



January 10, 2005

Debra Gonzalez  
California Department of Water Resources  
Office of Water Use Efficiency  
P.O. Box 942836,  
Sacramento, CA 94236-0001

Dear Ms. Gonzalez:

Please find enclosed one original, eight photocopies, and an electronic version of the proposal entitled "South Feather Water & Power Agency, Canal Seepage Reduction Program".

Please feel free to contact me at (530) 533-4578 if you have any additional questions.

Sincerely,

Matt Colwell  
Water Division Manager  
South Feather Water & Power Agency  
2310 Oro-Quincy Hwy  
Oroville, CA 95965  
Tel: (530) 533-4578; Fax: (530) 533-9700  
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**South Feather Water & Power Agency  
CANAL SEEPAGE REDUCTION PROGRAM**



**An Agricultural Water Use Efficiency Implementation Project submitted to**

**CALIFORNIA DEPARTMENT OF WATER RESOURCES  
CALIFORNIA BAY-DELTA WATER USE EFFICIENCY PROGRAM, Section A**

*By*  
**South Feather Water & Power Agency  
PO Box 581, 2310 Oro-Quincy Hwy  
Oroville, CA 95965**

**January 11, 2005**

## Project Information Form

Applying for:

Urban

Agricultural

1. (Section A) **Urban or Agricultural Water Use Efficiency Implementation Project**

(a) implementation of Urban Best Management Practice, # \_\_\_\_\_

(b) implementation of Agricultural Efficient Water Management Practice, # \_\_\_\_\_

(c) Implementation of other projects to meet California Bay-Delta Program objectives, Targeted Benefit # or Quantifiable Objective #, if applicable **38, 44, 42, 46** \_\_\_\_\_

(d) Specify other: \_\_\_\_\_

2. (Section B) **Urban or Agricultural Research and Development; Feasibility Studies, Pilot, or Demonstration Projects; Training, Education or Public Information; Technical Assistance**

(e) research and development, feasibility studies, pilot, or demonstration projects

(f) training, education or public information programs with statewide application

(g) technical assistance

(h) other

3. Principal applicant (Organization or affiliation):

South Feather Water & Power Agency

4. Project Title:

Canal Seepage Reduction Program

5. Person authorized to sign and submit proposal and contract:

Name, title Michael Glaze

General Manager

Mailing address South Feather Water & Power Agency

P.O. Box 581

Oroville, CA 95965

Telephone (530) 533-4578

Fax. (530) 533-9700

E-mail glaze@southfeather.com

6. Contact person (if different) Name, title Matt Colwell, Water Division Manager  
Mailing address South Feather Water & Power Agency  
P.O. Box 581  
Oroville, CA 95965  
Telephone (530) 533-4578  
Fax. (530) 533-9700  
E-mail mcolwell@southfeather.com

7. Grant funds requested (dollar amount): \$ 315,480  
*(from Table C-1, column VI)*

8. Applicant funds pledged (dollar amount): \$ 66,200

9. Total project costs (dollar amount): \$ 381,680  
*(from Table C-1, column IV, row n)*

10. Percent of State share requested (%) 83%  
*(from Table C-1)*

11. Percent of local share as match (%) 17%  
*(from Table C-1)*

12. Is your project locally cost effective?  
*Locally cost effective means that the benefits to an entity (in dollar terms) of implementing a program exceed the costs of that program within the boundaries of that entity.*  (a) yes

*(If yes, provide information that the project in addition to Bay-Delta benefit meets one of the following conditions: broad transferable benefits, overcome implementation barriers, or accelerate implementation.)*  (b) no

11. Is your project required by regulation, law or contract?  (a) yes  
If no, your project is eligible.

(b) no  
If yes, your project may be eligible only if there will be accelerated implementation to fulfill a future requirement and is not currently required.

*Provide a description of the regulation, law or contract and an explanation of why the project is not currently required.*

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12. Duration of project (month/year to month/year): 01/2006 to 12/2008
13. State Assembly District where the project is to be conducted: 3<sup>rd</sup> District
14. State Senate District where the project is to be conducted: 4<sup>th</sup> District
15. Congressional district(s) where the project is to be conducted: 2<sup>nd</sup> District
16. County where the project is to be conducted: Butte County
17. Location of project (longitude and latitude): 39 deg-31 min Latitude and  
121 deg 30 min Longitude
18. How many service connections in your service area (urban)? 6,485
19. How many acre-feet of water per year does your agency serve? 27,500 ac-ft
20. Type of applicant (select one):
- (a) City
  - (b) County
  - (c) City and County
  - (d) Joint Powers Authority
  - (e) Public Water District
  - (f) Tribe
  - (g) Non Profit Organization
  - (h) University, College
  - (i) State Agency
  - (j) Federal Agency
  - (k) Other
    - (i) Investor-Owned Utility
    - (ii) Incorporated Mutual Water Co.
    - (iii) Specify \_\_\_\_\_
21. Is applicant a disadvantaged community? If 'yes' include annual median household income. (Provide supporting documentation.)
- (a) yes, \_\_\_\_\_ median household income
  - (b) no

## Signature Page

By signing below, the official declares the following:

The truthfulness of all representations in the proposal;

The individual signing the form has the legal authority to submit the proposal on behalf of the applicant;

There is no pending litigation that may impact the financial condition of the applicant or its ability to complete the proposed project;

The individual signing the form read and understood the conflict of interest and confidentiality section and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant;

The applicant will comply with all terms and conditions identified in this PSP if selected for funding; and

The applicant has legal authority to enter into a contract with the State.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Name and title

\_\_\_\_\_  
Date

## ***South Feather Water & Power Agency***

### ***Canal Seepage Reduction Program***

#### ***Introduction***

Seepage from irrigation canals is a serious water management problem in California and contributes to unnecessary diversions from natural waterways feeding the California Bay Delta. California voters responded to this concern by appropriated 3.4 billion dollars to help improve water management. For South Feather Water and Power Agency, canal seepage is a particular concern where 110 miles of earthen canal originally constructed for mining purposes experience conveyance losses up to 90%. The South Feather Water & Power Agency (SFWPA) Canal Seepage Reduction Program includes a two-prong approach designed to identify canal reaches with high seepage rates and to implement prioritized canal-lining projects to produce the least-cost water savings. SFWPA is pursuing a Proposition 50 water use efficiency funded project to help reduce canal seepage, improve irrigation efficiency, and increase regional water supply reliability. SFWPA requests funding for implementing 10,500 feet of canal lining on the Palermo Canal as part of the Canal Seepage Reduction Program.

SFWPA is located in Oroville, Butte County, CA, which is included in CALFED sub-region 5 and diverts 27,000 acre-feet of water annually from the South Fork Feather River for irrigation and domestic purposes. SFWPA is seeking to implement canal-lining projects as part of a programmatic approach to reducing seepage. The following grant application package is developed in accordance with the requested proposal submittal contents identified in the Final 2004 Water Use Efficiency Proposal Solicitation Package, Section A: Agricultural Water Use Efficiency Implementation Projects.

#### ***Section A-15c. Statement of Work – Relevance and Importance***

##### ***Goals and Objectives***

The goal of this project is to reduce the amount of water lost to canal seepage and non-productive ET based on a least cost programmatic approach. The objective of this project is to implement canal lining on priority reaches of the Palermo Canal that will significantly reduce water loss from canal seepage to deep percolation. This project is an integral part of the SFWPA Canal Seepage Reduction Program and is a part of a collaborative effort with the Center for Irrigation Technology, California State University, Fresno (CIT), and Davids Engineering.

SFWPA proposes to line high seepage sections of the Palermo Canal using Agency personnel and the use of a concrete pumping service consistent with successful canal-lining projects implemented in 2003. The Agency can accomplish the lining of 3,500 lineal feet of canal each year, at three or four priority locations for a total of 10,500 feet of canal. It is estimated that the completed project will produce savings of 1,000 acre-feet of water annually that was lost to deep percolation in fractured rock. The estimated

cost of the total project is \$381,600. The Agency proposes that 83% (\$315,480) of the cost be funded by the Water Use Efficiency Program. The District would pledge the use of District personnel and equipment at a cost of \$66,200 to complete the project's funding.

### ***Local and Regional Need***

The Palermo Canal is a mostly earthen ditch originally constructed in the mid 1800's with a capacity currently of 25 cubic feet per second (cfs). The main canal originates from Lake Oroville Dam and is approximately 12 miles in length with an average width of five feet and an average depth of three feet (see map in Appendix A) and feeds smaller canals with an average width of two feet. The total length of the Palermo Canal is about 33 miles. The SFWPA delivers about 7,000 acre-feet (AF) annually to the Palermo Canal. It is estimated that an average of 5,700 AF of water is lost annually in the Palermo Canal due to seepage, which represents more than 80% of the total water volume diverted into the canal. Funding for this proposal is needed to implement 10,500 feet of canal lining in high seepage areas that are not a locally cost effective project and will conserve an estimated 1,000 acre feet annually.

This project is needed to implement agricultural water supplier *Efficient Water Management Practices, Canal Lining or Piping* (EWMP B5) that is not locally cost effective. The conserved water could provide additional water in Lake Oroville for downstream aquatic ecosystem enhancement, Bay-Delta water quality objectives, additional hydroelectricity generation, and for transfer to downstream communities. The proposed project will provide a direct water use efficiency benefit by reducing canal losses estimated at 1,000 acre-feet annually and improving overall water supply reliability in CALFED sub-region 5 and the Bay-Delta.

Lining canals is the initial step in a concerted effort to modernize SFWPA's irrigation distribution system to more efficiently match the demand with supplies. Implementing the Canal Seepage Reduction Program is the initial step to achieving increased irrigation flexibility resulting in reduced seepage losses, decreased water travel time, and reduced operational spills. However the cost effectiveness prohibits SFWPA from implementing the desired improvements. The Agency enjoys the benefit of ample water supply and gravity fed distribution system resulting in the low cost of water and the lack of revenue to implement the necessary improvements. SFWPA is seeking funding from the 2004 CALFED and DWR Agricultural Water Use Efficiency Proposition 50 Program, Section A to implement 10,500 feet of canal lining.

### ***Support of California Bay-Delta Program Goals***

The goals of the Water Use Efficiency Program as defined by the California Bay-Delta Program "include water quantity, water quality, and in-stream flow and timing improvements that directly or indirectly provide benefits to the Bay-Delta". The proposed project contributes to each of these goals, as defined for sub-region 5 (Lower Feather River and Yuba River) but also for many other CALFED sub-regions. The

project will directly and indirectly provide benefits toward the following targeted objectives:

Water Quantity

- Provide long-term diversion flexibility to increase the water supply for beneficial uses (Targeted Benefit 47).
- Decrease non-productive ET to increase the water supply for beneficial uses (Targeted Benefit 46).

Water Quality

- Reduce temperature to enhance and maintain aquatic species populations (Targeted Benefit 44)
- Reduce salinity to enhance and maintain beneficial uses of water (Targeted Benefit 42)

In-stream Flow/Timing

- Provide flow to improve ecosystem conditions (Targeted Benefit 38)

More specifically, the proposed project will reduce seepage along the Palermo Canal, and therefore will contribute to:

1) Increase water storage in Lake Oroville and decrease required diversions to SFWPA canals, thereby providing additional water for Feather River and Bay-Delta water quality, hydroelectricity production, and irrigation for downstream farming communities,

2) Improve the aquatic ecosystem of the Feather River by increasing water flow (and decreasing water temperature).

3) Decrease non-productive ET of vegetation growth around seepage areas and canal banks.

These benefits can also be indirectly attributable to other CALFED sub-regions such as Sub-regions 7, 9, 6 and 4.

***Integration with Local and Regional Integrated Water Resources Plans***

The proposed project is consistent with the Butte County Integrated Water Resources Plan and the Northern California Water Association Integrated Water Management Plan.

*Butte County Integrated Water Resources Plan*

The goal of the proposed project is consistent with the water use efficiency planning objective of the Butte County Integrated Water Resources Plan. The SFWPA least cost approach to identification and implementation of canal lining as part of the Canal Seepage Reduction Program is consistent with the Butte County Department of Water and Resource Conservation mission “To manage and conserve water and other resources for the citizens of Butte County.”

### Northern California Water Association Integrated Water Management Plan

This proposal is consistent with the water use efficiency section of the Northern California Water Association (NCWA) integrated water management program. This proposal has been discussed with NCWA staff and members, who have been supportive of the project as consistent with the goals of the NCWA integrated water management program.

Additionally, the proposed project is consistent with the following objectives of the CALFED water Use Efficiency Program:

- Reduce existing irrecoverable losses
- Achieve multiple benefits, including increasing water availability for irrigation or in-stream flow, enhancing water quality, and reducing diversion impacts.

Letters of support from Butte County and NCWA for the SFWPA Canal Seepage Reduction Program including the components to implement canal lining and research to identify, assess and monitor canal seepage are presented in Appendix B.

### ***Demand Management Activities***

Agricultural water management plans developed in California either through the United States Bureau of Reclamation (USBR) water conservation program or through the Agricultural Water Management Council (AWMC) Water Management Planning require the evaluation of agricultural water management practices pertaining to lining canals. SFWPA as an agricultural water provider has pursued evaluation and implementation of canal lining and seepage reduction projects in the past. SFWPA recognizes the benefit of utilizing the technology developed by CIT to help identify canal-lining projects and quantify seepage loss.

The Agency has successfully completed canal-lining projects in the past that have resulted in significant water savings. SFWPA intends to build on the past successes and implement additional canal-lining projects consistent with the AWMC EWMP B5 (*Line or pipe ditches and canals*). The Seepage Reduction Program and specifically the canal-lining activities will also contribute to implementing EWMP B6 (*Increase flexibility in water ordering by, and delivery to, water users*) and EWMP B4 (*Facilitate voluntary water transfers that do not unreasonably affect the water user, water supplier, the environment and third parties*).

SFWPA has adopted an Urban Water Management Plan in accordance with the Urban Water Management Planning Act evaluating 15-demand management measures. Demand Management Measure –3 evaluates distribution system audits, leak detection and repair. SFWPA began an aggressive distribution system pipe replacement program in 1995 and has expended nearly 8 million dollars to date significantly reducing unaccounted-for water. Open canal systems feed SFWPA's urban water treatment facilities and contribute significantly to water distribution system losses. Consistent with Urban water Demand Management –3 (*Distribution System Water Audits, Leak Detection, and Repair*), SFWPA is seeking to implement canal-lining projects to reduce

water loss in the distribution system. SFWPA seeks additional funds to continue reducing the amount of unaccounted-for water in the water distribution system.

### ***Section A-15d. Statement of Work – Technical/Scientific Merit, Feasibility***

#### ***Methods, Procedures, Equipment***

Agency personnel with experience and knowledge of canal-lining projects will perform the work completing 10,500 feet of lining over a three-year period. The site specific projects will be selected from a prioritized list of high seepage sections developed by Agency personnel and interim results obtained from a study conducted collaboratively by CIT, Davids Engineering, and SFWPA (see 2004 DWR/CALFED Water Use



Figure 1.  
Canal lining process showing prepared canal, shotcrete application and completed work.

Efficiency Grant Program, Section B, *Development of Standardized Procedure for Monitoring and Assessment of Canal Lining*, A Research Proposal).

Based on historical diversions and consumption for the Palermo Canal a loss rate is estimated at .0515 acre-feet per foot annually however many reaches exceed this loss rate. Identifying priority sections and quantifying the potential water savings will produce a least-cost approach to implementing the canal-lining projects. Based on historical loss rates and results of previous canal lining projects, SFWPA anticipates that the amount of conserved water resulting from lining 10,500 feet of high seepage rate sections will be approximately 1,000 acre-feet.

The District has had several successful projects lining canals with shotcrete. SFWPA personnel will be the project coordinator. The project coordinator's duties will include identifying project locations, organizing materials and personnel, and obtaining the access required for completing the project. SFWPA will complete all canal preparation work with Agency personnel and equipment. In many locations canal bank areas will

require brushing and clearing. A Bobcat skid steering mini-excavator with a tilt blade will be used to shape and prepare the earthen canal for shotcrete application. SFWPA would then assist the concrete pumping service with the liner application. Up to 600 feet of shotcrete hose length can be laid for difficult access locations. The shotcrete will be troweled to assure adequate depth and smoothness. Figure 1. shows a prepared section of the Palermo Canal in the process of shotcrete application and the finished product completed by Agency personnel in 2003. SFWPA will dedicate the personnel necessary to complete 3,500 feet each year.

Shotcrete work will be completed to avoid the peak irrigation season July - September. The Palermo Canal will be operated on a rotational basis during spring and fall months (low demand) to accommodate for periods of implementing ditch preparation and shotcrete work. Canal bank preparations will be concentrated in the winter months when accessible. This is a feasible project and can be completed in conjunction with the Agency's workload.

### **Task List and Schedule**

The task list and proposed schedule is shown in the timeline below:

<b>Palermo Canal Seepage Reduction Project</b>				
Planning Activities	2006			
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
Construction Activities				
Project Coordination	\$3,000	\$3,000	\$3,000	\$3,000
Environmental Review	\$15,000			
Clearing and Grubbing		\$4,076	\$4,076	\$4,076
Ditch Preparations		\$9,000		\$9,000
Ditch Lining		\$40,000		\$40,000
Quarterly Expenditure	\$18,000	\$56,076	\$7,076	\$56,076
Cummulative Annual Expense	\$18,000	\$74,076	\$81,151	\$137,227
Length of Canal Lined				3500'
	2007			
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
Project Coordination	\$3,000	\$3,000	\$3,000	\$3,000
Clearing and Grubbing		\$4,076	\$4,076	\$4,076
Ditch Preparations		\$9,000		\$9,000
Ditch Lining		\$40,000		\$40,000
Quarterly Expenditure	\$3,000	\$56,076	\$7,076	\$56,076
Cummulative Annual Expense	\$3,000	\$59,076	\$66,151	\$122,227
Length of Canal Lined				3500'
	2008			
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
Project Coordination	\$3,000	\$3,000	\$3,000	\$3,000
Clearing and Grubbing		\$4,076	\$4,076	\$4,076
Ditch Preparations		\$9,000		\$9,000
Ditch Lining		\$40,000		\$40,000
Quarterly Expenditure	\$3,000	\$56,076	\$7,076	\$56,076
Cummulative Annual Expense	\$3,000	\$59,076	\$66,151	\$122,227
Length of Canal Lined				3500'
<b>Project Total</b>				<b>\$381,680</b>

## ***Environmental Documentation***

South Feather Water & Power Agency will act as the lead agency in the CEQA process to comply with all local, County, State and Federal guidelines. The CEQA process will address all the potential environmental, social and economic impacts to the proposed project, including mitigation, required under CEQA.

SFWPA will complete an Initial Study (IS) as a preliminary analysis to determine the relative environmental impacts associated with the canal-lining project specific to the areas to be lined. The IS will evaluate if the project will have a significant adverse effect on the environment, thereby triggering the need to prepare a full environmental Impact Report (EIR). Based on the findings documented in the IS, SFWPA will initiate early consultation with local, regional, state and federal environmental agencies. Any significant environmental issues associated with the proposed project will be assessed and evaluated. Public participation on the proposed project and the potential environmental effects will be encouraged through public notification SFWPA's Board of Directors Meetings.

SFWPA routinely cleans, maintains, and enhances the irrigation distribution system and it is anticipated that the canal-lining project will not have a significant environmental impact and/or can be mitigated to a "Less Than Significant" or "No Impact" level. The preparation of a Negative Declaration or Mitigated Negative Declaration will be consistent with CEQA requirements. SFWPA will evaluate additional options if it is determined that a complete Environmental Impact Report be prepared under CEQA guidelines.

SFWPA anticipates filing a Negative Declaration/Mitigated Negative Declaration by Submitting to the State Clearinghouse: 1) the Initial Study; 2) Notice of Intent to Adopt a Negative Declaration (or Mitigated Negative Declaration); and 3) an Environmental Document Transmittal Form.

SFWPA will notify the public, State and local agencies, and local cities and counties that it intends to adopt a Negative Declaration or Mitigated Negative Declaration for a project. This notification serves as the beginning of a public review period of 30 days. Receipt of the notice by the Clearinghouse starts the 30-day review period for State agencies. After the review period the Agency will respond to any comments received. The agency will include those responses in the preparation of a final environmental document and submit a Notice of Determination to the State Clearinghouse and interested parties.

A schedule to implement the environmental review will be to complete the environmental review process in 90 days from a tentative approval notice for the project. Below is the estimated schedule for completion of all appropriate environmental documentation.

**Palermo Canal Seepage Reduction Project Environmental Review**

Planning Activities	2006	
Initial Study Preparation	Jan 1-15	
Public Comment and Review		Jan 16- Feb 16
Respond to Comments		Feb 16-22
Adopt Final Environmental Document		Feb 22
Notice of Determination		Feb 22- Mar 22

**Section A-15e. Statement of Work - Monitoring and Assessment.**

SFWPA understands that monitoring and verification of water savings resulting from canal lining is important to defining the overall success of a project. Traditional methods of evaluating diversions and water use records have been used to assess the success of previous SFWPA canal lining projects. This method is only a stochastic approach and does not adequately capture the actual water loss due to canal seepage and the resulting conserved water of lined sections. SFWPA proposes a monitoring and assessment plan that includes a collaborative research effort with the Center for Irrigation Technology, California State University, Fresno (CIT) that will scientifically quantify conserved water.

SFWPA and CIT are pursuing a DWR/CALFED 2004 WATER USE EFFICIENCY PROGRAM, Section B grant program that is designed to develop a standardized procedure for monitoring and assessment of canal lining. SFWPA will utilize this research program to assess pre-project conditions and data for this Canal Seepage Reduction Program and specifically monitor and assess conserved water resulting from the implementation of canal lining on the Palermo Canal.

The monitoring and assessment plan proposes to undertake a programmatic approach to canal lining and develop pre-project seepage rates for approximately 20 miles of the Palermo Canal. These seepage rates will be converted to volumes lost and savings computed for the lined sections.

The implementation of the proposed methodology and procedure will provide significant advancement in the development of a standardized procedure for monitoring and assessment of canal lining that can be used by other water agencies needing to evaluate, implement and monitor seepage reduction programs. This program methodology incorporates protocols for estimating the volume of conserved water resulting from canal lining recommended by the Agricultural Water Management Council available at:

<http://www.agwatercouncil.org/Canal%20Lining%20Protocols1.pdf>

SFWPA plans to undertake early implementation of canal lining projects concurrently with the research efforts to develop a standardized procedure for monitoring and assessment of canal lining. SFWPA will continue to implement canal lining on priority sections identified in the monitoring and assessment plan.

This Section A grant application proposes to line approximately six percent of the Palermo Canal and or less than 2 percent of the 112 miles of open canal system serving the Agency. Results of the collaborative effort to develop a standardized procedure for monitoring and assessment of canal lining will continue to be beneficial in the least cost approach to SFWPA's Canal Seepage Reduction Program.

Based on the companion Section B grant application The SFWPA Canal Seepage Reduction Program monitoring and assessment plan includes the following tasks:

*Task 1 - Develop Reconnaissance Seepage Survey Plan*

Canal reaches will be selected for a systematic reconnaissance seepage survey based on capacity, access, and knowledge of potential seepage locations. The survey plan is expected to cover 20 miles of open, unlined reaches of the Palermo canal. The plan will also include 1-2 miles of accessible canal that was previously lined with shotcrete using funds from the 2001 DWR Water Use Efficiency project awarded to SFWPA.

*Task 2 – Develop Water Balance*

Subject to the availability of data, a water balance will be developed for priority reaches of the Palermo canal identified in Task 1. The approach will be to use operational and other records to estimate monthly system inflows and outflows, including allowances for canal evaporation, and to estimate seepage as the water balance closure term.

*Task 3 – Develop Conceptual Seepage Model*

Review of published research findings (ANCID, 2000) coupled with experience on other projects, indicates that seepage loss from irrigation canals is governed by many inter-related factors. Typically, the most prominent factors are: *channel configuration* (channel top width and depth); *operational patterns* of starting and shutting off canals and laterals; *hydraulic conductivity* of underlying soils (in both the vertical and horizontal directions); *presence of clogging layers* due to sedimentation and how such layers are affected by operations and maintenance (O&M) activities; *presence of shallow groundwater tables*, and the *position of such water tables* in relation to the canal invert. Field inspections coupled with review of available information will be conducted to identify which of these factors must be considered, or may be neglected, in the case of the SFWP system. Based on this determination, the various equations (or models) that have been developed to estimate seepage losses will be reviewed, and an appropriate equation will be chosen to proceed with the investigation.

*Task 4 – Develop GIS Analytical Tool*

Available data pertaining to the parameters noted above (see Task 3) will be compiled and digitized for loading into an ArcGIS database. Available data regarding shallow water table elevations or depths will also be compiled and mapped. This tool will be used in the categorization and selection of reaches for ponding tests in Task 6.

#### Task 5 – Conduct Reconnaissance Seepage Surveys

CIT will use the Mobile Assessment (MA) System to conduct reconnaissance seepage surveys of the canal segments identified in Task 1. Analyses of the data will provide maps of soil water content and texture along the canal reaches surveyed.

#### Task 6 – Select Locations for Ponding Tests

Analyze reconnaissance seepage surveys to select representative canal reaches for ponding tests. Consideration of operating requirements, including ability or inability to shut down a canal for two to three days to conduct a ponding test, will be an important parameter in the selection of reaches for the ponding tests. The number of reaches selected for testing will depend on the number of groups, the estimated cost of performing the tests, the availability of SFWP field staff, operational considerations, and other factors.

#### Task 7 – Conduct Ponding Tests

Ponding tests are recommended here to provide the highest possible level of confidence in the seepage loss estimates. Each of the selected reaches will be hydraulically isolated from the system using check gates or temporary earthen plugs, or a combination of the two. It will then be filled to a level slightly higher than the normal operating depth. When the test starts, the rate of water level decline will be monitored regularly over time to estimate the volume of seepage loss. Computations will be performed to convert the seepage volume into a seepage rate (typically in  $\text{ft}^3/\text{ft}^2/\text{day}$ ).

#### Task 8 – Infer Seepage Estimates

The calculated seepage rates obtained from ponding tests and the EM survey results will be used to derive values for the variables required for the selected seepage equation (see Task 3). The equation will then be used as a calibration model to compute seepage losses for the multiple reaches the Palermo Canal.

#### Task 9 – Prepare Seepage Loss Analysis Technical Memorandum

A seepage loss analysis will be performed to evaluate the volumes of water lost to seepage along all EM surveyed reaches. This analysis will be used to determine the most cost-effective canal reaches to line, i.e., the canal segments having the highest seepage rates and where lining will result in the greatest water savings. A technical memorandum will be prepared to document the ponding tests, analyses, data and results of the seepage loss analysis. This technical memorandum will serve to document and verify the water savings that will occur from lining selected canal reaches of the SFWPA distribution system.

#### Task 10 – Prepare EM and Ponding Test Seepage Survey Procedure Technical Memorandum

A technical memorandum will be prepared to document the steps and analyses required to quickly and cost effectively identify the low-cost canal reaches for lining, including EM-31 surveys and ponding tests. This technical memorandum will provide clear, concise steps for districts to use the EM survey in conjunction with ponding tests to develop and document seepage rates in portions of their distribution system.

### Task 11 – Conduct Field Days for Research Outreach

Results from the study will be disseminated to irrigation districts, USBR, and universities during two field days at SFWPA and California State University, Chico (CSUC). The field day at SFWPA will show the use of the MA system and EM technology *in-situ*. Then, at the end of the project, a second field day conducted at CSUC will present the results of the project and describe the standardized procedure developed to identify and quantify seepage rate rapidly and cost-effectively along canal banks.

The estimated costs of the monitoring and assessment plan associated with this project (lining 10,500 feet of canal) are difficult to ascertain. The total proposed cost of the monitoring and assessment plan is \$267,000 (see Development of Standardized Procedure for Monitoring and Assessment of canal lining, A Research Proposal submitted to DWR/CALFED 2004 Water Use Efficiency Program, Section B, Submitted by CIT and SFWPA). It is estimated that the costs directly attributable to this project could be less than \$16,000. In an effort to not duplicate funding requests, the cost component of the monitoring and assessment plan are not addressed in this grant. Please refer to the research proposal for a complete discussion.

The benefits of the proposed monitoring and assessment plan that includes a collaborative research effort with the CIT will be significantly broader than quantifying the results of lining six percent of the Palermo Canal. SFWPA will have monitoring and assessment performed on a majority of the remaining reaches of the Palermo Canal in addition to a standardized approach to a canal seepage reduction program for the entire 112 miles of open canal system. DWR, CALFED and the AWMC receive significant benefits from the implementation of comprehensive seepage reduction program that can be emulated and more affectively applied to other water agencies.

## **Section A15f. Qualifications of the Applicants and Cooperators**

### **Project Manager Resume**

Matt Colwell, SFWPA Water Division Manger is responsible for the success of the Agency's Canal Seepage Reduction Program and will be managing the implementation of the 10,500 feet of Palermo Canal lining project. Mr. Colwell is responsible for a 30 person Water Division staff that will constitute the work force to implement this project. Many of the staff have performed prior canal lining programs and obtain outstanding qualifications to complete this project on time and within the budget. Water Division staff maintain working relationship with material suppliers and handlers. Mr. Colwell's resume is included in Appendix C

### **External Cooperators**

The implementation of the 2004 WUE Section A grant application for lining 10,500 feet of the Palermo Canal will be completed primarily by SFWPA Water Division staff. It is

anticipated that Matthews Ready-mix and Bob's Concrete Pumping will be contracted to supply and handle the shotcrete material.

As previously noted that the monitoring and assessment component of this application is incorporated in the companion 2004 DWR/CALFED Water Use Efficiency Grant Program, Section B, *Development of Standardized Procedure for Monitoring and Assessment of Canal Lining*, A Research Proposal collaboratively proposed by CIT, Davids Engineering and SFWPA.

### ***Water Use Efficiency Grant Project Participation***

SFWPA formerly named Oroville Wyandotte Irrigation District (OWID) participated in the CALFED/DWR 2001 WUE Grant Program. The Agency successfully completed 9,335 of canal lining on the Palermo Canal during the period of July 2001 to December 2003. The Agency considers this involvement a success and the anticipated benefits to CALFED were exceeded. Over 1,000 acre-feet annually are estimated to be conserved.

Mr. Colwell has participated in Proposition 13 and 204 grant programs in the past including Western Canal Water District's Water Use Efficiency Program where funding was received for the reconstruction and modernization of the meter calibration station and quantification of operational spills.

### ***Section A-15g. Outreach, Community Involvement, and Acceptance***

Project findings will be disseminated to DWR, CALFED WUE Program, irrigation districts, USBR, cooperators, Sacramento Valley water interests, public, and the scientific community. Two field days will be conducted at SFWPA and California State University, Chico, to show the use of the MA system and EM technology in-situ and to present the results of the project and inform interested parties on the newly developed procedure for rapid identification and quantification of canal seepage.

Research results will be published through popular trade/local journals to inform the public on (1) the innovative EM-ponding test technique for canal seepage assessment, and (2) on the potential water savings following lining of the canal reaches having high seepage losses. Research papers will also be published in refereed journals to document the methods and results obtained from this study to the scientific community. The project work will also be presented at professional and technical meetings using maps, photographs, posters, and slides. The level of details and scientific concepts will be based on the target audience.

### ***Section A-15h. Innovation***

This collaborative approach to integrating implementation projects with a research component for monitoring and assessing achieved benefits is an innovative approach to broaden the understanding and implementation of canal seepage reduction programs. SFWPA, CIT, and Davids Engineering anticipate a completed comprehensive program

that incorporates innovative technologies with traditional seepage reduction methods. This program is designed to address CALFED WUE program objectives by providing defined qualitative benefits to canal lining programs that have historically been qualitatively assessed.

Preliminary testing conducted by CIT indicates that the EM technology can be used effectively as a non-invasive means of measuring soil water content and rapidly assessing canal seepage. Combining this innovative technology with a limited regime of ponding tests is expected to result in a quick, cost-effective method to determine which canal reaches to line to obtain the most water savings at the lowest expenditure.

### ***Section A-15i. Benefits and Costs***

Funding for this proposal is needed to implement 10,500 feet of canal lining that is not a locally cost effective project and will conserve an estimated 1,000 acre feet annually and is a direct benefit to water supply reliability in CALFED Sub-region 5 and the Bay-Delta.

#### ***Cost and Benefit Tables***

Provided below are the benefit and cost tables provided in the PSP that are designed to provide a project budget and assess the local and Bay-Delta benefits.

##### ***Table C-1: Project Costs (Budget)***

The project budget is derived from a series of itemized cost estimates for each task identified in Section A15d – Task List and Schedule. The total proposed project budget is presented Table C-1 estimated at \$381,680.

The Administration category covers the project management labor throughout the proposed 3-year project. SFWPA Water Division Manager will be the project manager and the Agency will contribute all of these costs for this category.

Planning and Engineering is considered as the labor portion to plan the implementation of the project including identifying periods that operations will have to accommodate canal lining activities. This category also includes engineering of lined canal including shaping of the cross section of the lined canal and invert elevation to not impact overall flow. SFWPA will perform these functions and is seeking grant funding to implement this budget category.

Equipment Purchases and Rentals include the rental of a compressor to apply the shotcrete including an operator. The category also includes the cost of operation of a mini-excavator required for clearing, grubbing and canal preparation for shotcrete lining. SFWPA and subcontractors will perform these functions and is seeking grant funding to implement this budget category.

Materials and Implementation category consists primarily of the cost of the shotcrete material and the labor to apply the material. This cost is estimated on the volume of shotcrete required to line one foot of canal and extrapolated for the entire project.

SFWPA and subcontractors will perform these functions and is seeking grant funding to implement this budget category. Construction Costs are incurred from additional staff as foremen, laborers, utility workers and operators required to finish the shotcrete application and assist with material handling and canal preparation.

Construction costs are based on labor rates and overhead costs. SFWPA will perform these functions and is seeking grant funding to implement this budget category.

Environmental documentation is anticipated to be performed as outlined in Section A-15d. SFWPA will perform these functions and will contribute all of these costs for this category.

Even though the qualitative and quantitative benefits of the project are predominantly experienced at the Bay-Delta regional level, SFWPA proposes to cost share \$66,200.

**Applicant: South Feather Water & Power Agency**

Section A projects must complete Life of investment, column VII and Capital Recovery Factor Column VIII. Do not use 0.

**Table C-1: Project Costs (Budget) in Dollars)**

Category (I)	Project Costs \$ (II)	Contingency % (ex. 5 or 10) (III)	Project Cost + Contingency \$ (IV)	Applicant Share \$ (V)	State Share Grant \$ (VI)	Life of investment (years) (VII)	Capital Recovery Factor (VIII)	Annualized Costs \$ (IX)
Administration <sup>1</sup>								
Salaries, wages	\$20,000	0	\$20,000	\$20,000	\$0	3	0.3741	\$7,482
Fringe benefits	\$11,200	0	\$11,200	\$11,200	\$0	3	0.3741	\$4,190
Supplies	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
Equipment	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
Consulting services	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
Travel	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
Other	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
<b>(a) Total Administration Costs</b>	<b>\$31,200</b>		<b>\$31,200</b>	<b>\$31,200</b>	<b>\$0</b>			<b>\$11,672</b>
<b>(b) Planning/Design/Engineering</b>	<b>\$9,800</b>	<b>0</b>	<b>\$9,800</b>	<b>\$0</b>	<b>\$9,800</b>	<b>25</b>	<b>0.0782</b>	<b>\$766</b>
Equipment								
Purchases/Rentals/Rebates/Vouchers	\$75,680	0	\$75,680	\$0	\$75,680	25	0.0782	\$5,918
Materials/Installation/Implementation	\$126,800	0	\$126,800	\$0	\$126,800	25	0.0782	\$9,916
Implementation Verification	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
Project Legal/License Fees	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
Structures	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
Land Purchase/Easement	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
Environmental								
Compliance/Mitigation/Enhancement	\$15,000	0	\$15,000	\$15,000	\$0	25	0.0782	\$1,173
Construction	\$123,200	0	\$123,200	\$20,000	\$103,200	25	0.0782	\$9,634
Other (Specify)	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
Monitoring and Assessment	\$0	0	\$0	\$0	\$0	0	0.0000	\$0
Report Preparation	\$0	5	\$0	\$0	\$0	0	0.0000	\$0
<b>(n) TOTAL</b>	<b>\$381,680</b>		<b>\$381,680</b>	<b>\$66,200</b>	<b>\$315,480</b>			<b>\$39,079</b>
<b>(o) Cost Share -Percentage</b>				<b>17</b>				

1- excludes administration O&M.

Table C-2 Annual Operation and Maintenance Costs

There is anticipated minimal annual maintenance costs associated with the completed 10,500 feet of lined canal. Annual maintenance will likely include normal ditch cleaning and maintenance estimated at \$2,000.

**Table C-2: Annual Operations and Maintenance Costs**

Operations (1) (I)	Maintenance (II)	Other (III)	Total (IV) (I + II + III)
\$1,000	\$1,000	\$0	\$2,000

(1) Include annual O & M administration costs here.

Table C-3 Total Annual Project Costs

This table totals annual project implementation cost from Table C-1 and annual operation and maintenance costs from Table C-2 associated with the completed 10,500 feet of lined canal.

**Table C-3: Total Annual Project Costs**

Annual Project Costs (1) (I)	Annual O&M Costs (2) (II)	Total Annual Project Costs (III) (I + II)
\$39,079	\$2,000	\$41,079

(1) From Table C-1, row ( n ) column (IX)

(2) From Table C-2, column ( IV )

Table C-4 Capital Recovery Factor

Table C-4 is for application reference only and is purposely omitted.

Table C-5: Project Annual Physical Benefits (Qualitative and Quantitative)

There is not any significant quantifiable local benefit to SFWPA implementing this project. Qualitatively, canal lining is the initial step in a concerted effort to modernize SFWPA's irrigation distribution system to more efficiently match the demand with supplies. Implementing the canal lining project is the initial step to achieving increased irrigation flexibility resulting in reduced seepage losses, decreased water travel time, and reduced operational spills. However the cost effectiveness prohibits SFWPA from implementing the desired improvements. The Agency enjoys the benefit of ample water supply and gravity fed distribution system resulting in the low cost of water and the lack of revenue to implement the necessary improvements. This project is needed to implement agricultural water supplier efficient water management practices focused on canal lining or piping (EWMP B5) that is not locally cost effective. SFWPA is seeking funding from the 2004 CALFED and DWR Agricultural Water Use Efficiency Proposition 50 Program, Section A to implement 10,500 feet of canal lining.

The project provides direct benefit to the Bay-Delta system. The conserved water could provide additional water in Lake Oroville for downstream aquatic ecosystem enhancement, Delta water quality objectives, additional hydroelectricity generation, and for transfer to downstream communities.

The goals of the CALFED Water Use Efficiency Program include water quantity, water quality, and in-stream flow and timing improvements that directly or indirectly provide benefits to the Bay-Delta. The proposed project contributes to each of these goals, as defined, for sub-region 5 (Lower Feather River and Yuba River) but also for many other CALFED sub-regions. The project will directly and indirectly provide benefits toward the following targeted objectives:

#### Water Quantity

- Provide long-term diversion flexibility to increase the water supply for beneficial uses (Targeted Benefit 47).
- Decrease non-productive ET to increase the water supply for beneficial uses (Targeted Benefit 46).

#### Water Quality

- Reduce temperature to enhance and maintain aquatic species populations (Targeted Benefit 44)
- Reduce salinity to enhance and maintain beneficial uses of water (Targeted Benefit 42)

#### In-stream Flow/Timing

- Provide flow to improve ecosystem conditions (Targeted Benefit 38)

More specifically, the proposed project will reduce seepage along the Palermo Canal, and therefore will contribute to:

- 1) Increase water storage in Lake Oroville and decrease required diversions to SFWPA canals, thereby providing additional water for Feather River and Delta water quality, hydroelectricity production, and irrigation for downstream farming communities,
- 2) Improve the aquatic ecosystem of the Feather River by increasing water flow (and decreasing water temperature) and increasing in-stream flow timing by providing operational flexibility or conserved water in Lake Oroville.
- 3) Decrease non-productive ET of vegetation growth around seepage areas and canal banks.

The above-described benefits can also be indirectly attributable to other CALFED sub-regions such as Sub-regions 7, 9, 6 and 4.

The conserved water will occur annually during the irrigation season. SFWPA operates the Palermo Canal with constant head (water depth) and hence, the wetted perimeter of the conveyance facilities are constant independent of flow. It is assumed the rate of conserved water due to canal seepage is constant throughout the irrigation season. The rate on conserved water resulting from decreasing non-productive ET is assumed

to accumulate seasonally on historical ET demand pattern. The total conserved water estimated at 1,000 acre-feet annually will be available in Lake Oroville for Bay-Delta benefits.

Quantifiable Benefit of Water Savings

Most of the benefits are considered qualitative benefits due to lack of data and operational understanding of the conserved water. However, conserved water is retained in Lake Oroville and DWR will benefit for increased hydro production. Using the generation installed capacity information of the Oroville Dam project provided on the Department of Water Resources web site and an assumed power value of \$65/ MWH; a generation value of the water savings was calculated.

DWR Power Production		MW	cfs	AF-Hr	MWH/AF
Edward Hyatt	Installed Capacity	645	16,950	1401	0.46
Thermalito	Installed Capacity	114	17400	1438	0.08
					0.54

	MWH/AF	\$/MWH	AF	\$ value
Generation Value	0.54	65	1000	\$ 35,082

Based on this quantified benefit there is an ongoing annual hydro-generation value of \$35,082 and the break-even period for the grant funding will be nine years. There are multiple other non-quantified benefits that contribute to the economic feasibility of this project.

Applicant:

**South Feather Water & Power Agency**

**Table C-5 Project Annual Physical Benefits (Quantitative and Qualitative Description of Benefits)**

Qualitative Description - Required of all applicants <sup>1</sup>				Quantitative Benefits - where data are available <sup>2</sup>	
	Description of physical benefits (in-stream flow and timing, water quantity and water quality) for:	Time pattern and Location of Benefit	Project Life: Duration of Benefits	State Why Project Bay Delta benefit is Direct <sup>3</sup> Indirect <sup>4</sup> or Both	Quantified Benefits (in-stream flow and timing, water quantity and water quality)
Bay Delta	See Section A-15i, Cost and Benefits	Seasonal Pattern. Conserved water stored in Lake Oroville	50 years or greater	See Section A-15i, Cost and Benefits	Actual to be determined. Estimated 1,000 acre-feet annually
Local	No significant local benefit			Not applicable.	

- <sup>1</sup> The qualitative benefits should be provided in a narrative description. Use additional sheet.
- <sup>2</sup> Direct benefits are project outcomes that contribute to a CALFED objective within the Bay-Delta system during the life of the project.
- <sup>3</sup> Indirect benefits are project outcomes that help to reduce dependency on the Bay-Delta system. Indirect benefits may be realized over time.
- <sup>4</sup> The project benefits that can be quantified (i.e. volume of water saved or mass of constituents reduced) should be provided.

Table C-6: Project Annual Local Monetary Benefits

**Table C-6 Project Annual Local Monetary Benefits**

<b>ANNUAL LOCAL BENEFITS</b>	<b>ANNUAL QUANTITY</b>	<b>UNIT OF MEASUREMENT</b>	<b>ANNUAL MONETARY BENEFITS</b>
(a) Avoided Water Supply Costs (Current or Future Source)	0		\$0
(b) Avoided Energy Costs	0		\$0
(c ) Avoided Waste Water Treatment Costs	0		\$0
(d) Avoided Labor Costs	0		\$0
(e) Other (describe)	0		\$0
(f) Total [(a) + (b) + (c) + (d) + (e) ]			\$0

Table C-7: Project Annual Local Monetary Benefits and Project Costs

**Table C-7 Project Local Monetary Benefits and Project Costs**

(a) Total Annual Monetary Benefits [(Table C-6, row (f))]		\$0
(b) Total Annual Project Costs (Table C-3, column III)		\$41,079

Table C-8: Applicants Cost Share and Description

Even though the qualitative and quantitative benefits of the project are predominantly experienced at the Bay-Delta regional level, SFWPA proposes to cost share \$66,200 or 17 percent of the total project costs. The Agency enjoys the benefit of ample water

**Table C-8 Applicant's Cost Share and Description**

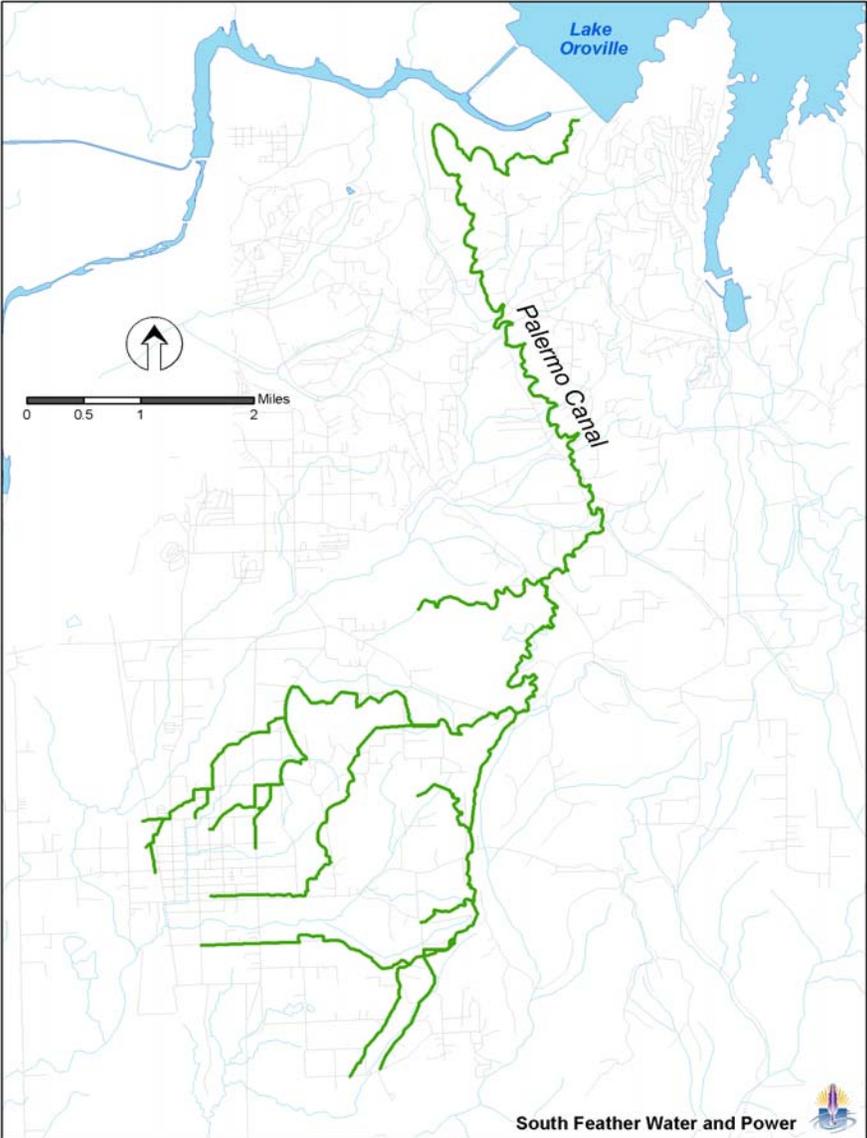
Applicant's cost share %: (from Table C-1, row o, column V)	17
Describe how the cost share (based on relative balance between Bay-Delta and Local Benefits) is derived. (See Section A-7 for description.)	
Provide Description in a narrative form.	

supply and gravity fed distribution system that results in low cost water delivery to customers and generates low revenues. Table C-6 identifies that qualitatively and quantitatively this project does not provide direct benefits to SFWPA. The Agency is in a strong position to conserve water for Bay-Delta Benefits and is willing to commit time, effort and resources to implement this project.

# **APPENDIX A**

## **Schematic of Palermo Canal**

**APPENDIX A**  
**Schematic of Palermo canal at SFWPA**



# **APPENDIX B**

## Letters of Support



*To promote the economic, social and environmental viability of Northern California by enhancing and preserving the water rights, supplies and water quality of our members.*

January 4, 2004

Debra Gonzalez  
California Department of Water Resources  
Office of Water Use Efficiency  
P.O. Box 942836  
Sacramento, CA 94236-0001

**RE: Support of 2004 WUE Grant Funding for the South Feather Water and Power Canal Seepage Reduction Program**

Dear Ms. Gonzalez:

The Northern California Water Association (NCWA) supports the South Feather Water and Power's (SFWP) Canal Seepage Reduction Program 2004 Water Use Efficiency grant application.

NCWA represents 70 agricultural water districts and agencies, private water companies, and individual water rights holders with senior rights and entitlements to the surface waters of the Sacramento Valley. NCWA's members also have overlying and appropriative water rights to groundwater resources in Northern California, from the Northern reaches of Shasta County to Sacramento County, from the edge of the Sierra Nevada Mountains in El Dorado County to Glenn County which extends to the Coast range.

Through this program, SFWP will work cooperatively with California State University, Fresno and the Center for Irrigation Technology to utilize the Mobile Assessment (MA) System in conducting reconnaissance canal seepage surveys. The results will be reported to assist SFWP to develop seepage estimates for canal reaches and to prioritize canal-lining projects. SFWP will implement canal-lining projects based upon information obtained from the reconnaissance studies. The program will be implemented in cooperation with, and support of, the Sacramento Valley Water Management Program.

We support and encourage you to fund the South Feather Water and Power Canal Seepage Reduction Program.

Sincerely,

A handwritten signature in black ink that reads "Todd N. Manley". The signature is written in a cursive, flowing style.

Todd N. Manley  
Director of Government Relations

**Butte County Department of Water & Resource Conservation**

January 5, 2005

Debra Gonzalez  
California Department of Water Resources  
Office of Water Use Efficiency  
P.O. Box 942836  
Sacramento, California 94236

Dear Ms. Gonzalez:

The Butte County Department of Water & Resource Conservation has worked cooperatively for the past year with South Feather Water and Power Agency (SFWPA) to secure federal funds for canal lining projects. These projects are coordinated with the County's Integrated Water Resources Planning efforts.

SFWPA is a multipurpose agency providing irrigation water, treated domestic water and hydroelectric power. The agency is seeking assistance from DWR (Proposition 50, Water Use Efficiency Program) for furthering its efforts in water use efficiency and conservation by identifying and minimizing open channel conveyance system losses. The proposed program (Program) will utilize innovative research techniques to quantify water seepage and losses to the system and then proceed on a priority basis with canal-lining projects.

The Program will work cooperatively with Fresno State and the Center for Irrigation Technology to utilize the Mobile Assessment (MA) System to conduct reconnaissance canal seepage surveys. The results will be reported to assist SFWPA to infer seepage estimates for canal reaches and to prioritize canal-lining projects. SFWPA will implement canal lining projects based information obtained from reconnaissance studies.

We will continue to seek the authorization supported by Congressman Doolittle in this year's federal authorization, and this Water Use Efficiency Program will help quantify the benefits of canal lining. We heartily endorse this creative water use efficiency project that will allow us to quantify water savings more accurately.

Sincerely,

Ed Craddock, Director

# APPENDIX C

## Qualifications

**MATTHEW S. COLWELL**  
Water Division Manager  
South Feather Water & Power Agency  
2310 Oro-Quincy Hwy  
Oroville, CA 95965  
530.533.4578  
mcolwell@southfeather.com

### **EDUCATION and LICENSE**

Bachelor of Science Degree: California Polytechnic State University, San Luis Obispo.  
Major: Agricultural Engineering  
**California Registered Civil Engineer RCE 52171**

### **EXPERIENCE**

- **South Feather Water & Power Agency, Oroville, CA**  
**WATER DIVISION MANAGER** - - Responsible for Water Division management under direction of the General Manager. Responsibilities include personnel management of 34 employees and operations of domestic, irrigation and water treatment systems serving 7000 customers. Service area includes 38,000 acres, 112 miles of irrigation canals, and 140 miles of domestic water distribution system.
- **CDM Inc. Sacramento, CA**  
**PROJECT MANAGER** - - Responsible for all phases of project management of water resource related projects, including client relations, project schedule and budget. Supervised support staff for completion of multiple phase analysis and report development. Responsible for water resources discipline business development. Projects include:  
*Agricultural Water Management Council, CALFED Water Use Efficiency Program:* Analyzed water district agricultural water management practices for affects on statewide water use efficiency objectives.  
*Butte and Tehama Counties:* Participated in the development of Butte and Tehama County water inventory and analysis plans. Participated in the development of Butte County Integrated Water and Resource Conservation Plan.  
*Sonoma County Water Agency:* Developed agricultural water demands for the feasibility of recycled wastewater reuse.  
*Lake County Flood Control and Water Conservation District:* Developed Lake County Water Inventory and Groundwater Management Plan Expansion Project. Developed Groundwater Assistant Program Grant Application (AB 303) for the Project.  
*Colusa Basin Drainage District:* Developed Scope, Schedule, and Budget for the Freshwater Creek Basin Integrated Resource Management Plan.
- **Optimal Water, Inc. Chico, CA**  
**REGIONAL MANAGER** - - Management and facilitation of water asset management and water marketing strategies for public and private water agencies. Develop and implement water-marketing programs. Assist water management agencies in structuring and negotiating water transactions. Comprehensive knowledge and expertise in water

transfers/exchanges, groundwater banking programs, and California hydrology. Extensive water contacts with local, state and federal officials.

- **Western Canal Water District, Richvale, CA**

**GENERAL MANAGER** -Management of 70,000-acre agricultural water delivery system under direction of a five member elected Board. Responsible for all District management functions including 12 staff members, \$1.4 million operating budget and \$14 million assets. Direct and implement policy related to diverted surface irrigation water in accordance with State water rights law. Actively represent the District with extensive coordination with local, State and Federal agencies on water policy issues. Direct capital improvement projects including planning, environmental documentation, and financing. Actively participate in professional associations (ACWA, NCWA, BBWUA, NSVWF). Special issues include open system operation, water measurement, groundwater, conjunctive use, water banking, endangered species concerns.

- **California Department of Water Resources, Sacramento, CA**

**ASSOCIATE ENGINEER, Water Resources** - -Direct the operations of the California State Water Project (SWP) within the mandated policies and regulations and to optimize uses of available water in a flexible, environmentally sensitive and reliable manner. Planned and analyzed operations of multiple SWP water supply, flood control, and hydroelectric facilities for industrial, municipal and agricultural uses. Maintained compliance with USCOE, SWRCB San Francisco Bay/San Joaquin Delta, and FERC standards. Maintained and analyzed endangered species protection measures set in USFWS, CDFG, NMFS, and EPA biological documentation. Operations planning on daily, weekly, monthly, and annual time steps including demand and hydrologic analysis. Performed extensive communication with SWP contractors for operations support and analysis. Provide technical support for CALFED pertaining to operations of the SWP. Familiar with CVPIA, FERC, San Francisco San Joaquin Bay Delta Water Quality Control Plan, State and Federal Bay Delta Accord and AFRP issues. Provide extensive coordination of CVP/SWP operations to optimize and balance the many factors competing for the available water supply.

**ASSOCIATE / ASSISTANT ENGINEER, Water Resources** - -Developed, improved and implemented stochastic hydrology models for the issuance of seasonal and weekly snowmelt forecasts and water year runoff for state and federal water projects, irrigation districts, municipal utilities, and the general public. Provided hydrologic guidance for operational decisions for major multipurpose reservoirs. Produced Sacramento and San Joaquin River streamflow forecasts used to set water quality and fishery standards in the Sacramento-San Joaquin Delta. Installed, maintained and monitored remote hydrometeorological data acquisition locations. Utilized a wide variety of data sources, software and hardware to conduct complex hydrologic studies. Issue flood bulletins on major rivers in cooperation with the California-Nevada River Forecast Center. Real time operations of the Sacramento Watershed Model.

**JUNIOR CIVIL ENGINEER** - -Responsible for State Water Project surveillance including operation, monitoring and maintenance of hydraulic piezometer, slope indicators and vertical ground settlement devices on dams, canals, pumping plants and pipelines. Other duties include surveying, design and supervision of civil projects, and computer operation for data management.