Agricultural Drainage Treatment for Selenium & Nitrate Removal

Project Information

1. **Proposal Title:**

   Agricultural Drainage Treatment for Selenium & Nitrate Removal

2. **Proposal applicants:**

   Dennis Falaschi, Panoche Drainage District

3. **Corresponding Contact Person:**

   Dennis Falaschi
   Panoche Drainage District
   52027 West Althea Avenue Firebaugh, CA 93622
   209 364-6136
   MBHEDRICK@aol.com

4. **Project Keywords:**

   Contaminants
   Heavy Metals (mercury, selenium, etc.)
   Water Quality Management

5. **Type of project:**

   Implementation_Pilot

6. **Does the project involve land acquisition, either in fee or through a conservation easement?**

   Yes

   If yes, is there an existing specific restoration plan for this site?

   No

7. **Topic Area**:

   Ecosystem Water and Sediment Quality

8. **Type of applicant:**

   Local Agency

9. **Location - GIS coordinates:**

Latitude: 36.85

Longitude: -120.65

Datum:

Describe project location using information such as water bodies, river miles, road intersections, landmarks, and size in acres.

In Panoche Drainage District near intersection of Nees Ave. and Russel Ave.

10. **Location - Ecozone:**

    12.1 Vernalis to Merced River, West San Joaquin Basin, 1.3 South Delta, 2.1 Suisun Bay & Marsh, 2.5 San Pablo Bay

11. **Location - County:**

    Fresno

12. **Location - City:**

    Does your project fall within a city jurisdiction?

    No

13. **Location - Tribal Lands:**

    Does your project fall on or adjacent to tribal lands?

    No

14. **Location - Congressional District:**

    18

15. **Location:**

    California State Senate District Number: 16

    California Assembly District Number: 30

16. **How many years of funding are you requesting?**

    3

17. **Requested Funds:**
    a) Are your overhead rates different depending on whether funds are state or federal?

       No

       If no, list single overhead rate and total requested funds:

Single Overhead Rate: 1.5

Total Requested Funds: $28,000

b) Do you have cost share partners already identified?

Yes

If yes, list partners and amount contributed by each:

Panoche Drainage District $90,000

c) Do you have potential cost share partners?

No

d) Are you specifically seeking non-federal cost share funds through this solicitation?

No

If the total non-federal cost share funds requested above does not match the total state funds requested in 17a, please explain the difference:

18. **Is this proposal for next-phase funding of an ongoing project funded by CALFED?**

Yes

If yes, identify project number(s), title(s) and CALFED program (e.g., ERP, Watershed, WUE, Drinking Water):

98-B14 Irrigation Drainage Water Treatment for Selenium Removal ERP

Have you previously received funding from CALFED for other projects not listed above?

No

19. **Is this proposal for next-phase funding of an ongoing project funded by CVPIA?**

No

Have you previously received funding from CVPIA for other projects not listed above?

No

20. **Is this proposal for next-phase funding of an ongoing project funded by an entity other than CALFED or CVPIA?**

No

Please list suggested reviewers for your proposal. (optional)

Michael Delamore	**U.S. Bureau Of Reclamation**	**559-487-5039**	**mdelamore@mp.usbr.gov**
Manucher Alemi	**Department of Water Resources**	**916-651-9662**	**malemi@water.ca.gov**

21. **Comments:**

Environmental Compliance Checklist

<u>Agricultural Drainage Treatment for Selenium & Nitrate Removal</u>

1. **CEQA or NEPA Compliance**
   a) Will this project require compliance with CEQA?

      Yes

   b) Will this project require compliance with NEPA?

      Yes

   c) If neither CEQA or NEPA compliance is required, please explain why compliance is not required for the actions in this proposal.

2. **If the project will require CEQA and/or NEPA compliance, identify the lead agency(ies).** *If not applicable, put "None".*

   <u>CEQA Lead Agency:</u> Panoche Drainage District
   <u>NEPA Lead Agency (or co-lead:)</u> Panoche Drainage District
   <u>NEPA Co-Lead Agency (if applicable):</u>

3. **Please check which type of CEQA/NEPA documentation is anticipated.**

   CEQA
   XCategorical Exemption
   -Negative Declaration or Mitigated Negative Declaration
   -EIR
   -none

   NEPA
   XCategorical Exclusion
   -Environmental Assessment/FONSI
   -EIS
   -none

   If you anticipate relying on either the Categorical Exemption or Categorical Exclusion for this project, please specifically identify the exemption and/or exclusion that you believe covers this project.

   We expect the project will qualify for research/information collection categorical exclusion/exemption, however, NEPA/CEQA funding is budgeted in case Categorical Exclusions are found to be inadequate. NEPA: Research Categorical Exclusion, DOI 516 Dept. Manual 2, Appendix 1, sect. 1.6. CEQA: Information Collection Categorical Exemption, Title 14. CCR, Ch. 3., Art. 19., sect. 15306.

4. **CEQA/NEPA Process**
   a) Is the CEQA/NEPA process complete?

      No

If the CEQA/NEPA process is not complete, please describe the dates for completing draft and/or final CEQA/NEPA documents.

CEQA/NEPA compliance is a component of Task 1 scheduled for completion by July 2002.

b) If the CEQA/NEPA document has been completed, please list document name(s):

5. **Environmental Permitting and Approvals** (*If a permit is not required, leave both Required? and Obtained? check boxes blank.*)

LOCAL PERMITS AND APPROVALS

Conditional use permit	
Variance	
Subdivision Map Act	
Grading Permit	Required
General Plan Amendment	
Specific Plan Approval	
Rezone	
Williamson Act Contract Cancellation	
Other	

STATE PERMITS AND APPROVALS

Scientific Collecting Permit

CESA Compliance: 2081

CESA Compliance: NCCP

1601/03

CWA 401 certification

Coastal Development Permit

Reclamation Board Approval

Notification of DPC or BCDC

Other

FEDERAL PERMITS AND APPROVALS

ESA Compliance Section 7 Consultation

ESA Compliance Section 10 Permit

Rivers and Harbors Act

CWA 404

Other

PERMISSION TO ACCESS PROPERTY

Permission to access city, county or other local agency land.
Agency Name:

Permission to access state land.
Agency Name:

Permission to access federal land.
Agency Name:

Permission to access private land.
Landowner Name: Terre Belle Farms — Obtained

6. **Comments.**

Terre Belle Farms has agreed to sell to the Panoche Drainage District the land required for the project.

Land Use Checklist

Agricultural Drainage Treatment for Selenium & Nitrate Removal

1. **Does the project involve land acquisition, either in fee or through a conservation easement?**

   Yes

   If you answered yes to #1, please answer the following questions:

   a) **How many acres will be acquired?**

      Fee: 6
      Easement: 0
      Total: 6

   b) Will existing water rights be acquired?

      No

   c) Are any changes to water rights or delivery of water proposed?

      No

2. **Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?**

   No

3. **Do the actions in the proposal involve physical changes in the land use?**

   Yes

   If you answered yes to #3, please answer the following questions:

   a) How many acres of land will be subject to a land use change under the proposal?

      6

   b) Describe what changes will occur on the land involved in the proposal.

      4 acres of existing crop land will be graded to create the drainage treatment facility. The other 2 acres comprise the existing pilot treatment facility.

   c) List current and proposed land use, zoning and general plan designations of the area subject to a land use change under the proposal.

Category	Current	Proposed (if no change, specify "none")
Land Use	**Farming**	**Drainage Water Treatment Facility**
Zoning	**Agriculture**	**None**
General Plan Designation	**Agriculture**	**None**

d) **Is the land currently under a Williamson Act contract?**

No

e) **Is the land mapped as Prime Farmland, Farmland of Statewide Importance, Unique Farmland or Farmland of Local Importance under the California Department of Conservation's Farmland Mapping and Monitoring Program?**

No

f) **Describe what entity or organization will manage the property and provide operations and maintenance services.**

Panoche Drainage District

4. **Comments.**

Conflict of Interest Checklist

<u>Agricultural Drainage Treatment for Selenium & Nitrate Removal</u>

Please list below the full names and organizations of all individuals in the following categories:

- **Applicants listed in the proposal who wrote the proposal, will be performing the tasks listed in the proposal or who will benefit financially if the proposal is funded.**
- **Subcontractors listed in the proposal who will perform some tasks listed in the proposal and will benefit financially if the proposal is funded.**
- **Individuals not listed in the proposal who helped with proposal development, for example by reviewing drafts, or by providing critical suggestions or ideas contained within the proposal.**

The information provided on this form will be used to select appropriate and unbiased reviewers for your proposal.

Applicant(s):

Dennis Falaschi, Panoche Drainage District

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes

If yes, please list the name(s) and organization(s):

W.J. Oswald Lawrence Berkeley National Laboratory

F.B. Green Lawrence Berkeley National Laboratory

Helped with proposal development:

Are there persons who helped with proposal development?

Yes

If yes, please list the name(s) and organization(s):

T.J. Lundquist Lawrence Berkeley National Laboratory

Comments:

Budget Summary

Agricultural Drainage Treatment for Selenium & Nitrate Removal

Please provide a detailed budget for each year of requested funds, indicating on the form whether the indirect costs are based on the Federal overhead rate, State overhead rate, or are independent of fund source.

Independent of Fund Source

Year 1												
Task No.	Task Description	Direct Labor Hours	Salary *(per year)*	Benefits *(per year)*	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
1	Planning, permitting, and design		6000	1000	600	500	32000	0	0	40100.0	2000	42100.00
2	Construction and construction administration		5000	800	600	1500	484000	196000	15000	702900.0	8000	710900.00
3	Commissioning and operation		1800	300	0	65000	20000	0	0	87100.0	4000	91100.00
4	Research and performance monitoring		1200	200	0	0	20000	6000	0	27400.0	1000	28400.00
5	Project management, reporting, analysis, and tech transfer		6000	1000	600	1100	10000	2000	0	20700.0	1000	21700.00
		0	20000.00	3300.00	1800.00	68100.00	566000.00	204000.00	15000.00	878200.00	16000.00	894200.00

Year 2												
Task No.	Task Description	Direct Labor Hours	Salary *(per year)*	Benefits *(per year)*	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
1										0.0		0.00
2										0.0		0.00
3			1800	300		65000	0	0	0	67100.0	4000	71100.00
4							422000			422000.0	1000	423000.00
5			6000	1000	600	1100	10000			18700.0	1000	19700.00
		0	7800.00	1300.00	600.00	66100.00	432000.00	0.00	0.00	507800.00	6000.00	513800.00

Year 3												
Task No.	Task Description	Direct Labor Hours	Salary *(per year)*	Benefits *(per year)*	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
1										0.0		0.00
2										0.0		0.00
3			1800	300		65000				67100.0	4000	71100.00
4							422000			422000.0	1000	423000.00
5			6000	1000	600	1100	10000			18700.0	1000	19700.00
		0	7800.00	1300.00	600.00	66100.00	432000.00	0.00	0.00	507800.00	6000.00	513800.00

Grand Total=1921800.00

Comments.

Budget Justification

Agricultural Drainage Treatment for Selenium & Nitrate Removal

Direct Labor Hours. Provide estimated hours proposed for each individual.

3-YEAR TOTALS, General Manager 190 hrs, Water Master 250 hrs, Drainage Coordinator 180 hrs, Foreman 130 hrs, Technician 230 hrs.

Salary. Provide estimated rate of compensation proposed for each individual.

Total wage compensation is estimated to be $35,600. Panoche Drainage District personnel policy recommends that the salaries of individuals not be displayed publicly such as on a website.

Benefits. Provide the overall benefit rate applicable to each category of employee proposed in the project.

Benefits are budgeted at 17% of wages for all categories.

Travel. Provide purpose and estimate costs for all non-local travel.

Travel by District staff to conferences, State agencies, and LBNL will be required. Approximately two air trips and six car trips are budgeted per year. Weekly trips from Berkeley for research activities are included in the LBNL subcontract budget.

Supplies & Expendables. Indicate separately the amounts proposed for office, laboratory, computing, and field supplies.

Operation of the Facility is scheduled for 3 months of Year 1 and 24 months during Year 2 and Year 3. 12-MONTH O&M SUPPLIES BUDGET; Substrate and Coagulant/Flocculant $45,000; Electricity @ $0.12/kWh $12,000; Waste Disposal (Kettleman Hills Landfill) $8,000; 12-month Total $65,000. Additional supplies totalling $5,300 over 3 years will cover office expenses related to technology transfer and project management.

Services or Consultants. Identify the specific tasks for which these services would be used. Estimate amount of time required and the hourly or daily rate.

The following Construction Budget is based on recent experience in wastewater treatment facilities construction by LBNL engineers and the Panoche Drainage District (PDD) consulting engineer. A general construction contractor will execute the construction subcontract which falls under Task 2. A consulting engineer will collaborate with LBNL and PDD to prepare the planning documents and Facility design and to manage the construction. ESTIMATED CONSTRUCTION BUDGET Reduction Pond Units Earthwork and Erosion Control $78,000 Liner, Geotextiles, and Baffles $111,000 Fermentation Cells $94,000 Substrate Tanks, Pumps, and Shed $15,000 Subtotal $298,000 Clarification and Filtration Dissolved Air Flotation Unit, Pumps, & Training $167,000 Rapid Sand Filters, Pumps, and Training $29,000 Drying Bed $3,000 Subtotal $199,000 General Piping, fencing, hydraulic transfer structures, electrical, real-time monitoring system $59,000 Construction Subtotal $571,000 Engineering and Construction Management (15%) $86,000 Subtotal $657,000 Contingency (10%) $66,000 Total Construction and Equipment Cost $723,000 The following Research Budget is based on experience studying the pilot ABSR Facility. LBNL will execute the research subcontract. Some funds are provided for each of the five Tasks but primarily the budget is dedicated to Tasks 1, 4,

and 5. ESTIMATED RESEARCH BUDGET Year 1 Personnel; Months; Cost WJ Oswald; 0.5; $6769 FB Green; 1.3; $8093 NWT Quinn; 0.5; $3879 TJ Lundquist; 1.3; $5200 GA Anderson; 1.8; $4635 Total Labor $28,576 Total Benefits $7677 Scientific Burden $6163 TOC Analyzer $6000 Lab & office supplies, lab waste disposal $20,860 Travel $5834 Recharges $2280 Overhead (45%) $20,814 Federal charges $3796 Total Year 1 $102,000 Year 2 Personnel; Months; Cost WJ Oswald; 1.2; $16,244 FB Green; 7.5; $48,088 NWT Quinn; 1.2; $9,590 TJ Lundquist; 7.5; $30,900 GA Anderson; 12.0; $31,827 C Hseih, GSR; 7.5; $20,309 M Gasca, GSR; 7.5; $20,309 Total Labor $177,267 Total Benefits $49,164 Scientific Burden $38,493 Lab & office supplies, lab waste disposal $22,046 Travel $5834 Recharges $2280 Overhead (45%) $120,839 Federal charges $16,077 Total Year 2 $432,000 Year 3 Personnel; Months; Cost WJ Oswald; 1.2; $16,244 FB Green; 7.3; $48,210 NWT Quinn; 1.2; $9,877 TJ Lundquist; 7.3; $30,978 GA Anderson; 12.0; $32,782 C Hseih, GSR; 7.5; $20,918 M Gasca, GSR; 7.5; $20,918 Total Labor $179,928 Total Benefits $49,884 Scientific Burden $39,068 Lab & office supplies, lab waste disposal $16,430 Travel $5834 Recharges $2280 Overhead (45%) $122,499 Federal charges $16,077 Total Year 3 $432,000 LBNL Subcontract 3-Year Total $966,000

Equipment. Identify non-expendable personal property having a useful life of more than one (1) year and an acquisition cost of more than $5,000 per unit. If fabrication of equipment is proposed, list parts and materials required for each, and show costs separately from the other items.

The following equipment installed costs are also included in the subcontract budgets in the box above. 1 Dissolved Air Flotation Unit $160,000 2 Rapid Sand Filters $14,000 2 Influent pumps $4,000 1 Filter influent pump $2,000 2 Substrate pumps $2,000 1 Substrate tank $3,000 2 Coagulant pumps $3,000 2 Float pumps $3,000 1 Total organic carbon analyzer (lab equipment) $6,000

Project Management. Describe the specific costs associated with insuring accomplishment of a specific project, such as inspection of work in progress, validation of costs, report preparation, giving presentatons, reponse to project specific questions and necessary costs directly associated with specific project oversight.

Funds budgeted for Panoche Drainage District (PDD) senior staff (totalling approximately $40,000) are primarily to support project management. Project management tasks include (1) ensuring proper completion of subcontracted tasks and associated cost validation, (2) Ensuring treatment facility permitting, design, and operation are consistent with policies and preferences of the PDD Board of Directors and CALFED, (3) participating in technology transfer activities such as tours, presentation, bulletin writing, and technical report review.

Other Direct Costs. Provide any other direct costs not already covered.

Land purchase at the treatment plant site is estimated to require $15,000.

Indirect Costs. Explain what is encompassed in the overhead rate (indirect costs). Overhead should include costs associated with general office requirements such as rent, phones, furniture, general office staff, etc., generally distributed by a predetermined percentage (or surcharge) of specific costs.

The minimal overhead charged by the Panoche Drainage District contributes to the support of office and field staff, phones, copying, and other minor miscellaneous general expenses.

Executive Summary

Agricultural Drainage Treatment for Selenium & Nitrate Removal

Proposed project is the next step in development of the Algal-Bacterial Selenium Removal (ABSR) Process for treatment of agricultural drainage. Full-scale implementation of the ABSR Process is expected to be possible following the proposed three-year project and would lead to decreased loads of selenium and nitrate reaching the San Joaquin River via Mud Slough. CALFED identifies selenium as a likely contributor to the decline of fish and wildlife populations, and the San Francisco Bay Regional Water Quality Control Board staff recommend decreasing current selenium loading to the estuary by at least 50% (CALFED, 2000). Nutrients such as nitrate are an indirect source of oxygen-depleting substances that hinder fish migration in the San Joaquin River (CALFED, 2000). During the 1999-2000 water year, approximately 2,100 kg of selenium were discharged with agricultural drainage via Mud Slough to the San Joaquin River (SJR) (SFEI, 2001). Subsurface agricultural drainage is thought to be the primary cause of increasing nitrate concentrations in the SJR since the 1960s (Kratzer and Shelton 1998). Treatments proposed for removal of selenium and nitrate, such as reverse osmosis and wetlands, have yet to overcome the disadvantages including membrane scaling/high power use and high land requirements, respectively (Tanji, 1999; Hedrick, 2001). The ABSR Process has been developed to remove selenium and nitrate from subsurface agricultural drainage. During the past four years, a 20,000-gallon per day, pilot-scale ABSR Facility has been operated by the Panoche Drainage District (District) and used by researchers at the University of California (UC) and Lawrence Berkeley National Laboratory (LBNL) to develop and evaluate several ABSR operating modes during all seasons to determine their applicability for future larger-scale ABSR facilities. The pilot ABSR Facility, with advanced treatment consisting of dissolved air flotation followed by sand filtration, has been shown to economically remove 87% of influent total selenium and 95% of influent nitrate. These results recommend the ABSR Process for scale-up testing. Construction, operation, and research monitoring of a 16-fold scale-up (1 acre-foot/day or 220 gpm) ABSR Facility is proposed for a site adjacent to the existing pilot ABSR Facility. The work will be conducted by the District, the District engineer, a general contractor, and the research groups that currently study the pilot ABSR Facility.

Proposal

Panoche Drainage District

Agricultural Drainage Treatment for Selenium & Nitrate Removal

Dennis Falaschi, Panoche Drainage District

AGRICULTURAL DRAINAGE TREATMENT FOR SELENIUM & NITRATE REMOVAL

Proposal to the

CALFED BAY-DELTA PROGRAM
ECOSYSTEM RESTORATION PROGRAM

by the

PANOCHE DRAINAGE DISTRICT

October 5, 2001

A1. Executive Summary

Proposed project is the next step in development of the Algal-Bacterial Selenium Removal (ABSR) Process for treatment of agricultural drainage. Full-scale implementation of the ABSR Process is expected to be possible following the proposed three-year project and would lead to decreased loads of selenium and nitrate reaching the San Joaquin River via Mud Slough. CALFED identifies selenium as a likely contributor to the decline of fish and wildlife populations, and the San Francisco Bay Regional Water Quality Control Board staff recommend decreasing current selenium loading to the estuary by at least 50% (CALFED, 2000). Nutrients such as nitrate are an indirect source of oxygen-depleting substances that hinder fish migration in the San Joaquin River (CALFED, 2000).

During the 1999-2000 water year, approximately 2,100 kg of selenium were discharged with agricultural drainage via Mud Slough to the San Joaquin River (SJR) (SFEI, 2001). Subsurface agricultural drainage is thought to be the primary cause of increasing nitrate concentrations in the SJR since the 1960s (Kratzer and Shelton 1998). Treatments proposed for removal of selenium and nitrate, such as reverse osmosis and wetlands, have yet to overcome the disadvantages including membrane scaling/high power use and high land requirements, respectively (Tanji, 1999; Hedrick, 2001). The ABSR Process has been developed to remove selenium and nitrate from subsurface agricultural drainage. During the past four years, a 20,000-gallon per day, pilot-scale ABSR Facility has been operated by the Panoche Drainage District (District) and used by researchers at the University of California (UC) and Lawrence Berkeley National Laboratory (LBNL) to develop and evaluate several ABSR operating modes during all seasons to determine their applicability for future larger-scale ABSR facilities. The pilot ABSR Facility, with advanced treatment consisting of dissolved air flotation followed by sand filtration, has been shown to economically remove 87% of influent total selenium and 95% of influent nitrate. These results recommend the ABSR Process for scale-up testing. Construction, operation, and research monitoring of a 16-fold scale-up (1 acre-foot/day or 220 gpm) ABSR Facility is proposed for a site adjacent to the existing pilot ABSR Facility. The work will be conducted by the District, the District engineer, a general contractor, and the research groups that currently study the pilot ABSR Facility.

A2. Water Quality Issues

Selenium: Selenium found in subsurface drainage readily bioaccumulates throughout exposed aquatic habitats. Such bioaccumulation and can result in chronic toxicity in waterfowl and fish, especially salmonids (Ohlendorf *et al*., 1986; RDTC, 1999; CALFED, 2000). The San Francisco Bay RWQCB has recommended decreasing current selenium loading to the Bay estuary by 50% or more.

The major sources of selenium in the Bay-Delta are agricultural drainage and oil refinery effluents (CALFED, 2000).

The Grasslands Area Farmers have invested in techniques for improved drainage management, and selenium mass discharges have decreased by 54% since 1996 (Authority, 2001). But during the 1999-2000 water year, the Grasslands districts discharged drainage containing approximately 2,100 kg of selenium to the San Joaquin River via Mud Slough (SFEI, 2001). During June 1999 to June 2001, the total selenium concentration in this drainage ranged from 26 µg/L to 99 µg/L in flows of 32 acre-feet/d to 163 acre-feet/d (AF/d) (CVRWQCB, 2001).

Nitrogen: Nitrogen contamination of rivers and groundwater is a major environmental and public health concern the SJR basin (CVRWQCB, 1998). Some of the deleterious effects of nitrogen are ammonia toxicity and eutrophication including oxygen depletion and organic carbon production. Mud Slough and Salt Slough contribute nearly half of the nitrate load to the SJR and subsurface agricultural drainage has been the primary cause of increasing nitrate since the 1960s (Kratzer and Shelton, 1998). Algae contribute to oxygen demand due to their respiration in the dark and due to nitrification of ammonia released during their decomposition. This oxygen demand contributes to the low dissolved oxygen (DO) barrier that can form seasonally at the Stockton Deep Water Ship Channel (Lee and Jones-Lee, 2000). Low DO impairs fish migration; kills aquatic organisms; creates odors; and impairs fish reproduction and juvenile rearing (CALFED, 2000).

Nutrients affect water disinfection indirectly by supporting the growth of algae and other organisms, which subsequently add organic carbon to water supplies. Organic carbon is a precursor to disinfection byproducts and numerous other problems in drinking water treatment (CALFED, 2000). Among other benefits, lowering algae and organic carbon concentrations in the SJR would presumably lower the cost of enhanced coagulation and/or microfiltration at water treatment plants.

Applicability to CALFED Goals

The proposed project will meet CALFED goals by the further development and demonstration of an economical process to remove nitrate and selenium from drainage prior to its discharge to the SJR. These contaminants are direct stressors or lead to stressors such as algae blooms in the SJR (CALFED, 2000). Numerous CALFED projects are synergistic and share similar goals with the proposed project including the current pilot-scale ABSR project and other CALFED projects on DO depletion and real-time water quality management.

The site of the proposed scale-up ABSR Facility has been used as the site of many drainage treatment studies since the mid-1980s. The site is adjacent to the existing pilot ABSR Facility and the Panoche Drainage District's reverse osmosis research project. Synergies already occur between the ABSR and RO project staffs such as increased frequency of plant observation and information interchange. The expansion of this testing site builds on existing District and CALFED work and will undoubtedly lead to further interaction between projects.

A3. Nature, Scope, And Objectives

We propose to study selenium and nitrate removal in large-scale experiments using the ABSR Process. By reducing the overall selenium mass and consequential toxicity potential, the ABSR Process should benefit the Bay-Delta system from Mud Slough to the ocean. The proposed facility will provide further performance data and operational requirements that will assist the Panoche Drainage District and other Districts on the westside of the SJR Basin, Tulare Basin, Salton Sea Basin, and other areas with similar drainage problems.

The ABSR Project is integrated with District, RWQCB, DWR, and USBR activities through the

In-Valley Planning Workgroup and the Grasslands Bypass Agreement. The ABSR Project would allow continuation of the existing database on water quality currently collected and analyzed by UC and LBNL from the Buick and Northside Drains and the drainage sump serving the existing pilot ABSR Facility. These data combined with District flow data allow loads of many constituents to be calculated. The ABSR Facility will use a real time water quality monitoring system that is integrated with District's existing system used to monitor the Grasslands Bypass.

Reduction of selenium and nitrogen contamination of drainage would give flexibility to salt management techniques such as brine disposal. Brines from RO or evaporation disposal are more safe and less likely to have algae blooms. Drainage treatment is a more long-term solution than is drainage recycling and active land management that may have long-term land salinization problems. Treatment supports the tradable load concept by having a single entity removing measurable contaminant loads.

A 20,000-gallon per day, pilot-scale ABSR Facility has been treating agricultural drainage water in the District on the west-side of the San Joaquin Valley since 1997. The pilot-scale ABSR Facility consists of a series of ponds designed to promote indigenous microorganisms which remove nitrate and selenium. The ABSR Process is similar to the commercially mature wastewater treatment process that was developed by Professor W.J. Oswald and his engineering research associates at UC over the past four decades. During 1997 and 2000, the Pilot ABSR Facility reduced nitrate over 95% and reduced total soluble selenium mass by 80%. Recent pilot sand filtration studies have shown over 90% removal of total selenium. Filtration is important to remove particulate and organic selenium. Investigations at the Facility have focused on optimizing operational parameters and determining operational costs and scale-up engineering requirements. Preliminary combined captial and operations cost for the ABSR Process are estimated to be $200/AF to $300/AF for full-scale ABSR Facilities with a capacity of 30 AF/d including solids disposal. The literature indicates that the ABSR Process has longest track record and lowest projected cost of any drainage treatment technology for selenium removal (Quinn *et al*., 1998). The ABSR project is a collaboration among the District and engineers, microbiologists, and chemists from the University of California at Berkeley and Lawrence Berkeley National Laboratory. Up to this time, the project has been sponsored by the U.S. Bureau of Reclamation. Through other funding sources, operation of the pilot-scale ABSR Facility is expected to continue for new experiments and for comparison with the proposed the intermediate-scale, 1-AF/d ABSR Facility.

The ABSR Process

The basic concept underlying the ABSR Process is to grow microalgae in drainage water and to use the algal biomass, together with supplements, as the carbon sources for indigenous nitrate- and selenium-reducing bacteria such as *Pseudomonas* and *Bacillus* (Oswald, 1985; Gerhardt *et al.*, 1991; Lundquist *et al.*, 1994; Green *et al*., 2001; Zarate, 2001). In the near absence of oxygen and nitrate, the bacteria use soluble selenate as an electron acceptor reducing it to selenite and other insoluble forms such as organic and elemental selenium. A portion of the selenite combines with polyvalent cations present in the drainage to form insoluble precipitates that remain in the sediment on the floor of the deep Reduction Ponds (RPs). Further selenite and particulate selenium removal and clarification can be accomplished by dissolved air flotation and sand filtration. Supplemental carbon sources such as molasses and algal biomass are used as bacterial substrates.

Past and current studies show that DO and nitrate concentrations must be reduced to low levels before selenate reduction can be optimal. In the ABSR Process, DO and nitrate are reduced during respiration by microorganisms at the floor of the RPs which are either sufficiently deep or covered to decrease the intrusion of atmospheric oxygen. Since nitrate concentrations in drainage water are often as high as 90 mg/L as N compared to <0.5 mg/L of selenium, the carbon requirement for nitrate reduction far exceeds that required for selenium reduction. At 2,000 to 4,000 mg/L (as SO_4^{2-}), sulfate is even more concentrated in drainage than nitrate and, therefore, could divert substantial carbon substrate to sulfate reduction. However, sulfate reduction has been found to be only a minor reaction in the ABSR Process, and it does not appreciably interfere with nitrate or selenium reduction.

If the filter effluent requires reoxygenation or ammonia removal, it can be subsequently treated in a HRP where microalgae produce dissolved oxygen and ammonia assimilation. HRPs are shallow, continuously-mixed raceways designed to maximize algal productivity and bacterial oxidation of dissolved organic matter. The low-speed paddle wheel mixing of HRPs requires only 5 to 10 kWh/acre/d (Green, 1998).

Insoluble selenium removed from the water column accumulates in settled algal-bacterial biomass and inert materials on the floor of the RPs. This biomass is continuously undergoing anaerobic decomposition, so the volume of solid residues increases only slowly over many years. Based on experience with similar pond designs, removal and disposal of the solids in a landfill should not be required for many years, if not several decades (Green *et al.*, 1995). Alternatively, the dried inert solids which contain nitrogen, phosphorus, as well as selenium, could be valuable as a soil amendment and fertilizer in the eastern Central Valley where the soils are selenium deficient.

Large-scale ABSR Facilities are expected to pose much less hazard to wildlife than the surrounding drainage channels, evaporation ponds, or drainage-contaminated wetlands. Concentrated selenium would be sequestered in deep Reduction Ponds. In contrast, the selenium-contaminated sediments of wetlands support invertebrates and require special management to prevent feeding by birds that would likely lead to selenium bioaccumulation.

Conceptual Model for ABSR Experiments

The experiments with the intermediate-scale ABSR Facility will focus on mass balances and redox potential balances to validate treatment performance and elucidate treatment mechanisms. This approach is described in some detail in the Hypotheses and Tasks sections. A conceptual sketch of the ABSR Process is attached.

Other potential benefits of the ABSR Technology are pretreatment for hardness and selenium prior to RO treatment. Scaling of RO membranes caused by hardness is a major detriment to salt removal from drainage and consequentially, reduction of salt in the SJR. This aspect of the ABSR Technology will be explored at the existing Pilot ABSR Facility pending Proposition 204 funding.

Objectives, Hypotheses, and Research Plan Outline

Many of the experiments described below cannot be performed adequately in the existing pilot system or in the laboratory. These experiments will help determine the feasibility and cost of full-scale ABSR Facilities treating tens of acre-feet per day and covering tens of acres.

The monitoring program of Task 4 will complement and support the experiments outlined with hypotheses below. Hypotheses 1 and 2 relate to prevention of DO in the surface of the proposed intermediate-scale Reduction Pond from interfering significantly with nitrate and selenium reduction. At 1.2 acres, the surface area of the proposed Reduction Pond will be 12-times that of the pilot Reduction Ponds. All hypotheses will be tested by comparing an intervention in one Reduction Pond Unit to the other Reduction Pond Unit which will act as the experimental control.

Hypothesis 1: The increased depth (17 ft) of the proposed Reduction Pond vs. the 10-ft deep pilot Reduction Ponds will improve treatment by preventing wind mixing of surfaced DO into the anoxic reducing zones. Influent flow short-circuiting will be less in the 17-ft vs. 10-ft deep Reduction Pond. **Background:** Increased depth increases anaerobic activity in sewage treatment ponds and reduces wind mixing. The increased size of the proposed ABSR Facility will allow construction of a Reduction Pond with the depth originally envisioned for full-scale facilities. **Approach:** Dye tracer studies during summer and winter will indicate surface water mixing depths and influent flow short-circuiting. Redox/temperature measurements by four sets of probes, suspended at 3-ft intervals in the water column, will be correlated with continuously-recorded wind speed and direction. **Adaptive Management:** If wind mixing is found to be significant, molasses substrate dose will be increased and the dampening effect upon redox fluctuations will be determined. The expense of the additional molasses will be compared with expense and measured benefit of other interventions such as pond baffles or floating covers.

Hypothesis 2: Despite a much lower surface-to-volume ratio, the intermediate-scale Reduction Pond will remove selenium and nitrate at rates similar to the pilot Reduction Ponds. **Background:** The location of the treatment bacteria is crucial in process scale-up due to lower surface-to-volume ratios. Suspended bacterial biomass and particulate selenium in the pilot Reduction Ponds indicate that a majority of selenium reduction occurs in the water column rather than in the bacterial biomass attached to the pond walls and floor. **Approach:** Compare reduction rates of the intermediate-scale Reduction Ponds with the rates in the pilot Reduction Ponds during the periods when they were uncovered. The molasses dosing rates in the pilot and intermediate-scale Reduction Ponds will be matched.

Hypothesis 3: Media for bacterial attachment placed in the Reduction Pond will reduce suspended solids and particulate selenium in the Pond effluent and increase nitrate and selenium removal rates. **Background:** Thick biomass is seen growing on the walls of the pilot Reduction Ponds and inside associated pipes. Increased attachment surface area may promote attached bacteria over suspended bacteria, possibly lowering particulate selenium in the Reduction Pond effluent. **Approach:** Place media, such as geotextile, in one Reduction Pond unit. Compare biomass growth and selenium content, and selenium treatment efficiency with control Reduction Pond unit.

Hypothesis 4: Continuous operation of particle separation equipment (dissolved air flotation followed by rapid sand filtration) for removal of particulate selenium, selenite, and suspended solids will be reliable and require less than 1 hour for daily maintenance and adjustment. **Background:** Flotation and filtration have been successful at the pilot ABSR Facility at 10 gpm, but full-scale equipment has better features than pilot units such as higher throughput ratings, absence of clogging valves, and automatic controls. District personnel will gain operational experience with full-scale equipment prior to making decisions to invest in larger facilities. **Approach:** Evaluate full-scale, state-of-the-art particle separation equipment (e.g., DAF Corp. & KWI, Inc.) in terms of water quality performance, coagulant requirements, and operator requirements.

Hypothesis 5: With a 15-day hydraulic residence time (HRT) and 0.25 g/L molasses dose, the large-scale ABSR Facility with full-scale particle separation equipment remove at least 85% of influent total selenium and remove at least 85% of the selenium bioaccumulation/bioconcentration potential of the drainage. **Background:** During a 2-month experiment, unfiltered effluent from the pilot ABSR Facility was found to contain particulate selenium, selenite, and possibly organic selenium which bioaccumulate in invertebrates. Two methods have since been demonstrated to remove these constituents: 1) flotation and filtration using ferric chloride coagulant, and 2) slow sand filtration. **Approach:** Monitor influent and effluent water quality and bioaccumulation per Task 4. Adjust HRT and dose, as needed, to achieve removals of 85% or greater.

Many other hypotheses will be tested but the above are particularly important.

A4. Methods, Procedures, and Facilities

Adaptive Management

Adaptive management is a normal component of the proposed engineering research. The research goal is to improve treatment performance by adapting the operation or configuration of the Facility according to research results. The mechanisms of treatment and the microbiological, physical, and chemical behavior of the system will be investigated under programmed sets of variables. The adaptive management plans are embodied in the monitoring and research described in the hypotheses above and in the Monitoring Task 4 below.

Proposed Facility

A preliminary design has been completed as part of the preparation of this proposal and allows estimation of Facility construction and operation costs and land requirements. The proposed ABSR Facility design is similar to sewage treatment facility designs by the engineering firm Oswald Engineering Associates, Inc. such as was implemented for the Delhi County Water District in 1997 and the Hilmar County Water District in 2001, both in Merced County. Therefore, the construction techniques and costs are well known.

The major components of the 1-AF/day ABSR Facility will be a Reduction Pond divided with a baffle into two identical units, a dissolved air flotation (DAF) clarifier, and an automatic backwash sand filter. Two separate Reduction Ponds would be preferable in order to increase the overall operational flexibility of the Facility, but to reduce project costs, the single Reduction Pond will be divided into two units using a water-tight, longitudinal baffle. With a divided Reduction Pond, operating parameters may be optimized by conducting experiments using one unit as the control and the other as the variable. Additional baffles will divide each half Reduction Pond unit into at least three cells to reduce flow short-circuiting. The Reduction Pond will be lined with high density polyethylene plastic membrane. A possible future phase of the project would include construction of High Rate Ponds for reoxygenation and ammonia removal. The studies proposed herein will determine this need.

The site is ideal due to its proximity to channels carrying drainage with the highest selenium concentrations within the Panoche Drainage District. The source of drainage for the Facility will be the Buick Drain which collects drainage from 12 sumps with high selenium concentrations. The average total soluble selenium concentration in the Buick Drainage has been 401 μg/L during April 1998 to March 2000. A pipe will bring drainage from the Buick Drain under the access road to a 10,000-gallon desilting basin. There, a pump will deliver the drainage to a metering and splitter structure. Flow will be divided between the divided Reduction Pond units. The entire Reduction Pond will have a surface area of 1.2 acres and a 17-foot water depth. Animal feed-grade molasses will be dosed into the influent at 2-4 gallons/hour. The influent, with molasses, will then be discharged at the floor of each Reduction Pond unit. In the Reduction Pond, drainage nitrate will be denitrified, and selenate will be reduced to selenite, elemental selenium, and organic selenium.

The Reduction Pond effluents will be coagulated and subjected to DAF clarification and sand filtration to remove bacteria, algae, and particulate forms of selenium. The DAF clarifier will be a 10-foot diameter by 4-foot tall KWI Superfloat or DAF Corp FC100 capable of treating 1.8 AF/day. The sand filter will be an Everfilt or equivalent with automatic backwash and a maximum capacity of 2 AF/day. The excess capacity in the DAF and filter is beneficial in the event that the treated flow can be increased above 1 AF/day. The final effluent from the sand filter will be discharged back into the Buick Drain. Solids collected from the DAF and filter will be dried in under-drained sand beds occupying 0.2 acres. The sand beds will be covered with netting if birds are attracted. The solids will be dried and placed in covered stockpiles for disposal on a regular basis. Conditions attractive to wildlife will not be created.

The following tasks will be performed during the proposed 1-AF/day ABSR Facility implementation. Many details are omitted due to the page limitation.

Task 1. Planning, permitting, and design (April-July 2002)

- District contracts with Summers Engineering, Inc. (the District Engineer) for surveying and preparation of the planning documents and permit applications. The preliminary and final designs will be provided by LBNL. District purchases six acres adjacent to and including the pilot ABSR Facility (see Plan View).
- The District will be the lead agency for any NEPA/CEQA compliance requirements. The site has been used for decades for row crops and has no valuable habitat. As a research project, we expect that the project will receive a categorical exclusion from NEPA/CEQA, but time and funds are allowed in the event that a RWQCB discharge permit is required. The Engineer and LBNL personnel have considerable experience in obtaining discharge permits from RWQCB/CVR.

Task 2. Construction (August-October 2002)

- Engineer prepares construction bid documents. District selects general construction contractor. Construction completed.

Task 3. Training and operation (Phase 1: November 2002-April 2004)

- LBNL personnel train District operating staff. District starts-up and operates the Facility in collaboration with LBNL.
- District maintains equipment, provides substrate and coagulant, records operating conditions and flows; monitors water quality parameters (pH, temperature, DO, and redox potential).

Task 4. Research and performance monitoring (Phase 1: November 2002-April 2004)

- LBNL performs a series of tests over the half year of operation that are intended to answer design questions (described above in "Research Plan Outline"). Performance optimization will continue pending subsequent funding. Seasonal maximum hydraulic loading rates and the corresponding substrate doses required for nitrate and selenium reduction will be determined. Also during the first year of operation, the minimum coagulant doses will be determined for the full-scale DAF that results in the sand filter effluent quality described in the Table 1.
- District seeks funding for additional year of optimization and performance monitoring.

Subtask 4.1. Mass balances and treatment performance validation

- The data required to perform selenium, nitrogen, phosphorus, and carbon mass balances will be collected by LBNL. These data will also be used to calculate balances of redox equivalents. Weekly composite samples will be collected from the Facility influent and effluent. Weekly grab samples will be collected at the influent and effluent of each intermediate treatment unit. Influent and effluent flows will be recorded continuously using telemetered monitoring equipment similar to existing District equipment. Samples of pond sediments, DAF solids, and filter backwash will also be analyzed. Effluent turbidity will be monitored, and general minerals and trace metals will be determined quarterly. Methods are described in *Standard Methods* (APHA, 1998) and Martens and Suarez (1997) with modifications for ABSR Process developed by UC Berkeley and LBNL (Zarate, 2001).
- **Selenium:** Selenium species to be determined routinely in water samples are selenate, selenite, particulate selenium, and organic selenium. The inorganic and organic selenium concentrations in multiple pond sediment samples will be determined twice-annually. Total selenium in DAF and filter solids will be confirmed at least quarterly. The concentration of

volatile selenium compounds in water samples will be determined at least twice annually. The selenium mass balance will reveal the partitioning of selenium within the Facility ponds and validate the removal performance of the Facility.

• **Nitrogen:** The following forms of nitrogen will be monitored in each treatment component: nitrate, nitrite, ammonia, and organic. Total Kjeldahl nitrogen will be measured in the pond sediments and in the DAF/filter solids. Gas samples collected at the pond surface will be analyzed for dinitrogen gas and oxides of nitrogen.

• **Carbon:** Total organic and inorganic carbon and total and volatile suspended solids in the influent and effluent of each pond will be determined weekly, in the DAF/filter solids once per month, and in the pond sediments once per year. Gas samples captured from the pond surfaces will be analyzed for carbon dioxide and methane gas.

• **Phosphorus:** Phosphorus is limiting nutrient in drainage and is a vital in biological treatment. The total and soluble reactive phosphorus will be monitored in the influent and effluent of each pond weekly, in the DAF/filter solids once per month, and in the pond sediments once per year.

• **Sulfur:** Dissolved hydrogen sulfide concentration versus depth will be determined monthly in each unit of the Reduction Pond.

• **QA/QC:** All water quality analyses will be validated with QA/QC procedures using matrix spikes, split and duplicate samples, blanks, and standards.

Subtask 4.2. Environmental effects

• Selenium bioaccumulation/concentration by several types of caged invertebrates and periphyton will be measured twice-yearly in the influent and effluent of the Facility. Particulate matter and selenium will be monitored (Task 4.1). Statistical hypothesis testing will be used. Inclusion of activated carbon in the final filtration media will also be evaluated by bioassay.

• The number, species, and activity of any birds at the Facility will be recorded daily.

Subtask 4.3. Monitoring of microbial communities

• The Biolog assays will provide preliminary identifications of bacteria present in the ABSR Facility ponds at least twice per year. Confirmations using 16S rDNA will be performed as necessary. The bacterial types and density will be compared to treatment performance and used as part of the validation of treatment.

Subtask 4.4. Cost Analyses

• Records will be maintained of the costs of all electricity, substrates, coagulants, and personnel time.

• The cost records and the treatment performance data will be used to update cost estimates of the ABSR Process as applied at larger scales (e.g., 10 AF/day and 30 AF/day) and under various seasonal conditions. The results will be provided to the In-Valley Treatment and Disposal Workgroup and to agencies for use in planning activities.

Task 5. Project management, report preparation, data analysis, engineering analysis, and technology transfer (April 2002-April 2004)

• The Engineer and LBNL will coordinate activities described in Tasks 1 and 2. The District and LBNL will coordinate the operation, monitoring, and supply requisitions of Task 3.

• LBNL will prepare the quarterly and annual reports. The reports will be peer-reviewed and describe project activities and treatment results and interpret all analytical, quality control, and operations data. LBNL will also prepare articles for submission to peer-reviewed journals such as *California Agriculture* and the *Research Journal of the Water Environment Federation.*

- An article describing project activities and results will be published twice-annually in the District newsletter, *The Panoche Fan*. Presentations will be made at water conferences.
- The newsletters and other ABSR Process information will be maintained on an LBNL project website that is linked to other drainage-related websites such as the U.C. Salinity/Drainage Program and the Grasslands Bypass Project.
- Facility tours will be provided to interested growers, regulators, scientists, and non-profit organizations.

A6. Monitoring and Assessment Plan & Data Handling and Storage

The monitoring and assessment activities are described in Task 4 and Task 5 above. The data collected from the proposed Facility will be stored and manipulated in Excel spreadsheets which can be made accessible to CALFED. The spreadsheets will be used for calculating mass balances and investigating the influences of operations and environmental conditions. Data will be analyzed in terms of mass pollutant removals, concentration averages, and effluent concentration probabilities. Laboratory quality control results will be entered in the same spreadsheets as the sample data, allowing convenient confirmation of the reliability of the laboratory analyses. Multi-variate statistics may be used to analyze seasonal influences on treatment, and orthogonal squares experimental designs may be used during DAF and filter evaluations.

Performance Measures

Based on information available to date, the influent and final effluent are expected to have the annual average characteristics shown in Table 1. The goal of the treatment facility is not necessarily to remove selenium to < 5 µg/L, the regulatory objective, in the ABSR Facility effluent but to greatly reduce selenium in the areas contributing the greatest selenium load to the SJR. By reducing selenium loads, other drainage management techniques and river dilution can be used to meet the 5 µg/L limit at the Crows Landing compliance point on the SJR .

Table 1. Expected influent and effluent water quality at the 1-AF/day ABSR Facility.

Parameter	Expected Influent Levels	Expected Effluent Levels
Total selenium	394 µg/L	<60 µg/L
Selenate-Se	388 µg/L	<50 µg/L
Selenite-Se	3 µg/L	<5 µg/L
Organic-Se	3 µg/L	<5 µg/L
Total nitrogen	72 mg/L	<14 mg/L
Total ammonia as N	1 mg/L	<2 mg/L
Nitrate+nitrite as N	70 mg/L	<10 mg/L
Organic N	1 mg/L	<2 mg/L
Turbidity	4 to 30 NTU	<5 NTU
Suspended solids	5 to 40 mg/L	<10 mg/L
Orthophosphate	0.3 mg/L	<0.5 mg/L
BOD_5	3 mg/L	<4 mg/L

A7. Intermedia Impacts

The ABSR Process involves converting soluble selenium to insoluble forms that are removed from the water as solids. These solids will be dried and, if required, disposed in the Kettleman Hills landfill. These solids may prove to be valuable as a soil amendment. In the ABSR Process, nitrate is mostly converted to inert nitrogen gas with a small amount being assimilated into bacterial biomass. If bacterial substrate levels are decreased to low levels, oxides of nitrogen may be produced in addition to nitrogen gas. Energy consumption by the ABSR Process and its associated carbon dioxide emission is low compared to conventional wastewater treatment technologies or advanced methods such as reverse osmosis.

A8. Long-Term Operations and Maintenance

The District is likely to continue the operation of the ABSR Facility after completion of the proposed CALFED research project in order to reduce selenium loads to the Grasslands Bypass. The District has served the area for over 40 years and is financially sound with a current annual budget of $1.1 million. The District is the largest in the Grasslands Bypass area and is managed by General Manager, Dennis Falaschi, and its five-member Board of Directors.

B1. Environmental Justice

The project will contribute to environmental justice by promoting the ecological sustainability of irrigated agriculture in the western SJV. Farming supports people across socio-economic classes. With full-scale implementation of ABSR Process, the water quality improvements in the SJR should benefit downstream drinking water quality and reduce toxicity to wildlife.

B2. Outreach and Local Involvement

Community and professional outreach activities are described in Task 7 above. The Panoche Drainage District in cooperation with its associated irrigation district, the Panoche Water District, are the local public entities responsible for irrigation water management. District activities are coordinated with the San Luis & Delta-Mendota Water Authority and the RWQCB. The District frequently hosts tours of its water and drainage facilities for State, national, and international groups. Information is disseminated locally through the Panoche Fan newsletter. The site landowner is supportive of the proposed project (see attached letter).

B3. Training, Employment, and Capacity Building Potential

Three to five District employees will be trained in ABSR Facility operation and management. The operators will gain experience and expertise in water treatment technology providing a foundation for their operation of future full-scale ABSR facilities.

Regional personal income and employment projections to 2009 were made in the Grassland Bypass Project EIS/EIR (URS, 2001). Drainage management using only drainage recycling for irrigation, without treatment, would cause regional output to decline by $55 million, personal income to decline by $16 million, and employment to decrease by 960 jobs. These declines would be caused primarily by lower crop productivities due to salt accumulation on farmland. With the Bypass and treatment, regional output was projected to increase by $33 million, personal income to increase by $9 million, and employment to increase by 550 jobs.

B4. Communications and Local Community Knowledge of Project (see B2)

C. QUALIFICATIONS

The Panoche Drainage District has been a leader among westside water districts in water conservation, irrigation efficiency, drainage volume reduction, and selenium management efforts. In addition to hosting numerous selenium treatment studies and providing significant in-kind services and cash contributions, the District has implemented two full-scale selenium management projects during the past six years. The District is the largest drainage district in the Grasslands Bypass Project, and in 1998 the District completed a drainage water recirculation system to allow blending and reuse of drainage water in order to help meet selenium load limits. Through extensive planning, monitoring, and drainage management, the District has made great progress in reducing selenium discharges and has gained essential experience in selenium control in both wet and dry years.

For the proposed project, subcontracting partnerships will be formed between the District and consulting engineers and with researchers at LBNL with specialties in the ABSR Process and drainage management (W.J. Oswald, F.B. Green, N.W.T. Quinn, Center for Environmental Biotechnology, LBNL; T.J. Leighton, Molecular and Cell Biology, UC; D.P. Weston, Integrative Biology, UC), and with a construction contractor. All partners and their staffs have extensive previous experience with the ABSR Process and Grasslands area drainage issues.

The short resume of Principal Investigator Dr. W.J. Oswald are appended to this proposal.

D. COSTS AND BENEFITS: Cost Sharing

During each phase of the project, the District will contribute necessary staff time at no cost to CALFED. During the planning and design phase, the District staff will participate in preparation of planning documents and attend planning meetings. After project approval, District personnel will arrange the acquisition of the Facility site, select a construction contractor, and oversee construction themselves or contract with a surveyor engineer and a construction engineer to provide site surveys and inspections.

After completion of the Facility, District personnel will operate and monitor the Facility with the guidance of LBNL researchers. Routine monitoring will include confirming flow measurements and molasses dosing rates, checking DAF air flow, confirming coagulant dosing rates, checking filter backwash frequency, and general site surveillance. The District will also assist with off-loading of bulk supplies. Electricity will be paid by the District. The annual in-kind services of the District are estimated to be at least $30,000 per year for three years.

Budget Justification

Planning/permitting cost estimates are based on experience of the engineers with similar facilities. The construction cost estimates are based on a preliminary design and unit costs prepared by LBNL. Operations and maintenance estimates were prepared by LBNL based on costs at the pilot ABSR Facility. Finally, monitoring and research costs are based on sample collection and analysis costs of the current pilot project including QA/QC, research management, and report preparation. Analysis costs are many times lower than available at commercial laboratories.

Benefit Summary and Breakdown

Benefits to overall CALFED goals are described in an earlier section.

Outcome	Measure	Benefits (Beneficiary)	Qualitative Value
Reduced selenium in SJR/Delta/ Bay	Selenium removed by ABSR Facility	Reduced environmental stress (aquatic wildlife); Reduced loading to the Grasslands Bypass (Authority*)	Possible increased fish and waterfowl stocks due to reduced selenium toxicity
Reduced nitrogen in SJR/Delta/ Bay	Nitrogen removed by ABSR Facility	Reduced environmental stress (aquatic wildlife); reduced algae and organic carbon in SJR (water treatment plants, public; fish migration);	Possible reduced drinking water treatment costs; reduced disinfection byproducts; increased fish stocks

* San Luis & Delta-Mendota Water Authority

Cost-Benefit Assessment

The proposed research will presumable lead to full-scale implementation of the ABSR Process which would provide a significant improvement in water quality in drainage entering the SJR. Assignments of monetary benefits due to improved water quality are difficult to make. However, regulatory agencies have determined that water quality should be improved as discussed in A2. Treatment of the Grasslands Bypass flow (40 cfs, 25 mg/L N) for selenium and nitrate removal would have a total cost of $4-9 million/year (20 years, 7% interest) based on preliminary information from the pilot ABSR project. Nitrogen discharge to SJR would decrease by ~2,500 kg per year which, given no other limitations, has the potential to growth 30,000 kg of algal suspended solids. Selenium removal would be approximately 1,800 kg per year. During 1985-1995, selenium load to the lower SJR from all sources ranged from 2,700-7,300 kg/year (RDTC, 1999).

The facility will also provide infrastructure for research and demonstration of other technologies that may be synergistic with the ABSR Process such as salt and boron removal technologies. The Facility should provide the District with the ability to remove about 120 kg of selenium per year from drainage discharged to the SJR.

The Panoche Drainage District reserves the right to negotiate the standard contract terms and conditions.

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Schedule

	2002									2003												2004												2005		
	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Task 1. Preliminary and final design and permitting																																				
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Construction																																				
Task 3. Commissioning and operation																																				
Task 4. Research and performance monitoring																																				
Task 5. Project management, data analysis, engineering analysis, report preparation, and technology transfer																																				
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Q = Quarterly Report, N = Newsletter published, A = Annual Report, F = Final Report; report submitted on the 10th of indicated month.

WILLIAM J. OSWALD

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Staff Scientist
LAWRENCE BERKELEY NATIONAL LABORATORY
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EDUCATION
- Bachelor of Science - Civil Engineering
  University of California, Berkeley
- Master of Science - Sanitary Engineering
  University of California, Berkeley
- Doctor of Philosophy - Sanitary Engineering, Biology, and Public Health
  University of California, Berkeley

PROFESSIONAL
- Emeritus Professor of Biomedical and Environmental Health Sciences and Civil and Environmental Engineering, School of Public Health and College of Engineering, University of California, Berkeley
- Registered Civil Engineer, State of California
- Sanitary Engineering Director, U.S. Public Health Service
  (Inactive Reserve)
- American Academy Environmental Engineers, AAEE Certified

AFFILIATIONS
- American Academy of Environmental Engineers, Diplomate
- American Society of Civil Engineers, Fellow, Life Member
- American Association for the Advancement of Science (Fellow)
- American Water Works Association, Life Member
- New York Academy of Science
- Water Pollution Control Federation, Life Member
- Inter-American Society of Sanitary Engineers
- International Cell Research Organization

HONORARY SOCIETIES
- Chi Epsilon
- Sigma Xi
- Tau Beta Pi
- Delta Omega

AWARDS AND HONORS
- Water Pollution Control Federation:
  Harrison Prescott Eddy Medal for Noteworthy Research.
- American Society of Civil Engineers:
  Outstanding Faculty Award (Student Chapter), U.C. Berkeley; James Croes Medal (National); Rudolf Hering Medal (National); Arthur M. Wellington Award (National)
- U.S. Bureau of Reclamation, The Environmental Protection Agency and the Department of Water Resources: Special Commendation for Excellence of Consulting Services on Interagency Central Valley Drainage Project.
- Council for Agricultural Planning and Development, Republic of China: Distinguished Paper Commendation.
- National Science Foundation and World Health Organization: Various fellowships for International Speaking Engagements, Symposia, and Consultations.

SPECIALTIES

- Sanitary/Environmental Engineering
- Applied Phycology
- Microbial Waste Management Systems
- Environmental Systems Engineering

EXPERIENCE

- **Research Engineer** - In addition to responsibilities associated with his university emeritus professorship, has had more than fifty international, federal, state and local research and development grants as a Research Engineer to study various aspects of microbiological systems for waste treatment, environmental control, energy production, methane fermentation, fertilizer production, pharmaceutical production, water and nutrient reclamation, and toxic waste treatment. Current research involves applications of Advanced Integrated Wastewater Pond Systems for energy conservation and toxicant removal.

- **Professional Engineer** - Has provided system designs for more than 50 successful wastewater management systems. Currently consulting for the U.S. Agency for International Development on municipal wastewater infrastructure for the City of Varanasi, India. Has provided advisory, review and consultative services for more than 35 years on water supply and waste management systems, biological engineering and environmental control to the World Health Organization, The Pan American Health Organization, the United Nations Environmental Program, the International Bank for Reconstruction and Development (World Bank), the Asian Development Bank, the U.S. Agency for International Development, the U.S. Army, Navy and Air Force, the U.S. Bureau of Reclamation, United States Congress, House and Senate, Office of the President, U.S. Public Health Service, U.S. Department of the Interior, U. S. Department of Agriculture, the National Academy of Sciences, the National Academy of Engineering, the National Aeronautic and Space Administration, the California State Legislature and California State Department of Water Resources; the Oceanic Institute of Hawaii, the governments of Australia, Bolivia, Brazil, Chile, Colombia, Cuba, Czechoslovakia, Egypt, France, Germany, Hungary, India, Israel, Jamaica, Mexico, People's Republic of China, Philippines, Portugal, Puerto Rico, Russia, Saudia Arabia, Singapore, Sweden, Taiwan, Tunisia, and Venezuela, as well as over 100 local agencies and private firms. Professor Oswald is known internationally as one of the world's foremost authorities on conventional waste stabilization ponds, Advanced Integrated Wastewater Pond Systems, algal High Rate Ponds, methane fermentation, microalgal production, wastewater reclamation, nutrient recycle, and toxicity control.

- **Teaching** - Emeritus Professor of Biomedical and Environmental Health Sciences and Environmental Engineering, School of Public Health and College of Engineering, University of California, Berkeley. Every year since 1992 has taught four to eight three-day courses for the American Society of Civil Engineers Continuing Education Program. Specialist in water quality management and low-cost appropriate technology for waste treatment and disposal systems, anaerobic digestion, solar energy applications and alternative energy resource recovery systems. Has taught: Water Resource Engineering (Quality), Principles of Sanitary Engineering, Environmental Health Science (Water and Wastewater), Biological Control Systems, Pond Design and Applied Phycology. Former Major Field Adviser in Bioengineering. Major Professor for more than 50 Master of Science and MPH and 26 Doctor of Philosophy and Doctor of Public Health graduates.

- **Inventor** - Inventor of Advanced Integrated Wastewater Pond Systems; Advanced Facultative Ponds; High Rate Ponds; Algatron; methods to optimize Methane Fermentation, Photosynthetic Oxygenation, and the cultivation of *Porphyridium cruentum*.

- **Writer** - Professor Oswald has authored over 400 papers, articles and reports published in professional journals, books and trade publications throughout the world. The complete publication list since 1950 is available upon request.