99B-104

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

Proposal Title: Development of Propagation & Re-introduction Techniques for Delta Special Status Plant Species

Applicant Name: Bitterroot Restoration, Inc. - Thomas G. Parker

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Amount of funding requested: $114,700 for 3 years

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

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

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

What county or counties is the project located in? ____

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

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

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

- ☐ San Joaquin and East-side Delta tributaries fall-run chinook salmon
- ☐ Winter-run chinook salmon
- ☐ Late-fall run chinook salmon
- ☒ Delta smelt
- ☒ Splittail
- ☐ Green sturgeon
- ☒ Migratory birds
- ☐ Other: ____
- ☐ Spring-run chinook salmon
- ☐ Fall-run chinook salmon
- ☐ Longfin smelt
- ☐ Steelhead trout
- ☐ Striped bass
- ☐ All chinook species
- ☐ All anadromous salmonids

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

Aquatic Habitat Plant Community V.1 p.368

Seasonal Wetland Habitat Plant Community V.1 p.379

Development of Propagation & Re-introduction Techniques for Delta Special Status Plant Species

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EXECUTIVE SUMMARY

Development of Propagation & Re-introduction Techniques for Delta Special Status Plant Species

Submitted by : Tom Parker, Bitterroot Restoration, Inc., Corvallis, Montana, and Shengjun Lu (Ph. D, Plant Physiology) Bitterroot Restoration Inc., Lincoln, CA

Native species recovery and conservation has been identified as one among several funding priorities for this proposal solicitation package. Suisun thistle, soft bird's-beak, Mason's lilaeopsis, and Delta button-celery are included as priority species for recovery. In addition to these, many more plant species have been selected as species of concern in the Delta area (Appendix A). The ability to grow Delta plant species on a large scale would make it possible to restore large areas of native ecological communities in the Delta. In addition, more than 1100 miles of levees could potentially be re-vegetated at the critical land/water interface where most habitat loss has occurred. Bitterroot Restoration (BRI) proposes to develop the fundamental knowledge and technology for large-scale production of Delta native plant species and define techniques for re-introduction of these plants.

Bitterroot Restoration, Inc., with a nursery/office in Lincoln, CA northeast of Sacramento, has developed propagation protocols and restoration techniques for more than 300 western United States plant species since 1986. In California, we are growing plants and/or developing ecological restoration plans for Yosemite National Park, Sequoia-King's Canyon National Park, Atlas Mine Superfund Site, and Army Corps of Engineers projects along the Sacramento River.

As biologists with extensive experience implementing complex projects, we can communicate knowledge we generate through rigorous biological methods to engineers and construction site supervisors who depend on clear, quantifiable specifications. Through the approach outlined in this proposal, we will create a powerful tool for engineers, contractors, and volunteers as they re-assemble greatly altered Delta habitats. Every project in the Delta will benefit from having clear guidelines for soil amendments, soil microorganism incorporation, grading, hydrologic requirements, timing of planting, and construction details relating to inter-specific competition for resources. While many plant communities can be restored by re-establishing natural processes, severely altered ecosystems often require human intervention in the form of active re-introduction of living plants. By learning how to grow special status Delta plants from local seed sources, we will help preserve the genetic integrity of these rare populations, and provide the means for a ready source of plant material to ensure diversity in restoration projects.

Two project phases will run concurrently: 1) propagation protocol development to be conducted under laboratory and greenhouse conditions and 2) re-vegetation trials which will consist of field experimentation and demonstration plots. If this project is funded in summer 1999, seed collection can begin immediately, and we will be able to publish the first round of results in early 2000. The plant propagation protocols will be developed at our Lincoln, California greenhouse and nursery facility. Re-vegetation trials will be conducted as part of Frank's Tract restoration activities or on some other appropriate site of CALFED's choosing. The field portion of this proposal will be most effective if it is done in conjunction with another funded restoration project—this should be specified in the funding agreement and it would be the responsibility of CALFED to match our field experimentation with an appropriate project.

The total cost for implementation of this project is based on developing revegetation specifications for all 37 species listed in Appendix A. If CALFED decides to fund only a portion of this effort (by selecting a subset of species), the cost will decrease. However, the decrease will not be directly proportional, because of fixed and mobilization costs that are partially independent of scale.

Products will include:

- a plant propagation manual describing and illustrating seed germination, nutrient, and other growing requirements for each species; and
- a specification handbook for designers, engineers, and contractors that includes details about plant handling, site preparation, installation (including timing), management of hydrology, and maintenance of plantings.

Bitterroot Restoration, Inc.'s staff includes professionals in wetland ecology, plant physiology, botany, restoration ecology, horticulture, and landscape design. Our company's structure as a design/grow/build firm rises from our integrated approach toward solving restoration problems. We are ecologists, who are able to take the principles of ecology and apply them on the ground to ensure project success. The importance of this applied approach has been demonstrated to us by our observations that projects sometimes succeed or fail due to inherent complexities of natural systems. A rigorous scientific approach to project design is informed by feedback from our implementation crews, and from monitoring completed projects. Experience is our guide, and our experiences in the Delta will allow us to guide others to more successful re-establishment of rare Delta plants.

The need for this type of work is clearly indicated by the many acres of subsided peat islands that are potential restoration sites. Many miles of levies will eventually provide substrate for land/water ecotones. Native plant propagules for only the most common wetland species will be readily available on heavily disturbed sites. These substrates are also likely to be invaded by weedy, exotic species. Active revegetation with appropriate native plant species will occupy the soil matrix and exclude weedy species. Species we plan to help restore by the methods outlined in this proposal fill very specialized niches and have narrow site requirements. In many cases, they will not become re-established without focused action. We propose to define these necessary actions. The total cost is $114,700.

PROJECT DESCRIPTION

Proposed Scope of Work

Native species recovery and conservation has been identified as one among several funding priorities for this proposal solicitation package. Suisun thistle, soft bird's-beak, Mason's lilaeopsis, and Delta button-celery are included as priority species for recovery. In addition to these, many additional plant species have been identified as species of concern in the Delta area (Appendix A). The ability to grow Delta plant species at a large scale would make it possible to restore large areas of native ecological communities in the Delta. In addition, more than 1100 miles of levees could potentially be re-vegetated at the critical land/water interface where most habitat loss has occurred. Bitterroot Restoration (BRI) proposes to develop the knowledge and technology for large-scale production of Delta native plant species and define techniques for re-introduction of these plants.

Two project phases will run concurrently: 1) propagation protocol development to be conducted under laboratory and greenhouse conditions and 2) re-vegetation trials which will consist of field experimentation and demonstration plots. If this project is funded in summer 1999, seed collection can begin immediately, and we will be able to publish the first round of results in early 2000.

Phase I. Propagation Protocol Development

Task 1: Literature Review. BRI will identify existing research results at the species level regarding seed germination, propagation, and mycorrhizal associations for Delta plant species of concern. Sources may include: universities; peer-reviewed journals; botanical gardens; national seed storage laboratory; California Native Plant Society; The Nature Conservancy; California Natural Heritage Program; U.S. Fish and Wildlife Service; Thomas Payne Institute; and local native plant nurseries. The results of this search will be included as a chapter in the Phase I report.

Task 2: Seed Acquisition/Collection. Seed acquisition from seed banks, botanical gardens, and other sources will be conducted prior to beginning field collection of seed. Any seed collection will be conducted under mutually agreed upon guidelines following coordination with CALFED agencies and acquisition of appropriate permits. All sources of seed will be reported in the Phase I report.

Task 3: Seed Germination Protocols. Information already exists regarding germination of many species coming from genera or families represented on the list of special status Delta plants. Because seed germination requirements vary dramatically in natural ecosystems, germination techniques in the laboratory also vary widely. Wetland plant seeds are often adapted to long periods of submersion in water, or to being buried in anaerobic soil. Conditions for germination may occur infrequently. Therefore, seeds need to be able to survive in a dormant state for periods of up to several years. Even within the same genera, germination requirements vary dramatically. Techniques for breaking seed dormancy or inducing germination include: chemical and mechanical scarification; warm and cold stratification; nutrient enrichment; and growth regulators.

Methods—Before attempting to compare germination methods, we will test each seed lot for viability according to AOSA rules for testing to establish a basis for comparing germination success among treatments. If rules have not been developed for a particular species, we will develop the techniques. We will use 2,3,5-triphenyl tetrazolium chloride, which indicates a living embryo by staining it red. This will result in an estimated average percent viability for each species.

For each species, the range of possible germination techniques will be identified, based on our (and others') experience with similar species. These techniques include seed morphology, ecology, and environmental conditions will be reviewed. This reduced set of techniques will be treated as variables, which will allow us to form hypotheses to be tested through a completely randomized, block experiment. Variables will include treatment type, duration, associated temperatures, pH, light, stratification media, and germination substrate. Relative percent germination, defined as percent germination/percent viability, will be the success criteria.

For each species, results of germination research will be presented in narrative, tabular, and color photographic form as part of the report for Phase I.

Task 4: Propagation Protocols. For each special status Delta plant species, propagation protocols will be developed. Basic variables to be considered are: soil components; pH; nutrient solutions; watering regimes; growing temperatures; light requirements; hardening procedures; and holding methods. Considerable information already exists about propagation of native plant species. However, producing large quantities of native plant species in an economical manner requires a clear understanding of how each variable affects each species. Even if someone has already successfully propagated a species, this does not necessarily mean they have identified the most efficient and economical method to produce that species on a large scale and with repeatable quality. Even within species, different seed sources can respond differently because of genetic and environmental variation from germination through maturity.

Methods—Based on information already available for similar plant species, we will narrow the range of possible soil mix, nutrient, light, temperature, growing medium, watering regimes, and other independent variables. This limited set will form the basis for hypotheses, which we will then test by performing a completely randomized factorial experiment for each species. Dependent variables will be plant quality standards used in restoration horticulture. These include height, caliper, root tightness, root to shoot ratio, biomass absence of disease and pathogens, and other standards that might be specific to selected plant species.

For each species, results of propagation protocol research will be presented in narrative, tabular, and color photographic form as part of the report for Phase I.

Phase II : Re-vegetation trials

Task 1: Evaluation of Re-introduction Techniques. We will evaluate different techniques for ensuring plant survival following outplanting. Classes of techniques to be tested include: site preparation and its influence on hydroperiod; plant competition control; erosion control; and herbivory deterrents.

Methods— The variables affecting plant survival in the field include: soil quality; water quality; hydroperiod; herbivory; competition; erosion; and planting technique.

Because restored island habitat may be constructed on dredged material of highly variable composition, it will be important to all potentially growing substrates. The implications of such an analysis are too unpredictable to include soil quality in a conceptual experimental design. Plant available water will probably carry a relatively high nutrient load, so we will not attempt to control nutrients experimentally. However, we will consider water quality analyses as we interpret our experimental results. We can control hydrology by preparing the site with a 30 to 1 slope, terraced at five different levels, which will provide potential habitat for both submergent and emergent plants across a five meter wide plot. Plants will be assigned to a terrace based on their known hydroperiod requirements. Herbivory will be controlled by using cylindrical plant protectors as a treatment and by using cotton string and lathe (high stakes with a spaghetti-like network of string woven among them) as another treatment. Competition will be controlled by using synthetic mulch mats as a treatment. Establishment of plants in a coir matrix will be tested as an erosion control treatment.

Location of the Project

Plant propagation protocols will be developed at our Lincoln, California greenhouse and nursery facility. Re-vegetation trials will be conducted as part of Frank's Tract restoration activities or on some other appropriate site of CALFED's choosing. The field portion of this proposal will be most effective if it is done in conjunction with another funded restoration project—this should be specified in the funding agreement and it would be the responsibility of CALFED to match our field experimentation with an appropriate project.

These areas will be on lands owned by CALFED or other public entities and may include the McCormick-Williamson Tract, Sherman Island, Prospect Island, Liberty Island, and Twitchell Island. Sites should represent a range of salinity and tidal influence.

ECOLOGICAL/BIOLOGICAL BENEFITS

The ability to propagate and successfully establish uncommon native plants will help meet habitat restoration goals in the Delta. The information we generate will help define economically efficient methods for plant production. If the field portion is funded, we will provide highly visible demonstration projects for outreach and education. While many Delta issues are still being debated, most stakeholders agree on the need for ecosystem restoration. Being able to quantify costs and methods for rare plant re-establishment, and report these in a format that restoration project designers can translate into specifications, will result in more successful projects across the Delta.

Background and Ecological/Biological/Technical Justification
This proposal directly addresses multiple needs stated in the Ecosystem Restoration Program Plan and the Long-Term Levee Protection Plan. The information and technologies developed through this project will influence levee maintenance, erosion, sedimentation, and exotic plant species stressors through the future development of large-scale habitat restoration projects.

ERPP. The Ecosystem Restoration Program Plan (Volume 1) describes special status plant species that belong to several plant community groups occupying different habitats (ERPPv1 p. 182-197) (see Appendix A). A consistent need identified in the ERPP is the restoration of special status plant species and their habitats. On ERPPv1 pp. 203-205, planners have identified actions and opportunities for restoration, including reintroducing native plants to suitable sites, levee setbacks and breaches, and created levee berms. For example, at the ecosystem scale (ERPPv1 p. 182), one of the implementation objectives is "Develop appropriate methods to protect and restore habitat and populations of special-status plant species." At the species scale (ERPPv1 p. 189) an objective is to conduct studies to determine the micro-habitat requirements of eel-grass pondweed and determine reasons for limited distribution.

Our project addresses stressors associated with special-status plants in these ways:
1) Loss of appropriate habitat. The focus of Phases II will be the assessment of existing native plant communities and experimentation for creating new habitats to support desirable plant communities. Our intention is to make habitat compatible with the development of levee designs.

2) Loss of special-status plant ecotypes. Phase I directly addresses this stressor by identifying propagation protocols and preserving germ plasm for future use. In instances where special-status plant species are exterminated in the wild, germ plasm and protocols will be available for re-introduction efforts.

3) Information Deficit. Currently, little information exists on the propagation of native plants. Consequently, native plant production for many species is unpredictable and expensive.

Published protocols for plant propagation and re-introduction will result in additional tools available to CALFED decision makers and reduced costs due to more efficient production by growers.

Levee Protection & Maintenance. This proposal addresses the conflict between current management of levees and natural plant communities. Because current levee maintenance practices require keeping steep levee surfaces clear of vegetation, little or no substrate remains that is suitable for plant communities that depend on the land/water interface. According to the Long Term Levy Protection Plan, Appendix A, page 6, "...projects to restore or enhance habitat can achieve multiple objectives if they are planned with levee vulnerability in mind." Appendix B in the same document includes examples of levee cross-sections with more gradual slopes that would provide: 1) levee stability by increasing levee mass and 2) appropriate substrate for plant communities by creating a less steep levee face. If the PL 84-99 standard is adopted (page B-2, Long Term Levee Protection Plan), a 3:1 to 5:1 slope will provide much more suitable substrate for plant growth than is currently available on steeper levee slopes.

With respect to levees, our project addresses stressors in the following manner:
1) Levee Erosion. Currently, levee maintenance includes removal of vegetation. Developing technology to establish functioning plant communities with deep, binding root mass on re-sloped levees will meet both the goals of levee stability and habitat restoration. Our proposal will support the following Implementation Objectives, Targets, and Programmatic Actions related to the Levee stressor: Investigate the feasibility of levee setbacks in the Delta; convert selected Delta islands to a mosaic of deep and shallow-water and tule-marsh habitats; and build innovative benches to support shoreline habitats, where levees must remain (ERPPv1 p. 284).

2) Exotic Plant Invasion. Planting of native species addresses this stressor in two ways: 1) native plants physically occupy the substrate, limiting area available for exotics; and 2) native plants provide a seed source for perpetuating and expanding the native plant community.

3) Maintenance Costs. Availability of plant materials for bioengineering purposes will provide an alternative to hard engineering methods and potentially reduce cost associated with maintenance activities. Our proposal can support the following Implementation Objectives, Targets, and Programmatic Actions related to the Dredging and Sediment Disposal stressor: Maximize the reuse of dredged materials for habitat restoration and other beneficial uses and minimize the amount of disposed material that is subject to re-suspension and subsequent re-dredging.

Fish Species of Concern. Based on ERPPv2, the following fish species will benefit from improving aquatic wetland shallow water, or riparian habitats: Delta Smelt (p. 64); Longfin Smelt (p. 64); Splittail (p. 65); Chinook Salmon (p. 66); Steelhead Trout (p. 67); and other resident fish species (p. 68). Most other fish and animal species of concern would also benefit from wetland plant community reestablishment (ERPPv2 pp. 69-76).

1. Sediment. Plants filter sediment, providing a means to increase terrestrial habitat as sediment accumulates, and also creating cleaner water conditions. Reduced sedimentation into riverine systems would directly benefit fish species of concern.

2. Reduction of water table. Many areas have changed from a wetland plant community to an upland plant community. Wetland restoration projects will improve water storage in near-bank or near-shore areas as a result of higher densities of sponge-like root masses. Greater storage will yield greater release of water during low flow periods, directly benefiting fish species.

TECHNICAL FEASIBILITY

Because this project will take place in both greenhouses and as part of the restoration of an extremely disturbed site, we foresee no negative impacts to natural ecosystems or human communities. Work near rare plant populations will be performed with extreme care for the individual plants, and in close cooperation with the groups whose goals include protecting rare plant populations.

MONITORING AND DATA COLLECTION METHODOLOGY

Phase I. Development of Propagation Techniques

Task 3, Seed Germination Protocols and Task 4, Propagation Protocols, will require formal hypotheses and monitoring. While developing seed germination protocols, viability testing will provide a basis for determining relative germination resulting from different germination methods. For example, if viability of a species is determined to be 50%, and a one week cold stratification treatment yields 40% germination, the relative germination would be 40%/50% = 80%. Treatments yielding the highest relative germination rates will be considered successful.

During development of propagation protocols, a combination of nutrients, growth media, watering regimes and other potential factors will be varied. The selection of variables to test will vary by species based on existing information. Dependent variables will be selected depending on which morphological features are most important for a given species. Because some species may require more or less independent or dependent variables, statistical tests will range from univariate to multivariate analyses. However, because of the inherent variability within species, we will place at least as much weight on descriptive comparisons as we do on formal statistical results.

Phase II. Field Establishment Trials

Plots will be set up at the land/water interface. Each plot will contain six 5m x 5m sub-plots. Each sub-plot will contain 100 plants installed on 0.5 m centers (Appendix B). In each plot, six sub-plots will contain the following treatments:

1. pre-vegetated coir mats—3.5 inches thick;
2. translucent tree protectors;
3. synthetic, photodegradable mulch mats
4. four foot lath and cotton string (bird deterrent)
5. plants only (control)
6. bare substrate (negative control)

Two control sub-plots will contain just plants, and one sub-plot will be a negative control with no plants or treatments. Within sub-plots, plants will be distributed in a random stratified manner, based on their known hydroperiod requirements from prior ecological studies. These plots will be monitored each year during the peak biomass period and at the end of the growing season. Every individual will be recorded as either surviving or dead. Because the plants will be distributed in a stratified random manner, we will use ANOVA or Chi-Square to analyze data, depending on whether variance is balanced among samples. Hypotheses will address whether treatments influence survival.

Table 1. Monitoring outline for propagation technique development

Biological/Ecological Objective: Propagation Technique Development			
Hypothesis/Question to be Evaluated	Monitoring Parameter(s) and Data Collection Approach	Data Evaluation Approach	Comments/Data Priority
Which seed germination technique is best for a given species?	Germination percentage/Viability percentage= Relative Germination	Highest percentage is best.	Not really hypothesis testing
Which propagation method is best for a given species?	Independent Variables = nutrients, growing media, etc. Dependent Variables = morphological variables	Statistical Analyses	These will be formal hypothesis tests and results will be submitted to peer-reviewed journals.

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Table 2. Monitoring outline for field establishment technique development

Biological/Ecological Objective: Field Establishment Technique Development			
Hypothesis/Question to be Evaluated	Monitoring Parameter(s) and Data Collection Approach	Data Evaluation Approach	Comments/Data Priority
Do pre-vegetated coir mats, mulch mats, plant protectors increase survival vs. plants with no protection?	Completely randomized factorial design vs. stratified random block design. 100% sample of all plots. Survival data and descriptive data	ANOVA or Chi-Square depending on comparisons of variance.	Three replicates per site. Project budget based on three sites.

LOCAL INVOLVEMENT

We have communicated with staff at CALFED who suggested that this proposal would be appropriate given the extensive revegetation that will be required during some phases of the Ecosystem Restoration Program's activities. As CALFED decides which projects to fund in this round, there is an opportunity to match this project with other implementation projects.

In June 1998, we visited staff at The Nature Conservancy's Cosumnes River Preserve and briefly discussed the project idea. Also in June 1998, we discussed the project with California Natural Heritage Program staff.

Once field plots are established, they will be valuable educational tools for everyone from school children to professional restoration planners.

COSTS

Direct Costs are based on a technician wage of $14 per hour and a consultant wage of $18 per hour, including an additional 28 percent for taxes, insurance, and benefits. Overhead is calculated as a 30 percent margin. Of this margin, 8 percent is for general and administrative costs, 8 percent is for sales costs, 4 percent is for interest, 2 percent goes to support research and development, and 8 percent goes to profit. The total cost is $114,700.

Table 3. Budget

	Direct Labor Hours	Direct Salary & Benefits	Overhead Labor	Service Contract	Material & Acquisition	Misc. and Other Dir. Costs	Total Costs
Phase I							
Task I. Literature Review (C)	**120**	**2,800**	**1,200**				4,000
Task II. Seed Acquisition/ Collection/Storage							
Collect 37 species (T)	290	5,200	2,200				**7,400**
Mobilization and Travel						5,700	**5,700**
Clean, test for viability, and store 37 species (T)	750	13,500	5,800				**19,300**
Seed Cleaning and Testing Equipment					5,000		**5,000**
Task III. Seed Germination Protocols							
Germination Protocol Development	300	6,900	3,000				**9,900**
Supplies and Materials					6,700		**6,700**
Task IV. Propagation Protocols							
Protocol Development	400	9,200	4,000				**13,200**
Greenhouse Space					3,000		**3,000**
Supplies					1,000		**1,000**
Report preparation	100	2,300	1,000				**3,300**
Phase II							
Task I. Evaluation of Reintroduction *Techniques*							
Site Preparation Coordination	100	1,800	800				**2,600**
Field Plot Setup (Assuming three sites with six treatments ea replicated 3x)	280	5,000	2,200				**7,200**
Mobilization						6,300	**6,300**
Supplies and Materials					5,000		**5,000**
Baseline Monitoring and Reporting yr 1	100	2,300	1,000				**3,300**
Monitoring and Reporting yr 2	80	1,800	800				**2,600**
Monitoring and Reporting yr 3	80	1,800	800				**2,600**

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Project Management Task	200	4,600	2,000				**6,600**
Total		**57,200**	**24,800**		**20,700**	**12,000**	**$114,700**

Table 4. Quarterly budget

Quarterly Budget	**Oct-Dec 99**	**Jan-Mar 00**	**Apr-Jun 00**	**Jul-Sep 00**	**Oct-Dec 00**	**Jan-Mar 01**	**Apr-Jun 01**	**Jul-Sep 01**	**Oct-Dec 01**	**Oct-Dec 02**
Phase I										
Task I. Literature Review (C)	3,000	1,000								
Task II. Seed Acquisition/ Collection/Storage										
Collect 37 species (T)	2,000	2,000	2,000	1,400						
Mobilization and Travel	1,500	1,500	1,500	1,200						
Clean, test for viability, and store 37 species (T)	5,000	5,000	5,000	4,300						
Seed Cleaning and Testing Equipment	5,000									
Task III. Seed Germination Protocols										
Germination Protocol Development		3,000	3,000	2,000	1,900					
Supplies and Materials		4,000	2,700							
Task IV. Propagation Protocols										
Protocol Development		2,000	3,500	3,000	2,500	2,200				
Greenhouse Space		600	600	600	600	600				
Supplies		500	500							
Report preparation				500	1,000	1,800				
Phase II										
Task I. Evaluation of Reintroduction Techniques										
Site Preparation Coordination			2,600							
Field Plot Setup (Assuming three sites with six treatments ea replicated 3x)			2,200	2,500	2,500					
Mobilization			2,100	2,100	2,100					
Supplies and Materials			2,500	2,500						
Baseline Monitoring and Reporting yr 1					3,300					

Monitoring and Reporting yr 2									2,600	
Monitoring and Reporting yr 3										2,600
Project Management Task	1,500	1,000	1,000	1,000	1,000	500			300	300
Total	**18,000**	**20,600**	**29,200**	**21,100**	**14,900**	**5,100**			**2,900**	**2,900**

COST SHARING

We are proposing CALFED fund this project entirely through this PRP. By providing plant propagation guidelines for rare Delta plants, and by producing a specification manual for Delta-specific revegetation projects, CALFED would be introducing a mechanism for greater accountability in restoration projects throughout the many remaining years of the CALFED partnership.

We have reduced our normal hourly rates by half as a contribution to cost sharing.

APPLICANT QUALIFICATIONS

Bitterroot Restoration is uniquely qualified to complete this project. BRI has developed propagation protocols for over 300 plant species native to the western United States and produced these in commercial quantities. Our staff includes professionals in plant physiology, botany, restoration ecology, horticulture, landscape architecture, forest ecology, and natural resources. In addition, we have associates specializing in range ecology, soil science, photo-interpretation, and soil microbiology.

Tom Parker – Director of Consulting

M.S. Riparian Ecology, University of Montana. Tom designs and supervises implementation of bioengineered riparian and wetland restoration projects. Tom's academic work focused on the identification and delineation of wetland plant communities as well as riparian ecological health evaluation. He has completed Rosgen training in applied river morphology with expertise in the specification and application of bioengineering methods for erosion control and riparian restoration.

Dr. Shengjun Lu - Director of California Operations

Ph.D. Plant Physiology, Oregon State University. Dr. Lu has extensive knowledge and experience in plant propagation, plant nutrition, heavy metal toxicity, phytoremediation, root physiology, and root-microorganism associations. Since joining BRI in 1995, Dr. Lu has conducted research and consulting projects including phytoremediation of arsenic and pentachlorophenol contaminated soils, wastewater treatment wetlands, assessment of plant mortality from chlorine spills, nutrient requirements for mycorrhizal-colonized plants, and soil fertility analysis. Dr. Lu has six years of experience in the research area of tree physiological responses to environmental factors, plant nutrition, root physiology, and root diseases at Oregon State University. In addition, Dr. Lu has six years experience as a director of forestry research laboratories, and as a researcher in the area of vegetation conservation, plant stress physiology, and plant community ecology in China.

Dr. Dean Jordan – Director of Plant Production

Ph. D. Botany, University of Wyoming. Prior to joining BRI, Dr. Jordan was the Director of the Nevada Desert Free Air Carbon dioxide Enrichment facility (FACE) at the Nevada Test Site where he supervised an ecophysiological research program aimed at identifying undisturbed ecosystem responses to atmospheric carbon dioxide. This program is affiliated with the University of Nevada Department of Biological Sciences. Dean also has an M.S. in Forest Ecology and a B.A.. in physics. Dean has published in *Oecologia*; *Journal of Environmental Quality*; *Physiologia Plantarum*; *Plant, Cell & Environment*; *Journal of Chemical Ecology*; and other peer-reviewed journals.

Patrick Burke, President

M.S. Forest Ecology. University of Montana. As founder of Bitterroot Restoration, Pat is a respected leader in the evolving field of ecological restoration. He has pioneered native plant propagation techniques for many species, advocated the importance of understanding rhizosphere biota contributions to plant survival, and worked with industry professionals to develop economical ways to improve reclamation standards in the western mining industry. In addition to his biological background, Pat has a B.A. in Philosophy from the University of California at San Diego.

Tim Meikle – Director of Research and Development

M.S. Restoration Ecology, University of Wisconsin-Madison. Tim will provide critical review of research methods during all phases of the project. Tim has worked on ecological restoration projects in California, Nevada, Montana, Colorado, Wyoming, Alaska, Wisconsin, Minnesota, South Dakota, and North Dakota. Tim has experience in mined land reclamation, reclamation of contaminated sites, the 404 wetland permitting process, T&E species surveys and recovery efforts, vegetation reference site establishment and monitoring, utility corridor revegetation, wetland establishment, weed control and pesticide management, riparian revegetation, and grassland establishment.

Matthew Ogden- Plant Propagation Manager/Plant Production Assistant

B.A. Botany, B.S. Forest Resource Conservation, University of Montana. Matt's years at BRI have focused on seed physiology, seed collection, seed treatment and propagation technique development. In addition, Matt has extensive experience in wetland delineation, plant taxonomy, and T&E and Sensitive plant surveys.

Steven Kloetzel - Director of Bitterroot Revegetation Services

B.S. Forest Resource Conservation, University of Montana. Steve has worked for BRI since 1991. His areas of expertise include: implementation and coordination of field projects, project cost estimation, development of out-planting techniques, erosion control installation and prescriptions, seeding techniques and seed mix design, T&E and Sensitive plant surveys, NEPA documentation, and plant propagation.

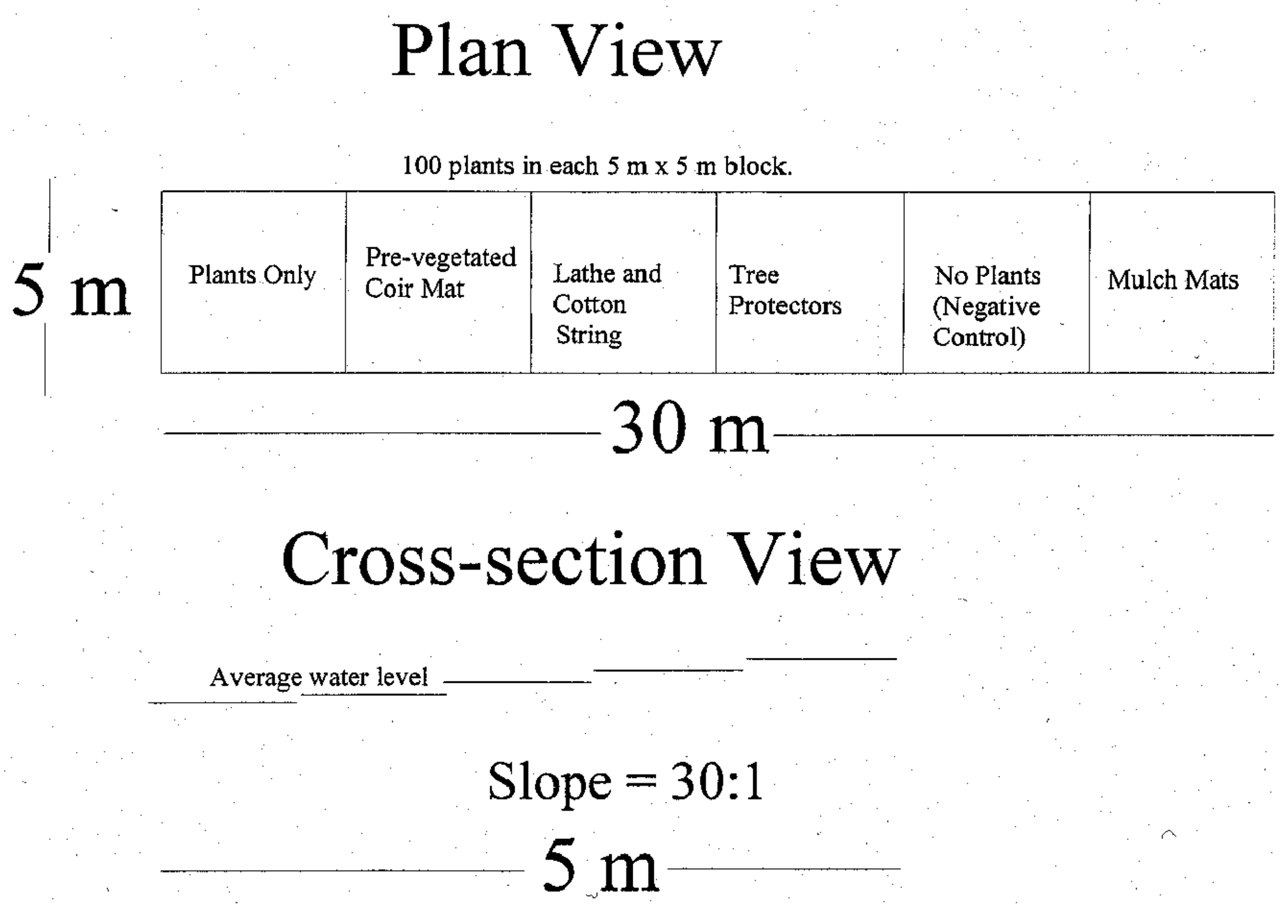
APPENDIX A : SPECIAL STATUS PLANT SPECIES TO BE ADDRESSED BY PROJECT

(Compiled from draft list of Delta Species proposed for inclusion in the Conservation Strategy.)

Type	Common Name	Scientific Name
Federally Listed as Endangered or Threatened		
P	Antioch Dunes evening-primrose	*Oenothera deltoides* ssp. *howellii*
P	Antioch Dunes evening-primrose (critical habitat)	
P	Colusa grass	*Neostapfia colusana*
P	Contra Costa goldfields	*Lasthenia conjugens*
P	Contra Costa wallflower	*Erysimum capitatum* ssp. *angustatum*
P	Contra Costa wallflower (critical habitat)	
P	Fleshy owl's clover	*Castilleja campestris* ssp. *succulenta*
P	Green's tuctoria	*Tuctoria greenei*
P	Large-flowered fiddleneck	*Amsinckia grandiflora*
P	Palmate-bracted bird's-beak	*Cordylanthus palmatus*
P	Sacramento Orcutt grass	*Orcuttia viscida*
P	Slender Orcutt grass	*Orcuttia tenuis*
P	Soft bird's-beak	*Cordylanthus mollis* ssp. *mollis*
P	Solano grass	*Tuctoria mucronata*
California Listed as Endangered, Threatened, Rare, or Fully Protected		
P	Boggs lake hedge-hyssop	*Gratiola heterosepala*
P	Delta button-celery	*Eryngium racemosum*
P	Mason's lilaeopsis	*Lilaeopsis masonii*
P	Suisun thistle	*Cirsium hydrophilum* var. *hydrophilum*
Federally Proposed		
California Species of Special Concern, or CNPS List 1 or 2		
P	Alkali milk-vetch[b]	*Astragalus tener* var. *tener*
P	Bristly sedge[b]	*Carex comosa*
P	Brittlescale[a]	*Atriplex depressa*
P	Delta mudwort[b]	*Limosella subulata*
P	Delta tule-pea[a]	*Lathyrus jepsonii* var. *jepsonii*
P	Eel-grass pondweed[a]	*Potamogeton zosteriformis*
P	Heartscale[a]	*Atriplex cordulata*
P	Heckard's pepper-grass[b]	*Lepidium latipes* var. *heckardii*
P	Hispid bird's-beak[b]	*Cordylanthus mollis* ssp. *hispidus*
P	Interior California larkspur[b]	*Delphinium californicum* ssp. *interius*

Type	Common Name	Scientific Name
P	Mad-dog skullcap[b]	*Scutellaria lateriflora*
P	Northern California black walnut (Native stands)[b]	*Juglans californica* var. *hindsii*
P	Pincushion navarretia[b]	*Navarretia myersii*
P	Rose-mallow[a]	*Hibiscus lasiocarpus*
P	Showy madia[b]	*Madia radiata*
P	Slough thistle[b]	*Cirsium crassicaule*
P	Suisun marsh aster[a]	*Aster lentus*
P	Valley sagittaria[a]	*Sagittaria sanfordii*
P	Valley spearscale[a]	*Atriplex joaquiniana*

Appendix B. Field establishment plot layout.



STATE OF CALIFORNIA

NONDISCRIMINATION COMPLIANCE STATEMENT

STD. 19 (REV. 3-95) FMC

COMPANY NAME
BITTERROOT RESTORATION, INC.

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

CERTIFICATION

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

OFFICIAL'S NAME
BITTERROOT RESTORATION, INC. PATRICK BURKE

DATE EXECUTED
APRIL 11, 1999

EXECUTED IN THE COUNTY OF
PLACER

PROSPECTIVE CONTRACTOR'S SIGNATURE

PROSPECTIVE CONTRACTOR'S TITLE
PRESIDENT

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME
BITTERROOT RESTORATION, INC