2004 Water Use Efficiency PSP

Section B:
Technical Assistance Proposal

AWMC
Agricultural Water Management Council

Water Use Efficiency Monitoring and Evaluation Project

January 2005

2004 Water Use Efficiency Proposal Solicitation Package

APPENDIX A: 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 _____
❑ (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): Agricultural Water Management Council

4. Project Title: Agricultural WUE Monitoring and Evaluation Project

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

Name, title	Mr. Mike Wade, Executive Director
Mailing address	Agricultural Water Management Council 717 K Street, Suite 511 Sacramento, CA 95814
Telephone	(916) 441-7868
Fax.	(916) 441-7864
E-mail	mwade@agwatercouncil.org

6. Contact person (if different):	Name, title.	Kathryn Charlton, Asst. Exec. Dir.
	Mailing address.	Agricultural Water Management Council 717 K Street, Suite 511 Sacramento, CA 95814
	Telephone	(916) 441-7868
	Fax.	(916) 441-7864
	E-mail	kcharlton@agwatercouncil.org

7. Grant funds requested (dollar amount): *(from Table C-1, column VI)*	**$334,820**
8. Applicant funds pledged (dollar amount):	$0
9.Total project costs (dollar amount): *(from Table C-1, column IV, row n)*	$334,820
10. Percent of State share requested (%) *(from Table C-1)*	100%
11. Percent of local share as match (%) *(from Table C-1)*	0%
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.* *(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.)*	❑ (a) yes ☑ **(b) no**
11. Is your project required by regulation, law or contract? If no, your project is eligible. 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.*	❑ (a) yes ☑ **(b) no**

12. Duration of project (month/year to month/year):	**1/06 to 12/07**
13. State Assembly District where the project is to be conducted:	Statewide
14. State Senate District where the project is to be conducted:	Statewide
15. Congressional district(s) where the project is to be conducted:	Statewide
16. County where the project is to be conducted:	Statewide
17. Location of project (longitude and latitude)	Statewide
18. How many service connections in your service area (urban)?	Not Applicable
19. How many acre-feet of water per year does your agency serve?	Not Applicable

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**

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APPENDIX B: 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
	Mike Wade, Executive Director	01/11/05

Statement of Work, Section 1: Relevance and Importance

The Agricultural Water Management Council (AWMC) is proposing the Water Use Efficiency (WUE) Monitoring and Evaluation Project (Project) as a technical assistance program to aid water suppliers in the development and associated reporting of project monitoring and evaluation plans for the implementation of Efficient Water Management Practices (EWMPs) or other agricultural water use efficiency actions. The monitoring and evaluation protocols proposed for development must 1) be practical and implementable by WUE program participants and 2) result in the consistent collection, reporting, and management of relevant data that allows for the assessment and documentation of implemented projects' performance.

The AWMC is a non-profit group that has approximately 100 member agencies, including agricultural water suppliers, environmental groups, and other interested parties. The primary purpose of the AWMC is to advance and promote effective agricultural water management practices in California. The wide membership and participation provide the AWMC with a unique position to offer technical assistance to a wide range of agricultural users. The AWMC member agencies agreed by common consent in April 2004 that the AWMC should pursue funding for this project because it would provide useful and beneficial assistance.

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Over the next three years the CALFED WUE Program will commit Proposition 50 Chapter 7 grant funds to WUE projects that provide regional water quantity, water quality, and environmental benefits. To evaluate the effectiveness of these projects, CALFED must clearly identify its needs and objectives and communicate appropriate performance measures to the agricultural water suppliers implementing WUE actions. The water suppliers must have appropriate and consistent measuring tools and procedures to prove agriculture WUE contribution to CALFED objectives.

Project Goals and Objectives

Through the proposed Project, the AWMC links science to the management and implementation of water use efficiency measures. The Project goal is to clarify the needs of CALFED agencies and programs related to WUE, provide a consistent means for measuring the performance of agricultural WUE actions towards achieving CALFED objectives, and to develop a data management system that will house the results of pre and post-project monitoring and verification data. The results of this Project will further define CALFED's goals that can be obtained through WUE and will demonstrate agriculture's contribution to regional environmental benefits.

To achieve these Project goals, the AWMC has developed the following project objectives:

1) Coordinate with CALFED to identify data needs related to WUE to accurately indicate performance towards CALFED objectives;

2) Design technical protocols for irrigation water suppliers to consistently and effectively monitor WUE projects; and

3) Provide a means for effective data collection, reporting, and management.

Project Need

The AWMC views this Project as an opportunity to assist water suppliers in the development, analysis, and implementation of WUE projects consistent with water management plans (WMPs) and the implementation of EWMPs. Proposition 50 requires grantees to include a monitoring and assessment component for their WUE projects. Historically, agricultural water agencies have had a difficult time meeting this requirement.

Monitoring and assessing the success of agricultural water use efficiency measures in saving water, improving water quality, or benefiting the environment depends on the availability of pre-project data as a basis for comparison. In many cases, this information is not available, and agencies use different methods to simulate, or estimate, pre-project conditions. Additionally, monitoring the post-project flow, water quality, and environmental conditions can vary greatly by water agency. For example, one agency may monitor on a district-wide basis, while another agency may monitor at a farm-level. The different monitoring and assessment methods that agencies choose may not be the most accurate and thorough methods, and they may not be comparable to methods chosen by other agencies. These inconsistencies can prevent regional assessment of the success of agricultural water use efficiency programs.

Through this Project, the AWMC will provide water suppliers with consistent monitoring protocols that will assist in demonstrating an implemented EWMP's contribution towards regional water quantity needs.

This Project also supports the CALFED WUE Program's Targeted Benefits and Quantifiable Objectives development and the CALFED Science Program. The CALFED Agricultural WUE Program has developed a specific listing of CALFED-related goals in the Central Valley believed to be related to agricultural water management practices. Referred to as Targeted Benefits, these objectives address improvements in water quality, quantity, and in-stream flow and timing. A Quantifiable Objective (QO) is a numerical target for agricultural water management that addresses a portion of each of the Targeted Benefits. Currently, agencies find it difficult to accurately and consistently measure EWMP benefits; therefore, CALFED cannot readily assess how well water use efficiency efforts are meeting QOs and Targeted Benefits. The proposed Project will collect additional data to further define Targeted Benefits and QOs and standardize the approaches to evaluate the progress towards achieving them.

Statement of Work, Section 1: Relevance and Importance

The Science Program provides a framework for establishing performance indicators to measure progress in achieving CALFED goals. The proposed AWMC Monitoring and Evaluation Project will assist agricultural water suppliers to monitor water use efficiency projects in a comprehensive and consistent manner for the specific data needs of performance indicators crucial to the Science Program analysis and annual report.

The proposed Project will initiate future WUE activities by showing water suppliers that their WUE actions can contribute to regional environmental benefits that are recognized by the State. Water suppliers can use the monitoring protocols to demonstrate their efforts towards achieving CALFED goals and receive further funding for non-locally cost effective WUE projects. The proposed Project will assist water suppliers statewide; therefore, the Project's benefits will be noticed across California.

The following table summarizes the proposed Project's tasks, including the start and end dates and individual costs. The schedule assumes the notice to proceed is on January 1, 2006. Following the table is a detailed description of each task and the associated deliverables. Tasks 1, 2, 4, and 5 must be funding concurrently; Task 3 could be funded separately from the others.

Table 1
Proposed Project Start and End Dates and Task Budget

Task	Start Date	End Date	Cost
Task 1: CALFED Interviews	1/1/06	6/30/06	$55,540
Task 2: Monitoring and Evaluation Protocols			
Subtask 2.1	1/1/06	6/30/06	$ 12,000
Subtask 2.2	1/1/06	12/31/06	$ 25,000
Subtask 2.3	1/1/06	12/31/06	$ 12,000
Subtask 2.4	4/30/06	4/30/07	$ 24,000
Subtask 2.5	4/30/06	7/30/07	$ 83,420
Subtask 2.6	1/1/07	9/30/07	$ 20,420
Task 3: Management and Reporting Database	6/1/07	12/31/07	$45,740
Task 4: Stakeholder Involvement and Outreach	1/1/06	12/31/07	$35,400
Task 5: Project Management	1/1/06	12/31/07	$21,300
Complete Project	1/1/06	12/31/07	$334,820

Task 1 Understand CALFED Elements' Needs Related to WUE Efforts

Water use efficiency practices could contribute to water quality, quantity, and flow and timing needs on California's waterways. These benefits would support the objectives of many CALFED elements. The purpose of this task is to coordinate with relevant CALFED elements to identify monitoring and assessment data needs relative to 1) agricultural WUE project types and 2) water quantity, water quality, and environmental benefits on the local and regional level.

CALFED Elements:
- Governance
- Ecosystem Restoration
- Watersheds
- Water Supply Reliability
- Storage
- Conveyance
- Environmental Water Account
- Water Use Efficiency
- Water Quality
- Water Transfers
- Levees
- Science

The AWMC will interview CALFED representatives of relevant program elements to define how agricultural water use efficiency could interact with each element, and to identify the type of data needed to measure the progress of water use efficiency efforts towards each element's objectives. Table 2 shows potential ways that agricultural water use efficiency could function as a piece of the CALFED program elements. These interactions between water use efficiency and the element objectives form the basis for monitoring and validation data needs.

Table 2 *Potential Roles of WUE within CALFED Elements*	
CALFED Element	**Potential Interactions with Agricultural Water Use Efficiency**
Ecosystem Restoration	Ag WUE could reduce diversions from waterways, thereby increasing instream flows
Watersheds	Ag WUE could reduce water demand, which would provide additional water for watershed purposes
Storage	Ag WUE could reduce water demand and provide water for CALFED storage projects
Conveyance	Ag WUE could help with flow and timing issues and assist conveyance
Environmental Water Account	Ag WUE could reduce water demands, which would allow the agricultural user to sell the unused water to the EWA
Water Use Efficiency	Ag WUE could further develop Targeted Benefits and QOs
Water Quality	Ag WUE could change the quantity and timing of agricultural discharge, which could improve the water quality in receiving bodies. Ag WUE could also reduce diversions from waterways, which would increase instream flows and potentially increase water quality in those water bodies.
Water Transfers	Ag WUE could reduce water demands, which would allow the agricultural user to sell the unused water to other water users
Science	Ag WUE is an element in the annual CALFED Science Report to show progress towards CALFED's goals

The AWMC will incorporate these data needs into monitoring and evaluation protocols to facilitate comparison between effects of water use efficiency actions and CALFED needs. This task will enable CALFED to understand how agricultural water use efficiency actions could address multiple objectives, and will ensure that monitoring and verification protocols meet CALFED data needs.

The AWMC will interview CALFED and agency staff to better understand the data needs associated with each element. Table 3 identifies a preliminary list of potential interviews that will be revised through additional research.

Table 3 *CALFED Element Potential Interviewees*		
CALFED Element	**Potential Interviewees**	
	Agency(s)	**Individual(s)**
Ecosystem Restoration	USFWS	Campbell Ingram
Watersheds	CBDA	John Lowrie
Storage	DWR, Reclamation	Steve Roberts, John Woodling, Nanette Engelbright
Conveyance	CBDA	Darryl Hayes
Environmental Water Account	DWR, Reclamation, CBDA	Curtis Spencer, Ron Ott
Water Use Efficiency	CBDA, DWR, Reclamation, NRCS, State Board	Mark Roberson
Water Quality	CBDA	Lisa Holm
Water Transfers	DWR	Dean Reynolds
Science	CBDA	Water Management Science Board Member

The AWMC plans to conduct separate in-person interviews for each CALFED element. In some instances, there will likely be more than one individual to interview; the AWMC will hold a group interview. During the interviews, the AWMC will explain types of data that can be collected from monitoring WUE actions, such as measurements of water quality parameters or redirected flows. The AWMC will ask interviewees if they have additional data needs that can be addressed through WUE monitoring and verification. The AWMC also plans to identify if the CALFED elements have specific objectives defined, such as Quantifiable Objectives, to which agricultural WUE could contribute. From these interviews, the AWMC plans to obtain a clear understanding of data needs as they relate to water use efficiency efforts.

The AWMC will provide a summary of each interview to the interviewee to confirm that data needs are accurately understood and portrayed. After receiving concurrence from each interviewee, the AWMC will prepare a technical memorandum summarizing data needs and plans to incorporate these needs into WUE monitoring protocols.

Task 1 Deliverables:

Interview Identification Memorandum – This memorandum will identify interviewees and interview questions.

CALFED Program Elements Data Needs Summary Report – This report will compile data provided by the interviews.

Task 2 Develop Monitoring and Evaluation Protocols

The purpose of this task is to establish a common framework among water suppliers for measuring the performance of EWMPs towards achieving CALFED regional objectives. This task will incorporate information gathered in Task 1 into monitoring and verification protocols to assure that water suppliers collect consistent WUE data measurable to CALFED objectives. The protocols under the proposed Project do not describe water quality measurements. Through Task 1, the proposed Project will identify CALFED's water quality data needs related to WUE, and the AWMC believes that incorporating water quality measurements into the protocols would be a beneficial future project.

Reclamation has begun to define monitoring and verification protocols for some of the most common, simpler actions taken to conserve water. These protocols focus on quantifying water savings from these WUE actions. *Procedures for Verifying Irrigation Water Conservation Savings by Drainwater Reuse, Tailwater Reuse, Distribution System Automation and Canal Lining/Piping* (Reclamation 2001) describes the listed actions and outlines data collection requirements, assumptions, and procedures for computing water savings resulting from these actions. These protocols have been applied to sample projects and refined into a set of monitoring and verification guidelines to assist CALFED WUE applicants with the monitoring and verification section of PSP responses. Protocols for canal lining, on-farm conversion to drip irrigation, spillage reduction and drainage reuse are available in Adobe Acrobat format on the AWMC web site. Exhibit A includes the On-Farm Drainage to Drip Irrigation Technical Memorandum as an example of the monitoring protocols to be developed under the proposed Project.

The proposed Project expands on this previous work by developing user guides for additional EWMPs and a common organizational and monitoring and verification conceptual framework. Table 4 summarizes the technical EWMPs and describes completion status of six actions that increase the effectiveness of monitoring and verification of EWMPs effectiveness towards increasing water use efficiency. The following pages describe these six actions in further detail.

Table 4
Summary of Available EWMP Monitoring and Verification Information

Technical EWMPs	Identify and Describe Actions	Conceptual Framework	Water Balance Context	Monitoring and Verification Protocol	User Guides	Comprehensive Documentation
Facilitate Use of Available Recycled Water						
Facilitate Financing of Capital Improvements for On-farm Irrigation Systems						
a. Convert surface irrigation systems to drip	◆		◆	◆	◆	
b. Build on-farm tailwater recovery systems						
c. Others						
Line or Pipe Ditches/Canals	◆		◆	◆	◆	
Increase Water Ordering/Delivery Flexibility within Operational Limits	◆		◆	◆		
Construct/Operate Water Supplier Tailwater and Spill Recovery Systems	◆		◆	◆		
Optimize Conjunctive Use of Surface and Groundwater						
Automate Canal Structures	◆		◆	◆		

Evaluating EWMP implementation is generally based on the amount of money spent; and what was built, purchased, or implemented. It is much more difficult to evaluate the ultimate goal of the EWMPs, to increase water savings, because of the differing responses of water users to the natural hydrology variability of precipitation and streamflow. The AWMC's proposed Project addresses this challenge by specifying the data needed and the computations necessary to document increased water use efficiency and quantify water savings. Improved monitoring and verification will ensure that public money is spent effectively and will provide valuable knowledge about the effectiveness of EWMPs to achieve increased water savings and benefits towards CALFED's goals.

Improved monitoring and verification will ensure that public money is spent effectively and will provide valuable knowledge about the effectiveness of EWMPs to achieve increased water savings and benefits towards CALFED's goals.

The EWMPs all target more than one flow path for water conservation and often may increase losses through other district distribution system and/or individual on-farm flow paths. These effects on non-targeted flow paths, often called *consequential effects*, are unintended and sometimes unexpected. The linkage between district distribution and on-farm systems is such that improved distribution system efficiency can be offset by decreased on-farm efficiency and vice versa. For example, increasing delivery system flexibility to respond more quickly to on-farm water needs may result in increased distribution system spillage offsetting some of the on-farm savings achieved. Thus, an integrated approach is required for monitoring and verification that requires a water balance perspective. The following subtasks describe work that would be performed to develop monitoring and verification protocols for the subject EWMPs.

Subtask 2.1 Identify and Describe Actions to Implement EWMPs

In some cases, many actions could be taken to implement a particular EWMP. For example, the EWMP, Facilitate Financing of Capital Improvements for On-farm Irrigation Systems, could include financial incentives for converting a surface system to a drip system, installing a tailwater recovery system on a farm, or something else. Implementing these actions will have varying effects on water use efficiency and potentially require different data for monitoring and assessment of water savings. The AWMC will identify actions that can be taken to implement EWMPs in Table 4. The AWMC will define the actions and describe the facilities required and common configurations used to implement the EWMP. If examples exist of implementation of the EWMP and the results, the AWMC will briefly describe the common implementation approaches.

Subtask 2.2 Develop a Conceptual Framework Encompassing all the EWMPs

The EWMPs consist of a wide range of practices all with the goal of increasing water use efficiency. This task will use the results of Task 1 and build on the principles expressed in *Verification-based planning for modernizing irrigation systems* (Burns, et al. 2000) and *Procedures for Verifying Irrigation Water Conservation Savings by Drainwater Reuse, Tailwater Reuse, Distribution System Automation and Canal Lining/Piping* (Reclamation 2001) to develop a conceptual framework for monitoring and verification of all the EWMPs. The conceptual framework will show the relationship between EWMPs, actions taken to implement EWMPs, *primary targeted flow paths* (those flow paths with reduced volumes resulting from the action taken to implement the EWMP), and *consequential effects* (other flow paths that may be reduced, and flow paths that may have increased volumes). The framework will be used to identify the actions taken for which monitoring and assessment protocols must be developed. The AWMC will develop the conceptual framework by reviewing the pertinent literature. The framework will be completed for the EWMPs for which monitoring and verification protocols have not been developed (see Table 4) through a series of brainstorming and work sessions.

Subtask 2.3 Identify and Describe Conservation and Consequential Effect Elements in a Water Balance Context

Each action taken to implement an EWMP targets one or more flow paths to conserve water. These actions may also result in consequential effects that can increase losses through another flow path. For example, on-farm improvements, such as converting to drip irrigation could decrease applied water; however, the required increased flexibility in the district delivery system could result in increased operational spills. This task will critically analyze the possible targeted flow paths and consequential effects elements that may result from an action described in Subtask 2.1. A water balance approach will define all the flow paths in the water balance and analyze flow path by flow path the effects of the specific action taken to implement each EWMP.

Subtask 2.4 Develop Data Collection and Computation Protocols to Estimate Water Savings

AWMC will develop data collection and computations methods necessary for monitoring and verification protocols to estimate water savings. The AWMC will base data collection and computations on the data required to compute water savings. It is expected that Task 1 will indicate that the volume of water saved is a critical CALFED data need. The AWMC will indicate if the data collected to compute water savings satisfies possible other data needs of CALFED, which will be identified by Task 1, or if additional data must be collected. The monitoring and verification protocols will strive to develop low-cost with- versus without-project comparisons to estimate the water savings from actions. Pre-project data is important for 1) developing savings estimates before a project is constructed, but and 2) establishing a baseline which can be normalized to develop the without project water balance needed to estimate WUE actions water savings following project completion. However, many water suppliers do not have comprehensive or consistent data to make an accurate estimate of pre-project conditions. In most of these instances, the water supplier should review the monitoring and verification protocol and consider collecting the required data for a year prior to implementing the action. Each protocol will also define the with-project data necessary to perform a water savings computation. The AWMC will provide recommended monitoring and verification protocols, normalization procedures and preferred data for each action.

Subtask 2.5 Develop User Guides Including Sample Calculations

The AWMC will write user guides for the EWMPs similar to the ones posted on the AWMC web site. These guides will be tailored to a general water supplier, however, will be easily adaptable to the specific conditions of a water supplier. The guides will emphasize that when these monitoring and verification protocols are followed, the water supplier can show a measurable contribution to CALFED regional goals.

The AWMC will add these additional guides to the AWMC web site to assist applicants in development of monitoring and verification protocols. These user guides will include a sample calculation based on real data if available or by synthesizing reasonable sample calculations where necessary.

The AWMC will provide an opportunity for water suppliers to comment on the user guides through email and on the AWMC website. The AWMC will hear comments on the user guides at their scheduled public meetings, regular AWMC meetings, and also at their booth at water related conferences, such as Association of California Water Agencies conferences. The AWMC will review the comments and incorporate them, if possible, into the user guides. A major goal of the user guides is keep the protocols general for all water suppliers to use. The AWMC anticipates that many comments will relate to water supplier specific conditions. To preserve its goal, the AWMC will limit incorporation of these comments into the protocols.

Subtask 2.6 Develop Comprehensive Documentation for Monitoring and Verification of all EWMPs

This task will integrate the existing documentation for monitoring and verification of EWMPs and the new documentation developed during this task into a comprehensive set of consistent guidelines under the conceptual framework developed in Subtask 2.2. This will include revision and improvement of the existing guidelines where necessary so that they are consistent with the conceptual framework.

Task 2 Deliverables

Methodology Technical Memorandum – This technical memorandum will describe the methods to be used to develop the monitoring and evaluation protocols, including:

- Common actions and required facilities to implement each of the listed EWMPs;
- A conceptual framework for monitoring and verification of the EWMPs;
- A short description of the conservation (targeted flow path(s)) and consequential effects aligned with each action described for the listed EWMPs and related actions; and
- Recommended data collection activities necessary with emphasis on pre-project data that can be normalized to the with-project perspective.

EWMP User Guides - For each technical EWMP in Table 4, the AWMC will write user guides for posting on the AWMC web site explaining the data collection and computation protocols required to estimate water savings including a sample computation.

Task 3 Create Database to Report and Manage WUE Data

The objective of this task is 1) to build a database driven application for CALFED that will house monitoring and evaluation data and measure its performance towards achieving regional objectives and 2) develop user friendly reporting templates for agricultural water suppliers that can be easily inputted into CALFED's database. This task combines the efforts of both Tasks 1 and 2 by linking CALFED science needs to WUE efforts.

The AWMC will create a relational database structure using Microsoft Access that facilitates storing information. The AWMC will develop a graphical user interface (GUI) based on focus

group sessions that will aid CALFED in intuitive data querying and result set filtering. The GUI design will also provide a mechanism for discrete row-level data entry and editing while providing bulk data import methods for batch processing. Printable reports can be generated with simple button clicks that allow CALFED to preview the selected reports before committing them to paper. The draft database design will store the following information:

- Agricultural water suppliers;
- WUE project type;
- Location (CALFED Region and waterbody);
- Monitoring Data;
- CALFED Elements;
- CALFED Elements data needs.

The AWMC will add fields to existing tables and create new database tables as the data structure is developed and finalized. The AWMC will provide CALFED the complete database for future monitoring and evaluation uses. The AWMC will facilitate a training session and provide documentation for CALFED staff regarding the use and management of the application.

In conjunction with database application development, the AMWC will also create reporting templates for agricultural water suppliers, to assist in data reporting and in batch processing of large amounts of data, such as inputting existing pre-project data. The bulk import application will present an efficient and suitable method for agricultural water suppliers to input their monitoring data en mass and a straightforward means to transfer the data to the database. The reporting templates will incorporate the data needs of the CALFED elements identified in Task 1. The AWMC will develop the reporting templates so that they can be easily imported into the CALFED database. The AWMC will distribute the templates to agricultural water suppliers. Although not an element of this funding request, the AWMC would anticipate requesting that its members submit monitoring reports as stipulated in CALFED-funded WUE implementation contracts for inclusion in the database.

The AWMC will work with a subset of its membership to assist with development of the reporting templates, including the bulk import template. The AWMC anticipates that the focus group would involve two to three meetings with a group of five or six water supplier staff, focusing on those agency staff that would be using the reporting template to report monitoring and evaluation data. Recognizing that the users of the reporting templates will encompass a wide variety of individuals, the AWMC will also utilize the focus group to assist in the identification of user guidelines, which may be developed as “help” screens.

Task 3 Deliverables

WUE Monitoring and Evaluation Database - The Microsoft Access database will include the appropriate fields and information to track the progress of agricultural WUE efforts and identify agricultural WUE contribution to regional goals.

WUE Monitoring and Reporting Templates – The templates will facilitate efficient inputting of monitoring data into the database.

Task 4 Stakeholder Involvement and Outreach

The AWMC will keep stakeholders updated and involved during implementation of the proposed Project. Outreach will occur through methods described in the Outreach, Community Involvement, and Acceptance Section beginning on page 25.

Task 5 Project Management

Project management activities will include contract maintenance and invoicing, administrative coordination between the contracting agency and the AWMC, consultant management, and any other activities required to ensure the contract is completed consistent with the agreed upon terms.

Environmental Documentation

The proposed Project does not require environmental documentation.

Statement of Work, Section 3: Monitoring and Assessment

A critical factor for project success includes the monitoring and assessment of the protocols being developed for implementation by the AWMC member agencies and other WUE program participants. The monitoring and evaluation protocols proposed for development must 1) be practical and implementable by WUE program participants and 2) result in the consistent collection, reporting, and management of relevant data that allows for the assessment and documentation of implementation project performance. The monitoring and assessment plan is structured to monitor these criteria, as well as:

- Documenting project benefits;
- Marking project progress; and
- Determining the success of the project in relation to project goals and objectives.

Documenting Project Benefits

The AWMC will be collaborating with CALFED WUE Program staff, other CALFED Program staff (as described in Task 1) and water agency personnel during the development of monitoring and evaluation protocols. The benefits of the proposed project will largely be ensured through the collaborative development of the protocols, including the incorporation of suggestions and feedback received from those collaborating on the development of protocols and the associated project performance database. Suggestions and feedback received from CALFED participants and water agency staff will be compiled and provided to CALFED to document that needed project benefits are incorporated into the final WUE monitoring and evaluation protocol.

Marking Project Progress

Project progress will be tracked by the AWMC and reported to CALFED, including both technical and budgetary progress. The AWMC will append the project scope, schedule, and budget to contractual agreements entered into with project cooperators (consultants). Project cooperators will be required to submit monthly technical progress reports and invoices. Both the progress report and associated invoices will provide task level detail reflecting technical and budgetary progress during the proceeding month. Invoices will be required to include the percent complete by task through the current invoice period.

As the project duration is 24 months, the AWMC will assess the project technical and the associated budgetary progress at least monthly in a manner that has been successful during the completion of previous grant projects (see the following section, Qualifications of Applicants and Cooperators, for previous grant funded projects). Progress reports will be forwarded with monthly invoices to CALFED.

Project progress will also be demonstrated through the submittal of deliverables as described in the previous section, Statement of Work, Section 2: Technical/Scientific Merit. Additionally,

quarterly project progress reports will be submitted to the CALFED detailing technical progress, budget status, and work remaining.

Determining the Success of the Project in Relation to Project Goals and Objectives

The AWMC has been careful to link the project goal and objectives (see Statement of Work, Section 1: Relevance and Importance) to individual tasks described in the scope of work. The work and associated deliverables defined under each task directly relates to a corresponding project objective. A project objective will be successfully satisfied at the completion of each task. This direct link between project objectives and task activities/deliverables provides CALFED with direct evidence of the activities that will be completed to successfully satisfy each objective. Table 5 summarizes the relationship between the project objectives and task headings.

Table 5
Relationship Between Project Objectives and Corresponding Tasks

Project Objective	Project Task
Coordinate with CALFED to identify data needs related to WUE to accurately indicate performance towards CALFED objectives	Understand CALFED elements' need related to WUE efforts
Design technical protocols for irrigation water suppliers to consistently and effectively monitor WUE projects	Develop monitoring and evaluation protocols
Provide a means for effective data collection, reporting, and management	Create database to report and manage WUE data

Qualifications of Applicants and Cooperators

The AWMC is a non-profit organization established in 1996 dedicated to bringing together all interested parties in agricultural water management. The AWMC formed as a result of AB 3616 - the Agricultural Water Suppliers Efficient Water Management Practices Act of 1990. The purpose of the AWMC is to work with agricultural water suppliers to improve water management efficiency and to demonstrate to the public and water industry how agricultural water is efficiently used.

The AWMC works in a voluntary and cooperative manner to establish a consistent, unified, and credible process that will advance agricultural water management in California and assist agricultural water suppliers in demonstrating that they are using water efficiently. It is the Council's responsibility to aid the signatory water suppliers through development and implementation of Water Management Plans to increase efficiency.

The AWMC maintains a unique position to provide research and data to agencies and the public interested in California water resource management. The AWMC has formed partnerships with the California Department of Water Resources, U.S. Bureau of Reclamation, CALFED Bay-Delta Authority, California Department of Food and Agriculture and California Irrigation Institute as well as members from the agricultural community and environmental and public interest groups. All are signatories to the AB 3616 Memorandum of Understanding (MOU). Partnerships strengthen the consensus-based actions of the AWMC and ensure various points of view are represented in AWMC actions. AWMC continues to seek partnerships with those interested in efficient water management.

The AWMC strives to create a forum to share and communicate water management strategies and new technologies. The Council maintains a positive relationship with agricultural water suppliers throughout California and works cooperatively on projects that support water use efficiency. Over 100 water suppliers and water resource conservation districts are signatories to the AB 3616 MOU.

The AWMC has assembled a highly qualified project team to implement the proposed Project. The Project Team is comprised of the AWMC and its consultants. The Project Team provides extensive experience and knowledge in agricultural engineering, water use efficiency implementation, and the CALFED program. The following sections provide brief descriptions of key personnel and their relevant qualifications and experience.

Key Personnel

Mike Wade, Executive Director, Agricultural Water Management Council

Mr. Wade assumed the duties as Agricultural Water Management Council Executive Director in May 2002. Responsibilities include operating the state-wide non-profit Council organization and implementation of AB 3616. AWMC is recognized as the lead organization overseeing agricultural water supplier water management planning and the improvement of agricultural water use efficiency in California.

Mr. Wade is also responsible for the day-to-day operation of the California Farm Water Coalition, the state's only educational organization dedicated to providing the public with factual information on agricultural water use. Duties include staff management and delegation of assignments and development of educational programs and public awareness activities on a statewide basis. The distribution of fact-based educational materials to schools is a major priority for the Coalition, which led to the development of nine lessons and an activity book for students ranging from kindergarten to the sixth grade.

Public awareness programs have included advertising on radio, television, theater screen advertising, and on public transit including the Los Angeles Metropolitan Transit System, BART trains and MUNI buses in San Francisco and Sacramento light rail trains. Exhibit B includes Mr. Wade's resume.

Kathryn Charlton, Assistant Executive Director, Agricultural Water Management Council

Ms. Charlton has been responsible for carrying out program activities for the AWMC since June 2002. She developed the outreach strategy to reach agricultural water suppliers that were not AWMC members and effectively convey a message about the importance of district participation for mutual benefit. As a result AWMC membership increased over 20 percent, reaching membership acreage targets outlined in the Cooperative Agreement one year ahead of schedule.

Ms. Charlton oversaw the development of new on-line net benefit analysis software that is currently being used by irrigation districts to evaluate projects associated with their water management plans. She coordinated efforts to secure USBR funding for an on-line water conservation plan update web site and directed efforts to integrate CALFED Quantifiable Objectives into the AWMC water management planning process.

External Cooperators

The AWMC will use consulting firms, CDM and Davids Engineering Inc., to help implement the proposed Project. The AWMC has chosen qualified consultants with extensive experience in water use efficiency implementation and California water resource planning. CDM is a full-service consulting, engineering, and environmental firm specializing in large water resource and water quality improvement projects. Worldwide, CDM has 3,600 employees with regional offices in Sacramento, Walnut Creek, Lake Tahoe, and Reno. The Sacramento office will serve AWMC throughout the duration of this project.

Davids Engineering, Inc. has provided professional engineering services to irrigation districts and resource management agencies since its founding in 1993, with an emphasis on agricultural water management. The company has successfully completed projects in California, Oregon, Arizona, Washington and Nebraska and in several developing countries. Most of these projects involve design and implementation of water management practices that enhance the viability of irrigated agriculture while conserving water for dedication to environmental and other purposes.

Qualifications of Applicants and Cooperators

The following resume briefs describe two key members of the AWMC's project team. The AWMC has worked with both members in previous projects.

Gina Veronese, Agricultural Economist, CDM

Ms. Veronese's area of expertise is in the planning and analysis of water resource projects relating to agriculture in California. Ms. Veronese has previously worked with the AWMC to develop a process to integrate agricultural water use efficiency opportunities identified in local water management plans with current CALFED water use efficiency goals. This project required comprehensive understanding of agricultural practices at the District and farm levels and effects to water quantity, quality, and flow timing needs of California's rivers. Ms. Veronese will apply this experience to the proposed Project to develop consistent, realistic performance indicators for water suppliers to demonstrate contributions to CALFED needs. Ms. Veronese had an integral part in preparing the EIS/EIR for CALFED's Environmental Water Account (EWA). She was responsible for analyzing the effects of crop idling to regional economies and agricultural land use. Through this project, Ms. Veronese gained valuable knowledge of CALFED program needs and California water resources and operations. Ms. Veronese has also developed integrated water resource plans for Butte and Solano counties. Development of these plans included a stakeholder-based process to understand the needs of various interests within the County. Ms. Veronese will use this background to work will CALFED representatives to determine CALFED data needs that could be partially met through water use efficiency actions.

Bryan Thoreson, P.E., Ph.D., Irrigation Engineer, Davids Engineering

Mr. Thoreson professional experience is in water resources and irrigation engineering and he has degrees in agricultural engineering and practical farming experience on his family's farm. At Davids Engineering, he serves as principal engineer, project manager and project engineer. He specializes in irrigation water conservation, having skills and experience in the areas of irrigation scheduling, assessing and improving on-farm application efficiency, flow measurement, data management, and irrigation and drainage system operations and maintenance (O&M). Mr. Thoreson has extensive experience in software development and application related to irrigation engineering, including development, deployment and maintenance of customized Oracle SQL databases. Mr. Thoreson worked with the AWMC to develop and review technical descriptions of drainwater recycling, tailwater recovery systems, system automation and canal lining water conservation measures with the ultimate goal of specifying technical procedures for verifying water savings. Mr. Thoreson also assisted the Imperial Irrigation District (IID) efforts to integrate water measurement data collection and quality control functions into a computerized (Oracle) information system. He also provided support, through data analyses, to verify water conservation achieved by projects implemented by IID under its Water Conservation and Transfer Program with Metropolitan Water District of Southern California (MWD). Throughout his work, he has consistently demonstrated a unique command of both theoretical principle and practical application.

Qualifications of Applicants and Cooperators

Previous Grant Projects

This section describes previous water use efficiency grants that the AWMC has received.

USBR Education Grants (2000-2001)

The Agricultural Water Management Council received an $85,000 grant in 2001 from the US Bureau of Reclamation (USBR) to conduct irrigation water management education to farmers. Grant funds were redistributed to irrigation and resource conservation districts for the purpose of conducting a variety of water management workshops including micro-irrigation, improvement of irrigation practices to reduce deep percolation, irrigation system maintenance, mobile lab training and water use efficiency workshops. Programs goals were met on-time and under budget.

Three-way Cooperative Agreement (2002-2004)

AWMC received additional support in 2001 when a three-way cooperative agreement was signed between the AWMC, DWR and USBR. The Cooperative Agreement's primary purpose was to implement AB3616, the Efficient Management Practices by Agricultural Water Suppliers Act of 1990. The California Bay Delta Authority (at the time referred to as CalFed) assisted in negotiations to bring the three parties together and develop a work plan outlining the tasks that would guide AWMC activities. DWR and USBR each provided $600,000 in funding over the three year Cooperative Agreement contract period.

Under the guidance of the Cooperative Agreement the AWMC assisted member-districts in developing water management plans, oversaw independent audits of the Plans, worked to integrate CalFed Quantifiable Objectives into the Plans, created a database for tracking Plan implementation as well as initiated additional cooperative activities within the water management community. Today over 4 million irrigated acres are part of the AWMC water management planning process and efforts continue to increase AWMC membership among non-member districts.

Integration of Quantifiable Objectives into Water Management Planning

As part of the Cooperative Agreement, AWMC developed a process for agricultural water suppliers to identify local water management opportunities that contribute to specific Bay-Delta Authority objectives. This project communicates regional objectives to the local water management planning level and assists water suppliers understand the relationship between local and statewide management objectives. The Targeted Benefits and Quantifiable Objectives were developed for specific geographic regions and water bodies. AWMC has developed district reports for members showing which Targeted Benefits and Quantifiable Objectives are applicable to each district and a methodology for linking the Targeted Benefits and Quantifiable Objectives to local actions. AWMC is currently working to develop a format to integrate the Quantifiable Objectives into the water management planning process.

USBR Web Water Conservation Plan Update Reporting Website (2004-2007)

AWMC and USBR worked together in 2004 to develop an Internet web site that would allow federal water contractors with water conservation plans to complete and submit their required annual updates completely on-line. The project is funded through a $101,000 USBR grant over three years. Utilizing a special data base on a secure server, AWMC will be able to collect and report data to USBR in a variety of report formats that will improve the speed and accuracy of the reporting process. AWMC members can access the web site with a secure username and password, edit their reports, print copies and submit a final version in electronic format.

Outreach, Community Involvement, and Acceptance

Outreach is an essential component to the successful implementation of the proposed Project. The AWMC public outreach objectives for the proposed Project include:

- Develop and implement a process whereby agricultural water suppliers are informed of Monitoring and Evaluation Protocols; and
- Provide the opportunity for agricultural water suppliers to share ideas and input on the development and implementation of water use efficiency measures.

Effective outreach efforts on this Project are especially important to ensure agricultural water supplier participation. The activities described below will inform stakeholders on how implementation of the proposed Project will demonstrate the benefits achieved by district WUE operational improvements. Also, encouraging stakeholders to provide ideas and feedback will result in monitoring and verification protocols that meet the needs of CALFED but are also feasible from an agricultural perspective. The outreach efforts seek to create a collaborative working environment where the results will meet the needs of all stakeholders.

The AWMC works in a voluntary and cooperative manner to establish a consistent, unified, and credible process that will advance agricultural water management in California and assist agricultural water suppliers to demonstrate that they are using water efficiently. The AWMC will focus on three levels of outreach:

- Notification: notify interested parties that the project has started and when user guides are available for use.
- Information: provide information updates throughout the project and educate agricultural water suppliers regarding the user guides when they are complete.
- Participation: provide opportunities for these stakeholders to share ideas and provide input on the project.

Notification Activities

The AWMC will use several tools to notify member agencies and the public of the status of the project. The AWMC will mail an announcement to agricultural water suppliers (both AWMC members and non-members) as well as post an announcement in an issue of the AWMC quarterly newsletter, Best Management, and the Association of California Water Agencies newsletter, ACWA News, to notify the agricultural water community about the project.

The AWMC hosts a full functioning website at www.agwatercouncil.org that provides tools and resources for irrigation water purveyors to evaluate their water operations and prepare water management plans. The AWMC will add a feature to the website that describes the project, including the scope and schedule, at the beginning of the project. The monitoring and verification protocols will be posted to the AWMC website alongside other technical

resources specific for water management planning and implementing the AB 3616 Efficient Water Management Practices.

Information Activities

The AWMC will work to continuously provide information updates to interested parties. The AWMC will provide updates on its website as part of the feature described above. The main information activities, however, will focus on helping users to apply the information contained in the user guides. The AWMC will work to educate agricultural water suppliers on the contents and methods in the user guides through three methods:

- Conference sessions;
- Public meetings; and
- Individual contact with Proposition 50 grant recipients.

The AWMC is also a regular exhibitor at the semi annual Association of California Water Agencies conferences, the Mid-Pacific Water Contractors Conference, and the California Irrigation Institute Conference. AWMC will work with the different conferences to host a session that will reach water suppliers, including those who are not AWMC members, to demonstrate how the protocols can be used.

The AWMC will conduct a public meeting at the conclusion of the project as a training session for interested agricultural water suppliers. The AWMC will publicize this meeting on its website and in the initial mailings described in the Notification activities. The AWMC will work to try to time this meeting to be at the same time and location as a regular AWMC quarterly meeting to boost meeting attendance, and all interested parties will be encouraged to attend.

The AWMC will make an assertive effort to contact recipients of Proposition 50 Chapter 7 Section A: Implementation Projects grant funds, to make the protocols available and assist with the monitoring and evaluation of the funded water use efficiency projects.

Participation Activities

In the initial mailings and website information on the project, the AWMC will include information regarding two public meetings. Disseminating meeting information in this way will ensure that the information reaches both AWMC members and other interested stakeholders. These public meetings will be held at the same times and locations as the AWMC's quarterly public business meetings to encourage meeting attendance.

The public meetings will be scheduled to correspond with critical milestones on the project. The AWMC will conduct the first meeting after drafting the methodology used to develop monitoring and verification protocols. The second meeting will be scheduled after the draft user guides are available. During these meetings, the AWMC will explain the draft methodology and draft user guides and solicit stakeholder input. The AWMC will attempt to

schedule this meetings at the same times and locations as other regional agricultural meetings or conferences to increase public participation.

AWMC quarterly public meetings are attended by stakeholders in the agricultural community throughout the state, including members of environmental and public interest groups, the academic community and representatives from the California Department of Water Resources and U.S. Bureau of Reclamation. The AWMC will also invite additional stakeholders through the notification activities above.

The AWMC has already worked through its public meetings to help complete this grant proposal. At the January 27, 2004 meeting, AWMC staff presented the idea to develop monitoring and verification protocols to members and meeting attendees for input and feedback. A subcommittee was appointed to work with AWMC staff and develop the project concept further. At the April 21, 2004 meeting, the AWMC discussed a comprehensive project outline and unanimously approved a motion to pursue Proposition 50 grant funding to create monitoring and evaluation procedures. Furthermore, AWMC publishes a quarterly newsletter, Best Management. An article appeared in the August 2004 issue of Best Management that was distributed to all agricultural water suppliers, including a wider distribution to urban counterparts on the Urban Water Conservation Council, notifying readers of AWMC's intent to pursue this project. Through the public meetings and newsletter, AWMC has not received any opposition or negative responses to this project.

Innovation

Proposition 50 requires a monitoring and assessment component for each awarded WUE project. The different monitoring and assessment methods that agencies choose may not be the most accurate and thorough methods, and they may not be comparable to methods chosen by other agencies. These inconsistencies can prevent regional assessment of the success of agricultural water use efficiency programs.

The AWMC proposes to resolve the data inconsistencies with development of consistent monitoring and evaluation procedures and protocols. This will provide consistent data collection among various WUE projects and agricultural water suppliers and allow for a straightforward comparison of progress and objectives. This has not yet been accomplished for agricultural water use efficiency projects.

The proposed Project will also coordinate the needs of the CALFED elements and show how agricultural WUE efforts can contribute to them. Agricultural WUE is an available source for all CALFED elements to address water quantity, water quality, and instream flow and timing issues. Through this Project, CALFED can utilize the benefits of agricultural WUE and progress towards meeting their needs.

Benefits and Costs

Local Benefits

The proposed Project provides benefits to the local agricultural community. The AWMC plans to use this Project to reach members of the agricultural community to demonstrate that agricultural WUE can contribute to regional benefits, which makes WUE projects eligible for grant funding. Agricultural water suppliers are able to receive funding for non-locally cost effective projects by showing a contribution to CALFED goals. Increased funding opportunities could provide additional incentive to implement EWMPs and increase WUE. The proposed Project will also assist recipients of Proposition 50 grant funding in the required monitoring and evaluation component of their implemented projects.

A major benefit to be gained from the proposed Project is consistent measurement of agricultural WUE actions. Currently, districts may use different monitoring and assessment methods that make it difficult to accurately measure the performance of WUE actions. The proposed Project's monitoring and verification protocols will provide consistent data collection among water suppliers. The protocols will also assure that the data collected will be consistent with CALFED's methods of measuring performance towards achieving goals.

CALFED Bay-Delta Benefits

Increased WUE actions benefits the Bay-Delta through improvement in water quantity, water quality, and in-stream flow. The proposed Project will provide protocols to measure the water quantity benefits and a database to track progress. The proposed Project will benefit the CALFED program elements by demonstrating that agricultural WUE can contribute to multiple program goals. The AWMC will provide CALFED with AWMC member's monitoring and evaluation data in a means that can be easily transferred to the database. Data collected through the proposed Project will further support CALFED Agricultural WUE Program's development of Targeted Benefits and Quantifiable Objectives and performance indicators, as described in the Science Program.

Costs

The AWMC is requesting funding in the amount of $334,820 to support completion of activities described in Statement of Work, Section 2: Technical/Scientific Merit, Feasibility. The section includes Table 1 on page 10 that describes the task level budget for the proposed work effort. An AWMC cost share component is not proposed for this work.

As is shown in the attached Table C-1, no funding is requested for equipment or supplies. Travel related costs for AWMC staff total $500. Of the total project budget, the AWMC requires approximately $60,000 in labor costs which will include participation in both administration and completion of technical tasks. The AWMC will lead Task 4, Stakeholder Involvement and Outreach, and will direct and review work under each of the other tasks. The remaining budget is dedicated to completion of the technical tasks to be performed by the consultant members of the AWMC team, including Camp Dresser & McKee Inc. and Davids

Engineering. Indirect costs by consultants are estimated to be less than five percent of consulting fees.

The benefits of the proposed Project, coupled with the anticipated information to be gained, result in a sound financial investment of WUE grant funds. This Project will provide concise, consistent WUE monitoring and evaluation protocols for use by CALFED-funded WUE implementation projects and will result in the development of a data management system for project performance information. The output of this Project provides CALFED with a well-defined, consistent method to quantify both the local and regional benefits of WUE implementation projects. The Project will continue to provide benefits into the future as more agricultural districts follow the monitoring protocols and provide the data for the database. This information will then be available for other districts to increase understanding of water use efficiency benefits and refine available techniques. The long-term benefits of the proposed Project increase the cost effectiveness of these grant funds.

Applicant: Agricultural Water Management Council
WUE Monitoring and Evaulation Project

THE TABLES ARE FORMATTED WITH FORMULAS: FILL IN THE SHADED AREAS ONLY
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[1]								
	Salaries, wages	$5,310	0	$5,310	$0	$5,310	0	0.0000	$0
	Fringe benefits	$3,190	0	$3,190	$0	$3,190	0	0.0000	$0
	Supplies	$0	0	$0	$0	$0	0	0.0000	$0
	Equipment	$0	0	$0	$0	$0	0	0.0000	$0
	Consulting services	$12,300	0	$12,300	$0	$12,300	0	0.0000	$0
	Travel	$500	0	$500	$0	$500	0	0.0000	$0
	Other	$0	0	$0	$0	$0	0	0.0000	$0
(a)	Total Administration Costs	$21,300		$21,300	$0	$21,300			$0
(b)	Planning/Design/Engineering	$203,410	0	$203,410	$0	$203,410	0	0.0000	$0
(c)	Equipment Purchases/Rentals/Rebates/Vouchers	$0	0	$0	$0	$0	10	0.0000	$0
(d)	Materials/Installation/Implementation	$0	0	$0	$0	$0	0	0.0000	$0
(e)	Implementation Verification	$0	0	$0	$0	$0	0	0.0000	$0
(f)	Project Legal/License Fees	$0	0	$0	$0	$0	0	0.0000	$0
(g)	Structures	$0	0	$0	$0	$0	0	0.0000	$0
(h)	Land Purchase/Easement	$0	0	$0	$0	$0	0	0.0000	$0
(i)	Environmental Compliance/Mitigation/Enhancement	$0	0	$0	$0	$0	0	0.0000	$0
(j)	Construction	$0	0	$0	$0	$0	0	0.0000	$0
(k)	Other (Specify)	$0	0	$0	$0	$0	0	0.0000	$0
(l)	Monitoring and Assessment	$55,050	0	$55,050	$0	$55,050	0	0.0000	$0
(m)	Report Preparation	$55,060	0	$55,060	$0	$55,060	0	0.0000	$0
(n)	**TOTAL**	$334,820		$334,820	$0	$334,820			$0
(o)	Cost Share -Percentage				0	100			

1- excludes administration O&M.

Tables are not included in the 30 page limit, per section A-15 of the WUE PSP Package

Applicant: **Agricultural Water Management Council**
WUE Monitoring and Evaluation Project

THE TABLES ARE FORMATTED WITH FORMULAS: FILL IN THE SHADED AREAS ONLY

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

	Qualitative Description - Required of all applicants[1]				**Quantitative Benefits - where data are available[2]**
	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[3] Indirect [4] or Both	Quantified Benefits (in-stream flow and timing, water quantity and water quality)
Bay Delta	See Benefits and Cost Section, Page 29	Statewide benefits occur consistently throughout and after this Project	Benefits will continue through the life cycle of CALFED funding associated with WUE project implementation monitoring and evaluation	Indirect benefits, Use of the monitoring and evaluation protocols and reporting database will measure performance toward CALFED goals over time.	Not Applicable
Local	See Benefits and Cost Section, Page 29	Statewide benefits occur consistently throughout and after this Project	Benefits will continue through the life cycle of CALFED funding associated with WUE project implementation monitoring and evaluation	**Not applicable.**	Not Applicable

[1] The qualitative benefits should be provided in a narrative description. Use additional sheet.

[2] Direct benefits are project outcomes that contribute to a CALFED objective within the Bay-Delta system during the life of the project.

[3] Indirect benefits are project outcomes that help to reduce dependency on the Bay-Delta system. Indirect benefits may be realized over time.

Exhibit A
Example Monitoring and Verification Protocol- Canal Seepage

Technical Memorandum – Canal Seepage Monitoring and Verification

Monitoring and Verification Perspectives and Assumptions

Monitoring and verification protocols have been developed to assist irrigation districts and water agencies in estimating the volume of water conserved by a water use efficiency action. These protocols will also aid the applicant in developing monitoring and verification procedures to be implemented after the project is completed. Protocols have been developed for five project types:

Agriculture

District

1. Canal Lining or Piping,
2. Spillage Reduction,
3. Drainage Reuse,

Farm

4. On-farm Improvements and

Urban

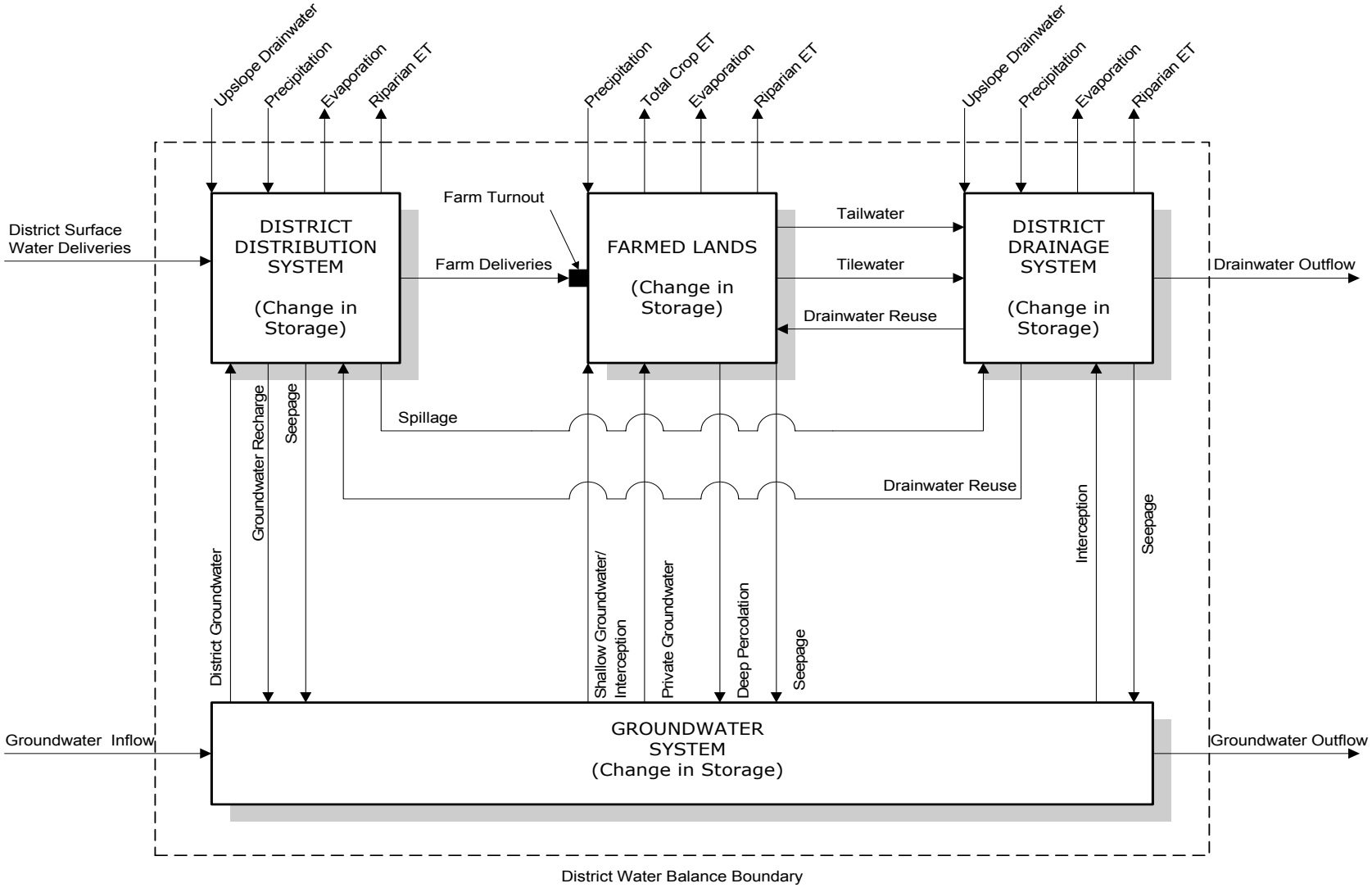
5. ET Controllers

Conserving water in an irrigation system can be like trying to stop the leaks in a bucket full of holes; stopping one leak can lead to greater flow from another leak. In other words, measures taken to conserve water often have unintended and unexpected consequential effects. Thus, additional effort and data is necessary to achieve an in-depth understanding of the system when it is necessary to verify that water has actually been conserved. This additional time and effort can be justified where the rights or interests of other water users may be impacted or if public money is being spent on the improvements. Developing low-cost protocols to estimate water savings as part of the planning process and to monitor and verify savings following project implementation was a major challenge of the work described herein.

Developing a comprehensive, quantitative water balance (Figure 1) is an essential first step to identifying and formulating programs or projects aimed at conserving water. The quantitative understanding of the water balance flow paths enables identification of targeted flow paths associated water conservation projects and consequential effects and assembly of projects into programs. The quantified flow paths of the water balance ultimately become the basis for the estimated water savings during the planning process and the verification of savings following project implementation. In all cases, the firm foundation of quantified pre-project flow paths leads to increased confidence in the verified project savings.

The ultimate goal of most water conservation projects, both at district and farm level is to reduce the total amount of water diverted from all sources, including stream diversion, groundwater pumping and other water deliveries, into the district distribution system.

Figure 1. Standard District Water Balance Structure



Source: Water Management Planner, Bureau of Reclamation, October 2000

Thus, the ideal ultimate measure of the water volume conserved is the reduction in the total volume of water diverted into the district. Unfortunately, issues of temporal and spatial scales coupled with the inaccuracies inherent in even the best water measurement often render this measurement inconclusive or, in some cases, even misleading.

Temporal Scales

The process of developing a comprehensive, quantitative water balance, identifying and implementing a project and verifying water conserved often takes several years. This is due to the cyclic nature of many water balance flow paths during the irrigation season leading to a need for a minimum of one full year of pre- and post-project data. For this reason, it is recommended that water balance be developed on an annual time step and ideally cover 10 to 30 years to ensure inclusion of a representative pattern of "wet", "dry" and "normal" year types.

Another result of the time required to plan and implement a project is that the other conditions, such as hydrologic year type, crops grown, district operating procedures, among others, may have changed from the pre-project measurement to the post-project measurement. These changing conditions can result in relatively small volumes of conserved water becoming "lost" in the "normal" year-to-year variation. For this reason, verification should ideally compare with- and without-project conditions rather than pre- and post-project conditions. This requires normalizing pre-project data to develop the without-project data set. Normalization, a challenge under ideal conditions, can become nearly impossible without a reliable pre-project data set.

Spatial Scales

Many water conservation projects impact only a small area in a district. For example, a canal lining project will often only line a few miles of a district distribution system that may run tens of miles. Or, a spillage reduction project may impact only a few of many spillage locations in a district. Thus, often the volume of water saved by these projects is small when compared to the total volume diverted by the district. This small volume often is "lost" in the "normal" year-to-year variability observed in the total volume diverted. Thus, the analysis must draw a boundary around the targeted flow path and focus on documenting a reduction in this flow path.

Measurement Inaccuracies

Even under ideal conditions, flow measurement accuracies are in the range of two to five percent. Often the volume of water targeted for conservation is less than two to five percent of the district total diversion. In this case, the volume conserved cannot be identified in the district total diversion measurement.

Other flow paths, such as deep percolation (water flowing from the root zone of farmed lands to the groundwater) are difficult to measure and in general can only be estimated. Thus, for on-farm improvement measures that aim to reduce the volume of deep percolation and tailwater, the volume of water delivered to the farm is often used because it can be measured directly. Also, the volume of water targeted for conservation is larger compared to the total volume delivered. The temporal scale can be normalized based on

standard ET tables available at the Irrigation Training and Research Center (ITRC) and the spatial scale is small enough that it is possible to use the deliveries in this case.

Recoverable vs. Irrecoverable Losses

Losses that return to the hydrologic system may be available for reuse, depending on the physical and water quality characteristics of the surface water and groundwater systems. The return flow paths may be on the land surface, such as through natural creeks and drains, or below ground, through the groundwater system. Characteristics that influence whether and when residual irrigation water can be reused (for irrigation, environmental, municipal and industrial and other purposes) include:

- Natural and artificial drainage flow patterns, which determine whether and where residual waters return to the water supply,
- Flow lag times, which influence when residual waters become available for reuse,
- Presence and location of storage reservoirs relative to irrigated areas,
- Location of points of irrigation return flow relative to other diversion locations, and
- Presence of saline sinks (surface or subsurface).

Where irrigation losses return to the surface water or groundwater systems, the return flow timing and quality may be altered in ways that affect the value of the return flows to downstream users. It is especially important to identify where residual waters flow into saline sinks because, by definition, the quality of the return flow is degraded to the extent that it becomes unusable. Reduction of losses flowing into saline sinks always results in saved water, which is not necessarily the case where return flows enter reusable surface water or groundwater systems.

Assumptions

To develop low-cost monitoring and verification protocols, some assumptions have been necessary. Assumptions specific to a given protocol are stated in that protocol. The following general assumptions have been made for all of the protocols developed:

1. The guidelines assume the applicant has determined that conserving water from the targeted flow path will cause no detrimental effects. This may be because the water flows to an irrecoverable destination pool, such as a saline sink, and can not be reused. Alternatively, it has been demonstrated that reducing the flow to a recoverable destination pool will cause no detrimental effects.
2. Consequential effects are impacts the conservation measure may have on other system flow paths. Except for the significant consequential effect drainage reuse may have on spillage, these potential effects are assumed to be negligible. However, applicants are encouraged to consider carefully the impact a proposed project may have on other flow paths and to include the impacts if deemed significant.
3. Variability caused by charges in hydrologic year type, cropping, district, operations, procedures and other factors are assumed to be negligible; therefore normalization is not required.

General versus Specific

Although the guidelines that follow are of necessity of a general nature, the conditions existing at the irrigation districts and water agencies expected to use these guidelines vary greatly. Thus, critical thinking while applying the guidelines is encouraged. This is especially true with regard to the general assumptions noted above and the specific assumptions stated in each protocol. Justified departures from specified protocols are encouraged where they can be supported by the specific physical and institutional situation at a water agency. However, when adapting these general guidelines to a specific situation, one should remember that monitoring and verification requires water measurement, especially measurement of pre-project water volumes. It is worth repeating that in every case, accurate, pre-project data is the firm foundation upon which monitoring and verification must be built.

Suggested References

Burns, J.I., G.G. Davids, A.K. Dimmitt and J. Keller. 2000. Verification-based planning for modernizing irrigation systems in Irrigation and Drainage in the New Millennium. USCID. Denver. pp. 51-63.

Bureau of Reclamation, Mid Pacific Region. 2001. Procedures for verifying irrigation water conservation savings by drainwater reuse, tailwater reuse, distribution system automation and canal lining/piping. Bureau of Reclamation, Mid Pacific Region Report.

Canal Seepage Monitoring & Verification

About This Document

This pamphlet serves as a reference for agencies interested in applying for grant funding under the CALFED Agricultural Water Use Efficiency Program. In particular, the information presented here is intended to help applicants seeking funding for canal lining and piping projects to comply with CALFED's requirements for estimating potential water savings. There are generally two approaches to canal lining; a *programmatic approach* where the objective is to identify the canal reaches where canal lining would produce the least-cost water savings, and a *specific approach* where candidate reaches have been identified and the need is to estimate potential savings if they were lined. This guide supports the latter approach. (Parties who are interested in the programmatic approach are referred to Procedures for Verifying Irrigation Water Conservation Savings by Drainwater Reuse, Tailwater Reuse, Distribution System Automation and Canal Lining/Piping.)

Factors Affecting Canal Seepage

Water is lost in unlined canals through the soil/water interface. The total amount of water lost to seepage during an irrigation season depends upon the following factors:

- The seepage coefficient (K), typically expressed in units of ft^3/ft^2-day, which represents the average rate of loss per unit of wetted canal area for a specific reach
- The canal wetted area (A), expressed in ft^2, and
- The seepage opportunity time (T), expressed in days.

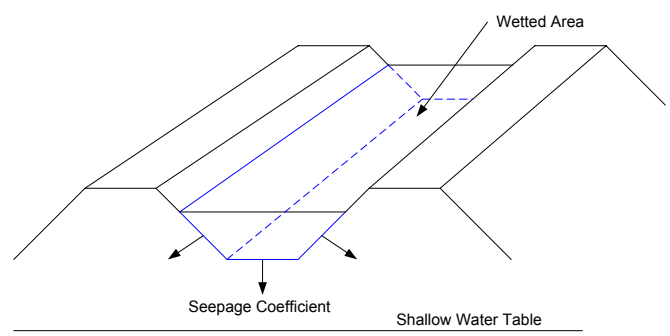


Figure 1. Conceptual Seepage Diagram

Thus, the volume of seepage (V) in ft^3 for any time interval is computed as:

Equation 1

$$V = K * A * T$$

The seepage coefficient, K, in turn is influenced by many factors, the dominant ones being:

- Soil permeability, which affects how fast water flows through the soil
- Depth to shallow water table, and how this influences "mounding" and subsurface flow of water seeping from canals
- Depth of water in the canal
- "Clogging" of the water-soil interface, such as from siltation or biological growth.

These parameters tend to reach steady state conditions within a few days or weeks after canal filling. Once this condition is reached, seepage does not change appreciably with time, but typically varies widely from place to place, because soils, groundwater conditions and clogging tendencies are all spatially variable.

Seepage Reduction Strategies

Seepage reduction is generally achieved by reducing the seepage coefficient by installing an impermeable (PVC or plastic membrane) or slowly permeable (concrete) lining at or below the soil-water interface or installing a pipeline. In the process of installing the lining, the wetted area may also be reduced; however, reduction of the seepage area alone is not a common seepage reduction strategy. Similarly, reducing the seepage opportunity time (T) is not practical as a long-term strategy, although it may be a viable dry-year strategy.

The seepage reduction strategy employed should be appropriate for the conditions found at the project site. The integrity of the lining material and construction technique are crucial for installing a lining that will remain effective for its full life.

Estimating Potential Water Savings

To determine whether the benefits obtained from a canal-lining project exceed the monetary investment involved, potential savings attributed to canal lining must be established with sufficient accuracy. The volume of water saved by canal lining is equal to the difference between the without-lining and with-lining seepage volumes:

Equation 2

$$Savings = (K * A * T)_{without} - (K * A * T)_{with}$$

Assuming that T will not be changed by lining/piping, and that any change in wetted area can be anticipated, the challenge is to establish sufficiently reliable estimates of the without- and with-project seepage coefficients. The remainder of this document is dedicated to these two tasks.

Quantifying Existing Canal Seepage

Methods

The seepage coefficient is generally quantified by using one of the following methods:

1. **Ponding tests** – Qualified ponding tests performed along the canal reach proposed for lining are the CBDA preferred method of seepage estimation. A sufficient number of tests should be performed to be representative of the variability in canal conditions. Ponding tests performed on comparable reaches may be used provided that the reaches meet the requirements for similarity.
2. **Inflow/outflow testing (instantaneous)** – A program of inflow/outflow measurement designed and conducted specifically to determine seepage losses in the canal reach proposed for lining may be acceptable. The accuracy of this type of testing will be evaluated by comparing the magnitude of the measurement error to the computed seepage rate.

3. **Inflow/outflow testing (operational data**) – Estimates of seepage based on diversion records or other operational flow data may be sufficient, but it is unlikely that operational data will accurately quantify seepage. Therefore, funding applications for project implementation using savings estimates from operational data have a lower level of confidence than ponding tests or instantaneous inflow/outflow tests. Applicants may significantly improve their chances of receiving implementation funding by first conducting pre-project monitoring.
4. **Literature on canal seepage** – Due to variations in soil and canal construction, estimated seepage volumes based on the wetted area of the canal reach and published seepage rates do not provide an adequate basis for project implementation. Applicants would increase their chances of receiving implementation funding by first conducting pre-project monitoring.
5. **Operator judgment** – Estimated seepage volumes based on the observations and judgment of system operators are not an adequate basis for project implementation. Applicants would increase their chances of receiving implementation funding by first conducting pre-project monitoring.

Information from a Similar Reach

The tests should be performed on the section of canal to be lined. However, a separate canal reach can be tested provided that it can be demonstrated that it is similar to the canal reach to be lined. Two canal reaches can only be considered similar if **all** of the following conditions are met:

- **Permeability -** The permeability of the soils traversed by the canals is the same. To ensure this, the reaches should be located on the same soil types, verified through two conditions that must be met: 1) reaches must be the same soil textures and 2) reaches must be in soil with similar compaction (bulk density).
- **Geometry -** The geometry of the two canals is the same.
- **Distance to Water Table -** The location of the water table relative to the canal invert is the same. In areas with shallow water tables, confirmation of this can be obtained by auguring investigation holes along each reach and measuring down to the water table. The average distances between the canal invert and the water table for the two reaches should be reported.
- **Canal Conditions -** The condition of the canal is the same including surface sealing from silt, compaction of soil, weed growth, etc.

How Likely is the Project to Receive Funding Based on the Current Information?

As previously noted, the accuracy of the seepage estimate is largely determined by the method of measurement. To aid the applicant in deciding whether their information is sufficient, a graph depicting the quality of pre-project data typically achieved by measurements methods has been developed.

Within each measurement type, the quality of the estimate varies depending on how the test is performed. Tests performed in accordance with accepted procedures that generate more accurate estimates will generally fall at the upper end of the quality range.

Ponding tests have the potential of providing the most accurate estimates of water lost from canals due to seepage. Inflow/Outflow tests are highly dependent upon the errors inherent in the flow measurement technique and the volume of water lost to seepage. To provide an accurate estimate, the amount of water lost must be significantly greater than the error associated with the flow measurements.

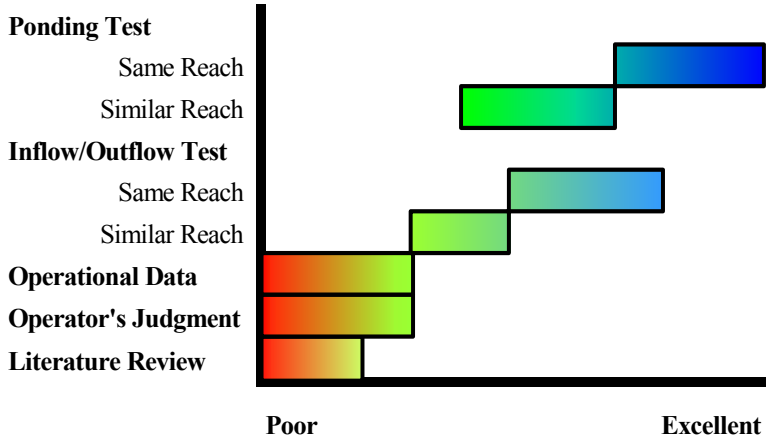


Figure 2. Quality of Pre-project Data for Monitoring & Assessment

Operational data, literature review and operator's judgment do not provide sufficiently accurate estimates of the volume of water lost to seepage. Prior to lining the canal, a ponding test or inflow/outflow test should be performed to provide accurate pre-project data for verification of water savings.

Description of Relevant Parameters

Qualifying Ponding Test

The accuracy of loss rates estimated by the ponding method will depend on the attention given to relatively simple details in preparing for and conducting the tests. Generally speaking, the end of the irrigation season is the most appropriate time for making ponding tests. At this time, bank storage has been satisfied and the water table in the adjacent areas has stabilized so that conditions are representative of those during the irrigation season. Ponding tests should be performed in accordance with the guidelines published by the Bureau of Reclamation in Bulletin No. 65 (1968).

- **Length -** The length of the pond is an important consideration. In general, the pond should be long enough to make the sum of the pond end areas a very small percentage (not more than 3%) of the total wetted area.
- **Location -** Ideally, the ponded areas will correspond to the canal lengths that are candidates for lining. For extensive lining programs, this is impractical. However, for lining projects typical of those that have been funded in past PSP cycles, the length of the lined sections can reasonably be included in a ponding test. As a general rule, it is desirable to avoid reaches where it is difficult to determine the wetted cross section and where turnout leakage cannot be stopped.
- **End Structures -** Where feasible, use existing check structures or check drops to pond water; these structures generally have foundations or cut-off walls that reduce lateral seepage. Plastic sheets can be used to stop gate leakage.
- **Wetted Perimeter -** Calculate the average wetted perimeter by measuring the side slope, top width and bottom width at different stations along the canal reach. Cross sections should be measured every half mile and at every point of change in canal geometry.

- **Canal Elevations -** Elevations measured to within 0.1 ft. The survey should help establish the shape of the canal.
- **Water Surface Elevations -** During the ponding test, elevation readings taken at stilling wells located at the head and tail of the canal section. Measurements should be recorded to the nearest 0.01 ft.
- **Evaporation -** Evaporation must be measured by using an evaporation pan.
- **Test Redundancy -** The results from a single qualifying ponding test are sufficient.
- **Depth -** The starting depth in the pond should be slightly higher than the design or operating depth to secure data above and below that level.
- **Measurement -** Measurement of the rate of drop in the water surface begins after the pond is filled, all gages are set and the recorder is operating. Generally, the pond will drop quickly during the initial stages of the test and will then level off and remain relatively constant. Pond seepage should be calculated using the measurements taken after the pond losses have stabilized. Elevation measurements should be taken often enough to adequately characterize the seepage losses.
- **Reporting -** Seepage rates should be reported as ft^3/ft^2-day and as an annual volume.

<u>Qualifying Instantaneous Inflow/Outflow Test</u>

The Inflow/Outflow method utilizes accurate measurements of water flowing into and out of the reach of canal being investigated. The seepage is calculated by finding the difference between the measured inflow and outflow, including evaporation. The equation used to calculate seepage is as follows:

Equation 3

$$Seepage = Inflow - Outflow - Evaporation$$

To effectively use the inflow/outflow method for determining seepage the following criteria must be met:

- **Steady-state Flow -** To eliminate the effect of unsteady flow and bank channel storage on the accuracy of the test, the stage of the canal should be kept constant throughout the test period. Verify that steady-state flow conditions exist by monitoring the readings from a staff gauge.
- **Single Inflow -** The canal reach must have a single, quantifiable inflow.
- **Single Outflow -** The canal must have a single, quantifiable outflow.
- **No Deliveries -** No inlets or deliveries may occur between the inflow and outflow measurement stations.
- **Wetted Perimeter -** Calculate the average wetted perimeter by measuring the side slope, top width and bottom width at different points along the canal reach. Cross sections should be measured every half mile and at every point of change in canal geometry.
- **Seepage Losses to Error Ratio -** The seepage losses have to be much greater than the error in the inflow/outflow measuring devices. If seepage rates are small,

longer reaches of canal must be used to account for the inaccuracies of the flow measurements. Seepage losses should be 5 times greater than the error in the measurement devices.

- **Flow Measurement Method -** Flow measurements can be taken using a variety of methods. The preferred method is to use existing canal structures. This provides accurate flow measurements and allows the tests to be repeated throughout the season to verify the seepage rates. Temporary flow measurement devices such as broad-crested weirs or cutthroat flumes can be installed if necessary, but this is usually only appropriate in small channels. Installing a temporary flow measurement device will raise the upstream water surface level and, consequently, increase seepage losses. Current meters may also be used to determine flow rate.
- **Test Redundancy -** A minimum of three tests are required. A single inflow/outflow test in not sufficient.
- **Reporting -** Seepage rates should be reported as ft^3/ft^2-day and as an annual volume.

Qualifying Operational Data Inflow/Outflow Test

Seepage estimates based on operational data are generally considered insufficient for project implementation funding. Due to the inherent inconsistencies of flow into and out of the canal encountered during operation, performing an accurate calculation of seepage is not feasible.

Qualifying Literature on Canal Seepage

The use of published seepage estimates to establish the volume of water lost to seepage does not provide the accuracy necessary to be considered for project implementation. The actual amount of seepage from a canal will vary depending upon the conditions encountered at the project location. Published values of seepage can be used to help identify areas of the distribution system that should be further investigated using one of the approved methods outlined in this brochure.

Qualifying Operator Judgment

Observations by operators are often a good source for identifying sections of the canal system with higher seepage estimates, but do not provide the accuracy required to verify the water savings from a canal lining project. Anecdotal evidence can be useful in determine sites that should be investigated further using a qualified ponding test or qualified instantaneous inflow/outflow test.

Estimating With-project Canal Seepage

Assuming that the liner is installed according to specifications, estimates of with-project canal seepage can be performed prior to project implementation by using published K values for the lining selected and the new canal dimensions. Additional water savings may be attributed to secondary savings such as reduced evaporation

Table 1. Typical Seepage Rates of Some Common Lining Materials

Lining Material	K ft^3/ft^2-day
Concrete	0.07
60 mil HDPE Membrane	0.00

Source: Bureau of Reclamation, 1994

caused by a reduction in surface area or decreased losses on start up due to initial filling of soil voids. These savings are typically small and, therefore, have not been taken into consideration in this brochure.

Tips on Improving the Likelihood of Receiving Funding

1. Use internal funds to conduct a program of ponding tests. Internal funding of ponding tests enables test results to be submitted as part of an application for funding of project implementation.
2. Use internal funds to conduct a program of instantaneous inflow/outflow tests. The accuracy that can be associated with this type of test varies with the geometry of the canal and with the volume of flow. Under suitable conditions, when properly performed, this type of testing may provide an adequate basis for estimating without-project seepage. Internal funding of this study would enable test results to be submitted as part of an application for funding of project implementation. The risk of inflow/ outflow testing is that the tests may be inconclusive which would necessitate use of ponding tests to define seepage.
3. Prepare a request for CALFED program plan funding of ponding tests on canal reaches that are under consideration for canal lining. Ponding tests would be used both to define without-project seepage rates and to select the most cost-effective reach for an implementation project. This approach minimizes the requirement for internal funding but extends the project through at least two CALFED program plan funding cycles with one cycle devoted to pre-implementation monitoring and a later cycle devoted to project implementation.
4. Prepare a request for CALFED program plan funding that includes ponding tests to be performed prior to canal lining. In this case, the implementation funding might be awarded based on seepage estimates developed using methods that are not rated as being highly reliable. However, disbursement of implementation funding would be contingent on completion of ponding tests and on test results that supported the water saving estimates upon which the implementation funds had been awarded.

Post-project Monitoring & Verification

Post-project monitoring and verification is another requirement for grant funding. Performing a qualified seepage test prior to lining or piping the canal is essential for post-project verification of the volume of seepage reduction. The seepage rates from unlined canals are extremely variable due to the factors discussed earlier.

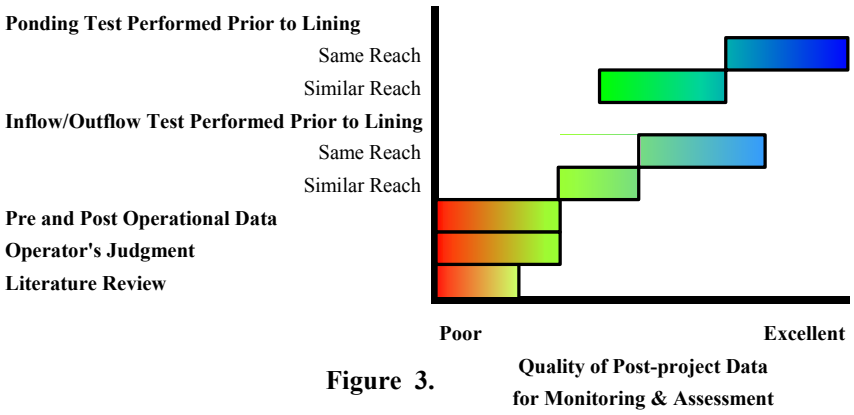


Figure 3.

Assuming that the canal lining is maintained in good condition (at most a few small cracks and joint sealant), published values for seepage coefficients that are available for most lining materials can be used to estimate the post-project seepage rate instead of performing post project ponding tests. Generally, the difference between the without- and with-project seepage can be assumed to be the amount of water conserved by the project. This assumption is valid provided that changes in operating conditions that affect seepage (i.e. seepage opportunity time, canal geometry, etc.) have negligible affects on the amount of seepage that occurs.

Because the integrity of the lining is critical in the reduction of seepage from the canal, its condition should be validated. In addition, regular maintenance should be performed to preserve the condition of the lining. Published seepage values are not appropriate for use in lined canals that are in need of repair.

Sample Calculations

An irrigation district is applying for CALFED program plan funding for the lining of 4,500 ft of earthen canals with concrete. The canal reach to be lined runs through a single permeability zone; however the district has performed two ponding tests for a representative average. The canal typically operates 180 days per year and has an average wetted perimeter of 20 ft. The geometry of the canal will remain unchanged by the lining. These computations should be repeated for each distinct (different permeability zone or wetted perimeter) reach.

Table 2. Sample Calculation with Pre-project Data and Estimated and Verified Savings

A	B	C	D	E	F
No.	Description	Source/Formula	Pre-project[1]	Estimated Savings	With-project
1	Type of Canal	District	Unlined	Concrete lining	Concrete lining
2	Predominant soil type along reach	District	Sandy loam	Sandy loam	Sandy loam
3	Length of reach, feet	District	4,500	4,500	4,500
4	Weighted average wetted perimeter at normal operating depth[2], feet	District	20	20	20
5	Seepage opportunity time, days	District	180	180	180
6	Representative seepage coefficient derived from ponding test(s) in unlined reach, $ft^3/ft^2/day$	District	0.51	NA	NA
7	Typical seepage coefficient for concrete lined reach, $ft^3/ft^2/day$	USBR, 1994	NA	0.07	0.07
8	Canal wetted area exposed to seepage, ft^2	D3*D4	90,000	90,000	90,000
9	Seepage volume, acre-feet	D8*D6*D5/43560	190	26	26
10	**Estimated Savings, acre-feet**	**D9-E9**	**NA**	**164**	**NA**
11	**Verified Savings[3], acre-feet**	**D9-F9**	**NA**	**NA**	**164**

[1]Pre-project data is assumed equivalent to without-project condition.

[2]Average wetted perimeter, often less in concrete lined canals, is assumed to be the same.

[3]Assumes concrete lining is well maintained.

References

Swihart, J., J. Haynes, A. Comer, 1994. Deschutes—Canal-lining Demonstration Project Construction Report, *Under Deschutes River Basin Water Conservation Projects*, p 97.

United States Department of the Interior, Bureau of Reclamation. (1968). Measuring seepage in irrigation canals by the ponding method. *Irrigation Operation and Maintenance, Bulletin No. 65.*

Exhibit B
Project Manager Resume

MIKE WADE

Executive Director
Agricultural Water Management Council 2002 - present
California Farm Water Coalition 1998 - present
Commenced duties as the Agricultural Water Management Council Executive Director in May 2002. Responsibilities include operating the statewide non-profit AWMC organization and implementation of AB 3616-The Agricultural Water Suppliers Efficiency Water Management Practices Act of 1990. Assists agricultural water suppliers improve water management efficiency through water management planning and technical assistance as well as participates in public policy stakeholder workgroups. Holds a seat on the California Bay-Delta Authority Water Use Efficiency Subcommittee.

Also responsible for the day-to-day operation of the California Farm Water Coalition, the State's only educational organization dedicated to providing the public with factual information on agricultural water use. Duties include staff management and delegation of assignments and development of educational programs and public awareness activities on a statewide basis. The distribution of fact-based farm water information to the public is the primary focus of the Coalition.

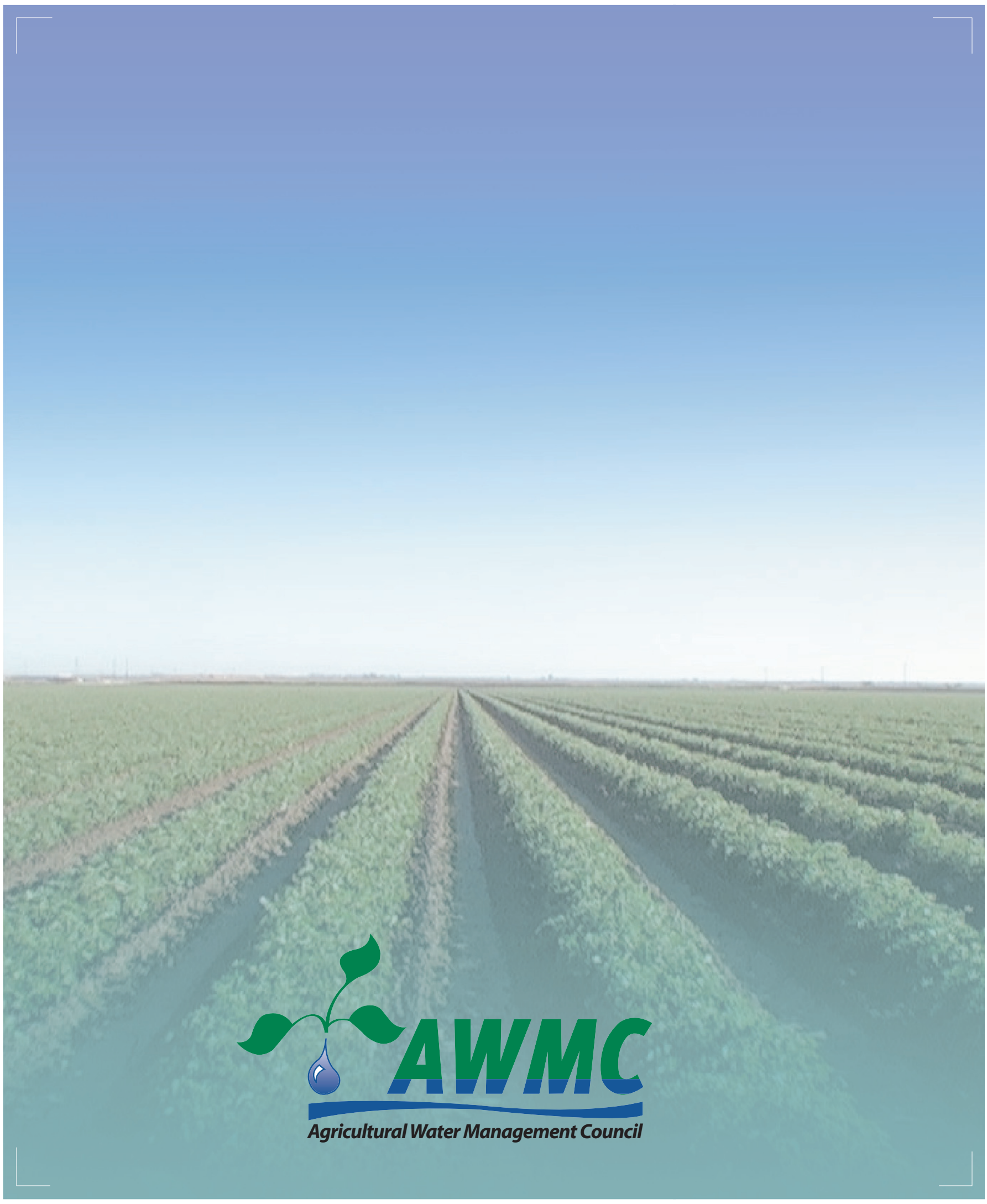
Executive Director
Merced County Farm Bureau 1988 - 1998
Responsible for the day-to day operation of Merced County's largest general farm organization. Duties included staff management and delegation of assignments to accommodate organizational needs; assisting the board of directors in policy development and carrying out policy motives with governmental agencies; active involvement in legislative issues at local, state and national levels; served on the Citizens Advisory Committee to the San Joaquin Valley Unified air pollution Control District; on the Merced County General Plan Advisory Committee and on the California Farm Bureau Federation State Biosolids Working Group.

Testified before Congressional subcommittee and at USEPA hearings on air quality issues, as well as before the California State Senate and Assembly on behalf of the agriculture industry on air quality, transportation and rural crime prevention issues.

Executive Director
California Christmas Tree Association 1991 - 1998
Responsible for the day-to day operation of California's only organization dedicated to the Christmas tree industry. Duties included management of association resources and providing technical information to grower-members in order to improve productivity and marketability of Christmas trees; developing marketing strategies and tools for grower use as well as providing public relations and media services to promote the California Christmas tree industry; maintaining a comprehensive research library of technical information, articles and bulletins for use by grower-members; organizing annual meetings, conferences and trade shows; and production of a quarterly trade magazine.

Program Director
California Farm Bureau Federation 1985 - 1987
Responsibilities included management of the California Farm Bureau's Young Farmers and Ranchers (YF&R) and Rural Crime Prevention programs. The YF&R program is designed to surface and train future leaders for the Farm Bureau organization. Also organized and presented programs to county farm bureaus to reduce the incidence of rural crime in California. Raised over $240,000 for CFBF political action committee, Farm Pac.

Partner
Wade Enterprises 1977 - 1999
Partner in family almond farming operation. Participated in day-to-day operation of orchard management including responsibilities for irrigation management, pest control applications, pruning and harvest.


AWMC
Agricultural Water Management Council