparison Studies: A Report from a Subgroup of the Scientific Committee on Ocean Research, Working Group 109, "Biogeochemistry of Iron in Seawater" Amsterdam 1-5 November, 1998. In Press EOS.

We will comply with Interagency Agreements form 4187

I-019140

Forms

1. Attachments D and E - Table D-1

APPLICATION FOR FEDERAL ASSISTANCE

OMB Approval No. 0348-00-

2. DATE SUBMITTED	Applicant Identifier
April 16, 1999	
3. DATE RECEIVED BY STATE	**State Application Identifier**
4. DATE RECEIVED BY FEDERAL AGENCY	**Federal Identifier**

1. TYPE OF SUBMISSION:

Application: ☐ Construction ☒ Non-Construction
Preapplication: ☐ Construction ☐ Non-Construction

5. APPLICANT INFORMATION

Legal Name: CA Dept. of Water Resources
Organizational Unit: Environmental Services Office
Address (give city, county, State, and zip code): 3251 "S" Street, Sacramento CA 95816
Name and telephone number of person to be contacted on matters involving this application (give area code): Peggy Lehman (916) 227-7551

6. EMPLOYER IDENTIFICATION NUMBER (EIN): 94-6035570

7. TYPE OF APPLICANT: (enter appropriate letter in box) A

A. State
B. County
C. Municipal
D. Township
E. Interstate
F. Intermunicipal
G. Special District
H. Independent School Dist.
I. State Controlled Institution of Higher Learning
J. Private University
K. Indian Tribe
L. Individual
M. Profit Organization
N. Other (Specify) _____

8. TYPE OF APPLICATION:

☒ New ☐ Continuation ☐ Revision

If Revision, enter appropriate letter(s) in box(es) ☐ ☐

A. Increase Award B. Decrease Award C. Increase Duration
D. Decrease Duration Other (specify):

9. NAME OF FEDERAL AGENCY: US Fish & Wildlife Service

10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: ☐☐-☐☐☐

TITLE: N/A

11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT: Determination of the Causes of Dissolved Oxygen Depletion in the San Joaquin River

12. AREAS AFFECTED BY PROJECT (Cities, Counties, States, etc.): San Joaquin County

13. PROPOSED PROJECT

Start Date	Ending Date
8/99	12/02

14. CONGRESSIONAL DISTRICTS OF:

a. Applicant 3, 5 b. Project 3

15. ESTIMATED FUNDING:

Federal	$ 2,370,928 (866,408 Phase I) .00
Applicant	$ .00
State	$ .00
Local	$ .00
Other	$ .00
Program Income	$ .00
TOTAL	$ .00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

a. YES. THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:

DATE _____

b. No. ☐ PROGRAM IS NOT COVERED BY E. O. 12372
☐ OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?

☐ Yes If "Yes," attach an explanation. ☐ No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT, THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED.

a. Name of Authorized Representative	b. Title	c. Telephone Number
Dr Randall L Brown	Chief, Environmental Services Office	(916) 227-7531
d. Signature of Authorized Representative		**e. Date Signed**
Randall K Brown - FAX for RL Brown		April 16, 1999

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I -019142

I-019142

OMB Approval No. 0348-0044

BUDGET INFORMATION - Non-Construction Programs

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Year 1		$	$	$ 866,408	$	$ 866,408
2. Year 2				752,260		752,260
3. Year 3				752,260		752,260
4.						
5. Totals		$	$	$ 2,370,928	$	$ 2,370,928

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1)	(2)	(3)	(4)	Total (5)
a. Personnel	$ 304,791	$ 299,791	$ 299,791	$	$ 904,373
b. Fringe Benefits	224,849	219,849	219,849		664,547
c. Travel					
d. Equipment	84,627	48,627	48,627		181,871
e. Supplies					
f. Contractual	107,740	57,740	57,740		223,220
g. Construction					
h. Other					
i. Total Direct Charges (sum of 6a-6h)					
j. Indirect Charges	144,401	125,377	125,377		395,155
k. TOTALS (sum of 6i and 6j)	$ 866,408	$ 752,260	$ 752,260	$	$ 2370928
7. Program Income	$	$	$	$	$

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SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e) TOTALS
8.	$	$	$	$
9.				
10.				
11.				
12. TOTAL (sum of lines 8 - 11)	$	$	$	$

SECTION D - FORCASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$	$	$	$	$
14. NonFederal					
15. TOTAL (sum of lines 13 and 14)					

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (Years) (b) First	(c) Second	(d) Third	(e) Fourth
16. August 1999 – December 2001	$ 866,408	$ 752,260	$ 752,260	$
17.				
18.				
19.				
20. TOTAL (sum of lines 16-19)	$ 866,408	$ 752,260	$ 752,260	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges:	22. Indirect Charges:
23. Remarks:	

I—019144

I-019144

U.S. Department of the Interior

Certifications Regarding Debarment, Suspension and Other Responsibility Matters, Drug-Free Workplace Requirements and Lobbying

Persons signing this form should refer to the regulations referenced below for complete instructions:

Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions - The prospective primary participant further agrees by submitting this proposal that it will include the clause titled, "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions. See below for language to be used; use this form for certification and sign; or use Department of the Interior Form 1954 (DI-1954). (See Appendix A of Subpart D of 43 CFR Part 12.)

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions - (See Appendix B of Subpart D of 43 CFR Part 12.)

Certification Regarding Drug-Free Workplace Requirements - Alternate I. (Grantees Other Than Individuals) and Alternate II. (Grantees Who are Individuals) - (See Appendix C of Subpart D of 43 CFR Part 12)

Signature on this form provides for compliance with certification requirements under 43 CFR Parts 12 and 18. The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of the Interior determines to award the covered transaction, grant, cooperative agreement or loan.

PART A: Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions

CHECK__IF THIS CERTIFICATION IS FOR A PRIMARY COVERED TRANSACTION AND IS APPLICABLE.

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

PART B: Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions

CHECK__IF THIS CERTIFICATION IS FOR A LOWER TIER COVERED TRANSACTION AND IS APPLICABLE.

(1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

(2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

DI-7010
March 1995
(This form consolidates DI-1953, DI-1954.

PART C: Certification Regarding Drug-Free Workplace Requirements

CHECK X IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS NOT AN INDIVIDUAL.

Alternate I. (Grantees Other Than Individuals)

A. The grantee certifies that it will or continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about–
(1) The dangers of drug abuse in the workplace;
(2) The grantee's policy of maintaining a drug-free workplace;
(3) Any available drug counseling, rehabilitation, and employee assistance programs; and
(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will –
(1) Abide by the terms of the statement; and
(2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

(e) Notifying the agency in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification numbers(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted –
(1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a) (b), (c), (d), (e) and (f).

B. The grantee may insert in the space provided below the site(s for the performance of work done in connection with the specific grant:

Place of Performance (Street address, city, county, state, zip code)

Environmental Services Office
3251 S Street Sacramento CA 95816

Check___if there are workplaces on file that are not identified here.

PART D: Certification Regarding Drug-Free Workplace Requirements

CHECK__IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS AN INDIVIDUAL.

Alternate II. (Grantees Who Are Individuals)

(a) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant;

(b) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing, within 10 calendar days of the conviction, to the grant officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall include the identification number(s) of each affected grant.

I-019146

PART E: **Certification Regarding Lobbying**
Certification for Contracts, Grants, Loans, and Cooperative Agreements

CHECK__ IF CERTIFICATION IS FOR THE AWARD OF ANY OF THE FOLLOWING AND THE AMOUNT EXCEEDS $100,000: A FEDERAL GRANT OR COOPERATIVE AGREEMENT; SUBCONTRACT, OR SUBGRANT UNDER THE GRANT OR COOPERATIVE AGREEMENT.

CHECK__ IF CERTIFICATION IS FOR THE AWARD OF A FEDERAL LOAN EXCEEDING THE AMOUNT OF $150,000, OR A SUBGRANT OR SUBCONTRACT EXCEEDING $100,000, UNDER THE LOAN.

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, and officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

As the authorized certifying official, I hereby certify that the above specified certifications are true.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL Dale K. Hoff - All for

TYPED NAME AND TITLE Dr Randall L Brown, Chief Environmental Services Office

DATE April 16, 1999

I —019147

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ASSURANCES - NON-CONSTRUCTION PROGRAMS

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
Dale K. Hoffman-Flaum for RL Brown	Chief, Environmental Services Office
APPLICANT ORGANIZATION	DATE SUBMITTED
California Department of Water Resources	4/16/99

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