CALFED BAY-DELTA PROGRAM
PROPOSAL
(July 28, 1997)

The Role of Upstream Mercury Loading and Speciation on Localized and Downstream Bioaccumulation: A Regional Assessment of Sources and Fates of Mercury Throughout the Bay-Delta Watershed

Applicants:

Thomas H. Suchanek and Darell G. Slotton

in collaboration with:

Brenda S. Johnson, Douglas C. Nelson, James F. Quinn, Jeffrey F. Mount, John E. Reuter, and Charles R. Goldman

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I. EXECUTIVE SUMMARY

A. Project Title: **The Role of Upstream Mercury Loading and Speciation on Localized and Downstream Bioaccumulation: A Regional Assessment of Sources and Fates of Mercury Throughout the Bay-Delta Watershed**

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B. Project Description and Primary Biological/Ecological Objectives: Our program addresses one of the key areas of concern identified in the CALFED Bay-Delta Ecosystem Restoration Program Plan: water quality. We focus on the ecosystem stressor mercury, a contaminant having widespread impacts on California aquatic resources, largely as the result of historic mining for mercury, gold, and silver. This project will provide the information required (and not currently available) for state, federal, public, and private agencies to take appropriate and cost-effective remedial actions to reduce the system-wide impacts of this bioconcentrating, toxic heavy metal. Specifically, we propose to conduct work which will (1) identify and differentiate the existing levels of mercury input to the Bay-Delta system, particularly that fraction which is bioavailable, (2) help us to understand the various forms of mercury and their impacts upon the Bay-Delta ecosystem, especially in relation to fisheries resources, and (3) enable us to develop an implementation plan for lowering the input of the most highly bioavailable portion of mercury entering the Bay-Delta system from upstream sources in the Coast Range and the Sierra Nevada. This plan will ultimately reduce the impact of mercury on ecological processes and improve ecosystem health and the long-term quality of fisheries and other aquatic resources within the Bay-Delta system.

C. Approach/Tasks/Schedule: In order to accomplish our objectives, we plan to perform the following tasks: (1) characterize and rank the existing bulk and bioavailable mercury loading to the Bay-Delta system from tributary source regions throughout the entire watershed, (2) identify the relationship between bulk mercury loading from the upper watershed regions, the various forms of mercury derived from these regions, and the production of toxic methyl mercury within the Bay-Delta system, (3) evaluate existing records of mercury in sediments, water and biota in order to better understand the historical depositional input of mercury into the Bay-Delta system and use this information to assess additional sampling needs, (4) develop a GIS database of sampling data and mercury hot-spots to assist in the analysis of spatial and temporal trends in the fate of mercury transported to the Bay-Delta, and (5) develop an implementation plan to reduce bioavailable mercury input to the Bay-Delta system by remediating specific point sources of mercury contamination (such as mines) in the upper watershed regions.

D. Justification for Project and Funding by CALFED: Mercury pollution and, particularly, the bioaccumulation of toxic methyl mercury in food webs, is a global problem impacting aquatic ecosystems and consumers of aquatic organisms. In California, the threat from this stressor is compounded by the legacy of mining-related mercury across wide areas of the state. Abandoned mercury mines in the Coast Range continue to generate highly mobile, bioavailable mercury to their watersheds. On the other side of the state, millions of kilograms of refined elemental mercury were lost into Sierra Nevada drainages during the course of gold and silver mining. Both of these regions supply an ongoing loading of the metal to the Bay-Delta and its watershed. Mercury has been clearly identified by many California state agencies as an aquatic pollutant of great concern. Its toxicity to higher order consumers of aquatic organisms is well established, while the effects on reproduction, development, and juveniles of all aquatic and aquatic-feeding species are only poorly understood. Because of the widespread nature of the bulk contamination in California, virtually every sub-region of the Bay-Delta and its watershed is effected. All of the named CALFED priority habitats and priority species (in addition to numerous others) are exposed to this ecosystem stressor. Mercury additionally constitutes a significant human health hazard throughout the Bay-Delta by the consumption of fish that contain mercury. Our project will determine the primary sources of bioavailable mercury in the Bay-Delta watershed as well as the feasibility of remedial actions that could reduce mercury accumulation in target species and habitats throughout the system. This work is highly relevant and consistent with CALFED objectives of improving water quality, ecological function and ecosystem health.

E. Budget Costs and Third Party Impacts:

Budget Costs: $1,434,331 (three years)

Third Party Impacts: None expected.

F. Applicant Qualifications: The applicants and named collaborators are all Ph.D. level University of California researchers with strong reputations in the various facets of ecosystem assessment. Drs. Suchanek and Slotton bring a combined 18 years experience directing applied research, assessment, and remediation feasibility studies specifically focusing on the bioaccumulation and transport of mercury. Drs. Reuter, Goldman, and Nelson have each been involved with ecosystem-level mercury projects for 5 years or more. These and other team members bring strong expertise in areas needed for the project, including mercury methylation microbiology (Nelson), sediment transport (Mount), and Geographic Information System (GIS) manipulation and modeling and regional data integration (Quinn and Johnson). The applicants and other team members have all successfully developed and carried out related studies (see page 20 for a list of some of these), many of which provide the foundation for this proposed work.

G. Monitoring and Data Evaluation: This work will provide a baseline of information/data against which future monitoring can be compared. Specific remediation recommendations are a targeted product of this project, but the actual remediation will be accomplished in future phases of this work (not by this team). We will identify which specific sites need remediation, but are not proposing to do the remediation ourselves. Future monitoring of mercury inputs to the Bay-Delta system will be needed to ensure that specific remediation projects have been effective. Our data will receive scrutiny by our own team of mercury experts as well as a much broader group of mercury specialists participating in the Consortium of Mercury Related Projects, described below in Section H.4, and in more detail in the mercury integration proposal of Suchanek *et al.* 1997 (*Integration of Mercury Studies/Results in the San Francisco Bay-Delta System*).

H. Local Support/Coordination with other Programs/ Compatibility with CALFED Objectives: 1) Letters of support (attached) for this UC Davis Bay-Delta watershed mercury project have been supplied by the following agencies: State Water Resources Control Board, San Francisco Regional Water Quality Control Board, USGS, San Francisco Estuary Institute, US Fish and Wildlife Service, Cal. Dept. of Fish and Game, and Cal. Department of Health Services. See Section X (page 28) for attached letters.

2) Matching: UC Davis will provide (1) 33% match for the purchase of equipment, (2) faculty salaries: 10% of salaries for D.C. Nelson, J.F. Quinn, J.F. Mount and C.R. Goldman, (3) data from previous mercury monitoring studies by the applicants in upper watershed regions so that sampling will not need to be repeated.

3) We have established a close linkage between our project, which focuses on upper watershed sources and source fate, and the large USGS effort which focuses on mercury dynamics within the Bay-Delta (see proposal by Marvin-DiPasquale *et al.* 1997). The two projects represent highly complimentary approaches to the system-wide mercury problem. Within the tributary regions, our program is unique in both its coverage (the entire San Francisco Bay watershed) and its biological emphasis. Our bioindicator approach to source identification and ranking identifies precisely that portion of the total mercury loading actually available for uptake by biota. Our methylation rate studies identify the relative availability of various inorganic mercury substrates for microbial conversion to the toxic methyl form within the predominant aquatic habitats of the system. Other proposals submitted by USGS, Lawrence Berkeley Labs, and the Dept. of Conservation would provide extremely relevant information on geochemical aspects within areas of geographic overlap and in general. In the event that multiple projects are funded, we would utilize the geochemical information of other programs rather than collecting these peripheral, but important, data ourselves and confine our program to biological work.

4) We will collaborate with as many other mercury-related projects within the CALFED study area as are funded during this three year period by participating in the Consortium of Mercury Related Projects being proposed as a separate CALFED project by Suchanek, Slotton, and Johnson: (*Integration of Mercury Studies/Results in the San Francisco Bay-Delta System*). This integration effort has already commenced with pre-proposal workshops including representatives of most of the major mercury-related projects, where we discussed the most effective approaches and endeavored to avoid duplication of funding and work.

II. TITLE PAGE

Title of Project:

The Role of Upstream Mercury Loading and Speciation on Localized and Downstream Bioaccumulation: A Regional Assessment of Sources and Fates of Mercury Throughout the Bay-Delta Watershed

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III. PROJECT DESCRIPTION

A. Project Description and Approach

Mercury (Hg), derived primarily from mercury mining (in the CA Coast Range) and from gold and silver mining (in the Sierra Nevada) is contaminating the Bay-Delta ecosystem (see Fig. 1 for distribution of mines). Mercury concentrations in Sacramento River water often exceed the allowable Total Maximum Daily Loads (TMDLs) (based on the USEPA Clean Water Act). An even more important aspect of this mercury contamination problem is that the chemical form of the mercury determines how bioavailable it is and how significantly it may contribute to uptake and bioaccumulation in the aquatic ecosystem of the Bay-Delta, especially for important fish species. Methyl mercury, the toxic form of mercury that bioaccumulates most efficiently, is the form that is of most concern. One important task in understanding this contamination/ bioaccumulation process is to determine what proportion and what chemical fraction of the mercury loading from the upper watershed regions of the Bay-Delta system is biologically available to the food webs throughout system. An equally important task is to determine the fate of the various forms of mercury once they reach the Bay-Delta, or are transformed by processes within the Bay-Delta.

If individual point sources of mercury contamination from the upper watershed regions in the Coast Ranges and Sierra Nevada can be identified as contributing a significant fraction of the downstream bioavailable mercury load, a targeted implementation plan of remediation can be successful in reducing the loading of this critical portion of the mercury which ultimately flows into the Bay-Delta system.

In order to accomplish our objectives we will perform the following tasks: (1) characterize and rank the existing bulk and bioavailable mercury loading to the Bay-Delta system from tributary source regions throughout the entire watershed, (2) conduct mercury methylation and fate experiments to identify the relationship between bulk mercury loading from the upper watershed regions, the various forms of mercury derived from these regions, and the production of toxic methyl mercury within the Bay-Delta system, (3) reconstruct a history of mercury contamination in the Bay-Delta system by evaluating existing records of mercury in sediments, water, and biota and use this information to direct project sampling, (4) develop a geographic information system (GIS) database of sampling data and mercury hot-spots to assist in the analysis of spatial and temporal trends in the fate of mercury transported to the Bay-Delta, and (5) formulate alternative remediation options for reducing contaminant effects by mercury in the Bay-Delta system, for example, by remediating specific point sources of mercury contamination (such as mines) in the upper watershed regions.

• **Task 1)** Quantify bulk and bioavailable mercury sources in upper watershed regions: We will: (1) use aquatic invertebrates as indicators of bioavailable mercury in upper watershed regions that have not been characterized to date (see Fig. 2 for proposed and previously sampled sites), (2) define the relationship between environmental mercury concentrations and speciation and the mercury being accumulated by bioindicator organisms, 3) utilize previously collected and ongoing collections of aqueous mercury data, together with flow data, to estimate bulk loading, and (4) using a combined petrographic and geochemical provenance analysis, identify relative present and historical contributions of mercury-bearing sediment source areas within the Bay-Delta system (e.g., Coast Ranges and Sierra Nevada). The discrimination between sediment source areas becomes important if present and historic transport and bioavailability of mercury can be linked to changes in location and nature of mining activity. By developing a comprehensive database for bulk and, particularly, bioavailable mercury throughout the entire Bay-Delta watershed, and primarily the upstream tributaries, we will determine the relative importance of the various potential source regions, with the ultimate purpose of identifying those source regions which need the most critical remediation. Key localized source regions will be identified and, for those with the most promising remediation potential, we will begin collecting baseline data for parameters which can be monitored during and after future remedial actions to assess effectiveness.

Over the past two decades the use of aquatic invertebrates as bioindicators has received considerable attention (Phillips 1980). Cain *et al.* (1991, 1995) and Hare (1992) advanced the concept of using aquatic invertebrates for trace element contamination and Slotton *et al.* (1996, 1997a,b) have applied this technique very successfully to mercury assessment in northern California. The organisms sampled, by definition, integrate that fraction of the bulk mercury load that is available for bioaccumulation into the food chain.

Slotton's group has utilized this technique effectively to identify and rank mercury source regions throughout the northwestern Sierra Nevada foothill gold mining region (Slotton *et al.* 1995a, 1997a), the Cache Creek watershed (Slotton *et al.* 1997b), and the Marsh Creek Watershed on Mt. Diablo (Slotton *et al.* 1996) (see Figs. 3 and 4). We will apply this approach to the entire Bay-Delta watershed (Fig. 2).

One essential component of this work is a quantification of water column mercury at selected sites along a gradient of mercury concentration and speciation, to compare with bioindicator (i.e. bioavailable) mercury at those same sites. At these sites aqueous mercury species, in conjunction with invertebrate collections, will be quantified several times throughout an annual cycle. The aqueous mercury species we will quantify are: raw (i.e. unfiltered) total mercury, dissolved total mercury, raw methyl mercury, and dissolved methyl mercury. If these or more extensive aqueous speciation data can be provided at key sites by other projects, we plan to utilize those data instead. These resulting relationships will be essential in linking time-integrated bioindicator mercury data to aqueous loads and speciation. Proposed sites for this work include the Sierra Nevada and Coast Range sites indicated in Figures 3 and 4, as well as the Yolo Basin wetlands.

By quantifying (1) mercury concentrations in the aquatic invertebrates, (2) environmental levels and speciation of mercury within water from selected sites where aquatic invertebrates are collected, and (3) flow data, we will be able to estimate bioavailable mercury loading from the upper tributary regions feeding into the Sacramento and San Joaquin River systems. Similarly, the assimilation of aqueous mercury data from other projects, together with flow information, will provide the basis for the estimation of bulk mercury loading on a watershed-wide basis.

• **Task 2)** Conduct mercury methylation and fate experiments: A key component of this project is a series of laboratory core tube and tank experiments (microcosms) to investigate the relative mercury methylation potential of different inorganic mercury fractions within a variety of representative sediment/water environments, including Bay-Delta bottom sediments under both oxic and anoxic conditions, river sediments, and sediments along a gradient of salinity. The long-standing view in the published scientific literature is that a specific group of anaerobes, the sulfate-reducing bacteria, are the principal methylators of inorganic mercury in sediments. Especially relevant to the current project, it is also asserted that an estuarine concentration of sulfate, i.e. intermediate between marine (30 mM) and freshwater concentrations, promotes maximal methylation rates by these bacteria (Compeau and Bartha 1984; Gilmore and Henry 1991). Therefore, the concentration of sulfate within various Bay-Delta sediments will be an important variable that will be tested for its influence on methyl mercury production.

We have developed relatively simple, yet very successful, techniques to quantify mercury methylation rates and potential over the past 5 years during our methyl mercury contamination investigations at Clear Lake (Mack *et al.* 1997, Suchanek *et al.* 1997a,b) and will employ the same methodology here. This approach will be applied to key forms of sediment mercury with microcosms under varying environmental conditions (e.g. along salinity, sulfate, oxygen, and other gradients) to determine the relative availability of the different forms for methylation, across the range of conditions. These analytical techniques will also be applied to determine net efflux from sediments (using sediment cores). The experiments will provide a strong indication of the types of mercury sources most critical to the methylation process throughout the system, and most appropriate for remedial attention. In another series of methylation rate experiments, the mercury methylation potential will be determined in natural sediments from representative habitats throughout the system. This will demonstrate the key regions and habitats where mercury derived from upstream sources is being transformed into the toxic methyl form and where additional localized remediation may be necessary or caution taken during other types of future remediation efforts.

• **Task 3)** Reconstruct history of Hg contamination throughout the Bay-Delta watershed: In order to understand the magnitude of present day inputs of mercury into the Bay-Delta system, we need to document whether levels of mercury are increasing, decreasing, or remaining constant. Unfortunately, few data exist on the transport to and deposition of mercury in the Bay-Delta, despite the fact that more than 65,000 tons of mercury were mined in the California Coast Range between 1850 and 1920 (Nriagu 1994), with considerable amounts likely being lost into streams in that area, and that 3,500 tons [Nriagu 1994 suggests it could have been as much as 6,600 tons] of refined elemental mercury were released into Sierra Nevada waterways as a result of placer gold mining (Luoma and Phillips 1988). In the proposed project we will attempt to reconstruct a history of the sources and effects of mercury contamination in the

sediments, water, and biota of the San Francisco Bay-Delta ecosystem. The historic data described below, in addition to other information obtained during this project, will be evaluated, compiled, and placed in our developing GIS database (see below under Task 4) for analysis.

Sediments: While dated laminated sediment cores from the San Francisco Bay estuary system have been analyzed for chronologies of contamination by cadmium, chromium, copper, nickel, lead, zinc, PCB, PAH, and DDT (Abu-saba 1994, Hornberger 1994, Hornberger *et al.* 1997, Pereira and Hostettler 1994, Ritson and Flegal 1994, San Francisco Estuary Institute 1995, van Geen 1994, Venkatesan 1994), determination of mercury levels in Bay-Delta cores have been undertaken only very recently from cores representing just three locations within the CALFED study area (Grizzly, San Pablo, and Richardson Bays) (Bouse *et al.* 1997, Hornberger *et al.* 1997, Luoma *et al.* 1996). We will continue to search for already existing sediment data that can be used to elucidate the history of mercury deposition in the Bay-Delta, which will help define the problem and suggest potential remedial actions. If such data prove to be insufficient for an accurate and useful categorization of mercury inputs into the Bay/Delta proper, it may be necessary for us to either (1) analyze additional cores already collected and archived by the USGS, and/or (2) collect new cores in strategic locations. The USGS has agreed to provide archived cores for analysis, in addition to logistical assistance in the collection of new cores. We will also collaborate with C. Simenstad (University of Washington, Seattle) in an ongoing CALFED Category III project, which involves core analysis in the evaluation of successional sequences of reflooded wetlands within the Bay-Delta system. We will use portions of his cores to evaluate the depositional history of mercury as a function of the development/destruction of Delta levees. Mount's investigations of sediment petrography from representative core and watershed samples will help to elucidate the source regions associated with various depositional layers of mercury within the Bay-Delta.

Water: Aqueous mercury data exist from historic and ongoing water sampling by various state and local agencies. Most of these data are in raw form and are measures of undifferentiated, total mercury in flowing river water. Larry Walker Associates (1997) conducted a mercury loading study in the Sierra Nevada tributaries to the Sacramento River. The National Water Quality Assessment (NAWQA) program of USGS has conducted monthly sampling for mercury at eleven fixed sites in the Sacramento River watershed since 1996 (total mercury has been measured at all sites; methyl mercury has also been monitored at five of these). Downstream, in the Delta, the San Francisco Estuary Regional Monitoring Program (RMP) and the Bay Protection and Toxic Cleanup Program (BPTCP) together have provided a continuous dataset of mercury concentration in northern estuary water, sampled at four locations, since 1989 (Thompson and Davis 1997). Historic sampling was conducted by USGS in the San Joaquin drainage as well. All available aqueous mercury data, together with associated flow information, will be compiled and evaluated in order to provide estimates of aqueous mercury loading in the major downstream tributaries.

Biota: A considerable amount of biotic mercury data has been collected by the Toxic Substances Monitoring Program (TSMP), administered by the California State Water Resources Control Board (SWRCB). Data exist for collections made throughout the state (primarily the main-stem rivers) between 1977 and 1993. The TSMP utilized fish as bioindicators of aqueous toxicants. Considerable fish muscle mercury data are available, but they are patchy and in many cases not consistent between sites for species and/or size of individuals sampled. Many sites were sampled only once. However, these data (in most cases still in raw form) represent a potentially rich source of preliminary information on mercury bioavailability throughout much of the Bay-Delta watershed, particularly in the downstream mainstem rivers. As a preliminary step, we will compile the existing TSMP data for mercury within the Bay-Delta watershed, place them into our GIS database (see Task 4) and extract as many useful relationships as possible. These data can also be compared to the Regional Monitoring Program (RMP) of the Bay-Delta proper (San Francisco Estuary Institute 1995), in which fish have been collected approximately every three years, though also with a fairly exploratory sampling design. Compilation and development of the historic TSMP database for mercury in fish flesh will be one of the initial-phase components of this project, which will help us to determine and direct a strategy for future sampling and directed studies.

• **Task 4)** Develop a GIS database for analysis of Hg contamination trends and sources: Using a Geographic Information System (GIS) as our foundation, we will develop an organizational template into which we can archive, compile, and analyze data concerning past and present mercury levels

and potential sources of contamination. Analysis of spatial patterns (both within the Bay-Delta ecosystem and in upstream watershed source regions) and temporal trends (historical, annual, and seasonal) will be facilitated by the development of a GIS database containing information on mercury distribution within the entire watershed region. Such a data repository with long-term storage capability will enable us (and others) to determine the relative importance of potential sources of mercury contamination (mines, natural geologic sources, potential industrial sources), as well as inter-relationships among the factors that mediate mercury bioaccumulation and transport (local ecology, reservoirs, dredging and filling). We will combine presently available data on mercury contamination from sediment cores and biological monitoring programs (see above) with spatial data layers containing the locations of mercury, gold, and silver mines (USBM 1995, CDMG 1997), geologic deposits containing mercury (USGS 1996), industrial sources, rivers and streams, dams and reservoirs, and historic and present-day tidal marshes to form a comprehensive analytical environment for examining relationships among mercury distribution and source locations. Spatial relationships will be queried using ArcInfo GIS software (ESRI, Redlands, CA) on both Unix and PC platforms at the Information Center for the Environment (ICE), at UC Davis. With the addition of new data obtained during our proposed project, this GIS approach will also provide a foundation for spatially explicit simulations that will be useful for exploring remediation alternatives.

- **Task 5)** Formulate alternative remediation options to reduce contaminant effects: A key objective of this project is to assess the overall importance of highly localized, yet remediable, sources of mercury. We will determine whether or not feasible, localized remediation opportunities exist which will have a high probability of significantly reducing the ultimate production of methyl mercury and its movement into aquatic food webs throughout the watershed. For drainages in the Bay-Delta watershed that have not yet been studied, and for the watershed as a whole, the products of the proposed work are needed before effective remediation options can be presented. Because our previous work indicates that abandoned mercury mines in the Coast Range are likely contributing a significant proportion of the entire watershed's bioavailable mercury load, one component of our program is to (a) rank these sites as potential mercury sources, (b) evaluate them for their potential to be remediated and (c) collect crucial baseline data from those sites that show the most promise for remediation. With a comprehensive, multi-year set of physical, chemical, and biological baseline data, future remedial projects can be designed and initiated which can be assessed for effectiveness at every stage. This has been done at the Mt. Diablo Mercury Mine and Marsh Creek watershed in Contra Costa County (Slotton *et al.* 1996), allowing a rapid remedial approach at this site, but it has yet to be done in any of the other key abandoned mine source regions.

Previous work in the Sierra Nevada indicates that gold mining has contaminated many hundreds of river miles and affected numerous drainages (Slotton *et al.* 1995a, 1997a). This includes most of the Bear River, the South and Middle Forks of the Yuba River, and the Cosumnes River. Because of the wide dispersal of refined, elemental mercury throughout the length of these tributaries, the region does not provide many straightforward, engineering-type remediation opportunities. However, recent work indicates that the current loading of bulk mercury from this source may be relatively small in comparison with that emanating from the abandoned mercury mines of the Coast Range. The information gained in this project will refine a preliminary model of mercury loading for the Sacramento River drainage (Larry Walker & Associates 1997) and expand it to encompass the entire Bay-Delta watershed. It is unknown whether the rivers of the central and southern Sierra Nevada behave similarly to those that have been studied in the northwestern portion of the range. Preliminary data indicate that the Cosumnes River in particular, which is one of the only remaining un-dammed drainages in the region, may contribute a large load of highly bioavailable mercury directly into the San Joaquin Delta (Fig. 3). The actual contribution of the Coast Range historic mercury mining districts also needs to be defined, where it has not been to date, for bulk inorganic mercury loading and, particularly, the bioavailable mercury fractions that can be monitored with bioindicators. The watershed-wide information acquired in this project will be crucial to the development of any potentially effective remediation for the system as a whole.

B. Location and/or Geographic Boundaries of Project

Invertebrate bioindicators (integrators of bioavailable mercury) will be sampled in Bay-Delta watershed tributaries that have not yet been characterized (Fig. 2). This will include an array of sites in the following regions: (a) Central and southern Sierra Nevada tributaries to the San Joaquin River, from the Cosumnes

River south to the Kings River; (b) Southern and Central Coast Range tributaries to the San Joaquin drainage from the west side of the Central Valley, other than Marsh Creek; (c) North Coast Range tributaries to the Sacramento River drainage, other than Cache Creek, from Putah Creek through the north end of the Sacramento Valley; (d) North central California tributaries to the Sacramento River system in the Redding/Shasta region; (e) the Napa River Drainage; and (f) South San Francisco Bay inflows from the New Almaden Mercury Mine and associated regions. We will also make comparative collections in wetland areas of the Yolo Bypass immediately downstream of Cache and Putah Creek inflows, where restoration work has been underway in a multi-agency effort (Yolo Basin Wetlands Project). Water will be collected from selected invertebrate test sites (Figs. 3, 4, plus Yolo Basin, and in baseline monitoring at key potential remedial sites identified). Several new sediment cores may be taken within the Delta and Bay to help with our understanding of historic mercury loading. Mercury methylation experiments will utilize sediments and water collected from key sites throughout the watershed and Bay-Delta proper.

C. Expected Benefits

Mercury has been clearly identified by many California state agencies as an aquatic pollutant of great concern. Its toxicity to higher order consumers of aquatic organisms is well established, while the effects on reproduction, development, and juveniles of all aquatic and aquatic-feeding species are only poorly understood. Because of the widespread nature of the bulk contamination in California, virtually every sub-region of the Bay-Delta and its watershed is effected. All of the named CALFED priority habitats and priority species are exposed to this ecosystem stressor, as are virtually all other co-occurring aquatic species and consumers of watershed aquatic organisms. Mercury additionally constitutes a significant human health hazard, through consumption of fish from the entire system. Our project will determine the primary sources of bioavailable mercury throughout the Bay-Delta watershed, the fate of that mercury in the system, and the feasibility of remedial actions that could reduce mercury accumulation in target species and habitats throughout the system. This work is highly relevant and entirely consistent with CALFED objectives. Without this knowledge, the potential benefits of various remedial actions remain unclear. The findings of this project will provide the scientific rationale for appropriate, cost-effective mercury remedial work on a watershed-wide basis.

D. Background and Biological/Technical Justification

In each of the diverse, ongoing California mercury projects of our UC Davis research group, we have found that the bioaccumulation of mercury in biota is typically not correlated with bulk inorganic mercury concentrations in the immediate surrounding environment (Slotton and Reuter 1995, Slotton *et al.* 1991, 1995b, 1995c, 1996, 1997a,b, Suchanek *et al.* 1993, 1995, 1997a,b, 1998a, 1998b, Mack 1997, Mack and Nelson 1997, Mack *et al.* 1997,). In fact, several of the projects indicate that the vast majority of the bulk mercury in a given system is essentially inert biologically, with only a very small percentage of the total sediment mercury load apparently being available for conversion to toxic methyl mercury by methylating bacteria, and subsequent movement into and through the food web.

To date, mercury management decisions (including remediation) have been based primarily upon data generated from aqueous grab samples of bulk mercury. It is crucial to future remediation options that we identify and quantify the specific fraction(s) of this bulk, inorganic mercury which is available for bacterial methylation within the major aquatic regimes of the watershed. It is equally important that we determine the extent of the bulk mercury load that may not contribute to the biological uptake problem, locally in upstream aquatic ecosystems, within the main-stem rivers, and within the sediments of the Bay-Delta. If this "inert" fraction is large and the fraction contributing to bioaccumulation is small (as our previous studies suggest), the potential for feasible, localized source region remediation efforts to significantly reduce mercury uptake in food webs throughout the watershed would be greatly enhanced. In particular, we need to determine the relative importance of highly localized sources such as seepage of dissolved mercury from mercury mine tailings, as we have observed at Clear Lake's Sulphur Bank Mercury Mine Superfund Site (Suchanek *et al.* 1997), Davis Creek Reservoir (Slotton 1991, Slotton *et al.* 1995a, Reuter *et al.* 1996), the Mt. Diablo Mercury Mine (Slotton *et al.* 1996), and additional Coast Range mine sites (Slotton *et al.* 1997b). We know of no other approach that will allow the development of an effective remediation plan for mercury inputs from the upper watershed regions into the Bay-Delta system.

Of the mercury fraction that is available for methylation, it is unclear where the majority of this methylation occurs. There exist vastly different physical/chemical characteristics of sediments from different regions within the Bay-Delta environment. Besides the obvious salinity gradients, there has been considerable attention paid to the "entrapment zone", an area characteristic of high flocculent build-up, aggregation and settling, and where there appears to be elevated phytoplanktonic primary productivity and suspended materials in the water column. How this or any other region within the Bay-Delta with unique physical/ chemical features may influence the production of methyl mercury is unknown, but this information will be ultimately important in our ability to understand the fate of mercury derived from upper watershed source regions once it reaches the Bay-Delta. Our project will address the production of methyl mercury under these specific environmental conditions in order to develop a remediation strategy that will be appropriate for present and future years.

E. Proposed Scope of Work

Year 1: We will begin the bioindicator survey of upper watershed sites in the Coast Range and Sierra Nevada. A focus of the first year's sampling will be the identification of important regions that may contain potential remediation sites. Concurrently, we will assemble and evaluate existing data for mercury in water, sediments, and biota from the watershed, develop a GIS database and begin preliminary mercury methylation rate experiments. This information will help us determine water/invertebrate test sites for the second and third years, as well as the need for potential Bay and Delta sediment cores. An Annual Progress Report will document the results of work completed and provide rationale for water sampling stations, baseline data monitoring at chosen potential remedial locations, sediment cores, and the ongoing direction of the mercury methylation rate experiments. Year 2: Annual Report will document the results of all work to that point, including mapping of relative bioavailable mercury in all major tributaries of the watershed. Year 3: Work will consist of directed sampling, further methylation experiments based on earlier findings, and extensive data interpretation and modeling. The Final Report will include interpretation and conclusions and a set of remedial recommendations on mercury contamination within the Bay-Delta and its watershed. Quarterly progress reports will be provided throughout the project.

F. Monitoring and Data Evaluation

A portion of this project represents the survey and monitoring of mercury levels within various biotic/abiotic components of the Bay-Delta system and associated watershed. This work will also provide a baseline of data against which future, longer-term monitoring will be compared. Key parameters include flow, aqueous dissolved and total mercury, surficial sediment mercury deposits, and mercury in a range of bioindicator organisms. Specific remediation options are a targeted product of this project, but the actual remediation will be accomplished in future phases of this work (not by this team). We will identify which specific sites need remediation, but are not proposing to do the remediation ourselves. Future monitoring of mercury inputs to the Bay-Delta system will be needed to ensure that specific remediation projects have been effective. Our data will receive scrutiny by (1) our own team of mercury experts as well as (2) a much broader group of mercury specialists participating in the Consortium of Mercury Related Projects (consisting of whichever mercury related projects are funded by CALFED) as described in detail in the mercury projects integration proposal of Suchanek *et al.* 1997 (*Integration of Mercury Studies/Results in the San Francisco Bay-Delta System*), should that group be funded. In the event that the mercury integration proposal is not funded, Suchanek and Slotton are in close communication with mercury experts throughout the U.S. and will endeavor to have this group evaluate the results and data products that are produced from this project.

G. Implementability

Sampling will be conducted at public locales throughout the watershed and/or with the permission of landowners as necessary. The applicants hold scientific collecting permits from the California Department of Fish and Game approving the types of biological sampling proposed. No threatened or endangered species will be collected in this work. The project has widespread support from numerous public and governmental entities (see supporting letters), the project team is largely in place, and work could commence almost immediately upon notification.

IV. COSTS AND SCHEDULE TO IMPLEMENT PROPOSED PROJECT

A. Budget Costs

As with most projects of this magnitude and scope, the most significant budget category for this project is personnel/benefits costs (ca. 71%). Extensive field collections and laboratory processing of samples are required from tributary sites throughout the entire San Francisco Bay watershed. Travel, equipment, supplies and communications costs are minimal, at roughly 1-3% each. All total mercury analyses will be performed in-house at our UC Davis Mercury Analytical Laboratory (supervised by D.G. Slotton). A dedicated Atomic Absorption Spectrometer (AA), specifically for total inorganic mercury analyses (for sediments and biota), will be purchased for this project, the total cost of which (ca. $18,000) will be far less (by a factor of 4-5) than sending these samples out for analysis to a contract laboratory. (Note: the Office of Research at the University of California, Davis will match 33% of the cost of all equipment, including the AA). We do not, however, presently have the capability to analyze methyl mercury or aqueous mercury. Therefore, it will be necessary to send a significant number of these samples out to contract laboratories for analysis. Other direct costs, which include the methyl mercury analyses performed by contract laboratories, are 11%.

Below is a breakdown of the budget by task.

TASK BUDGET FOR 3 YEARS (1998-2000)

Project Task	Direct Labor (person-months)	Direct Salary and Benefits	Equipment*	Supplies & Expendables	Travel	Service Contracts	Miscellaneous and Other Direct Costs
Task 1: Quantify mercury inputs from upper watersheds	102.06	$356,404	$22,875	$13,075	$6,600	$45,000	$7,445
Task 2: Quantify methyl mercury production rates (microcosms)	87.48	$305,489	$3,050	$15,690	$5,610	$105,000	$19,854
Task 3: Evaluate/integrate existing mercury data	43.74	$152,745	$1,525	$10,460	$3,300	$0	$7,445
Task 4: Develop GIS database for mercury	29.16	$101,830	$1,525	$7,845	$825	$0	$7,445
Task 5: Formulate remedial options to reduce ecosystem contamination	29.16	$101,830	$1,525	$5,230	$165	$0	$7,445
	* U.C. Davis will match 33% of equipment costs						

Note: Budget breakdown continued on next page.

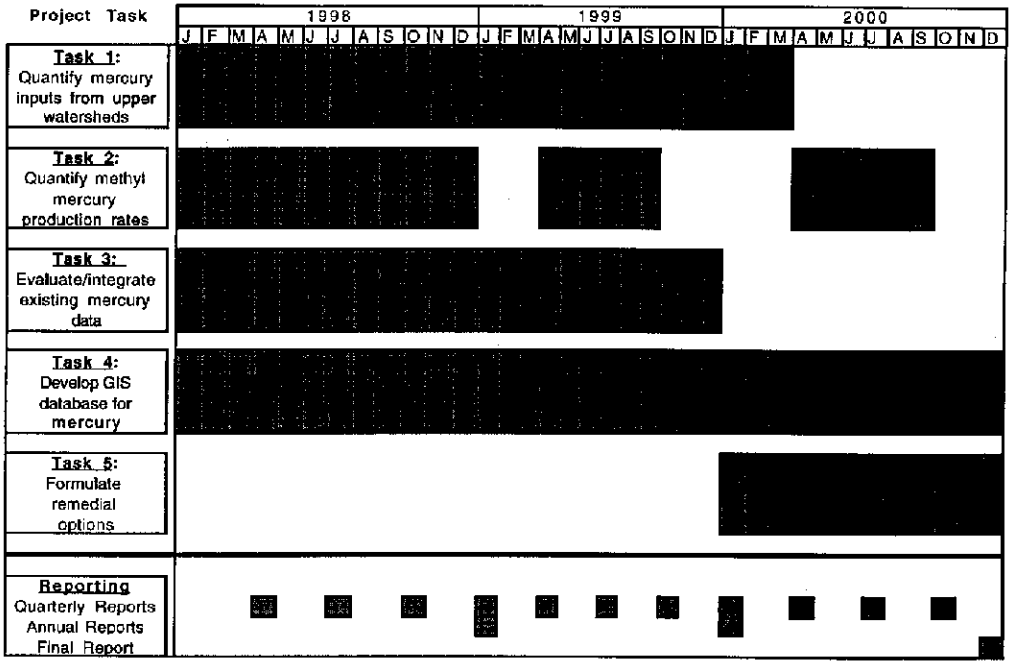
Budget breakdown: (con'd)

Budget Summary Information:

Project Task	Direct Costs (Subtotal)	Indirect Costs (Overhead) 10%	YEAR 1	YEAR 2	YEAR 3	TOTAL COSTS	
Task 1: Quantify mercury inputs from upper watersheds	$451,399	$42,571	$222,286	$222,286	$49,397	$493,970	
Task 2: Quantify methyl mercury production rates (microcosms)	$454,693	$44,883	$249,788	$124,894	$124,894	$499,576	
Task 3: Evaluate/integrate existing mercury data	$175,475	$17,113	$96,294	$96,294	$0	$192,588	
Task 4: Develop GIS database for mercury	$119,470	$11,513	$43,661	$43,661	$43,661	$130,983	
Task 5: Formulate remedial options to reduce ecosystem contamination	$116,196	$11,185	$0	$0	$127,381	$127,381	**CALFED REQUEST**
						$1,444,498	$1,434,331

B. Schedule Milestones

PROJECT MILESTONES FOR 3 YEARS (1998-2000)



C. Third Party Impacts

- none known -

V. APPLICANT QUALIFICATIONS

This research team has a vast amount of experience in mercury ecotoxicology and related fields, especially in aquatic environments.

Dr. Suchanek has led multi-disciplinary and inter-disciplinary ecosystem projects/programs for over 18 years, primarily dealing with the effects of anthropogenic stressors on ecosystem health, and has focused on the impacts of mercury on California resources since 1991. All of these programs have involved multiple investigators from many disciplines and several have involved multi-million dollar budgets. Dr. Suchanek is also western regional director of the National Institute for Global Environmental Change (a Department of Energy sponsored program) for which he administers a $1.2M/yr program dealing with anthropogenic impacts on ecological systems. Dr. Suchanek is Principle Investigator for an ongoing inter-disciplinary project (which is in its final phases) studying the biogeochemistry and ecosystem impacts of mercury contamination from the Sulphur Bank Mercury Mine Superfund Site on the aquatic ecosystem of Clear Lake, CA. He is also a Co-Principle Investigator for the Center for Ecological Health Research (an EPA-funded program at U.C. Davis), in which he specializes on issues relating to the impacts of mercury on ecosystem health, especially at Clear Lake. Numerous reports and publications (see list in References section) dealing with a variety of mercury issues have resulted from these and related studies, and the final product will be a set of effective remedial recommendations (to the U.S. Environmental Protection Agency) targeted to lower mercury levels in edible fishes within Clear Lake.

Dr. Slotton has directed applied research projects addressing heavy metal contamination and bioaccumulation issues in California aquatic ecosystems for over 12 years, with a primary focus on mercury. He has led investigations of copper, zinc, and cadmium contamination at Iron Mountain Mine and Camanche Reservoir, where sediment resuspension and metals transport, solubility, and bioavailability were investigated in a multi-year project. Since 1985, he has run a mercury biogeochemistry monitoring and research program at Davis Creek Reservoir in the California Coast Range, as well as a mercury analytical laboratory at UC Davis. One area of specialization has been the use of various bioindicators to explore mercury cycling and transport questions. Since 1993, Dr. Slotton has led a research program in the foothill gold mining region of the Sierra Nevada, primarily focusing on benthic invertebrates as proxies for relative bioavailable mercury concentrations and loading in the various tributaries. He is in the third year of a study of mercury mass loading, bioaccumulation, and remedial options at the Mt. Diablo Mercury Mine and Marsh Creek watershed. Other recent projects include mercury assessment studies throughout the Cache Creek and Putah Creek watersheds, and investigations of potential mercury bioaccumulation problems in gravel mining lakes. Dr. Slotton has also been a part of the Clear Lake Superfund Mercury Project (see above) since its inception.

Dr. Johnson currently serves as Regional Integrator for the Center for Ecological Health Research at UC Davis. In this capacity, she is developing conceptual and strategic linkages among those research programs being conducted by Center scientists that focus on the ecological function of the Sacramento River and Sierra Nevada Watersheds, and Clear Lake, Lake Tahoe, and San Francisco Bay-Delta ecosystems. She has led and participated in a number of large-scale interdisciplinary ecological studies combining approaches as diverse as molecular genetics, ecotoxicology, population modeling, and GIS. In her integration role, Dr. Johnson is involved in reconstruction of the ecological history of much of the region that CALFED has delineated as the Category III Study Area. She will be responsible for integrating the GIS database on mercury distribution and impacts.

Dr. Nelson is an internationally recognized expert on microbiology of the sulfur cycle. Both oxidative and reductive portions of the cycle are included in his multifaceted program which encompasses field research (deep-sea sulfide-rich vents and seeps; sediments of Clear Lake, CA; evaporation ponds of the San Joaquin drainage) and laboratory research (ecology and physiology of pure cultures, mixed cultures and microcosms). Funding sources include NSF, NOAA-National Undersea Research Program, Mineral Management Services of US Department of Interior and UC Salinity Drainage Program. Since 1992, he has been involved in US EPA sponsored studies of mercury methylation in Clear Lake sediments. Important findings there included: (1) a demonstration that sulfate-reducing bacteria, previously believed

by others to be primary methylators of mercury in anoxic sediments, perform only about 25% of the total sediment methylation (2) a demonstration that the vast majority of sediment inorganic mercury is not available for methylation. The experimental, analytical, and interpretive methodologies developed in this work will be utilized in the proposed project

Dr. Quinn is the director of a world-class GIS center (Information Center on the Environment) at U.C. Davis as well as the principal investigator for several other state and federal projects, including: the California Watershed Projects Inventory, the California State Parks Biodiversity Project, the Man in the Biosphere Reserve Inventory and Monitoring Project, the National Park Service Biodiversity Project and the Modeling and Decision Support Systems Group of U.C. Davis' Center for Ecological Health Research. Dr. Quinn also serves on numerous advisory bodies to state and federal interagency programs, including the California Biodiversity Council, the Interagency Ecological Program, and the National Biological Information Infrastructure.

Dr. Mount has more than 17 years experience as a stratigrapher and sedimentologist working in the fields of marine and non-marine sedimentation. He has also successfully managed eight large National Science Foundation (NSF) and several American Chemical Society (ACS) research grants during this time. During the past five years he has been actively involved in science education about the state's rivers, culminating in his book titled "California Rivers and Streams: The Conflict Between Fluvial Process and Land Use". The proposed geochemical/petrographic provenance analysis of sediment sources within the Bay/Delta watershed stems from NSF-supported work currently being conducted by Dr. Mount in the Clear Lake and Cache Creek watershed. This work involves bulk geochemical and mineralogic analysis of sediments in order to 1) document source areas for mercury-enriched sediment currently being transported within the watershed, and 2) to document historical changes in the relative contribution of sediment source areas as a function of changing land use practices. Analytical methods developed for the Clear Lake study will be applied to the work contained in this proposal.

Dr. Reuter is the Director of the Lake Tahoe Interagency Monitoring Program (LTIMP), a multi-agency monitoring and research effort formed to understand the effects of watershed and atmospheric processes on the water quality of Lake Tahoe. He is also directing a 5-year US EPA sponsored project to model water quality and set water quality standards for nearby Pyramid Lake, Nevada. Between 1993 and 1994, he served as the Acting Director of the UC Davis Institute of Ecology. Since 1994 he has co-managed the Sierra Nevada Watershed Program as part of the Center for Ecological Health Research. Dr. Reuter has extensive experience coordinating and interpreting the data from large, multi-disciplinary projects. He has been involved in many aspects of both research and applied limnology, with the focus of various projects including: phytoplankton and periphyton ecology, eutrophication, water chemistry, fisheries management, wetland ecology, lake restoration, water column and benthic nutrient cycling, primary productivity, paleolimnology, ecology of the Sierra Nevada, atmospheric deposition, stream nutrient loading, environmental consequences of sediment dredging, use of bioindicators to assess ecosystem health, and, since 1985 and in association with Dr. Slotton, mercury and heavy metal cycling.

Dr. Goldman, Professor of Limnology in the Division of Environmental Studies, has been with the University of California, Davis, since 1958. He developed the first courses in limnology and oceanography at UCD, served as Department Chair repeatedly, and was founding Director of the Institute of Ecology. He has supervised 80 graduate students and 29 postdoctorals during his 38 years at UC Davis. Dr. Goldman has published 4 books and 398 scientific articles, and has produced 4 documentary films which are in worldwide distribution. He has served on many national and international committees and is frequently sought for consultation and research missions to foreign countries on major environmental problems. His single most important and sustained contribution is his 38 years of research on Lake Tahoe, though he has been involved with dozens of diverse environmental research projects, including much of Dr. Slotton's mercury work as well as a mercury mitigation study for the City of Santa Barbara in the 1970s. While aggressively pursuing basic research on aquatic dynamics, he has also been able to translate the findings directly to state, national and international policy decisions, contributing decisively to the conservation and judicious use of aquatic resources from the Antarctic to the lakes and wetlands of South and Central America, New Guinea, Africa, Asia, Europe and the United States.

VI. Compliance With Standard Terms and Conditions

Agreement No. _____

Exhibit _____

STANDARD CLAUSES -
INTERAGENCY AGREEMENTS

Audit Clause. For contracts in excess of $10,000, the contracting parties shall be subject to the examination and audit of the State Auditor for a period of three years after final payment under the contract. (Government Code Section 8546.7).

Availability of Funds. Work to be performed under this contract is subject to availability of Category III funds.

Interagency Payment Clause. For services provided under this agreement, charges will be computed in accordance with State Administrative Manual Section 8752.1.

Termination Clause. Either State agency may terminate this contract upon 30 days advance written notice. The State agency providing the services shall be reimbursed for all reasonable expenses incurred up to the date of termination.

NONDISCRIMINATION COMPLIANCE STATEMENT

COMPANY NAME: THE REGENTS OF THE UNIVERSITY OF CALIFORNIA

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.

Sandra M. Dowdy
Contracts and Grants Analyst

OFFICIAL'S NAME: JUL 24 1997

DATE EXECUTED: JUL 25 1997

EXECUTED IN THE COUNTY OF: Yolo

PROSPECTIVE CONTRACTOR'S SIGNATURE: Sandra M. Dowdy

PROSPECTIVE CONTRACTOR'S TITLE: Sandra M. Dowdy
Contracts and Grants Analyst

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME: THE REGENTS OF THE UNIVERSITY OF CALIFORNIA

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Figure 1. Mercury, Gold, and Silver Mines

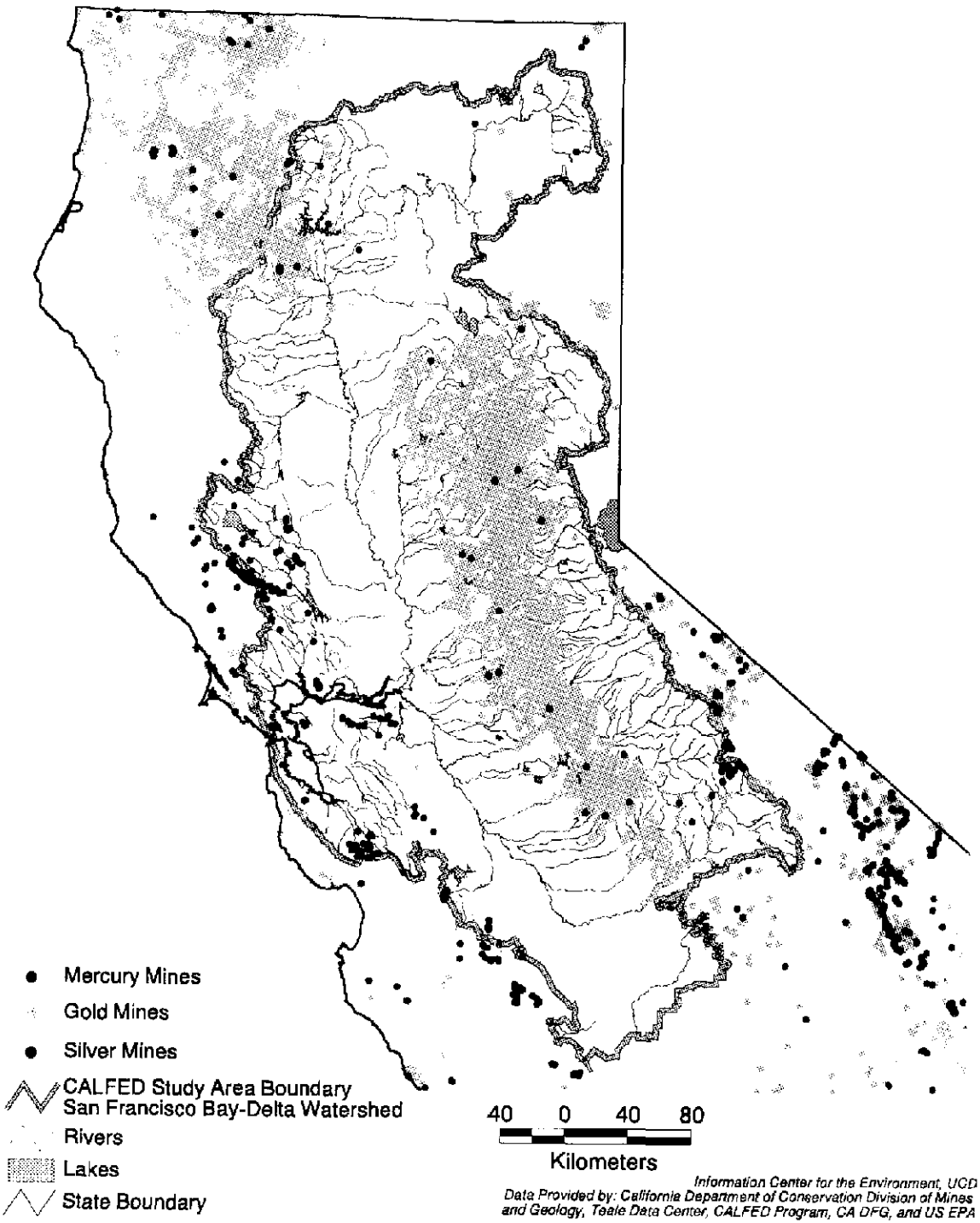

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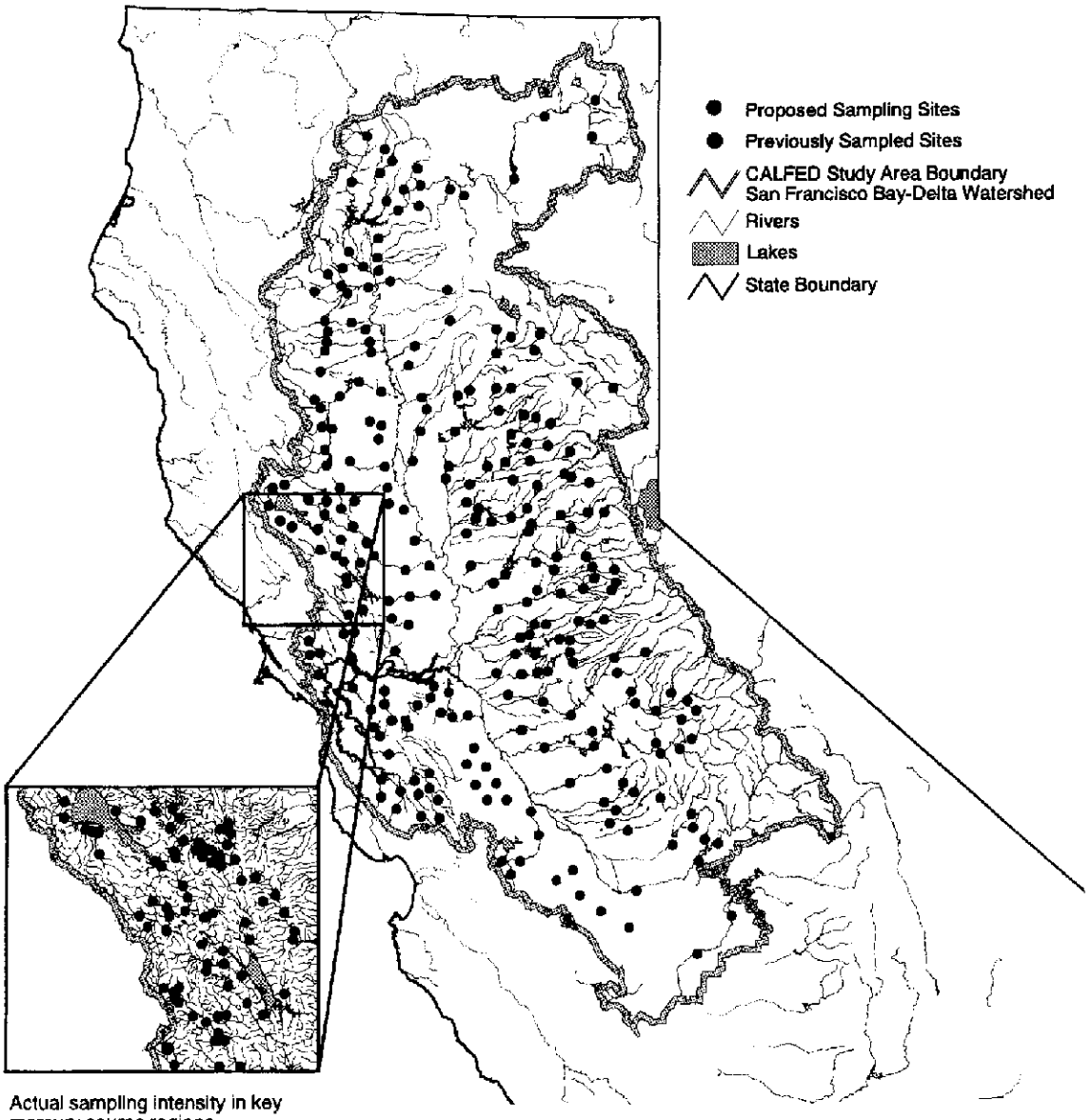
Figure 2. Mercury Bioindicator Sampling Sites



Information Center for the Environment, UCD
Data Provided by: Teale Data Center, CALFED Program, CA DFG. and US EPA

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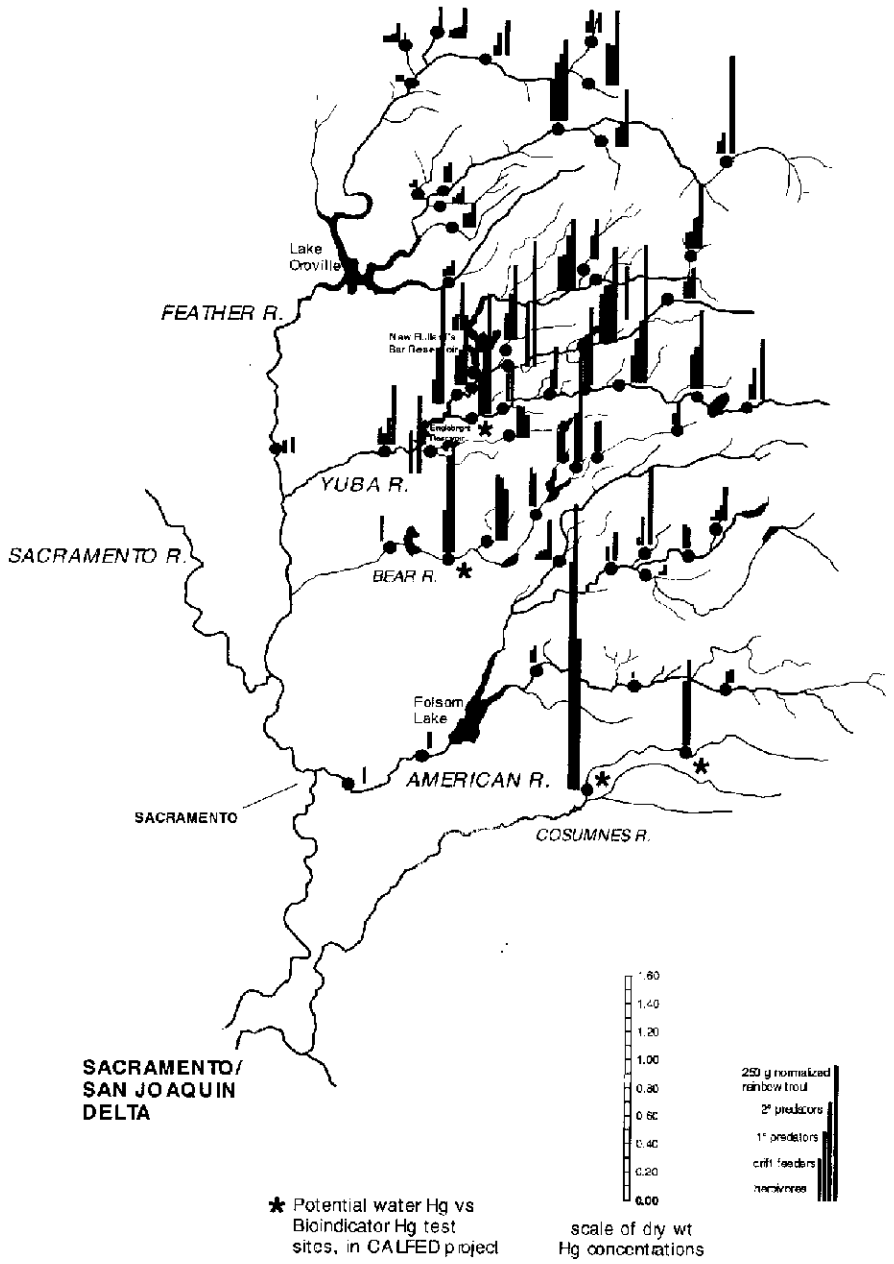
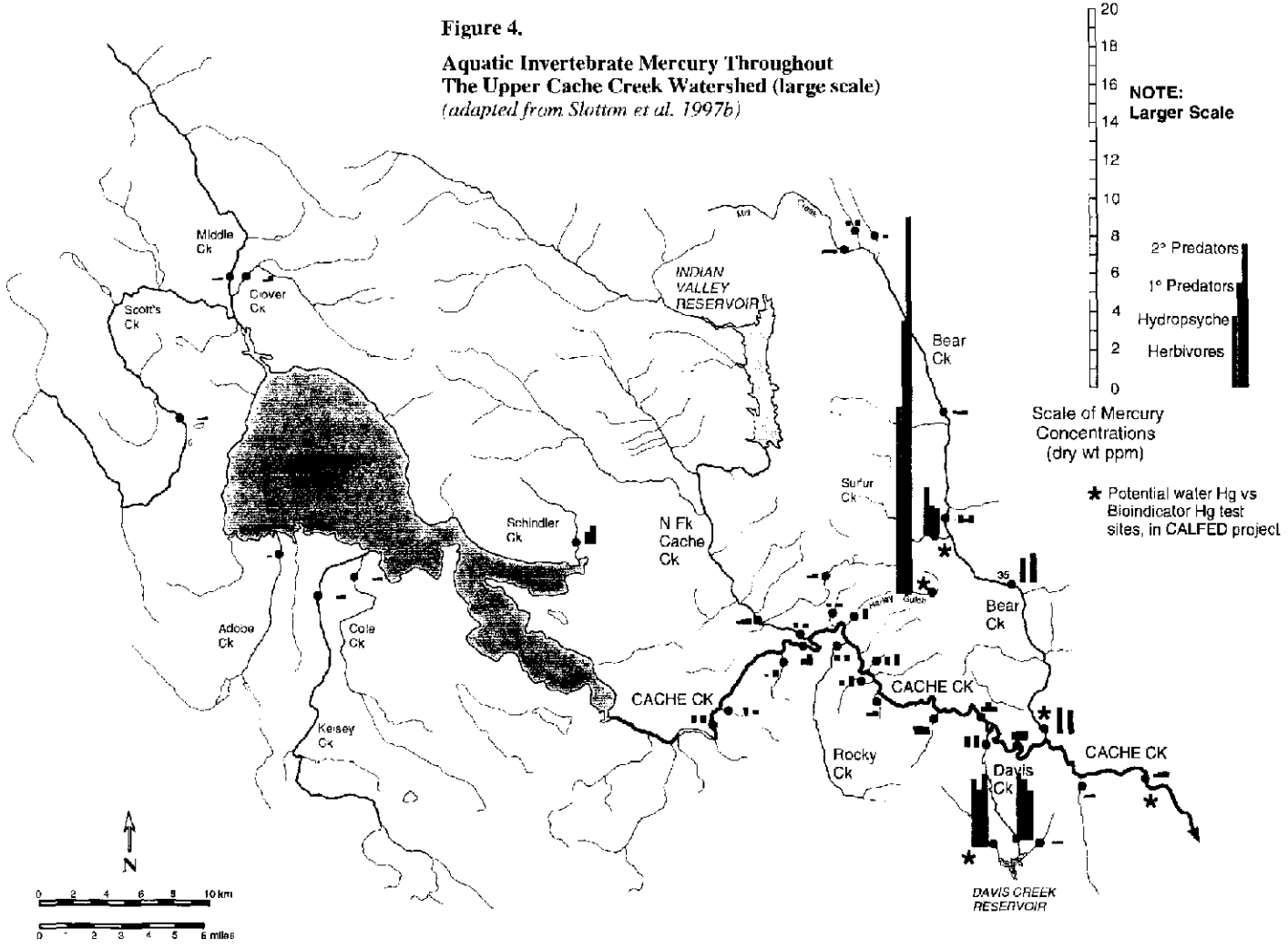


Fig. 3. Northwest Sierra Nevada Invertebrate and Trout Bioindicator Mercury Data
(adapted from Slotton et al. 1997a)

Figure 4.

Aquatic Invertebrate Mercury Throughout The Upper Cache Creek Watershed (large scale)
(adapted from Slotton et al. 1997b)



X. LETTERS OF LOCAL SUPPORT/COORDINATION

Attached are the following letters of support and matching funds for this proposal:

1) University of California (Kevin M. Smith) Associate Vice Chancellor for Research) Equipment Matching Funds ($10,167)

2) U.S. Geological Survey - Letter of Support/Collaboration

3) U.S. Fish and Wildlife Service (Contaminants Division) - Letter of Support/Collaboration

4) State of California: Department of Health Services - Letter of Support

5) State of California: Department of Fish and Game - Letter of Support

6) State of California: Water Resources Control Board - Letter of Support

7) San Francisco Bay Regional Water Quality Control Board - Letter of Support

DAVIS: OFFICE OF THE VICE CHANCELLOR FOR RESEARCH
Kevin M. Smith, Associate Vice Chancellor
Office: 752-6374 Fax: 752-5432
417 Mrak Hall

July 23, 1997

Dr. Thomas Suchanek
Division of Environmental Studies
College of Agricultural & Environmental Sciences

RE: **The Role of Upstream Mercury Loading and Speciation on Localized and Downstream Bioaccumulation: A Regional Assessment of Sources and Fates of Mercury Throughout the Bay-Delta Watershed**
CALFED, Bay-Delta Program
UCD Equipment Matching Funds Program

Dear Dr. Suchanek:

I am very enthusiastic about your proposal **The Role of Upstream Mercury Loading and Speciation on Localized and Downstream Bioaccumulation: A Regional Assessment of Sources and Fates of Mercury Throughout the Bay-Delta Watershed** which you will submit to CALFED. Your project will be important in addressing a key area of concern over water quality in the Bay-Delta system.

The Office of Research is prepared to commit up to $10,167 in equipment matching funds, a 33 percent match ratio, for the fiscal year 1997-98. These monies are to be used for the purchase of an atomic absorption spectrometer and other equipment necessary to conduct your project. The Office of Research's commitment level will be adjusted proportionately if the budget is partially funded. When you require details on transferring funds to your account, please contact Carolyn Sawai, Office of Research, at 2-4091. The program requires that any monies remaining from your Equipment Matching Funds be returned to the Office of Research for reallocation to another project.

The campus administration is cognizant of your efforts in the field of environmental studies. The University of California, Davis, contributes significantly in terms of cost sharing on academic year salaries in support of faculty research. The addition of equipment matching funds to this campus commitment is another demonstration of the value placed on the comprehensive program you are developing.

Please be assured you have my best wishes for success in your project.

Sincerely,

Kevin M. Smith
Associate Vice Chancellor for Research

KMS/crs

c: Dean Barbara Schneeman
Doreen Appert
Terry Franchi
Marilyn Kays

United States Department of the Interior

U.S. GEOLOGICAL SURVEY

July 20,1997

Dr. Tom Suchanek
Univ. Calif. at Davis,
Davis, CA

Dear Dr. Suchanek:

We hereby formally state our interest in establishing mechanisms for cooperation and communication between the USGS mercury study and the UC Davis studies, especially if all should be funded under the Category III CALFED process. We believe the watershed focus of your work complements our Bay-ward focus strongly. For example, our tools for identifying hydraulic mining wastes and our detailed studies of methylation processes should be useful in your surveys of methylation potential in cores. USGS has already agreed to work with you in obtaining cores.

We agree that meeting in a workshop atmosphere at least twice per year is essential; and that in such meetings we should continually discuss areas where our interests might overlap so that we avoid any unnecessary duplication of effort. Some duplication could be beneficial in terms of verification of analytical results and findings in this complex system, but, of course, too much duplication is to the advantage of neither party. We are looking forward to working with you.

Best regards,
Sam Luoma
US Geological Survey

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
3310 El Camino Avenue, Suite 130
Sacramento, California 95821-6340

IN REPLY REFER TO:
FWS/EC-97-077

July 28, 1997

Ms. Kate Hansel
CALFED Bay-Delta Program
1416 Ninth Street, Suite 1155
Sacramento, California 95814

Subject: Support Letter for Suchanek and Slotton Proposal To CALFED

Dear Ms. Hansel:

The Environmental Contaminants Division of the U.S. Fish and Wildlife Service strongly supports the proposal being submitted to CALFED by Thomas H. Suchanek, Darell G. Slotton et al. (entitled *The Role of Upstream Mercury Loading and Speciation on Localized and Downstream Bioaccumulation: A Regional Assessment of Sources and Fates of Mercury Throughout the Bay-Delta Watershed*). We are focusing on high priority scientific questions regarding contaminants (and specifically mercury) in the upper watershed regions that feed into the Bay-Delta and in particular in the Cache Creek region as well as San Francisco Bay tidal wetlands. Their proposal addresses critical issues involving the biological uptake and bioaccumulation of mercury that are similar to and consistent with our goals in addressing mercury issues within California.

Two of the most important aspects of Suchanek and Slotton's proposed study are (1) the use of biological indicator organisms that will provide data not only on mercury levels within the watershed, but will address specifically the concentrations of bioavailable mercury that contaminate this system, and (2) the development of a GIS data base of mercury contamination throughout the watersheds of the Sacramento and San Joaquin Rivers. This information will be extremely useful to our agency in upcoming consultations with the U.S. Environmental Protection Agency on basin plan standards for mercury and will allow us to better assess the impacts of mercury on fish and wildlife populations throughout California. We look forward to collaborating on this project, which we feel will benefit all Local, State, and Federal agencies in their assessment of mercury impacts on California's valuable natural resources, especially within the Bay-Delta system.

Sincerely,

Steven Schwarzbach, Ph.D.
Division Chief, Environmental Contaminants

I-005938

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY PETE WILSON, Governor

DEPARTMENT OF HEALTH SERVICES
2151 BERKELEY WAY
BERKELEY, CA 94704-1011

(510) 450-3818

July 23, 1997

To Whom it May Concern:

I am writing in support of Drs. Suchanek and Slotton's proposal, "The Role of Upstream Mercury Loading and Speciation on Localized and Downstream Bioaccumulation: A Regional Assessment of Sources and Fates of Mercury Throughout the Bay-Delta Watershed." Elevated levels of mercury in some Bay-Delta fish species pose significant risks to human health and have resulted in health advisories. Yet surprisingly little is known about the sources, pathways, and bioaccumulation of this contaminant in the upper watersheds that ultimately contribute to the Bay-Delta system. The California Department of Health Services (CDHS) has a primary goal of protecting and preserving public health in the state. The Environmental Health Investigations Branch of the CDHS has primary responsibility to conduct investigations and epidemiological studies on environmental agents and their effects on human health. This project will fill important gaps in our understanding of mercury in the Bay-Delta system and ultimately help agencies like CDHS to address the potential impact of these sources on human health. I urge you to fund this proposal.

Sincerely,

Richard Kreutzer

Richard Kreutzer, M.D., M.P.H.
Chief
Environmental Health
Investigations Branch

STATE OF CALIFORNIA—THE RESOURCES AGENCY PETE WILSON, Governor

DEPARTMENT OF FISH AND GAME
FISH AND WILDLIFE WATER POLLUTION CONTROL LABORATORY
2005 NIMBUS ROAD
RANCHO CORDOVA, CA 95670
(916) 358-2858

July 25, 1997

To Whom It May Concern at CALFED,

I am writing this letter of support for the work proposed for CALFED funding by Dr. Darell Slotten and Dr. Thomas Suchanek of the University of California, Davis. Their proposal focuses on watershed mercury sources and current relative loading of both bulk and bioavailable mercury. The bioaccumulation of mercury in fish from the proposed study area is well documented. The work described in this proposal complements the fish tissue mercury analyses performed by the Department of Fish and Game for the Toxic Substances Monitoring Program (TSMP). The mass loading information would be especially useful for the interpretation of TSMP data. This work is essential to understanding the sources and fate of mercury in the Delta and in the Bay and will provide information needed to determine which remediation options would be effective in reducing bioavailable mercury in the watershed.

I urge the CALFED proposal review committee to support this proposal by giving it favorable consideration.

Sincerely,

David B. Crane
Laboratory Supervisor

MEMORANDUM

Cal/EPA

State Water Resources Control Board

901 P Street
Sacramento, CA
95814
(916) 657-0887
FAX (916) 657-2388

Pete Wilson
Governor

TO: Whom It May Concern
CALFED

FROM: Syed M. Ali, Ph.D., Chief
Planning Section
DIVISION OF WATER QUALITY

DATE: July 28, 1997

SUBJECT: SUPPORT FOR MERCURY PROPOSAL

The State Water Resources Control Board (SWRCB) staff has reviewed the mercury proposal submitted for CALFED funding by Dr. Thomas Suchanek and Dr. Darell Slotton, University of California, Davis. The proposed work will complement SWRCB's monitoring activities for mercury in the Bay-Delta, and fill data gaps with respect to understanding mercury behavior in the aquatic environment and its potential adverse impacts on human health and aquatic life. Unfortunately, the SWRCB has no matching funds for this proposal.

Please call me at 657-0887 if you have any questions on this subject.

cc: Dr. Thomas Suchanek/
Dr. Darell Slotton
Division of Environmental Studies
University of California
Davis, CA 95616

Our mission is to preserve and enhance the quality of California's water resources, and ensure their proper allocation and efficient use for the benefit of present and future generations.

Cal/EPA

San Francisco
Bay Regional
Water Quality
Control Board

2101 Webster St. #500
Oakland, CA
94612
(510) 286-1255
FAX (510) 286-1380

Pete Wilson
Governor

July 24, 1997

To: CALFED Restoration Program Reviewers
From: Kim Taylor, San Francisco Bay Regional Water Quality Control Board

Re: Research on Mercury Loading in the Sacramento River and San Francisco Bay-Delta Watersheds

Staff at the San Francisco Bay Regional Water Quality Control Board have recently undertaken a thorough review of mercury as it relates to water quality problems in the San Francisco Bay watershed. We have considered all aspects of the problem ranging from levels observed in fish tissue and the chemical form of mercury most prevalent in Bay waters to identification of ongoing sources and the costs of pollution prevention programs. As part of that process, we have identified three critical information gaps. Dr. Slotton's proposal will clearly meet our needs for the first and his past work on Mt. Diablo mine exemplifies the type of information we need at other mine sites.

The first critical information gap is a need to map out mercury loadings and transport throughout the entire watershed system. We have a working hypothesis that most of the mercury that finds its way into fish tissue in the Bay comes from a huge, buried stock washed into the sediment during the gold rush--and that this stock of mercury will slowly clean itself out of the Bay over a period of decades. At the same time, however, current water quality regulations require remediation of *ongoing* sources until fish tissue levels decline. In our minds, the key environmental problem that must be solved in our Region is to ensure that ongoing inputs are reduced to a level that will allow for the long-term, natural cleanup of mercury levels in Bay sediments. In other words, ongoing inputs need to be lower than natural cleanup levels in order to reach our goal of reducing mercury levels in fish tissue and the water column. In order to re-tool the regulatory program for mercury towards this long-term strategy, the critical, missing piece of information is roughly how much mercury is still entering the Bay sediment system from riverine sources and in what chemical form that mercury is in. Dr. Slotton's proposal will provide precisely this kind of information.

The second critical information gap is a need for much more detailed knowledge about individual, ongoing mercury sources in the watershed. We are developing policy options that would allow for regulated entities to choose the most cost effective means of

reducing ongoing mercury loading--even if that means conducting off-site remediation work. For many of the point source dischargers in the Bay Area, it would be much more economical to contribute funds towards mine site remdiation than install end-of-the-pipe control technologies. In order to facilitate these types of loading reductions, it is necessary to have detailed, site-specific data on mercury at abandoned mines that describes current conditions, remediation measures, and possible load reductions. Once such information becomes available, it much more likely that funds can be directed towards remediation projects. We would ask, therefore, that CALFED consider this when reviewing site characterization proposals against site cleanup proposals.

The third information gap regarding mercury is whether or not anthropogenic activities are affecting the overall rate at which the existing stock is transformed into methylmercury. Activities such as dredging, levee repair, wetlands restoration and/or destruction may all affect mercury biogeochemical transformation.

We appreciate the time and effort CALFED is taking to review and fund ecosystem restoration projects. If you have any questions, please call me at (510) 286-3821 or email at KAT@gwgate.swrcb.ca.gov.

Sincerely,

Kim Taylor, PhD
Environmental Specialist III
Planning Division