

I. EXECUTIVE SUMMARY **DWR WAREHOUSE**

a. **Project Title:** Net Input of Selenium to the Bay-Delta system from the San Joaquin River
Applicant Name: U.S. Geological Survey (USGS)

b. **Project Description:** The purpose of this project is to calculate the best possible estimate for the net input of selenium to the Bay-Delta system from the San Joaquin River using existing data. Selenium in the Bay-Delta system may adversely impact green sturgeon, diving ducks, and other species that reside at upper trophic levels of a food chain in which selenium bio-accumulates. This work is critical because any change in the physical flow system in the south Delta that reduces the amount of San Joaquin River water leaving the Delta via the State Water Project (SWP) and Central Valley Project (CVP) pumps will increase the amount of selenium that enters the Bay-Delta system.

c. **Approach/Tasks/Schedule:** The project will calculate the amount of selenium transported into the Delta from the San Joaquin River, and the amount of selenium transported out of the Delta by the SWP and CVP, to estimate the net input of selenium to the Bay-Delta system from the San Joaquin River. The project will combine an analysis of the flow data within the Delta collected as part of the USGS Hydrodynamics program with an evaluation of water quality data collected by several agencies over the last decade to arrive at independent estimates of selenium transport for the San Joaquin River. Specific objectives of the investigation are:

- 1) determine the amount of San Joaquin River surface water that is exported from the Delta using existing in-Delta flow data;
- 2) estimate the net input of selenium to the Bay-Delta system from the San Joaquin River by accounting for the largest inputs and outputs using historical data on the flow and concentrations of selenium and other dissolved constituents; and
- 3) determine the data necessary for rigorous quantification of the net input of selenium to the Bay-Delta system from the San Joaquin River.
- 4) implement monitoring to quantify the net input of selenium to the Bay-Delta system from the San Joaquin River.

The first three objectives will be completed by December, 1998. The last objective is not budgeted for in this proposal, and will be addressed in coordination with the activities described in the multi-agency Inquiry Proposal titled "Design of San Francisco Bay-Sacramento/San Joaquin Delta Estuary Water Quality Monitoring and Assessment Program".

d. **Justification for Project and Funding by CALFED:** Both primary (green sturgeon) and secondary (migratory birds) species that may benefit from CALFED ecosystem restoration may be adversely impacted by selenium. There are two primary sources of selenium in the Bay-Delta system: oil refineries that discharge directly to the Bay or Delta, and subsurface agricultural drainage from the western San Joaquin Valley transported by the San Joaquin River. A cursory review of existing data indicates that in the past much of the selenium entering the Delta from the San Joaquin River was likely exported by the SWP and CVP without impacting most of the Delta. Any change in the flow system in the Delta will also change the amount of San Joaquin River water exported, and hence change the net selenium flux into the Delta from the San Joaquin River. Other management actions may reduce the selenium input from both refinery and agricultural sources. The proposed investigation will provide the foundation for assessing the ecological risk of selenium from this source in proportion to other current sources, the benefits of proposals for

abatement of selenium from the different sources, the impacts of physical modification of the Delta flow system on selenium transport, and will provide the basis for designing a rigorous monitoring plan. In addition, because of the potential for transport of boron, salinity, and pesticides into the Delta by the San Joaquin River, it is of vital importance that the proportion of San Joaquin River water that enters the Delta under present conditions - the "no action" option - are determined as accurately as possible.

e. Budget Costs and Third Party Impacts: Completion of project objects 1 through 3 will require \$153,700 from CALFED, and will involve two senior hydrologists, a GIS/database expert, and one junior hydrologist. There will be no third party impacts.

f. Applicant Qualifications: Dr. Charles Kratzer has a doctorate in Environmental Science and Engineering from the University of California, Los Angeles. He has been studying the water-quality impacts of agricultural drainage in the San Joaquin Valley for more than 14 years: 7 with the State Water Resources Control (1983 to 1991), and 6 with the USGS (1991 to present). Rick Oltmann has been a hydrologist with the USGS since 1970, working primarily on hydrodynamic studies of the Delta.

g. Monitoring and Data Evaluation: No new data collection is necessary to complete the first three objectives. Data evaluation will consist of compiling existing data (1986 through the present) on the flow and water quality (selenium and possibly boron and major ion chemistry) for the Sacramento River, the San Joaquin River, the SWP and CVP export pumps, and several within-Delta gaging stations, and calculating mass balances on both water and solutes. The fourth objective will require the results of the first three objectives as well as new water samples for low-level selenium analysis. Therefore, this objective will be designed in coordination with the multi-agency Inquiry Proposal titled "Design of San Francisco Bay-Sacramento/San Joaquin Delta Estuary Water Quality Monitoring and Assessment Program".

h. Local Support/Coordination with other Programs/Compatibility with CALFED objectives: The results of objective 1 - determination of the amount of San Joaquin River water exported - are consistent with the overall CALFED objective to "provide good water quality for all beneficial uses" because the San Joaquin River is a major source of pesticides, trace elements, and salinity to the Delta. The results of proposal objectives 1 through 3 are relevant to the CALFED objective of improving ecological functions by placing bounds on the amount of selenium, and potentially other contaminants that are known to impact aquatic biota, input to the Bay-Delta system by the San Joaquin River. This information is critical for assessing the ecological costs/benefits of any action that changes the flow system in the Delta. There is no specific local sponsor, but the results will be extremely relevant to all agricultural and municipal users of south Delta water impacted by elevated selenium, salinity, and boron. This investigation will utilize existing data collected by the Department of Water Resources, the Bureau of Reclamation, the Central Valley Regional Water Quality Control Board, the USGS, and other agencies, and hence will coordinate with the data acquisition and evaluation activities of these agencies.

Net Input of Selenium to the Bay-Delta system from the San Joaquin River

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III. PROJECT DESCRIPTION

a. Project Description and Approach

The purpose of this project is to calculate the best possible estimate for the net input of selenium to the Bay-Delta system from the San Joaquin River using existing data. Selenium in the Bay-Delta system may adversely impact green sturgeon, diving ducks, and other species that reside at upper trophic levels of a food chain in which selenium bio-accumulates. The results are relevant because any change in the physical flow system in the south Delta that reduces the amount of San Joaquin River water leaving the Delta via the SWP and CVP pumps will increase the amount of selenium that enters the Bay-Delta system.

The project will calculate the amount of selenium transported into the Delta from the San Joaquin River, and the amount of selenium transported out of the Delta by the State Water Project (SWP) and Central Valley Project (CVP), to estimate the net input of selenium to the Bay-Delta system from the San Joaquin River. The project will combine an analysis of the flow data within the Delta collected as part of the USGS Hydrodynamics program with an evaluation of water quality data collected by several agencies over the last decade to arrive at independent estimates of selenium transport for the San Joaquin River.

The project approach is to address three specific objectives.

1) Determine the amount of San Joaquin River surface water that is exported from the Delta using existing in-Delta flow data.

Flow data for the largest inputs and outputs of fresh water to the Delta have been collected for more than a decade. Most of the fresh water in the Delta enters from the Sacramento River at Freeport (site E, figure 1) and from the San Joaquin River near Vernalis (site A, figure 1). Fresh water exits the Delta either to Suisun Bay, the export pumps of the SWP and CVP, or by within-Delta consumptive use. The problem in the past has been that the relative proportions of these outputs could not be defined. With the more recent addition of continuous flow monitors within the south Delta (sites B, C, and D, figure 1) the amount of San Joaquin River water exported by the CVP and SWP can be calculated as the difference between inputs and outputs in the mass-balance:

$$Q(\text{SWP+CVP pumpage}) - Q(\text{sites D+C}) = Q(\text{San Joaquin exported})$$

where Q is a discharge. The difference between the discharge of the San Joaquin River into the Delta (site A) and the amount exported, Q(San Joaquin exported), will be the net San Joaquin inflow for the Delta:

$$Q(\text{site A}) - Q(\text{San Joaquin exported}) = Q(\text{net San Joaquin inflow})$$

The values of Q(San Joaquin exported) and Q(net San Joaquin inflow) can be further constrained by using the flow data for the San Joaquin River at Stockton (site B, figure 1). Although the residual, Q(San Joaquin exported), will primarily represent San Joaquin River flow, it could contain some Sacramento, Cosumnes, or Mokelumne River flow moving south past site B during periods of low - or "reversed" - flow in the San Joaquin River. Data suggests that flow at site B

was reversed about half of the time during 1987 through 1991, and this scenario can be evaluated with existing data.

The proposed mass-balance only accounts for the largest components of flow, and does not attempt to estimate components that are small and have little or no data. For example, San Joaquin River flow that moves north past site B may still be captured by the pumps by flowing south through Turner and Columbia Cuts. This component of flow is expected to be minor, however, and cannot be quantified with existing data because contributions of flow from north Delta sources cannot be distinguished from contributions of San Joaquin River water for Columbia and Turner Cuts. The proposed mass-balance will be the best possible evaluation of within-Delta flows until more extensive flow measurements are made at additional sites.

2) Estimate the net input of selenium to the Bay-Delta system from the San Joaquin by accounting for the largest inputs and outputs using historical data on the concentrations of selenium and other solutes.

Data on selenium concentrations in the freshwater inputs and outputs to the Delta are insufficient to calculate an accurate mass-balance for two primary reasons. First, the temporal variability of selenium concentrations in the sources of selenium to the San Joaquin River are much greater than the weekly to monthly frequency of the monitoring at sites A, E, and the export pumps. Secondly, the detection limits for selenium used in the past, while variable, are high relative to observed concentrations, and nondetections are frequent. This is especially true during critical periods of high flow, when a even low concentration could result in a large amount of mass transport (load).

In this evaluation the mass of selenium input from the San Joaquin River will be calculated using a combination of data from agencies monitoring water quality at site A (DWR, USGS, USBR, and CVRWQCB). The frequency of data in the combined data set will be somewhat better than weekly at best. The combined data set on selenium concentrations will be used with the calculated values for the net San Joaquin River inflow to the Delta to arrive at an estimate of the net input of selenium to the Bay-Delta system from the San Joaquin River. Two lines of evidence will then be used to assess the validity of the estimate of the net input of selenium from the San Joaquin River: selenium concentrations in the exported SWP and CVP water, and attempts to mass-balance boron, sulfate, or other solutes that might serve as tracers characteristic of San Joaquin River water.

3) Determine the data necessary for rigorous quantification of the net input of selenium to the Bay-Delta system from the San Joaquin River.

Based on the findings of the first two objectives, recommendations will be made for a monitoring program that will explicitly address temporal variability and detection limit, while considering the value added by additional monitoring sites (e.g. selenium analysis at sites B, C, and D).

A fourth objective is to implement a detailed monitoring program to quantify the net input of selenium to the Bay-Delta system from the San Joaquin River. It will require the collection of water samples for low-level selenium analysis, analysis for other chemical constituents that are characteristic of San Joaquin River water, and possibly additional flow data in the Delta. This objective will not be evaluated in this proposal, but will be addressed in coordination with the activities described in the multi-agency Inquiry Proposal titled "Design of San Francisco Bay-Sacramento/San Joaquin Delta Estuary Water Quality Monitoring and Assessment Program".

b. Location and/or geographic boundaries of project

The immediate study area for this proposal are the Delta channels that connect the Sacramento River below Freeport and the San Joaquin River near Vernalis to the State Water Project and Central Valley Project pumps (see figure 1 for the locations of water quality monitoring sites and USGS gaging stations used in this proposal). This study area is in Alameda, Contra Costa, Sacramento, and San Joaquin Counties. The project findings will, however, be reflective of management actions taken throughout the San Joaquin Basin that are aimed at reducing the amount of selenium from agricultural subsurface drainage that reaches the San Joaquin River.

c. Expected benefits

This project will provide two critical pieces of information: the proportion of San Joaquin River water that enters the Delta under present conditions - the "no action" option; and the net input of selenium to the Bay-Delta system from the San Joaquin River Basin. The first piece of information will be of enormous benefit to everyone concerned about the ecological (and drinking water) impacts of water quality in the Delta because the San Joaquin River is a major source of pesticides, trace elements, and salinity. These parties include south Delta agricultural water users concerned with elevated boron and salinity; municipal drinking water purveyors that obtain their water from the south Delta; and groups concerned with the impact of trace elements and pesticides on the Bay-Delta ecosystem. Placing bounds on the net input of selenium from the San Joaquin to the Delta will provide the foundation for assessing the ecological risk of selenium from this source in proportion to other current sources, the benefits of proposals for abatement of selenium from the different sources, the impacts of physical modification of the Delta flow system on selenium transport, and will provide the basis for designing a rigorous monitoring plan.

In short, these findings will be critical for assessing the ecological costs/benefits of any action that changes the physical flow system in the Delta.

d. Background and Biological/Technical Justification

Because of the potential for transport of selenium, boron, salinity, and pesticides into the Delta by the San Joaquin River, it is of vital importance that the proportion of San Joaquin River water that enters the Delta under present conditions - the "no action" option - are determined as accurately as possible.

Almost every proposal for changes in the management of the Bay-Delta system will change the physical flow system. These physical changes include, but are not restricted to, changes in the physical configuration affecting cross-Delta flow of Sacramento River water, structural changes in south Delta channels, and the timing and amount of pumping in relation to discharge from the Sacramento and San Joaquin Rivers. Under current conditions an unknown proportion of the flow from the San Joaquin River flow entering the Delta is exported from the Delta by the SWP and CVP pumps. Any change in the present physical flow system will change the amount of San Joaquin River water exported. Two classes of actions in particular will increase the net flux of San Joaquin River water into the Delta: actions taken to improve the water quality of exported water by reducing the amount of San Joaquin River water pumped; and any action (physical barriers or flow modification) taken to increase the survival of out-migrating salmonids from the San Joaquin

River by increasing their rate of transport through the Delta. These actions will not only increase the net flux of San Joaquin River water into the Delta, but will increase the flux of contaminants transported by the river into the Delta.

Selenium is arguably the contaminant of most concern in the San Joaquin River from the biological perspective. Changes in the flow system that reduce the amount of San Joaquin River water leaving the Delta will increase the amount of selenium entering the Delta. Both primary (green sturgeon) and secondary (migratory birds) species that may benefit from CALFED ecosystem restoration may be adversely impacted by selenium. There are two primary sources of selenium in the Bay-Delta system: oil refineries that discharge directly to the Bay or Delta, and subsurface agricultural drainage from the western San Joaquin Valley transported by the San Joaquin River. A cursory review of existing data indicates that under past operational conditions much of the selenium entering the Delta from the San Joaquin River may have been exported by the SWP and CVP and hence not impacted the Delta. Finally, there are activities underway that may reduce the selenium input from both refinery and agricultural sources. The proposed evaluation will provide the basis for assessing the ecological risk of the net selenium input from the San Joaquin River.

e. Proposed Scope of Work

As no new data collection is planned, this project has a very restricted scope of work, consisting of two phases. First, all of the necessary existing flow and chemical data will be collected from the various agencies and compiled into a database. Second, the data will be evaluated as described above and a USGS report prepared containing the results of the evaluation.

f. Monitoring and Data Evaluation

No new data collection is necessary to complete the first three objectives of this proposal. The approach to data evaluation is described in more detail under section IIIa (above). Data evaluation for these objectives will consist of compiling existing data (1986 through the present) on the flow and water quality (selenium, boron, and major ion chemistry) for the Sacramento River, the San Joaquin River, the SWP and CVP export pumps, and several within-Delta gaging stations, and calculating mass balances on both water and solutes. The fourth objective will require the collection of water samples for low-level selenium analysis, analysis for other chemical constituents that are characteristic of San Joaquin River water, and possibly additional flow data in the Delta. This data collection can not be designed without the results of the first three objectives. Therefore, the monitoring and associated data evaluation for the fourth objective will be designed in coordination with the activities described in the multi-agency Inquiry Proposal titled "Design of San Francisco Bay-Sacramento/San Joaquin Delta Estuary Water Quality Monitoring and Assessment Program".

g. Implementability

All of the data necessary for this evaluation is available from public agencies. The Central Valley Regional Water Quality Control Board is in the process of preparing the San Joaquin River Salinity and Boron Basin Plan Amendment, and the principal investigator of the USGS proposal will coordinate his data review with the CVRWQCB efforts. As no new data is being collected, there are no issues regarding compliance with laws and regulations, etc.

IV. COSTS AND SCHEDULE TO IMPLEMENT PROPOSED PROJECT

a. Budget Costs

This project is extremely cost-effective because it will use only existing data collected primarily by DWR, the USGS, the USBR, the CVRWQCB. It will thereby provide added benefit to the large amount of funds already spent on data collection by the USGS, DWR, USBR, and the CVRWQCB.

The gross costs of the project are \$178,600; \$153,700 are requested from CALFED. The USGS will match 15% of the labor costs, or \$24,900 gross, as part of its Federal-State Cooperative Water Resources Program, subject to availability of these funds at the time the grant is approved. Because all of the objectives consist solely of the labor necessary to evaluate the existing data, costs were not broken down by objective.

Project Phase and Tasks	Direct Labor Hours	Direct Salary and Benefits	Overhead Labor	Service Contracts	Material and Acquisition Contracts	Misc. and other Direct Costs	Total Cost
All	2720	\$83,000	\$89,300	----	----	\$6,300	\$178,600

b. Schedule Milestones

The first three objectives will be completed by December, 1998. The first phase, compilation of existing data, will be completed by late spring, 1998 ; the second phase (evaluation and report preparation) will be completed and the product will be ready for review by October, 1998. The product of the investigation will be a USGS report containing a database of the relevant flow and water quality data, and the results of the evaluation of the objectives.

The fourth objective will be addressed in coordination with the activities described in the multi-agency Inquiry Proposal titled "Design of San Francisco Bay-Sacramento/San Joaquin Delta Estuary Water Quality Monitoring and Assessment Program".

c. Third Party Impacts

As the proposal is for evaluation of existing data and does not require any new work, there will be no third party impacts.

V. APPLICANT QUALIFICATIONS

Dr. Charles Kratzer has a doctorate in Environmental Science and Engineering from the University of California, Los Angeles. He has been studying the water quality impacts of agricultural drainage in the San Joaquin Valley since beginning his doctoral research titled "Agricultural Drainage Problems in the San Joaquin Valley". Dr. Kratzer served as the technical expert on San Joaquin Valley water resource issues for the State Water Resources Control Board from 1983

through 1991. His work at the State Board included development of a linked groundwater/surface water model for the lower San Joaquin River; modeling the salt load imbalance in the San Joaquin Valley; proposing conjunctive use and reservoir reoperation schemes in the San Joaquin Valley. He moved to the U.S. Geological Survey Water Resources Division in October 1991 where he has continued to study the water quality of the San Joaquin River system as part of the USGS National Water Quality Assessment. At the USGS he evaluated 40 years of nutrient and sediment data for the San Joaquin-Tulare Basins; conducted studies on the transport of both dissolved and sediment-bound pesticides; and conducted dye-tracer tests on the San Joaquin River and its tributaries in support of pesticide transport studies

Rick Oltmann has a BS in civil engineering from CSU, Sacramento. He has been a hydrologist with the USGS since 1970, and with the hydrodynamics project since 1984. His primary responsibilities are to lead hydrodynamic studies of the Delta, to supervise collection and to analyze continuous flow data, and to oversee maintenance of a large hydrodynamics data base. He has recently been involved in developing and calibrating a new hydrodynamic model of the Delta.

VI. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

The USGS is in compliance with all specified terms and conditions with the exception of item 9 of Attachment D of the RFP. Federal law pertinent to this item is as follows:

The USGS agrees to cooperate to the extent allowed by federal law, in submittal of all claims for alleged loss, injuries, or damage to persons or property arising from the acts of USGS employees, agents, subcontractors, or assigns, acting within the scope of their employment in connection with the performance of this agreement, pursuant to the Federal Tort Claims Act (28 U.S.C. &2671, et seq.).

This federal requirement has not been an obstacle in the past, as evidenced by our approximately 10 million dollars in cooperative agreements with numerous state and other public agencies that we entered in federal fiscal year 1998.

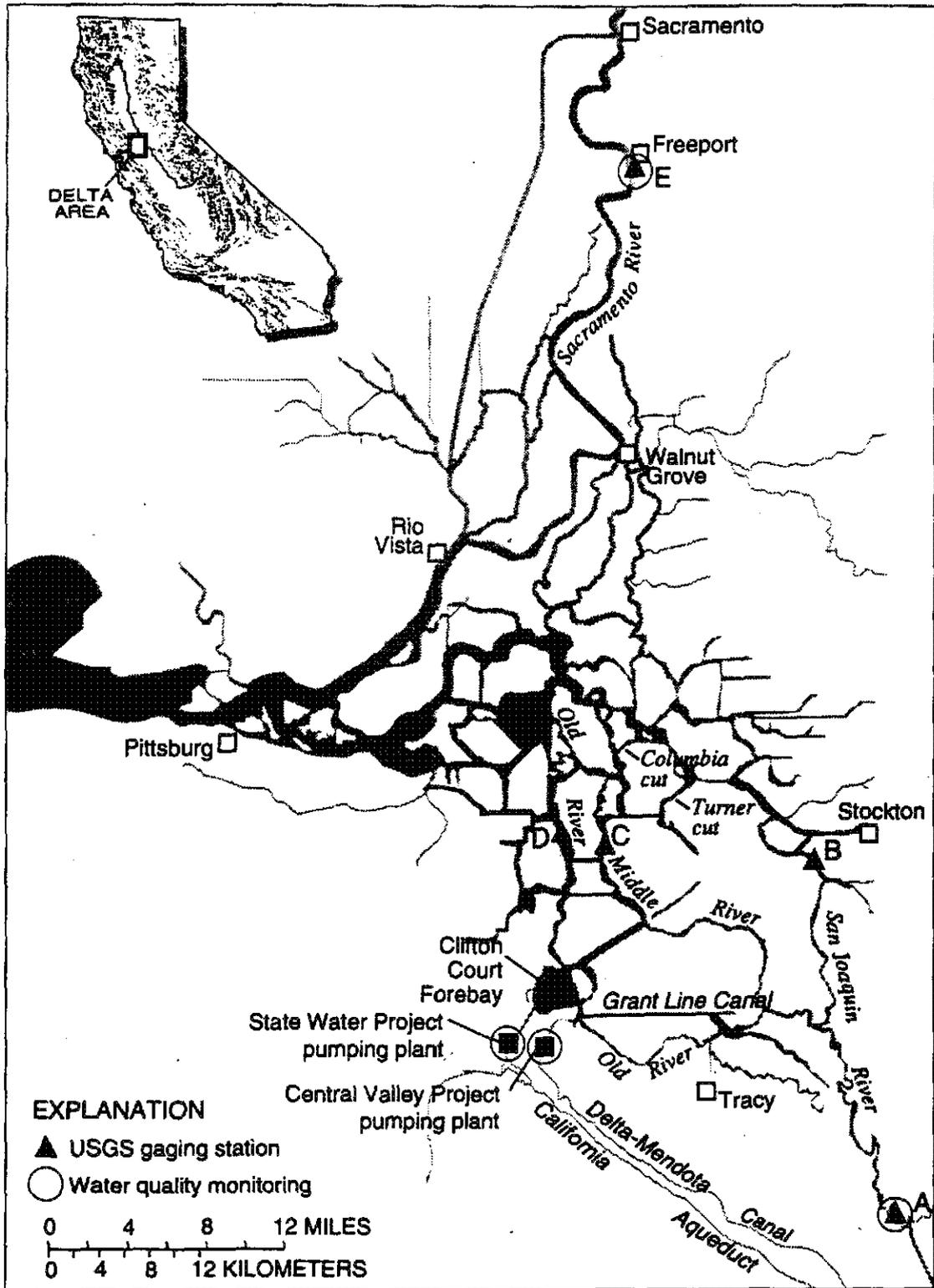


Figure 1. Locations of monitoring sites for continuous flow and water quality.

NONDISCRIMINATION COMPLIANCE STATEMENT

COMPANY NAME

U.S. Geological Survey

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME

Michael V. Sulters

DATE EXECUTED

July 25, 1997

EXECUTED IN THE COUNTY OF

Sacramento, California

PROSPECTIVE CONTRACTOR'S SIGNATURE

R. F. [Signature]

PROSPECTIVE CONTRACTOR'S TITLE

District Chief

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME

U.S. Geological Survey