

July 2, 1998

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To the CALFED Bay-Delta Program:

The Department of Water Resources (DWR) and Philip Williams & Associates, Ltd. (PWA) are pleased to submit our proposal for the Ecosystem Restoration Projects and Programs entitled "Learning Laboratory for Restoring Subsidized Lands in the Delta: Phase I Restoration Design Component." The Learning Laboratory project will create a freshwater tidal wetland restoration demonstration project on Twitchell Island and is extremely important in meeting CALFED restoration objectives in the Delta. The enclosed proposal is for a component of the larger Learning Laboratory project.

This proposed work will not only develop a specific plan for Twitchell Island but will address key Delta restoration design criteria including crucial questions such as:

- **How can wave energy be limited in subsidized flooded islands to promote natural sedimentation and marshplain evolution?** Analysis of flooded islands such as Franks Tract, Big Break, and lower Sherman illustrates that sediment deposition on flooded islands is hindered by persistent wave action. The proposed project will quantify the relationship between wind speed, fetch, water depth, and sediment accumulation.
- **How can restoration projects encourage the formation of ecologically-valuable tidal slough habitat?** Subsidence-reversal techniques can result in tule monocultures rather than a complex network of marshplain and tidal sloughs. The proposed project will determine sustainable slough channel configurations and dimensions for the proposed restoration site and for the Delta as a whole.

There will be two program work products: 1) a specific design for Twitchell Island that is a "site template" for restoration; and 2) design criteria that can be used to guide tidal wetland restoration plans throughout the Delta.

The proposal is to complete the unfunded component of Phase I of the Learning Laboratory project. We originally requested CALFED funding for all of Phase I in July 1997. CALFED was supportive of the entire Phase I effort, but because of funding constraints, awarded \$3,583,000 for only the subsidence reversal component. Funding for the design component was deferred, with the expectation that we would apply for funding during this cycle. This proposal now seeks funding for this remaining component. It is important that both components are carried out together because the results of each affect the other. Specifically, the site template

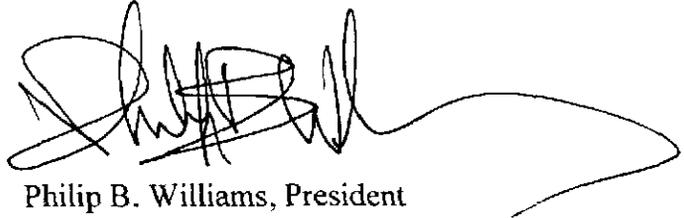
configuration defines the desired type, elevation, volume, rate of accumulation, and location of subsidence-reversal; these guidelines inform the subsidence-reversal research.

We believe that this is an exciting restoration opportunity and one that is essential for long-term restoration of the Delta which maximizes the use of lands already in public ownership. Please call either of us with any questions regarding the enclosed proposal. Thank you in advance for your consideration.

Sincerely,



Curt Schmutte, Chief
Flood Protection and
Geographic Information Branch
Department of Water Resources



Philip B. Williams, President
Philip Williams & Associates, Ltd.

enclosure

- cc. Roger Fuji, United States Geological Survey
Greg Thomas, Natural Heritage Institute
Robert MacArthur, Northwest Hydraulic Consultants, Inc.
Steve Deverel, Ph.D.
Steve Johnson, The Nature Conservancy

COVER PAGE

May 1998 CALFED ECOSYSTEM RESTORATION PROPOSAL SOLICITATION

Proposal Title: Learning Laboratory for Restoring Subsidied Lands in the Delta:
Phase I Restoration Design Component

Applicant Names: Curt Schmutte, P.E.
Department of Water Resources

Philip Williams, Ph.D., P.E.
Philip Williams & Associates, Ltd.

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415/945-0600

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Amount of funding requested: \$325,000 for 3 years

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

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

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

- Sacramento River Mainstem
- Delta
- Suisun Marsh and Bay
- Landscape (entire Bay-Delta watershed)
- San Joaquin River Mainstem
- Sacramento Tributary: _____
- East Side Delta Tributary: _____
- San Joaquin Tributary: _____
- Other: _____
- North Bay: _____

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

- San Joaquin and East-side Delta tributaries fall-run chinook salmon
- Winter-run chinook salmon
- Spring-run chinook salmon
- Late-fall run chinook salmon
- Fall-run chinook salmon

- Delta smelt
- Longfin smelt
- Splittail
- Steelhead trout
- Green sturgeon
- Striped bass
- Migratory birds

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

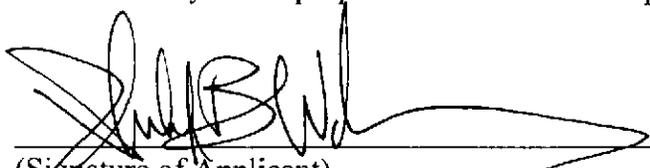
- State agency
- Federal agency
- Public/Non-profit joint venture
- Non-profit
- Local government/district
- Private party (PWA will receive the funding, so is indicated here)
- University
- Other:

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

- Planning
- Implementation
- Monitoring
- Education
- Research

By signing below, the applicant declares the following:

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



 (Signature of Applicant)



 (Signature of Applicant)

II. EXECUTIVE SUMMARY

a. PROJECT TITLE AND APPLICANT NAME

Project Title: Learning Laboratory for Restoring Subsided Lands in the Delta:
Phase I Restoration Design Component

Applicant Names: Department of Water Resources (DWR) & Philip Williams & Associates, Ltd. (PWA)

b. PROJECT DESCRIPTION & PRIMARY BIOLOGICAL/ECOLOGICAL OBJECTIVES

The goal of the Learning Laboratory for Restoring Subsided Lands in the Delta ("Learning Laboratory") project is to develop and demonstrate techniques for restoring deeply subsidized Delta islands to tidal wetland habitat. Tidal wetland restoration in the Delta is a CALFED priority and will provide significant ecological, flood management, water quality, and water supply benefits. To accomplish the project goal, we propose to create a freshwater tidal wetland restoration demonstration project on Twitchell Island. The demonstration project will not only restore tidal wetland habitat, but will also serve as a learning laboratory to develop and test restoration techniques for future, larger-scale restoration efforts.

This proposal is for the restoration design component of the larger Learning Laboratory project. The goals of this component are to design a "site template" for the restoration demonstration project at Twitchell Island and to create design criteria that can be used to guide tidal wetland restoration plans throughout the Delta. The design guidelines will address key Delta restoration design criteria including crucial questions such as:

- **How can wave energy be limited in subsidized flooded islands to promote natural sedimentation and marshplain evolution?** Analysis of flooded islands such as Franks Tract, Big Break, and lower Sherman illustrates that sediment deposition on flooded islands is hindered by persistent wave action. The proposed project will quantify the relationship between wind speed, fetch, water depth, and sediment accumulation.
- **How can restoration projects encourage the formation of ecologically-valuable tidal slough habitat?** Subsidence-reversal techniques can result in tule monocultures rather than a complex network of marshplain and tidal sloughs. The proposed project will determine sustainable slough channel configurations and dimensions for the proposed restoration site and for the Delta as a whole.

The proposed project will develop design criteria for restoration and design a restoration "template." Twitchell Island is deeply subsidized; breaching the levee and reintroducing tidal action with the existing site elevations would not be conducive to wetland development. Therefore, a site template will be constructed prior to levee breaching. The template will include features such as a cross-levee to prevent flooding on other parts of the island and berms to limit wind fetch (Figure 1). Subsidence-reversal techniques will be used to raise the ground surface elevations in selected locations. The template will be designed to maximize the opportunity for natural sediment deposition, tidal exchange, and vegetation colonization to restore the site to a self-sustaining tidal wetland.

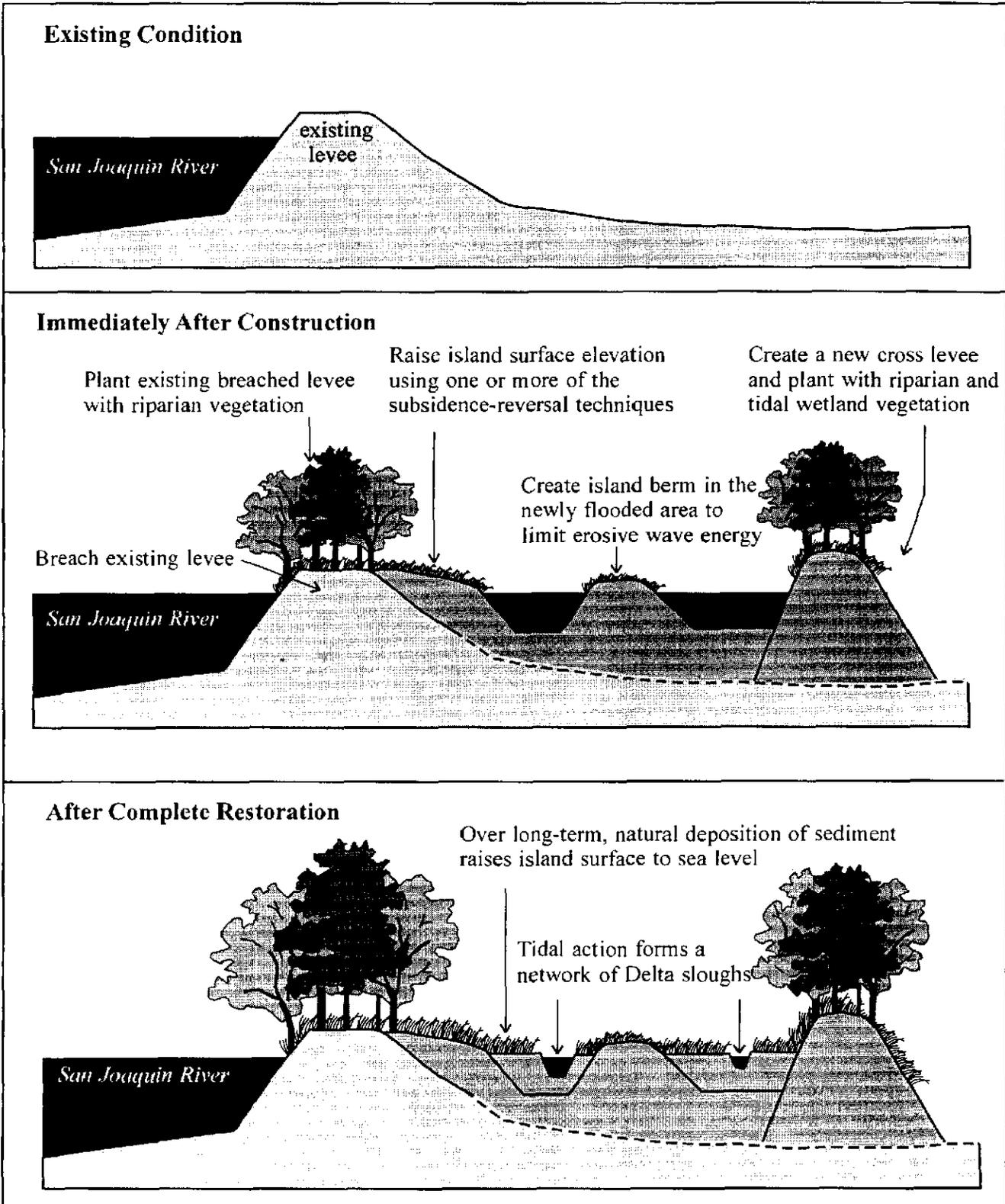
The learning laboratory project will restore the following priority habitats at Twitchell Island: freshwater tidal perennial aquatic, freshwater non-tidal aquatic, Delta sloughs, and freshwater emergent wetland. The project will also benefit special-status plant, fish, and wildlife populations.

c. APPROACH/TASKS/SCHEDULE

The Learning Laboratory project will proceed in phases. Phase I includes evaluation of subsidence reversal techniques and conceptual restoration design. Subsequent phases will include construction of a restoration demonstration project on Twitchell Island, monitoring and data evaluation, and possibly other restoration demonstration projects. The subsidence-reversal component of Phase I was funded by CALFED during the July 1997 funding cycle. This proposal seeks funding for the design component.

The design component of Phase I includes the following tasks: (1) development of design criteria to limit wave energy and allow natural tidal slough channel formation at Twitchell Island; (2) development of a tidal wetland design guidelines document that will have general applicability to future restoration projects in the Delta; (3) coordination with LTMS to evaluate the availability of dredged material for reuse in restoration; (4)

Twitchell Island Subsidence Reversal Habitat Restoration Project



conceptual restoration design (site template); and (5) development of a monitoring and adaptive management plan. Task 1 will use quantitative analysis, historical aerial photo analysis, and field observations to quantify the relationship between wind speed, fetch, water depth, and sediment accumulation. Task 1 will also use historical channel mapping, such as that shown on Figure 2, and field measurements to understand natural and existing slough channel configurations and dimensions. Task 2 will build on the findings of Task 1 to create a broader design document. The conceptual design will include hydrodynamic modeling to predict patterns of sedimentation and scour and will estimate the time frame required for habitat development.

We propose to schedule the project tasks in coordination with the subsidence-reversal component of Phase I. We anticipate that Phase I will be completed by December 2001.

d. JUSTIFICATION FOR PROJECT FUNDING FROM CALFED

The proposed project will complete Phase I of the Learning Laboratory project. CALFED has already funded the subsidence reversal component of Phase I. In July 1997, DWR, PWA, and other Learning Laboratory team members submitted a proposal to CALFED for Phase I. CALFED was supportive of the entire Phase I effort, but because of funding constraints, awarded funding for only the first component. It is important that the remaining design component is funded as soon as possible. This component needs to proceed simultaneously with the subsidence-reversal component in order to focus efforts on elements of the various subsidence-reversal techniques that will be most useful in the design. Specifically, the site template will define the desired type, elevation, volume, rate of accumulation, and location of subsidence-reversal; these guidelines inform the subsidence-reversal research. Project planning will be more cost effective if the components are carried in coordination.

e. BUDGET COSTS AND THIRD PARTY IMPACTS

This application requests \$325,000 in CALFED funds. The requested funds are for services to be provided by PWA. The proposed project also requires the coordination of DWR and other participants of the subsidence-reversal component of the project. The cost of these coordination efforts have already been funded by CALFED as part of the subsidence-reversal project. No adverse third party impacts are anticipated.

f. APPLICANT QUALIFICATIONS

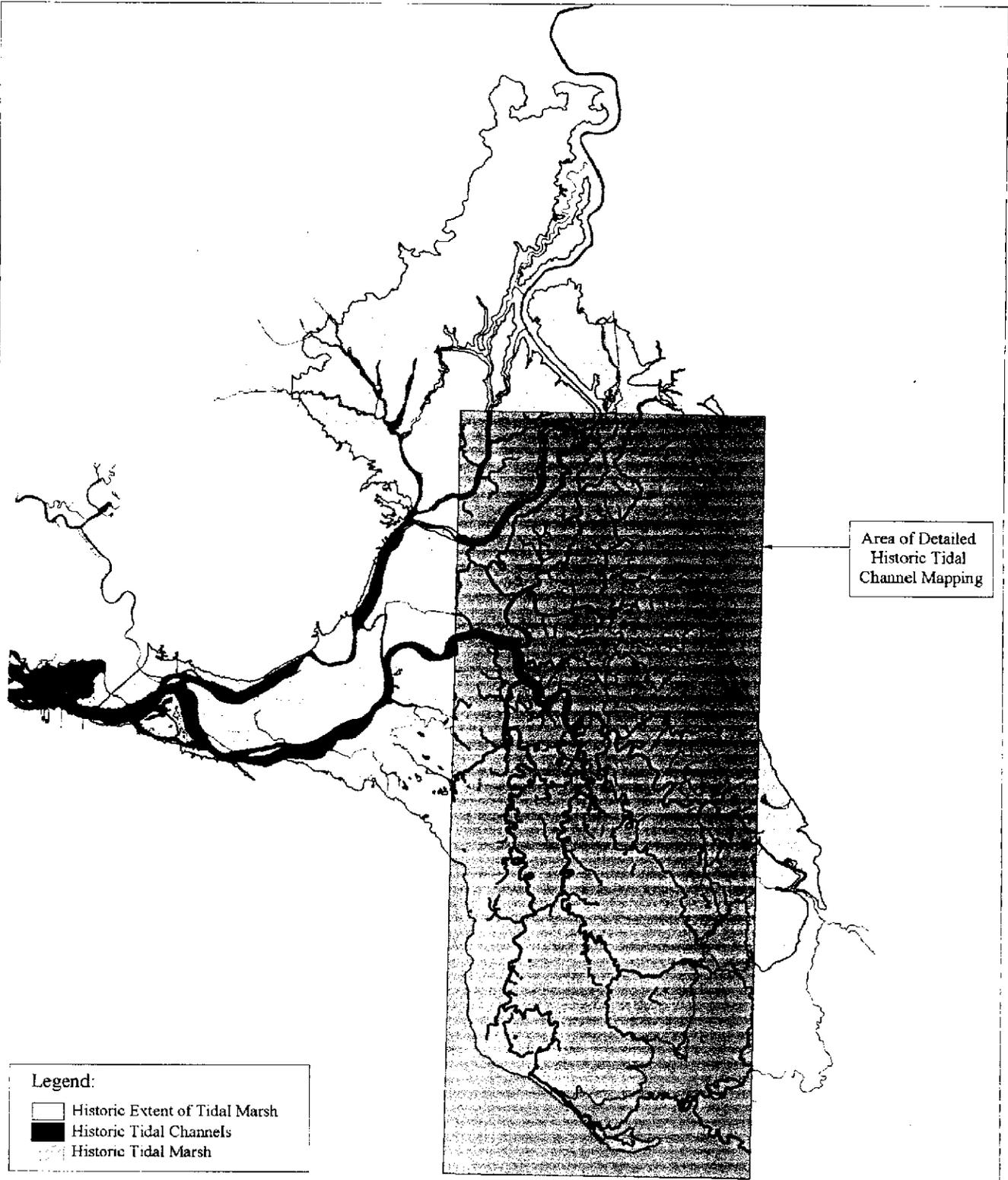
DWR engineers, biologists, and land agents have multiple years of experience with levee construction and habitat restoration in the Delta. PWA has over 20 years of tidal wetland restoration experience and has designed over 400 wetland restoration projects. PWA is currently working with the University of Washington on a closely-related Category III study of the evolution of tidal wetland habitat in re-flooded (breached-levee) Delta islands as well as the CALFED-sponsored investigation of riparian habitat restoration at Tyler Island.

g. MONITORING AND DATA EVALUATION

The project implementation phase will include physical and biological monitoring to evaluate, learn from, and adaptively manage the project. Project monitoring will be coordinated with the Delta-wide, Interagency Ecological Programs's monitoring efforts. The monitoring plan will be developed during the current phase of work.

h. LOCAL SUPPORT/COORDINATION WITH OTHER PROGRAMS/ COMPATIBILITY WITH CALFED OBJECTIVES

The Learning Laboratory project is supported by the State Water Contractors, USACE, SWRCB, RWQCB, BCDC, EPA, the Nature Conservancy and the UC Davis Public Service Research Program. Key resource agency personnel will be consulted during development of the conceptual design. This project is compatible with all CALFED objectives.



Legend:
 [White Box] Historic Extent of Tidal Marsh
 [Black Box] Historic Tidal Channels
 [Stippled Box] Historic Tidal Marsh

Figure 2
Historic Delta Tidal Marsh and Tidal Channels

Sources: Atwater (1982), DWR (1995), PWA Analysis
 Digitized by US Bureau of Reclamation

N

PWA
 PHILIP WILLIAMS & ASSOCIATES
 CONSULTANTS IN HYDROLOGY



PWA #98-080

III. TITLE PAGE

- a. TITLE OF PROJECT**
Learning Laboratory for Restoring Subsidized Lands in the Delta: Phase I Conceptual Restoration Design Component
- b. NAMES OF APPLICANTS/PRINCIPAL INVESTIGATORS**
- | | |
|--|---|
| Curt Schmutte, P.E.
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(415) 945-0606 fax
pbw@pwa-ltd.com |
|--|---|
- c. TYPE OF ORGANIZATION AND TAX STATUS**
- | | |
|---|---|
| Department of Water Resources
State Agency | Philip Williams & Associates, Ltd.
S-Corporation |
|---|---|
- d. TAX IDENTIFICATION NUMBER**
- | | |
|---|--|
| Department of Water Resources
52-1692634 | Philip Williams & Associates, Ltd.
94-3083005 |
|---|--|
- e. PARTICIPANTS/COLLABORATORS IN IMPLEMENTATION**
United States Geological Survey
Natural Heritage Institute
Northwest Hydraulic Consultants, Inc.
Steve Deverel, Ph.D.

IV. PROJECT DESCRIPTION

a. PROJECT DESCRIPTION AND APPROACH

The goal of the Learning Laboratory for Restoring Subsided Lands in the Delta (“Learning Laboratory”) project is to develop and demonstrate techniques for restoring deeply subsidized Delta islands to tidal wetland habitat. Tidal wetland restoration in the Delta is a CALFED priority and will provide significant ecological, flood management, water quality, and water supply benefits. To accomplish the project goal, we propose to create a freshwater tidal wetland restoration demonstration project on Twitchell Island. The demonstration project will restore tidal wetland habitat and, more importantly, will serve as a learning laboratory to develop and test restoration techniques for future, larger-scale restoration efforts. These techniques can be used by CALFED to develop a broad-scale, long-term habitat restoration program for the Delta.

This proposal is for the restoration design component of the larger Learning Laboratory project. The goals of this component are to design a “site template” for the restoration demonstration project at Twitchell Island and to create design criteria that can be used to guide tidal wetland restoration plans throughout the Delta. The design guidelines will address key Delta restoration design criteria including crucial questions such as:

- **How can wave energy be limited in subsidized flooded islands to promote natural sedimentation and marshplain evolution?** Analysis of flooded islands such as Franks Tract, Big Break, and lower Sherman illustrates that sediment deposition on flooded islands is hindered by persistent wave action. This project will quantify the relationship between wind speed, fetch, water depth, and sediment accumulation.
- **How can restoration projects encourage the formation of ecologically-valuable tidal slough habitat?** Subsidence-reversal techniques can result in tule monocultures, which do not provide significant habitat benefits. This project will test the potential for simultaneously reversing subsidence and creating a rich mosaic of marshplain and tidal sloughs.

The portion of Twitchell Island proposed for restoration is deeply subsidized (approximately 10 feet below sea level). To breach the levee and reintroduce tidal action with the existing site elevations would not be conducive to wetland development. Instead, a site template will be constructed prior to levee breaching that will include features such as a cross-levee to prevent flooding on other parts of the island and berms to limit wind fetch (Figure 1). The existing levee and new cross-levee will be planted with riparian vegetation. Subsidence-reversal techniques will be used to raise the ground surface elevations in selected locations. The template will be designed to maximize the opportunity for natural sediment deposition, tidal exchange, and vegetation colonization to restore the site to a self-sustaining tidal wetland.

The Learning Laboratory project will proceed in phases. Phase I includes evaluation of subsidence reversal techniques and restoration design. Subsequent phases will include construction of a restoration demonstration project on Twitchell Island, monitoring and data evaluation, and possibly other restoration demonstration projects.

The subsidence-reversal component of Phase I was funded by CALFED during the July 1997 funding cycle. This component tests techniques for raising subsided ground surface elevations through sediment capture and tule cultivation. It also includes water quality studies to assess and mitigate potential water quality impacts associated with the restoration techniques.

The current proposal seeks funding for the design component of Phase I. It is important that the design is funded now so that it can be integrated with the subsidence-reversal research. Concurrent development of the design and subsidence-reversal techniques will help focus the subsidence-reversal research on issues that are most important to the site template design. The site template will define the desired elevation, volume, grain size distribution, and spatial configuration of fill. Potential design priorities that could affect the focus of subsidence reversal efforts include: importing sediments with geotechnical properties useful for template construction; creating the largest volume of fill as quickly as possible; filling to higher elevations (possibly more difficult and expensive) in selected locations; and filling in remote, harder to reach portions of the site. Project planning will be more cost effective if the design and subsidence-reversal components are conducted in coordination.

b. PROPOSED SCOPE OF WORK

The proposed scope of work includes the following tasks:

1. develop design criteria for (a) maximum wave energy to promote marshplain evolution and (b) for tidal slough channel dimensions to allow natural channel formation at Twitchell Island;
2. prepare a general design guidelines document applicable to tidal restoration projects throughout the Delta;
3. coordinate with LTMS to evaluate the availability of dredged material for reuse in tidal wetland restoration in the Delta;
4. develop a restoration design "template" that limits wind fetch and wave energy and promotes marshplain and slough channel formation as the wetland evolves; and
5. develop a monitoring and adaptive management plan.

Task 1: Design Criteria for Maximum Wave Energy and Tidal Slough Channels

Wave Energy

Identification of the maximum design wave energy for the restoration site is a critical issue. Excessive wave energy inhibits natural sedimentation and vegetation establishment because sediments are continually resuspended. Wave energy is a function of wind speed, fetch, and water depth and can be controlled at the site through the specific combinations of open water fetch and depth. Task 1 will use quantitative analysis, historical aerial photo analysis, and field observations to understand the relationship between wind speed, fetch, water depth, and sediment accumulation.

PWA will analyze wind and tide data and quantitatively characterize wave energy for various fetch-depth combinations. PWA will use the results their field work and historical aerial photo analysis being conducted for the Category III project "Evolution of Flooded Delta Islands" (with the University of Washington) to characterize the relationship between wave energy and marsh formation or erosion.

Tidal Slough Channels

Another critical design issue is how to encourage the formation of tidal slough channels. An understanding of freshwater tidal slough channel characteristics is important for selecting maximum fill elevations, sizing the levee breach, and spatially configuring borrow areas and internal peninsula locations. If the initial elevation of sediment siphoned into the site is too high prior to breaching the dike, a functioning slough channel drainage system is unlikely to develop. Monitoring of other marsh restoration designs that relied on imported sediment (instead of natural sedimentation) has shown that slough channels and complex marsh habitat may not form unless the initial elevation is low enough to allow for natural sedimentation to occur in the stages of marshplain evolution when slough channel and vegetation establishment occur simultaneously. Under sizing the levee breach can inhibit tidal exchange into the site and limit sediment deposition. Understanding where channels are likely to form and their likely dimensions helps spatially configure borrow areas and internal peninsulas in areas where they are most advantageous. The peninsulas should encourage, not restrict channel development. Borrow areas can be located in predicted channel locations, helping to guide channel development and limit the loss of useful fill material to channel scour.

PWA will recommend a maximum fill elevation for the site template. PWA will conduct field surveys of nearby Delta marshes and use experience gained in our current CALFED project looking at the physical processes in restored Delta Islands, as well as our investigation of "first generation" tidal marsh restoration sites using dredged material in San Francisco Bay, and from designing and monitoring the Sonoma Baylands tidal marsh restoration project using dredged material.

PWA will develop hydraulic geometry relationships for the Delta (similar to the relationships developed for San Francisco Bay) that relate marsh drainage area to expected tidal channel dimensions (width and depth). We will use historical channel mapping, such as that shown on Figure 2, and field studies of existing channels currently being conducted by PWA and others in the Delta. The hydraulic geometry relationships will be used to determine the optimum breach dimensions that will promote tidal circulation and habitat evolution.

Task 2: Tidal Wetland Design Guideline Document

PWA will use the findings of Task 1 to create design guidelines for tidal wetland restoration that will have general applicability to future restoration projects throughout the Delta.

Task 3: Coordination with LTMS

PWA will coordinate with LTMS to evaluate the availability of dredged material for reuse at the Twitchell Island demonstration project and other restoration projects in the Delta. Dredged materials may be used at the site to supplement other subsidence-reversal methods. Since the focus of this project is to develop restoration techniques that have the potential for broad application within the Delta, dredged materials will be used for the Twitchell Island project only in quantities that could be reasonably be expected to be available to other projects.

Task 4: Restoration Design "Template"

PWA will develop a conceptual design for freshwater tidal marsh restoration that utilizes peninsulas, or other features, to limit wave action and promote natural sedimentation. The design will allow slough channel formation as the wetland evolves. We will analyze historic maps, photographs and

survey data to characterize slough channel geometry, drainage density, channel order, and marshplain elevation relationships.

PWA will utilize a two-dimensional depth-integrated hydrodynamic sediment transport model (DIVAST) to simulate patterns and rates of sedimentation and a long-term one-dimensional sedimentation model that simulates marsh accretion to estimate the time-frame necessary for restoration of a functioning freshwater tidal marsh habitat. PWA will rely on data available from USGS and sediment modeling data generated by NHC for the San Joaquin River as part of the sediment budget as input to the models.

Development of the design will include meetings with resource agency personnel to obtain their input on project goals early in the design process and input on a draft version of the conceptual design once this is available.

Task 5: Monitoring and Adaptive Management Plan

PWA will develop a plan to monitor, evaluate, and adaptively manage the evolution of the site following construction. The plan will incorporate data collection that will be useful for future freshwater tidal marsh restoration of subsided Delta Islands.

c. LOCATION AND/OR GEOGRAPHIC BOUNDARIES OF PROJECT

Twitchell Island is in southwestern Sacramento County adjacent to the San Joaquin River near its confluence with the Sacramento River.

d. EXPECTED BENEFITS

Funding this portion of the learning laboratory project will allow Phase I of the Learning Laboratory to move forward in a timely and cost-effective manner. The tasks proposed here will guide the subsidence-reversal component of the Learning Laboratory project that has already been funded by CALFED and provide valuable input to other tidal wetland restoration projects in the Delta.

The design guidelines document that will be developed as part of this project is intended to be used for other restoration projects throughout the Delta addressing key criteria such as wind-wave action and slough channel development.

The larger learning laboratory project will restore the following priority habitats at Twitchell Island: freshwater tidal perennial aquatic, freshwater non-tidal aquatic, Delta sloughs, and freshwater emergent wetland. The project will benefit special-status plant, fish, and wildlife populations, and provide high-quality habitat for other fish and wildlife dependent on the Delta. Specific CALFED priority species are listed below in Section IV(e). Most importantly, the learning laboratory will yield data and identify techniques that will enable CALFED to develop a broad-scale, long-term habitat restoration program for the Delta.

The learning laboratory project will create a number of third party benefits and achieve non-ecosystem CALFED objectives. Restoring tidal marsh habitat and otherwise rebuilding island surface elevations on subsided lands will reduce the long-term costs of levee maintenance and the risk of catastrophic levee failure during seismic or hydrologic events. Breaching existing levees will provide incremental flood control benefits by increasing flood plain storage capacity.

e. BACKGROUND & BIOLOGICAL/TECHNICAL JUSTIFICATION FOR PROJECT

The long-term agricultural, ecological, and water supply future of the Delta is dependent on halting subsidence and restoring island elevations. This project is a necessary step in the implement of a restoration demonstration project at Twitchell Island and provides valuable design information for future Delta restoration projects.

The proposed work will meet many of the objectives outlined in the CALFED Bay-Delta Program Ecosystem Restoration Program Plan (ERPP). Table 1 lists these objectives, and their section and page number from the March 1998 ERPP.

TABLE 1. ERPP Objectives addressed by the proposed project

Section	ERPP Objective	Page #
Stream Meander	Restore natural stream (tidal slough) meander processes to allow the natural recruitment of sediments and create habitats.	37
Natural Floodplains and Flood Processes	Expanding floodplains of the Bay-Delta; promoting flood detention and encouraging wetland formation; increasing the frequency of inundation of vegetated floodplains connected to tidal channels; increasing the acreage and connectivity of natural habitat areas within estuaries	45
Bay-Delta Hydraulics	Establish and maintain a hydraulic regime in the Bay-Delta to create and maintain habitat (approach: restore large acreages of tidal wetlands and tidal channels to increase the tidal volume of the estuary)	57
Bay-Delta Aquatic Foodweb	Restore the amount of basic nutrients available to estuarine and riverine systems in order to provide a sustainable level of foodweb productivity	63
Nontidal Perennial Aquatic Habitat	Increase the area of shallow-water and intertidal mudflat habitat to improve conditions that support increased primary and secondary productivity	82
Delta Sloughs	Restore a portion of the historical Delta slough distribution.	88
Fresh Emergent Wetland	Restore tidally-influenced freshwater emergent wetland in the Delta	100
Riparian and Riverine Aquatic habitats	Restore riparian scrub, woodland, and forest habitat along largely non-vegetated banks of Delta island levees	110
Delta Smelt	Ensure the recovery of this species	136
Longfin Smelt	Ensure the recovery of this species	140
Splittail	Ensure the recovery of this species	144
White and Green Sturgeon	Restore the distribution and abundance of the white sturgeon to historical levels and ensure the recovery of the green sturgeon	148
Chinook Salmon	Ensure the recovery of this species	153
Steelhead Trout	Ensure the recovery of this species	160
Striped Bass	Restore population levels to those of the 1960s	165
American Shad	Maintain naturally spawning populations that support sport fisheries similar to fisheries that existed in the 1960s and 1970s	168
Resident Fish Species	Maintain and restore the distribution and abundance of resident native fish species	172
Bay-Delta Aquatic Foodweb Organisms	Maintain, improve, or restore the population densities to sustainable levels	181
Special Status Plant Species	Restore tidal freshwater marsh species	186
Plant Community Groups	Increase the amount of aquatic habitat; protect and enhance tidal freshwater marsh; restore tidal riparian vegetation	199, 206, 219

TABLE 1 (continued)

Section	ERPP Objective	Page #
California Red-Legged Frog	Assist in the recovery of this species	225
California Black Rail	Assist in the recovery of this species	237
Greater Sandhill Crane	Assist in the recovery of this species	240
Riparian Brush Rabbit	Assist in the recovery of this species	254
Shorebird and Wading Bird Guild	Maintain healthy populations	256
Waterfowl	Maintain healthy populations	259
Neotropical Migratory Bird Guild	Maintain healthy populations	265
Lange's Metalmark, Delta Green Ground Beetle, and Valley Elderberry Longhorn Beetle	Increase population abundance	268
Levees, Bridges, and Bank Protection	reestablish geomorphological processes in artificially confined channel reaches	284

f. MONITORING DATA AND EVALUATION

The project implementation phase will include physical and biological monitoring to evaluate, learn from, and adaptively manage the project. A key objective of this monitoring plan will be to assess and improve design criteria for tidal wetland restoration. Project monitoring will be coordinated with the Delta-wide, Interagency Ecological Programs's monitoring efforts. The monitoring plan will be developed during the current phase of work.

g. IMPLEMENTABILITY

We are not aware of potential impediments to implementing the proposed project (Phase I: conceptual design component). DWR and PWA are participants in the funded component of Phase I and will coordinate the proposed work with the funded project.

For the larger Learning Laboratory project, DWR purchased most of Twitchell Island with revenue from the State Water Contractors for the express purpose of habitat restoration. The State Water Contractors Association has assured DWR management that they fully support this project. The USACE, SWRCB, RWQCB, BCDC, and EPA as well as the U.C. Davis Public Service Research Program also support this project (see letters of endorsement). DWR, the lead agency, intends to conduct the necessary environmental reviews prior to project construction. No designated critical habitat for state or federally listed or candidate terrestrial species has been identified on Twitchell Island. The project is consistent with both the Delta Protection Act and associated Resource Management Plan. The project applicants will work with Delta Landowners and will invite them to serve on the project advisory committee.

V. COSTS AND SCHEDULE TO IMPLEMENT PROPOSED PROJECT

a. BUDGET COSTS

This application requests \$325,000 in CALFED funds. A breakdown of project costs is presented in Table 2. The requested funds are for services to be provided by PWA. The proposed project also requires the coordination of DWR and other participants of the subsidence-reversal component of the project. The cost of these coordination efforts have already been funded by CALFED as part of the subsidence-reversal project.

b. SCHEDULE MILESTONES

We propose to schedule the project tasks in coordination with the subsidence-reversal research. We anticipate that the proposed project and the subsidence-reversal research will be completed by December 2001. Table 3 summarizes the schedule milestones and deliverables by task:

TABLE 3. Schedule Milestones

Task	Dates	Deliverable
Task 1: Design Criteria for Maximum Wave Energy and Tidal Slough Channels	Oct. 1998 - Jun. 1999	Technical memorandum
Task 2: Tidal Wetland Design Guideline Document	Oct. 1998 - Dec. 1999	Tidal Wetland Design Guideline Report
Task 3: Coordination with LTMS	Oct. 1998 - Jun. 1999	Attend meeting(s)
Task 4: Conceptual Restoration Design	Dec. 1998 - Dec. 2001	Conceptual design report and hydrodynamic model of the design
Task 5: Monitoring and Adaptive Management Plan	Jun. 2001 - Dec. 2001	Monitoring and Adaptive Management Plan report

c. THIRD PARTY IMPACTS

No negative third-party impacts are anticipated as a result of these efforts.

TABLE 2. Cost Breakdown

Project Phase and Task	Direct Hours	Direct Salary & Benefits	Overhead Labor G&A + Fee	Service Contracts	Material and Acquisition Contracts	Misc. and Other Direct Costs	TOTAL Cost
1 Design Criteria for Maximum Wave Energy							
collect wind & tide data	62	\$2,143	\$2,634			\$200	\$4,978
wave energy analysis	58	\$2,039	\$2,506				\$4,545
historical analysis & field observations	38	\$1,363	\$1,675			\$200	\$3,238
technical memo	20	\$811	\$996			\$80	\$1,887
identification of max. fill elevation	32	\$1,327	\$1,632				\$2,959
tidal channel geometry	192	\$6,956	\$8,550				\$15,506
technical memo	20	\$811	\$996			\$80	\$1,887
2 General Design Guideline Document							
generalize design guidelines	590	\$21,258	\$26,127			\$50	\$47,435
prepare report	328	\$12,150	\$14,934			\$497	\$27,581
3 Coordination with LTMS							
LTMS Coordination	24	\$992	\$1,219			\$50	\$2,276
assessment of dredged material availability	44	\$1,503	\$1,848				\$3,351
4 Conceptual Restoration Design							
existing conditions	164	\$5,915	\$7,270				\$13,186
define goals and objectives	12	\$521	\$640				\$1,161
opportunities and constraints	12	\$521	\$640				\$1,161
define design assumptions	12	\$521	\$640				\$1,161
define design criteria	12	\$521	\$640				\$1,161
alternative selection	56	\$2,374	\$2,918				\$5,292
hydrodynamic modeling	980	\$34,802	\$42,774			\$5,000	\$82,576
Long term accretion	152	\$5,449	\$6,697				\$12,146
Biologist	0	\$0	\$0	\$30,000			\$30,000
Team Coordination	108	\$4,264	\$5,240			\$200	\$9,704
prepare report	392	\$14,153	\$17,396			\$300	\$31,849
5 Monitoring and Adaptive Management Plan							
identify key processes	28	\$1,042	\$1,280				\$2,322
define monitoring plan	100	\$3,791	\$4,659				\$8,449
team Coordination	12	\$521	\$640				\$1,161
prepare monitoring plan report	100	\$3,563	\$4,379			\$100	\$8,042
TOTAL	3548	\$129,311	\$158,933	\$30,000	\$0	\$6,757	\$325,000

VI. APPLICANT QUALIFICATIONS

The project applicants will enter into a Memorandum of Understanding (MOU) delineating governance, fiscal management, roles, and responsibilities. The new MOU will be consistent with the existing MOU for the subsidence reversal component of Phase I. DWR and PWA are parties to the existing MOU, together with the other project participants. DWR will assume the role of lead agency and Curt Schmutte will serve as project director for DWR. The Management Council for the new MOU will be the same as for the existing MOU and will be comprised of all parties to the existing MOU. Chairmanship will rotate among the parties on an (approximately) annual basis. Management decisions will be made by consensus. For the new MOU, PWA will be the fiscal agent and contract administrator, unless a different arrangement is requested by CALFED.

Curt Schmutte will serve as the overall Learning Laboratory project director and will be responsible for coordination with cooperating entities. Philip Williams, Ph.D., P.E., will serve as the principal in charge for PWA. Michelle Orr, M.S., of PWA will be the project manager. Scott Wright, M.S., of PWA will direct the hydrodynamic modeling element.

Curt Schmutte, P.E., is a Supervising Engineer and Program Manager with DWR and will supervise the project for lead agency. He previously led the System Integrity components of the CALFED program and has implemented difficult Delta levee, habitat, and barrier projects. As program manager, he was responsible for successfully developing the vision, plan, organization, process and schedule for CALFED Levee and Channel Technical Team. As manager of DWR's SB 34/AB 360 program, he has managed over \$30 million in Delta levee improvement projects including difficult mitigation elements. Mr. Schmutte has also managed subsidence studies and pilot projects with the LTMS program to study the viability of using San Francisco Bay dredged material on Delta levees. His project success has involved: 1) budgeting; 2) directing and coordinating engineering/ environmental consultants, contractors, and numerous Departmental staff; 3) maintaining project schedules; 4) obtaining all necessary project permits and environmental documentation (CEQA, ESA, Sections 404 and 401, Waste Discharge Requirements, Section 1600 Stream Bed Alteration agreements, monitoring programs, and SMARA plans); and 5) presentations to water agencies, management, and the public. He is currently a partner on four Category III habitat development/restoration projects: the Lower Sacramento River Project, Franks Tract, Prospect Island and Tyler Island projects. He is also the project manager for the Sherman Island Category III project which will be creating a new 4 acre in-channel island and the Decker Island project which will be creating 10 acres of new wetland and riparian habitat.

Philip Williams & Associates, Ltd. PWA has completed over 400 wetland restoration plans and analysis of tidal, seasonal, and riparian wetlands and has conducted long-term monitoring of several tidal wetland restoration sites in the San Francisco Bay Estuary in the past 20 years. PWA's design experience includes the recently completed Sonoma Baylands Tidal Wetland Restoration Project and the proposed Hamilton Wetland Restoration project. Both of these projects use dredged material to reverse physical effects of subsidence on diked former tidal marsh. The Hamilton project is a conceptual design for tidal wetland restoration on 900 acres of subsided lands at the Hamilton Army Airfield and adjacent properties. PWA is part of a team with the University of Washington that

received Category III funding to conduct hydrologic monitoring and analysis to predict the evolution of ecological functions in re-flooded (breached-levee) Delta islands. PWA has also teamed with the University of Washington to assess breached-dike restoration potential for juvenile Pacific Salmon habitat in two estuaries in Oregon.

- **Philip B. Williams, Ph.D., P.E., President.** Dr. Williams has pioneered practical technical analysis of tidal marsh restoration and management, coastal wetland hydrology, and hydraulics, flood and riparian management, reservoir operation, harbor maintenance dredging, watershed sediment yield, ground water management and the impacts of climate change.
- **Michelle Orr, M.S.,** has focused her professional work on the areas of tidal wetland, watershed runoff, and hydraulic processes. Ms. Orr's project experience includes the Category III re-flooded (breached-levee) Delta islands project with the University of Washington, the Hamilton Wetland Restoration project, and other seasonal and tidal wetland restoration projects.
- **Scott Wright, M.S.,** is a hydraulic engineer with a background in river mechanics accompanied by an emphasis on numerical modeling of hydrodynamics, contaminant and sediment transport processes. Most recently, he has worked extensively on the Napa river Flood Protection Project. This work has consisted of numerical modeling of flooding and cohesive and non-cohesive sediment transport on a tidally influenced reach of the Napa River.

VII. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

Standard Form DI-2010

A completed form is attached.

Standard Form 424

We have reviewed Standard Form 424 in its entirety and foresee no obstacles to submittal of a completed version if we are selected for funding. We will be happy to submit a completed form at that time.

**ATTACHMENT A
PROJECT SUPPORT LETTERS**

Please note that the attached letters were written in support of this project when it was originally submitted to CALFED in July 1997.

LONG TERM MANAGEMENT STRATEGY



July 18, 1997

Lester Snow
Executive Director
CALFED Bay Delta Program
1416 Ninth Street, Suite 1155
Sacramento, CA 95814

Dear Mr. Snow:

The undersigned State and Federal agencies are working on the Long Term Management Strategy (LTMS) for dredged material in the San Francisco Bay Region. Two project proposals submitted in response to the Category III Request for Proposals (RFP), the *Learning Laboratory for Restoring Subsidied Land* and the *Hamilton Army Airfield Wetlands Restoration Projects*, meet both CALFED and LTMS goals.

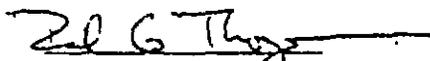
Both of these projects will benefit CALFED priority habitats and priority species, including anadromous fish and migratory birds, through ecosystem restoration. Both projects use dredged material for beneficial uses and fulfill the LTMS goal of maximizing the use of dredged material as a resource. Reducing the amount of dredged material disposed in the Estuary is critical to reducing the impacts to anadromous fish that use the Bay/Delta. Both projects also have multiple partners and opportunities for cost-sharing including cost sharing for use of dredged material.

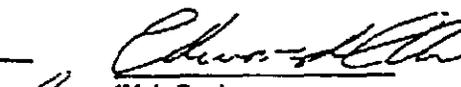
In particular, the Hamilton project will provide for the restoration of up to 2500 acres of seasonal and tidal wetlands combined. It is an important project to the LTMS agencies in that LTMS needs an upland site as soon as possible and it has a huge capacity for dredged material. If we do not act now, we will lose this restoration opportunity due to the end of the Base Realignment and Closure (BRAC) process. In addition, if the Bel Marin Keys property is to be included in this project, it must be purchased as soon as possible.

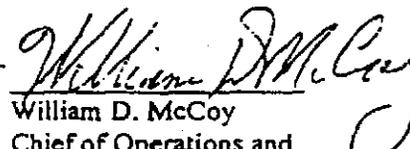
The Learning Laboratory Project will show how island restoration can optimally benefit from the use of dredged material, will promote the use of dredged material normally disposed of in the Delta and potentially at the Suisun Bay Disposal Site, will provide an invaluable lesson in understanding what can be done to restore Delta Islands.

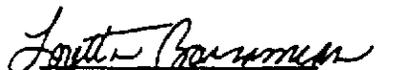
We believe that both of these projects will greatly benefit CALFED and LTMS goals bringing even greater benefits to the environment. We thank you for your consideration.

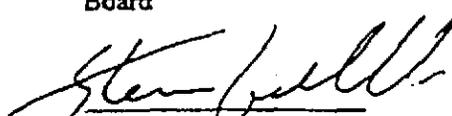
Sincerely,


Richard G. Thompson
Lt. Col., U.S. Army
District Engineer
U.S. Army Engineer District

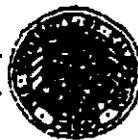

Walt Pettit
Executive Director
State Water Resources Control
Board


William D. McCoy
Chief of Operations and
Readiness
South Pacific Division
U.S. Army Corps of Engineers


Loretta Barsamian
Executive Officer
Regional Water Quality Control
Board


Will Travis
Executive Director
San Francisco Bay Conservation
and Development Commission


Alexis Strauss
Acting Director, Water Division
U.S. Environmental Protection
Agency



DIRECTOR
PUBLIC SERVICE RESEARCH PROGRAM
(916) 732-7823
FAX: (916) 732-7748

DAVIS, CALIFORNIA 95616-8688

July 25, 1997

Lester Snow
Executive Director
CALFED Bay-Delta Program
1416 Ninth Street, Suite 1155
Sacramento, CA 95814

Dear Lester:

I am writing to express strong support for the proposal being submitted for CALFED Category III funding by the Natural Heritage Institute and others: "A Learning Laboratory for Restoring Subsidized Land in the Delta."

We believe this is an extremely important issue in the overall context of ecosystem restoration in the Bay-Delta. A research briefing on Flood/Water Management and Ecological Restoration was presented last month as an element of the Memorandum of Understanding between the Resources Agency and UC Davis. Participants included CALFED's Dick Daniel, Mary Selkirk, Chair of the Ecosystem Restoration Workgroup, and a number of other knowledgeable and experienced individuals. The issue of restoring subsidized land received a great deal of emphasis in the discussion at this briefing.

We are particularly interested in the elements of the proposal which deal with an international symposium. We believe there may be a great deal to learn from colleagues who are dealing with similar issues in other parts of the country and the world. Several of us at UC Davis have been exploring the idea of an international symposium on tidal fresh water marsh restoration and we would welcome the opportunity to work with the Natural Heritage Institute and others in presenting such a symposium.

Best regards,

A handwritten signature in cursive script that reads "Dennis".

Dennis Pendleton
Director
Public Service Research Program

**ATTACHMENT B
FORM DI-2010**

U.S. Department of the Interior

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

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

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

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

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

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

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

CHECK IF THIS CERTIFICATION IS FOR A PRIMARY COVERED TRANSACTION AND IS APPLICABLE

- (1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:
- (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded by any Federal department or agency;
 - (b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
 - (c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and
 - (d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.
- (2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

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

CHECK IF THIS CERTIFICATION IS FOR A LOWER TIER COVERED TRANSACTION AND IS APPLICABLE

- (1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.
- (2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

DI-2010
June 1996
(This form replaces DI-1853, DI-1864,
DI-1856, DI-1866 and DI-1867)

~~PART C: Certification Regarding Drug-Free Workplace Requirements~~

~~CHECK IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS NOT AN INDIVIDUAL~~

Alternate I. (Grantees Other Than Individuals)

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

- (a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;
- (b) Establishing an ongoing drug-free awareness program to inform employees about--
 - (1) The dangers of drug abuse in the workplace;
 - (2) The grantee's policy of maintaining a drug-free workplace;
 - (3) Any available drug counseling, rehabilitation, and employee assistance programs; and
 - (4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;
- (c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);
- (d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will --
 - (1) Abide by the terms of the statement; and
 - (2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;
- (e) Notifying the agency in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification numbers(s) of each affected grant;
- (f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted --
 - (1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
 - (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;
- (g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a) (b), (c), (d), (e) and (f).

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

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

770 Tamalpais Drive, Suite 401
 Corte Madera, CA 94925

Check if there are workplaces on file that are not identified here.

~~PART D: Certification Regarding Drug-Free Workplace Requirements~~

~~CHECK IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS AN INDIVIDUAL~~

Alternate II. (Grantees Who Are Individuals)

- (a) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant;
- (b) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing, within 10 calendar days of the conviction, to the grant officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall include the identification number(s) of each affected grant.

DI-2010
June 1986
(This form replaces DI-1853, DI-1854,
DI-1855, DI-1856 and DI-1863)

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

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

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

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

- (1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, and officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify accordingly.

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

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

Elizabeth S. Andrews

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL

Elizabeth S. Andrews, P.E., Principal

July 1, 1998

TYPED NAME AND TITLE

DATE

01-2010
June 1996
(This form replaces 01-1962, 01-1964,
01-1966, 01-1968 and 01-1983)