Performance Monitoring of Egeria Control Actions in Frank's Tract, West Delta Region

Project Information

1. **Proposal Title:**

   Performance Monitoring of Egeria Control Actions in Frank's Tract, West Delta Region

2. **Proposal applicants:**

   Terry McNabb, ReMetrix LLC
   Mark Heilman, PhD, ReMetrix LLC
   Doug Henderson, ReMetrix LLC

3. **Corresponding Contact Person:**

   Douglas Henderson
   ReMetrix LLC
   11550 N. Meridian, Suite 600 Carmel, IN 46032
   317 580-8035
   doug@remetrix.com

4. **Project Keywords:**

   Aquatic Plants
   Monitoring
   Nonnative Invasive Species

5. **Type of project:**

   Monitoring

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

   No

7. **Topic Area**:

   Non-Native Invasive Species

8. **Type of applicant:**

   Private for profit

9. **Location - GIS coordinates:**

Latitude:	38.042
Longitude:	-121.606
Datum:	NAD83

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

Location is Frank's Tract in the Sacramento-San Joaquin Delta. It is next to Bethel Island, approximately two miles east of the San Joaquin River. Frank's Tract is 2800 surface acres.

10. **Location - Ecozone:**

    1.4 Central and West Delta

11. **Location - County:**

    Contra Costa

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:**

    11th

15. **Location:**

    California State Senate District Number: 7

    California Assembly District Number: 15

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

    1

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: 24%

    Total Requested Funds: $42,556

b) Do you have cost share partners already identified?

No

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?**

No

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)

Pat Thalken	**Calif. Dept. of Boating and Waterways - Aquatic Weed Unit**	**916-263-8141**	**pthalken@dbw.ca.gov**
Mike Stewart	**US Army Corps of Engineers, Engineering Research and Development Center**	**601-634-2606**	**stewarr@wes.army.mil**
Nate Dechoretz	**Calif. Dept. of Food And Ag - Control and Eradication Division**	**916-654-0768**	**NDechore@smtp1.cdfa.ca.gov**
Robert Leavitt	**Calif. Dept. of Food And Ag - Control and Eradication Division**	**916-654-0768**	**rleavitt@cdfa.ca.gov**

21. **Comments:**

This monitoring and research project has overflow benefits for many organizations working within Frank's Tract and the Bay-Delta. Aerial and satellite imagery are multi-disciplinary tools, and Frank's Tract is a high-use, high-value recreational area.

Environmental Compliance Checklist

Performance Monitoring of Egeria Control Actions in Frank's Tract, West Delta Region

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

      No
   b) Will this project require compliance with NEPA?

      No
   c) If neither CEQA or NEPA compliance is required, please explain why compliance is not required for the actions in this proposal.

      This is an analysis of aerial photography for monitoring. It will only require flying an airplane or satellite over the site.

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

   CEQA Lead Agency:
   NEPA Lead Agency (or co-lead:)
   NEPA Co-Lead Agency (if applicable):

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

   CEQA
   -Categorical Exemption
   -Negative Declaration or Mitigated Negative Declaration
   -EIR
   Xnone

   NEPA
   -Categorical Exclusion
   -Environmental Assessment/FONSI
   -EIS
   Xnone

   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.

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

      Not Applicable

   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

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:

6. **Comments.**

Land Use Checklist

Performance Monitoring of Egeria Control Actions in Frank's Tract, West Delta Region

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

   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?**

   No

   If you answered no to #3, explain what type of actions are involved in the proposal (i.e., research only, planning only).

   Aerial photography and computer analyses only.

4. **Comments.**

Conflict of Interest Checklist

Performance Monitoring of Egeria Control Actions in Frank's Tract, West Delta Region

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):

Terry McNabb, ReMetrix LLC
Mark Heilman, PhD, ReMetrix LLC
Doug Henderson, ReMetrix LLC

Subcontractor(s):

Are specific subcontractors identified in this proposal? No

Helped with proposal development:

Are there persons who helped with proposal development?

Yes

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

Pat Thalken **Calif. Dept. of Boating and Waterways**

Shaun Hyde **SePRO Corp.**

Comments:

The assisting individuals provided only background information, not direct text or budgetary input. ReMetrix specializes in aquatic plant monitoring studies with in-house personnel. We will not need to subcontract the work.

Budget Summary

Performance Monitoring of Egeria Control Actions in Frank's Tract, West Delta Region

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	Aerial imagery Acquisition								16000	16000.0		16000.00
2	Satellite Image Acquisition								1600	1600.0		1600.00
3	Imagery Analysis	80	6400							6400.0		6400.00
4	Project Adminitration	20	1800							1800.0		1800.00
5	report Composition	40	3600							3600.0		3600.00
6	Quarterly Updates	16	1440							1440.0		1440.00
7	Computer Equipment Usage	136				213.52				213.52		213.52
8	Other (shipping)					100				100.0		100.00
9	Overhead (24%)								7534	7534.0		7534.00
10	10% Project Margin									0.0	3868	3868.00
		292	13240.00	0.00	0.00	313.52	0.00	0.00	25134.00	38687.52	3868.00	42555.52

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**
		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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**
		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Grand Total=42555.52

Comments.

Budget Justification

Performance Monitoring of Egeria Control Actions in Frank's Tract, West Delta Region

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

McNabb - Report Writing - 20 hrs. Heilman - Analysis and Report - 60 hrs. Henderson - Analysis and Report - 40 hrs.

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

McNabb - $90/hr. Heilman - $80/hr. Henderson - $80/hr

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

n/a

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

n/a

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

$100 - shipping charges

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.

n/a

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.

n/a

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.

McNabb - 20 hrs.

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

aerial imagery - $16000 satellite imagery - $1600

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.

10% margin - standard rate for all projects

Executive Summary

Performance Monitoring of Egeria Control Actions in Frank's Tract, West Delta Region

Performance Monitoring of Egeria Control Actions in Frank's Tract, West Delta Region Executive Summary: The proposed study is a monitoring and research project to occur in three phases. The study can be funded partly or in full. The study aims to provide monitoring for Egeria densa control efforts by the California Department of Boating and Waterways in Frank's Tract, in the west Delta Region. The methods of monitoring use both digital 1-meter multispectral aerial imagery and newly available 2.8-meter multispectral satellite imagery. The aerial imagery is primarily for completing a pre-control and a post-control monitoring project for the 2002 Boating and Waterways season. The aerial imagery will be mapped and statistics will be produced to measure the efficacy of the Egeria control efforts in Frank's Tract. Phases One and Two are represented by this portion of the study. Phase Three is a comparison of newly available 2.8-meter multispectral satellite imagery with the 1-meter aerial imagery collected for Phase Two. The goal of Phase Three is to determine if quantification of Egeria control using the satellite imagery compares favorably to the more-established method of using 1-meter aerial imagery. If the results are favorable, lower long-term monitoring costs for Bay-Delta projects can be realized using 2.8-meter satellite imagery. The uniqueness of the proposed study to other remote sensing monitoring projects are: (1) Speed of turnaround, in a manner timely enough for Boating and Waterways to make in-season refinements to their plans, (2) The use of newly available satellite imagery, and (3) The ability of the project to accomplish monitoring and research at the same time. A fourth unique aspect is ReMetrix's established expertise in aquatic vegetation assessments and monitoring studies.

Proposal

ReMetrix LLC

Performance Monitoring of Egeria Control Actions in Frank's Tract, West Delta Region

Terry McNabb, ReMetrix LLC
Mark Heilman, PhD, ReMetrix LLC
Doug Henderson, ReMetrix LLC

Performance Monitoring of *Egeria* Control Actions in Frank's Tract, West Delta Region

Section A: Project Description Project Goals and Scope of Work

1. Problem Addressed

Annual aquatic plant control efforts are greatly enhanced by quantification of results. Quantification allows managers to concretely determine the efficacy of current approaches, and then make adjustment to improve efficacy and cost-effectiveness. In order to increase efficiency in quantification, new tools for monitoring must be scientifically evaluated against existing tools to determine which are most viable and cost effective for long-term monitoring.

The California Department of Boating and Waterways is working to control the proliferation of *Egeria densa* in key areas of Frank's Tract, in the west Delta Region. The proposed study supports and works in coordination with Boating and Waterways' efforts, though they are not directly involved in carrying out the study in any way.

The hypotheses of the proposed study are that (1) both aerial and satellite mapping are effective at efficiently quantifying *Egeria* control results, and that (2), newly available satellite imagery products may represent a more cost-effective long-term monitoring solution for the Bay-Delta program.

The objectives of the proposed study are to (1) monitor the efficacy of the Egeria control efforts, and 2) compare the monitoring accuracy of newly available 2.8-meter multispectral resolution satellite imagery with currently used 1- and 2-meter resolution aerial imagery.

The process will be to collect 1-meter resolution aerial imagery before and after the *Egeria* control actions, quantify the change, and provide clear maps and statistics to support the results. This is a complete monitoring package in itself. But also, as a second phase of the study, newly available 2.8-meter multispectral resolution satellite imagery will be collected near the same time as the second aerial imagery collection. The results of analyzing the satellite imagery will be compared to the results of analyzing the aerial imagery. Maps and statistics will be used in the final report to support the study's conclusions.

The goals of the proposed study are to (1) monitor, and (2) establish an effective and useful new tool for quantifying *Egeria* control efforts in the Bay-Delta region. A third (3) beneficial goal is to make the byproducts of the study (up-to-date digital satellite and aerial images, and associated GIS data layers) available to other agencies working in the CALFED Bay-Delta Program.

2. Justification

Aerial and satellite imagery are widely known tools for analyzing broad geographic areas more efficiently than ground-based crews. Digital aerial and satellite assessments are used regularly for monitoring and change detection in many realms, from the military to urban planning to resource management. It is only natural that these tools have been applied to monitoring control efforts for managing non-native invasive aquatic vegetation that maintains a near-surface presence.

For large areas, efficiency in quantifying efficacy of non-native vegetation control is key to longer-term cost-saving considerations. Quantifiable data is essential to truly monitoring an ecological system; anecdotal evidence has proven to be insufficient and even misleading in many cases. The use of ground crews is fine for small areas, but for large areas such as Frank's Tract ground crews become too costly, both in dollars and in diverted man-hours. Also for large areas, multiple crews must typically be used within the region.

Remote sensing imagery analyses help to alleviate the above problems by reducing the long-term costs associated with monitoring, both in budgets and diverted man-hours. An area that would take a couple weeks to quantitatively characterize with one or more ground crews can instead be completed by one imagery analyst over a few days. Plus, the imagery remains intact for re-analysis or comparisons in later months or years. One can effectively "go back in time" using archived imagery.

The satellite *vs.* aerial comparison portion of this project seeks to lower the long-term costs of monitoring even more. The costs of acquiring aerial imagery are greater than satellite imagery. So if newly available spatial resolutions of multispectral satellite imagery can monitor an area comparably to aerial imagery, then the long-term monitoring costs will be reduced. Phase Three of the proposed study seeks to answer the new satellite *vs.* aerial questions quantitatively.

Computer hardware and software capabilities improve yearly for analyzing large digital imagery datasets in greater detail and with greater efficiency. The use of digital imagery is thus becoming an increasingly effective option for monitoring large-scale aquatic plant control efforts. Satellite imagery offers the potential additional benefits of lower collection and rectification costs, though satellite collection parameters are often less flexible.

The high cost of non-native aquatic vegetation control measures, either chemical or biological, warrants a proportional investment in quantifying the efficacy of control measures. Using public funding to control thousands of acres of non-native invasive plants initiates a level of accountability that has traditionally not been present in aquatic plant control.

Frank's Tract is a perfect candidate for such monitoring efforts because it is an area of high public value and use. Simply, ecosystem managers must quantify the effects of their

actions in order to refine them, and they also must justify expenditures to proper governing authorities. Monitoring programs such as the one proposed herein accomplish both of those needs, and open the doors to potential new monitoring options. Furthermore, other agencies not involved in aquatic plant control can use the aerial and satellite imagery of Frank's Tract for their own baseline studies and monitoring efforts.

3. Approach

The study will take place within one year, and will have three phases. Phase One will be a pre-control baseline quantification using 1-meter aerial imagery. Phase Two will be a post-control change quantification using 1-meter aerial imagery. Phase Three will be a post-control quantification comparison using new satellite versus aerial imagery.

For Phases One and Two, two sets of multispectral aerial imagery will be acquired, one set in the spring and one set in late summer. Both natural-color and color-infrared imagery will be collected. The collection dates will be coordinated with the control efforts of the California Boating and Waterways Aquatic Weed Unit. The collection times will take tidal fluctuations in Frank's Tract into account. Because aerial imagery will be used for these Phases, specific collection windows can be established and carried out to take advantage of proper project timing and good weather.

After each set of aerial imagery is collected, it will be digitally processed and geo- and orthorectified to provide maximum image accuracy. Rectification processes remove distortions in the imagery caused by a number of physical factors, such as lens effects, terrain variances, and image sensor angle. It also associates the pixels of the imagery with real-world geographic coordinates. Rectification is a very important step because the accuracy of the analyses are only as reliable as the accuracy of the imagery. Much of the cost of the aerial imagery is incurred not in collection, but in proper rectification of the imagery before analysis.

For Phase Three, a new 2.8-meter resolution multispectral image will be collected in late summer, around the same time as the aerial imagery of Phase Two. Again the timing of the imagery collection will be planned to coincide with the schedule of activities for Boating and Waterways, and also with tidal fluctuations if possible. The closer in timeframe that the satellite imagery is collected to the aerial imagery, the more accurate the correlation for this phase of the study.

Once each set of imagery is collected, it will be analyzed for aquatic plant presence and abundance using image processing software. Comparisons between natural color imagery and infrared imagery also frequently yield species information. We have been given permission to use ground field data from the California Boating and Waterways ground crews to confirm our data interpretation. Using this ground data will require no additional work for the Boating and Waterways ground crews; it will just involve sharing the data they already intend to collect. The areas of control and treatment by Boating and Waterways are clearly defined, so monitoring can be highly focused specifically on those

areas. However, tangential effects in regions outside the treatment areas (the "control areas") will also be recorded.

Statistics will be compiled for the study areas and presented in a final report quantifying the amounts and percentages of vegetation change. Quarterly reports will summarize the findings to date. The digital files of the analyzed areas (from the aerial imagery) will be converted to Geographic Information System (GIS) layers for final analysis and map production. A series of maps will be included in the final report that identify and illustrate the key areas affected by the *Egeria* control actions, and will provide a visual aid to interpreting the statistics. The maps produced in monitoring studies are often the most valuable tool for refining methodologies and approaches for aquatic plant management and other ecological studies.

The digital imagery and GIS files will be provided to other CALFED Bay-Delta agencies for their monitoring, management, and planning efforts. The results of this monitoring study have multi-disciplinary use.

4. Feasibility

The practices proposed for this monitoring and comparison study are thoroughly established in practice, and in literature such as *Aerial Mapping: Methods and Applications* (Falkner, 1995), and *Satellite Remote Sensing of Natural Resources* (Verbyla, 1995).

In regard to timeframe, ReMetrix has successfully delivered final reports for all of its seasonal remote sensing studies well within a calendar year. In fact, completion speed is one of the strengths that ReMetrix brings to the proposed monitoring study. ReMetrix delivers project results in ample time for ecosystem managers to use the results in their next stage of planning. Such would be the case with this study also: Boating and Waterways would have the results of Phase One (pre-control aerial analysis) in time to make late-season adjustments to their approach. They would have the results of Phase Two (post-control aerial analysis) in time to plan their approach for spring 2003. And they would receive the results of Phase Three within weeks of Phase Two.

The only aspect of the proposed study that is subject to feasibility issues is the acquisition of 2.8-meter resolution multispectral satellite imagery. The satellite providing this imagery is scheduled to be operational in January of 2002, so it is highly likely that it will be in routine collection by late summer 2002. Past satellite launch malfunctions can not make this a guarantee.

ReMetrix has planned for a *same-cost* contingency if the 2.8-meter resolution multispectral imagery is not available by late summer. In such a case, ReMetrix would perform the same proposed satellite *vs.* aerial comparison study using 1-meter multispectral pan-sharpened imagery from a similar satellite that is already fully operational. *Switching these satellite products would not alter the budget of the proposed*

study. Also, potentially switching satellite imagery would have absolutely no effect on carrying out the monitoring portions of this study (Phases One and Two), which rely only on the use of aerial imagery.

The use of alternate satellite imagery would *only* occur in the event that the 2.8-meter imagery product is *not* available by late summer. However, having a contingency in place from the beginning protects the integrity of the proposed study and maintains the effective use of potential CALFED funding.

5. Performance Measures

Performance will be measured using the categories outlined in Attachment G of the Proposal Solicitation Package, as described below for this study:

Project Activities:

Activity	Metric
Project Administration	Organization of aerial and satellite imagery collection dates with Boating & Waterways (B&W) and relevant collection agencies
Collection of pre-control aerial imagery	Delivery of the imagery to ReMetrix labs
Analysis of pre-control aerial imagery	Summary of preliminary analysis results in Quarter 1 progress report to both CALFED and Boating & Waterways (B&W)
Collection of post-control aerial imagery	Delivery of the imagery to ReMetrix labs
Analysis of post-control aerial imagery	Update on percentage of completed analysis in Quarter 2 progress report
Collection of post-control satellite imagery	Delivery of the imagery to ReMetrix labs
Analysis of post-control satellite imagery	Summary of analysis results in Quarter 3 progress report to CALFED and B&W
Completion of all analysis	Delivery of final data to both CALFED and Boating & Waterways

Project Outputs:

Output	Metric
Preliminary pre-control summary	Quarter 1 progress report
Post-control summary	Quarter 3 progress report
Satellite vs. aerial imagery comparison	Final Report
Maps and statistics	Final Report
Dissemination of results	Digital data provided to CALFED; Presentation of data at relevant conferences Published paper, pending results

Project Outcomes:

Outcome	Metric
Refined non-native plant control approaches in Frank's Tract	Statistics and maps detailing areas of good control and poor control
Establishment of a new tool for large-scale monitoring in the Bay-Delta Program (that of newly available 2.8-meter resolution multispectral satellite imagery)	Successful classification of Egeria using the new class of satellite imagery, and incorporation of this class of imagery in future Bay-Delta monitoring programs
Addition to the knowledge base of satellite image interpretation for non-native aquatic plants	Final report detailing results, and potential for a published paper

Environmental Indicators:

Indicator	Metric
Decreased presence of Egeria in areas that Boating and Waterways endeavors to control	Statistical and visual evidence from the monitoring study

6. Data Handling and Storage

All aerial and satellite image data will be in digital format for manipulation and analysis in GIS and remote sensing software. Original rectified and georeferenced image data and all associated metadata (acquisition dates / sources, projection, datum, sensor properties, etc.) will be recorded and provided to CALFED on CD-ROM. Derived digital products and associated metadata from image analysis and related GIS manipulations will also be provided on CD-ROM. All data will be collected and maintained in the same projection and datum for efficient analysis and display. Efforts will be made to use the same projection and datum for the data as is commonly used by other agencies working in Frank's Tract. At time of delivery to CALFED, all source and derived data will meet current STDS (Spatial Data Transfer Standard) protocols to allow efficient access and use in potential future studies of the study area.

7. Expected Products/Outcomes

A) Quarterly reports to CALFED presenting preliminary results of initial spring aerial image acquisition and analysis of aquatic vegetation in Frank's Tract (May 2002). Report drafts will include hardcopy maps of study area along with general statistics of image analysis. The preliminary draft maps will also be made available to Boating and Waterways for field use in their summer management activities. Digital data is not planned to be submitted with quarterly reports, though if desired, that can be arranged.

B) Final report summarizing: (1) results of monitoring study of pre-control and post-control aerial image data for *Egeria* change detection in Frank's Tract with focus on Boating and Waterways control sites, and (2) results of comparison of late-summer

satellite and aerial image analysis for aquatic vegetation, determining the viability of using new 2.8-meter satellite products for future *Egeria* monitoring in the Bay-Delta (final report December 2002).

C) Presentation of final results to the annual meeting of the Western Aquatic Plant Management Society (WAPMS) (March 2003)

D) Presentation of final results to the annual national meeting of the Aquatic Plant Management Society (APMS) (July 2003)

8. Work Schedule

Scheduled Date	Benchmark
Early April 2002	Acquisition of pre-control aerial imagery, upon final approval of the proposed study. (ReMetrix is willing to begin work on the study prior to final contract signing)
Early May 2002	Start of imagery analysis of first aerial collect.
May 30, 2002	Completion of analysis of first aerial collect and submission of quarterly report to CALFED and Boating and Waterways summarizing preliminary results.
Late August/September 2002	Concurrent acquisition of post-control aerial imagery and 2.8m-resolution multispectral satellite imagery, based on timing of Boating and Waterways Egeria control schedule.
Late September 2002	Begin post-control aerial and satellite imagery analysis; quarterly update to CALFED reviewing status of imagery collection and analysis.
October 31, 2002	Completion date for analysis of aerial and satellite data.
November 2002	Development of final report to CALFED.
December 2002	Submission of final report and associated digital files to CALFED and Boating and Waterways.

The itemized budget for the proposed study is attached at the end of this document in Section D. It is labeled "Funding for All Phases."

Partial funding of this study will remove only part of the imagery needs. If only the monitoring portion is funded (Phases One and Two), then there is no need to collect and analyze the newly available satellite data (Phase Three). The budget for this scenario is attached at the end of this document in Section D, labeled "Phases One and Two Only."

If only the new satellite *vs.* aerial comparison portion of the study is funded (Phases Two and Three), there would be no need to collect pre-control aerial photography for in-season monitoring (Phase One). The budget for this scenario is attached at the end of this document in Section D, labeled "Phases Two and Three Only."

It would not make sense to fund other scenarios than the three mentioned directly above.

Section B: Applicability to CALFED ERP and Science Program Goals and Implementation Plan and CVPIA Priorities

1. ERP, Science Program and CVPIA Priorities

The proposed study is directly applicable to the first itemized priority for restoration of Multi-Regional Bay-Delta Areas. This is stated in Sections 3 as:

> "Prevent the establishment of additional non-native species and **reduce the negative biological, economic, and social impacts of established non-native species in the Bay-Delta estuary and its watersheds.**" (p.18)

The text highlighted in boldface type in the above statement is the specific priority that the proposed study addresses. The manner that the proposed study will accomplish this priority will be to supplement the efforts of Boating and Waterways and other agencies working in Frank's Tract to address *Egeria densa* infestations. Progress will be made toward the above priority by helping Boating and Waterways refine their approaches to *Egeria* management.

2. Relationship to Other Ecosystem Restoration Projects

The most direct relationship of the proposed study to other Bay-Delta Ecosystem Restoration Projects is the close coordination with the *Egeria* control actions being undertaken in Frank's Tract by Boating and Waterways. The proposed study is intended to monitor the efficacy of the control actions, provide data to refine those actions (even in mid-year), and evaluate new, lower-cost options for satellite monitoring in future years. We will work closely with the Boating and Waterways program to support their needs.

Relationship to projects by other agencies that can benefit from the proposed study are any agencies currently working in Frank's Tract. *Since the imagery will cover the entirety of Frank's Tract, any other agencies working on projects in any part of Frank's Tract will have the availability of high-resolution airborne data (both aerial and satellite) to augment their efforts.*

Agencies other than Boating and Waterways that should definitely be included in the above italicized statement are:

- The California Department of Water Resources;
- The California Department of Fish And Game;
- The Bureau of Reclamation;
- San Francisco State University's Romberg Tiburon Center for Environmental Studies;
- The United States Geological Survey;
- The United States Army Corps of Engineers.

3. Requests for Next-Phase Funding

Not applicable.

4. Previous Recipients of CALFED Program or CVPIA Funding

Not applicable.

5. System-Wide Ecosystem Benefits

The system-wide ecosystem benefits for controlling non-native invasive aquatic species is well understood. Though ReMetrix is not directly undertaking *Egeria* control efforts, the proposed study is designed to improve efforts of those agencies that are undertaking such efforts. Improvements in approach or technique of Bay-Delta *Egeria* control will result from the proposed study, as will a better understanding of the system in general. All of these translate toward increased ecosystem benefits system-wide, wherever *Egeria* is encountered.

From a more general, "beyond *Egeria*" system-wide perspective, establishment of the viability of the newly available 2.8-meter resolution multispectral satellite imagery for large-scale Bay-Delta aquatic ecosystem monitoring is perhaps the most significant contribution. This contribution can save money and man-hours in the long-term, and leave future Bay-Delta researchers with a more robust data set from which to gauge system change.

6. Additional Information for Proposals Containing Land Acquisition

Not applicable.

Section C: Qualifications

ReMetrix is the national aquatic vegetation assessment and mapping leader. The company is focused exclusively on understanding the dynamics of non-native aquatic vegetation, assessing the characteristics of the vegetation, and producing statistics and GIS-based maps to support efforts to address non-native aquatic vegetation.

ReMetrix has conducted work nationwide on bodies of water ranging over 30.000 surface acres. In 2000, ReMetrix completed aquatic vegetation and habitat assessments on approximately 150,000 surface acres. ReMetrix has worked in nine states including California (Big Bear Municipal Water District, Big Bear, CA), and has conducted successful, pioneering aquatic vegetation remote sensing projects for agencies such as the Engineering Research and Development Center of the US Army Corps of Engineers, and the Bureau of Aquatic Plant Management of the Florida Department of Environmental Protection.

ReMetrix has a scientific staff that is well equipped for aquatic vegetation monitoring and assessment:

The lead investigator of the proposed study, Terry McNabb, has a degree in Aquatic Biology from Michigan State University. Mr. McNabb has been involved with non-native aquatic vegetation management, assessment, and monitoring on a daily basis for 29 years. He is also a former President of the national Aquatic Plant Management Society.

Dr. Mark Heilman has a PhD in Aquatic Ecology from Notre Dame University. Dr. Heilman is an expert on aquatic plant biology, and has also conducted over a dozen remote sensing assessments of non-native aquatic vegetation using both aerial and satellite imagery.

Douglas Henderson has a Master's Degree in Geological Sciences from The University of Texas. He has over six years of experience doing environmental remote sensing and GIS assessments, and has conducted over twenty assessments of non-native aquatic vegetation using remote sensing techniques. Mr. Henderson has also published three relevant articles on environmental remote sensing assessments, which are listed in Section G below.

Section D: Cost

1. Budget

The budget is presented in three scenarios: full funding of the proposed study, and two alternate funding scenarios covering partial funding of the proposed study. These additional two partial scenarios are described further in the text of Section A, Part 8, above.

Budget Option One: Funding for All Phases

Bi-Annual Comparison of Study Area Using Aerial Imagery
With Annual Comparison of Satellite Imagery

	Cost of Acquisition	Number of Acquisitions	Total
Aerial Image Acquisition	8000.00	2.00	16000.00
Satellite Image Acquisition	1600.00	1.00	1600.00
	Rate	**Hours**	
Image Analysis	80.00	80.00	6400.00
Project Administration	90.00	20.00	1800.00
Report Composition	90.00	40.00	3600.00
Quarterly Updates	90.00	16.00	1440.00
Computer Usage Fee	1.57	136.00	214.00
Other (Shipping, Printing, etc.)			100.00
		Subtotal:	31154.00
		24% Operating Expense:	7534.00
		10% Revenue Margin:	3869.00
		Grand Total:	**42557.00**

Budget Option Two: Phases One and Two Only

Bi-Annual Comparison of Study Area Using Aerial Imagery

	Cost of Acquisition	Number of Acquisitions	Total
Aerial Image Acquisition	8000.00	2.00	16000.00
	Rate	**Hours**	
Image Analysis	80.00	64.00	5120.00
Project Administration	90.00	16.00	1440.00
Report Composition	90.00	32.00	2880.00
Quarterly Updates	90.00	16.00	1440.00
Computer Usage Fee	1.57	112.00	176.00
Other (Shipping, Printing, etc.)			100.00
		Subtotal:	27156.00
		23% Operating Expense:	6182.00
		10% Revenue Margin:	3334.00
		Grand Total:	**36672.00**

Buget Option Three: Phases Two and Three Only

Annual Comparison of Study Area Using Aerial Imagery vs. Satellite Imagery

	Cost of Acquisition	Number of Acquisitions	Total
Aerial Image Acquisition	8000.00	1.00	8000.00
Satellite Image Acquisition	1600.00	1.00	1600.00
	Rate	**Hours**	
Image Analysis	80.00	48.00	3840.00
Project Administration	90.00	12.00	1080.00
Report Composition	90.00	24.00	2160.00
Quarterly Updates	90.00	12.00	1080.00
Computer Usage Fee	1.57	84.00	131.88
Other (Shipping, Printing, etc.)			100.00
		Subtotal:	17992.00
		27% Operating Expense:	4830.00
		10% Revenue Margin:	2282.00
		Grand Total:	**25104.00**

2. Cost Sharing

Not applicable.

Section E: Local Involvement

Local involvement has been coordinated only with the California Department of Boating and Waterways. ReMetrix is happy to involve any other stakeholders or interest groups, though the proposed study is designed to specifically support the Boating and Waterways *Egeria* control efforts.

Section F: Compliance with Standard Terms and Conditions

ReMetrix is willing to comply with all standard State and Federal contract terms, including full disclosure of study results.

Section G: Literature Cited

Falkner, Edgar, 1995. *Aerial Mapping: Methods and Applications*, CRC Press, Boca Raton, 322 p.

Henderson, Douglas R., 2001. "Advances In Aquatic Plant Management Using Mapping Technologies," *Aquatics*, Vol. 23 (1), p. 4-8.

Henderson, Douglas R., 1999. *Using Remote Sensing for Environmental Baseline Studies*, Proceedings: SPE/EPA Exploration and Production Environmental Conference, p. 531-6.

Henderson, Douglas R., 1999. *Change Detection Analysis of Rainforest Impacts Resulting From Seismic Exploration*, Proceedings: International Petroleum Environmental Conference, 7 p.

Verbyla, David L., 1995. *Satellite Remote Sensing of Natural Resources*, CRC Press, Boca Raton, 198 p.