FINAL REPORT

Water Use Efficiency Comprehensive Evaluation

CALFED Bay-Delta Program Water Use Efficiency Element

August 2006

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EXECUTIVE SUMMARY

BACKGROUND

In the summer of 2000, federal, state and stakeholder representatives negotiating the CALFED Bay-Delta Program Record of Decision struggled to resolve differences over the Water Use Efficiency (WUE) Program Element. Some saw WUE as the cornerstone of CALFED's water management strategy. Others saw WUE as important, but not an initiative to be funded with more than the proposed $1 billion in state and federal funds.

Finally, negotiators reached a compromise: Provide unprecedented funding for WUE, but require an extensive evaluation to assess the program's effectiveness. This report—known as the Comprehensive Evaluation—represents the final version of the evaluation called for in the August 2000 Record of Decision (ROD).

APPROACH

The Comprehensive Evaluation is structured to assess the potential of each of WUE's four main components—agricultural water conservation, urban water conservation, recycling and desalination—to contribute to CALFED goals and objectives. The analysis has two main parts: a "look forward" that seeks to determine the potential of water use efficiency actions statewide given different levels of investment and policies, and a "look back" that assesses progress to-date.

The analysis, conducted by California Bay-Delta staff and consultants with input from CALFED Agencies and stakeholders, is intended primarily to help policymakers target future investments in the WUE Element and develop appropriate assurances. Additionally, the projections generated by the Comprehensive Evaluation are expected to—and already do—feed into other studies, such as the California Water Plan Update.

FINDINGS

The ROD viewed WUE investments as a cost-effective way to accelerate the implementation of conservation and recycling actions statewide. (Desalination was incorporated into the program at a later date.) More specifically, the ROD suggested that, with extensive federal, state and local investment, WUE might be able to generate between 1.0 to 1.3 million acre-feet in the first seven years of the program.

In reviewing this report, readers need to be aware that the Comprehensive Evaluation was constrained by significant data limitations. For example, there is no comprehensive data related to locally funded actions within the agricultural, desalination and recycling components; only on the urban side is there an extensive database that collects voluntarily reported savings associated with local WUE actions. Similarly, expected benefits associated with grant-funded projects reflect local agency proposed savings; the figures do not represent observed savings. This data gap represents a serious challenge to agencies and stakeholder communities committed to developing a well informed water management strategy. Still, there are important findings to be considered. The Comprehensive Evaluation suggests the following cross-cutting findings:

- Projections strongly support the position that aggressive investment in water use efficiency actions can result in significant reductions in applied water use over the next 25 years. Depending on the level of investment and other policies, the analysis projects savings of 1.4 to 3.2 million acre-feet by 2030: 180,000 to 1.1 million acre-feet for the agricultural sector; and 1.2 million to 2.1 million acre-feet from urban. Additionally, there is very large potential from both desalination and recycling.

- There is solid demand at the local level for state and federal water use efficiency grants. Over the past four years, 235 grants totaling $305 million have been

STAGE 1 WATER SAVINGS: PROJECTED AND EXPECTED

		ROD Projections	Potential Savings (Modeled)	Expected Savings	Projected Yearly Average Cost per AF of Savings[1]
Agricultural[2]	Lower Bound	260,000 AF	180,000 AF	50,000 AF	$28/AF for in-stream savings; $350/AF for supply reliability savings[3]
	Upper Bound	350,000 AF	250,000 AF	50,000 AF	
Urban	Lower Bound	520,000 AF	267,000 AF	101,000 AF	$160 to $340/AF
	Upper Bound	680,000 AF	356,000 AF	142,000 AF	
Recycling	Lower Bound	225,000 AF	Not Modeled	387,000 AF	$800/AF
	Upper Bound	310,000 AF	Not Modeled	510,000 AF	
Desalination	Lower Bound	Not Modeled	Not Modeled	20,000 AF (no range)	$957 per AF, on average; range from $430 to $1,387
	Upper Bound				

1. Comment by SWRCB: "The word 'yearly' should be deleted. The costs presented in this table are not associated with a time frame. The table should be made consistent with the text, which repeats data from the table in the correct units, $/AF, without a time reference. The methodology to calculating these costs is presented in Appendix 2D. The formula used to calculate costs yields the units of $/AF. The authors cited as the source of this formula have used this formula and reported resulting costs in terms of ¢/kL
2. Figures based on recent grant-funded projects.
3. The Agricultural WUE figures include the savings and costs associated with both recoverable and irrecoverable savings.
4. The range of per-acre foot average costs associated with ag savings was between $5/AF and $112 for in-stream savings, and $28 to $515 for water supply reliability savings.

awarded across all four components. The demand for grant funding has repeatedly outstripped the available funds. In the urban sector alone, funding requests from urban water suppliers have exceeded available state/federal funds by a roughly eight-to-one ratio; agricultural requests were double the available funding.

- An analysis of WUE savings over the first seven years (Stage 1) offers a mixed picture. (See table above.) Agricultural and urban WUE show the potential to generate substantial water savings at average costs ranging from $28 to $340 per acre-foot, but the overall savings are likely to fall far short of both ROD and Comprehensive Evaluation projections due to three main factors: (1) agricultural and urban grant funding for WUE actions is 80% lower than projected in the ROD; (2) key agricultural and urban assurances actions anticipated in the ROD are not yet implemented; and, (3) local WUE actions are either below projected levels or there is insufficient data to measure progress. Recycling is anticipated to exceed ROD projections, but the cost—$800 per acre-foot on average—is significantly higher than savings generated through agricultural or urban water use efficiency actions. Savings generated through desalination, also expensive relative to demand management options, averaged $957 per acre-foot.

- Although grant-funded water savings account for only a small percentage of total savings potential, they leverage significant additional local investment, act as an investment catalyst, help to promote regional partnerships and joint ventures, and increase the geographic base of implementation.

- Sufficient project-level baseline data or observed project cost and performance data have not been collected. Therefore, an understanding of progress toward meeting ecosystem restoration, water quality and water supply reliability objectives is not possible. In addition, the lack of project- and program-level data severely limits the use of adaptive management for program improvement.

In addition to these overarching findings, there are several sector-specific findings important to highlight.

AGRICULTURAL WATER USE EFFICIENCY

- Through 2004, the agricultural Proposal Solicitation Package (PSP) grant program funded 60 grants to pursue targeted benefits, research, and education projects. Almost $18 million in grant funding was awarded by the state; locals contributed $9.5 million. Applicant-reported annual benefits are approximately 40,000 acre-feet for in-stream flow and timing and more than 10,000 acre-feet for water supply. Benefits are expected to last from 3 to 50 years.

- Approximately 3% of the in-stream flow and timing (ecosystem restoration) benefits identified in the quantifiable objectives are expected through grant funded activity. Approximately 3% of the water quantity (water supply reliability) benefits identified in the quantifiable objectives are expected through grant funded activity.

- State and federal funds for agricultural WUE grants through Stage 1 are expected to be about 10% of funding amounts identified in the ROD. The amount of agricultural WUE occurring at the local level is not known.

- Realization of agricultural WUE potential depends on locals implementing cost-effective actions. However there is no comprehensive reporting of water conservation benefits available from state or federal water management plans and, therefore, the extent of non-CALFED-funded WUE is not known. There are no centralized data repositories to assess progress at the farm level.

- The average cost per acre-foot of savings appears to be within the range expected by the ROD. Costs for providing the in-stream flow benefits ranged from $5 to $203 per acre-foot. Costs for water supply reliability benefits ranged even more widely. Projects that reduced irrecoverable losses ranged in cost from $230 to $515 per acre-foot.

- Significant funding was provided under other non-CALFED programs that potentially met CALFED WUE objectives. Almost $80 million was provided by other state and federal programs for grants and technical assistance related to agricultural water use efficiency. Local agencies and growers provided another $168 million in cost-sharing under these programs.

URBAN WATER USE EFFICIENCY

- Through 2004, the urban PSP grant program has funded 122 urban conservation implementation, research, and education projects. $50.5 million in grant funding has been awarded over this period. Urban conservation projects funded by the PSP process account for between 16% to 19% of total expected water savings through the first four years of Stage 1. The other 81% to 84% of expected savings are a result of unassisted local implementation. Grant funded projects have expected annual water savings of about 37,000 acre-feet. Total urban water savings from grants and unassisted local implementation through Stage 1 are expected to range between 101,000 to 142,000 acre-feet.

- State and federal funds for urban grants through Stage 1 are expected to be about 23% of funding amounts set forth in the ROD. Comprehensive Evaluation results suggest that had the urban PSP program received full Stage 1 funding, grant-funded savings alone could have generated as much as 125,000 acre-feet of water savings by the end of Stage 1.

- Had local water suppliers also pursued all locally cost-effective conservation measures per the ROD, total urban sector savings by the end of Stage 1 could have ranged between 267,000 to 356,000 acre-feet—about two and a half times what is likely to be realized.

- The Comprehensive Evaluation also highlights the important role played by efficiency codes. Once in place, these codes provide an automatic and on-going source of water savings to the state at minimal costs. Codes related to toilet, showerhead, and washer efficiency, as well as codes that require metering customer water connections, account for 46% to 84% of the anticipated savings in the projections of long-term water savings potential.

- The impact of the Urban Memorandum of Understanding (MOU) is varied. On the one hand, more than 190 urban water suppliers—representing two-thirds of all Californians—have now signed the Urban MOU and annual water savings tied to implementation of urban Best Management Practices (BMPs) have increased by 15% to 20% annually since 1991. Still, the impact of the MOU has varied considerably by region and rates of compliance for most BMPs remain low. BMP data strongly suggest the MOU process is not working as intended and its impact on urban water use remains well below its full potential.

- The ROD called on CALFED Agencies to implement a process to certify water supplier compliance with the Urban MOU by the end of 2002. It further stated that access to CALFED Agency grant funding should be conditional on compliance with the Urban MOU once the certification process was in place. Although agencies and stakeholders proposed a consensus approach to urban certification, to date these ROD provisions have not been implemented.

- While unit costs for many funded projects have been higher than anticipated by the ROD, on average the cost per acre-foot of expected water savings has ranged between $160 to $340 per acre-foot. The average unit cost of savings for the urban PSP program is within the expected cost range of $150 to $450 per acre-foot cited in the ROD. The evaluation raises questions regarding the efficacy of funding many small- to medium-scale projects with high unit costs versus funding fewer, larger projects with greater opportunities for economies of scale.

RECYCLING AND DESALINATION

- Any assessment of recycling and desalination potential is greatly constrained by significant data limitations. While stakeholder listings of likely projects suggest strong potential, it is important to recognize that these projections assume continued funding through Proposition 50 and local project sponsorship. It is also important to keep in mind that the listings are not definitive and some of the projects may be speculative in nature. None of the data is observed or verified.

- Near-term benefits from recycling are proposed to range from 387,000 to 513,000 acre-feet. This is almost double the low end of the Stage 1 estimates, a fact that is likely tied to higher-than-expected funding levels. Desalination projects are expected to generate 20,000 acre-feet. (These are projects to come online as a result of Proposition 50 Funding only.)

- The Comprehensive Evaluation's projection of recycling and desalination potential strongly supports the position that aggressive investment can result in significant water supply benefits through 2030. A list of potential and existing recycling projects identified by stakeholders suggests there are 730 potential projects throughout the state, with 565 projects reporting a potential yield of more than 3 million acre-feet. The desalination list suggests there are 174 potential and existing projects throughout the state with a reported yield of more than 1.6 million acre-feet.

RECOMMENDATIONS

The analysis and associated findings and considerations suggest that agencies responsible for the WUE Program may want to consider changes in the way the program is implemented. Below are specific recommendations that staff and the consultant Team believes merit serious consideration. Any final approach is best considered as part of a dialogue that brings the affected stakeholder community to the table in a transparent series of discussions. The recommendations—provided at the request of DWR staff and described in greater detail at the end of the Overarching Section—fall into four main categories:

PROGRAM STRUCTURE/ASSURANCES

The Comprehensive Evaluation suggests program implementers should consider three specific recommendations related to program structure and assurances. They are: (1) assess the viability of the grant-driven WUE approach given expected state and federal fiscal constraints; (2) determine whether to implement a process to certify compliance with the Urban MOU; and, (3) revisit the effectiveness of the quantifiable objectives approach and associated assurances.

MONITORING PERFORMANCE

Data gaps and limited program assessments greatly handicap effective program implementation. To remove this important barrier, WUE Program implementers are encouraged to consider the following: (1) develop and track specific performance measures for the WUE Program; (2) where fiscally feasible, move forward with the broadly supported package of administrative and legislative water use measurement actions; (3) improve collection of data on locally funded actions; and, (4) revise the grant process to more closely monitor, verify and track results.

FINANCIAL ASSISTANCE PROGRAM

A review of WUE financial assistance programs suggests that there is insufficient information to determine the extent to which current grant and loan programs are supporting WUE Program objectives. Based on the Comprehensive Evaluation findings, implementation agencies are encouraged to (1) revisit grant program structure and protocols, and (2) determine the need, efficacy and structure of WUE loan programs.

TECHNICAL ASSISTANCE AND RESEARCH

The Comprehensive Evaluation suggests that both technical assistance and research efforts to-date have consisted of a patchwork of initiatives. Agency implementers are encouraged to consider the following recommendations related to these important tasks: (1) evaluate WUE research funded activities to-date, identify research priorities for the next program stage, and establish protocols to disseminate research findings and (2) conduct a market assessment to determine the appropriate structure and scope of technical assistance programs and develop a strategic plan for implementation.

NEXT STEPS

This body of work completes the evaluation called for in the August 2000 Record of Decision (ROD). CALFED Program Director Joe Grindstaff has asked that stakeholders, in coordination with implementing agencies, develop an approach to implementing the recommendations contained in the Comprehensive Evaluation.

INTRODUCTION

BACKGROUND

In 2000, as federal, state and stakeholder representatives negotiated the CALFED Bay-Delta Program Record of Decision (ROD), participants voiced very different views of the newly minted Water Use Efficiency (WUE) Element.

Some participants saw the WUE Element as the cornerstone of CALFED's water management strategy. These individuals called for, among other policies, extensive grant and loan funding to spur more aggressive local water use efficiency actions. Other participants saw WUE as important, but not necessarily a primary focus of the CALFED Program and certainly not an initiative to be funded with more than $1 billion in state and federal funds.

As the negotiators hammered out the final agreement that eventually was codified in the August 2000 ROD, they reached a compromise: Provide unprecedented funding to the WUE Element, but require an extensive evaluation after several years to assess the program's effectiveness:

> *"….by December of 2004 CALFED Agencies will conduct a comprehensive evaluation of the [WUE] Program's first 4 years, and will make appropriate additional State and Federal investments and actions to assure continued aggressive implementation of water use efficiency measures in the State."*

This report—known as the Comprehensive Evaluation—represents the final version of the evaluation called for in the August 2000 Record of Decision.

THE WATER USE EFFICIENCY ELEMENT

The WUE Element described in the ROD is unique nationally in its magnitude and its aggressive approach to water management. The WUE Program—one of eleven CALFED Program Elements—consists of agricultural, urban, urban wastewater recycling (recycling) and managed refuges components. In 2003, desalination was added to the program to take advantage of ongoing efforts by Department of Water Resources' (DWR) Office of Water Use Efficiency and the State Water Resources Control Board (SWRCB).

The WUE Element has three main goals that support the overall CALFED effort: (1) reduce water demand through "real water" conservation, (2) improve water quality by altering volume, concentration, timing and location of return flows, and (3) improve ecosystem health by increasing instream flows where necessary to achieve targeted benefits. The program is based on the recognition that, although efficiency measures are implemented locally and regionally, the benefits accrue at local, regional and statewide levels.

The ultimate goal of the WUE Element is to develop a set of programs and assurances that contribute to CALFED goals and objectives, has broad stakeholder acceptance, fosters technically and economically efficient water use, and helps support a sustainable economy and ecosystem.

THE COMPREHENSIVE EVALUATION

Most broadly, the Comprehensive Evaluation is intended to provide a thorough look at the WUE Element—both its effectiveness to-date and its potential to contribute to CALFED's effort to develop a long-term, comprehensive plan to restore the ecological health and improve water management for beneficial uses of the Bay-Delta system. More specifically, information developed through the analysis can help policymakers target future investments in the WUE Element and develop appropriate assurances.

Additionally, water use efficiency projections generated by the Comprehensive Evaluation are expected to—and already do—feed into other related studies, including: (1) the DWR's work on the California Water Plan Update; (2) Common Assumption modeling for the ongoing surface storage investigations; and, (3) the long-term Environmental Water Account's Environmental Impact Report.

To meet these various purposes, the Comprehensive Evaluation is structured to both assess performance to-date and project future potential for each of WUE's four components: agricultural water use efficiency, urban water use efficiency, recycling and desalination. These facets of the analysis, referred to as the "look-back" and "look-forward" are described briefly below. (A more detailed explanation of how these analyses were undertaken—data sources, methodologies and critical assumptions—are provided in Volumes 1 through 3 of this document.)

LOOK-FORWARD

The aim of the California Bay-Delta Authority's (CBDA) "look-forward" effort is to answer the question: What is the potential of water use efficiency actions statewide given different levels of investment and policies? In other words, the WUE Element is striving to develop a range of projections that reasonably bracket potential water use efficiency savings over the next 25 years or so. To generate a "reasonable bracket" of water use efficiency projections, the evaluation undertakes a series of analyses that assume differing levels of investments and different policy actions.

LOOK-BACK

The look-back effort consists of a process and impact evaluation based on what the WUE Element accomplished through its grants, loans and technical assistance efforts between 2000 and 2004. The process evaluation looks at how the program is structured and operated, assesses the program's effectiveness, and draws implementation lessons. The impact evaluation includes: an activity accounting; a flow-path analysis of CALFED funded grants, loans, and technical assistance; and results of various surveys. The geographic and temporal extent of the look-back effort depends on the availability of data but generally covers the state.

Though the look-forward analysis was conducted first—data from the look-forward was needed early on to inform the California Water Plan Update—information gleaned from the look-back analysis was used to re-assess the look-forward findings and shape the Comprehensive Evaluation's overarching conclusions and considerations.

INPUT INTO THE COMPREHENSIVE EVALUATION

The Comprehensive Evaluation was conducted primarily by CBDA staff and consultants. However, recognizing the sensitivity and complexity of the Comprehensive Evaluation and the need for extensive input, the team coordinated with staff from the DWR, the US Bureau of Reclamation (USBR), the SWRCB and the Natural Resources Conservation Service (NRCS). The team also coordinated with CALFED Agency staff to ensure data generated through the Comprehensive Evaluation was in a format beneficial to ongoing studies such as the California Water Plan Update and the Common Assumptions modeling.

The specific public outreach efforts undertaken to explain and seek feedback on the proposed approach included:

WATER USE EFFICIENCY SUBCOMMITTEE MEETINGS

Staff and consultants met with the WUE Subcommittee on several different occasions to lay out their proposed methodology, seek feedback on critical assumptions and present preliminary look-forward results.

PUBLIC WORKSHOPS

In coordination with the WUE Subcommittee, staff and consultants held general workshops to present and seek feedback on their analytic approach to generating projections for agricultural water use efficiency, urban water use efficiency, recycling, desalination and regulated deficit irrigation (RDI).

PUBLIC REVIEW DRAFT

A public review draft of this document was made available in spring 2006 for stakeholders to review and provide comment. The Program received several written comments and made a number of revisions based on the feedback. A stakeholder comment summary is provided at the end of this report in Appendix: Stakeholder Comments.

It is important to note that while this document has been reviewed in its entirety by relevant CALFED agencies, stakeholders have only had the opportunity to review and comment on certain sections and findings. For that reason, this version is considered a Public Review Draft. Further review and revision is anticipated.

REPORT STRUCTURE

The Comprehensive Evaluation is presented in a format intended to make it easy for interested readers to look both in-depth at and across each of the four different WUE components. Accordingly, the report is divided into two main sections: Overarching Findings of each component and Volumes that cover the look-back and look-forward Analysis for each component.

The *Overarching Findings* presents a summary of the primary findings and any overarching considerations generated by the evaluation. At the request of DWR staff, it also includes specific recommendations that the consultant Team believes merit serious consideration.

The *Volumes* are structured similarly. The first portion focuses on the look-back, starting with an overview of the Program's implementation approach, a brief review of pre-ROD activities and then a detailed assessment of activities, impact to-date and comparison with ROD estimates. The second section focuses on the look-ahead, laying out the different projection levels studied, the methodology and data used, and the study results. The final sections of volume 1 and volume 2 present relevant appendices.

The volume on recycling and desalination is greatly streamlined in comparison to the agricultural and urban water use efficiency volumes due to significant data limitations.

The evaluation looks carefully at activities implemented by the DWR (primary implementer of agricultural and urban water conservation and desalination), the Bureau of Reclamation (limited grant activity and technical assistance dedicated to Central Valley Project Improvement Act contractors), the State Board (grants and loans targeted at recycling), NRCS (local technical assistance) and the CBDA (oversight and coordination).

NEXT STEPS

This body of work completes the evaluation called for in the August 2000 Record of Decision (ROD). CALFED Program Director Joe Grindstaff has asked that stakeholders, in coordination with implementing agencies, develop an approach to implementing the recommendations contained in the Comprehensive Evaluation.

ACRONYMS

AB 1658	California Agricultural Water Management Planning Act of 1986
AB 3616	Agricultural Efficient Water Management Act of 1990
AF	acre-feet
AWMC	Agricultural Water Management Council
AWWARF	American Water Works Association Research Foundation
BDPAC	Bay-Delta Public Advisory Committee
BMPs	Best Management Practices
CBDA	California Bay-Delta Authority
CII	Commercial, Industrial, Institutional
CIMIS	California Irrigation Management Information System
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CUWCC	California Urban Water Conservation Council
DWR	Department of Water Resources
EQIP	Environmental Quality Incentive Program
ET	evapotranspiration
ETAW	Evapotranspiration of Applied Water
EWMPs	efficient water management plans
FACA	Federal Advisory Committee Act
IID	Imperial Irrigation District
MOU	Memorandum of Understanding
NRCS	Natural Resources Conservation Service
PSP	Proposal Solicitation Package
QOs	Quantifiable Objectives
RDI	Regulated Deficit Irrigation
ROD	Record of Decision
SAE	seasonal application efficency
SB 23	Senate Bill 23
SWRCB	State Water Resources Control Board
TAF	Thousand Acre-feet
TBs	Targeted Benefits
ULF	ultra-low flush
WUE	Water Use Efficiency
USBR	US Bureau of Reclamation
USFWS	US Fish and Wildlife Service
UWMPA	Urban Water Management Planning Act
VITIS	VITicultural information system

OVERARCHING FINDINGS

AGRICULTURE

INTRODUCTION TO AGRICULTURAL WUE COMPREHENSIVE EVALUATION

The Agricultural Comprehensive Evaluation is in two parts. The first part provides a review and evaluation of the first four years of agricultural Water Use Efficiency (WUE) implementation. The review discusses the role of agricultural WUE as described by the CALFED Record of Decision (ROD); the structure of the agricultural WUE program; implementation of this program; and program results over the first four years of implementation and anticipated by the end of Stage 1 of the CALFED Program. The second part provides an analysis of agricultural WUE potential through 2030 for six different projections of state and federal funding along with local levels of investment in agricultural WUE. The intent of these projections is to bracket the expected range of WUE given existing and reasonably foreseeable levels of state and federal investment deemed consistent with the ROD and state and federal fiscal constraints.

This overarching findings section briefly describes the agricultural WUE program structure and potential envisioned by the ROD, and then summarizes results of the two parts of the agricultural Comprehensive Evaluation and addresses the efficacy of the current agricultural WUE program structure. It concludes with considerations for the future direction and structure of the agricultural WUE program.

AGRICULTURAL WUE PROGRAM STRUCTURE AND STAGE 1 SAVINGS POTENTIAL ENVISIONED BY ROD

The CALFED ROD states that the goal of the WUE Program is to accelerate the implementation of cost-effective actions to conserve and recycle water throughout the State. The ROD recognizes that WUE can have water supply benefits, water quality benefits, and in-stream flow and timing benefits. The ROD calls for the implementation of WUE initiatives to achieve these benefits, such as agricultural quantifiable objectives.[1] The ROD calls for the CALFED Agencies to implement a competitive grant and loan program as the best mechanism to assure cost-effective investments in water use efficiency. It further states that:

- Loans and technical assistance are appropriate to help local agencies pursue locally cost-effective WUE.
- Grants are appropriate to pursue WUE that, while not locally cost-effective, provide additional statewide benefits, including water supply, water quality, and in-stream flow and timing.
- CALFED agencies should tailor the required local cost-share requirements to reflect the distinction between local and statewide benefits of a funded project.
- Each grant and loan package must include specific requirements for performance and accountability.

Additionally, the ROD directed that:

- The WUE program shall develop recommendations for appropriate measurement of agricultural water use and submit them to the Legislature for action.
- CALFED Agencies (DWR and Reclamation) will establish specific milestones, and associated benefits, remedies and consequences to track and guide the implementation of the agricultural WUE Program. CALFED Agencies will put in place a stakeholder and agency work group to accomplish this work.
- CALFED agencies (DWR and Reclamation) shall work with the Agricultural Water Management Council to provide technical assistance to agricultural districts devel-

1. ROD, pg. 59.

oping management plans under the AB 3616 process.
- The WUE program shall develop a finance plan for completion of Stage 1 actions.
- CALFED Agencies will conduct a comprehensive evaluation of the Program's first 4 years.

Historically there was a disagreement on the approach toward WUE implementation between irrigators and those that advocate strict implementation of WUE practices such as the efficient water management practices (EWMPs). Advocates of the strict approach feel that forcing water suppliers to undertake a list of practices will result in improved WUE. On the other hand, end users feel that changes should occur based on profit or return-on-investment. In the past the objectives that the water user focused on were internal in nature, such as how will the improvements benefit the bottom line. The CALFED agricultural WUE program moved the emphasis of the objective approach to one that looks to provide benefits beyond the water user. In addition, the CALFED WUE approach places a heavy emphasis on results and verification of all efforts. Although there are some successes, this approach is in its infancy in program development, outreach and implementation.

The Agricultural WUE component centers its strategy on: encouraging water users and water suppliers to implement locally cost-effective EWMPs; and providing funding to foster implementation of practices that provide statewide benefits beyond what is achieved through locally cost-effective practices. The program recognizes that, although efficiency measures are implemented locally and regionally, the benefits accrue at local, regional, and statewide levels. The Program is designed to:

- Build on existing water management programs
- Achieve multiple benefits, including water quality improvement, water supply reliability, and ecosystem restoration
- Reduce existing irrecoverable flows
- Preserve local flexibility
- Use incentive-based actions over regulatory actions
- Provide assurance of high water use efficiency

The WUE program is structured to help achieve the CALFED goals by developing objectives associated with water quantity, water quality, and in-stream flow benefits. Technical work was designed to translate the CALFED goals into more specific objectives. Using a stakeholder group that included agricultural and environmental interests, the program developed specific categories of benefits that could be addressed by agricultural WUE. Where possible, these benefits are expressed quantitatively as acre-feet of water at specific locations for specified time periods. The outcome of this effort is a set of objectives called the targeted benefits and quantifiable objectives.[2] The program envisioned that the grants and technical assistance components would be implemented to achieve the objectives, and that the program would be evaluated based largely on its effectiveness in achieving the objectives.

LONG-TERM AGRICULTURAL WUE POTENTIAL

The Comprehensive Evaluation's six projections of agricultural WUE potential strongly support the position that aggressive investment in agricultural WUE can result in significant reductions in irrecoverable flows (flows to saline sinks and non-beneficial evapotranspiration) and recoverable flows (in-stream flow and timing changes primarily achieved through changes to diversions, return flows and seepage) through 2030. These projections evaluated agricultural WUE potential from: (1) Local implementation of EWMPs as well as other locally cost-effective WUE actions; and (2) additional agricultural WUE actions co-funded through CALFED agency grant programs.

The first five projections adopted different assumptions regarding public (state and federal) and local investment rates. The sixth projection is a technical potential that assumes 100% adoption of all WUE actions. This last projection serves as a reference point or bookend to evaluate the other five. In addition, there is an analysis of the potential to use regulated deficit irrigation (RDI) to achieve reductions in non-productive evapotranspiration (ET). Water use efficiency potential for the projections are given in Table 1.1. The results of the projections analysis indicate the following:

- Agricultural WUE actions for projection levels 1, 3 and 5 can generate by 2030 between 150,000 and 947,000 acre-feet of recoverable flows (or 3% to 21% of the technical potential) and 34,000 and 190,000 acre-feet of irrecoverable flows (or 2% and 10% of the technical potential).
- Application of regulated deficit irrigation techniques on amenable crops is projected to yield approximately 142,000 acre-feet of reductions in non-productive ET. This water is then available for other beneficial uses such as transfers or consumptive use.
- All projection levels show potential to meet a portion or all of the in-stream flow needs identified in the targeted benefits.

EXPECTED STAGE 1 AGRICULTURAL WUE RESULTS

Regarding Stage 1 agricultural WUE potential, the Comprehensive Evaluation concluded the following:

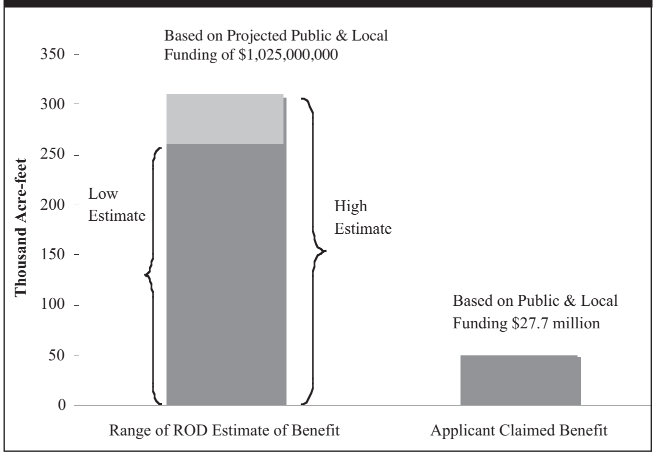
2. A full explanation of the process used and the benefit listing is available at www.calwater.ca.gov/Archives/WaterUseEfficiency/WaterUseEfficiencyQuantifiableObjectives.shtml.

TABLE 1.1 CBDA ESTIMATES OF 2030 ON-FARM AND DISTRICT AGRICULTURAL WUE POTENTIAL

Projection Level (PL)	Local Agency Investment Assumption	CALFED Grant Funding Assumption	Recoverable Flows (1,000 acre-feet/year)	Irrecoverable Flows (1,000 acre-feet/year)	Regulated Deficit Irrigation (1,000 acre-feet/year)
1	Historic Rate	Proposition 50 only	150	34	142
2	Locally Cost-Effective	Proposition 50 only	No change in locally cost-effective rate—results same as PL 1		
3	Historic Rate	Proposition 50 + $15 million/year	565	103	142
4	Locally Cost-Effective	Proposition 50 + $15 million/year	No change in locally cost-effective rate—results same as PL 3		
5	Locally Cost-Effective	Proposition 50 + $40 million/year (2005–14) $10 million/year (2015–30)	947	190	142
6*	$1.592 billion annually		4,338	1,819	142

* Projection 6 estimated the technical potential of agricultural WUE. It assumed 100% adoption statewide. Funding assumptions are based on implementation costs and are not divided between local and public funding.

FIGURE 1.1 STAGE 1 AGRICULTURAL WUE: ROD ESTIMATES AND APPLICANT-CLAIMED BENEFITS



- Benefits from agricultural WUE are expected to fall well short of the both the ROD and Comprehensive Evaluation Stage 1 estimates of WUE potential. Figure 1.1 compares expected agricultural WUE benefits by the end of Stage 1 based on the review of the first four years of agricultural WUE implementation to the ROD and Comprehensive Evaluation estimates of Stage 1 potential. The difference between the ROD and results of the first four years of implementation are partially due to program funding that was significantly lower than the projected need. In addition key assurances actions anticipated in the ROD are not yet implemented; local actions are either below projected levels or there is insufficient data to measure progress; and insufficient linkage between grant-funding decisions and water suppliers' implementation of locally cost-effective actions.
- Projects funded by the agricultural WUE grants are estimated to provide about 40,000 acre-feet of instream flow benefits for ecosystem restoration. Depending upon the project these benefits are expected to last from 7 to 50 years.
- Projects funded by the agricultural WUE grants are estimated to provide about 10,400 acre-feet of water supply reliability benefits. These benefits constitute both recoverable and irrecoverable flow and are expected to last from 3 to 30 years.
- Approximately 3% of the in-stream flow and timing (ecosystem restoration) benefits identified in the quantifiable objectives are met through grant funded activity. Approximately 3% of the water quantity (water supply reliability) benefits identified in the quantifiable objectives are met through grant funded activity.
- Providing the water supplier and user community with specific objectives resulted in funding requests for pursuing the identified targeted benefits.
- Significant funding was provided under other non-CALFED programs that potentially meet CALFED WUE objectives, Almost $80 million was provided by the Natural Resources Conservation Service (NRCS), State Water Resources Control Board (SWRCB) and Department of Water Resources' (DWR) drainage program for grants and technical assistance related to agricultural water use efficiency. Local agencies and growers provided another $168 million in cost-sharing under these programs. No data is available on non-federal, non-state investment in agricultural WUE.

AGRICULTURAL WUE PROGRAM OUTCOMES

The Comprehensive Evaluation found that expected agricultural WUE by the end of Stage 1 is likely to fall short of estimated potential. Agricultural WUE benefits are expected to come from two sources: implementation of locally cost-effective practices; and implementation of additional actions primarily funded through state and federal grants. In addition technical assistance was identified as a necessary component for program implementation.

Implementation of locally cost-effective EWMPs and on-farm practices were to provide a base level of WUE and the CALFED financial assistance programs would add to this base. Thus an analysis of agricultural WUE during the first four years of the program is divided into two categories: (1) savings realized through local implementation of cost-effective EWMPs and on-farm actions; and (2) savings realized through CALFED financial assistance programs. In both instances, the Comprehensive Evaluation found substantial discrepancies between planning estimates of Stage 1 WUE potential and actual implementation. This section uses available data to evaluate WUE for both categories.

Technical assistance supports the implementation of the WUE program. At the local level, technical assistance provides agencies and end users the necessary tools and information to address the program objectives. There are two main vehicles for technical assistance—the Agricultural Water Management Council (AWMC) and the state and federal agencies implementing the program: the NRCS, the DWR and the Bureau of Reclamation (Reclamation).

An independent audit of local agency water conservation plans, managed by the AWMC, found that most participants were in compliance with the intended language of the respective requirements. However, there is no comprehensive reporting of water conservation benefits available from water management plans and therefore the extent of non-CALFED funded WUE is not known. There are no centralized data repositories to assess progress at the farm level.

Agricultural WUE Financial Incentive Program

The second component of the WUE program for the agricultural sector was a competitive loan and grant program to support local implementation. The WUE Preliminary Implementation Plan assumed the ROD funding level of $513 million through Stage 1 for agricultural loans and grants. Outcomes of agricultural WUE incentive program are as follows:

- A competitive Proposal Solicitation Package (PSP) process for agricultural *grants* was developed by CALFED Agencies and was operated over the first four years of Stage 1. CALFED agencies developed an agricultural *loan* program to support implementation of locally cost-effective actions. However, no applications were received for the loans.
- Through 2004, the agricultural PSP *grant* program funded 63 grants to pursue targeted benefits, research, and education projects. Approximately $18.5 million in grant funding was awarded by the state; locals contributed $9.5 million.
- The majority of the awarded *grant* funds were for implementation projects that pursue targeted benefits. Other grant funds were used for research and general agricultural WUE support. Of the $17.8 million awarded from 2001–04, $13.4 million was awarded to implementation projects pursuing targeted benefits.
- Applicant reported annual benefits are approximately 40,000 acre-feet for in-stream flow and timing and more than 10,000 acre-feet for water supply. Benefits are expected to last from 3 to 50 years. These benefits have not been compared with project reports nor have they been field verified.
- The amount of agricultural WUE occurring at the local level is not known at either the user or water supplier level. There are no readily available, compiled sources of information that identify ongoing efforts.
- State and federal funds for agricultural WUE grants through Stage 1 are expected to be about 10% of the funding amounts identified in the ROD. Grant funding requests from local water suppliers exceeded the available public funds by a ratio of about two-to-one during the first four years of program implementation. Since the majority of the non-funded projects were research and demonstration it is not clear if additional funding would have generated benefits.
- Annual costs for providing the in-stream flow benefits ranged from $5 to $203 per acre-foot. Annual costs for water supply reliability benefits ranged even more widely. Projects that reduced irrecoverable flows ranged from $230–$515 per acre-foot. These cost estimates are based on information supplied by the applicant and have not been verified.
- There is no mechanism within the PSP to verify that the applicant-claimed benefits are realized. The Bay-Delta Public Advisory Committee endorsed the agricultural assurances package called for in the ROD. However, there has been no discernible effort to utilize the PSP to pursue the assurance commitments.
- An independent panel of water use measurement experts developed a definition of appropriate agricultural water use measurement. Using the product of the independent panel, stakeholders and the BDA board recommended an implementation approach that included administrative and legislative actions. Although legislation was introduced no progress was made on implementing these actions.

- The average costs of funded projects are within the cost range expected by the ROD. However, this cost information is based on a bare minimum of data points by grant applicants and has not been verified.
- The program does not market the loan program to support implementation of locally cost-effective actions.
- There is no mechanism that takes the results of publicly funded project results and aggregates them to inform program performance and accountability. There are no existing data sources to inform the baseline performance of agricultural WUE.

CONSIDERATIONS FOR MOVING FORWARD

The results of the Comprehensive Evaluation suggest several considerations for moving forward with the agricultural WUE program.

- The Comprehensive Evaluation's projections of agricultural WUE potential affirm the important role that irrigation water management can play in managing the state's water resources over the next several decades. Savings of recoverable flows for projections 1, 3 and 5 range from 150,000 to 947,000 acre-feet, thereby capturing between 3% and 21% of the technical potential. Savings of irrecoverable flows for projections 1, 3 and 5 range from 34,000 to 190,000 acre-feet, effectively capturing between 2% and 10% of the technical potential.
- Realization of this potential depends in part on locals implementing cost-effective actions. The quantitative benefits of the AWMC and Reclamation planning processes are not known. There are no data sets that indicate the contribution of local WUE baseline (such as the information contained in the AWMC plans) and project-level implementation data (such as pre- and post-canal lining seepage flows) that are needed to report on the WUE that occurs at the local level.
- The Comprehensive Evaluation suggests that state and federal financial assistance programs play an important role in affecting WUE. On their own, grant programs are unlikely to allow the state to realize the upper-end of the range of the WUE potential. In conjunction with policies promoting implementation of locally cost-effective WUE, state and federal financial assistance can leverage additional local investment to promote the most promising and cost-effective actions.
- The agricultural assurances package that identifies the benefits that ensure that water suppliers and users are performing at the locally cost-effective level is fundamental are maintaining an objective program. Currently there is insufficient data and information to establish a baseline or to assess the progress-to-date in program delivery and performance. The assurance package is important in that it would provide the agricultural and environmental community the assurance that the program's efforts are affecting change.

URBAN

INTRODUCTION TO URBAN WUE COMPREHENSIVE EVALUATION

The urban Comprehensive Evaluation is in two parts. The first part provides a review and evaluation of the first four years of urban WUE implementation, discussing the role of urban WUE as described by the CALFED Record of Decision (ROD); the structure of the urban WUE program; implementation of this program; and program results over the first four years of implementation and anticipated by the end of Stage 1 of the CALFED Program. The second part provides an analysis of urban conservation potential over the next 25 years for six different projections of state/federal funding and local levels of investment in urban WUE. The intent of these projections is to bracket the expected range of water savings given existing and reasonably foreseeable regulatory requirements affecting urban water use efficiency, the set of existing Best Management Practices (BMPs) as governed by the Urban MOU, other proven water saving technologies, and alternative levels of state/federal investment deemed consistent with the ROD and state/federal fiscal constraints. It concludes with considerations for the future direction and structure of the urban WUE program.

URBAN WUE PROGRAM STRUCTURE AND STAGE 1 SAVINGS POTENTIAL ENVISIONED BY ROD

The ROD viewed WUE investment in the urban sector as a cost-effective way to better balance urban water supply and demand in the near-term, especially compared to surface storage and major conveyance improvements that the ROD estimated would take at least 5–10 years to complete.[3] There were several reasons cited for this view:

- WUE was seen as a way to quickly address growing urban water demands and simultaneously reduce pressure on Delta resources caused, in part, by these demands.
- Relieving pressure on Delta resources through urban WUE investments was not new to the ROD. The ROD's proposed urban WUE approach was built upon earlier urban conservation initiatives that stemmed from Bay-Delta conflicts, most notably the Memorandum of Understanding Regarding Urban Water Conserva-

3. ROD, pg. 59.

Urban Best Management Practices	
BMP 1	Residential Survey Programs
BMP 2	Residential Plumbing Retrofit
BMP 3	System Water Audits
BMP 4	Metering w/Commodity Rates
BMP 5	Large Landscape Conservation
BMP 6	High Efficiency Clothes Washers
BMP 7	Public Information Programs
BMP 8	School Education Programs
BMP 9	Commercial Industrial Institutional
BMP 10	Wholesaler Agency Assistance Programs
BMP 11	Conservation Pricing
BMP 12	Conservation Coordinator
BMP 13	Water Waste Prohibitions
BMP 14	Residential Ultra-Low Flush Toilet Replacement Programs

tion in California (Urban MOU). The Urban MOU had been in effect since 1991 and had achieved widespread adoption.

- Over 190 urban water suppliers, serving approximately two-thirds of all Californians, have now signed the Urban MOU and are implementing its urban conservation BMPs to some degree. The BMPs have also been adopted for use in several other water management initiatives and legislation, including the Urban Water Management Planning Act (UWMPA), the Central Valley Project Improvement Act (CVPIA), and the Sacramento Water Forum Agreement.[4]

Using the Urban MOU process as a starting point, the ROD proposed a two-pronged approach for urban WUE.[5] The first prong was implementation of locally cost-effective BMPs by urban water suppliers. This base level of implementation was to be supported by CALFED through a program to certify water supplier compliance with the Urban MOU, low-interest loan programs and technical assistance. The second prong was the use of grants to leverage additional local investment in urban conservation. These grants were to go towards measures that, while not locally cost-effective from the perspective of an individual water supply agency, would provide statewide water supply, water quality, and ecosystem restoration benefits.

According to the ROD, these two initiatives had the potential to produce substantial urban water savings by the end of Stage 1. It described the approach as "aggressive and unprecedented nationally."[6] State and federal expenditures for urban WUE through Stage 1 were estimated at $350 million. Local investment was projected to easily exceed this amount. Resulting water savings by the end of Stage 1 were expected to range between 520,000–680,000 acre-feet, enough water to meet the domestic water demands of 2.7 to 3.5 million Californians.

LONG-TERM URBAN SAVINGS POTENTIAL

The Comprehensive Evaluation's six projections of urban savings potential strongly support the position that aggressive investment in urban conservation can result in significant reductions in urban applied water use over the next 25 years. These projections evaluated urban water savings potential from three sources: Efficiency codes that require certain water using appliances and fixtures to meet specified levels of efficiency; local implementation of BMPs as well as other locally cost-effective conservation measures; and additional urban conservation measures co-funded through CALFED Agency grant programs.

The first five projections adopted different assumptions regarding state/federal and local investment rates. The sixth projection measured the water savings potential assuming 100% adoption of the measures under evaluation. This last projection served as a reference point from which to evaluate the other five. Water savings potential for the six projections are shown in Table 1.2. The results of the projections analysis indicate the following:

- Water savings for projections 1 through 5 range between 1.2 million and 2.1 million acre-feet per year by 2030, and capture 39% to 68% of technical potential. The projected range of savings would meet the domestic water demands of 6.3 million to 10.9 million residents at current rates of household water use.
- While California's population is projected to increase 35% by 2030, urban water use would increase by only 12% if California were to realize the upper-end of the range of projected urban water savings (i.e. Projection 5).
- Water savings from local agency implementation are sharply affected by the local investment assumption. Realizing the upper-end of the range of savings potential requires full implementation of locally cost-effective BMPs (Projections 2, 4, and 5). The analysis indicates that historic rates of investment in BMPs would not be adequate to realize the upper-end of the savings range (Projections 1 and 3). Savings potential assuming implementation of all locally cost-effective measures is approximately five times greater than from assuming the historic rate of BMP implementation.
- Efficiency codes are a significant source of water savings for the urban sector. Codes related to toilet, showerhead, and washer efficiency, as well as codes

4. The UWMPA is a piece of California legislation, while CVPIA is federal legislation. The Sacramento Water Forum Agreement is a regional initiative.
5. ROD, pg. 60.
6. ROD, pg. 64.

TABLE 1.2 CBDA ESTIMATES OF 2030 URBAN CONSERVATION SAVINGS POTENTIAL

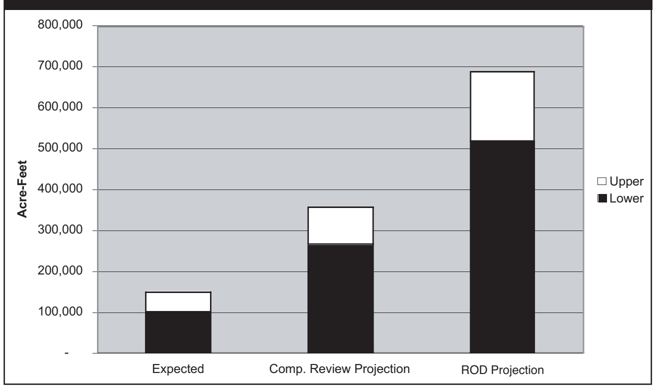
Projection Level (PL)	Local Agency Investment Assumption	CALFED Grant Funding Assumption	Efficiency Code (acre-feet/year)	Local Agency (acre-feet/year)	Grant Funded (acre-feet/year)	Total Projected Savings (acre-feet/year)
1	Historic Rate	Proposition 50 only	970,000	172,000	11,000	1,153,000
2	Locally Cost-Effective	Proposition 50 only	970,000	881,000	11,000	1,862,000
3	Historic Rate	Proposition 50 + $15 million/year	970,000	172,000	257,000	1,399,000
4	Locally Cost-Effective	Proposition 50 + $15 million/year	970,000	881,000	257,000	2,108,000
5	Locally Cost-Effective	Proposition 50 + $40 million/year (2005–14) $10 million/year (2015–30)	970,000	881,000	224,000	2,075,000
6*	N/A	N/A	N/A	N/A	N/A	3,096,000

* Projection 6 estimated the technical potential of the urban conservation measures evaluated by CBDA. It assumed 100% adoption statewide of these measures and provided a reference point for the other five projection levels.

that require metering customer water connections are essential to realizing the projected water savings potential. Efficiency codes account for 46% to 84% of total savings for projections 1 through 5.

- Although grant funded water savings account for only a small percentage of total savings potential, they leverage significant additional local investment, can act as an investment catalyst, help to promote regional partnerships and joint ventures, and increase the geographic base of implementation.

FIGURE 1.2 URBAN STAGE 1 WATER SAVINGS: EXPECTED VS. PROJECTED



EXPECTED STAGE 1 WATER SAVINGS

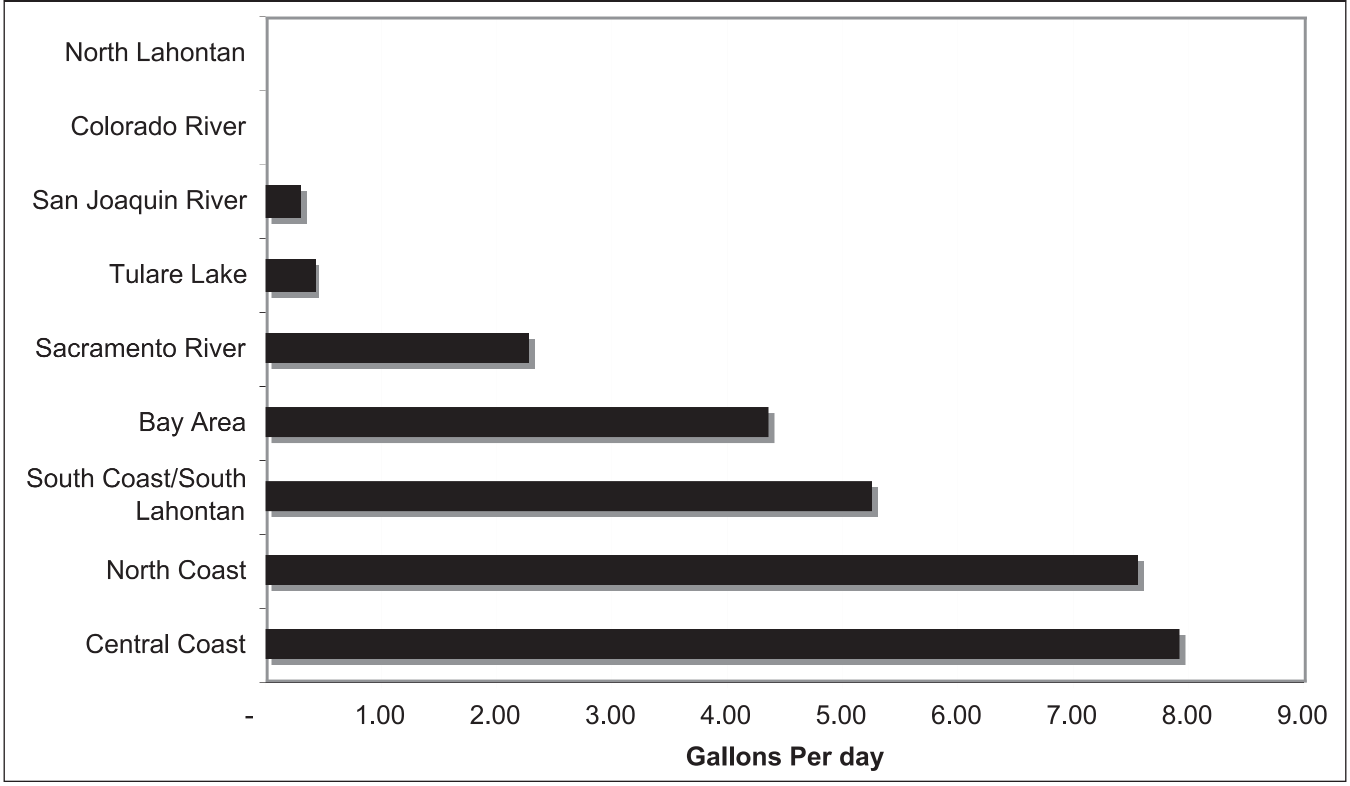
Regarding Stage 1 urban sector water savings potential, the Comprehensive Evaluation concluded the following:

- The ROD estimates of Stage 1 urban savings potential appear to be overstated. Modeling done for the Comprehensive Evaluation suggests that local implementation of cost-effective conservation measures coupled with state/federal funding amounts put forward by the ROD could produce, under ideal circumstances, upwards of 475,000 acre-feet of water savings by the end of Stage 1—about 91% of the lower-bound ROD estimate of urban savings potential.
- Urban sector water savings by the end of Stage 1 are expected to fall well short of the both the ROD and Comprehensive Evaluation Stage 1 estimates of savings potential. Figure 1.2 compares expected water savings by the end of Stage 1 based on the review of the first four years of urban WUE implementation to the ROD and Comprehensive Evaluation estimates of Stage 1 savings potential.
- Adopting less aggressive local implementation assumptions would put the expected savings range between 267,000 and 356,000 acre-feet—about 50% to 70% of the lower-bound ROD estimate of Stage 1 urban savings potential. Although considerably below the ROD projection, this volume of water savings is nonetheless sizeable.
- Stage 1 urban sector annual savings are expected to range between 101,000 and 150,000 acre-feet, about 39% of the conservative Comprehensive Evaluation Stage 1 projection, and about 20% of the ROD Stage 1 projection.

URBAN WUE PROGRAM OUTCOMES

The Comprehensive Evaluation found that expected water savings by the end of Stage 1 are likely to fall short of estimated potential. Urban sector savings were to come from two sources: implementation of locally cost-effective BMPs per the Urban MOU; and implementation of additional conservation measures funded in part via state/federal grants. In both instances, the Comprehensive Evaluation found substantial discrepancies between planning assumptions upon

FIGURE 1.3 2004 PER CAPITA BMP SAVINGS BY REGION



which estimates of Stage 1 savings potential were based and actual implementation.

Urban MOU Implementation

Water savings from urban BMP implementation have grown steadily since the Urban MOU was first adopted in 1991. By 2004, the last full year of BMP data, annual water savings were approximately 180,000 acre-feet. Since 1991 annual water savings have increased by 15% to 20% per year, according to data from the California Urban Water Conservation Council (CUWCC).[7]

The impact of the Urban MOU on water use, however, has varied considerably by region and rates of compliance for most BMPs remains low, as shown by Figures 1.3 and 1.4. Addressing uneven rates of BMP implementation and assuring statewide compliance with the Urban MOU process were important Stage 1 WUE Program objectives stipulated by the ROD. These objectives have yet to be met.

The ROD called on CALFED Agencies to implement a process to certify water supplier compliance with the Urban MOU by the end of 2002. It further stated that access to CALFED Agency grant funding should be conditional on compliance with the Urban MOU once the certification process was in place. To date, these ROD provisions concerning Urban MOU compliance have not been implemented.

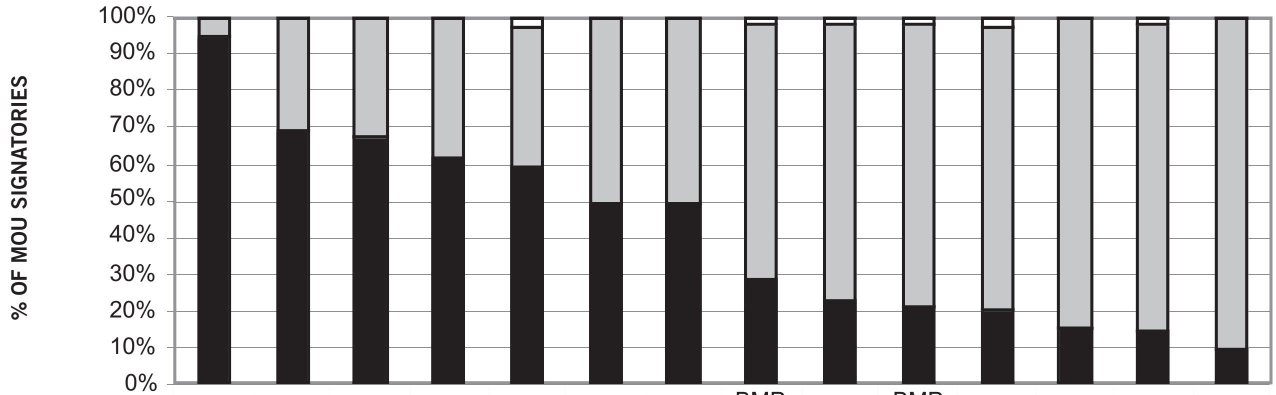
A framework for certifying water supplier compliance with the Urban MOU was completed in June of 2002 and put before the Bay-Delta Public Advisory Committee (BDPAC) for action in August of 2002. While BDPAC engaged the topic during its August meeting, it chose to take no action on the proposal, citing unresolved technical issues, water supplier concerns about unbalanced implementation of the CALFED Program, and questions about the efficacy of making the voluntary Urban MOU process into a quasi-regulatory program.

Because CALFED Agencies have not adopted a process to certify compliance with the Urban MOU, the second ROD stipulation that grant funding be made conditional on compliance also has not been put into effect.[8] Grant eligibility is conditional on having filed an Urban Water Management Plan with DWR, but this requirement does not ensure Urban MOU compliance. CALFED Agencies have not set a timetable for linking grant eligibility to Urban MOU compliance, though the ROD expected such a linkage by the beginning of 2003.

Whether the proposed certification program would have resulted in greater rates of compliance with the Urban MOU and implementation of the BMPs is uncertain. What the available data clearly indicate, however, is that the voluntary Urban MOU process is not functioning as originally intended.

7. While an annual growth rate of 15% to 20% is an important accomplishment, both the look-forward analysis and data on current MOU compliance rates suggest significant remaining conservation potential in the urban sector.

FIGURE 1.4 URBAN MOU BMP COMPLIANCE RATES AS OF 2002



	BMP 03	BMP 07	BMP 08	BMP 04	BMP 06	BMP 11	BMP 12	BMP 05 - Srvy	BMP 02	BMP 05 - Bdgt	BMP 01	BMP 14	BMP 09	BMP 13
Exemptions	0%	0%	0%	0%	2%	0%	0%	2%	2%	2%	2%	0%	2%	0%
Out of Compliance	5%	31%	33%	38%	38%	50%	51%	69%	75%	77%	78%	84%	83%	90%
In Compliance	95%	69%	67%	62%	60%	49%	49%	29%	23%	21%	20%	16%	15%	10%

- Very few MOU signatories follow the BMP exemption process when they choose not to implement BMPs. The rate of exemption filings ranges between 0–2% of water suppliers. While the exemption process is a cornerstone of the voluntary Urban MOU, BMP implementation data clearly show the process is not working as intended.
- The proportion of signatories out of compliance with BMP requirements equals or exceeds 50% for nine BMPs. Non-compliance rates are highest for BMPs requiring significant customer interaction and water supplier financial commitment—BMPs 1, 2, 5, 9, and 14. These are also the BMPs expected to produce the most water savings.
- None of the water suppliers with large numbers of unmetered connections are complying with BMP 4.[9]
- Non-reporting or incomplete reporting of BMP activity remains a problem. Reporting rates, while improving over time, are still low. Like the exemption provisions, BMP reporting was considered a key part of the voluntary Urban MOU. Here too, the data suggest the process is not working as intended.
- Overall, the data show that most Urban MOU signatories do not voluntarily comply with the Urban MOU process. Few submit exemptions for the BMPs they are not implementing and few are complying with most of the BMPs.

Urban WUE Loan/Grant Program

The second component of the WUE program for the urban sector was a competitive loan and grant program to support local implementation of BMPs. The WUE Preliminary Implementation Plan budgeted $350 million through Stage 1 for urban loans and grants. Outcomes of urban WUE loan/grant program to date have been as follows:

- A competitive PSP process for urban grants was developed by CALFED Agencies and has operated successfully over the first four years of Stage 1.
- CALFED Agencies have not developed an analogous urban loan program to support implementation of locally cost-effective BMP implementation. It is unclear whether there is local demand for such a program.
- Through 2004, the urban PSP grant program has funded 122 urban conservation implementation, research, and education projects. $50.5 million in grant funding has been awarded over this period. Funded projects have expected annual water savings of about 37,000 acre-feet. Accounting for the lag between funding and implementation, approximately 40% of this savings will be on line by the end of Stage 1.
- Urban conservation projects funded by the PSP process account for between 16–19% of total expected water savings through the first four years of Stage

8. On page 60 the Record of Decision states: "Water agencies must implement water use efficiency measures that are cost-effective and appropriate at the local level. This level of attainment will be defined by agency compliance with the AB 3616 Agricultural Water Management Plans (for agricultural districts) or implementation of applicable Urban Water Conservation Council "best management practices" (for urban districts). CALFED Agencies anticipate that State and Federal assistance to agencies to attain this base level of water use efficiency will generally be in the form of technical assistance and capitalization loans, not grants. In addition, access to further CALFED Water Use Efficiency Program benefits (e.g., grants) will be conditioned on agency implementation of the applicable water management plans."

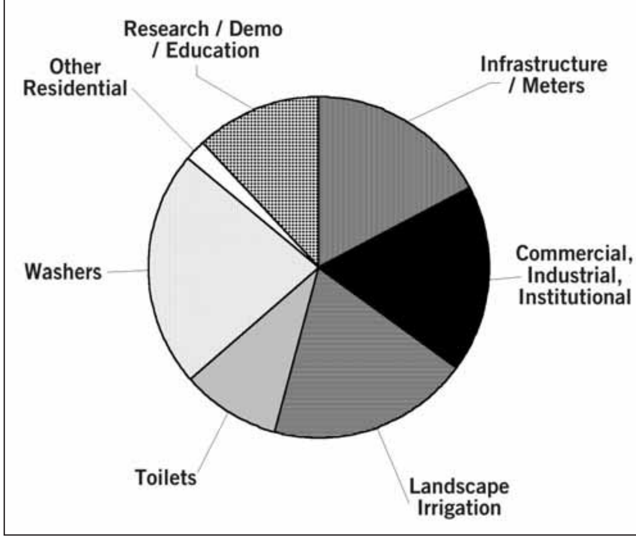
9. Passage of state metering legislation last year, which requires metering of all urban connections by 2025, is likely to change this situation, albeit slowly.

1. The other 81–84% of expected savings are a result of unassisted local implementation.
- State/federal funds for urban grants through Stage 1 are expected to be about 23% of funding amounts set forth in the ROD. Funding requests from urban water suppliers have exceeded available state/federal funds by a ratio of about eight-to-one during the first four years of program implementation.
- Comprehensive Evaluation results suggest that had the urban PSP program received full Stage 1 funding it could have resulted in 125,000 acre-feet of water savings by the end of Stage 1.
- Most funding has been for implementation projects rather than research, demonstration, or education. Of the $50.5 million awarded between 2001 and 2004, $44.5 million has been awarded to implementation projects. Grant funding has addressed all aspects of urban water use. The distribution of grant awards by conservation activity is shown in Figure 1.5.
- While unit costs for many funded projects have been higher than anticipated by the ROD, on average the cost per acre-foot of expected water savings, as reported by grant applicants, has ranged between $160 and $390 per acre-foot. The average unit cost of savings for the urban PSP program is within the expected cost range of $150 to $450 per acre-foot cited in the ROD.

On balance, the urban PSP program has followed ROD guidance in some respects and not in others.

- It has implemented a competitive PSP process that evaluates both local and statewide benefits of proposed projects.
- The average costs of funded projects are within the cost range expected by the ROD, though the program has shown a tendency to fund many small to medium scale projects with high unit costs and may be forgoing opportunities for economies of scale.[10]
- The program has not implemented a loan program to support implementation of locally cost-effective conservation measures. In two out of four funding years, it has used grants to fund locally cost-effective projects even though the ROD stipulated that grants should not be used for this purpose.
- The program has not conditioned grant funding on compliance with the Urban MOU, though it has conditioned it on compliance with the UWMPA.
- PSP program funding has fallen far short of ROD levels. By the end of Stage 1, PSP program funding is expected to be only 23% of the ROD target.

FIGURE 1.5 URBAN GRANT FUNDING ALLOCATION: 2001–2004



CONSIDERATIONS FOR MOVING FORWARD

The results of the Comprehensive Evaluation suggest several considerations for moving forward with the urban WUE program.

- The Comprehensive Evaluation's projections of urban water savings potential affirm the important role urban demand management could play in managing the state's water resources over the next several decades. Savings potential from the range of local and state/federal investment considered by the Comprehensive Evaluation is 1.2 to 2.1 million acre-feet.
- Realization of this potential depends critically on local implementation of conservation measures. The existing, purely voluntary Urban MOU process is not working as intended. While the ROD called for a process to certify water supplier compliance with the Urban MOU, and BDA staff developed a framework for such a process, it has yet to be implemented. Going forward, CALFED Agencies need to consider carefully the role the Urban MOU plays in local implementation of conservation and whether changes to this process would allow the state to tap into the considerable water savings potential identified by the Comprehensive Evaluation's analysis of savings potential.
- The Comprehensive Evaluation also highlighted the important role played by efficiency codes. Once in place, these codes provide an automatic and on-going source of water savings to the state at minimal costs.

10. Reversing this tendency potentially could increase the efficiency of the program, but might impact the ability of smaller communities to effectively compete for grant funds. Currently the program is structured to increase the likelihood of funding projects in small economically disadvantaged communities.

Going forward, CALFED Agencies need to consider the relevance and effectiveness of existing efficiency codes and encourage development of other efficiency codes where practical.
- The Comprehensive Evaluation suggests that state/federal financial assistance programs play an important but limited role. By themselves they are unlikely to allow the state to realize the upper-end of the range of savings potential. In conjunction with policies promoting implementation of locally cost-effective conservation measures, however, state/federal financial assistance can leverage additional local investment in conservation, promote the most promising and cost-effective conservation technologies, and help to forge regional and statewide urban conservation initiatives. The existing PSP process is meeting some of these objectives, but also may be foregoing important scale economies by funding many small projects rather than fewer large projects. Results of the Comprehensive Evaluation suggest a rebalancing may be needed between funding as many applications as possible with available funds and economic efficiencies associated with larger-scale projects.

RECYCLING AND DESALINATION

INTRODUCTION TO WASTEWATER RECYCLING AND DESALINATION COMPREHENSIVE EVALUATION

The recycling and desalination Comprehensive Evaluation is in two parts. The first part provides a review and evaluation of the first four years of recycling and desalination implementation. The review discusses the role of recycling as described by the CALFED ROD; the structure of the recycling program; implementation of this program; and program results over the first four years of implementation and anticipated by the end of Stage 1 of the CALFED Program. The second part provides an analysis of recycling and desalination potential based on a reasonably foreseeable level of state and federal funding. Although desalination is not covered in the CALFED ROD it is included in this analysis.

RECYCLING PROGRAM STRUCTURE AND STAGE 1 SAVINGS POTENTIAL ENVISIONED BY ROD

The CALFED ROD states that the goal of the WUE Program is to accelerate the implementation of cost-effective actions to conserve and recycle water throughout the State. The ROD recognizes that WUE can have water supply benefits, water quality benefits, and in-stream flow and timing benefits. The ROD calls for the implementation of WUE initiatives to achieve these benefits.[11] The ROD calls for the CALFED Agencies to implement a competitive grant and loan program as the best mechanism to assure cost-effective investments in water use efficiency. It further states that:

- Loans and technical assistance are appropriate to help local agencies pursue locally cost-effective WUE.
- Grants are appropriate to pursue WUE that, while not locally cost-effective, provide additional statewide benefits, including water supply, water quality, and in-stream flow and timing.
- CALFED agencies should tailor the required local cost-share requirements to reflect the distinction between local and statewide benefits of a funded project.
- Each grant and loan package must include specific requirements for performance and accountability.

Additionally, the ROD directed that:

- The WUE program shall develop recommendations for appropriate measurement of water use and submit them to the Legislature for action.
- The WUE program shall develop a finance plan for completion of Stage 1 actions.
- CALFED Agencies will conduct a comprehensive evaluation of the Program's first four years.

LONG-TERM RECYCLING AND DESALINATION POTENTIAL

The Comprehensive Evaluation's projection of recycling and desalination potential strongly supports the position that aggressive investment in recycling can result in significant water supply benefits through 2030. The approach taken in the recycling and desalination potential analysis was to work with stakeholders to develop a listing of all recycling and desalination projects. This approach was taken in part to satisfy the "reasonably foreseeable" NEPA criteria. Several efforts were made to refine the listing; however, the reader is cautioned that the project listings are not definitive and includes many projects that may be speculative.

The recycling list indicates that there are 730 projects throughout the state with 565 projects reporting a yield of over 3 million acre-feet. There are 100 projects that list capital cost information totaling $2.1 billion. The desalination list indicates that there are 174 projects throughout the state with 173 projects reporting a yield of over 1.6 million acre-feet. There are 39 projects that list capital cost information totaling $2.13 billion.I n another analysis the Recycled Water Task Force, using population projections, wastewater production and economic assumptions estimated a potential between 1.4 to 1.67 million acre-feet by 2030.

11. ROD, pg. 59.

A potential funding source for recycling and desalination projects is Chapter 8 of Proposition 50 contains that contains $380 million in funding capacity for integrated regional water management. It is assumed that these funds are available for both demand management and supply augmentation however at this time there is no basis for allocating the funding and therefore no projections of future projects are made.

EXPECTED STAGE 1 RECYCLING
AND DESALINATION RESULTS

Regarding Stage 1 recycling and desalination potential, the Comprehensive Evaluation concluded the following.

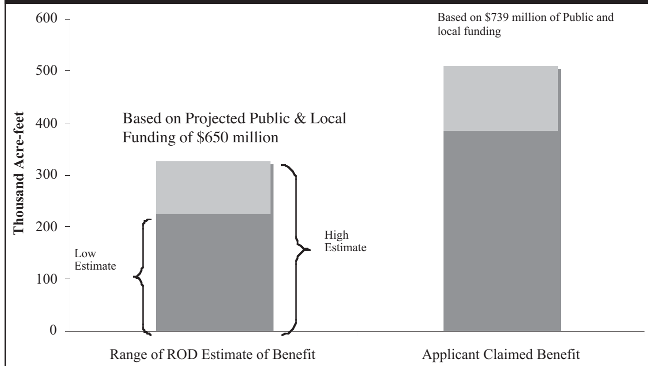
- Figure 1.6 shows benefits from recycling are expected to range from 387,000 to 513,000 acre-feet. This is almost double the low end of the Stage 1 estimates. The difference between the ROD estimates and the Comprehensive Evaluation estimates may be due to the fact that funding for the first four years was greater than the ROD estimate.
- No results or applicant-claimed benefits are available from the Proposition 50 funding that was allocated in Year 4. Assuming that there are yield benefits from these projects, this will increase the overall recycling amount.

CONSIDERATIONS FOR MOVING FORWARD

The results of the Comprehensive Evaluation suggest several considerations for moving forward with the recycling and desalination program.

- The Comprehensive Evaluation's projections of recycling potential affirm the important role that water management can play in managing the state's water resources over the next several decades. Based on a tentative project listing the recycling potential is greater than 3 million acre-feet. Based on the tentative desalination listing there are about 1.6 million acre-feet of potential new yield.
- The Comprehensive Evaluation suggests that state and federal financial assistance programs play an important role in affecting WUE. On their own, grant programs are unlikely to allow the state to realize the upper-end of the range of the WUE potential. In conjunction with policies promoting implementation of locally cost-effective recycling, state and federal financial assistance can leverage additional local investment to promote the most promising and cost-effective actions.

FIGURE 1.6 COMPARISON OF ROD ESTIMATES FOR RECYCLING THROUGH STAGE 1 AND APPLICANT-CLAIMED BENEFITS*



* Since the public review draft was released the SWRCB reported an additional $39 million for 4 construction projects.

RECOMMENDATIONS

The analysis and associated findings and considerations suggest that agencies responsible for the WUE Program may want to consider changes in the way the program is implemented. Below are specific recommendations that the consultant Team believes merit serious consideration. Any final approach is best considered as part of a dialogue that brings the affected stakeholder community to the table in a transparent series of discussions.

PROGRAM STRUCTURE/ASSURANCES

Recommendation 1: Assess viability of WUE approach given expected fiscal constraints.

The ROD proposed a WUE program unprecedented in its scope, magnitude, and funding. Expectations of program performance were predicated on sizable amounts of state and federal financial assistance to local implementing agencies. Only a small fraction of the funding proposed in the ROD has actually materialized and present state and federal fiscal conditions strongly suggest further diminishment in future funding. The CALFED Program needs to determine whether a minimally funded approach is sufficient to meet WUE and broader CALFED Program objectives.

Recommendation 2: Decide whether to implement a process to certify compliance with the Urban MOU.

Findings from the Comprehensive Evaluation clearly indicate the current voluntary MOU process is not working and that water savings from implementation of locally cost-effective conservation measures are well below full potential. As envisioned by the ROD, a process to certify water supplier compliance with the Urban MOU was a key assurance for realizing water savings from locally cost-effective conservation measures. Urban MOU certification is currently in limbo.

Following release of the CBDA staff recommendation, no further progress on implementing a certification program has been made, but neither has the idea been officially discarded. The decision whether or not to move forward with certification is pivotal. Moving forward with certification will require substantial commitments by the CALFED Program, implementing agencies, and stakeholders to develop and implement an effective, fair, and robust process. A decision not to move forward with certification will require very different but no less substantial commitments to craft a new approach for assuring a high level of local investment in urban water use efficiency.

Recommendation 3: Revisit effectiveness of quantifiable objectives approach and associated assurances.
As articulated in the Record of Decision, quantifiable objectives were to serve as the foundation of the agricultural water use efficiency program. Local actions were to be targeted at achieving quantifiable objectives. Grant funding was to be prioritized for agencies delivering quantifiable objectives results at the local level. And a broadly supported assurances package was to be used to assess progress towards quantifiable objectives implementation. The Comprehensive Evaluation suggests mixed success over the past few years. While some local water agencies have actively sought grant funding to pursue quantifiable objectives and the Bureau of Reclamation has successfully embedded quantifiable objectives into its regional criteria, other key elements have fallen far short of expectations and needs. Only one-quarter of the quantifiable objectives have been articulated, outreach to local agencies has proven more challenging and time-consuming than anticipated, and significant grant-funding has been awarded to projects not promising to meet quantifiable objectives. Implementing agencies need to tackle this issue head-on. If quantifiable objectives are to play a pivotal role, deficiencies in the current implementation approach must be addressed. If quantifiable objectives are to be diminished in importance, a new approach—and associated assurances—must be crafted and put into place.

MONITORING PERFORMANCE

Recommendation 4: Develop specific performance measures for WUE Program.
The WUE Program has yet to articulate a comprehensive set of performance measures that it will use to evaluate program performance and determine whether the program is meeting stated objectives. These measures are needed if the program is to successfully adapt to changing circumstances and make mid-course corrections. The program needs to identify several key performance measures for each of its several program areas. These measures should address water savings, cost-effectiveness, and supply-reliability, water quality, and ecosystem benefits derived from WUE investments. In addition, these measures should identify significant implementation barriers facing local water agencies.

Recommendation 5: Proceed with measurement proposal.
Efforts to assess and project water use efficiency potential are seriously constrained by the lack of credible and comprehensive water use measurement data, particularly in the agricultural sector. Consistent with the ROD, the CBDA last year developed a proposed package of legislative and administrative actions intended to improve the state's collection of basic agricultural and urban water use measurement data. This package—broadly supported by stakeholders yet still awaiting action—needs to move forward if the State is to craft water management policy informed by current water use.

Recommendation 6: Improve collection of data on locally funded actions.
The Comprehensive Evaluation was greatly hampered by the lack of data related to locally cost-effective agricultural water use efficiency actions. Without reliable data on locally funded actions, it is not possible to credibly assess and project the potential contributions agriculture can make to the state's water management needs. The State should work with the AWMC and other interested parties to develop a reliable and comprehensive system for tracking locally cost-effective investment and results. The BMP reporting database developed by the CUWCC provides one example of how data can be efficiently collected from a wide array of implementing agencies throughout the state.

Recommendation 7: Revise the grant process to monitor, verify and track results.
To date, the grant process has relied on recipients to report expected benefits of proposed projects. Only minimal effort has been made to monitor, verify and aggregate results in a usable database. As a result, the Program cannot accurately assess the impact of water use efficiency actions and better target future grant funding. WUE implementing agencies should put in place mechanisms to develop baseline and project-level implementation data to report on WUE activities occurring at the local level. For example, when implementing a canal lining action there needs to be project level data that informs the quantity of pre-project seepage and the reduction in seepage once the action is implemented. Furthermore, program-wide baseline data is not available and therefore an understanding of progress toward meeting in-stream flows, water quality and water supply reliability objectives is not possible. Examples of program-wide data are

cumulative changes in district diversions, basin-wide ET changes or changes in in-stream flows. The grant-tracking database developed by the CALFED Ecosystem Restoration Program could provide a possible model for this effort.

FINANCIAL ASSISTANCE PROGRAMS

Recommendation 8: Revisit grant program structure and protocols.

Experience with the grant program to-date spotlights several issues important to address. Will agencies target grant dollars at beyond locally cost-effective actions only or will funding be made available for locally cost-effective projects? Is it important to award grants evenly across the state and among different-sized local water agencies or is it a greater imperative to target those projects capable of delivering the greatest statewide benefits? To what extent is it appropriate to limit grant funding to only those actions deemed consistent with AWMC or Urban MOU compliance? These and related issues should be openly engaged and resolved—with stakeholder input—prior to the next grant-funding round.

Recommendation 9: Determine the need and efficacy of urban and agricultural loan programs.

The ROD proposed using low-interest loans rather than grants to assist agencies implementing locally cost-effective WUE measures. This was seen as one way to reduce implementation barriers, particularly for smaller or lower-income communities. To date, the WUE Program has not implemented an urban loan program and it remains unclear whether there is either broad or specific demand for one. A loan program for agricultural WUE projects was developed, but there has been no demand for it. The current lack of demand for low-interest loans may point to a mismatch between policy and local need, but it also may be primarily a function of the credit environment over the last half-decade. The CALFED Program should assess the viability and efficacy of urban and agricultural loan programs. This assessment should consider under what credit market conditions there would be broad demand by local implementing agencies for a low-interest loan program; whether a low-interest loan program would provide sufficient financial assistance to economically disadvantaged communities implementing locally cost-effective WUE measures; and more generally, whether WUE financing presents a significant implementation barrier that can be effectively addressed through a loan program.

TECHNICAL ASSISTANCE AND RESEARCH

Recommendation 10: Conduct market assessment to determine appropriate structure and scope of technical assistance programs and develop strategic plan.

The ROD outlined an ambitious WUE technical assistance program to address local implementation barriers, disseminate information and research findings, and help local agencies develop effective WUE programs. To date, technical assistance efforts have consisted of a patchwork of programs and outreach. Roles and responsibilities among the CALFED implementing agencies are minimally defined and coordination has been minimal. A bottom-up assessment of the need, type, scope, and delivery of technical assistance is needed. One possible approach is to begin with a survey of potential technical assistance recipients to determine what type of programs and delivery mechanisms would best serve their needs. Results from such a survey could support development of a technical assistance strategic plan that would more clearly articulate program goals, organization, coordination, costs and funding.

Recommendation 11: Evaluate WUE research funded to-date, identify research priorities for next program stage, and establish protocols to disseminate research findings.

The ROD envisioned a robust WUE research program to support local implementation of conservation programs and to ensure that information on the latest WUE technologies and methods was widely disseminated. In addition, the CALFED water measurement proposal included a stakeholder-supported list of focused research needs. While a variety of research has been undertaken over the first four program years, it has not been guided by an explicit set of research priorities and objectives. This has resulted in a piecemeal approach that has made it difficult to determine if the program is directing research dollars to the best areas of inquiry. While a Science Application Advisory Committee was established to guide WUE research, the program has not effectively utilized it. As a first step, a review of research funded to date is needed. This assessment could then support a more comprehensive assessment of research needs and priorities for the next stage of implementation. Lastly, the program needs to consider how best to ensure that information developed through research makes a practical difference in meeting program objectives. A key element here will be ensuring that research findings of significance are translated into pragmatic program guidance and broadly disseminated to local implementing agencies.

VOLUME 1: AGRICULTURAL WATER USE EFFICIENCY

LOOK-BACK: IMPLEMENTATION RESULTS

THE ROLE OF WUE IN THE ROD

The CALFED Record of Decision (ROD) intended the Water Use Efficiency Program (WUE) to accelerate implementation of cost-effective actions to conserve and recycle water throughout the state. The ROD cited two primary reasons for giving near-term emphasis to WUE investments. The first was WUE's potential to "yield real water supply benefits to urban and agricultural users in the short term."[1] The second was WUE's ability to "generate significant benefits in water quality and timing of in-stream flows."[2] While the ROD was careful not to establish specific targets for WUE with respect to water supply benefits, it did identify the range of water savings that WUE could potentially achieve by the end of Stage 1.[3] These estimates were divided between urban water savings, agricultural water savings, and recycled water, as follows:

- 520–680,000 acre-feet in the Urban Sector
- 260–350,000 acre-feet in the Agricultural Sector
- 225–310,000 acre-feet in water reclamation projects

The ROD did not subdivide these estimates into water supply and in-stream flow potential, though it did note the "substantial contribution that water use efficiency investments can make to other CALFED program goals."[4] Moreover, the ROD called for the implementation of several WUE initiatives, such as agricultural quantifiable objectives and state/federal financial assistance programs, intended to generate both water supply and in-stream flow benefits statewide.

The ROD proposed an unprecedented level of state, federal, and local funding of WUE through Stage 1. The ROD estimated that achieving the water savings potentials cited above "would require an investment by State and Federal governments in the range of $1.5 to $2 billion over the seven years of Stage 1."[5] During the first four years of the program, the ROD proposed state and federal expenditures of $500 million, primarily for agricultural and urban conservation and recycling grants and loans, and an additional $500 million coming from local matching funds.[6] It labeled the proposed program scope and level of investment as "aggressive and unprecedented nationally."[7]

Agricultural WUE actions in the ROD are intended to address water supply, water quality, and in-stream flow and timing benefits. The ROD calls for the implementation of WUE initiatives to achieve these benefits. The ROD viewed WUE investments in the agricultural sector as a cost-effective way to better balance supply and demand in the near-term, especially compared to surface storage and major conveyance improvements that the ROD estimated would take at least 5–10 years to complete.[8] WUE was seen as a way to quickly address water demands that can meet ecosystem restoration, water supply reliability and water quality needs.

1. ROD, pg. 59.
2. Ibid.
3. The ROD estimates include only water that would have otherwise been lost to evaporation or an unusable sink, such as the ocean.
4. ROD, pg. 59.
5. ROD, pg. 63-64.
6. Ibid.
7. ROD, pg. 64.

BACKGROUND

In the past, agriculture used WUE to respond to water shortages brought on by drought or inability to get water where and when it is needed. Beginning in the 1970s, as water supply development decreased, there was a general trend away from surface irrigation to pressurized systems, particularly for orchard and vines. In addition, a number of agricultural water agencies updated their capabilities to provide greater water delivery flexibility to the farm. During this period, legislation for the California Agricultural Water Management Planning Act of 1986 (AB 1658) and the federal Reclamation Reform Act of 1982 was passed.

AB 1658 required all agricultural water suppliers delivering over 50,000 acre-feet of water per year to prepare an Information Report. The purpose of the Information Report was to identify whether the district had a significant opportunity to conserve water or reduce the quantity of saline or toxic drainage water through improved irrigation water management. Districts with a significant opportunity to conserve water or reduce drainage were required to prepare Water Management Plans. During the drought of the late 1980s and early 1990s, the state passed the Agricultural Efficient Water Management Act of 1990 (AB 3616). In 1996 the Agricultural Water Management Council (AWMC) was formed as an outgrowth of the AB 3616 legislation. The AWMC is a voluntary organization of water suppliers (and other interested parties) that agree to prepare a water management plan that addresses thirteen efficient water management practices (EWMPs).

In response to the Reclamation Reform Act of 1982, Reclamation's Mid-Pacific Region developed guidelines for preparing water conservation plans. All federal water contractors serving over 2,000 acres were required to submit the plans. The Central Valley Project Improvement Act of 1992 required the Mid-Pacific Region to revise its existing guidelines to include a set of best management practices.

In the early 1980s, the Department of Water Resources (DWR) started the California irrigation management information system (CIMIS) program in cooperation with UC Davis

8. ROD, pg. 59.

researchers. CIMIS was designed to assist local agencies and growers in irrigation scheduling and water use forecasting. The DWR also developed an irrigation water management assistance program to evaluate on-farm irrigation systems and make recommendations to improve their management, operation and maintenance.

Although previous efforts were effective in improving on-farm and district level water use, the 1994 CALFED accord provided an opportunity to utilize agricultural WUE to meet objectives with statewide impact. The CALFED WUE program element began in earnest in 1998, with the convening of an independent review panel on agricultural WUE. The panel's charge was to:

- Review, critique, and provide recommendations to strengthen the technical assumptions and approach of the agricultural section of CALFED's report on water use efficiency.
- Provide guidance on strategies for identifying Bay-Delta problems, structuring solutions, and quantifying potential benefits.
- Identify additional data collection and research needs.

Following this panel, the agricultural WUE staff worked with a diverse set of stakeholders to develop an implementation program, as described in the next section.

APPROACH TO IMPLEMENTATION

To implement the principles and objectives outlined in the ROD, the agricultural WUE program used a multi-disciplinary technical team of experts in water conservation, water quality, resource economics, irrigation engineering, and local water delivery operations to develop a strategy grounded in four essential principles:

- The Central Valley consists of numerous sub-regions, each with its own needs and local hydrologic distinctions.
- Locally based actions can help CALFED achieve multiple, statewide objectives related to water quality, quantity and in-stream flow and timing.
- Incentive-driven, locally tailored programs are effective because they tap into the experience and creativity of individuals most familiar with local conditions.
- A successful program requires a clear set of goals, a strategy for assessing progress and an open process for revising its approach to take account of new information.

Technical work resulting from this process was designed to translate CALFED goals into specific objectives that irrigated agriculture could potentially contribute toward. The output of this technical work was the targeted benefits and quantifiable objectives. Targeted benefits express the in-stream flow, water quality and water quantity need whereas the quantifiable objectives are considered a first order approximation of the targeted benefits that can potentially be met by making investments in cost-effective agricultural WUE actions at both the farm and water supplier level. A full explanation of the process and a description of the targeted benefits is available at: www.calwater.ca.gov/Archives/WaterUse Efficiency/WaterUseEfficiencyQuantifiableObjectives.shtml.

The program envisioned that the grants and technical assistance components would be implemented to achieve the quantifiable objectives, and that the program would be evaluated based largely on its effectiveness in achieving the objectives. An objectives-based approach measures success based on program outcomes, not by an accounting of how many projects are initiated or by how much money is provided for grants and technical assistance. Important features of an objectives-based program are:

- Program design, implementation, and evaluation are data and results driven.
- Beneficiaries and benefits are identified, and benefits are quantified when possible.
- Appropriate cost shares for grants and technical assistance programs are related to benefits in order to achieve statewide objectives at lowest cost to taxpayers.
- Assurances that benefits accrue to the state are provided through a rigorous and quantitative process to monitor results of particular projects and grants, and to evaluate the program's achievement of benefits and its cost-effectiveness.

The strategy of the agricultural WUE element is to encourage water users and water suppliers to implement EWMPs that are locally cost-effective; and to providing funding to foster implementation of practices that provide statewide benefits beyond what is achieved through locally cost-effective practices. Although efficiency measures are implemented locally and regionally, the benefits accrue at local, regional, and statewide levels. The Program was designed to:

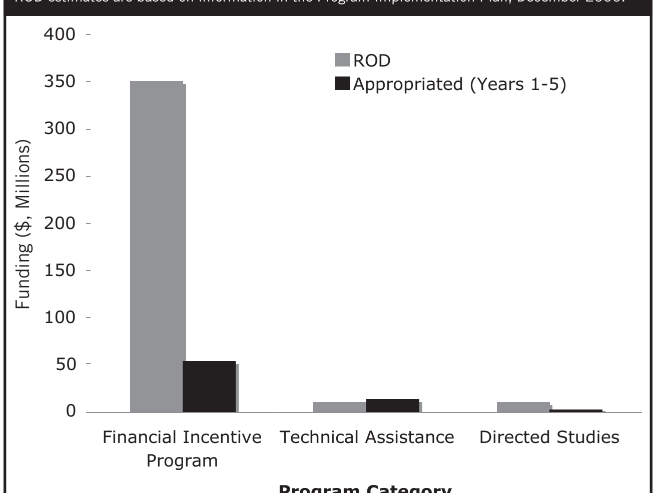
- Build on existing water management programs
- Achieve multiple benefits, including water quality improvement, water supply reliability, and ecosystem restoration
- Reduce existing irrecoverable flows
- Preserve local flexibility
- Use incentive-based actions over regulatory actions
- Provide assurance of high water use efficiency

Significant findings from the review process include:

- Comprehensive data on local water conservation actions is not available for analysis; therefore the extent of local WUE efforts are not known.
- Grant funded project performance information is not available; this prevents an analysis of the benefits derived from each project.
- Project-level baseline data is not available to analyze project contributions toward targeted benefits and quantifiable objectives. Furthermore, program-wide baseline data is not available and therefore an understanding of progress toward meeting in-stream flows, water quality and water supply reliability objectives is not possible.
- A lack of economic data prevents the establishment of cost information for project development and review. In addition, the extent of implementation of locally cost-effective implementation is not known.
- Findings from research activities are not available to improve the assumptions used for adaptive management of the program.
- Lack of a coordinated funding mechanism or a program for on-farm improvements prevents progress in areas that consume the majority of developed water in the state.
- There is no coordination of statewide, non-Category A funding activity for agricultural WUE efforts within the CALFED solution area.
- A lack of performance measures prevents an assessment of progress achieved through technical assistance.
- No formalized oversight is used to track the ROD, Program Implementation Plan or Assurances.
- Funding for the program activities compared with the ROD estimates is shown in Figure 2.1.

FIGURE 2.1 COMPARISON OF ROD AND ACTUAL FUNDING FOR YEARS 1–5 OF THE AGRICULTURAL WUE PROGRAM

ROD estimates are based on information in the Program Implementation Plan, December 2000.



AGRICULTURAL WUE INCENTIVE PROGRAM

The ROD proposes a two-pronged approach for agricultural WUE potential for Stage 1.[9] The first is the implementation of locally cost-effective actions by water suppliers. This base level of implementation is supported by CALFED through low-interest loan programs and technical assistance. The second prong is the use of grants to leverage further local investment in agricultural WUE. These grants are to go towards measures that, while not locally cost-effective from the perspective of an individual water supply agency, provide statewide water supply, water quality, and ecosystem restoration benefits. The idea stated in the ROD was that "some water use efficiency measures may not be cost-efficient when viewed solely from a local perspective, but may be cost-effective when viewed from a statewide perspective, compared to other water supply reliability options." In this case, CALFED Agencies anticipate a larger State and Federal assistance share in the form of grants."[10]

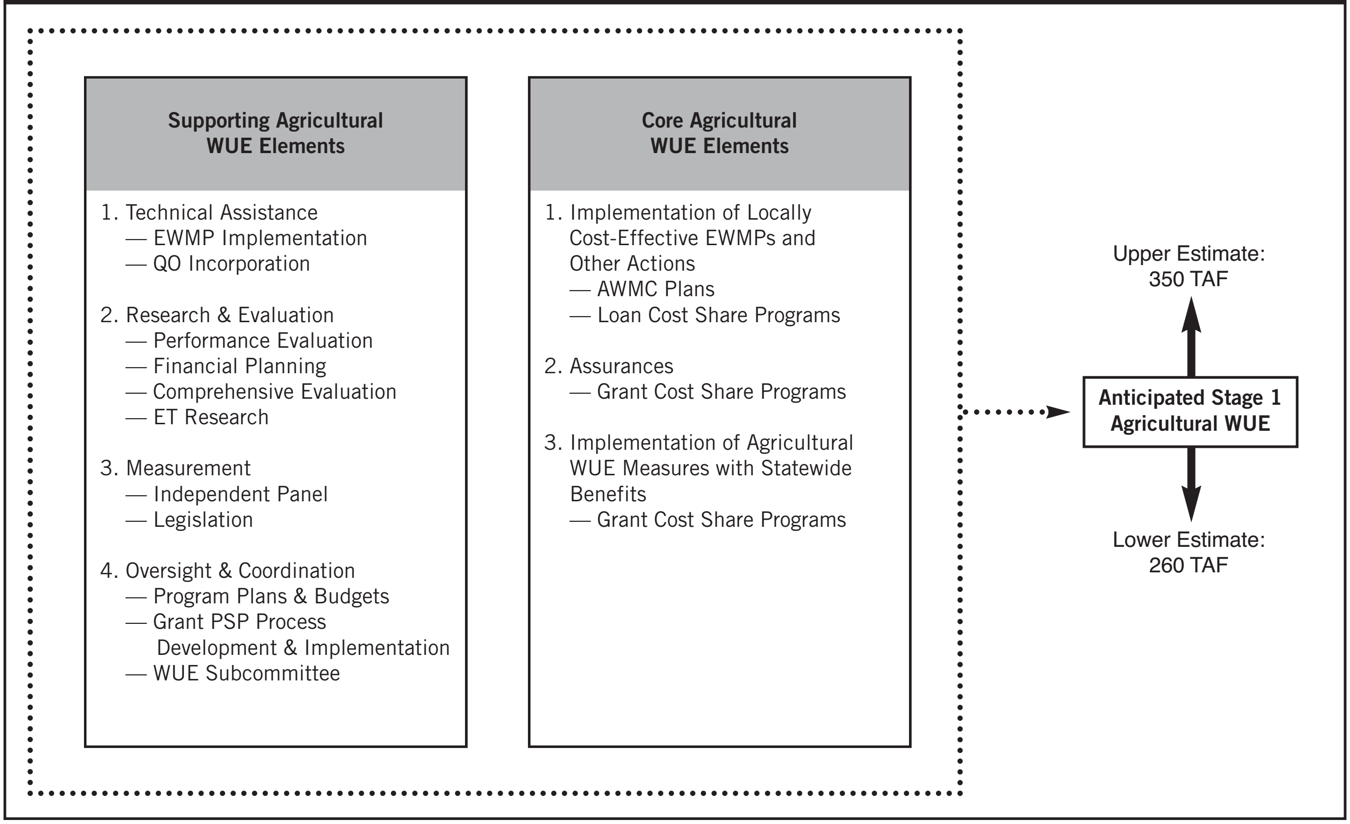
In addition to the two core agricultural WUE program elements—implementation of locally cost-effective practices supported with loan and AWMC participation and implementation of supplemental agricultural WUE measures providing statewide net benefits supported with a grant process—the ROD identified several supporting program components. These included: technical assistance to local water suppliers, research and evaluation of agricultural WUE programs, better definition of appropriate measurement of agricultural water use, the development of assurances, and oversight and coordination of CALFED Agencies responsible for implementing agricultural WUE.

Technical Assistance—The ROD called on DWR and the US Bureau of Reclamation (USBR) to work with the AWMC to help agricultural districts comply with the AB 3616 process. It included a similar requirement to work with the California Urban Water Conservation Council (CUWCC) to provide technical assistance to urban agencies developing management plans under the Urban Water Management Planning Act (UWMPA). CALFED Agencies were to provide $34 million in technical assistance over the first four years of Stage 1 to support these efforts.[11] Although the Program Implementation Plan identified a level of funding for technical assistance, the ROD did not provide guidance on how to allocate the funding between urban and agricultural assistance, nor did it propose how to allocate the funding between CALFED Agencies and the two water management councils (i.e., CUWCC and AWMC).

Research and Evaluation—The ROD specified that agricultural WUE direct research and applied studies to evapotranspi-

9. ROD, pg. 60.
10. Ibid.
11. Ibid. Funding of this effort was to come from NRCS and CDFA in addition to DWR and USBR.

FIGURE 2.2 AGRICULTURAL WUE PROGRAM STRUCTURE AS DESCRIBED IN THE ROD



ration (ET) and water use measurement. In addition, the CALFED Agencies were to develop WUE evaluation procedures as part of a program implementation plan that was due by December 2000.[12] Also, it required CALFED Agencies to develop a detailed finance proposal for WUE through Stage 1.[13] Meeting this requirement would involve completing tasks that could be categorized as both research and evaluation and oversight and coordination. Finally, the ROD called on CALFED Agencies to conduct a Comprehensive Evaluation of WUE's first four years of implementation.[14] This too can be viewed as a research and evaluation task for the program.

Appropriate Measurement of Water Uses—The ROD recognized the critical role of water measurement in WUE. It is not be possible to credibly measure WUE performance without reliable and timely data on urban and agricultural water uses. For this reason, the ROD required CALFED Agencies are to convene an independent panel on appropriate measurement of water use and, working with the California State Legislature, to use the panel's recommendations to "develop legislation for introduction and enactment in the 2003 legislative session requiring the appropriate measurement of all water uses in the State of California."[15] While much of the panel's focus was on measurement of agricultural water use, it also was to address measurement of urban water uses.

Oversight and Coordination—Oversight and coordination functions for agricultural WUE revolve around designing and implementing processes for loan and grant programs, coordinating technical assistance efforts between CALFED Agencies, the AWMC, the CUWCC and developing program priorities, plans, and budgets. Most of this work was guided in part by input from the WUE Subcommittee. Per the ROD, the Department of the Interior was to establish this committee as part of the Federal Advisory Committee Act (FACA)-a chartered public advisory committee overseeing all of CALFED. The role of the WUE subcommittee is to "advise State and Federal agencies on structure and implementation of assistance programs, and to coordinate Federal, State, regional and local efforts for maximum effectiveness."[16]

All of these related efforts were intended to help the State achieve the Stage 1 agricultural WUE potential put forward by the ROD and discussed in the previous section. Figure 2.2 summarizes the structure of the agricultural WUE program envisioned by the ROD.

12. ROD, pg. 61.
13. ROD, pg. 62.
14. Ibid.
15. ROD, pg. 63.
16. ROD, pg. 62.

LOOK-BACK: STAGE 1 RESULTS

AGRICULTURAL WUE

Local agricultural water suppliers have implemented WUE measures to stretch existing supplies and to expand service. Although there is limited quantification of the efficiency improvements, there is general agreement that over time this has resulted in an overall improvement in both district and on-farm efficiencies.

Implementation of locally cost-effective EWMPs and on-farm practices were to provide a base level of funding for WUE, and the CALFED financial assistance programs would add to this base. Thus, the analysis of the first four years of the agricultural WUE program is divided into two parts: (1) savings realized through local implementation of cost-effective EWMPs and on-farm actions; and (2) savings realized through CALFED financial assistance programs. This section uses available data to evaluate WUE for both categories.

The CALFED ROD estimated that Stage 1 benefits from an aggressive implementation of agricultural WUE would range between 260,000 to 350,000 acre-feet of reduction in irrecoverable flows, recoverable flows as well as water quality improvements. These estimates, while not targets, are nonetheless important to the relevance of the WUE Program element as part of CALFED's overall Stage 1 water management strategy. An independent audit of local agency water conservation plans by the AWMC found that most participants were in compliance with the intended language of the respective requirements. However, there is no comprehensive reporting of water conservation benefits available from water management plans and therefore the extent of non-CALFED funded WUE is not known. There are no centralized data repositories to assess progress at the farm level.

CALFED INCENTIVE PROGRAM WATER SAVINGS

All CALFED incentive program results are based on grants awarded through a competitive process.[17] When calculating benefits, it is noted that there is a (sometimes significant) time lapse between when grants are awarded and when projects are completed and start producing water savings. This analysis assumes that the applicant-claimed expected benefits begin at the conclusion of the contract period. The quantity and duration of those benefits is taken from applicants' estimates. Although the expected benefits from the 2004 Proposition 50 Proposal Solicitation Package (PSP) will not be realized for several years, they are still included in this analysis.

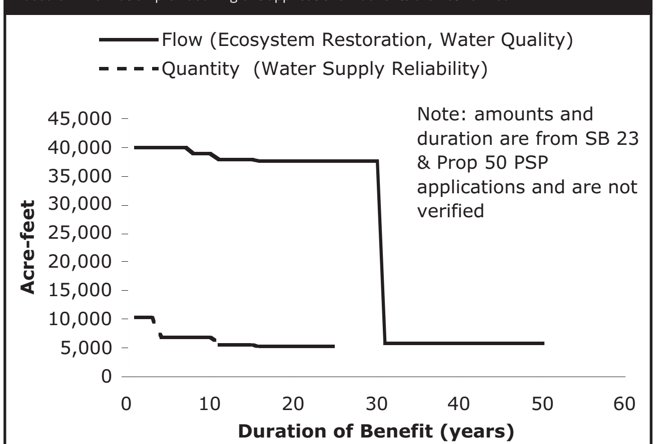
Figure 2.3 shows the expected benefits for either water supply reliability (quantity) or ecosystem restoration (flow and quality) at project start-up along with the projected duration of those benefits. These benefits are based on estimates provided by grant applicants and have not been evaluated or verified.

The flow benefits curve represents changes in how recoverable flows are routed, primarily by reducing diversions or spills. The objective of in-stream flow change is to leave more flow in the river for aquatic habitat improvement. Applicants claimed almost 40,000 acre-feet of recoverable flows directed toward in-stream needs with a duration of 7–50 years. Monthly flow regimes and location-specific flow data are necessary to analyze the applicants' reported benefits to the targeted benefits and quantifiable objectives. For example, on the Stanislaus River there is a quantifiable objective of 83,000 acre-feet for an average year type with a monthly breakdown that ranges from 0–24,000 acre-feet. However, PSP applications and post-project submittals do not contain this type of hydrologic data, thus preventing any further analysis at this time. It is anticipated that DWR will monitor projects funded with Proposition 50 and update the anticipated benefits.

Water quality benefits reported by applicants include reduction in river temperatures due to increased in-stream flows, reduced salinity due to reduced discharge of saline water, and a reduction in sediment loads of return flow water. However, there are no quantified water quality benefits to report. Appendix A contains a list of all targeted benefits and their status.

The quantity benefits accrue to water supply reliability and include both recoverable and irrecoverable losses. For the SB 23 and Proposition 50 WUE projects, applicants claimed 10,380 acre-feet of annual benefits with durations of 3–25 years. About 50% (5,573 acre-feet) of the applicant-claimed quantity benefit is a reduction in irrecoverable losses from reduced on-farm percolation to saline sinks and from canal

FIGURE 2.3 RECOVERABLE AND IRRECOVERABLE WUE CHANGES
Based on information provided in grant applications—benefits are not verified.



17. A loan program (Proposition 13, 1999, $35 million in program funds, $31.7 million available) is available to implement locally cost-effective WUE measures; however, there were no applicants for the funds.

lining in areas with a perched saline water table. The remaining volume (4,867 acre-feet) is due to diversion reductions and is considered recoverable flow. An example water supply reliability project is the SB 23-funded Placer County Water Agency grant. They received funding for canal lining and system automation. Through these actions, the district increases its water supply reliability by stretching their existing surface water entitlements. The benefit to the Bay-Delta is the delay in increased diversions means more water is available for in-stream flows. In addition to grants that were specific for targeted benefits, several grants provided supported the overall targeted benefit approach. In particular, SB 23 funding to the Irrigation Training and Research Center at Cal Poly San Luis Obispo was used to help local water agencies address targeted benefits in their water management plans and when pursuing funding opportunities.

COMPARISON TO ROD ESTIMATES

Expected agricultural sector water savings by the end of Stage 1 are likely to fall extremely short of the estimated potential. Figure 2.4 shows a comparison of the current estimates of agricultural WUE by the end of Stage 1 to ROD estimates. The applicant-claimed benefit in Figure 2.4 is discussed in detail in the following section of this document and reflects the benefits based on the currently available funding and the current approach to implementation. Expected savings during Stage 1 are based on the following assumptions:

- All water savings claims are based on applicants' estimates and are not verified.
- Expected benefits include estimates for the 2005 Proposition 50 awards that have not yet begun.
- There is an additional amount of savings based on on-going water supplier activity; however, there is no comprehensive reporting or analysis of this component to base an estimate on.

The applicant-claimed estimate is based on applicants' reported benefits and these are expected to decay over time (Figure 2.4). In addition, the in-stream benefit reported for the look-back may not appear at the time and location of need identified in the quantifiable objectives. Further analysis of this issue is not possible at this time as applicants only report the annual benefit and not monthly or year-type information.

Under these assumptions, expected water supply reliability benefits are 10,380 acre-feet and in-stream flow changes are 39,871 acre-feet (Figure 2.4). In addition, there are non-quantifiable water quality benefits for salinity and temperature. The benefits shown in Figure 2.4 are based on the expected benefit at start up. The duration of benefits is between 3 and 50 years.

FIGURE 2.4 COMPARISON OF ROD ESTIMATES FOR AGRICULTURAL WUE THROUGH STAGE 1 AND APPLICANT-CLAIMED BENEFIT FROM SB23 & PROPOSITION 50 FUNDING

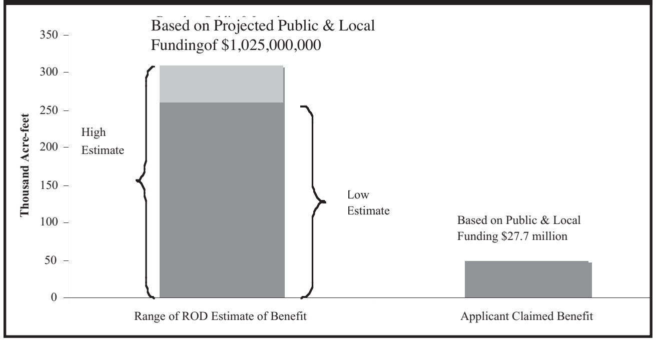
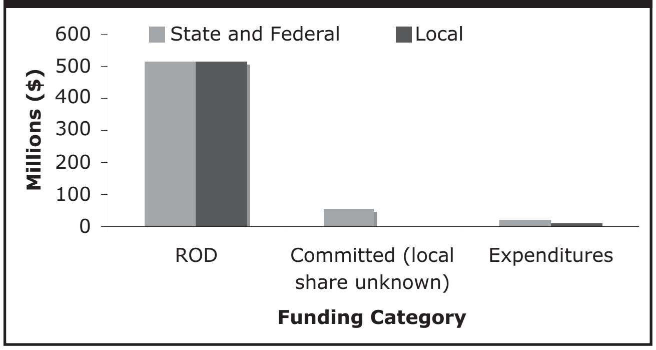


FIGURE 2.5 ROD STAGE 1 FUNDING ESTIMATES, COMMITTED FUNDING AND EXPENDITURES TO DATE



The ROD estimates were based on two key assumptions. One was that technical assistance to the AWMC would promote the implementation of locally cost-effective EWMPs. The other was that CALFED implementing agencies would provide $513 million in financial incentives for local WUE implementation through Stage 1, in addition to a local match of $513 million. During the first four years of the program it was anticipated that $175 million in grant funding would be available through State or Federal programs for agricultural WUE. As of year 4, $18.2 million of CALFED directed state and federal funding with a local match of $9.5 million was directed towards agricultural WUE.[18] Stage 1 agricultural WUE funding (including Proposition 50) is now expected to be about 10% of the initially projected amount.[19]

The main reason for the shortfall in program performance is that the ROD funding levels failed to materialize and as a consequence so did the water savings. In addition, there is no indicator that can directly quantify the effectiveness of technical assistance. The ROD stated that the savings estimates were not targets. Given the reduced funding level, applicant claims of benefits are well ahead of what the ROD

18. WUE Preliminary Program Plan, Appendix A.
19. Through 2004/05, grants for agricultural WUE totalled $17.8 million. Assuming that grants for 2005/06 and 2006/07 total another $35.8 million, total Stage 1 grant funding for agricultural WUE will be $53.6 million or just over 10% of the ROD estimate, as Figure 2.5 shows.

TABLE 2.1 SUMMARY OF AGRICULTURAL WUE GRANTS RECEIVED AND FUNDED

Grant Program	# Applications Received	Available Funding (in millions)	Requested Funding (in millions)	Local Match (in millions)	# Grants Awarded	State Share (in millions)	Local Share (in millions)
SB 23	43	$5.8	$15.7	$39.9	23	$5.8	$.4.3
Proposition 13[1]	26	$1.2	$2.6	NA	13	$1.2	NA
Proposition 50[2]	62	$17.0	$48.0	NA	27	$11.2[3]	$5.2
Total	**131**	**$24.0**	**$66.3**	**$39.9**	**63**	**$18.2**	**$9.5**

1. Proposition 13 provided funding for feasibility studies only.
2. Amador Water Agency was awarded a $500,000 grant through the Agricultural WUE program; however, agency is urban—see urban analysis for details.
Total awarded was $11.74 million; however, $500,000 was for a grant to the Amador Water Agency grant that is included in the urban look-back.

estimates is achievable for a given level of funding.

Other potential barriers include the newness of the program and the uncertainty of how to incorporate targeted benefits into local agency water management plans and grant applications. The development of specific statewide objectives for local agencies to pursue broadens their traditional effort of reducing irrecoverable flows. This new approach, coupled with new terminology, creates uncertainty about how to design and implement the CALFED agricultural water use efficiency approach. In addition, with all of the competing funding programs there were, in some instances there was little time or interest to develop grant applications.

AGRICULTURAL FINANCIAL ASSISTANCE PROGRAM PERFORMANCE

The WUE Preliminary Implementation Plan budgeted $513 million for state and federal financial assistance programs in addition to a $513 million local share for agricultural WUE implementation through Stage 1. The financial assistance programs included low-interest loan programs for locally cost-effective conservation measures and grant programs for measures that were not locally cost-effective but provide statewide benefits. Although the WUE program developed a low interest rate loan program for agricultural WUE, no applications for the funding were received.

SUMMARY OF AGRICULTURAL GRANT FUNDING

Approximately $23.6 million was available during three grant funding cycles for agricultural WUE efforts between 2000 and 2005 (see Table 2.1). Funding was available to pursue targeted benefits and quantifiable objectives, general WUE support, research, evaluation and feasibility studies. Although applications were submitted for monitoring and evaluation of past and current WUE projects, none were funded. Combined grant funding under SB 23, Proposition 13 and Proposition 50 awarded $18.2 million, with a local match of $9.5 million during this time. While the SB 23 funding was available to any individual or agency, Propositions 13 and 50 is only available to local water supply agencies, universities and non-profit organizations. The effect of limiting funding is that individual landowners cannot compete for grant funding. In addition, there are a limited number of local agencies with programs directed toward on-farm improvements.

Table 2.1 gives the total number of grants funded along with the state and local share for agricultural WUE projects. The majority of the projects were implemented in the CALFED solution area. A few were funded outside the solution area but the results are expected to be transferable to the CALFED objectives. It should be noted that the Proposition 50 funding was awarded in June 2005 with contracting currently underway. It will take several years for the benefits of these funds to materialize.

A primary objective of the agricultural WUE element is the pursuit of quantifiable objectives. Therefore grants were separated into three main categories—those that pursue quantifiable objectives, research and evaluation and those that provide general WUE support (Table 2.2).

A breakdown of the categories of quantifiable objectives

TABLE 2.2 SUMMARY OF GRANT FUNDING BY SOURCE OF FUNDING AND TYPE OF PROJECT

Funding Objective	State & Federal	Local	Total
Loans	$0	$0	$0
Grants (Targeted Benefits: SB23)	$5,225,654	$3,796,040	$9,021,694
Grants (Targeted Benefits: Prop 13)	$913,836	$0	$913,836
Grants (Targeted Benefits: Prop 50)	$7,570,682	$3,690,700	$11,261,382
SUBTOTAL	$13,710,172	$7,486,740	$21,196,912
Grants (general WUE support)	$2,127,336	$942,065	$3,069,401
Grants (Research and Evaluation)	$2,354,466	$862,005	$3,216,471
TOTAL GRANTS	**$18,191,974**	**$9,290,810**	**$27,482,784**

TABLE 2.3 SUMMARY OF EXPECTED BENEFITS BASED ON AGRICULTURAL WUE GRANT FUNDING
Expected benefits are based on information provided in grant applications

Benefit Category Funded Through Grants	Targeted Benefits Addressed	Expected Benefit at Start-Up (acre-feet per year)	State	Local	Total
Flow	13	39,871	$8,484,059	$4,518,475	$13,002,534
Quantity	24	10,380	$4,511,777	$2,935,265	$7,447,042
Subtotal	37	50,251	$12,995,836	$7,453,740	$20,449,576
Quality	18	Varies depending on constituent	$400,500	$33,000	$433,500
Total	**55**	——	**$13,396,336**	**$7,486,740**	**$20,883,076**

FIGURE 2.6 ANNUAL COST OF IN-STREAM FLOW, TIMING AND WATER TEMPERATURE BENEFITS ACHIEVED THROUGH WUE GRANT FUNDING

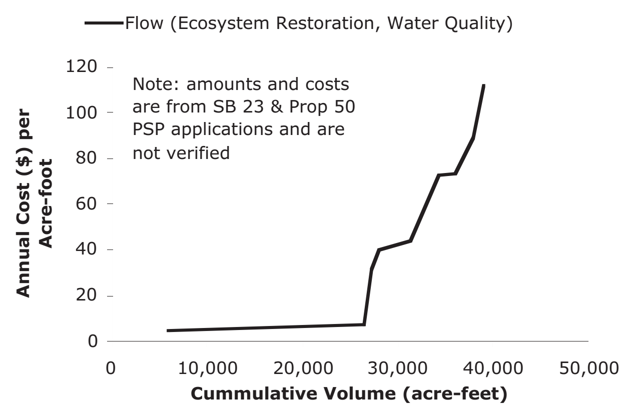
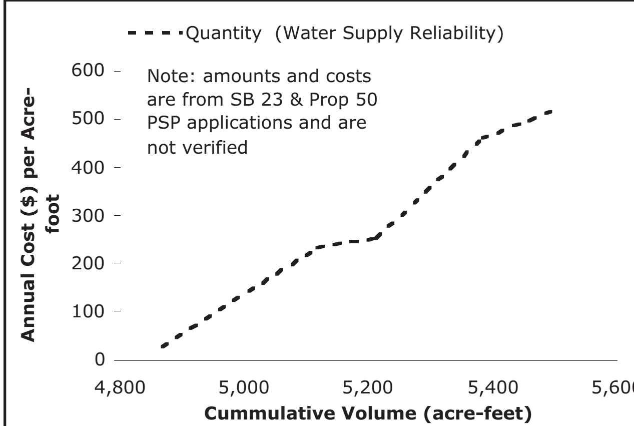


FIGURE 2.7 ANNUAL COST OF WATER QUANTITY BENEFITS ACHIEVED THROUGH WUE GRANT FUNDING



associated with grants is provided in Table 2.3. Reported benefits are based on what applicants state on their grant application, and are expressed in three categories: in-stream flow and timing, water quality, and water quantity. The number of targeted benefits addressed includes both implementation and feasibility projects; the expected benefits at start-up are estimated only for implementation projects. Approximately 75% of all grant funds were allocated to projects that claimed an effort toward quantifiable objectives. A total of $2.027 million for 11 grant funded projects was used for technical assistance to local agencies, feasibility studies and mobile labs. Due to a lack of verification, there are no quantified results to report for this funding at this time. A complete listing of the targeted benefits, funding activity, and expected benefits is given in Appendix 1A.

GRANT-FUNDED AGRICULTURAL WUE COSTS

The grant funding component of the WUE program is designated for the non-locally cost-effective portion of projects. Estimation of the cost of agricultural WUE projects is required for program development, adaptive management and project tracking. Knowledge of project cost information allows more efficient use of public money when pursuing statewide benefits. Local project cost and monetary benefit information was required in grant applications for SB23 and Proposition 50 implementation funding. Applicants were required to discuss and if possible quantify local and statewide non-monetary benefits. In addition, applicants were asked to describe how the cost share (based on the relative balance between Bay-Delta and local benefits) is derived. Not all grant applicants, particularly non-implementation projects, were able to provide cost and benefit information. When applicants were able to provide this information, it was used by reviewers when analyzing grant applications.

Unit cost of in-stream flow and water supply reliability funded projects are shown in Figures 2.6 and 2.7. These estimates are based on the 13 out of 60 funded projects that provided sufficient cost data. Cost information available for eight projects that provide in-stream flow benefits ranged from $4.99–$203 per acre-foot (Figure 2.6). For the five projects that provided sufficient cost information for water quantity benefits, the costs ranged from $28 per acre-foot for a recoverable flow project to $515 per acre-foot for a project that reduced irrecoverable flows (Figure 2.7). Of the flow represented by the quantity line in Figure 2.6, 4,867 acre-feet were provided by a single water supply reliability project that pursued recoverable flows, at an annual cost of $28 per acre-foot. The remaining water quantity projects pursued irrecoverable losses at a cost that ranged from $230–$515 per acre-foot.

OTHER FUNDING THAT SUPPORTS CALFED OBJECTIVES

Other state and federal programs provided funding for agricultural WUE that aligned with the CALFED objectives. Table 2.4 summarizes the spending on these programs during the first four years of CALFED WUE. It is noted that these funds are Category B[20], and as such they are not consistently reported as funding for the CALFED Program. In most cases, the scope of these programs is not limited to the CALFED objectives in the solution area. Therefore, an initial review was required to eliminate projects that were outside of the solution area or that did not meet one of the CALFED objectives.

Three criteria were used to determine if funding was related to the CALFED objectives and solution area: where the funded action was taken; the benefit of the funded action; and whether the funded action was applied to irrigated agriculture. For example, the State Water Resources Control Board (SWRCB)'s Proposition 50 grants were made available statewide to implement actions that reduce water quality impacts resulting from irrigated agriculture. The total awarded by the SWRCB was $46.1 million, of which $12.52 was aligned with CALFED objectives within the solution area. DWR's drainage program awarded about $5.7 million. All of the drainage program objectives are reflected in the targeted benefits thus meeting the CALFED objectives.

In the annual program plan developed by CALFED, the Natural Resources Conservation Service (NRCS) estimated that about $5 million annually of funding from its Environmental Quality Incentive Program (EQIP) meets the CALFED objectives. A detailed analysis of practices funded by the NRCS in 2002 indicated that about 40% of the $16 million EQIP budget meets the objectives of CALFED. The same 40% multiplier was used for all other years (2000, 2001, 2003, 2004 and 2005) to generate the $59 million given in Table 2.4. Discussion about the NRCS EQIP program breakdown for 2002 is given in Appendix 1B3. Although the outcomes of these programs directly contribute to the CALFED goals, there is no monitoring or program implementation mechanism that connects the efforts.

AGRICULTURAL MILESTONES AND ASSURANCES

No quantifiable targets were established in the ROD for the WUE element. In place of targets, the ROD included a commitment to establish milestones that track and guide program implementation. In addition, the ROD calls on CALFED to undertake annual evaluations to assess the effectiveness of its WUE Element and guide subsequent investments and program refinements. Specifically, the Record of Decision includes the following commitment: "Within one year from the adoption of this ROD, CALFED Agencies will establish specific milestones, and associated benefits, remedies and consequences to track and guide the implementation of the agricultural WUE program." The assurances document was completed and approved by the California Bay-Delta Authority in 2002. The complete document is available at www.calwater.ca.gov.

Maintaining a focus on the assurances is an oversight function. Although baseline and project level information was not available to quantifiably respond to progress, there is sufficient information to discuss program activity toward targeted benefits and quantifiable objectives. Agricultural WUE assurances contain three types of milestones: administration, implementation and results. The single administrative milestone is to enroll 4.65 million acres of irrigated lands into the AWMC by the end of Stage 1. This is a key milestone since the AWMC work is viewed as facilitating planning that leads to locally cost-effective WUE actions. As of year four in the agreement, 5.5 million acres of agricultural land is represented in the AWMC.

The implementation and results milestones are summarized in Table 2.5. The data used to develop the information is taken from grant applications and is not verified. For in-stream flow, 23% of the quantifiable objectives representing approximately 3% of the average flow volume needed is addressed. These are in the Sacramento Valley and the tributaries of the San Joaquin. Because applicants only provided annual flow data, monthly comparison by year type is not possible. For water quantity, 21% of the quantifiable objectives representing approximately 3% of the average volume are addressed. There

TABLE 2.4 OTHER GRANT FUNDING THAT ADDRESSES CALFED OBJECTIVES (Dollars spent during 2001–2004)

Category B Funding	State	Local	Total
Grants (SWRCB, Proposition 50 Ag Water Quality)[1]	$12,520,350	Not Available	?
Water 2025 (Reclamation)[2]	$1,694,935	$3,562,229	$5,257,164
Grants (DWR, Drainage Program Proposition 204)	$5,700,000	Not Available	?
Technical Assistance (NRCS, EQIP)[3]	$59,072,813	$163,977,125	$223,049,938
TOTAL	**$78,988,098**	**$167,539,354**	**$240,827,452**

1. Total grant funding available for this program was $46.4 million.
2. This program covers 19 western states. Of this, $2.44 million was spent in California for both urban and agricultural suppliers in 2004 and 2005.
3. NRCS requires a 75% local share for all EQIP outlays.

20. Category B are projects and activities that are related to CALFED objectives that are tracked by the Authority staff. Category A are projects and activities that directly contribute to CALFED objectives, go through the CALFED process, and are reported through the Cross-Cut budget. See Implementation MOU for further detail: www.calwater.ca.gov/CALFEDDocuments/adobe_pdf/Amended_and_Restated_MOU_9-03.pdf

TABLE 2.5 SUMMARY OF AGRICULTURAL MILESTONES – TARGETS AND STATUS

Milestone	Year	Target Threshold	Status
AWMC Enrollment	4	Enroll 4.65 million acres	5.5 million acres enrolled
Grant Program Participation	2	100% of grant funds allocated	75% of available grant funding allocated to targeted benefits as of year 5 with three grant funding rounds, 13% of all quantifiable objectives are being addressed
	4	35% of quantifiable objectives in each region are being pursued	
Grant Program Projected Effects	2	5% of cumulative flow and 2% of cumulative quantity and quality quantifiable objectives	As of year 5 applicants claim 3% of flow and 3% of quantity and 0% of quality quantifiable objectives are being pursued
	4	50% of cumulative flow and 20% of cumulative quantity and quality quantifiable objectives	
Grant Program Realized Affects	2	2% of cumulative flow and 1% of cumulative quantity and quality quantifiable objectives	No information available to address this
	4	20% of cumulative flow and 10% of cumulative quantity and quality quantifiable objectives	

TABLE 2.6 AGRICULTURAL WUE TECHNICAL ASSISTANCE FUNDING BY AGENCY (2000–2005)

Agency	Activity	Status	Public Funding	Local Match
DWR	AWMC	See detail in narrative	$600,000	$0
USBR	AWNC	See detail in narrative	$600,000	$0
USBR	NRCS	Farm level implementation strategy for the CALFED WUE program	$25,000	$0
USBR	CV Contractors	Water Conservation Field Services Program (see detail in narrative)	$2,846,756	$2,846,756
		SUBTOTAL	$4,071,756	$2,846,756
DWR	Statewide WUE	See detail in narrative	$6,807,000	$0
USBR	CVPIA	General water conservation support	Not Reported	Not Reported
NRCS	Statewide WUE	Conservation support	Not Reported	Not Reported
		SUBTOTAL	$6,807,000	$0
		TOTAL	**$10,878,756**	**$2,846,756**

are 18 water quality targeted benefits addressed; however, none of them are quantified. There is no information to indicate if the grant program effects have been realized.

IMPLEMENTATION OF SUPPORTING WUE ELEMENTS

TECHNICAL ASSISTANCE

Total funding for agricultural technical assistance was $13.7 million for DWR, the USBR and the NRCS (Table 2.6). Funds were used to support the AWMC, CIMIS, other DWR Office of Water Use Efficiency activities and for Reclamation's water conservation field services program. At the state and federal levels, funding for technical assistance is through ongoing programs and specific bond funds. DWR funds technical assistance through Proposition 50, the Energy Resources Program Account, and general fund. Reclamation funds technical assistance through its water conservation field services program under the Central Valley Project Improvement Act (CVPIA). In addition to these, a limited number of grants were awarded to agencies that provide technical assistance to local agencies. In particular, Cal Poly San Luis Obispo received grant funds to assist agricultural water suppliers with pursuing quantifiable objectives.

DWR and Reclamation each provided $600,000 for a total of $1.2 million to the AWMC to implement the 2001 Cooperative Agreement (discussed below). This funding is used by the AWMC to support implementation of the CALFED WUE program. Specifically, the council works to increase water supplier awareness and understanding of the targeted benefits and quantifiable objectives. Reclamation's water conservation field services program provided approximately $2.85 million to Central Valley Project contractors for planning, education, demonstration, and implementation. Reclamation requires a 50% cost share resulting in $5.7 million in overall activity. DWR maintains staff to manage statewide agricultural and water use efficiency efforts and to support grant funded activities. Table 2.6 summarizes technical assistance by implementing agency. Although the NRCS and the USBR provide technical assistance they do not report the expenditure as a Category A item.

AWMC ASSISTANCE

In December 2001 the AWMC entered into a contract (Cooperative Agreement) with the USBR and DWR to participate in, monitor, and evaluate the implementation of the EWMPs by agricultural water suppliers. The tasks undertaken by the AWMC under the terms of the agreement assist the USBR, DWR, and the other agencies participating in the CALFED Bay-Delta Program in developing a program of technical and financial incentives for water use efficiency in the agricultural sector. The Cooperative Agreement extends through December 2006. The DWR and the USBR each provided $600,000 to the AWMC. The objective of this agreement is to achieve:

- Broader participation in the Council, including the preparation of comprehensive and consistent Water Management Plans.
- Timely implementation of locally cost-effective EWMPs.
- Increased credibility of the Council's Water Management Plan process in affected communities.
- Refinement of and support for implementation of CALFED's Water Use Efficiency Program.

Appendix 1C lists the agreement tasks, a description of the tasks and the outcome of each task.

The Stage 1 finance plan estimated that agricultural WUE needed $10.4 million during the first four years. Based on the analysis, almost $11 million was spent on agricultural technical assistance with approximately $6.8 million going for DWR staff, $2.85 for CVPIA support and $1.2 million for AWMC support.

DEFINITION OF APPROPRIATE MEASUREMENT

The definition was completed by the Independent Review Panel on Appropriate Measurement in Sept 2003 and adopted by the Bay-Delta Authority in April 2004. Through the following location-specific definitions, the Panel presented an approach for the State to improve estimates of major water balance components:

Surface Water Diversions—Measure all major surface water diversions at the "highest technically practical" level (i.e., use flow-totaling devices, data loggers and telemetry). Manage data locally and report it to the State. Impact to water users is expected to be minimal since more than 80% of major surface water diversions are already using such devices.

Groundwater Use—Measure groundwater use at the "high" level (continuously compute regional groundwater use by detailed sub-basin hydrologic water balances and a water table fluctuation method). The expected impacts to water users are likely to be minimal and mean additional state planning costs of roughly $2 million per year.

Crop Water Consumption—Measure crop consumption at the "high" level (i.e., use of satellite-generated remote-sensing of evaporative water consumption). House data in a state repository. This would have no direct impact on water users but represents a minimum of $500,000 additional annual cost to state or federal water agencies.

Farm-gate Deliveries—Collect and report to the State aggregate farm-gate delivery data, whether currently estimated or directly measured. Current farm-gate measurement approaches are considered appropriate and no changes are deemed necessary at this time. These methods are sufficient to support the stated objectives including water transfers and water use efficiency. Even the "basic" level of farm-gate measurement is typically accurate to within plus or minus 15% by volume and can support incentive water pricing. This does not preclude state and federal entities from linking approval of grant-funding applications or water contracts to higher levels of measurement. This definition does not represent an upgrade of farm-gate hardware or methods, but does imply an increased water supplier data collection and reporting costs equivalent to a half- to full-time staff position.

In addition, the Panel considered developing definitions of appropriate measurement for return flows, water quality, and in-stream flows. However, lack of information regarding the location, distribution and type of existing measurement makes this impossible at this time. Instead, the Panel recommends that the State undertake a Comprehensive Evaluation to determine existing measurement needs focusing on location-specific information requirements. Wherever possible, the analysis should build on existing data sets. The full text of the definition is available online at www.calwater.ca.gov.

WATER MEASUREMENT IMPLEMENTATION

Following the definition of appropriate measurement, an implementation approach was developed by the staff of CALFED agencies (CBDA, DWR, SWRCB and USBR) and key stakeholders. There were two aspects of the approach - items requiring legislation and activities that require administrative changes. Measurement items requiring legislation include:

Reporting of Aggregate Farm-gate Delivery Data—This would require agricultural water suppliers above a certain size threshold to report aggregate farm-gate delivery data. This would impact all affected water suppliers, as this is a new requirement.

Measurement and Reporting of Surface Water Diversions—This would require surface water diverters with diversion capacities above a certain threshold to measure diversions using the best available technologies and report the data annually to the State.

Development of Database and Reporting Standards—This would involve the development and maintenance of a coordinated water use database and associated data collection and reporting standards and protocols. This system would eliminate redundant and inconsistent requirements.

A legislative package (SB 866) was introduced in February 2005 by Senator Kehoe and sent to the Natural Resources and Water Committee in March 2005. No hearings have been held on the bill. The last activity on this bill was April 20, 2005. The legislative package includes important caveats to exempt smaller water suppliers, limit the impact to diverters in the tidal zone and ensure periodic "look-backs" to ensure the efficacy of these actions. It also recommends linking compliance to access to grants and loans. The actions called for in this legislation are intended to maximize value to the state while minimizing cost.

Proposed administrative actions that support the definition of appropriate measurement include the use of remote sensing to determine consumptive water use, improvement of the methods used to determine net groundwater use, and undertaking a research and adaptive management program to ensure that emerging technologies and shifting economics keep the State's measurement approach current. Immediate research includes studies that refine return flow, water quality and in-stream estimates. Long-term research includes the cost and benefits of farm-gate measurement, direct measurement of groundwater extractions and a comparison between remote sensing and traditional crop consumption estimates.

The proposed administrative actions require funding and to date no funding has been identified. There is an initial Reclamation funded study underway to utilize remote sensing to estimate crop water use, but the scope is limited to two locations within the Central Valley and will only cover a single growing season.

RESEARCH AND EVALUATION

The ROD requirement for research and evaluation is based on the development of a finance plan, updating of the quantifiable objectives, the development of the agricultural milestones, research on ET, water measurement and performance measures. It was anticipated that the majority of the studies would be made available through grants.

Research grants were awarded through directed actions and through the PSP grant programs for a total of $3,381,726. Through directed actions, Reclamation funded eight projects for $1.025 million. Using Proposition 50 and SB 23, DWR funded eight research projects for $2,356,000 million. The local match for the grants and directed studies is $862,005. In addition, the CALFED program crosscut budget reports $3,725,000 of science funding for all WUE components (ag, urban, recycling and desal). It is not clear how much of the directed action funding is reported in the science crosscut budget. Research projects funded through SB 23, directed actions and Proposition 50 include:

- Evaluation of salt tolerant crops
- Indirect diversion reduction through soil water monitoring
- Benefits and costs of deficit irrigation in alfalfa
- Development of the VITicultural info system (VITIS)
- Water use efficiency in Sacramento Valley rice cultivation
- Improved water use efficiency for vegetables grown in the San Joaquin Valley
- Monitoring wetting front advance rate for irrigation management in flood irrigated alfalfa production systems
- Regulated deficit irrigation (initially funded by USBR with follow up funding from Proposition 50)
- Quantitative analysis of evaporation and transpiration
- Technical analysis of how to incorporate quantifiable objectives into district operations
- Utility of using remote sensing to verify ET and regulated deficit irrigation
- Monitoring and evaluation protocols of WUE actions
- Determination of the evaporation component of consumptive water use of tomato and peaches
- Establishment and initial results of implementing regulated deficit irrigation
- A quantitative assessment of the benefits of mobile labs and the use of polyacrylamide
- Determine efficacy of several WUE actions.

A complete listing of all research projects with applicant, funding source, expected benefit, status and the amount of public and local funding is given in Appendix 1D.

Although considerable funding was allocated toward science and research there is currently no mechanism for incorporating the results into the agricultural WUE program. The only method used for making research results available is through individuals pushing the information forward. The multi-year program plan does indicate that a Science Application Advisory Committee will be utilized to review and incorporate science findings. Although this committee is identified and funded for this purpose, it has only been used for a few initial meetings and has not produced any findings or recommendations.

While much of the need for scientific review is often focused on habitat restoration efforts, the CALFED Science Program will cover all of the program components. For Stage 1 the emphasis for the Science Program will be on ecosystem restoration activities. The lead scientist will work with CALFED program managers and CALFED Agencies to develop priorities for these program areas.

REFINING QUANTIFIABLE OBJECTIVES

The initial targeted benefits listing was completed in 2000 based on technical work and stakeholder involvement. During the initial work effort, it was acknowledged that the quantifiable objectives must be kept current through an update process. The 2001 WUE program implementation plan states that the refinement of quantifiable objectives will be transferred from CALFED to Reclamation and DWR. To date, some of the quantifiable objectives refinement activity has been transferred to the implementing agencies.

Reclamation developed guidance language for Central Valley Project (CVP) contractors to respond to the quantifiable objectives (Appendix 1E). All CVP agricultural and refuge contractors who are required to submit Water Management Plans under their respective Criteria are required to review and respond to quantifiable objectives that are applicable to their service area. There are three documents that are used for this: the Standard Criteria for Evaluating Water Management Plans, Regional Criteria for Evaluating Water Management Plans for the Sacramento River Contractors and the Criteria for Developing Refuge Water Management Plan. Due to plan preparation cycles, no plans or updates have yet been prepared using the criteria; however it is expected that several will be available in the next few months.

The cooperative agreement with the AWMC required the evaluation of the quantifiable objectives along with the evaluation of the EWMPs and to link each water supplier to their corresponding targeted benefits. The targeted benefits linkage was completed and this information was made available to Council members for the 2005 Proposition 50 PSP. An initial effort was made at the evaluation of quantifiable objectives within the context of a model incorporation effort. Although the project was completed, no further work was initiated because the cost of the effort greatly exceeded the availability of funds for further work. At this time the AWMC is scoping a new effort. In addition, the AWMC reports that there is a general need to further educate the Council members on the targeted benefits and how they fit into district and on-farm water management improvements.

In January 2005, the WUE Subcommittee began discussions on how to address a lack of oversight on the progress on quantifiable objectives. The subcommittee decided on an approach that is a hybrid effort wherein existing quantifiable objectives work is retained while all new efforts go toward completing new targeted benefits. In addition, a new assurance package is under development to support the change in emphasis. The program plan currently identifies funding for all but the assurance portion of the effort. This effort will be led by DWR with support from the California Bay-Delta Authority (CBDA) and Reclamation.

PROJECT EVALUATIONS

This document represents the first major effort to comprehensively evaluate the CALFED WUE Program. Two efforts were made to review the SB 23 grant program. DWR prepared a draft review of all projects in 2004 that was circulated but never finalized. The second attempt was through a directed action by Reclamation to review a limited number of the agricultural WUE grants. The Reclamation effort required the contractor to interview grant administrators to obtain their pre- and post-project data. After the initial interviews, it was apparent that there was insufficient information to generate results, and therefore the effort was re-scoped to provide reference guides for applicants to use when developing monitoring and verification efforts. Several Proposition 50 applications were received to review WUE projects; however, none received grant funding. The year 6 program plan states that project evaluation is a high priority item.

PERFORMANCE MEASURES

One of the ROD-identified research priorities is performance measures. Performance measures are used to translate program goals and objectives into measurable benchmarks of program progress that present information on program implementation, conditions, trends, outcomes and the significance of program activities in meeting the objectives and goals. Performance measures are used to:

- Evaluate progress in obtaining program objectives and goals
- Inform future decisions via adaptive management

- Provide information designed to facilitate management decisions and
- Inform the public and policy makers on program progress.

The 2005 program plan identifies the existing information on performance measures. The plan specifies that in year 6 (2005–06), the implementing agencies will develop an initial set of indicators and conceptual models, and that a more complete set of metrics will then be developed. Information from this report will be used to revise targets and inform program assessment.

OVERSIGHT AND COORDINATION

Oversight and coordination for agricultural WUE during the first four years of Stage 1 focused on several areas of program implementation: design and implementation of the PSP grant process; the development of agricultural assurances; development and implementation of the definition of appropriate measurement; development of quantifiable objectives and coordination of the WUE subcommittee and the annual program plan. Total expended on oversight and coordination over years 1–5 was $2.07 million for all water use efficiency efforts.

SUMMARY AND CONCLUSIONS

The agricultural WUE program attempted to meet all of its goals as set forth in the ROD. Significant achievements include:

- A grant and loan program was developed and implemented to support agricultural WUE projects. Funding for agricultural WUE grants was available from SB 23, Proposition 13 (feasibility grants only), and Proposition 50. From 2001 to 2005, 60 agricultural WUE grants were approved, with $18.2 million of state funding and $9.5 million of local funding. Also, funding is available for low interest loans to support agricultural WUE, but no applications have been received.
- Projects funded by the agricultural WUE grants are estimated to provide about 40,000 acre-feet of in-stream flow benefits for ecosystem restoration. These benefits are expected to last from 7 to 50 years, depending upon the project.
- Projects funded by the agricultural WUE grants are estimated to provide about 10,400 acre-feet of water supply reliability benefits. These benefits are expected to last from 3 to 30 years, depending upon the project.
- Approximately 3% of the in-stream flow and timing (ecosystem restoration) benefits identified in the quantifiable objectives have been met through grant-funded activity.
- Approximately 3% of the water quantity (water supply reliability) benefits identified in the quantifiable objectives have been met through grant-funded activity.
- Costs for providing the in-stream flow benefits ranged from $5 to $200 per acre-foot. Costs for water supply reliability benefits ranged even more widely. One funded project provided reductions in recoverable flows at a cost of $28 per acre-foot. Projects that reduced irrecoverable losses ranged in cost from $230 to $515 per acre-foot.
- Significant funding was provided under other non-CALFED programs that also met CALFED WUE objectives. Almost $80 million was provided by other state and federal programs for grants and technical assistance related to agricultural water use. Local agencies and growers provided another $168 million in cost-sharing under these programs.
- Almost $11 million of CALFED funding was spent on technical assistance, including $1.2 million for the Agricultural Water Management Council, $2.85 million in a cost-sharing agreement with CVP water contractors, and $6.8 million for DWR staff.
- A research program was developed. Just over $3.8 million was spent for research on crop water use, water quality, remote sensing technology, and regulated deficit irrigation.
- Recommendations on appropriate measurement of agricultural water use were developed and submitted to the Legislature for action. Measurement recommendations were made for surface water diversions, return flows, water quality, in-stream flows, and groundwater conditions.
- Milestones for tracking agricultural WUE achievements were developed. The milestone to enroll 4.65 million acres in the AWMC was exceeded. By 2004, over 5 million acres were represented by agencies that had joined the AWMC.

LOOK-FORWARD: PROJECTIONS OF WATER SAVINGS

The aim of the Authority's "look forward" effort is to answer the question: What is the statewide and regional potential of water use efficiency actions given different levels of investment and policies? In other words, the WUE Program has attempted to develop a range of projections that reasonably bracket potential water use efficiency savings over the next 25 years or so.

The primary intent of the exercise is to generate a range of projections that the Authority can use to: (1) assist state and federal decision-makers in assessing the ramifications of various implementation strategies; (2) provide input to other planning and analytical efforts, including the California Water Plan Update (DWR, Bulletin 160-05) and the modeling of potential surface storage projects (the "Common Assumptions" effort); and (3) provide information for program evaluation and finance planning. WUE Program staff and consultants are coordinating closely with the DWR and others to ensure that its projections are generated in a format that can most easily support the DWR's future quantitative modeling efforts.

To generate a reasonable range of water use efficiency projections, staff and consultants conducted a series of analyses that assume differing levels of investments and different policy actions. For agricultural water use efficiency, the variables in the analysis are tied primarily to funding levels and the adoption of locally cost-effective water use efficiency practices.

APPROACH AND GENERAL ASSUMPTIONS

This document provides a summary of the methodology and results for the projection of water use efficiency in California in support of the four-year Comprehensive Evaluation of agricultural water use efficiency for the CALFED Program. The analysis covers all regions of the state, using the planning area information developed by the DWR in its California Water Plan Update, and covers a planning period out to the year 2030.

The analysis uses land and water use data and other assumptions to model system improvements based on practical farm and district level infrastructure improvements. A range of estimates is made based on a set of projection levels, each of which includes assumptions about a statewide investment level and other policy guidelines. Land and water use data are taken from the California Water Plan Update. Other assumptions are based on stakeholder input, agency requirements, literature review, professional knowledge and available public information. The model is spreadsheet-based and uses the constrained optimization routine that is built into Microsoft Excel. In some cases, iterations of the model are required to match available monetary input with practical outcomes.

Results are shown as potential annual volume of savings from WUE improvements and the estimated costs of those improvements. Results are presented by analysis area; district vs. on-farm; and reductions in recoverable loss vs. irrecoverable loss. For results that include recoverable flows in the CALFED solution area, a comparison is made between the volume of water that could potentially be rerouted and the in-stream flow need specified in targeted benefits.

A number of important assumptions are used to guide this analysis. A key assumption is that growers will adopt the most cost-effective irrigation systems, either on their own (locally cost-effective) or in response to additional state investment. Other assumptions on implementation rate, distribution of funding, technical potential, groundwater use, and the potential role of regulated deficit irrigation (RDI) are described below. Finally, the development and role of targeted benefits is described. Targeted benefits are identified by specific location where water use efficiency actions can potentially achieve in-stream flow, water quality and water quantity benefits.

COST-EFFECTIVENESS

Locally cost-effective actions are those that can be projected to occur in the absence of additional funding from the CALFED Program or other non-local sources. At the farm level, locally cost-effective savings result from adjustments to the mix of irrigation systems that reduce applied water at no net increase in costs. This occurs due to improvements in irrigation technologies and increased experience with more water-saving technologies. This assumption will tend to overestimate locally cost-effective savings because local conditions and grower preferences will sometimes restrict their adoption of the most cost-effective systems. This is offset by the assumption that the real marginal value of water will not change in the future. This is a very conservative assumption considering that increasing competition for water and the broadening market for transfers and temporary exchanges will tend to increase the value of water. All else equal, higher marginal values for water would increase the cost-effectiveness of WUE improvements.

At the on-farm level, it is assumed that all locally cost-effective practices are implemented for all projection levels. At the district level, it is assumed that all locally cost-effective practices are implemented for projection levels 2, 4 and 5. The locally cost-effective level for district practices is determined using input from the water management plans prepared for the AWMC and USBR.

DISTRIBUTION OF FUNDING

For the first iteration of analysis, money was divided among analysis areas[21] and between district and on-farm investments using the following guidelines.[22]

- Statewide investment in WUE is assumed to be split equally between on-farm improvements and district-level improvements. This approach guarantees that sufficient spending will occur for districts to improve delivery flexibility as needed to enable on-farm improvements.
- Spending is allocated among analysis areas according to their ability to contribute to targeted benefits. A two-step allocation approach was used for planning purposes. First, the total spending target was allocated among eligible hydrologic regions according to the number of targeted benefits within the regions (including in-stream flow, water quality, and water quantity targeted benefits). Second, the spending was allocated to the analysis areas within each hydrologic region according to each area's potential for contributing to the targeted benefit through WUE improvements.
- All spending was for implementation actions.

TECHNICAL POTENTIAL

The analysis for Projection Level 6 (full technical potential) assumes that there are no cost barriers. All technically demonstrated practices will be implemented regardless of cost. Technically demonstrated practices are determined through literature reviews, demonstrated use, and professional experience.

IMPLEMENTATION RATE

This is the rate at which districts and farmers invest in upgrades to their water delivery and irrigation systems. The analysis in this report does not make explicit assumptions about implementation rate—the analysis here compares the achieved implementation of WUE at different levels of ongoing, annual investment. For each projection level, early years would be dominated by investment in capital upgrades, but over time the spending would shift to operation, maintenance, and replacement.

REGULATED DEFICIT IRRIGATION (RDI)

This is the use of irrigation strategies to reduce the amount of consumptively used water when it is not needed for crop growth or health. Based on literature reviews and information from technical professionals, an ET reduction of approximately 2.5 inches is applied to appropriate crops. In order to reflect the limitations of district delivery capability, the implementation rate is assumed to be 25% of acreage for crops that are amenable to the technology. The 25% of acreage is assumed to occur over the duration of the analysis. The application of RDI can apply to any projection level. The volume of water resulting from RDI is identified for each projection level, though RDI savings are estimated using a separate analysis.

GROUNDWATER USE

Many agricultural areas use a combination of groundwater and surface diversions for irrigation. The majority of groundwater for irrigation is pumped by growers from private wells, although some districts also deliver water pumped from district-owned wells (usually as a supplement to the district's surface water supply). Most of the analysis in this report addresses water use efficiency as a whole and does not attempt to identify practices and improvements targeted specifically to groundwater or surface water use.

TARGETED BENEFITS

This section provides the background, purpose and conceptual approach to the development of targeted benefits and quantifiable objectives. The conceptual foundation of the Ag WUE Incentive Program rests on several key elements. Broadly speaking, the Program is structured to identify, quantify, and link specific CALFED goals with practical on-farm and district distribution system water management actions. This approach has coined the terms targeted benefits and quantifiable objectives as part of a conceptual model to make the program a relevant, credible program to implement and measure. Targeted benefits cover in-stream flow and timing, water quality, and water quantity goals.

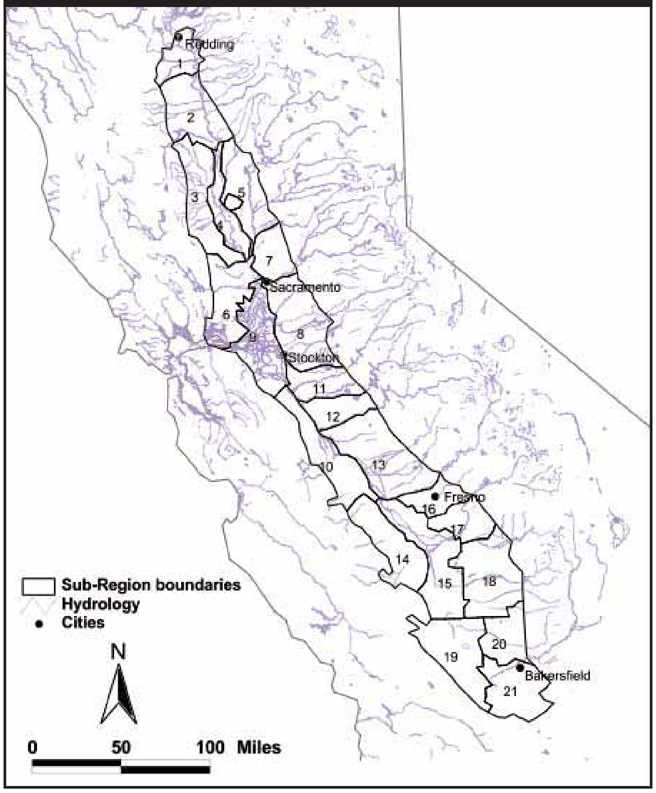
To facilitate this effort, CALFED developed numerical targets, expressed as acre-feet of water, for specified locations and times in each of 21 subregions. These 21 subregions are illustrated on the map of California's Central Valley presented in Figure 2.8. These numerical targets represent CALFED's initial estimates of the practical, cost-effective contribution irrigated agriculture can make to attain identified benefits. These estimates, referred to as quantifiable objectives, are approximations and may be revised as more detailed information is developed. A full explanation, including examples, is available at www.calwater.ca.gov.

Targeted benefits are a specific listing of CALFED-related goals that are believed to have a connection to agricultural water management practices. Based on its review of existing CALFED goals and discussions with stakeholder groups, the WUE Program identified 196 targeted benefits that related to specific objectives of water quality, quantity, and in-stream

21. See Table 2.8 on page 45 for a definition of analysis areas.

22. All of these assumptions are for planning purposes only, and will not be used to determine how WUE financial incentive programs will actually be implemented. To date the WUE program has relied on a competitive grant system to assess the best mix of projects to fund.

FIGURE 2.8 SUB-REGION BOUNDARIES: CENTRAL VALLEY GROUND AND SURFACE WATER MODEL

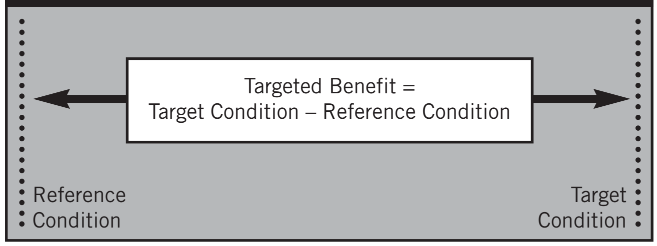


flow and timing. For example, the US Fish and Wildlife Service (USFWS) identified that anadramous fish need increased flows on the Stanislaus River at specific times. Because irrigation water is diverted from the Stanislaus River, changes in irrigation flows can potentially provide increased flows for fish.

The Central Valley includes tremendous variability in hydrology, land use, and water use patterns, and CALFED objectives also vary substantially across regions and watersheds. Smaller, more homogenous areas were needed. As illustrated in Figure 2.8, targeted benefits were identified in and associated with 21 subregions within the Central Valley. Targeted benefits were developed primarily from existing CALFED documents, the State's Impaired Water Body list (303d), and discussions with local agricultural representatives. Figure 2.10 summarizes the types of targeted benefits found in each of the 21 subregions; a more detailed listing of the targeted benefits is available at www.calwater.ca.gov. Considerable effort was made to develop a comprehensive list of targeted benefits, but it is recognized that the list is incomplete and will be updated as more and new information becomes available.

Quantifiable objectives are the bridge between CALFED goals and local actions. They represent the CALFED Program's best estimate of the practical and cost-effective contribution agriculture can make towards achieving CALFED objectives.

FIGURE 2.9 ILLUSTRATION OF TARGETED BENEFIT



In limited cases, irrigated agriculture could institute water management practices that achieve the entire targeted benefit. However, in most cases, irrigated agriculture will only contribute a portion of the benefits required to meet CALFED goals. Temperature targets on many of the rivers and streams in the Central Valley are good examples of the limited ability for irrigated agriculture to meet CALFED goals.

The process of developing quantifiable objectives is a time- and information-intensive effort. Targeted benefits were quantified by month, hydrologic year type, and subregion (or river reach). The difference between the current condition (reference condition) and the target condition was computed for each month and year type to determine how much benefit would be needed (Figure 2.9). In some cases, there was not enough conclusive data to quantify the targeted benefit. In other instances, there was not a complete understanding of the cause and effect relationship between the targeted benefit (e.g., a particular flow rate) and the intended CALFED objective (e.g., decreased salmon smolt mortality). In these situations, the WUE Program worked closely with others, such as the CALFED Ecosystem Restoration Program and Science Program, to develop more comprehensive data.

IDEALIZED AGRICULTURAL POTENTIAL

Subregional water balances were developed to get a more complete understanding of the flow paths that affect a targeted benefit. The flow path approach is crucial to the analysis because it helps us to understand how water moves through a given region, and it provides a first glimpse of the possible contribution irrigated agriculture could make to the targeted benefit. The water balance information was used to determine the idealized agricultural potential.

The idealized agricultural potential represents the contribution toward the targeted benefit that irrigated agriculture could make if it were irrigated perfectly with no losses or discharges (Figure 2.11). It is important to note that such an idealized situation is not technically possible or economically feasible. However, the idealized agricultural potential was identified to determine the outer bounds of irrigated agriculture's contribution. To estimate the practical contribution irrigated agriculture can realistically make, the ideal-

FIGURE 2.10 CATEGORIES OF TARGETED BENEFITS BY SUBREGION IN THE CENTRAL VALLEY

Targeted Benefits will be achieved by altering flow paths of irrigated agriculture.

Abbreviated Categories of Targeted Benefits

			Quality								Quantity			
Region	**Subregion**		**Flow Timing**	**Nutrients**	**Group A Pesticides**	**Pesticides**	**Salinity**	**Native Constituents**	**Temperatures**	**Sediments**	**Long-Term Diversion Flexibility**	**Nonproductive Evaporation**	**Short-Term Diversion Flexibility**	**Flows to Salt Sinks**
Sacramento Valley	1	Redding Basin	X								X	X		
	2	Sacramento Valley, Chico Landing to Red Bluff	X			X			X		X	X		
	3	Sacramento Valley	X		X	X	X				X	X		
	4	Mid-Sacramento Valley, Chico Landing to Knights Landing	X			X	X				X	X		
	5	Lower Feather River and Yuba River	X		X	X	X		X		X	X		
	6	Sacramento Valley Floor, Cache Creek, Putah Creek, and Yolo Bypass	X			X					X	X		
	7	Lower Sacramento River below Verona	X			X	X		X		X	X		
Delta & Tributary	8	Valley Floor East of Delta	X						X		X	X		
	9	Sacramento — San Joaquin Delta	X	X	X	X	X	X	X		X	X	X	X
West Side San Joaquin Valley	10	Valley Floor West of San Joaquin River	X		X	X	X	X		X	X	X		X
	14	Westlands Area								X	X	X		X
East Side San Joaquin Valley	11	Eastern San Joaquin Valley above Tuolomne River	X	X	X	X	X		X		X	X		
	12	Eastern Valley Floor between Merced and Tuolomne Rivers	X		X	X	X		X		X	X		
	13	Eastern Valley Floor between San Joaquin and Merced Rivers	X		X	X	X		X		X	X		
Southern San Joaquin Valley	15	Mid-Valley Area									X	X		X
	16	Fresno Area	X		X	X	X		X		X	X		
	17	Kings River Area									X	X		X
	18	Kaweah and Tule River Area									X	X		X
	19	Western Kern County									X	X		X
	20	Eastern Kern County									X	X		
	21	Kern River Area									X	X		X

ized agricultural potential was reduced by the portion that was not considered cost-effective or technically feasible. The portion that remained was the achievable agricultural potential, defined as the technically feasible, cost-effective contribution towards the given objective. The achievable agricultural potential is the water volume that can be used each month to meet the targeted benefit. The relationship between the idealized and the achievable agricultural potential is shown in Figure 2.11.

The achievable agricultural potential was compared to the targeted benefit to determine the quantifiable objective, as illustrated in Figures 2.12 and 2.13. Figure 2.12 shows a situation where the targeted benefit was greater than what irrigated agriculture could contribute. In this case, all of the achievable agricultural potential could be used and another source of benefits must then be pursued in order to satisfy the full targeted benefit. Figure 2.13 shows a situation where the targeted benefit was less than the achievable agricultural potential. In this situation more benefits were available than would be needed to satisfy the targeted benefit.

FIGURE 2.11 RELATIONSHIP BETWEEN THE IDEALIZED AND ACHIEVABLE AGRICULTURAL POTENTIAL

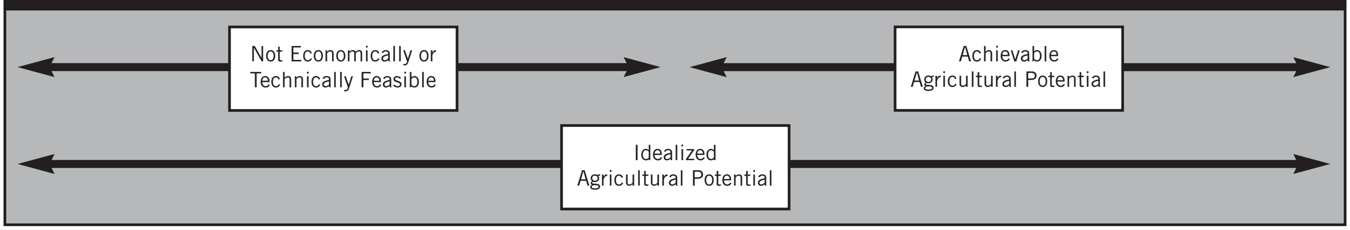


FIGURE 2.12 QUANTIFIABLE OBJECTIVE WHEN POTENTIAL LESS THAN TARGETED BENEFIT

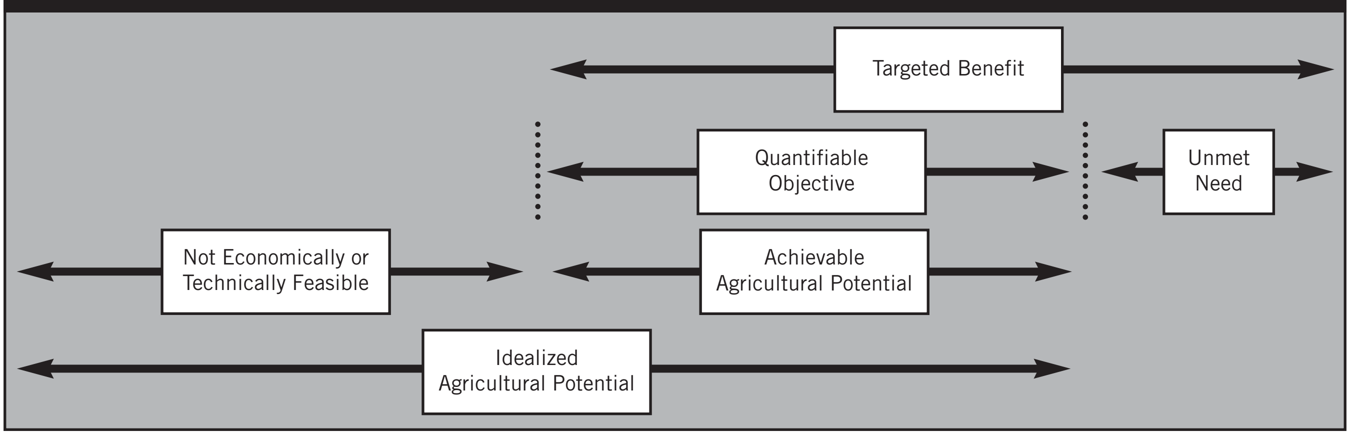
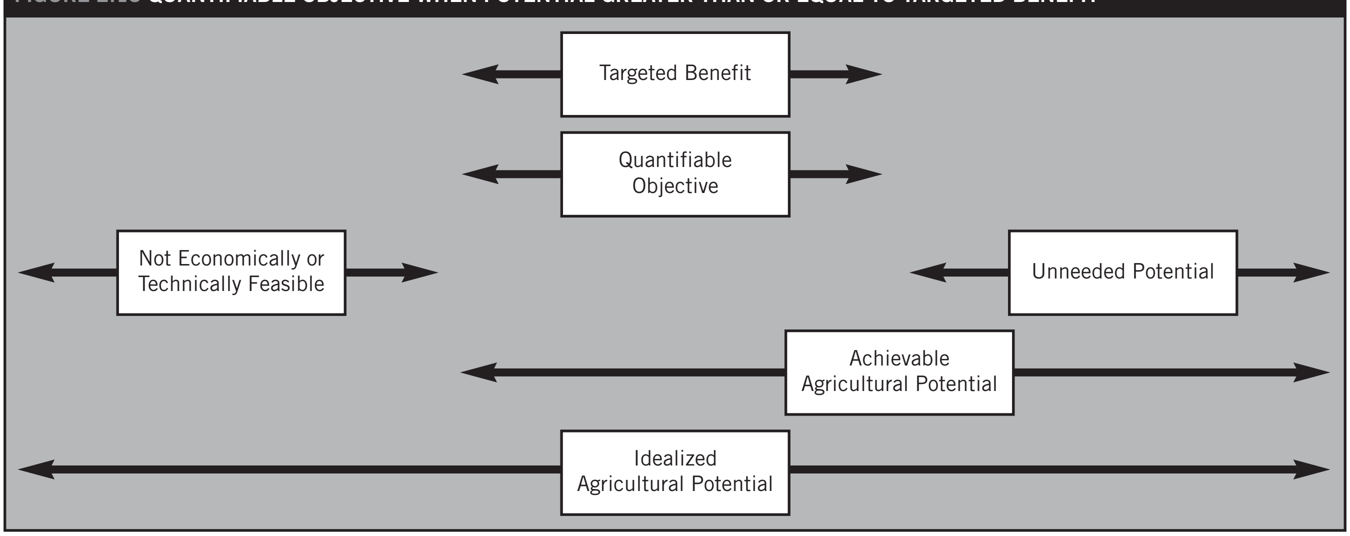


FIGURE 2.13 QUANTIFIABLE OBJECTIVE WHEN POTENTIAL GREATER THAN OR EQUAL TO TARGETED BENEFIT



PROJECTION LEVELS

The following is a description of the projection levels bounding the agricultural water use efficiency component of the Comprehensive Evaluation. Each projection level consists of an on-farm and a district component. In addition to the six projections there is an additional evaluation of regulated deficit irrigation that illustrates the WUE potential of this emerging technology.

PROJECTION LEVEL 1 (PL-1): REASONABLY FORESEEABLE

This projection level is intended to represent the current trend of investment for locally cost-effective on-farm and district practices. State investment in non-locally cost-effective practices is limited to Proposition 50 funding of $15 million per year through 2006 (three fiscal years).

PROJECTION LEVEL 2 (PL-2): LOCALLY COST EFFECTIVE PRACTICES

Projection level 2 assumes full implementation of locally cost-effective district practices. State investment in non-locally cost-effective practices is limited to Proposition 50 funding of $15 million per year through 2006 (three fiscal years).

PROJECTION LEVEL 3 (PL-3): MODERATE FUNDING

Projection level 3 is intended to represent the current trend of investment for locally cost-effective on-farm and district practices. State investment in non-locally cost-effective practices is assumed to be $15 million per year until 2030.

PROJECTION LEVEL 4 (PL-4): LOCALLY COST EFFECTIVE PRACTICES WITH MODERATE FUNDING

Projection level 4 assumes full implementation of locally cost-effective district practices. State investment in non-locally cost-effective practices is assumed to be $15 million per year until 2030.

PROJECTION LEVEL 5 (PL-5): LOCALLY COST EFFECTIVE PRACTICES WITH ROD FUNDING LEVELS

Projection level 5 is similar to PL-3 except that it assumes funding consistent with levels in the ROD. Funding would be $40 million per year for 10 years and then $10 million per year for remaining years through 2030.

PROJECTION LEVEL 6 (PL-6): TECHNICAL POTENTIAL[23]

No funding constraint is imposed for this projection level. All technically demonstrated practices will be implemented, and the implied cost will be estimated.

23. The team acknowledges that some stakeholders who attended public briefings and workshops on this topic considered the term "technical potential" to be potentially misleading. The team considered other terminology but decided that "technical potential" is acceptable if accompanied by appropriate definitions and qualifiers.

ADDITIONAL PROJECTION: REGULATED DEFICIT IRRIGATION

This additional projection estimates water use efficiency potential assuming adoption of regulated deficit irrigation practices on appropriate crops. The methodology, data, and assumptions are taken from recent studies conducted by technical experts.

LAND AND WATER USE DATA

Land and water use information is from the California Water Plan Update (DWR Bulletin 160, 2005) that provides data for 1998, 2000 and 2001. For this analysis the year 2000 was selected because it represents a normal water year in the Sacramento Valley and the San Joaquin Valley. Land use information represents the latest available statewide compilation of land use.

LAND USE

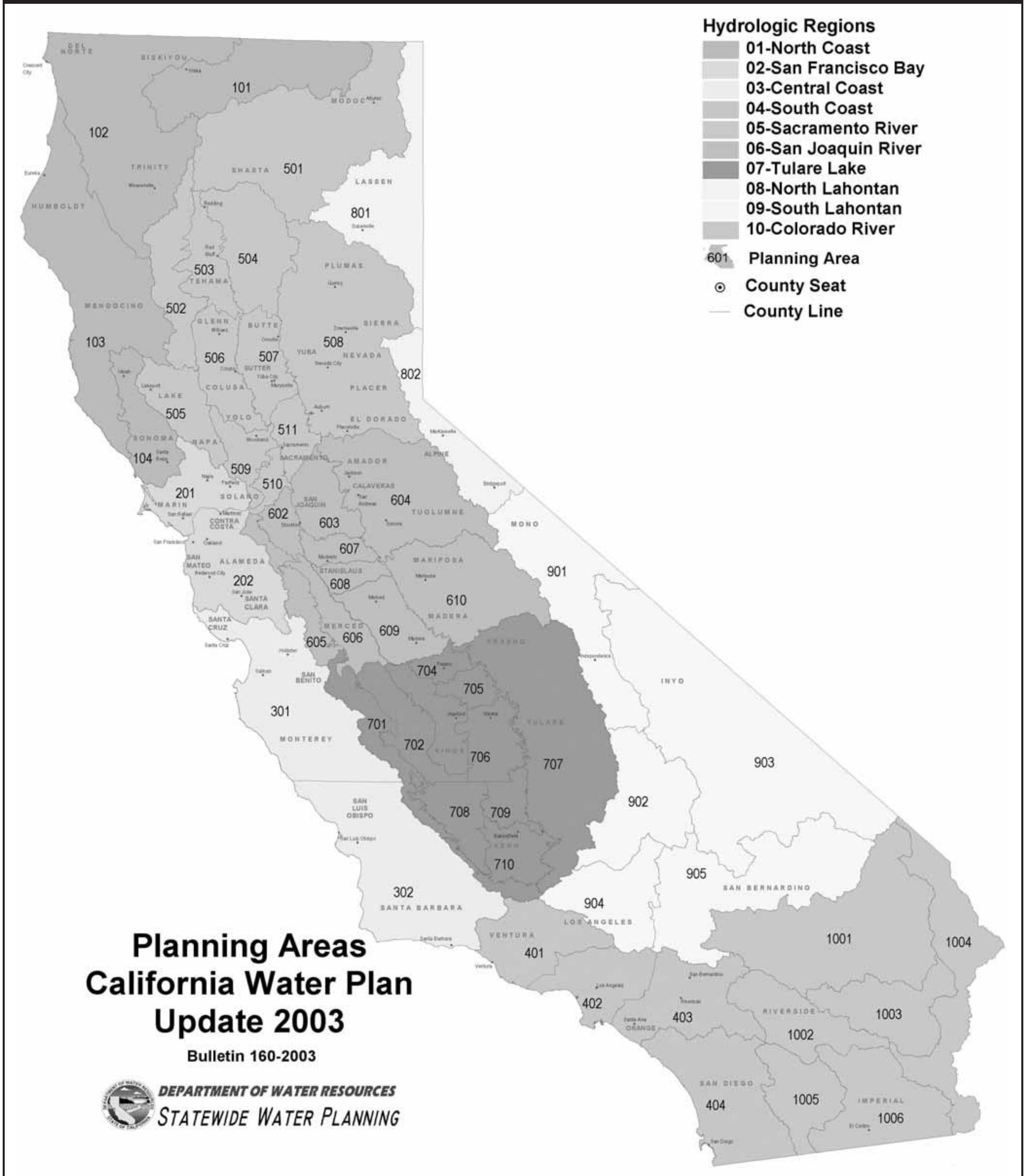
On a five-year interval, the DWR conducts land use surveys by county and reports them at the planning area level (Figure 2.14). For this analysis, all planning areas with more than fifty thousand acres of irrigated land are included. Table 2.7 summarizes the irrigated acres in the included planning areas. The included areas are further consolidated to create analysis areas that represent one or more planning areas (Table 2.8). Analysis areas are regions where irrigation management and water supply are relatively consistent. Combining planning areas sacrifices little in accuracy at this level of planning and reduces the total number of model runs that are needed to complete the analysis.

The DWR land use survey reports 21 crop categories, including one that represents multi-cropped lands. For the modeling analysis these crop categories are consolidated into eight categories that align with the information developed to characterize the cost and performance of irrigation systems for each analysis area. Table 2.9 shows how the DWR crop categories correspond to the eight categories used in this analysis. Table 2.10 summarizes the irrigated crop acres by analysis area and crop category.

WATER USE

Water use information is taken from the May 25, 2004 water balance spreadsheets prepared by the DWR staff (www.waterplan.ca.gov). These spreadsheets were used to develop the summary information presented in the California Water Plan Update. Agricultural water use (demand) for the year 2000 was used for each planning area and consolidated into the analysis areas, as indicated in the land use section. The analysis in this document describes the flow path of water from river diversion to the end user. Diverted water either flows back to surface water bodies (streams, lakes, and the ocean), flows to groundwater, or flows to the atmosphere by

FIGURE 2.14 DWR PLANNING AREAS



crop transpiration and evaporation. This analysis of water use efficiency maintains the distinction between delivery by the water supplier and application by the end user or grower. The vast majority of end users in California are dependent on organized water suppliers such as water or irrigation districts. As such, the description of water quantities and flows in all regions in the state is organized into two levels: water supplier and field application. A diagram of the flow

TABLE 2.7 DWR PLANNING AREAS

Name	ID	Irrigated Crop Acres
Upper Klamath	101	207,000
Russian River	104	67,000
North Bay	201	57,000
Northern	301	277,000
Southern	302	162,000
Santa Clara	401	90,000
Santa Ana	403	69,000
San Diego	404	91,000
Shasta - Pit	501	134,000
Lower Northwest Valley	503	122,000
Northeast Valley	504	77,000
Colusa Basin	506	512,000
Butte - Sutter - Yuba	507	520,000
Southeast	508	85,000
Central Basin West	509	248,000
Sacramento Delta	510	170,000
Central Basin East	511	128,000
San Joaquin Delta	602	250,000
Eastern Valley Floor	603	281,000
Valley West Side	606	414,000
Upper Valley East Side	607	206,000
Middle Valley East Side	608	231,000
Lower Valley East Side	609	565,000
San Luis West Side	702	576,000
Lower Kings-Tulare	703	604,000
Fresno - Academy	704	156,000
Alta - Orange Cove	705	272,000
Kaweah Delta	706	558,000
Semitropic - Buena Vista	708	305,000
Kern Valley Floor	709	207,000
Kern Delta	710	327,000
Lassen	801	93,000
Coachella	1002	52,000
Colorado River	1004	114,000
Imperial Valley	1006	452,000
Subtotal for analysis		8,675,000
Sum of acreage in all planning areas with less than fifty thousand irrigated acres		837,000
	Total	**9,512,000**

TABLE 2.8 CONSOLIDATION OF DWR PLANNING AREAS INTO ANALYSIS AREAS

DWR Planning Area ID	Analysis Area	Counties Represented in Analysis Area
101	1010	Modoc, Siskiyou
104	1040	Mendocino, Sonoma
201	2010	Napa, Sonoma, Solano
301+302	3010	Monterey, San Benito, San Luis Obispo, Santa Barbara, Ventura
401+403+404	4010	Ventura, San Diego
501+508	5010	Modoc, Shasta
503+504	5030	Tehama
506	5060	Glenn, Colusa
507	5070	Butte, Sutter
509	5090	Yolo, Solano
510+602	5100	San Joaquin, Solano, Yolo
511	5110	Sacramento
603	6030	San Joaquin
606	6060	Merced, Stanislaus
607+608+609	6070	Merced, Madera, Stanislaus
702	7020	Fresno, Kings
703+708	7030	Fresno, Kings, Kern
704+705+706	7040	Fresno, Kings, Tulare
709+710	7090	Kern, Tulare
801	8010	Lassen
1002	10020	Riverside
1004	10040	Imperial (Coachella)
1006	10060	Imperial

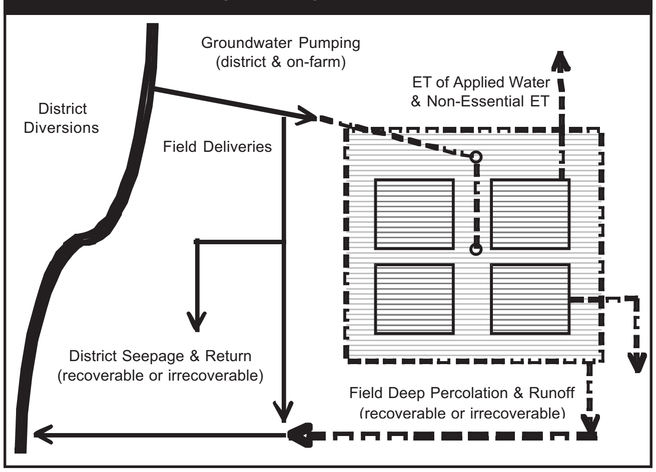
TABLE 2.9 CROP CATEGORIES

DWR Categories	Analysis Categories
Alfalfa Irrigated Pasture	Alfalfa and Pasture
Grains Dry beans Safflower	Grains
Rice	Rice
Cotton Corn Other Field Crops	Row Crops
Sugar Beets	Sugar Beets
Tomatoes, fresh and processing	Tomato
Almond Pistachio Other Deciduous Subtropical Vineyard	Tree Crops and Vineyards
Cucurbits Onion and Garlic Other Truck Crops	Vegetable

TABLE 2.10 CROP CATEGORIES AND IRRIGATED ACREAGE FOR EACH ANALYSIS AREA (Year 2000, in thousand acres)

Analysis Area	Alfalfa & Pasture	Grains	Rice	Row Crops	Sugar Beets	Tomato	Tree Crops & Vineyards	Vegetable	Total
1010	129.8	52.6	0.0	0.8	4.7	0.0	0.0	19.5	207.4
1040	11.9	0.2	0.0	0.5	0.0	0.0	53.6	0.9	67.1
2010	4.6	1.7	0.0	0.6	0.0	0.2	48.8	1.0	56.9
3010	18.0	22.3	0.0	4.4	0.0	5.4	123.2	431.7	605.0
4010	24.0	14.9	0.0	5.9	0.0	5.7	147.4	77.8	275.7
5010	190.2	11.5	6.9	0.1	0.4	0.0	6.0	3.7	218.8
5030	66.7	10.1	2.0	6.3	0.3	0.0	111.8	2.0	199.2
5060	34.0	63.6	226.9	45.4	3.8	42.8	85.3	15.0	516.8
5070	26.5	48.1	244.5	17.9	0.6	12.6	161.6	11.9	523.7
5090	55.1	62.7	16.4	46.0	1.0	37.7	31.8	5.3	256.0
5100	87.5	91.2	0.9	122.4	6.5	42.8	43.8	30.6	425.7
5110	22.4	13.2	68.7	9.1	0.7	0.5	11.6	1.5	127.7
6030	45.4	30.2	3.2	34.3	2.7	21.0	143.8	7.6	288.2
6060	92.5	69.7	6.9	130.3	7.3	42.0	44.6	44.1	437.4
6070	213.2	98.1	9.0	191.9	4.0	21.2	477.7	36.0	1,051.1
7020	24.9	89.8	0.0	232.8	10.5	98.2	55.5	81.5	593.2
7030	171.7	149.6	0.0	389.2	7.0	10.5	184.5	15.9	928.4
7040	129.3	111.4	0.0	234.6	8.6	3.7	602.8	20.5	1,110.9
7090	73.5	57.2	0.0	139.3	2.1	5.4	232.9	69.1	579.5
8010	85.4	5.6	0.5	0.0	0.0	0.0	0.0	1.2	92.7
10020	2.3	0.0	0.0	3.7	0.0	0.4	33.5	23.1	63.0
10040	66.9	13.1	0.0	31.9	0.0	0.1	5.2	28.6	145.8
10060	241.2	59.6	0.0	77.5	34.0	0.6	4.6	92.4	510.0
Total	**1,817.1**	**1,076.4**	**585.9**	**1,724.9**	**94.2**	**350.9**	**2,609.9**	**1,020.8**	**9,280.2**

FIGURE 2.15 MAJOR WATER SUPPLIER AND FIELD LEVEL FLOW PATHS



paths used in the analysis is shown in Figure 2.15.

Water use at the water supplier level and field level are further subdivided into recoverable and irrecoverable flows. Table 2.11 shows how the water supply and use categories in the California Water Plan Update are converted to recoverable and irrecoverable flows at the supplier and field levels. At the water supplier level, the recoverable flows are the sum of surface runoff and deep percolation. These flow paths can be altered and reused for beneficial purposes. Irrecoverable flows are the sum of flows to saline sinks, surface flows to either the Delta or the Pacific Ocean and surface water evaporation. Reducing flows to these sinks increases the water supply that is available for beneficial uses. Column G in Table 2.11 indicates flows that go to other states or to the ocean and are not included in the analysis. In line with these distinctions, this document's analysis of potential savings from water use efficiency allocates all changes in water use to either savings in recoverable losses or savings in irrecoverable losses.

At the field level groundwater pumping and district deliveries make up the applied water. Field applied water is subsequently divided into recoverable and irrecoverable flows. Groundwater use information reported in the California Water Plan Update is not reported by sector but rather by the insti-

TABLE 2.11 MAPPING OF THE DWR WATER PLAN—WATER USE CATEGORIES FOR THE COMPREHENSIVE EVALUATION ANALYSIS

	Water Supplier Level (District)							Field & District		Field Level (On-Farm)									
	Total	Recoverable +		Irrecoverable +			Other	GW Pump	+ District Deliveries	= Field Applied Water =	Recoverable			Irrecoverable +					Other
		Deep Percolation	Surface Return	Saline Deep Perc	Saline Return	Non-Essential E+ET	Other States & Ocean				Deep Percolation	Surface Return	Cult Prac	Crop ETAW	Cult. Prac	Saline Deep Perc	Saline Surface Return	Non-Essential E+ET	Other States & Ocean
Identifier	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**	**n**	**o**	**p**	**q**	**r**	**s**
DWR (Water Plan)	**sum of b:h**	24	20, 22	25	21	18	19, 20			**sum of i:s**	5, 7	10,12	--	3		6	11	13, 4	9, 10

Identifier

a = sum(b:f)+I: all water in PA, GW proportioned to Field and District (90:10)
b water flows to groundwater, occurs within district facilities
c water flows to surface return, flows out of PA
d water flows to saline groundwater, occurs within district facilities
e water flows to saline surface return, flows out of PA
f water flows from surface reservoirs and open channels
g not used for WUE analysis: only PA water accounting
h these values taken from CALAG economic model for 1993 water year: closest to 2000
i = (j - h)
j = sum(k - r)
k water flows to groundwater, occurs within district facilities
l water flows to surface return, flows out of PA
m irrecoverable cultural practices: leaching requirement, reclamation and heat control
n water flows to evaporation and transpiration from ag lands
o recoverable cultural practices: weed water, rice flood up, flow through for salinity control - assumed to be in k or l
p water flows to saline groundwater, occurs within district facilities
q water flows to saline surface return, Flows out of PA
r water flows from
s not used for WUE analysis: only PA water accounting

DWR (Water Plan) Water Use Categories

1 AW - Crop Production
2 AW - Groundwater Recharge
3 ETAW
4 E + ET of Groundwater Recharge
5 Deep Percolation of Applied Water
6 Deep Percolation of Applied Water to Salt Sink
7 Deep Percolation of Groundwater Recharge
8 Reuse of Return Flow within Region
9 Return Flow and Deep Percolation to OR, NV, MX
10 Return Flow for Delta Outflow
11 Return Flow to Salt Sink
12 Return Flow to Developed Supply
13 Return Flow E + ET
14 Agricultural Applied Water Use
15 Agricultural Net Water Use (AW - Reuse)
16 Agricultural Net Water Use (ETAW + Irr Losses + Outflow)
17 Agricultural Depletion
18 Conveyance E + ET
19 Conveyance Return Flow and Deep Percolation to OR, NV, MX
20 Conveyance Return Flows for Delta Outflow
21 Conveyance Return Flows to Salt Sink
22 Conveyance Return Flows to Developed Supply
23 Conveyance Seepage (Reuse)
24 Conveyance Deep Percolation
25 Conveyance Deep Percolation to Salt Sink
26 Conveyance Loss Applied Water Use
27 Conveyance Loss Net Water Use (AW - Reuse)
28 Conveyance Loss Net Water Use (ETAW + Irr Losses + Outflow)
29 Conveyance Loss Depletion

tutional characteristics of the groundwater basin (adjudicated, un-adjudicated and banked). To assign the proportion of agricultural groundwater use for each analysis area, the ratio of agricultural to urban water use is used. In addition, groundwater use is proportioned to district or field level based on a general characterization of the analysis area. Recoverable flows are surface runoff, deep percolation and cultural practices such as climate control. Irrecoverable flows include productive and non-productive evaporation and transpiration, deep percolation to saline sinks, surface runoff to saline sinks, and cultural practices, such as leaching and soil reclamation.

Applied water and ET of applied water are presented as a weighted average by crop type for each analysis area. As background, the estimates of ET of applied water and applied water are given in Tables 2.12 and 2.13 by crop type and area. In some instances the DWR data are reclassified based on discussions with both DWR staff and staff at local agencies.

ON-FARM IRRIGATION METHODS SURVEY

In 2003, the DWR published the results of the 2001 update to the on-farm irrigation system survey. Respondents indicated the number of cropped acres under a particular irrigation method. Table 2.14 shows that approximately 5% of the statewide acreage responded to the survey.

Table 2.15 gives the statewide results for irrigation system type by crop category. The survey results are used to help set starting conditions for on-farm irrigation practices in this analysis. For this purpose, the survey's detailed irrigation system categories are consolidated into a smaller number

TABLE 2.12 APPLIED WATER BY ANALYSIS AREA AND CROP CATEGORY (acre-feet per acre)

Analysis Area	Alfalfa & Pasture	Grains	Rice	Row Crops	Sugar Beets	Tomato	Tree Crops & Vineyards	Vegetable
1010	3.15	1.76	0.00	1.82	3.42	0.00	0.00	2.29
1040	4.21	0.33	0.00	1.95	0.00	0.00	0.96	2.18
2010	4.11	0.48	0.00	1.96	0.00	2.32	1.12	2.36
3010	3.84	0.96	0.00	1.93	0.00	2.07	1.81	1.55
4010	5.31	1.82	0.00	2.02	0.00	1.83	3.79	2.17
5010	3.36	1.51	5.07	1.59	2.67	0.00	2.91	2.01
5030	4.14	0.69	5.34	2.06	3.01	0.00	2.88	1.65
5060	4.40	0.99	5.74	2.41	3.14	2.73	3.04	1.63
5070	4.92	1.05	5.48	2.26	3.38	2.62	3.62	1.82
5090	5.55	1.34	5.36	2.80	4.12	3.18	4.06	2.82
5100	5.60	1.13	5.71	2.85	4.33	3.12	2.91	2.60
5110	5.60	1.08	4.97	2.77	4.12	2.87	3.55	3.75
6030	5.29	1.09	5.10	2.54	3.59	2.51	2.32	3.02
6060	4.96	1.80	5.68	2.91	2.26	2.85	3.52	2.09
6070	4.47	1.31	5.24	2.56	1.84	2.73	2.99	1.89
7020	4.02	1.78	0.00	2.87	3.73	2.33	3.58	2.15
7030	4.65	1.56	0.00	2.93	2.20	2.95	3.33	2.41
7040	4.83	1.52	0.00	3.06	2.70	2.91	2.80	1.62
7090	5.08	1.94	0.00	3.49	2.61	2.97	3.51	2.14
8010	3.20	1.75	4.34	0.00	0.00	0.00	0.00	2.34
10020	6.70	0.00	0.00	3.31	0.00	3.86	4.35	3.66
10040	6.19	2.98	0.00	4.70	0.00	3.71	5.51	3.91
10060	6.80	2.94	0.00	3.35	5.23	3.20	5.47	3.48

TABLE 2.13 ET OF APPLIED WATER BY ANALYSIS AREA AND CROP CATEGORY (Year 2000, in thousand acres)

Analysis Area	Alfalfa & Pasture	Grains	Rice	Row Crops	Sugar Beets	Tomato	Tree Crops & Vineyards	Vegetable
1010	2.16	1.27	0.00	1.34	2.50	0.00	0.00	1.66
1040	2.70	0.25	0.00	1.46	0.00	0.00	0.81	1.66
2010	2.74	0.36	0.00	1.47	0.00	1.60	0.90	1.79
3010	2.75	0.65	0.00	1.35	0.00	1.53	1.29	1.06
4010	3.41	1.07	0.00	1.38	0.00	1.28	2.78	1.51
5010	2.31	1.07	2.80	1.10	2.00	0.00	2.16	1.45
5030	2.88	0.50	3.05	1.48	2.20	0.00	2.26	1.20
5060	3.08	0.70	3.27	1.68	2.20	1.89	2.39	1.12
5070	3.30	0.73	3.10	1.58	2.30	1.81	2.61	1.24
5090	3.72	0.91	3.00	1.92	2.80	2.20	2.85	1.89
5100	3.72	0.79	3.20	1.97	2.94	2.15	2.13	1.85
5110	3.63	0.73	2.78	1.91	2.80	1.98	2.50	2.51
6030	3.48	0.74	2.84	1.74	2.44	1.73	1.71	2.03
6060	3.18	1.25	3.40	2.33	1.70	2.14	2.68	1.41
6070	3.03	0.91	3.11	1.80	1.40	2.00	2.24	1.27
7020	3.43	1.30	0.00	2.19	2.80	1.91	2.65	1.47
7030	3.26	1.09	0.00	2.26	1.61	2.12	2.50	1.76
7040	3.30	1.01	0.00	2.19	2.07	2.06	2.11	1.06
7090	3.70	1.37	0.00	2.60	1.90	2.15	2.67	1.49
8010	2.24	1.33	2.60	0.00	0.00	0.00	0.00	1.70
10020	4.69	0.00	0.00	2.18	0.00	2.70	3.19	2.53
10040	4.68	1.86	0.00	2.95	0.00	2.60	4.10	2.43
10060	5.02	2.00	0.00	2.13	3.40	2.20	4.10	2.40

TABLE 2.14 STATEWIDE RESPONSE TO THE DWR IRRIGATION METHODS SURVEY

DWR Crop Category	Statewide Acres	Responding Acres	Participation Rate (%)
Alfalfa	1,126,200	68,900	6.1
Almond & Pistachio	682,400	79,800	11.7
Corn	625,300	34,500	5.5
Cotton	913,200	37,600	4.1
Cucurbit	133,700	1,000	0.7
Dry beans	122,900	3,000	2.4
Grains	861,600	26,500	3.1
Onion, Garlic	80,800	2,000	2.5
Other Deciduous	639,900	37,300	5.8
Other Field crops	191,700	7,700	4.0
Other Truck Crops	788,700	35,000	4.4
Pasture	834,000	31,800	3.8
Potato	44,400	3,000	6.8
Rice	586,800	2,200	0.4
Safflower	102,000	39,700	38.9
Subtropical Trees	434,000	1,700	0.4
Sugar Beets	94,300	6,800	7.2
Tomato (fresh)	49,300	7,600	15.4
Tomato (process)	302,000	1,000	0.3
Vineyard	899,200	80,500	8.9
Statewide Total	**9,512,400**	**507,400**	**5.3**

of broader system categories. Using the county level information of the irrigation system survey results and the analysis area crop acreage, an initial distribution of irrigation systems by crop is established. The starting mix is based on the acreage of surface, drip, or sprinkler irrigation acreage to the total for each crop category (Table 2.15).

METHODOLOGY

ON-FARM IRRIGATION SYSTEMS SAVINGS

Costs of reducing applied irrigation water are estimated using an irrigation cost and performance model. The model is built on a database of irrigation technologies that are both feasible and cost-effective. The data include estimates of capital component costs (e.g., pipes, valves, siphon tubes, land leveling), operational costs (labor, repairs, pressurization pumping), and management costs. For consistent comparison across systems, all costs are converted to annualized equivalents, with each capital component amortized over its useful life. Total annual costs for each system included annualized capital plus operations, maintenance, and management costs.

Basic data on irrigation system costs and performance were developed over a series of projects done for the U.S. Bureau of Reclamation. Initially the data were used to assist in assessment of subsurface drainage reduction in the San Joaquin Valley. In the mid-1990s the data were revised and

TABLE 2.15 STATEWIDE RESULTS OF THE DWR IRRIGATION METHODS SURVEY (Irrigation System Mix by Crop Category and Irrigation Method)

DWR Crop Category	Surface	Sprinkler	Micro-Sprinkler	Drip	Sub-Surface
Corn	87.1%	0.8%	0.0%	0.0%	12.1%
Cotton	93.9%	5.1%	0.0%	0.0%	1.0%
Dry beans	56.9%	43.1%	0.0%	0.0%	0.0%
Grains	87.3%	10.5%	0.0%	0.0%	2.2%
Safflower	57.6%	27.8%	0.0%	0.0%	14.6%
Sugarbeet	99.9%	0.0%	0.0%	0.1%	0.0%
Other Field crops	85.1%	12.9%	0.1%	1.6%	0.3%
Alfalfa	80.3%	17.4%	0.0%	0.0%	2.2%
Pasture	75.1%	20.2%	0.0%	0.0%	4.7%
Cucurbit	45.3%	23.6%	0.0%	31.1%	0.0%
Onion & Garlic	43.7%	56.3%	0.0%	0.1%	0.0%
Potato	1.2%	91.2%	0.0%	7.6%	0.0%
Tomato (fresh)	61.3%	0.0%	0.0%	38.7%	0.0%
Tomato (process)	67.8%	30.2%	0.0%	2.0%	0.0%
Other Truck Crops	36.1%	38.0%	0.7%	25.2%	0.0%
Almond & Pistachio	19.2%	11.3%	43.3%	26.0%	0.2%
Other Deciduous	33.7%	30.8%	14.8%	20.2%	0.4%
Subtropical Trees	10.1%	12.5%	64.0%	12.6%	0.9%
Turfgrass & Landscape	0.6%	89.0%	2.5%	7.6%	0.2%
Vineyard	20.8%	8.7%	1.3%	68.9%	0.2%
Total	**49.4%**	**15.6%**	**13.2%**	**19.9%**	**1.8%**

expanded to assist in analyzing potential impacts of the Central Valley Project Improvement Act on agricultural water use and crop production. For this review, some additional revisions were made and all costs were indexed to 2004 levels. The revised report is provided as Appendix 1A, and includes detailed information about data sources, calculations, and descriptions of costs and performance by irrigation system, management level, and crop category.

Appendix 1A includes a large number of potential irrigation systems for many of the crops, but a feasible system is not necessarily a cost-effective one.[24] For example, some systems for a given crop simply cost more and use more water. Growers would have no economic reason to select such systems when they are dominated (from a cost and performance perspective) by other systems. Therefore, the larger set of feasible systems was reduced by eliminating systems that are clearly not cost-effective. At least one example of a feasible irrigation system from each category of system (surface, sprinkler, or drip) was retained in order to provide for feasible calibration.

A significant and important feature of the irrigation system characterization is its recognition of the dual role of irrigation system technology (the hardware) and irrigation management. Within each of the broad categories of irrigation technologies (surface, sprinkler, and drip), there exist variations in hardware components, operational design, and management level. Water use efficiency and total costs vary according to both the technology and how it is managed. Management is characterized as low, medium, or high for each technology; the definitions of these levels vary by technology and are defined in Appendix 1A.

For purposes of this analysis, seasonal application efficiency (SAE) is the measure used to characterize the on-farm water use efficiency of irrigation systems. SAE is defined here as the ratio of the consumptive use of evapotranspiration of applied water (ETAW) to the total applied water. Note that other studies may define application efficiency in a different way. For example, some reports add additional water applied for leaching and other cultivation practices to the consumptive use before dividing the result by total applied water. Efficiencies calculated in that way are not directly comparable to the efficiency estimates used here. No specific calculation of leaching fraction is shown in the analysis because the development of the irrigation system cost and performance data includes a leaching component.

24. Here we define cost-effective as providing a particular level of water use efficiency at the least cost. If an irrigation system is clearly more costly than another system or mix of systems that can achieve the same efficiency, it is deemed not cost-effective.

On-Farm Model Calibration

Irrigation system changes can reduce deep percolation rates, uncollected runoff, and evaporative losses. Savings potential is the difference between current losses and potential losses under a different set of irrigation systems. Therefore, the starting conditions for each analysis area (each analysis area is a planning area or grouping of similar planning areas) must be estimated through a calibration process. The calibration to current conditions relies on the best available data of the mix of irrigation systems currently in use for the planning area and of the seasonal application efficiency by crop. The calibration model selects the mix of feasible irrigation systems for each crop and each analysis area in order to match the target data as closely as possible. The model requires that the acreage and water use estimates are matched exactly, using 2000 data developed for the California Water Plan Update. In addition, the calibration model attempts to minimize irrigation system costs. The joint objectives are incorporated into a composite objective function as a weighted average of the two objectives: minimize cost and minimize the sum of squared deviations (SSD) from the survey results.

The cost-minimizing term serves two important functions. First, it forces selection of the least-cost systems in cases where multiple optimal (or near-multiple optimal) solutions would occur. Second, it prevents over-fitting of calibration results to survey data that are several years old and, in some regions, could have substantial sampling error due to small survey response. The calibration model can be summarized as:

> *Choose the mix of irrigation systems for each crop category within an analysis area to minimize the weighted average of SSD and irrigation system costs, subject to the constraint that total applied water (and therefore irrigation application efficiency) by crop and area is equal to the estimated levels.*

The result of the calibration step is a mix of irrigation systems for each crop in each analysis area, the efficiency and deep percolation associated with the crop, and the annual cost per acre for that mix of irrigation systems. No modeling analysis can replicate the actual conditions on every irrigated acre in the analysis area, but the calibration results represent a reasonable estimate of the mix of systems, crops, and overall efficiencies.

On-Farm Model Projection-Level Analysis

Once the on-farm model is calibrated, each analysis area has a starting point described by the mix of irrigation systems and water use efficiency for each crop category. Projection-level analysis is designed to address the question of how much on-farm water application can be reduced for a given level of investment. As described above, all costs are expressed as annual equivalent dollars per acre, including capital, operation and maintenance, and management costs. Additional investment, or spending, from local and state/federal sources is then allocated among crops and irrigation system choices to provide savings in on-farm water use. The projection-level model can be summarized as:

> *Choose the mix of irrigation systems for each crop category within an analysis area to maximize the aggregate applied water savings in each analysis area, subject to the constraint that total costs of the irrigation improvements do not exceed a target annual amount.*

The result of the projection-level analysis is a mix of irrigation systems for each crop in each analysis area, the water use efficiency and deep percolation associated with the crop, and the annual cost per acre for that mix of irrigation systems. Model results for a projection level should be interpreted as reasonable approximations of the savings in water use achievable for a given cost. The specific irrigation systems selected by the model may not apply to all conditions within an analysis area.

The projection-level analysis is not designed as a statewide optimization, but rather optimizes for a spending target within each analysis area. Spending targets by analysis area are derived outside the model and are based on the geographic distribution of CALFED water use efficiency goals. Also, the model does not explicitly show a time trend of efficiency improvements as money is invested, but rather it compares the water use and cost under one "steady-state" mix of irrigation systems to another higher-cost mix of systems. The length of time required to achieve the change to higher water use efficiency will vary by analysis area, and will depend on the split of investment in capital improvements versus ongoing operation, maintenance, and management costs.

DISTRICT LEVEL SAVINGS

Costs of reducing recoverable and irrecoverable flows at the district level are estimated using a district level water delivery cost and performance model. The model is built on information taken from water management plans prepared for the AWMC and the USBR as well as individual irrigation districts that have upgraded their infrastructure and management. This information provides an estimate of costs and performance for five infrastructure improvements and three levels of district flexibility. The potential improvements include:

- Delivery flexibility
    - — Additional labor
    - — Additional labor plus central control
    - — Additional labor plus central control and regulating reservoirs
- Canal lining
- Seepage recovery
- Regulating reservoirs with automation
- Interceptors
- Pressurized pipe

The cost for each improvement is based on total project costs. Costs include capital, operation, and maintenance. All costs were converted to annual equivalents, with each capital component amortized over its useful life. Total annual costs for each system included annualized capital plus operation and maintenance costs. The savings associated with a district improvement is the volume of water conserved or volume of water assigned to a more flexible service (thereby enabling improved on-farm water management).

The maximum delivery efficiency achievable occurs with pressurized pipe. Some analysis areas already have most or all agricultural water delivered through pressurized pipe. These areas are considered at their technical potential and are not considered as candidates for further district efficiency improvements.[25] Table 2.16 summarizes the assumed mix of improvements that could be implemented in each analysis area as funding is increased. These mixes of improvements are intended to provide a reasonable assessment of the potential and should not be viewed as applicable to every district within an area.

Each improvement was characterized according to the flow path that it affects:

- Canal seepage: water in the canal that moves to groundwater or the vadose zone
- Canal spill: water that runs out the tail end of a canal to a drain or a reusable location
- On-farm inefficiencies: water that flows to on-farm drains or goes to field deep percolation, and could be reduced by more flexible district deliveries.

The initial allocation of money for district improvements is assumed to go toward the first level of district delivery flexibility in order to support improved on-farm irrigation systems, with subsequent investments made to reduce canal seepage or spills and for higher levels of delivery flexibility. For purposes of this analysis, district use fraction is defined as the ratio of the volume of water delivered at the farms to the total volume of water diverted into district facilities.

25. Note that this assumption is for planning purposes only. Districts in these areas remain eligible for grant funding and other WUE programs.

TABLE 2.16 DISTRICT INFRASTRUCTURE AND MANAGEMENT CHANGES FOR INCREASED WATER USE EFFICIENCY

Action	Description
Canal Lining	Lining of canals with materials that reduce infiltration, typically concrete.
Canal Seepage Recovery	Shallow recovery wells that pump local seepage into the canal or to another location.
Canal Automation	Use of hardware and software to allow automatic water or flow control.
Central Control	Hardware and software that allows a central operator to make changes from central location.
Regulating Reservoirs with Automation	Reservoirs that buffer the main and lateral canals to increase operational flexibility.
Interceptors	Laterals that capture spill from other district infrastructure and move it to another district location.
Piping	Use of plastic or concrete pipe to replace conveyance channels.
Flexibility - Low	Provides labor for central control and delivery changes when district can accommodate them.
Flexibility - High	Provides labor for flexibility (as above) plus additional delivery flexibility including regulating reservoirs.

TABLE 2.17 ASSUMED MIX OF APPROPRIATE DISTRICT EFFICIENCY ACTIONS BY ANALYSIS AREA

Analysis Area	Canal Lining			Seepage Recovery	Interceptor	Regulating Reservoir	Flexibility Low	Flexibility High
	Proportion of efficiency improvement through efficiency cost level							
	Low	Medium	High	Medium	Medium	Medium	Medium	Medium
1010	Insufficient information available for these regions or a lack of organized water suppliers.							
1040								
2010								
3010								
4010								
5010	15%			30%	15%	20%	20%	
5030	10%			50%	15%	15%	10%	
5060				60%	15%	15%	10%	
5070	15%			30%	15%	20%	20%	
5090	30%			30%		20%	20%	
5100				10%			90%	
5110	15%			30%	15%	20%	20%	
6030	30%			30%		20%	20%	
6060	25%			10%	25%	15%	25%	
6070		25%		10%	25%	15%	25%	
7020	Pressurized pipe is already the predominant delivery system within these areas.							
7030								
7040			15%	10%				75%
7090			15%	10%				75%
8010	Insufficient information available for these regions or a lack of organized water suppliers.							
10020			15%	10%				75%
10040		25%		10%	25%	15%	25%	
10060			10%	30%				

District Efficiency, Cost, and Performance

One of the primary goals of district level efficiency improvements is to provide improved service. This is accomplished through a combination of infrastructure and management changes. Infrastructure changes include canal lining, seepage recovery, canal automation, regulating reservoirs and interceptors. Management changes include increased system flexibility in water ordering capability. Table 2.16 lists these actions and describes the activity required to enable them.

Information on the existing level of district technologies is taken from water management plans submitted by local water suppliers to either the AWMC or the USBR. A second data source used was a district survey conducted by the University of California to establish existing district infrastructure. These data sources cover all of Reclamation's Central Valley Project contractors, water suppliers that are members of the AWMC, and a number of other local agencies. Each plan and data source was reviewed for infrastructure, water delivery policy, and potential for efficiency improvements. Much of this analysis is based on personal knowledge and professional judgment as well as contact with local agencies. This information was also provided for review through the public workshops used for this process and the CALFED WUE subcommittee.

Based on the information collected from the various planning documents, an assessment of the efficiency actions appropriate to improve district efficiency in each analysis area was developed (Table 2.17). Cost information for efficiency improvements was taken from data collected by the Imperial Irrigation District (IID) for the IID-Metropolitan Water District Water Conservation and Transfer Agreement (1989), the Sunnyside Irrigation District (Benton, Washington) improvement program, a review of Proposition 13 and SB23 grant projects, and local project information collected by Provost and Pritchard Engineering of Fresno. Based on these data and on personal knowledge and professional judgment, each analysis area was assigned a mix of potential district improvements that would be undertaken (Table 2.17). For each analysis area and projection level, the mix of system improvements is used to estimate a district-level water savings corresponding to the amount of money invested. Table 2.18 lists the per-unit costs, including amortized capital, operation, and maintenance used in the analysis.

District Model Calibration

The district-level analysis does not produce a model that requires calibration, as is the case for the on-farm model. Rather, each analysis area is characterized based on what mix of district improvements is most appropriate, as reflected in Table 2.18. This characterization is based on districts' water management and water conservation plans, knowledge of each area, and expert judgment.

TABLE 2.18 CAPITAL AND OPERATION & MAINTENANCE COSTS FOR DISTRICT LEVEL EFFICIENCY IMPROVEMENTS
(costs per unit are in 2004 dollars)

Action	Unit	Low	Med.	High	O & M
Canal Lining	AF	$34	$93	$194	$0
Canal Seepage Recovery	AF	$25	$50	$75	included in capital
Canal Automation	acre	$8	$17	$25	$2
Central Control	acre	$1	$2	$3	$3
Regulating Reservoirs with Automation	acre	$27	$53	$80	$9
Interceptors	AF	$33	$66	$99	$37

District Model Projection-Level Analysis

Projection-level analysis is designed to address the question of how much district savings can be achieved for a given level of investment. As described above, all costs are expressed as annual equivalent dollars per acre, including capital, operations, and maintenance costs. Additional investment from local and state/federal sources is then applied to the mix of district-level actions shown in Table 2.18, and the reductions in district delivery losses are estimated.

RESULTS

Results are presented as reductions in recoverable or irrecoverable volumes at both the on-farm and district level. At the district level, savings result from reductions in canal spill and seepage and evaporation. At the farm level, savings result from reductions in surface return, deep percolation, and non-productive evaporation. Evapotranspiration savings due to RDI are also included in a separate accounting for each projection level.

All savings are estimated assuming that the year 2000 crop mix remains in place for the planning horizon. In reality, cropping patterns shift over time and the direction and degree of shift varies by region. The "Additional Analyses" section (page 63) assesses how the potential for savings could change under an example shift in cropping pattern.

All costs are estimated as annualized amounts that include both capital investment and annual operation and maintenance. The present value of the annual cost is also shown for a 30-year planning horizon. For projection levels having state investment in on-farm systems, an additional one-time capital conversion cost estimate is shown. This rough estimate is used to indicate that the availability of state investment will induce some growers to relinquish some of the useful life of their current irrigation systems and replace them sooner than they would if they were spending only their own money. This incentive effectively shifts the stream of irrigation system investment spending forward in time, and is represented in the estimates as the present value of this shift in investment stream.

PROJECTION LEVEL RESULTS

Projection Level 1 (PL-1): Reasonably Foreseeable—On-farm
This analysis is performed to assess the locally cost-effective changes in water use. For PL-1 it is assumed that no state/federal funds are spent for on-farm improvements. PL-1 estimates the changes in on-farm efficiencies that appear likely to occur over time as growers replace existing irrigation systems with new systems. Changes in on-farm efficiencies are driven by irrigation system technology and cost, crop mix, regulations, and availability and cost of water supply. No change in the cost of water supply to growers nor any change in the opportunity cost of water (what growers could receive for water if transferred to another user) is assumed. No one-time capital conversion cost is estimated because only system changes that are cost-effective to growers are included. Based on these assumptions, there are still significant opportunities for applied water savings, although they would be achieved over an extended period of time as growers adopt newer technologies and replace existing systems. Results shown in Table 2.19 indicate:

- Annual applied water savings of 147,000 acre-feet per year in reduced recoverable losses and 108,000 acre-feet per year in reduced irrecoverable losses (flows to salt sinks).
- No net increase in irrigation system costs, per the assumptions of PL-1. This does not imply that growers' out-of-pocket costs are zero, but rather that, based on current estimates of system costs and water use, a lower water-use mix of systems can be adopted over time at no net increase in costs over the existing mix of systems.
- The final column in Table 2.19 is an estimate of potential reductions in crop ET from implementation of RDI.

Projection Level 1 (PL-1): Reasonably Foreseeable—District
This analysis assesses the maximum applied water savings achieved at the district level with a state investment of $15 million per year for three years (2004–06). The annual cost is based primarily on providing an increased level of district flexibility to the field level. The applied water savings is split into estimated changes in recoverable and irrecoverable losses, using California Water Plan Update estimates as a basis for the split (Table 2.20).

- Total annual cost for PL-1 is estimated based on the remaining three years of Stage 1 spending at $15 million per year. In order to compare tabular results directly to other projection levels, the $15 million for three years is converted to a $2.9 million annualized equivalent cost spread over 30 years.
- Annual applied water savings shown in Table 2.20 are estimated to total 1,300 acre-feet per year in reduced irrecoverable losses (flows to salt sinks and non-beneficial evaporation and ET) and about 3,600 acre-feet of reduced recoverable losses. Note that these savings do not include on-farm savings that become locally cost-effective because they are enabled by the district improvements. These savings also do not account for potential third-party impacts, such as reductions in groundwater recharge or surface return flow that would have been used by others.

Projection Level 2 (PL-2): Locally Cost-Effective
The incremental change from PL-1 to PL-2 assumes that all locally cost-effective EWMPs are implemented at both the on-farm and district level. The locally cost-effective on-farm practices are already estimated for PL-1. A review of the AWMC's water management plans (approximately 30) suggests that all irrigation water suppliers are operating at the locally cost-effective level.[26] This conclusion indicates that the results of PL-2 would be similar to the results given for PL-1.

Projection Level 3 (PL-3): Moderate Investment
This analysis assesses the applied water savings achieved at the field and district level by a moderate local and state/federal investment of $15 million per year through 2030. This money is spent half on on-farm improvements and half on district-level improvements. Existing irrigated lands using highly efficient and expensive irrigation systems (defined as pressurized systems operated at high management levels) are assumed to be at the technical potential, and irrigation systems on those lands would not be affected.

Projection Level 3 (PL-3): Moderate Investment—On-Farm
For this initial estimate, the annual on-farm investment of $7.5 million per year was allocated among analysis areas based on the number and magnitude of water quantity and quality objectives in each area. The model estimated the irrigation systems selected and the applied water savings. In addition, the applied water savings was split into estimated changes in recoverable and irrecoverable losses, using California Water Plan Update estimates as a basis for that split. Table 2.21 summarizes the results by analysis area. Results are as follows:

26. More precisely, the available information does not indicate any locally cost-effective practices available to districts that were not already being adopted or planned for adoption.

TABLE 2.19 SUMMARY ESTIMATES FOR ON-FARM SYSTEM COST AND SAVINGS - LOCAL INVESTMENT ONLY

Analysis Area	Annual Cost (M$/yr)	Present Value of Annual Cost (M$)	One-Time Capital Conversion Cost (M$)	Savings in Recoverable Loss (TAF)	Savings in Irrecoverable Loss (TAF)	Potential ET Saved by RDI (TAF)
1040	$0.00	$0.00	$0.00	0.0	0.2	4.0
2010	$0.00	$0.00	$0.00	0.0	0.3	3.7
3010	$0.00	$0.00	$0.00	1.2	0.2	7.9
4010	$0.00	$0.00	$0.00	0.1	5.4	9.7
5010	$0.00	$0.00	$0.00	2.8	17.6	0.3
5030	$0.00	$0.00	$0.00	3.1	37.7	6.3
5060	$0.00	$0.00	$0.00	6.3	0.0	5.4
5070	$0.00	$0.00	$0.00	1.3	0.0	4.7
5090	$0.00	$0.00	$0.00	11.8	0.0	1.7
5100	$0.00	$0.00	$0.00	7.1	0.0	2.7
5110	$0.00	$0.00	$0.00	18.7	0.0	0.8
6030	$0.00	$0.00	$0.00	0.0	1.3	9.1
6060	$0.00	$0.00	$0.00	12.2	0.0	2.3
6070	$0.00	$0.00	$0.00	12.6	0.0	27.5
7020	$0.00	$0.00	$0.00	0.2	3.0	3.0
7030	$0.00	$0.00	$0.00	16.2	4.8	11.1
7040	$0.00	$0.00	$0.00	20.8	0.6	24.9
7090	$0.00	$0.00	$0.00	7.9	0.8	15.0
8010	$0.00	$0.00	$0.00	0.4	16.9	0.0
10020	$0.00	$0.00	$0.00	3.3	5.6	2.4
10040	$0.00	$0.00	$0.00	21.0	13.7	0.0
Total	**$0.00**	**$0.00**	**$0.00**	**147.1**	**108.2**	**142.6**

TABLE 2.20 SUMMARY ESTIMATES FOR DISTRICT COST AND SAVINGS—LOCAL INVESTMENT PLUS PROPOSITION 50 FUNDING

Analysis Area	Irrigated Acres (1,000 ac.)	Annual Cost (M$/yr)	Present Value of Annual Cost (M$)	Savings in Recoverable Loss (TAF)	Savings in Irrecoverable Loss (TAF)
1040	67.1	$0.00	$0.00	0.0	0.0
2010	56.9	$0.00	$0.00	0.0	0.0
3010	605.0	$0.00	$0.00	0.0	0.0
4010	275.7	$0.00	$0.00	0.0	0.0
5010	218.8	$0.10	$1.42	0.0	0.0
5030	199.2	$0.10	$1.40	0.0	0.0
5060	516.8	$0.35	$4.77	1.4	0.5
5070	523.7	$0.46	$6.36	2.0	0.8
5090	256.0	$0.19	$2.56	0.0	0.0
5100	425.7	$0.45	$6.17	0.0	0.0
5110	127.7	$0.09	$1.27	0.3	0.1
6030	288.2	$0.13	$1.73	0.0	0.0
6060	437.4	$0.20	$2.73	0.0	0.0
6070	1051.1	$0.50	$6.82	0.0	0.0
7020	593.2	$0.00	$0.00	0.0	0.0
7030	928.4	$0.00	$0.00	0.0	0.0
7040	1110.9	$0.23	$3.15	0.0	0.0
7090	579.5	$0.12	$1.72	0.0	0.0
8010	92.7	$0.00	$0.00	0.0	0.0
10020	63.01	$0.00	$0.00	0.0	0.0
10040	145.8	$0.00	$0.00	0.0	0.0
Total	**8562.8**	**$2.91**	**$40.10**	**3.6**	**1.3**

- Total annual cost for achieving PL-3 on-farm savings is estimated to be $7.5 million per year (as defined by the assumptions of the projection level), plus an additional one-time capital conversion cost of about $39 million. The present value of the annualized costs is over $100 million (discounted for 30 years at 6%).
- Annual applied water savings are estimated to total over 175,000 acre-feet per year in reduced irrecoverable losses (flows to salt sinks and non-beneficial evaporation and ET) and about 540,000 acre-feet of reduced recoverable losses. Note that these savings do not account for potential third-party impacts, such as reductions in groundwater recharge or surface return flow that would have been used by others.
- The final column in Table 2.21 is an estimate of potential reductions in crop ET from implementation of RDI.

Projection Level 3 (PL-3): Moderate Investment—District

This analysis assesses the maximum applied water savings achieved at the district level with a state investment of $7.5 million per year through 2030. Total annual cost includes both amortized capital investment and operation and maintenance. The annual cost is based primarily on providing an increased level of district flexibility to the field level. The applied water savings is split into estimated changes in recoverable and irrecoverable losses, using California Water Plan Update estimates as a basis for the split in each analysis area.

- Annual applied water savings are shown in Table 2.22 and are estimated to total 9,900 acre-feet per year in reduced irrecoverable losses (flows to salt sinks and non-beneficial evaporation and ET) and about 20,500 acre-feet of reduced recoverable losses. Note that these savings do not account for potential third-party impacts, such as reductions in groundwater recharge or surface return flow that would have been used by others.
- Spending on district improvements also supports on-farm efficiency improvements. Some of the initial district spending is to improve the delivery flexibility, enabling on-farm improvements that are already included in Table 2.21.

Projection Level 4 (PL-4): Locally Cost-Effective Practices with Moderate Funding

This incremental change from PL-3 to PL-4 assumes that all locally cost-effective EWMPs are implemented at the district level. The on-farm savings are the same as shown in PL-3. A review of the AWMC's water management plans (approximately 30) suggests that all irrigation water suppliers are operating at the locally cost-effective level. This conclusion indicates that the results of PL-4 would be similar to the results given for PL-3.

Projection Level 5 (PL-5): Locally Cost-Effective Practices with ROD Funding Levels

The analysis assesses the applied water savings achieved at the on-farm and district level by a high level of state/federal investment. Combined local plus state/federal funding is assumed to be $40 million per year for ten years, dropping to $10 million per year for the remaining planning period. For analysis purposes, this has been converted to an annual equivalent amount of $30 million per year through 2030. This money is spent half on on-farm improvements and half on district-level improvements. Existing irrigated lands using highly efficient and expensive irrigation systems (defined as pressurized systems operated at high management levels) are assumed to be at the technical potential, and irrigation systems on those lands would not be affected.

Projection Level 5 (PL-5): Locally Cost-Effective Practices with ROD Funding Levels—On-Farm

For this estimate, the annual on-farm investment of $15 million per year was allocated among analysis areas based on the number and magnitude of water quantity and quality objectives in each area. The model estimated the irrigation systems selected and the applied water savings. In addition, the applied water savings was split into estimated changes in recoverable and irrecoverable losses, using California Water Plan Update estimates as a basis for that split. Table 2.23 summarizes the results by analysis area. Results are as follows:

- Total annual cost for achieving PL-5 on-farm savings is estimated to be $15 million per year (as defined by the assumptions of the Projection Level), plus an additional one-time capital conversion cost of about $39 million. The present value of the annualized on-farm costs is over $206 million (discounted for 30 years at 6%).
- Annual applied water savings are estimated to total 205,000 acre-feet per year in reduced irrecoverable losses (flows to salt sinks and non-beneficial evaporation and ET) and about 874,000 acre-feet of reduced recoverable losses. Note that these savings do not account for potential third-party impacts, such as reductions in groundwater recharge or surface return flow that would have been used by others.
- The final column in Table 2.23 is an estimate of potential reductions in crop ET from implementation of RDI.

TABLE 2.21 SUMMARY ESTIMATES FOR ON-FARM SYSTEM COST AND SAVINGS – MODERATE INVESTMENT LEVEL

Analysis Area	Annual Cost (M$/yr)	Present Value of Annual Cost (M$)	One-Time Capital Conversion Cost (M$)	Savings in Recoverable Loss (TAF)	Savings in Irrecoverable Loss (TAF)	Potential ET Saved by RDI (TAF)
1040	$0.12	$1.61	$0.02	0.0	5.3	4.0
2010	$0.13	$1.73	$0.06	0.0	4.8	3.7
3010	$0.51	$7.03	$0.16	18.9	3.3	7.9
4010	$0.25	$3.49	$0.02	7.2	13.9	9.7
5010	$0.20	$2.76	$0.19	10.9	17.8	0.3
5030	$0.20	$2.72	$0.75	12.3	37.8	6.3
5060	$0.67	$9.25	$2.96	64.6	0.0	5.4
5070	$0.90	$12.33	$0.33	74.9	0.0	4.7
5090	$0.36	$4.97	$3.10	39.3	0.0	1.7
5100	$0.87	$11.96	$3.32	59.0	0.0	2.7
5110	$0.18	$2.45	$1.36	31.1	0.0	0.8
6030	$0.24	$3.35	$0.08	0.2	18.8	9.1
6060	$0.38	$5.29	$2.91	31.8	0.0	2.3
6070	$0.96	$13.24	$4.08	59.4	0.0	27.5
7020	$0.20	$2.80	$4.68	1.3	18.4	3.0
7030	$0.35	$4.86	$6.23	30.4	9.1	11.1
7040	$0.44	$6.11	$4.88	43.6	1.3	24.9
7090	$0.24	$3.33	$2.42	21.0	2.1	15.0
8010	$0.08	$1.04	$0.13	3.1	17.0	0.0
10020	$0.10	$1.40	$0.57	7.3	8.0	2.4
10040	$0.11	$1.51	$0.81	28.2	18.1	0.0
Total	**$7.50**	**$103.24**	**$39.05**	**544.6**	**175.5**	**142.6**

TABLE 2.22 SUMMARY ESTIMATES FOR DISTRICT COST AND SAVINGS – MODERATE INVESTMENT LEVEL

Analysis Area	Irrigated Acres (1,000 ac.)	Annual Cost (M$/yr)	Present Value of Annual Cost (M$)	Savings in Recoverable Loss (TAF)	Savings in Irrecoverable Loss (TAF)
1040	67.1	$0.12	$1.61	0.0	0.0
2010	56.9	$0.13	$1.73	0.0	0.0
3010	605.0	$0.51	$7.03	0.0	0.0
4010	275.7	$0.25	$3.49	0.0	0.0
5010	218.8	$0.20	$2.76	0.0	0.0
5030	199.2	$0.20	$2.72	0.3	0.4
5060	516.8	$0.67	$9.25	5.8	2.1
5070	523.7	$0.90	$12.33	7.8	3.0
5090	256.0	$0.36	$4.97	0.0	0.0
5100	425.7	$0.87	$11.96	5.0	1.3
5110	127.7	$0.18	$2.45	1.5	0.4
6030	288.2	$0.24	$3.35	0.0	0.0
6060	437.4	$0.38	$5.29	0.0	1.9
6070	1051.1	$0.96	$13.24	0.0	0.0
7020	593.2	$0.20	$2.80	0.0	0.0
7030	928.4	$0.35	$4.86	0.0	0.0
7040	1110.9	$0.44	$6.11	0.0	0.0
7090	579.5	$0.24	$3.33	0.0	0.0
8010	92.7	$0.08	$1.04	0.0	0.0
10020	63.0	$0.10	$1.40	0.0	0.9
10040	145.8	$0.11	$1.51	0.0	0.0
Total	**8562.8**	**$7.50**	**$103.24**	**20.5**	**9.9**

TABLE 2.23 SUMMARY ESTIMATES FOR ON-FARM SYSTEM COST AND SAVINGS – ROD INVESTMENT LEVEL

Analysis Area	Annual Cost (M$/yr)	Present Value of Annual Cost (M$)	One-Time Capital Conversion Cost (M$)	Savings in Recoverable Loss (TAF)	Savings in Irrecoverable Loss (TAF)	Potential ET Saved by RDI (TAF)
1040	$0.23	$3.22	$0.03	0.0	10.4	4.0
2010	$0.25	$3.45	$0.06	0.0	6.5	3.7
3010	$1.02	$14.06	$0.17	33.6	5.9	7.9
4010	$0.51	$6.99	$0.02	13.5	21.5	9.7
5010	$0.40	$5.53	$0.19	18.4	17.8	0.3
5030	$0.40	$5.45	$0.74	21.4	37.9	6.3
5060	$1.34	$18.49	$2.97	105.5	0.0	5.4
5070	$1.79	$24.65	$0.34	120.9	0.0	4.7
5090	$0.72	$9.94	$3.10	60.8	0.0	1.7
5100	$1.74	$23.91	$3.34	104.7	0.0	2.7
5110	$0.36	$4.91	$1.36	41.5	0.0	0.8
6030	$0.49	$6.70	$0.08	0.4	32.2	9.1
6060	$0.77	$10.58	$2.91	51.5	0.0	2.3
6070	$1.92	$26.47	$4.10	106.1	0.0	27.5
7020	$0.41	$5.61	$4.86	0.4	5.4	3.0
7030	$0.71	$9.73	$6.23	44.7	13.3	11.1
7040	$0.89	$12.21	$4.88	66.5	1.9	24.9
7090	$0.48	$6.67	$2.42	34.1	3.4	15.0
8010	$0.15	$2.09	$0.13	5.8	17.1	0.0
10020	$0.20	$2.80	$0.56	11.0	10.3	2.4
10040	$0.22	$3.01	$0.81	33.3	21.3	0.0
Total	**$15.00**	**$206.47**	**$39.32**	**874.0**	**204.8**	**142.6**

TABLE 2.24 SUMMARY ESTIMATES FOR DISTRICT COST AND SAVINGS – ROD INVESTMENT LEVEL

Analysis Area	Irrigated Acres (1,000 ac.)	Annual Cost (M$/yr)	Present Value of Annual Cost (M$)	Savings in Recoverable Loss (TAF)	Savings in Irrecoverable Loss (TAF)
1040	67.1	$0.23	$3.22	0.0	0.0
2010	56.9	$0.25	$3.45	0.0	0.0
3010	605.0	$1.02	$14.06	0.0	0.0
4010	275.7	$0.51	$6.99	0.0	0.0
5010	218.8	$0.40	$5.53	1.4	2.1
5030	199.2	$0.40	$5.45	2.2	2.3
5060	516.8	$1.34	$18.49	14.9	5.3
5070	523.7	$1.79	$24.65	19.8	7.7
5090	256.0	$0.72	$9.94	6.8	1.7
5100	425.7	$1.74	$23.91	20.9	5.2
5110	127.7	$0.36	$4.91	4.2	1.0
6030	288.2	$0.49	$6.70	1.4	1.6
6060	437.4	$0.77	$10.58	0.0	8.4
6070	1051.1	$1.92	$26.47	0.7	10.3
7020	593.2	$0.41	$5.61	0.0	0.0
7030	928.4	$0.71	$9.73	0.0	0.0
7040	1110.9	$0.89	$12.21	0.0	0.0
7090	579.5	$0.48	$6.67	0.0	0.6
8010	92.7	$0.15	$2.09	0.0	0.0
10020	63.0	$0.20	$2.80	0.0	1.7
10040	145.8	$0.22	$3.01	0.0	0.3
Total	**8562.8**	**$15.00**	**$206.47**	**72.2**	**48.2**

TABLE 2.25 SUMMARY ESTIMATES FOR ON-FARM SYSTEM COST AND SAVINGS – TECHNICAL POTENTIAL

Analysis Area	Annual Cost (M$/yr)	Present Value of Annual Cost (M$)	One-Time Capital Conversion Cost (M$)	Savings in Recoverable Loss (TAF)	Savings in Irrecoverable Loss (TAF)	Potential ET Saved by RDI (TAF)
1040	$2.68	$36.93	$0.55	0.0	18.3	4.0
2010	$2.31	$31.85	$0.30	0.0	12.6	3.7
3010	$60.04	$826.41	$1.88	185.9	60.3	7.9
4010	$14.74	$202.89	$0.57	77.2	116.1	9.7
5010	$20.59	$283.43	$3.72	151.5	20.0	0.3
5030	$18.54	$255.22	$6.09	103.7	51.0	6.3
5060	$35.27	$485.52	$6.80	196.6	18.5	5.4
5070	$32.87	$452.45	$6.56	247.5	34.8	4.7
5090	$33.30	$458.35	$5.75	187.9	16.6	1.7
5100	$64.71	$890.71	$9.24	290.2	32.0	2.7
5110	$7.28	$100.18	$2.32	74.9	2.6	0.8
6030	$31.36	$431.67	$3.48	2.1	182.6	9.1
6060	$61.90	$852.10	$13.63	257.4	40.1	2.3
6070	$122.55	$1,686.90	$22.28	616.4	79.2	27.5
7020	$43.00	$591.90	$15.78	7.2	100.6	3.0
7030	$141.08	$1,941.97	$31.09	371.1	218.4	11.1
7040	$138.69	$1,908.99	$25.34	586.2	143.3	24.9
7090	$64.40	$886.41	$11.51	295.6	90.8	15.0
8010	$12.93	$178.01	$3.81	56.8	18.9	0.0
10020	$7.42	$102.16	$0.75	32.2	33.3	2.4
10040	$21.12	$290.73	$4.29	94.3	72.6	0.0
Total	**$936.79**	**$12,894.78**	**$175.76**	**3834.8**	**1362.3**	**142.6**

TABLE 2.26 SUMMARY ESTIMATES FOR DISTRICT COST AND SAVINGS – TECHNICAL POTENTIAL

Analysis Area	Irrigated Acres (1,000 ac.)	Annual Cost (M$/yr)	Present Value of Annual Cost (M$)	Savings in Recoverable Loss (TAF)	Savings in Irrecoverable Loss (TAF)
1040	67.1	$0.00	$0.00	0.0	0.0
2010	56.9	$0.00	$0.00	0.0	0.0
3010	605.0	$0.00	$0.00	0.0	0.0
4010	275.7	$0.00	$0.00	0.0	0.0
5010	218.8	$25.43	$350.08	23.2	33.8
5030	199.2	$18.52	$254.98	43.3	45.8
5060	516.8	$60.07	$826.88	113.9	41.0
5070	523.7	$68.48	$942.66	143.0	55.7
5090	256.0	$20.83	$286.72	37.2	9.1
5100	425.7	$39.59	$544.90	95.5	23.9
5110	127.7	$11.87	$163.46	12.9	3.2
6030	288.2	$20.10	$276.67	8.4	9.6
6060	437.4	$35.59	$489.89	0.5	106.5
6070	1051.1	$109.96	$1,513.58	13.6	203.2
7020	593.2	$0.00	$0.00	0.0	0.0
7030	928.4	$48.56	$668.45	0.0	153.8
7040	1110.9	$77.48	$1,066.46	0.0	191.8
7090	579.5	$40.42	$556.32	0.0	90.9
8010	92.7	$10.78	$148.32	4.6	8.5
10020	63.0	$5.49	$75.61	0.0	19.2
10040	145.8	$12.71	$174.95	0.0	61.1
Total	**8562.8**	**$605.89**	**$8,339.92**	**496.2**	**1057.0**

Projection Level 5 (PL-5): Locally Cost-Effective Practices with ROD Funding Levels—District

District-level costs for PL-5 are also $15 million per year (in annual equivalents), and includes both amortized capital investment and operation and maintenance. Importantly, the district-level expenditure is also required to enable the level of on-farm management and savings estimated for PL-5. The applied water savings is split into estimated changes in recoverable and irrecoverable losses, using DWR's Water Plan Update estimates as a basis for the split in each analysis area.

- Annual applied water savings are shown in Table 2.24 and are estimated to total 48,000 acre-feet per year in reduced irrecoverable losses (flows to salt sinks and non-beneficial evaporation and ET) and about 72,000 acre-feet of reduced recoverable losses. Note that these savings do not account for potential third-party impacts, such as reductions in groundwater recharge or surface return flow that would have been used by others.
- Spending on district improvements also supports on-farm efficiency improvements. Some of the initial district spending is to improve the delivery flexibility, enabling on-farm improvements that are already included in Table 2.23.

Projection Level 6 (PL-6): Technical Potential

This analysis is intended to indicate the maximum applied water savings achievable at the field and district delivery levels if cost were no barrier. All applied water savings are split into estimated changes in recoverable and irrecoverable losses, using DWR's Water Plan Update estimates as a basis for the split in each analysis area.

Projection Level 6 (PL-6): Technical Potential—On-farm

Cost is not limited in this projection, except that acreage already using highly efficient and expensive irrigation systems (defined as pressurized systems operated at high management levels) is assumed to be at the maximum technical potential. Target annual increases in investment (irrigation system costs) are set very high to ensure they are unconstrained, and the model estimated the irrigation systems selected, the applied water savings, and the actual increase in costs that result. Table 2.25 summarizes the results by analysis area. Results suggest the following:

- Total annual cost for achieving full technical potential is estimated at about $937 million per year, plus an additional one-time capital conversion cost of about $176 million. The present value of the annualized costs is almost $13 billion (discounted for 30 years at 6%).
- Annual applied water savings are estimated to total over 1.3 million acre-feet per year in reduced irrecoverable losses (flows to salt sinks and non-beneficial evaporation and ET) and over 3.8 million acre-feet of reduced recoverable losses. Note that these savings do not account for potential third-party impacts, such as reductions in groundwater recharge or surface return flow that would have been used by others. Third-party impacts would be quite substantial in this PL.
- The final column in Table 2.25 is an estimate of potential reductions in crop ET from implementation of RDI.

Projection Level 6 (PL-6): Technical Potential—District

This analysis assesses the maximum applied water savings achievable at the district level. Cost is not limited in this projection, except that districts already using highly efficient delivery systems (defined as piped delivery facilities with sufficient regulating reservoirs for management) are assumed to be at the maximum technical potential. The annual cost is the product of the average per acre cost of upgrading to the technical potential and the number of acres not currently served by piped systems. Table 2.26 summarizes the results by analysis area. Results suggest the following:

- Total annual cost for achieving full technical potential is estimated at just over $605 million per year. The present value of the annualized costs is over $8.3 billion (discounted for 30 years at 6%).
- In some analysis areas (for example, Bay Area, Central Coast, and South Coast) organized water suppliers that deliver irrigation water are currently operating at a high level of efficiency, so no money is shown spent in these areas. This assumption is used for planning purposes but it does not necessarily imply that state or federal funding should not be used in these areas for improved water management.
- Annual applied water savings are estimated to total over 1 million acre-feet per year in reduced irrecoverable losses (flows to salt sinks and non-beneficial evaporation and ET) and almost 500,000 acre-feet of reduced recoverable losses. Note that these savings do not account for potential third-party impacts, such as reductions in groundwater recharge or surface return flow that would have been used by others. Third-party impacts would be quite substantial in this PL.

Statewide Summary

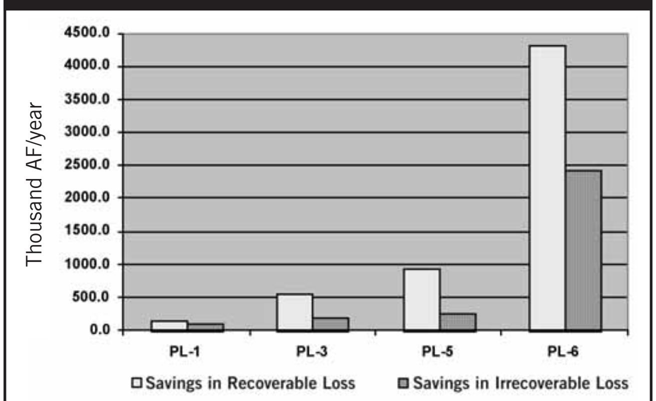
Figure 2.16 summarizes the estimated annual reductions in recoverable and irrecoverable losses by projection level. District and on-farm reductions are combined.

TABLE 2.27 SUMMARY TABLE OF RECOVERABLE FLOW AND IN-STREAM FLOW NEEDS

Analysis Area	River & Targeted Benefits[1]	Flow Need[2]	Range of Quantifiable Objectives[3]	On-Farm & District Recoverable Flows[4] PL-1	PL-3	PL-5	PL-6
5030 (NW Sacramento Valley)	Bear, Clear & Cow (1–5)	NA	NA	3.1	12.6	23.6	147.1
	Antelope, Deer & Mill (9–12)	NA	NA				
5060 (Colusa Basin)	Sacramento (6)	1,672	44–180	7.6	70.4	120.3	310.5
5070 (Butte, Sutter, Yuba)	Butte (37)	NA	NA	3.3	82.7	140.7	390.5
	Feather (38)	130	2.9–54				
	Yuba (39)	40	1–5.6				
	Bear River (56)	130	56.1–58.7				
5090 (Delta)	Cache & Putah (50)	NA		11.8	39.3	67.6	225.2
5110 (Central Basin)	American (55)	251	1.8–31.2	18.9	32.7	45.7	87.8
	Cosumnes (67)	212	0.6–1.5				
	Mokelumne (68)	15	2.3				
6030 (East Valley Floor)	Calavaras (66)	62	0.8	0.0	0.2	1.8	10.5
6070 (Eastside San Jose Valley) & 7040 (Fresno)	Stanislaus (113)	142	14–129.1	33.4	103.0	172.6	1.202.6
	Tuolumne (114)	20	13–43.3				
	Merced (130)	3	1.9				
	San Joaquin (113)	NA	NA				

1. Refers to the listed Targeted Benefit (see http://calwater.ca.gov/Archives/WaterUse Efficiency/WaterUseEfficiencyQuantifiableObjectives.shtml).
2. Targeted Benefit flow need.
3. Range over year type of quantifiable objective, volumes during irrigation season.
4. Includes locally cost-effective on-farm savings.

FIGURE 2.16 SUMMARY OF TOTAL ANNUAL REDUCTIONS (DISTRICT PLUS ON-FARM) IN AGRICULTURAL WATER USE BY PROJECTION LEVEL



TARGETED BENEFITS RESULTS

The projection analysis determines recoverable and irrecoverable flows for each analysis area. These results are then aligned with the analysis areas that contain the targeted benefits. Table 2.27 lists the in-stream flow targeted benefits, the associated analysis area, total flow need, and the range of quantifiable objective. In addition, the table presents the sum of on-farm and district recoverable flows. Irrecoverable flows are not included because program implementation history indicates that recoverable flows are all that applicants are willing to pursue when applying to meet ecosystem benefits.

The flow need and the range of quantifiable objectives in Table 2.27 are the total annual volume of water for a weighted average year type. These annual amounts vary by month and year type. The volumes of water made available under the various projection levels are an annual total and are not available on a monthly time step, therefore there is no temporal correlation between the volume of recoverable flows available, the flow need, and the range of quantifiable objectives. Furthermore, the hydrology estimates from the California Water Plan Update are only available on an annual basis without regard to year type, therefore no direct comparison can be made. Table 2.27 does not include water quality benefits that accrue due to changes in return flow and deep percolation—

TABLE 2.28 REDUCTIONS IN IRRECOVERABLE FLOWS, BY ANALYSIS AREA AND PROJECTION LEVEL

Analysis Area	Quantifiable Objective	Projection Level (on-farm & district irrecoverable flows in TAF/year) 1	3	5	6	RDI
5030	13	38	38	40	97	6
5060 & 5070	44	1	5	13	150	10
5090	5	0	0	2	26	2
5110	2	0	0	5	6	1
6030	9	1	19	34	192	9
5100	12	0	1	5	56	3
6060	86	0	0	8	147	2
6070	38	0	0	10	282	27
7020	9	3	18	5	101	3
7030	6	5	9	13	372	11
7040	35	1	1	2	335	25
7090	19	1	2	4	182	15
Total	**277**	**49**	**94**	**142**	**1,945**	**114**

which are the flow paths used to pursue in-stream benefits. For some rivers, such as those on the east side of the Sacramento Valley and the San Joaquin Valley, there appears adequate potential at moderate funding levels (PL-1 and PL-3) to use WUE to meet in-stream flow needs.

Table 2.28 lists the irrecoverable flow (water quantity) targeted benefits, along with their combined quantifiable objective and the projection analysis results. In addition, the volume of water generated through regulated deficit irrigation is provided. In PL-1, several regions demonstrate potential to meet the water quantity objectives through reduced flows to saline sinks and ET reductions through the use of micro-irrigation. Implementing regulated deficit irrigation shows potential to meet water quantity needs in several of the analysis areas.

AVERAGE AND INCREMENTAL COST

All costs have been expressed as annual equivalents, including amortized capital and annual operation, maintenance, and management. Projection levels 1 through 5 are defined by their assumed cost, whereas for PL-6 costs are estimated as the spending required to generate the full technical potential. Unit average cost is the total annual cost of the projection level divided by its total savings. Unit incremental cost is defined as the cost per acre-foot needed to generate the additional water savings, as compared to the next lower level of spending. For example, the incremental cost of water savings for PL-5 is the additional annual cost of PL-5 divided by the additional annual water savings. These are similar to marginal costs, except that the increment of change is a discrete jump in cost and savings between projection levels. Due to the very large jump in cost and savings between PL-5 and PL-6, an intermediate level of spending ($500 million per year) was analyzed simply for the purpose of getting a more realistic estimate of the incremental cost of water as the technical potential is approached.

FIGURE 2.17 AVERAGE AND INCREMENTAL COST OF REDUCTIONS IN IRRECOVERABLE LOSS BY PL

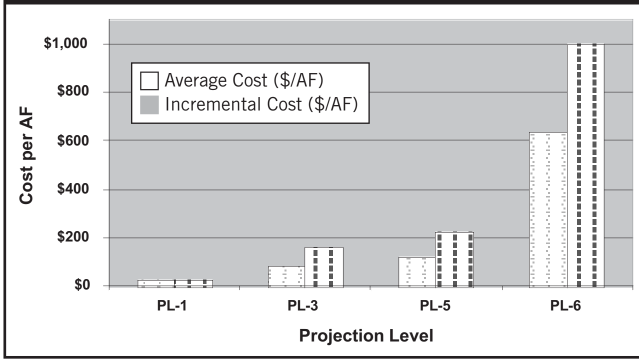


Figure 2.17 illustrates the average and incremental cost by projection level, expressed as the annual cost per acre-foot of reduction in irrecoverable loss. Both on-farm and district costs and reductions are included. Only irrecoverable losses are considered for two reasons. First, the incremental cost is particularly useful in comparing the cost of WUE to the cost of other water management and supply options being considered by the CALFED program. As a potential source of water supply for other uses, savings in irrecoverable losses provide a better comparison. Second, savings in recoverable losses can create significant third party impacts on other water uses—recoverable losses in one use or analysis area can appear as water supply to another use or analysis area. A meaningful estimate of the incremental cost per unit of reduced recoverable loss would need to account for such impacts.

All costs shown in the projection level analysis are estimated at the location of the savings. As such, they represent a reasonable estimate of the cost to provide saved water (reductions in irrecoverable losses) within the local area of the savings. In order to assess the cost of savings made available to a more distant location, say to an urban coastal demand region, a number of additional adjustments must be considered. First, transportation costs and conveyance losses will be incurred. If insufficient conveyance capacity is available, an additional cost may be needed to increase the capacity. Regulatory and capacity constraints often result in less water being received by the buyer than was saved by the seller. Finally, permitting and other transaction costs add to the final cost of water received.

ADDITIONAL ANALYSES

Effect of Land Use and Cropping Pattern Changes

The estimates of water use savings presented in the projection level analysis assumed that cropping patterns were held constant at acreages observed in the year 2000. In recent years, however, California crop production has exhibited a trend toward increased acreage of permanent crops, including grapes, almonds, and other deciduous orchards. Other crops, notably sugar beets and grains, have declined. These trends have been documented in statistics gathered by the Department of Water Resources and the Department of Food and Agriculture. The previous version of the California Water Plan Update (Bulletin 160-98, California DWR, 1999) used data through 1995 to project irrigated crop acreages out to the year 2020; these projections showed continued trends toward permanent crops and vegetables.

Recent data from the year 2000 indicate that the trends for permanent crops have progressed faster than previously estimated. In the major agricultural regions of the Central Valley, total acreages of grapes, almonds, and other deciduous orchards have already surpassed (after only 5 years) the levels the DWR projected they would reach after 25 years. Table 2.29 shows a statewide summary by crop category of the irrigated acreage in 1990 (actual), 2000 (actual), and 2020 (projected based on 1995 acreage). Although conclusions should not be drawn solely based on a comparison of two years, it appears that the shift of total crop acreage toward permanent crops is more rapid than earlier projected, responding to a more rapid growth in demand for these farm products. The DWR has not yet revised its crop acreage projections for the most recent California Water Plan Update.

Total land in irrigated crop production is also expected to decline, largely as a result of conversion of farm land to urban uses. Although some additional land may come into production, it will not offset the loss of farmland. The California Water Plan Update projected that by the year 2020 about 430,000 acres would be out of production compared to 1995. Some of this will be offset by additional double-cropping of vegetable crops.

Recent acreage statistics also show that rice and alfalfa have increased since 1995, driven by market demand for rice and dairy products.[27] These two crops are significant users of irrigation water. Earlier projections by the DWR had forecast their acreages to decline over time. It is unclear whether the increase in rice and alfalfa acreage will be maintained into the future.

These trends have important implications for agricultural water use quite apart from changes in water use efficiency. The projected net loss of land to irrigated farming will reduce agricultural water use in the future, all else equal.[28] However, the shift in crop mix could offset the total acreage effect or reinforce it, depending on the water use characteristics of the future crop mix. Applying the crop mix projected in the previous California Water Plan Update would result in an aggregate reduction in crop water use, but recent crop trends suggest that a more current assessment may provide a different conclusion. In order to get a sense of the potential for future crop water use, an example crop acreage projection was developed using recent available data to revise the DWR's earlier projection. This is an example only, and is not the result of a careful economic study of future demand and supply of California agricultural products.

The following general principles and assumptions were used to revise the crop acreage projections from the DWR's previous California Water Plan Update (Bulletin 160-98):

- Irrigated area in each region is the same as the Bulletin 160-98's projection for 2020.
- A simple update formula is used to revise the earlier projected trend in crop mix. The formula is a weighted average between the earlier linearized trend (comparing the 1995 and 2020 acreage estimates for Bulletin 160-98) and a new linear trend estimated from 1995 and 2000 crop acreage data.
- The earlier trend is given preference in the weighting unless that appears to be inconsistent with recent data. The new linear trend is given up to a 50% weight in the revised projection.
- Crop acreage trends for grapes, almonds, and other deciduous orchards are adjusted enough to account for the more rapid crop shifts that are implied by recent data.
- Because this is an example only, no further extrapolation beyond 2020 is made.

Results of the revised acreage projections are summarized by crop category for California in Table 2.29. The table shows the estimated acreage for 1995 and 2000. It also lists the original 2020 projection from Bulletin 160-98 and the example revised projection. Key differences in the example revised projection are: permanent crop acreage increases faster than previously projected; rice and forage acreage declines less than previously projected; and grain and row crop acreage declines faster than previously projected.

Table 2.30 compares estimates of acreage, applied water,

27. Alfalfa hay is a major component of dairy cattle feed.

28. We should stress that market forces could reverse this effect if, for example, demand grew for higher water-using crops such as rice and alfalfa. The dairy industry is the largest consumer of alfalfa and other forages, so increased demand for California dairy products would be expected to induce greater production of forage crops.

TABLE 2.29 COMPARISON OF OBSERVED AND PROJECTED CROP ACRES FOR CALIFORNIA

Crop Category	Estimated 1995 Crop Acres	Estimated 2000 Crop Acres	Bulletin 160-98 2020 Projected Crop Acres	Example Revised 2020 Projected Crop Acres
Alfalfa, Pasture	2,027,000	1,960,000	1,755,000	1,841,000
Grain	900,000	862,000	800,000	775,000
Rice	517,000	587,000	500,000	525,000
Row	2,149,000	1,955,000	1,965,000	1,760,000
Sugar Beet	178,000	94,000	120,000	45,000
Tomato	357,000	351,000	390,000	359,000
Tree Crops, Vineyards	2,327,000	2,656,000	2,395,000	2,835,000
Vegetable	1,060,000	1,048,000	1,265,000	1,119,000
Total Crop	9,515,000	9,512,000	9,190,000	9,260,000
Multi-Crop	447,000	537,000	555,000	625,000
Irrigated Land	9,068,000	8,975,000	8,635,000	8,635,000

TABLE 2.30 EXAMPLE REVISED CROP ACRES AND WATER USE PROJECTION FOR 2020 FOR ANALYSIS AREAS ONLY

	Estimated 2000 Crops and Water Use			Example Revised 2020 Projection		
Crop Category	Crop Acres	Applied Water (million AF)	ET of Applied Water (million AF)	Crop Acres	Applied Water (million AF)	ET of Applied Water (million AF)
Alfalfa, Pasture	1,817,000	8.68	6.06	1,808,000	8.44	5.89
Grain	1,076,000	1.66	1.15	774,000	1.27	0.88
Rice	586,000	3.23	1.83	525,000	2.89	1.64
Row	1,725,000	5.08	3.72	1,757,000	5.14	3.76
Sugar Beet	94,000	0.36	0.25	45,000	0.19	0.13
Tomato	351,000	0.95	0.70	359,000	0.96	0.71
Tree Crops, Vineyards	2,610,000	7.81	5.85	2,833,000	8.40	6.29
Vegetable	1,021,000	2.14	1.47	1,111,000	2.41	1.65
Total Crop	9,280,000	29.9	21.0	9,213,000	29.7	21.0

and ET of applied water implied by the revised acreage forecast to the same estimates for the 2000 crop mix, holding irrigation performance constant. The forecast implies that, on average for the state, total applied water would decline by about 200,000 acre-feet per year between 2000 and 2020 (from 29.9 million acre-feet per year to 29.7 million acre-feet per year), although the irrigation water applied per irrigated acre is virtually unchanged. ET of applied water per irrigated acre is about the same after the crop shifts, but the permanent crops that are increasing are irrigated at a higher SAE. The aggregate reduction in irrigation water application is entirely a result of the net reduction in irrigated acres. This revised projection is an example only, but illustrates the importance of market trends and the caution that must be used in drawing conclusions about projected future crop water use.

Increasing Use of Drip and Micro-sprinkler Irrigation on Permanent Crops

The example projection described above maintained the seasonal application efficiency by crop at average levels estimated by the DWR for the year 2000. Data from surveys of irrigation systems show that new permanent crop acres are much more likely to be developed with drip or micro-sprinkler irrigation.[29] The potential for additional savings in applied water from these irrigation system changes are assessed in two steps.

First, if all of the new acreage of permanent crops is installed with drip or micro-sprinkler the seasonal application efficiency is estimated to be about 90%, compared to the existing average of 75%. An increase of 224,000 acres of permanent crops is included in the example projection. If all of these acres were developed with drip irrigation at an SAE of

29. See Table 2.15 on page 49.

90%, about 100,000 acre-feet of applied water would be saved compared to application at the current average SAE.

Second, existing acreage of permanent crops could be expected to convert to drip or micro-sprinkler irrigation. Although the conversion has been fairly steady in recent years, that rate may or may not continue. For purposes of this sensitivity analysis, we assume that 10% of the existing acreage converts from systems currently averaging 70% SAE to drip systems at 90% SAE. About 185,000 acre-feet of applied water would be saved per year under this example.

DISCUSSION AND QUALIFICATION OF RESULTS

Split of On-farm and District Spending and Costs—For analytical purposes, the total state investment in agricultural WUE for PL-3 and PL-5 was split evenly between district and on-farm improvements. This does not imply that available grant funds would be directed for allocation in this way. It also does not represent a judgment about the cost-effectiveness of district versus on-farm improvements. Rather, it is a simplifying assumption used to recognize that:

- Both district and on-farm savings can play an important role in implementing an agricultural WUE program. Existing district delivery systems, on-farm systems, and crop mix vary widely across regions, so a mix of district and on-farm spending is needed to accommodate that variability.
- Although on-farm savings appear to be more cost-effective based on results displayed in Tables 2.15–2.18, that result is misleading because district flexibility spending allows water to be saved in on-farm irrigation, but that savings does not appear in the district results tables.
- Over time the mix of district and on-farm spending could change. Recent proposals for grant funding have focused more on district improvements. This is to be expected because districts are better able to identify their own system needs and to garner the resources needed to prepare a grant application. Over time, on-farm improvements should also play a role in applications for funding. The WUE program should monitor the way money is spent and assess whether the split of district and on-farm investment is appropriate or whether future grant funding cycles need to be modified to maintain a reasonable balance.

One-time Versus Continuing Investment—WUE improvements, especially at the on-farm level, require a combination of hardware improvements and operations and management improvements. Therefore, investments in WUE will provide the greatest long-term benefits if the financing program is structured to achieve that, with a combination of capital investment assistance and on-going operations and management assistance. Such a requirement suggests that reliance solely on bond-financed capital investments may not be the most sustainable way to assure long-term benefits.

Limitations of the Analytical Approach—A number of important assumptions have been made in the way data were collected, aggregated, and analyzed in this report. Although the report has attempted to present its analysis at a relatively detailed geographic disaggregation, it is important not to read too much into apparent differences across analysis areas. Some analysis areas had good measurements on many of the key water flow and water use data, but others did not. Assumptions and water balance calculations were used to estimate some of the data. Large apparent differences in some water use data in adjacent analysis areas could be partially attributed to the way different analysts made the necessary assumptions and calculations, or they could be a result of inaccurate or incompatible measurements. Other differences could reflect real differences in water use that result from variability in physical, economic, and institutional conditions.

Optimizing analysis was used to assess the potential savings and costs of on-farm improvements. Optimization, in the way it was used for this analysis, produces the greatest reduction in on-farm water application for a target level of investment, subject to constraints. In reality, a program to fund on-farm WUE improvements relies on imperfect information and uncertain results. Funds cannot be spent in a way the produces the greatest possible benefit. Therefore optimization likely overstates potential savings, all else equal. However, the tendency for an optimization approach to overstate potential savings is offset by the analytical assumption that the relative price (value) of water is constant in real terms. It is more likely that the value of water will increase more rapidly than general prices in the economy, and this would provide growers and districts with more incentive to adopt WUE improvements. This analysis that holds the relative value of water constant likely understates the future willingness of growers and districts to adopt cost-effective system improvements.

Importance of Objectives-based Program Implementation—The potential improvements in water use efficiency estimated in this review are based on spending money in a cost-effective manner to achieve CALFED objectives. In order for this assumption to be borne out, the grants program must be designed, implemented, and monitored in a way that supports cost-effective, objectives-based planning. The grants program needs to:

- Assure that CALFED objectives are fundamentally incorporated into the selection criteria for grant funding.
- Set review and selection criteria that are consistent from year to year and that encourage good applications.
- Provide adequate resources to monitor and evaluate the performance of funded projects.
- Gauge its own performance by how well it meets CALFED and other statewide objectives.

In short, the purpose of an effective grants program is not simply to award grants, but rather to achieve the defined objectives of improving water supply, water quality, and in-stream flow. If the grants program deviates significantly from an objectives-based approach, the overall performance is likely to fall substantially short of the projections made in this review.

Results are Planning-level Estimates Only—The district and on-farm improvements projected in the various projection levels indicate the potential for improvements, but should not be viewed as detailed projections or plans. Although estimates were made for analysis areas intended to represent relatively consistent water use conditions, actual conditions can vary in important ways between districts within an analysis area and between farms in a district. Water use estimates for each analysis area are derived from DWR estimates that are themselves only a best estimate based on a combination of good measurements, imprecise measurements, and water balance calculations.

The actual amount, distribution, and effectiveness of WUE investments will depend on future funding and on the particular projects that local partners propose for state funding. The same factors that have driven improvements in the past will also affect future projects: technological development, economic and regulatory conditions, and water supply conditions.

USES OF RESULTS

Water Use Efficiency Program—Results of the projection analysis provide the WUE program with a range of possible water use projections for different scales of statewide investment. The range allows planning and budget decision-makers to assess how the program might and perhaps should perform for different implementation intensities. Rough estimates of cost and unit cost can be compared against other CALFED Program elements and provide one way of judging the effectiveness of spending across program elements. The data and analytical results produced for the projection analysis also provide a baseline for periodic performance reviews and adaptive management.

Finance Planning—The January 2005 10-year Finance Plan for the CALFED Program used projection level 5 as the basis for estimating the funding needs for an on-going WUE grant program. The Finance Plan used analytical results from the projection analysis described in this document to estimate local versus non-local (CALFED) benefits for purposes of allocating costs among local, state, and federal beneficiary groups.

California Water Plan Update—The 2005 draft California Water Plan Update incorporated WUE projections among its potential tools for water management called "resource management strategies". For that document, projection levels 1, 3, and 5 are included as resource management strategies, along with several higher levels of investment. These WUE options are considered along with other water management strategies, including conjunctive management, recycling, surface storage, and transfers as potential ways to meet the State's future water demands.

Common Assumptions for Surface Storage Studies—Common Assumptions is an agency-led effort to ensure that a consistent approach to modeling and data is used for the investigation of the five CALFED surface storage sites. The potential quantities and costs associated with WUE options are being incorporated into the evaluation of the costs and benefits of potential surface storage projects. Results of projection level 1 will be used to help set the baseline future conditions for the studies. This analysis is used because it most closely meets NEPA's "reasonably foreseeable" criteria. The costs and quantities of higher levels of water use efficiency are being incorporated into the economic models that will be used to evaluate potential projects.

APPENDIX 1A:

LISTING OF TARGETED BENEFITS AND FUNDING ACTIVITY

TABLE 1A1 DEFINITIONS OF TARGETED BENEFIT LISTING IN TABLE 1A2	
Column Header	**Definition**
Targeted Benefit (TB#)	Listing that states an objective for irrigated agriculture. See www.calwater.ca.gov and search for "Details of quantifiable objectives."
Location	Provides general specificity of where benefit is needed.
Applicant	Agency of entity that received funding.
Quantifiable Objective	Represents the portion of the targeted benefit that applies to irrigated agriculture. See www.calwater.ca.gov and search for "Details of quantifiable objectives."
State funding	State funding toward the project. When a project addresses more than one Targeted Benefit, comments are used to list the other targeted benefits. State funding is only listed once but applies to all targeted benefits that the grant $ are pursuing—see comment for multiple targeted benefits.
Local funding	State funding toward the project. Local funding is only listed once but applies to all targeted benefits that the grant $ are pursuing—see comment for multiple targeted benefits.
Expected Benefit	What applicant claimed when application was submitted for funding. Benefit is only listed once but applies to all targeted benefits that the grant $ are pursuing—see comment for multiple targeted benefits.
Duration of Benefit	What applicant claimed when application was submitted for funding. Benefit is only listed once but applies to all targeted benefits that the grant $ are pursuing—see comment for multiple targeted benefits.
Comments—Reference to Other Targeted Benefits	Lists multiple targeted benefits pursued by grant.

Table 1A1 describes the columns in Table 1A2. The information is sorted by category of benefit as either in-stream flow and timing for aquatic habitat, water quality for ag, eco or M&I, or water quantity. Targeted benefits that are not addressed through funding efforts are also listed.

APPENDIX 1A

TABLE 1A2 TARGETED BENEFIT ACTIVITY AND FUNDING EFFORT—IN-STREAM FLOW AND TIMING

TB#	Location	Applicant	Quantifiable Objective (TAF/year)	State Funding	Local Funding	Expected Annual Benefit (AF)	Benefit Duration (Years)	Comments Reference to Other TBs
6	Sacramento River below Keswick	Anderson-Cottonwood ID	44–180	$1,875,266	$40,000	3,256	30	SB 23 Feasibility study see TB 7; Prop 50 Implementation for 3256 AF/yr, life estimated based on type of project
10	Deer Creek	Deer Creek ID	TBD	$1,442,434		1,700	30	Prop 50 1,154,000 for instream flow and temp see TB 16; Prop 50 feasibility for phase II
13	Sacramento River below Keswick	Anderson-Cottonwood ID; Clenn Colusa ID; Reclamation District 108	44–180	$268,153	$176,000			Three separate feasibility studies see SB23; 100,000 TB 13, 20, 27, 30, 35
20	Sacramento River below Keswick	Orland Unit WUA	44–180	$100,000	$13,636			SB 23 (3 grants) see TB 13, 20, 27, 30, 35; Prop 50 feasi-bility see 25, 26, 27, 81
30	Sacramento River below Keswick		44–180					See TB 13, 20, 27, 27, 30, 35
38	Feather River	Western Canal WD; Oroville-Wyandotte ID	2.9–54	$553,183	$402,471	6,510	50	SB23 (2 grants): canal lining @695 AF/yr and measurement calibration cost $265,000 South Feather & Western Canal; P50 $104,000 to Western Canal gate replacement also see TB 31, 33
76	Western Delta	Golden State Irrigation Services	TBD	$299,500	$488,657	453	15	
112	San Joaquin River	San Joaquin River Drainage Authority	TBD	$1,391,200	$956,938	22,632	30	
113	Stanislaus River	Modesto ID Oakdale ID	14–129.1	$1,505,500	$2,180,750	4,038	10	SB23 (2 grants); one specific for 113 other see TB 106, 107, 113, 114, 127, 130, 144; Prop 50 (2 grants) one for 113, other see 116, 121, 123, 125, 140 - life estimated
114	Tuolumne River		13–43.3					See TB 106, 107, 113, 114, 127, 130, 144
130	Merced River		1.9					See TB 106, 107, 113, 114, 127, 130, 144
131	San Joaquin River	Stevinson Water District	TBD	$896,000	$107,200	425	30	Also supports TB 138. Applicant received an additional $603,000 from SWRCB and $300,000 from BoR Water 2025
148	San Joaquin River	Columbia Canal Company	TBD	$152,823	$152,823	857	7	7 year project

APPENDIX 1A

TABLE 1A3 TARGETED BENEFIT ACTIVITY AND FUNDING EFFORT—WATER QUALITY

TB#	Location	Applicant	Quantifiable Objective (TAF/year)	State Funding	Local Funding	Expected Annual Benefit (AF)	Benefit Duration (Years)	Comments Reference to Other TBs
16	Deer Creek	Deer Creek ID	TBD					see TB 10
31	Sacramento River	Western Canal WD	TBD					see TB 38, 33; quality benefit not quantified
43	Colusa Drain	Clenn Colusa ID	TBD	$100,000	$19,000			
81	Delta	Branta Carbona ID and Yolo County RCD	TBD	$200,500	$14,000			see TB 81, 84, 87; states' potential of 700 t sediment and 2500 t salt
84	Delta		TBD					see TB 81, 84, 87
95	Grassland Marshes	Panoche ID	TBD	$100,000				see TB 95, 96, 97, 98 ,99, 102, 103
96	Mud and Salt Slough		TBD					see TB 95, 96, 97, 98 ,99, 102, 103
97	Mud Slough		TBD					see TB 95, 96, 97, 98 ,99, 102, 103
98	San Joaquin River		TBD					see TB 95, 96, 97, 98 ,99, 102, 103
99	Salt Slough		TBD					see TB 95, 96, 97, 98 ,99, 102, 103
102	Grassland Marshes		TBD					see TB 95, 96, 97, 98 ,99, 102, 103
103	Mud and Salt Slough		TBD					see TB 95, 96, 97, 98 ,99, 102, 103
116	Stanislaus River	Oakdale ID	TBD					Prop 50 see 116, 121, 123, 125, 140
121	Stanislaus River	Oakdale ID	TBD					Prop 50 see 116, 121, 123, 125, 140
123	San Joaquin River at Vernalis	Oakdale ID	TBD					Prop 50 see 116, 121, 123, 125, 140
125	Stanislaus River	Oakdale ID	TBD					Prop 50 see 116, 121, 123, 125, 140
138	Tuolumne River	Oakdale ID	TBD					see TB 131
140	San Joaquin River at Vernalis	Oakdale ID	TBD					Prop 50 see 116, 121, 123, 125, 140

TABLE 1A4 TARGETED BENEFIT ACTIVITY AND FUNDING EFFORT—WATER QUANTITY

TB#	Location	Applicant	Quantifiable Objective (TAF/year)	State Funding	Local Funding	Expected Annual Benefit (AF)	Benefit Duration (Years)	Comments Reference to Other TBs
7	non-productive ET reduction		6.5					see TB 6
18	non-productive ET reduction	Orland Unit Water Use Association	6.5	$100,000	$13,636			see TB 13, 18, 20, 27
26	Improve water supply reliability	Yolo County RCD	TBD	$272,000	$327,144			see TB 20, 25, 26, 81
27	Wetlands		7.9					two separate feasibility studies see TB 13, 20, 27, 30, 35
33	non-productive ET reduction	Western Canal WD	4.6					see TB 38, 31; quantity benefit not quantified
35	Wetlands		4.5					see TB 13, 20, 27, 27, 30, 35
51	Improve water supply reliability	Solano ID	TBD	$100,000				states' potential of 7500 AF
64	Improve water supply reliability	Placer County WA	TBD	$762,744	$662,744	4,867	30	SB 23 benefits are 4,867 Af/yr for 30 years; No benefit objective for P13
87	Reduce flows to salt sinks		TBD					see TB 81, 84, 87
106	Reduce flows to salt sinks	CSU Fresno, CIT	4.9–111	$175,010	$106,400	3,500	3	three grants; 3 yr @3,500 AF/yr and scheduling and mobile lab see TB 106, 107, 164, 167, 168, 176, 193, 196, 197
107	non-productive ET reduction	West Stanislaus RCD	8.7	$160,523	$263,235	1,360	10	three grants; 3 yr @3,500 AF/yr and scheduling and mobile lab see TB 106, 107, 164, 167, 168, 176, 193, 196, 197
127	non-productive ET reduction		7.5					see TB 106, 107, 113, 114, 127, 130, 144
144	non-productive ET reduction		8.2					see TB 106, 107, 113, 114, 127, 130, 144
164	non-productive ET reduction	West Hills Community College and Water Tech	8.9	$300,000	$785,886	28		two grants: 28 AF/yr and not quantified see TB 106, 107, 164, 167, 168, 176, 193, 196, 197
165	Improve water supply reliability	Westlands WD	TBD	$100,000				states' potential of 10,000 AF
167	Reduce flows to salt sinks		< 1					see TB 106, 107, 164, 167, 168, 176, 193, 194, 196, 197
176	non-productive ET reduction		7.3					see TB 106, 107, 164, 167, 168, 176, 193, 194, 196, 197
181	Improve water supply reliability	Consolidated ID	TBD	$100,000				
188	Reduce flows to salt sinks	Lost Hills ID	< 1	$2,131,500	$466,220	625		four grants: SB 23 (2 grants) canal lining 30 yr @280 AF/yr and automation w/no projected benefit; Prop 50 (2 grants) canal lining 345 AF/yr
189	non-productive ET reduction	Kern-Tulare WD	4.5	$310,000	$310,000			see TB 188 for automation grant
193	non-productive ET reduction		8.1					see TB 106, 107, 164, 167, 168, 176, 193, 194, 196, 197
194	Improve water supply reliability		TBD					see TB 106, 107, 164, 167, 168, 176, 193, 194, 196, 197
196	Reduce flows to salt sinks		< 1					see TB 106, 107, 164, 167, 168, 176, 193, 194, 196, 197
197	non-productive ET reduction		6.4					see TB 106, 107, 164, 167, 168, 176, 193, 194, 196, 197

APPENDIX 1A

TABLE 1A5 TARGETED BENEFIT ACTIVITY AND FUNDING EFFORT—NOT ADDRESSED

TB#	Location	Applicant	Quantifiable Objective (TAF/year)	State Funding	Local Funding	Expected Annual Benefit (AF)	Benefit Duration (Years)	Comments Reference to Other TBs
1	Battle Creek		TBD					
2	Bear Creek		TBD					
3	Clear Creek		TBD					
4	Cottonwood Creek		TBD					
5	Cow Creek		TBD					
8	Improve water supply reliability		TBD					
9	Antelope Creek		TBD					
11	Mill Creek		TBD					
12	Paynes Creek		TBD					
14	Elder Creek		TBD					
15	Sacramento River		TBD					
17	Mill Creek		TBD					
19	Improve water supply reliability		TBD					
21	Colusa Basin		TBD					
22	Colusa Drain		TBD					
23	Sacramento River		TBD					
24	Colusa Basin		TBD					
25	non-productive ET reduction		5.1					
28	Sacramento & Delevan National Wildlife Refuge		TBD					
29	Salt affected soils		TBD					
34	Improve water supply reliability		TBD					
36	Colusa & Sutter National Wildlife Refuge		TBD					
37	Butte Creek		TBD					
39	Yuba River		1–5.6					
40	Feather River		TBD					
41	Feather River		TBD					
42	Sacramento Slough near Verona		TBD					
43	Butte Creek		TBD					
44	Feather River		TBD					
45	Yuba River		TBD					
46	non-productive ET reduction		11.1					
47	Improve water supply reliability		TBD					
48	Wetlands		10.5					
49	Graylodge Wildlife Management Area		TBD					
50	Cache & Putah Creeks	Yolo County RCD	TBD					see TB 20, 24, 26, 50, 51
52	Sacramento River		TBD					
53	non-productive ET reduction		5					

TABLE 1A5 (CONT.) TARGETED BENEFIT ACTIVITY AND FUNDING EFFORT—NOT ADDRESSED

TB#	Location	Applicant	Quantifiable Objective (TAF/year)	State Funding	Local Funding	Expected Annual Benefit (AF)	Benefit Duration (Years)	Comments Reference to Other TBs
54	Wetlands		< 1					
55	American River		1.8–31.2					
56	Bear River		59.5–93.2					
57	Sacramento River below Keswick		44–180					
58	Natomas East Main Drain		TBD					
59	Sacramento River		TBD					
60	Natomas Drain		TBD					
61	American River		TBD					
62	Bear River		TBD					
63	non-productive ET reduction		< 1					
65	Wetlands		1					
67	Cosumnes River		0.6–1.5					
68	Mokelumne River		2.3					
69	Calavaras River		TBD					
70	Mokelumne River		TBD					
71	non-productive ET reduction		8.3					
72	Improve water supply reliability		TBD					
73	Wetlands		< 1					
74	Delta		TBD					
75	Sacramento River below Keswick		44–180					
77	Delta		TBD					
78	Delta		TBD					
79	San Joaquin River		TBD					
80	Delta		TBD					
82	San Joaquin River		TBD					
83			TBD					
85	Sacramento Slough		TBD					
86	Sacramento River		TBD					
88	Delta		6.6					
89	non-productive ET reduction		5					
90	Wetlands		TBD					
91	Salt affected soils		TBD					
92	Improve water supply reliability		TBD					
93	W. San Joaquin Tributaries		TBD					
94	San Joaquin River		TBD					
100	Panoche Creek		2.3					
101	Orestimba Creek		TBD					
104	San Joaquin River		TBD					
105	San Joaquin River at Vernalis		TBD					

TABLE 1A5 (CONT.) TARGETED BENEFIT ACTIVITY AND FUNDING EFFORT—NOT ADDRESSED									
TB#	Location	Applicant	Quantifiable Objective (TAF/year)	State Funding	Local Funding	Expected Annual Benefit (AF)	Benefit Duration (Years)	Comments Reference to Other TBs
108	Panoche Creek		2.3					
109	Improve water supply reliability		TBD					
110	Salt affected soils		TBD					
111	Wetlands		TBD					
115	Specific managed wetlands		TBD					
117	San Joaquin River		TBD					
118	Tuolomne River		TBD					
119	Harding Drain		TBD					
120	Harding Drain		TBD					
122	San Joaquin River		TBD					
124	Tuolomne River		TBD					
126	San Joaquin River		TBD					
128	Tuolomne River		TBD					
129	Improve water supply reliability		TBD					
132	Wetlands		13–43.3					
133	Tuolomne River		TBD					
134	Merced River		TBD					
135	San Joaquin River		TBD					
136	Tuolomne River		TBD					
137	Merced River		TBD					
141	San Joaquin River		TBD					
142	Merced River		TBD					
143	San Joaquin River		TBD					
145	Tuolomne River		TBD					
146	Improve water supply reliability		< 1					
147	Wetlands		1.9					
149	Merced River		TBD					
150	Merced River		TBD					
151	San Joaquin River		TBD					
152	Merced River		TBD					
154	San Joaquin River		TBD					
155	San Joaquin River at Vernalis		TBD					
156	Merced River		TBD					
157	San Joaquin River		17.4					
158	non-productive ET reduction		TBD					
160	Merced National Wildlife Refugre		3.8					
161	Wetlands		TBD					
162	Salt affected soils		TBD					
163	Five Mile Slough		TBD					

TABLE 1A5 (CONT.) TARGETED BENEFIT ACTIVITY AND FUNDING EFFORT—NOT ADDRESSED

TB#	Location	Applicant	Quantifiable Objective (TAF/year)	State Funding	Local Funding	Expected Annual Benefit (AF)	Benefit Duration (Years)	Comments Reference to Other TBs
166	All affected lands		TBD					
168	Salt affected soils		6.1					
169	non-productive ET reduction		TBD					
170	Improve water supply reliability		TBD					
171	Salt affected soils		TBD					
172	San Joaquin River		TBD					
173	San Joaquin River		TBD					
177	San Joaquin River		TBD					
178	Improve water supply reliability		TBD					
179	Salt affected soils		TBD					
180	Reduce flows to salt sinks		14.2					
182	non-productive ET reduction		TBD					
183	Salt affected soils		< 1					
184	Reduce flows to salt sinks		13.2					
185	non-productive ET reduction		TBD					
186	Improve water supply reliability		TBD					
187	Pixley Nt'l Wildlife Refuge		TBD					
190	Salt affected soils		TBD					
191	Improve water supply reliability		TBD					
192	Kern Nt'l Wildlife Refuge		TBD					
195	Salt affected soils		TBD					
198	Salt affected soils		TBD					
199	Improve water supply reliability		TBD					

APPENDIX 1B:

ANALYSIS OF THE NATURAL RESOURCES CONSERVATION SERVICE'S ENVIRONMENTAL QUALITY INCENTIVES PROGRAM

TABLE 1B1 ENVIRONMENTAL QUALITY INCENTIVES PROGRAM (EQIP) ALLOCATION FOR CALIFORNIA FROM 2000–05 ($ MILLION)

EQIP Funding Categories with Potential to Meet Ag WUE Objectives	NRCS EQIP Funding Allocations						Local Share[2]	Total
	2000	2001	2002	2003[1]	2004[1]	2005[1]		
Statewide Ground & Surface Water Conservation Initiative				9.9	9.2	9.1	112.4	140.5
Regular EQIP				17.2	26.0	29.7	291.3	364.1
SUBTOTAL	5.8	22.7	16.0	27.0	35.1	38.8	403.6	504.5
CALFED Solution Area Funding based on 2002 analysis [3]	2.3	9.2	6.5	11.0	14.3	15.7	164.0	205.0
Other EQIP Funding: NOT CONSIDERED								
Klamath Basin Ground and Surface Water Conservation Initiative				5.5	4.8	4.0		
Diesel Engine Replacement Program				3.5	0.7	0.7		
Air Quality Initiative				2.0	4.8	4.3		
Other				0.6		0.5		

1. This data taken from initial allocations, actual data may change.
2. Local share is assumed at 75% of total project cost.
3. See Table 1B3 for 2002 analysis.

The NRCS supports WUE through the Environmental Quality Incentives Program (EQIP). The EQIP provides technical, financial and educational assistance to farmers and ranchers to reduce soil erosion and water quality problems associated with agricultural operations, and to enhance wildlife habitat. The program provides cost-shares for certain environmental protection practices. Although there is no coordinated effort between CALFED and NRCS to implement EQIP, Table 1B1 provides the total spent or allocated in California. The NRCS's EQIP information is available at the county level and an analysis of the actions that align with the objectives within the CALFED solution area was prepared for 2002 (Table 1B3). This analysis indicates that of the $16 million spent on EQIP in 2002, $6.5 million aligns with CALFED agricultural WUE objectives within the CALFED solution area. Although the EQIP activities are vital for producers to participate in meeting CALFED objectives, the funding is category B and therefore is not counted when comparing money spent to ROD funding targets.

The initial step in the analysis was to determine the counties that are within the CALFED solution area and overlap with the Central Valley Ground and Surface Water Model (CVGSM). The counties considered for EQIP funding within the CALFED solution area are: Amador, Butte, Calaveras, Colusa, Contra Costa, El Dorado, Fresno, Glenn, Kern, Kings, Lake, Madera, Merced, Placer, Sacramento, San Benito, San Joaquin, Solano, Stanislaus, Sutter, Tehama, Tulare, Tuolumne, Yolo, Yuba.

The basic assumption with the geographic overlay is that all money spent within the county should be counted. The next step was to review each practice (Table 1B2) to determine if it supports the CALFED objectives of water supply reliability, improved water quality or ecosystem restoration. For each practice, the question asked was "Does the practice affect water use efficiency?" For example, cover cropping is a practice that is included due to the connection between reduced runoff and improved infiltration that occurs during irrigation events. There are non-WUE benefits associated with many of the practices; however, those benefits are not considered.

Using 2002 county level data, a ratio of funding for the EQIP program with the solution area was developed (Table 1B3). This ratio was then used as a constant for all other years. It is acknowledged that this is only an estimate, as county level funding varies by year, as does the funding for particular practices.

TABLE 1B2 PRACTICES OF THE ENVIRONMENTAL QUALITY INCENTIVES PROGRAM WITH POTENTIAL TO MEET CALFED ECOSYSTEM RESTORATION, WATER SUPPLY RELIABILITY AND IMPROVED WATER QUALITY OBJECTIVES THROUGH CHANGES TO IRRIGATION WATER MANAGEMENT

	CALFED Objective		
EQIP Practice (reporting unit)	Water Supply Reliability	Water Quality	Ecosystem Restoration
Conservation Cover-(ac.)	X	X	X
Controlled Drainage-(ac.)	X	X	X
Cover Crop-(ac.)	X	X	X
Dike-(ft.)	X	X	X
Diversion-(ft.)	X	X	X
Field Border-(ft.)	X	X	X
Filter Strip-(ac.)	X	X	X
Grade Stabilization Structure-(no.)	X	X	X
Grassed Waterway-(ac.)	X	X	X
Hedgerow Planting-(ft.)	X	X	X
Irrigation Land Leveling-(ac.)	X	X	
Irrigation System-Microirrigation-(ac.)	X	X	
Irrigation System-Sprinkler-(ac.)	X	X	
Irrigation System-Surface & Subsurface-(no.)	X	X	
Irrigation System-Tailwater Recovery-(no.)	X	X	
Irrigation Water Conveyance - Ditch and	X	X	
Irrigation Water Conveyance - Pipeline -	X	X	
Irrigation Water Management-(ac.)	X	X	
Land Grading-(ac.)	X	X	
Lined Waterway or Outlet-(ft.)	X	X	
Nutrient Management-(ac.)	X	X	
Pest Management-(ac.)	X	X	
Pipeline-(ft.)	X		
Pond-(no.)	X		
Precision Land Forming-(ac.)	X	X	
Pumping Plant for Water Control-(no.)	X		
Residue Management, Seasonal-(ac.)	X		
Sediment Basin-(no.)		X	
Soil Salinity Control-(ac.)		X	
Structure for Water Control	X	X	
Subsurface Drain-(ft.)	X	X	
Waste Storage Facility-(no.)		X	
Water Well-(no.)	X		

APPENDIX 1B

TABLE 1B3 ANALYSIS OF 2002 EQIP PRACTICES WITHIN THE CALFED SOLUTION AREA					
Practice	**Count of EQIP Practices**	**Amount**	**Total Cost of Installation**	**Cost Shares Earned**	**Cost Share**
Conservation Cover	3	5 acres	$4,871	$3,300	32%
Controlled Drainage	2	61 acres	$26,785	$9,818	63%
Cover Crop	64	918 acres	$247,082	$102,171	59%
Dike	2	2,500 feet	$17,827	$5,984	66%
Diversion	1	0 feet	$6,923	$4,500	35%
Field Border	5	386 feet	$6,158	$3,196	48%
Filter Strip	4	61 acres	$3,724	$1,373	63%
Grade Stabilization Structure	8	204	$31,973	$15,940	50%
Grassed Waterway	6	303 acres	$29,431	$13,818	53%
Hedgerow Planting	35	18,022 feet	$552,432	$21,868	96%
Irrigation Land Leveling	54	9,921 acres	$611,484	$255,076	58%
Irrigation System-Microirrigation	153	35,710 acres	$12,509,187	$1,217,680	90%
Irrigation System-Sprinkler	43	8,804 acres	$939,080	$343,915	63%
Irrigation System—Surface & Subsurface	14	2	$231,475	$117,138	49%
Irrigation System—Tailwater Recovery	68	82,537	$931,596	$489,495	47%
Irrigation Water Conveyance—Ditch	17	10,165	$349,523	$123,838	65%
Irrigation Water Conveyance—Pipeline	321	362,546	$4,910,593	$2,047,817	58%
Irrigation Water Management	258	22,017 acres	$497,962	$206,610	59%
Land Grading	5	1,001 acres	$43,437	$19,432	55%
Lined Waterway or Outlet	2	0 feet	$1,845	$1,125	39%
Nutrient Management	242	20,650 acres	$160,322	$89,787	44%
Pest Management	252	26,268 acres	$486,666	$263,532	46%
Pipeline	59	140,483 feet	$317,928	$169,479	47%
Pond	24	7,215	$262,545	$136,975	48%
Precision Land Forming	1	0 acres	$670	$335	50%
Pumping Plant for Water Control	27	11	$197,654	$84,817	57%
Residue Management, Seasonal	4	0 acres	$12,486	$7,530	40%
Sediment Basin	14	1,458	$13,765	$8,062	41%
Soil Salinity Control	27	5,521 acres	$21,787	$9,944	54%
Structure for Water Control	28	31	$1,065,820	$37,807	96%
Subsurface Drain	21	28,264 feet	$186,699	$140,774	25%
Waste Storage Facility	40	37,518	$1,188,801	$466,693	61%
Water Well	8	5	$62,467	$37,576	40%
TOTAL	**1,812**	———	**$25,930,998**	**$6,457,405**	**75%**

APPENDIX 1C:

AWMC, DWR AND USBR COOPERATIVE AGREEMENT

TABLE 1C1 STATUS OF TASKS TO BE COMPLETED IN THE THREE-WAY COOPERATIVE AGREEMENT AMONG DWR, USBR & THE AWMC

Task 1: Membership Recruitment	**Description**	**Outcomes**
2003 Target	The membership target level for Year 2 is 3.8 million acres. Meetings with prospective members.	Since the agreement was signed, membership has grown by over 40% and 1 million irrigated acres. The Council includes more than half of the state's irrigated acreage. There are currently 4.4 million acres enrolled in the Council.
2005 Target	The membership target level for Year 4 is 4.2 million acres. Meetings with prospective members.	
2007 Target	The membership target level for Year 7 is 4.7 million acres. Meetings with prospective members.	
	Develop a website that will enable members and prospective members to maintain contact with the Council and Council activities.	
Task 2: Water Management Plan	**Description**	**Outcomes**
Financial Assistance for WMP Development	Provide financial assistance to districts for the preparation of water management plans.	Financial assistance led to 17 new members and the submission of 8 new water management plan from 2002–05.
Model WMP	Developed a model water management plan for districts to use as a guide when writing their water management plan. The model contains sample text and tables as an example of the data that should be included in the plans.	The model water management plan was used by several water districts preparing their first water management plans. Several districts used the sample tables.
Improve Net Benefit Analysis Software	The AWMC website has an online net benefit analysis application. The application is designed to assist water suppliers in evaluating the benefits and costs of implementing the EWMPs.	Several districts used the NBA application to prepare the water management plan. The software helped the review process. It provides consistency of format.
Peer Review of WMP	A review of water management plans by other water suppliers and Environmental Group 2 members.	Five new water management plans were endorsed from 2002–05 and three progress reports were completed.
QO Integration	Incorporate the evaluation of quantifiable objectives along with the evaluation of EWMPs. Link each water supplier to the corresponding quantifiable objectives and targeted benefits.	Reports generated on the methodology for evaluation the connection between EWMPs and QOs. All agricultural water suppliers with in the CALFED area have been linked to the corresponding targeted benefits and quantifiable objectives.
Meetings with Water Suppliers	Meetings with water suppliers to assist with water management plan development and EWMPs.	Staff has met with members to assist with the development of water management plans. Eight new plans were submitted to the Council for 2002–04.
Quarterly Newsletter	Distribute quarterly newsletter that contains information on activities within the water community, specific projects districts have implemented for water use efficiency.	The AWMC distributes the newsletter to all agricultural water districts. Each quarter several districts contact the Council requesting further information with regards to the articles.
Website	Create and maintain website with tools for water management plan development and implementation.	The model water management plan, NBA software, monitoring and verification protocols, and quantifiable objective methodology were posted to the AWMC website.
Support for Educational Conferences	Support the California Irrigation Institute Conference.	
Task 3: Audits	**Description**	**Outcomes**
Develop Audit Procedures	Work with DWR, USBR, and CBDA to develop audit procedures to validate the credibility of water management plans.	All water management plans were audited by an independent reviewer to ensure credibility of the documents. The auditor found all of the plans to be adequate and to have fulfilled the intent of the MOU. Audit reports were returned to the districts so that they may be considered during the next scheduled update of the plan.
Brief Audits	All water management plans underwent a brief audit. The audit evaluated the validity of the data and conclusions, including the plan's conformity to the MOU requirements.	
Detailed Audits	Six water management plans underwent a detailed audit to verify data and conclusions, including a reconstruction of the net benefit analysis and a tour of the district by the auditor.	
Task 4: Reports and Data	**Description**	**Outcomes**
Develop Database of EWMP Data	Develop a database to track and evaluate district activities and implementation of EWMPs.	A summary database to track information and the status of agricultural water supplier activities is developed and is currently being populated.
Maintain Database	Update the database as needed for district implementation status of the EWMPs.	
Supply DWR, USBR, and CBDA with semi-annual Reports	Provide DWR, USBR, and CBDA with summary reports of district activities.	
Develop Annual Reports	Provide DWR, USBR, and CBDA with annual reports of AWMC activities.	On-going.

APPENDIX 1D:

AGRICULTURAL WUE RESEARCH

TABLE 1D1 AGRICULTURAL WUE RESEARCH FUNDING BY FUNDING SOURCE

Funding Source	Applicant	Expected Benefit	Status	Public Funding	Local Funding
DWR	Local Agencies	Improved water use efficiency (through mobile labs)	complete	NA	0
DWR	UC Davis	Year 2 results (2004/5) of RDI project funded by USBR	in progress	NA	0
USBR	Cal Poly SLO	Quantitative analysis of evaporation and transpiration	complete	NA	0
USBR	Cal Poly SLO	Technical analysis of how to incorporate quantifiable objectives into district operations	complete	$35,000	0
USBR	CSU Fresno	Utility of using remote sensing to verify ET and RDI	in progress	$120,000	0
USBR	Davids Engineering	Monitoring and evaluation protocols for four WUE actions	complete	$160,425	0
USBR	UC Davis	Determination of the evaporation component of consumptive water use of tomatoes and peaches	awaiting final report	$241,070	0
USBR	UC Davis	Establishment and initial results of implementing RDI	awaiting initial report	$222,000	0
USBR	West Stanislaus RCD	A quantitative assessment of the benefits of mobile labs and the use of polyacrylamide	project ended—no final report received	$125,000	0
USBR	Yolo County RCD	Determine efficacy of several WUE actions	complete	$121,798	0
SB 23	USDA	Evaluation of salt tolerant crops	complete	$69,500	0
P13	San Jacinto RCD	Indirect diversion reduction through soil water monitoring	complete	$100,000	0
Prop 50	UC Davis	Benefits and Costs of Deficit Irrigation in Alfalfa	contracting in progress	$632,000	0
Prop 50	CSU Monterey Bay	Characterizing Spatiotemporal Variations in Canopy Density, Soils, Climate, and Vineyard Water Balances to Derived Spatially-Explicit Irrigation Strategies: Development of the VITicultural Information System (VITIS)	contracting in progress	$118,590	0
Prop 50	UC Davis	Water Use Efficiency in Sacramento Valley Rice Cultivation	contracting in progress	$428,000	$39,005
Prop 50	USDA	Improved Water Use Efficiency for Vegetables Grown in the San Joaquin Valley	contracting in progress	$248,000	$260,000
Prop 50	UC Davis	Monitoring Wetting Front Advance Rate for Irrigation Management in Flood Irrigated Alfalfa Production Systems	contracting in progress	$197,343	0
Prop 50	UC Davis	Regulated Deficit Irrigation	contracting in progress	$563,000	$563,000
			Total	**$3,381,726**	**$862,005**

APPENDIX 1E:

SELECTED EXCERPTS FROM RECLAMATION'S CRITERIA FOR STANDARD, REGIONAL AND WETLANDS PLANNING

A STANDARD CRITERIA FOR EVALUATING WATER MANAGEMENT PLANS

Under Section 5 of the Bureau of Reclamation, Mid-Pacific Region Standard Criteria for Evaluating Water Management Plans, there is a requirement to report on plan implementation. The following is the general direction given to preparers:

> **Section 5: Plan Implementation**
>
> Water Management in general, and Water Management planning in particular, is an on-going process that starts with the preparation of a Comprehensive Plan. The purpose of preparing a Plan is for the Contractor to implement the programs developed during the planning process. Implementation of programs identified in the Plan is critical to the success of Water Management within a District. The Criteria focus not only on what constitutes an adequate Plan, but also on the Implementation of the programs described in that Plan.
>
> If there are CALFED quantifiable objectives (QOs) that apply to the geographic location of your district lands, identify the QOs that apply to the District and comment on potential for Contractor participation (see Attachment C for more information).
>
> Pursuant to water service and settlement contract terms, Contractors must report on Plan Implementation annually. Agricultural Contractors can complete an annual update by filling in the information for BMPs on the WaterShare website at http://watershare.mp.usbr.gov/.

In addition to the above information, the following instructions are in Attachment C of the document:

> **Attachment C—Assess QOs**
>
> CALFED is developing QOs that provide incentives for participation by water users, including contractors, in water management activities. These activities may or may not directly benefit the water user/contractor. If there are CALFED QOs that apply to the geographic location of your agency lands, identify the QOs that apply to your agency and comment on the potential for contractor participation. Evaluate and comment on any BMP or practice that is complementary, or could be complementary to the QOs identified in the district's service area. To see if your agency has QOs that apply, please refer to the section in the back of the planner entitled, "QOs by Agency." Find your agency in the alphabetical list. Review the QOs listed for your agency and comment on your agency's interest in obtaining funding to address the QO. Evaluate and comment on any BMP or practice that is complementary or could be complementary to the QOs in the district.

A sample of the Attachment C by agency is given in Figure 1E1. This listing is available for all CVP contractors that are required to complete a plan.

To date, ten responses to the criteria are available with the following break down: four with a positive outlook toward participation, five with comments that convey they see no potential for participation and one indicated that they already do things related to the QOs. Several CVP contractors applied for the 2005 Proposition 50 WUE PSP funding.

REGIONAL CRITERIA FOR EVALUATING WATER MANAGEMENT PLANS FOR THE SACRAMENTO RIVER CONTRACTORS

The Regional Criteria requires participating Sacramento River CVP contractors to prepare a Regional Plan that includes the QOs. This plan was due in June 2005. The following is taken from the Regional Criteria:

> **Section 4: Analyze Water Management QOs**
>
> Intent—Analyze the QOs identified by the CALFED Water Use Efficiency Program that will support improved (more efficient) Water Management in the Region served by the Participating Contractors. The Participating Contractors will review the list of applicable QOs. Where Participating Contractors identify QOs that are not applicable, the Participating Contractors will determine their non-applicability by the initial Annual Update (see the "Determination of Non-Applicability" paragraph in this section).
>
> Evaluation—In certain circumstances, specific information may not be available. For these circumstances, the Plan will describe for the initial Annual Update how the information will be obtained including an associated timeline for completion.

FIGURE 1E1 SAMPLE OF QO LISTING BY AGENCY TAKEN FROM ATTACHMENT C OF THE USBR STANDARD CRITERIA

Quantifiable Objectives (QOs) by Agency

Details are listed at: http://calfed.ca.gov/current/quantifiable_objectives.html

Water Supplier (1)	Description of the CALFED Objective (2)	Location (3)	Sub-Region Number	Targeted Benefit Number
ALPAUGH IRRIGATION DISTRICT (ID)	Decrease flows to salt sinks to increase the water supply for beneficial uses.	All affected lands	15	167
	Provide long-term diversion flexibility to increase the water supply for beneficial uses.	Kern NWR (NWR)	19	191
	Provide long-term diversion flexibility to increase the water supply for beneficial uses.	Pixley NWR	18	186
	Provide long-term diversion flexibility to increase the water supply for beneficial uses.	Salt affected soils	15	170

Detail Expected in an Adequate Plan—This section addresses the Participating Contractors' review of the QOs that apply to the geographic location of the Region served by the Participating Contractors and that are within the management purview of the Participating Contractors. The CALFED QOs that have been quantified as of the date of these Regional Criteria are identified in Appendix 1A4. In this section, the Participating Contractors will identify any QOs that they determine are not applicable and provide an analysis including, at a minimum, a statement of reasons for any such determination. The Participating Contractors will evaluate each of the remaining QOs to identify all or a portion of the QO that they propose to analyze for potential Implementation (Proposed QOs). For data not available during the preparation of this Plan, the Participating Contractors shall describe in the Plan how this information will be obtained for the initial Annual Update.

Background Regarding TBs and QOs

The TBs and the QOs are the cornerstone for the Implementation of agricultural water use efficiency element of the CALFED Program. The TBs are geographically specific in-stream flow and timing, water quality, and water quantity benefits that can potentially and partially be met through irrigation Water Management. The QOs are the CALFED Program's approximation, expressed in acre-feet, of the practical, cost-effective portion of a targeted benefit that can be achieved through improving irrigation Water Management. These approximations have been made for agricultural water users across a Sub-region, and do not necessarily represent the economically feasible portion of a targeted benefit that could be achieved at the local agency level.

The CALFED Program's TBs for the Central Valley are organized in relation to 21 Sub-regions. The six Sub-regions covered under these Regional Criteria are set forth in Table 1E1.

TABLE 1E1 NAMES AND NUMBERS OF THE CALFED PROGRAM SUB-REGIONS RELATIVE TO THE AREA SERVED UNDER THIS REGIONAL CRITERIA DOCUMENT

Sub-region Name	WUE Sub-region Number
Redding Basin	1
Sacramento Valley, Chico Landing to Red Bluff	2
Sacramento Valley, Colusa Basin	3
Mid-Sacramento Valley, Chico Landing to Knights Landing	4
Sacramento Valley Floor, Cache Creek, Putah Creek and Yolo Bypass	6
Lower Sacramento River below Verona	7

DETERMINATION OF NON-APPLICABILITY

In certain cases, the Participating Contractors in consultation with Reclamation, may determine the QOs to be "non-applicable." A determination of non-applicability could include, but will not be limited to, the following:

- Whether the QOs are already being pursued through other regional Implementation activities (duplicated effort).
- Whether the Participating Contractors in the Sub-region are unable to affect the related targeted benefits (ineffectiveness).
- Whether the CALFED Science Program has determined that the QO and/or its related targeted benefit are no longer warranted based on information collected through the Region's Water Flow and Water Quality Monitoring Program, or the Science Program's

determination that the fishery conditions in the Region have been satisfied (no longer necessary).

PRIORITIZATION OF QOS FOR FURTHER ANALYSIS AND QUANTIFICATION OF PROPOSED QOS

After the determination is made of which QOs are not applicable, the Participating Contractors will evaluate the remaining QOs to identify Proposed QOs. As part of this evaluation process, the Participating Contractors will:

- Provide a preliminary prioritization of the Proposed QOs based upon the following considerations: Potential for greatest local benefit, potential benefit to the CALFED Program, utilization of other on-going analyses, practicality of Implementation, and local environment.
- Annually analyze, at a minimum, one-fifth of the Proposed QOs to determine which Proposed QOs may be implemented. This information will be provided in the Annual Update. At least one Proposed QO should be analyzed for each Sub-region unless all QOs for that Sub-region have already been addressed. The scope and extent of the analysis of each Proposed QO will be dependent upon whether undertaking such analysis is financially feasible for the Participating Contractors based upon their existing resources, and if not, whether there is funding available to the Participating Contractors for that purpose. If undertaking an in-depth and detailed analysis of the Proposed QO is not financially feasible, and funding is not currently available, the Plan shall at a minimum, provide a reconnaissance level analysis. Such an analysis will be based upon existing data and information, including data presented in the Participating Contractors' water inventory (Section 2). In addition, the Plan shall identify in the Annual Update the efforts that the Participating Contractors will undertake in order to attempt to secure adequate funding to perform a detailed and in-depth analysis of the Proposed QO.

Section 5: Identify Actions to Implement and Achieve Proposed QOs

Intent—Develop a Water Management Implementation Plan that demonstrates a reasonable approach for implementing actions that will meet the Proposed QOs identified by the Participating Contractors in Section 4, as well as other actions that address the efficient Water Management objectives in the Region. Implementation of any Proposed QOs will be dependent upon whether such Implementation is economically and financially feasible for each of the Participating Contractors.

The types of actions that can be undertaken to address the TBs and the Proposed QOs include, but are not limited to, actions outlined in the BMPs for agricultural contractors in Reclamation's Standard Criteria.

Evaluation—In certain circumstances, specific information may not be available. For these circumstances, the Plan will describe in the initial Annual Update how the information will be obtained including an associated timeline for completion of the analysis.

Detail Expected in an Adequate Plan—This section will describe the particular actions that will be undertaken by each of the Participating Contractors to pursue the Proposed QOs developed as a result of the efforts described in Section 4. Alternatively, this section will identify in the initial Annual Update a process that the Participating Contractors will undertake and complete in order to develop a Water Management Implementation Plan that demonstrates a reasonable approach for implementing actions that will meet the applicable Proposed QOs. For data not available during the preparation of this Plan, the Participating Contractors will describe in the initial Annual Update how the information will be obtained.

DEVELOPMENT OF THE IMPLEMENTATION PLAN FOR SELECTED PROPOSED QOS

The Participating Contractors should develop the Implementation Plan as follows:

Develop a set of actions to accomplish each of the Proposed QOs that have been analyzed and identified for Implementation in Section 4. The Participating Contractors will select the most effective and reasonable practices or measures to accomplish the Proposed QOs. Measures that should be considered include improved grower education and Implementation of appropriate pricing and measurement requirements (based upon ongoing current cooperative studies) to encourage efficient Water Management. In addition, the Participating Contractors are also encouraged to explore and implement other potentially feasible practices that lead to efficient Water Management improvements in the Region.

Identify each action and describe the Implementation process, including each of the Participating Contractor's involvement in carrying out the actions.

Provide an analysis of the proposed actions, including potential impacts (e.g., environmental); costs, as well as opportunities for partnerships; an explanation for choosing the proposed actions; and the priority of the actions. In evaluating the potential actions, the Participating Contractors should consider opportunities for benefits that accrue only with a regional approach and/or as a result of partnership(s) with other entities.

ECONOMIC AND FINANCIAL FEASIBILITY
Implementation of any Proposed QOs will be dependent upon whether such Implementation is economically and financially feasible for the Participating Contractors based upon their existing resources, and if not, whether there is funding available to the Participating Contractors for that purpose. If such Implementation is not economically feasible, and funding is not currently available, the Plan shall identify in the Annual Update the efforts that the Participating Contractors will undertake in order to attempt to secure adequate funding.

Section 6: Establish Monitoring Program
Each of the Participating Contractors will work with Reclamation to implement measurements at strategic points to document existing conditions, and therefore, to monitor anticipated benefits resulting from the Implementation of the programs.

Intent—Document existing conditions for flows and water quality constituents for the selected QOs for key outflow locations in the Sub-regions and update these conditions annually. Measure the physical results of actions taken and collect other data necessary to assess progress toward achieving the QOs. Monitoring is also intended to provide to Participating Contractors both timely and accurate information on the quantitative impacts of their water use, and thus, an indication of how effective individual actions have been.

Evaluation—In certain circumstances, specific information may not be available. For these circumstances, the Plan will describe in the Annual Update how the information will be obtained including the associated timeline for completion. Factors which Reclamation can use to evaluate the monitoring program may include: Sampling frequency and technique, reporting format, analytical methodology, target constituents (or actions), and units of measurement.

Detail Expected in an Adequate Plan—This section will describe a mutually acceptable monitoring program for Implementation. Alternatively, this section shall identify in the initial Annual Update a process for developing a monitoring plan. The Participating Contractors will begin implementing the mutually acceptable monitoring plan developed by the Participating Contractors prior to the second Annual Update.

The monitoring program will include: (1) Specific monitoring (as appropriate) for each objective; (2) schedule, budget, and responsibility for monitoring; and (3) annual reporting requirements.

When finalized, the participants in the watershed group's program identified in Section 1 may satisfy all, or a portion of, this monitoring plan to the extent that the program addresses the flow and water quality constituents for the key outflow locations in the Sub-regions.

The Sacramento Valley Regional Plan was due June 2005.

CRITERIA FOR DEVELOPING REFUGE WATER MANAGEMENT PLANS

The Criteria for Developing Refuge Water Management Plans (Refuge Criteria) provides a common methodology, or standard, for efficient use of water by Federal Wildlife Refuges, State wildlife management areas and resource conservation districts that receive water under provisions of the Central Valley Project Improvement Act (CVPIA). They document the process and format by which Refuge Water Management Plans (Refuge Plan) should be prepared and submitted to Reclamation as part of the Refuge/District Water Supply Contracts and Memorandum of Agreements. The following is taken from: Section I. Exemptible BMPs.

For each exemptible BMP, report on the proposed Implementation schedule for 5 years and the estimated direct and indirect costs. Where appropriate, report the location, size, reason, and anticipated benefit of the proposed improvements. If the Refuge will study a BMP or conduct a pilot project describe the projected program and timeline. If any of the exemptible BMPs will not be implemented within 2 years of submitting this Refuge Plan, describe the projected program, timeline, and other relevant information.

10. CALFED Provide a short narrative describing past, present, or future plans that address the CALFED Water Use Efficiency Program goals identified for this Refuge. Respond only to questions for your specific Refuge.

Sacramento and Delevan National Wildlife Refuges (NWRs)
1. Describe actions that reduce the salinity of surface return water. (Targeted Benefit (TB) 24)
2. Describe actions that reduce nonproductive ET. (TB 25)

Colusa and Sutter NWR's
1. Describe actions that reduce nonproductive ET. (TB 33)

Gray Lodge State Wildlife Area (WA)
1. Describe actions that reduce nonproductive ET. (TB 46)

North Grassland, Volta, and Los Banos WA's
1. Describe actions that reduce selenium concentration in the Grassland Marshes. Reduce selenium concentration to 5 ug/L in the Grassland Marshes. (TB 95)
2. Describe actions that reduce San Joaquin River selenium and boron concentrations. Reduce San Joaquin River selenium concentration to 5 ug/L and boron concentration to 2 mg/L from March 15 to September 15 and to 2.6 mg/L September 16 to March 14. (TB 98)
3. Describe actions that reduce salinity in the Grassland Marshes and Mud and Salt Sloughs. Reduce salinity in the Grassland Marshes and Mud and Salt Sloughs. (TB 102, 103).

4. Describe actions that reduce nonproductive ET. Reduce unwanted ET. (TB 107)

San Luis and Kesterson NWR's, Grassland Resource Conservation District
1. Describe actions that reduce salinity in the San Joaquin River, Grassland Marshes, and Mud and Salt Sloughs. (TB 95, 96, 98)
2. Describe actions that reduce salinity in the Grassland Marshes and Mud and Salt Sloughs. (TB 102, 103, 104) (All of these six contaminant TBs could be incorporated into one Refuge manager response, e.g. addressed through the Grassland Drainage Program).
3. Describe actions that reduce nonproductive ET. (TB 107)

Merced NWR
1. Describe actions that provide additional flow to San Joaquin River. (TB 148)
2. Describe actions that reduce salinity at Vernalis. (TB 154)
3. Describe actions that reduce nonproductive ET. (TB 157)

Mendota WA
1. Describe actions that reduce flows to salt sink. (TB 167)
2. Describe actions that reduce nonproductive ET. Reduce unwanted ET. (TB 168)

Kern NWR
1. Describe actions that reduce nonproductive ET. (TB 189)

VOLUME 2: URBAN WATER USE EFFICIENCY

LOOK-BACK: IMPLEMENTATION RESULTS

URBAN WUE IN THE ROD

The CALFED Record of Decision (ROD) intended the Water Use Efficiency Program (WUE) to accelerate implementation of cost-effective actions to conserve and recycle water throughout the state. The ROD cited two primary reasons for giving near-term emphasis to WUE investments. The first was WUE's potential to "yield real water supply benefits to urban and agricultural users in the short term."[1] The second was WUE's ability to "generate significant benefits in water quality and timing of instream flows."[2] While the ROD was careful not to establish specific targets for WUE with respect to water supply benefits, it did identify the range of water savings that WUE could potentially achieve by the end of Stage 1.[3] These estimates were divided between urban water savings, agricultural water savings, and recycled water, as follows:

- 520–680,000 acre-feet in the Urban Sector
- 260–350,000 acre-feet in the Agricultural Sector
- 225–310,000 acre-feet in water reclamation projects

The ROD did not provide similar quantitative estimates of instream flow potential, though it did note the "substantial contribution that water use efficiency investments can make to other CALFED program goals."[4] Moreover, the ROD called for the implementation of several WUE initiatives, such as agricultural quantifiable objectives and state/federal financial assistance programs, intended to generate both water supply and instream flow benefits statewide.

The ROD proposed an unprecedented level of state, federal, and local funding of WUE through Stage 1. The ROD estimated that achieving the water savings potentials cited above "would require an investment by State and Federal governments in the range of $1.5 to $2 billion over the seven years of Stage 1."[5] During the first four years of the program, the ROD proposed state and federal expenditures of $500 million, primarily for grants and loans, and an additional $500 million coming from local matching funds.[6] It labeled the proposed program scope and level of investment as "aggressive and unprecedented nationally."[7]

WUE actions in the urban sector were primarily intended to help address the growing mismatch between water supply and demand caused by rapidly growing urban populations and static supplies. The ROD viewed WUE investment in the urban sector as a cost-effective way to better balance supply and demand in the near-term, especially compared to surface storage and major conveyance improvements that the ROD estimated would take at least 5–10 years to complete.[8] WUE was seen as a way to quickly address growing urban water demands and simultaneously reduce pressure on Delta resources caused, in part, by these demands.

1. ROD, pg. 59.
2. Ibid.
3. The ROD estimates include only water that would have otherwise been lost to evaporation or an unusable sink, such as the ocean.
4. ROD, pg. 59.
5. ROD, pg. 63-64.
6. Ibid.
7. ROD, pg. 64.

Urban Best Management Practices

BMP 1	Residential Survey Programs
BMP 2	Residential Plumbing Retrofit
BMP 3	System Water Audits
BMP 4	Metering w/Commodity Rates
BMP 5	Large Landscape Conservation
BMP 6	High Efficiency Clothes Washers
BMP 7	Public Information Programs
BMP 8	School Education Programs
BMP 9	Commercial Industrial Institutional
BMP 10	Wholesaler Agency Assistance Programs
BMP 11	Conservation Pricing
BMP 12	Conservation Coordinator
BMP 13	Water Waste Prohibitions
BMP 14	Residential Ultra-Low Flush Toilet Replacement Programs

Using urban demand management to relieve pressure on Delta resources was not new to the ROD. Much of what the ROD proposed with regard to urban WUE was built upon earlier initiatives, most notably the Memorandum of Understanding Regarding Urban Water Conservation in California (Urban MOU). The Urban MOU is a 1991 agreement between urban water suppliers and environmental interest groups establishing a voluntary framework and schedule for water supplier implementation of urban conservation best management practices (BMPs). Over 190 urban water suppliers, serving approximately two-thirds of all Californians, have now signed the Urban MOU and are implementing BMPs to some degree. The BMPs have also been adopted for use in several other water management initiatives and pieces of legislation, including the Urban Water Management Planning Act (UWMPA), the Central Valley Project Improvement Act (CVPIA), and the Sacramento Water Forum Agreement.[9]

The Urban MOU also established the California Urban Water Conservation Council (CUWCC) to oversee the BMP process, update and amend BMPs as appropriate, and provide assistance to urban water suppliers implementing BMPs. Urban water suppliers report progress on BMP implementation biannually to the CUWCC through its website. As a result of this reporting system, the CUWCC now has data on BMP implementation rates and water savings covering 1991–2004.

8. ROD, pg. 59.
9. The UWMPA is a piece of California legislation, while CVPIA is federal legislation. The Sacramento Water Forum Agreement is a regional initiative.

Because of the ubiquity of Urban MOU signatories throughout California, the familiarity of most urban water suppliers with the Urban MOU framework, the extension of the BMPs into other water management legislation and initiatives, and the BMP reporting system created by the CUWCC, it provided a logical foundation for the urban component of the WUE program. For this reason, the ROD emphasized urban incentive programs that "focus on implementing the Urban MOU process and on identifying and implementing measures that are supplemental to BMPs and are cost-effective from a statewide perspective."[10] It also called on the Department of Water Resources (DWR) and USBR to work with the CUWCC to provide technical assistance to help urban water agencies comply with UWMPA requirements.[11] And lastly, it called on CALFED implementing agencies to implement by the end of 2002 "a process for certification of water suppliers' compliance with the terms of the Urban MOU, including implementation of best management practices for urban water conservation."[12]

URBAN WUE APPROACH

The ROD proposed a two-pronged approach to realize the urban water savings potential for Stage 1.[13] The first was implementation of locally cost-effective BMPs by urban water suppliers. This base level of implementation was to be supported by CALFED through low-interest loan programs and technical assistance. The second prong was the use of grants to leverage further local investment in urban conservation. These grants were to go towards measures that, while not locally cost-effective from the perspective of an individual water supply agency, provided statewide water supply, water quality, and ecosystem restoration benefits. The ROD stated that "some water use efficiency measures may not be cost-efficient when viewed solely from a local perspective, but may be cost-effective when viewed from a statewide perspective, compared to other water supply reliability options. In this case, CALFED Agencies anticipate a larger State and Federal assistance share in the form of grants."[14] Access to this grant money, however, was to be made conditional on "agency implementation of the applicable water management plans," which in the case of urban water agencies meant "implementation of applicable Urban Water Conservation Council 'best management practices.'"[15] This was the reason the ROD charged CALFED Agencies to implement by the end of 2002 a process to certify water supplier compliance with the Urban MOU.[16]

10. ROD, pg. 61.
11. Ibid.
12. ROD, pg. 62.
13. ROD, pg. 60.
14. Ibid.
15. Ibid.
16. ROD, pg. 62.

In addition to the two core urban WUE program elements —implementation of locally cost-effective BMPs supported with loan and certification processes and implementation of supplemental urban WUE measures providing statewide net benefits supported with a grant process—the ROD identified several supporting program components. These included technical assistance to local water suppliers, research and evaluation of urban WUE programs, better definition of appropriate measurement of urban water uses, and oversight and coordination of CALFED Agencies responsible for implementing urban WUE.

TECHNICAL ASSISTANCE

The ROD called on DWR and USBR to work with the CUWCC to provide technical assistance to urban agencies developing management plans under the UWMPA. It included a similar requirement to work with the Agricultural Water Management Council (AWMC) to help agricultural districts to comply with the AB 3616 process. CALFED Agencies were to provide $34 million in technical assistance over the first four years of Stage 1 to support these efforts.[17] The ROD did not provide guidance on how to allocate the funding between urban and agricultural assistance, nor did it propose how to allocate the funding between CALFED Agencies and the two water management councils (i.e., CUWCC and AWMC).

RESEARCH AND EVALUATION

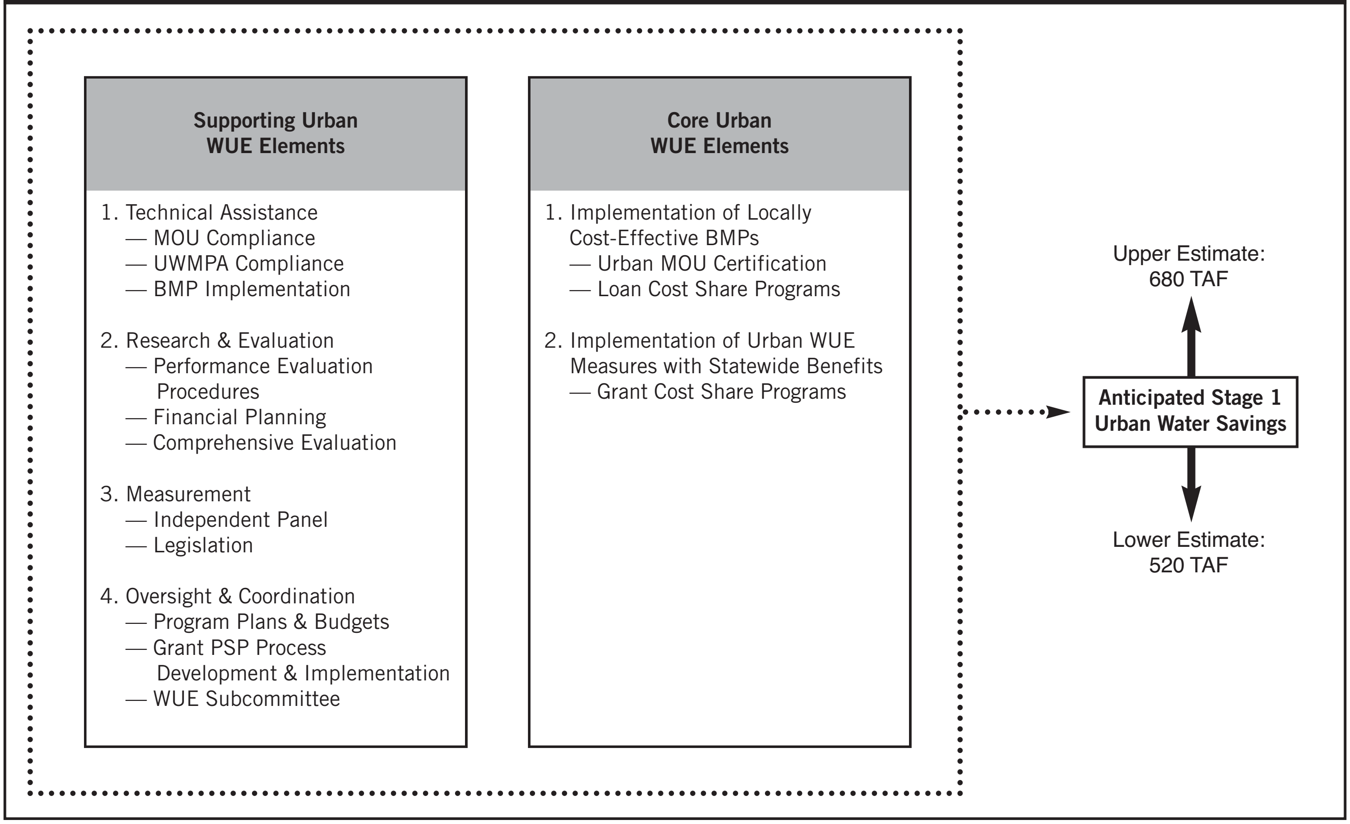
The ROD did not provide specific guidance on research and evaluation of urban WUE. It did, however, call on CALFED Agencies to develop WUE evaluation procedures as part of a program implementation plan which was due to be completed by December, 2000.[18] It also required CALFED Agencies to develop a detailed finance proposal for WUE through Stage 1.[19] Meeting this requirement would involve completing tasks that could be categorized as both research and evaluation and oversight and coordination. Finally, the ROD called on CALFED Agencies to conduct a Comprehensive Evaluation of WUE's first four years of implementation.[20] This too can be viewed as a research and evaluation task for the program.

APPROPRIATE MEASUREMENT OF URBAN WATER USES

The ROD recognized the critical role of water measurement in WUE. It simply would not be possible to credibly measure WUE performance without reliable and timely data on urban and agricultural water uses. For this reason, the ROD required CALFED Agencies to convene an independent panel on appropriate measurement of water use and, working with

17. Ibid. Funding of this effort was to come from NRCS and CDFA in addition to DWR and USBR.
18. ROD, pg. 61.
19. ROD, pg. 62.
20. Ibid.

FIGURE 3.1 URBAN WUE PROGRAM STRUCTURE DESCRIBED BY ROD



the California State Legislature, to use the panel's recommendations to "develop legislation for introduction and enactment in the 2003 legislative session requiring the appropriate measurement of all water uses in the State of California."[21] While much of the panel's focus was on measurement of agricultural water use, it also was to address measurement of urban water uses.

OVERSIGHT AND COORDINATION

Oversight and coordination functions for urban WUE revolved around designing and implementing processes for urban loan and grant programs, coordinating technical assistance efforts between CALFED Agencies and the CUWCC, and developing program priorities, plans, and budgets. This work was guided by input from the WUE Subcommittee. Per the ROD, the Department of the Interior was to establish this committee as part of the Federal Advisory Committee Act (FACA)-chartered public advisory committee overseeing all of CALFED. The role of the WUE subcommittee was to "advise State and Federal agencies on structure and implementation of assistance programs, and to coordinate Federal, State, regional and local efforts for maximum effectiveness."[22]

All of these related efforts were intended to help the State achieve the Stage 1 urban WUE potential put forward by the ROD and discussed in the previous section. Figure 3.1 summarizes the structure of the urban WUE program envisioned by the ROD.

21. ROD, pg. 63.

22. ROD, pg. 62.

LOOK-BACK: STAGE 1 RESULTS

URBAN WATER SAVINGS

Implementation of locally cost-effective BMPs was to provide a base level of water savings and CALFED financial assistance programs would add to this base. Thus an analysis of urban water savings during the first four years of the program can be divided into two parts: savings realized through local implementation of cost-effective BMPs; and savings realized through CALFED financial assistance programs. This section uses available data to evaluate water savings for both categories.

Water savings from urban BMP implementation have grown steadily since the Urban MOU was first adopted in 1991 (Figure 3.2). In its first year the Urban MOU generated approximately 33,000 acre-feet of water savings statewide. By 2004, the last full year of data available from the CUWCC, savings had grown to approximately 180,000 acre-feet, a year-over-year growth rate of about 15% to 20%.[23]

While growth in BMP water savings has been steady, the magnitude of these savings has not caused a substantial change in daily per capita urban water use. Statewide, CUWCC data suggest that BMP implementation through 2004 has reduced daily per capita urban water use by about 4.4 gallons.[24] This suggests, as shown in Figure 3.3, that over its first 13 years of implementation, the Urban MOU process has reduced daily per capita urban water use by approximately 2% statewide.

The MOU's impact on urban water use has been larger in some regions than others. As will be discussed in a later section, BMP implementation and compliance rates have not been uniform across the state. Most of the reported BMP activity and resultant water savings has occurred in two regions: the South Coast and the Bay Area (Figure 3.4). The picture changes somewhat when savings are normalized for population served. While the South Coast and Bay Area regions account for a disproportionate volume of BMP water savings, the North and Central Coast regions actually show higher per capita savings from BMP implementation (Figure 3.5). Whether BMP water savings are viewed in total or per capita, however, the data clearly show that the BMPs have had much less impact on urban water use in the Central Valley and desert regions of the state.

Since the MOU's initial signing in 1991, BMP water savings have been driven by three BMPs: BMP 5 (large landscape), BMP 9 [Commercial, Industrial, Institutional (CII) conservation including commercial toilet retrofits], and BMP 14 (residential toilet retrofits). By 2004, these three BMPs accounted for almost 90% of annual water savings (Figure 3.6). Of these three, BMP 14 has clearly had the greatest impact on urban water use, accounting for almost half of all water savings from BMPs.

The savings discussed in this section result from a voluntary and self-regulated Urban MOU process. As will be described in a subsequent section, while the WUE program made substantial progress working with stakeholders to develop a framework for certifying compliance with the Urban MOU, it did not succeed in implementing this framework as called for by the ROD.

MOU COMPLIANCE RATES

The ROD considered full implementation of locally cost-effective BMPs critical to the success of the WUE program.[25] It stated that water agencies "must implement water use efficiency measures that are cost-effective and appropriate at the local level." In other words, the ROD considered compliance with the Urban MOU as foundational to the success of the urban WUE program. This was a primary justification for proposing a process to certify Urban MOU compliance.

Since the signing of the ROD, the need for a certification program has come into question. The general argument has been that the MOU process as currently structured is sufficient to ensure adequate investment in urban water conservation and that the majority of urban water users are served by water suppliers that already comply with the MOU. Until recently, data necessary to either affirm or refute this position were unavailable. The CUWCC BMP reporting database has changed that. It has the capability to generate several important measures of the effectiveness of the current MOU process, which operates in the absence of any certification process. Three such measures are:

- The percent of urban water users served by water suppliers that have signed the MOU and therefore may be presumed to be implementing BMPs.
- The geographic uniformity of population served by MOU signatories.
- Compliance with BMP implementation requirements by MOU signatories.

23. A more precise estimate of the year-over-year savings rate is not possible. This is because reporting of BMP activity in 1991 also included a substantial amount of conservation activity conducted in the years prior to 1991 by water suppliers in the Bay Area and Southern Coast regions. Assuming that all implementation reported for 1991 actually occurred in prior years provides the lower-bound growth estimate of 15%. Assuming that half of reported activity occurred in prior years provides the upper-bound estimate of 20%.

24. In Bulletin 160-98 DWR estimated that daily per capita urban water use in 1995 under normal hydrologic conditions was approximately 229 gallons. Within this usage estimate is embedded the affects of BMP implementation between 1991 and 1995. By removing the statewide water savings due to BMP implementation over this period, one can estimate what 1995 water use would have been without the BMPs. The estimate is 231 gallons per capita day, which we have used as a reasonable estimate of normalized daily per capita urban water use at the start of the MOU.

25. ROD, pg. 60.

FIGURE 3.2 ESTIMATED WATER SAVINGS FROM URBAN MOU: 1991–2004

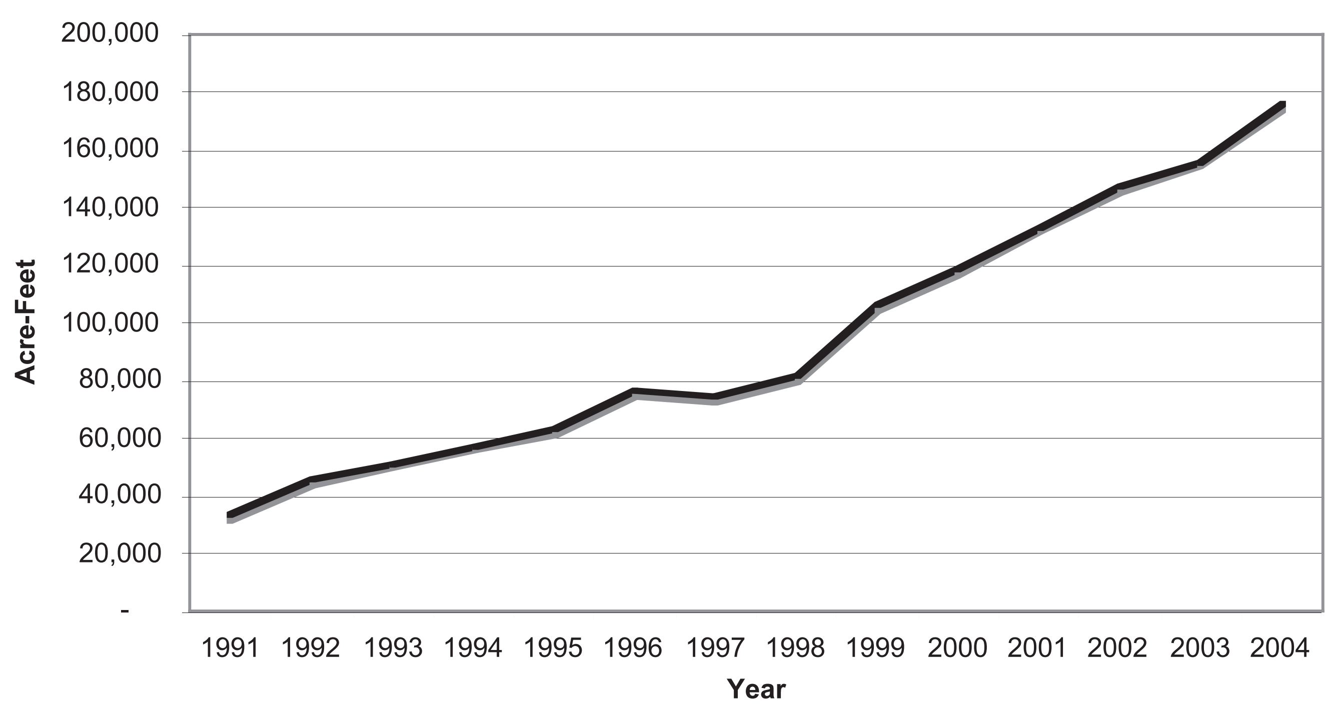


FIGURE 3.3 MOU INDUCED CHANGE IN DAILY PER CAPITA URBAN WATER USE

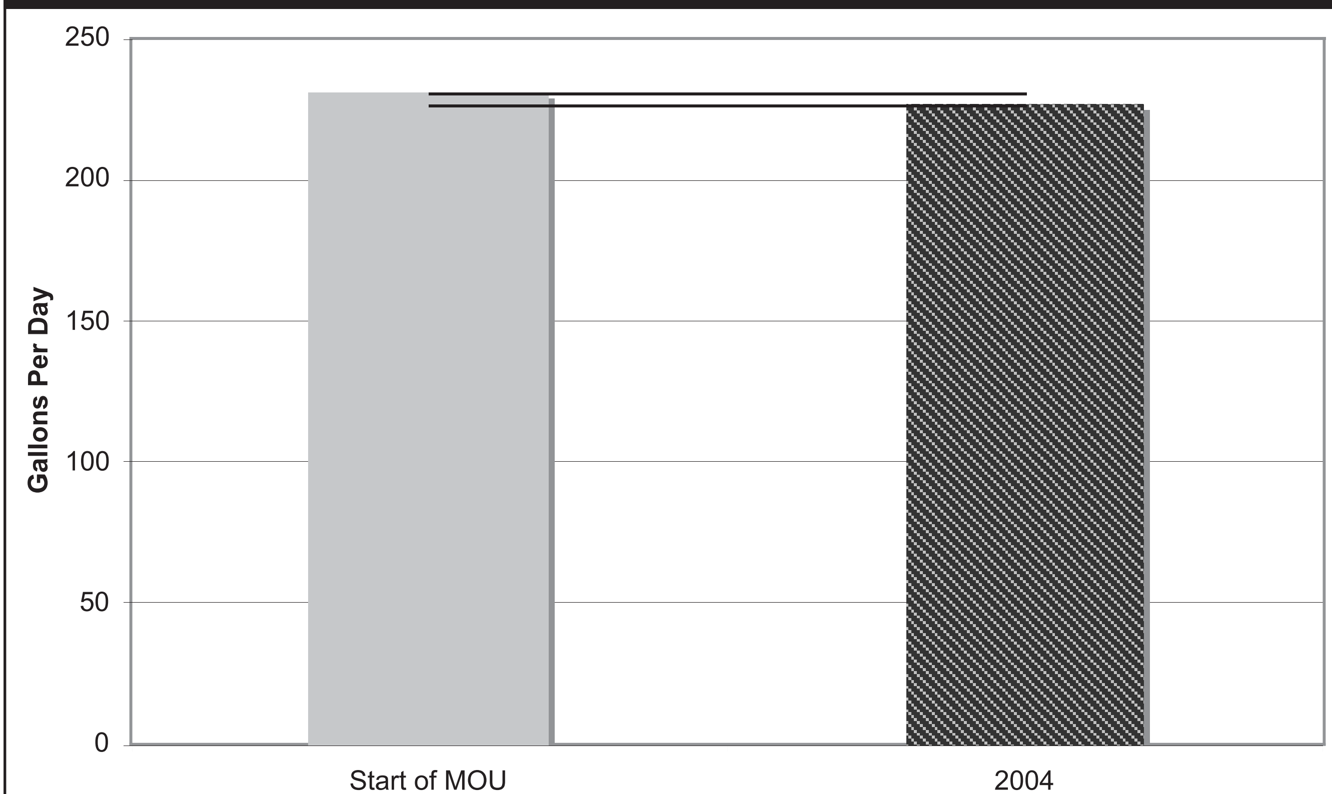


FIGURE 3.4 2004 BMP WATER SAVINGS BY REGION

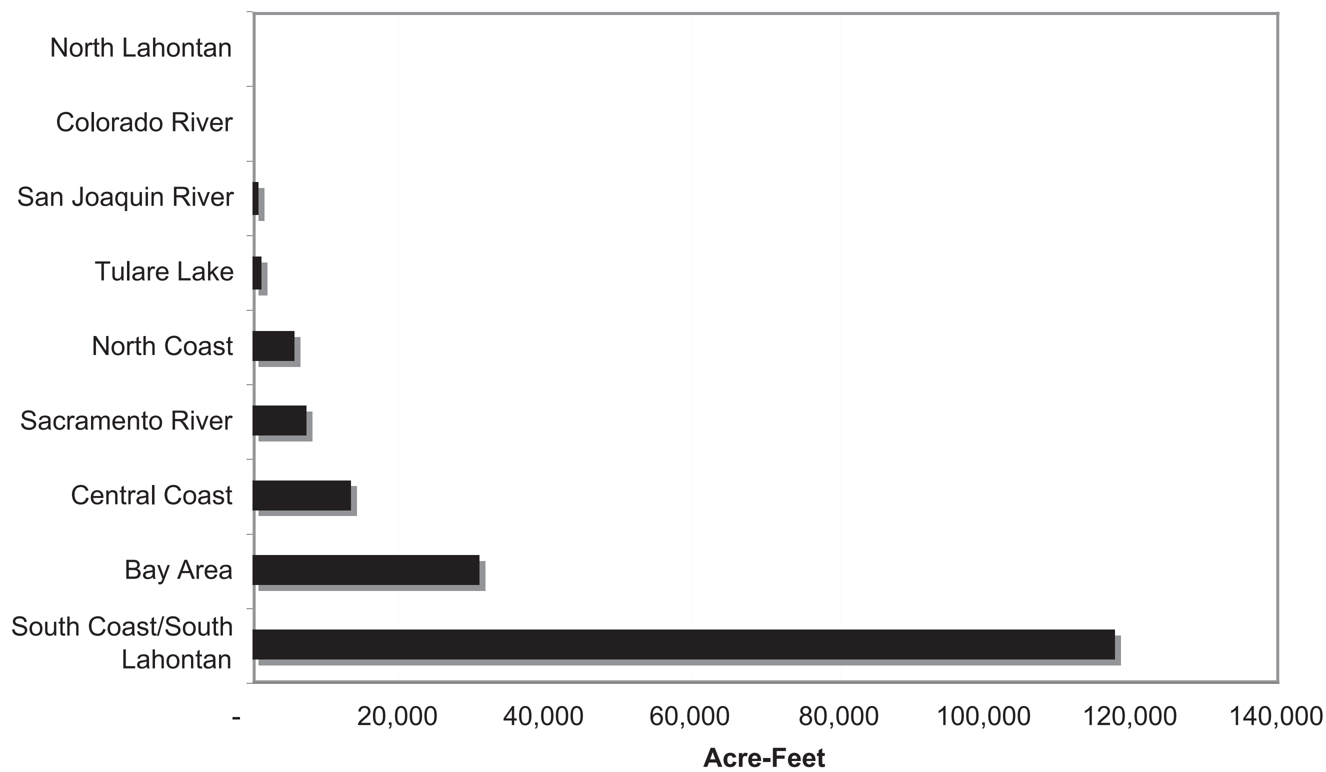


FIGURE 3.5 2004 PER CAPITA SAVINGS BY REGION

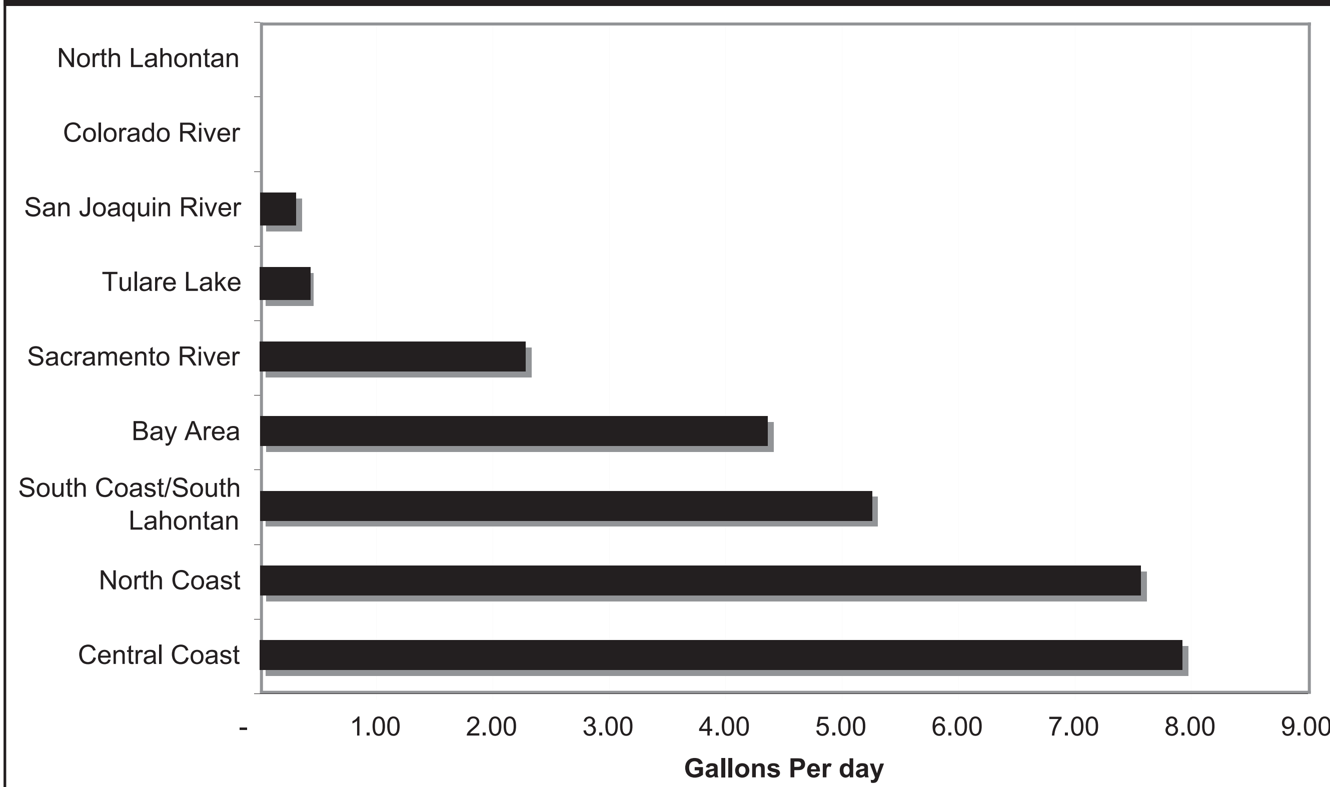


FIGURE 3.6 MOU WATER SAVINGS BY BMP

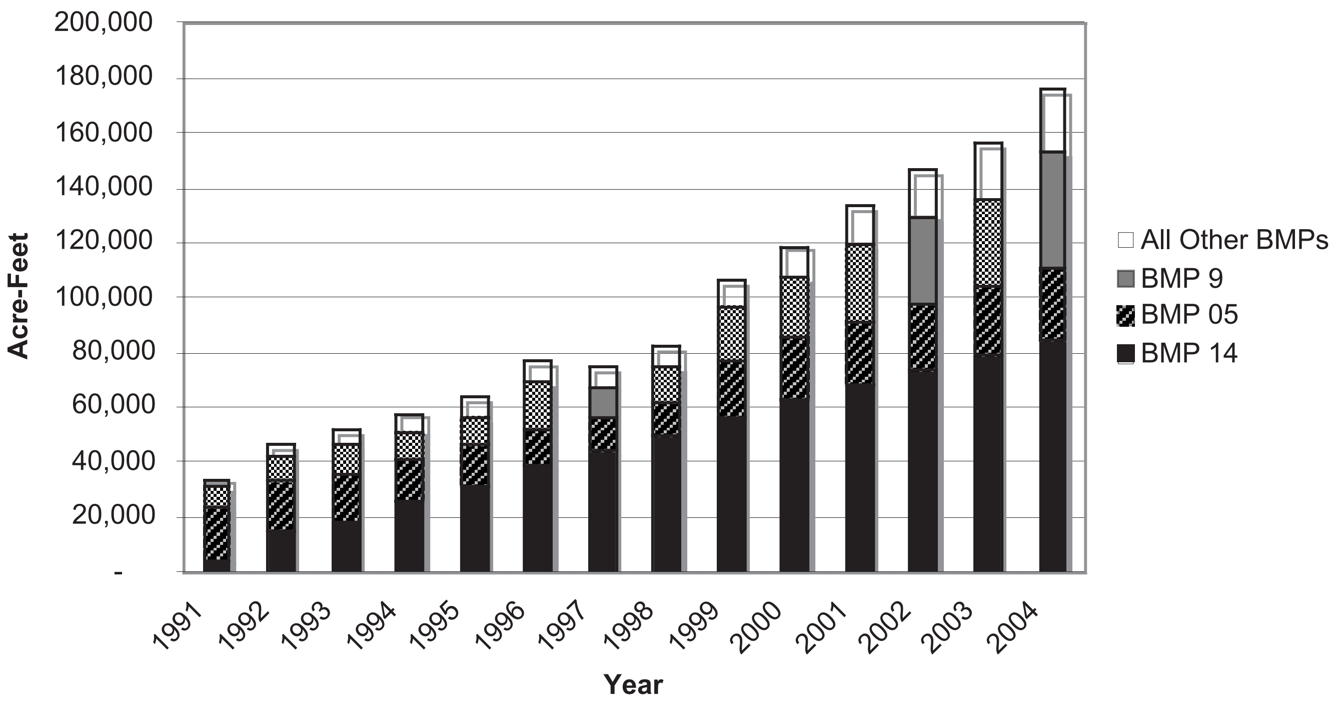
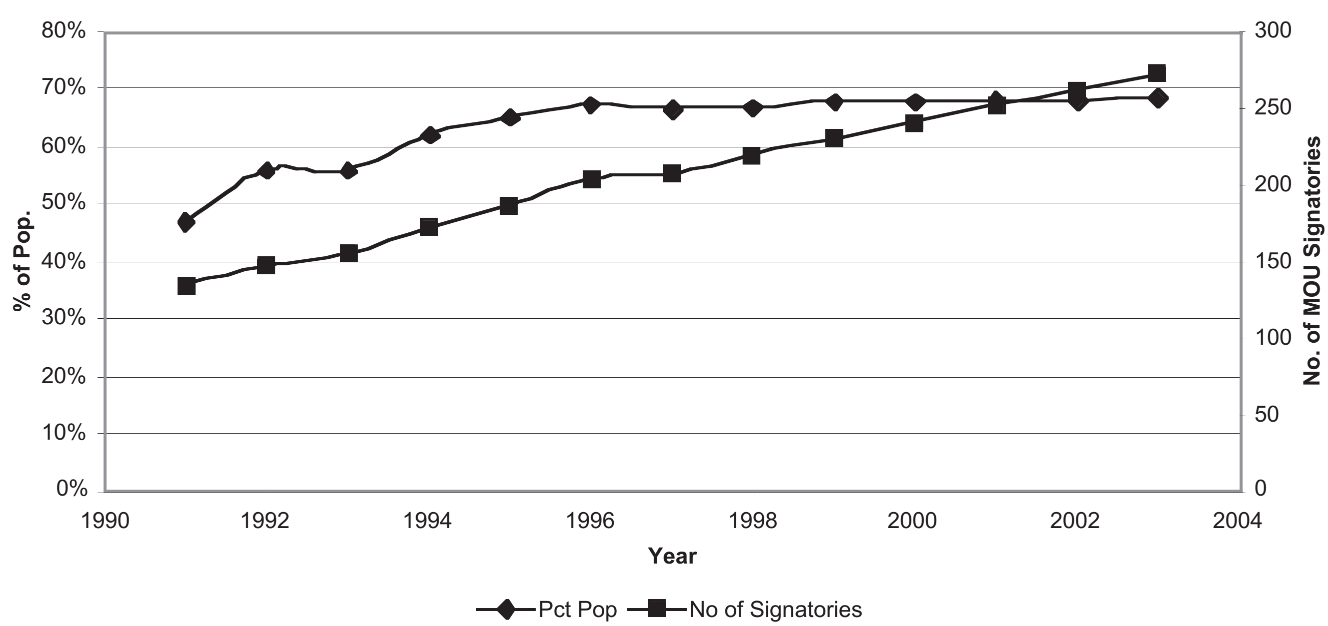
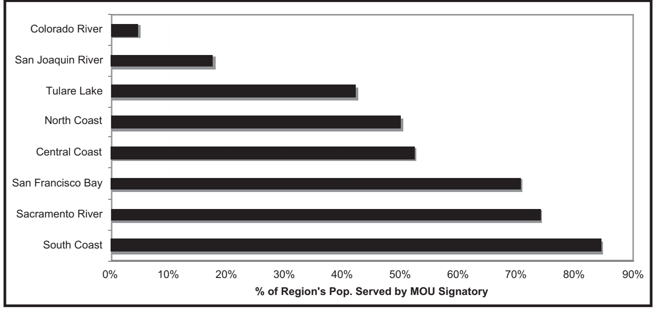


FIGURE 3.7 STATE POPULATION SERVED BY MOU SIGNATORY WATER SUPPLIERS



If water suppliers having signed the MOU already serve most urban water users, this would indicate the current voluntary process is effective, at least in regard to getting water suppliers having the most impact on urban water use to make a commitment to the BMP process. Likewise, if MOU adoption rates are largely uniform across the state, this would indicate the current voluntary process works well not just in some regions, but statewide. And, of course, high rates of BMP compliance would provide the most compelling evidence that the current voluntary approach is effective.

FIGURE 3.8 MOU PENETRATION BY REGION



POPULATION SERVED BY MOU SIGNATORIES

Urban MOU signatories now serve two-thirds of the state's population (Figure 3.7). While the amount of population served by Urban MOU signatories has increased every year since the initial signing of the Urban MOU, the rate of increase slowed significantly starting in 1997. The primary reason for the plateau is that water suppliers serving large populations signed the MOU in the early 1990s. Most new signatories are small water suppliers. Thus while the number of service areas added to the MOU each year has remained steady, the amount of population added each year has decreased. Overall, however, the current MOU process has been effective in terms of aggregate population served by MOU signatories.

REGIONAL DIFFERENCES

Population served by Urban MOU signatories is not geographically uniform, however (Figure 3.8). Penetration of the Urban MOU has been greatest in the South Coast, Bay Area, and Sacramento regions. Adoption of the Urban MOU process has been much slower in other inland regions, along the central coast, and in mountain and desert regions. Thus, the current voluntary MOU process has resulted in a situation where in some regions of the state most of the population is served water by MOU signatories while in other parts of the state the opposite is true.

BMP COMPLIANCE RATES

Each BMP in the Urban MOU defines a set of implementation requirements and a schedule for these requirements to be met. By signing the Urban MOU water suppliers pledge to make a good-faith effort to implement all of the BMPs that are locally cost-effective. For BMPs that are not locally cost-effective, the Urban MOU provides an exemption process by which water suppliers can opt out of implementation of those BMPs. Under this implementation framework there are essentially three possible states of the world with respect to each BMP's implementation:

- The water supplier is complying with the BMP's requirements and schedule.
- The water supplier has filed an exemption with the CUWCC.
- The water supplier is neither complying with the BMP's requirements and schedule nor has it filed an exemption with the CUWCC.

The first two states of the world describe cases where the water supplier would be complying with the terms of the Urban MOU. The last state of the world describes the case where the water supplier would not be complying, either because it is not implementing the BMPs or because it is not reporting its implementation. Figure 3.9 summarizes BMP compliance rates through 2002 for MOU signatories.[26] It clearly shows that for about half of the BMPs, most signatories are not complying with the Urban MOU.[27]

Weighting the compliance data by population has little effect on the overall picture of MOU compliance (Figure 3.10). The supposition that a large number of small water suppliers out of compliance with the Urban MOU account for the overall rates of non-compliance is not supported by the data. MOU non-compliance is pervasive. Water suppliers in compliance with the Urban MOU do not serve the majority of urban water users. Figures 3.9 and 3.10 suggest several important points regarding the effectiveness of the current, voluntary Urban MOU process:

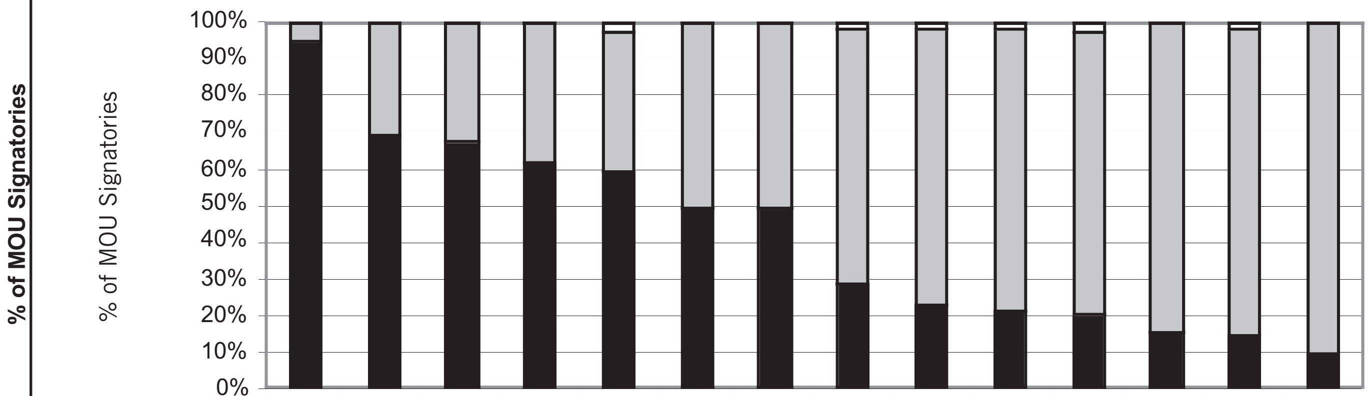
- While a sizable proportion of signatories are apparently not implementing BMPs per the requirements of the Urban MOU, very few of these signatories file exemptions with supporting documentation.[28] The rate of exemption filings with supporting documentation ranges between 0% and 2% of water suppliers. The exemption process was a cornerstone to the self-regulatory framework established by the Urban MOU. Data from the CUWCC suggest this process is not working as intended.
- The proportion of signatories out of compliance with BMP requirements having not submitted exemptions equals or exceeds 50% for nine BMPs. Non-compliance rates are highest for BMPs requiring significant customer interaction and water supplier financial

26. At the time of this analysis, reporting for 2003 and 2004 was still in progress. Because reporting for these years was still incomplete they were not included in the analysis of compliance rates.

27. It is sometimes suggested that low MOU compliance rates result in some regions because their cost of water is low. While it is true that the lower the cost of water the less likely it is that BMPs will be cost-effective to implement, it is not the case that this should be reflected in low rates of MOU compliance. The MOU anticipated that some agencies or regions would not find BMPs cost-effective to implement some of the time and therefore included an exemption process as part of the MOU agreement. Under the terms of the MOU agencies that do not find BMPs cost-effective to implement are supposed to file exemptions with the CUWCC demonstrating the economic case against implementation. Data from the CUWCC show most MOU signatories are not following this process.

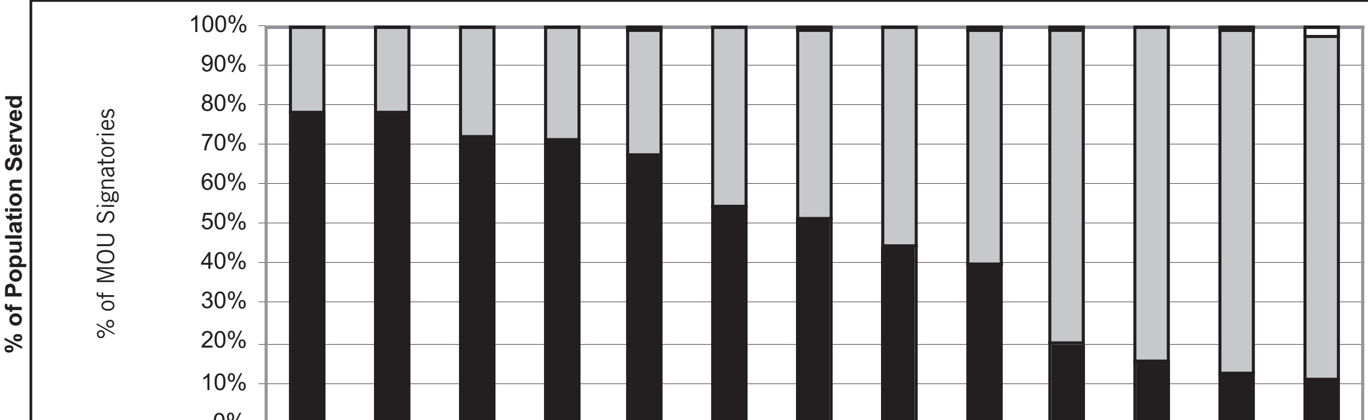
28. There is the possibility that implementation is occurring but not being reported. Even so, reporting is an important part of the Urban MOU process and non-reporting constitutes noncompliance.

FIGURE 3.9 **BMP COMPLIANCE RATES THROUGH 2002**



	BMP 03	BMP 07	BMP 08	BMP 04	BMP 06	BMP 11	BMP 12	BMP 05 - Srvy	BMP 02	BMP 05 - Bdgt	BMP 01	BMP 14	BMP 09	BMP 13
Exemptions	0%	0%	0%	0%	2%	0%	0%	2%	2%	2%	2%	0%	2%	0%
Out of Compliance	5%	31%	33%	38%	38%	50%	51%	69%	75%	77%	78%	84%	83%	90%
In Compliance	95%	69%	67%	62%	60%	49%	49%	29%	23%	21%	20%	16%	15%	10%

FIGURE 3.10 **POPULATION-WEIGHTED MOU COMPLIANCE RATES**



	BMP 07	BMP 11	BMP 12	BMP 08	BMP 06	BMP 04	BMP 02	BMP 03	BMP 09	BMP 14	BMP 13	BMP 05	BMP 01
Exemptions	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	1.3%	0.0%	1.1%	1.4%	0.0%	1.2%	2.4%
Out of Compliance	21.7%	21.9%	27.7%	28.5%	31.5%	45.4%	47.1%	55.7%	59.0%	78.7%	84.2%	86.3%	86.6%
In Compliance	78.3%	78.1%	72.3%	71.5%	67.1%	54.6%	51.6%	44.2%	39.9%	19.9%	15.7%	12.6%	10.9%

commitment (BMPs 1, 2, 5, 9, and 14).

- BMP 4 (metering) compliance is relatively high, but this is due to the fact that most water supplier service areas already are metered. None of the water suppliers with large numbers of unmetered connections are complying with BMP 4. Passage of state metering legislation in 2004, which requires metering of all urban connections by 2025, is likely to change this situation, albeit slowly.
- In many instances, water suppliers are found out of compliance by the CUWCC database system because of non-reporting. It may be that some of these water suppliers are implementing the BMPs but simply not reporting the information to the CUWCC. Reporting rates, while improving over time, are still low. Like the exemption provisions, reporting of BMP implementation was considered key to the overall effectiveness of the self-regulatory framework the Urban MOU established. Here too, the CUWCC data suggest the process is not working as intended.
- Overall, the CUWCC data indicate that most Urban MOU signatories do not comply with the BMP implementation process. Few submit exemptions for BMPs not being implemented and few are in compliance with most BMPs.

FIGURE 3.11 2004 URBAN WATER SAVINGS FROM LOCALLY AND GRANT FUNDED BMPS IMPLEMENTED FROM 1991–2004

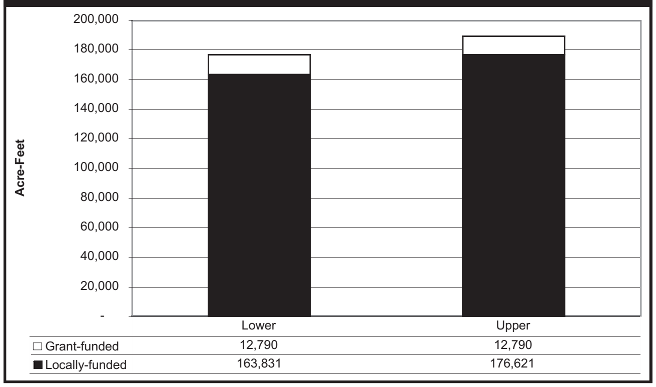
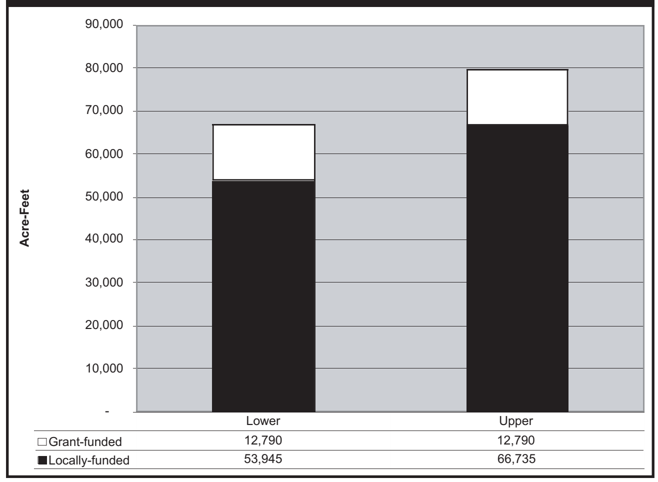


FIGURE 3.12 2004 URBAN WATER SAVINGS FROM LOCALLY AND GRANT FUNDED BMPS FOR THE PERIOD 2001–04



CALFED PSP GRANT PROGRAM WATER SAVINGS

All of the urban conservation implementation projects funded under the CALFED Proposal Solicitation Package (PSP) Grant Program supported implementation of one or more of the BMPs. It is therefore likely that water suppliers included at least some, if not all, of the conservation activity funded with grants in their BMP reports to the CUWCC. This creates an accounting challenge. Simply summing independent estimates of savings from the PSP process with CUWCC estimates of savings from BMP implementation will result in double counting to an unknown extent. The available data simply do not allow one to determine how much of reported BMP activity over the first four years of Stage 1 was funded through the CALFED PSP Grant Program. However, it is possible to provide the likely range of savings produced by locally funded and grant-funded BMP implementation.

The first thing to note is the lag between when grants are awarded and when projects are completed and start producing water savings. The foregoing analysis assumes a two-year lag.[29] The consequence of this assumption is that water savings from projects funded by the 2003 and 2004 PSP programs would not start until after 2004 and therefore fall outside the scope of this analysis. Only water savings from projects funded by the 2001 and 2002 PSP programs are counted.[30]

A lower-bound estimate of water savings would assume that all savings produced by grant-funded conservation projects are reported as BMP implementation to the CUWCC. This would mean that total water savings, inclusive of grant-funded projects, are the same as the MOU water savings discussed in the previous section. An upper-bound estimate would assume that none of the savings produced by grant-funded conservation projects are reported to the CUWCC. In this case, total savings is the sum of MOU and grant-funded water savings. The possible range of savings is shown in Figure 3.11. Under either case, projects funded through the CALFED PSP Grant Program accounted for approximately 7% of total water savings in 2004. Most of the MOU water savings realized in 2004 (approximately 93%) were not produced through CALFED financial assistance. It must be remembered, however, that much of the water savings realized in 2004 is the result of BMP activity occurring throughout the 1990s. It therefore is not very surprising that PSP funded projects from 2001 and 2002 account for less than 10% of this total.

Figure 3.12 shows water savings just from BMP activity for the period 2001 through 2004. These estimates include BMP activity funded by the 2001 and 2002 PSP programs as well as BMP activity funded locally. Looking back at the first four years of Stage 1, grant-funded BMP activity accounted for between 16–19% of estimated water savings. It is important to remember that these estimates do not include expected water savings from grants awarded in 2003 and 2004, since it is assumed that savings from these projects would not be realized until 2005 or later.

COMPARISON TO ROD ESTIMATES

Expected urban sector water savings by the end of Stage 1 are likely to fall well short of the potential savings estimates presented in the ROD. Figure 3.13 provides a comparison of likely water savings by the end of Stage 1 to ROD estimates. Expected savings through Stage 1 are based on the following assumptions:

- The lower-bound assumes that BMP activity funded by the CALFED PSP Grant Program is fully counted by the CUWCC BMP database while the upper-bound assumes none of this activity is captured by the database.
- Locally funded BMP savings for 2001–04 are based on

29. Contracting typically takes between six months and a year. Project implementation may then require anywhere from three months to three years. We assume that on average urban conservation projects take one year to implement.
30. Total expected urban water savings from the four PSP programs, however, are discussed in a later section of this report.

BMP implementation data submitted to the CUWCC by water suppliers. BMP savings for 2005–07 are derived assuming savings grow by 17.5% per year, the mid-point of the range of long-term growth of BMP water savings discussed previously.

- Grant funded water savings for 2003–06 are based on estimated yield from conservation projects funded by the 2001–04 PSP Grant Programs. Savings for 2007 are assumed to mirror 2006 savings.

Under these assumptions, expected urban water savings by the end of Stage 1 range between 101,000 and 150,000 acre-feet, about one-fifth of the Stage 1 water savings estimated by the ROD.

The ROD estimates were predicated on two key assumptions. One assumption was that CALFED would implement a program to certify water supplier compliance with the Urban MOU by the end of 2002. The other was that CALFED implementing agencies would provide $1.5 billion in financial incentives for local WUE implementation through Stage 1, of which approximately $350 million would be directed towards urban conservation.[31] Neither assumption proved true. While CALFED did develop a certification framework it did not succeed in implementing it. Likewise, although CALFED has provided financial incentives for urban conservation investments, funding is expected to be only about 23% of the initially projected amount.[32] Thus, one possible explanation for the shortfall is that the urban WUE program envisioned by the ROD failed to materialize and as a consequence so did the water savings. Another possible explanation is that the ROD water savings estimates for the urban sector were simply unachievable under any reasonable set of assumptions. Some stakeholders offered this second possible explanation as a prediction when the ROD was released.

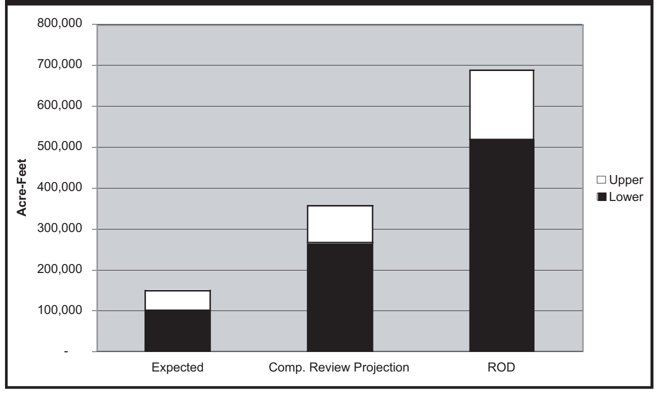
Results from the Comprehensive Evaluation's analysis of urban water savings potential can help evaluate which is the more likely explanation. One of the tasks of the Comprehensive Evaluation was to estimate potential water savings assuming urban water suppliers implemented all locally cost-effective conservation measures. This is the same as measuring the savings potential of an ideal certification program. The analysis concluded that water savings by 2007 would approach 350,000 acre-feet if all urban water suppliers implemented locally cost-effective conservation measures.

Another task of the Comprehensive Evaluation was to evaluate additional water savings achievable through CALFED grants. The analysis done for this task indicated that in the initial years of the program, CALFED could productively invest up to $73 million in urban conservation projects each year. Beyond this threshold, costs of the projects would likely exceed statewide benefits. Each million dollars of investment would add about 500 acre-feet of new water savings.

31. WUE Preliminary Program Plan, Appendix A.

32. Through 2004/05 grants for urban conservation have totaled $50 million. Assuming that grants for 2005/06 and 2006/07 total another $30 million, total Stage 1 grant funding for urban conservation would be $80 million, about 23% of the ROD estimate.

FIGURE 3.13 ANNUAL URBAN WATER SAVINGS BY END OF STAGE 1: EXPECTED VS. ROD ESTIMATES



Taking into account the fact that there is at least a two year lag between when grant funds are awarded and when water savings are realized, only grants awarded through 2004/05 would contribute towards Stage 1 water savings—under the ROD funding assumptions, a total of about $250 million. The Comprehensive Evaluation's analysis of urban water savings potential suggest this level of funding could yield upwards of 125,000 acre-feet of urban water savings by the end of Stage 1.

Taken together, local implementation of cost-effective conservation measures plus levels of state/federal grant funding consistent with ROD funding estimates, according to Comprehensive Evaluation modeling results, could generate upwards of 475,000 acre-feet—about 91% of the ROD's lower-bound estimate of Stage 1 urban savings potential. Thus, under full ROD funding and full implementation of locally cost-effective conservation measures, the Comprehensive Evaluation projections indicate that implementation of ROD certification and financial incentive objectives for urban WUE through Stage 1 could result in water savings that approached the lower-bound ROD estimate of water savings potential.

These analyses, however, do not fully take into account many real-world factors limiting CALFED's ability to capture all of this potential. These factors include information asymmetries that would reduce the effectiveness of a certification program; equity considerations that limit the ability of CALFED implementing agencies to operate a grant program based solely on benefit-cost metrics;[33] the possibility of diminishing returns that drive up unit costs of conservation at a faster rate than assumed by the modeling done for the Comprehensive Evaluation; and the inevitable delays associated with reviewing, processing, and contracting for grants and loans on scales

TABLE 3.1 URBAN WATER CONSERVATION GRANT FUNDING SUMMARY

Year	Funding Source	Available Funding	Proposals Submitted	Funding Requested	Proposals Funded	Funding Awarded	Total Cost of Funded Proposals	CALFED Cost Share
2001	SB 23	$6,000,000	73	$85,000,000	30	$6,000,000	$12,000,000	51%
2002	Prop. 13	$9,000,000	116	$80,000,000	21	$9,000,000	$11,000,000	81%
2003	Prop. 13	$18,000,000	60	$44,000,000	25	$18,000,000	$38,000,000	48%
2004	Prop. 50	$17,500,000	108	$188,000,000	46	$17,500,000	$49,000,000	36%
Totals		**$50,500,000**	**357**	**$397,000,000**	**122**	**$50,500,000**	**$110,000,000**	**46%**

implied by ROD funding levels. Under these real-world conditions it seems unlikely that the full 475,000 acre-feet of savings potential identified by the Comprehensive Evaluation's models would be realized. Capturing two-thirds of this potential would be laudable. Realizing three-fourths of it would be a major achievement. This puts the reasonable range of Stage 1 savings potential somewhere between 267,000 and 356,000 acre-feet. This is less than the potential estimated by the ROD, but also considerably more than the amount currently expected to be realized through Stage 1.

URBAN FINANCIAL ASSISTANCE PROGRAM PERFORMANCE

The WUE Preliminary Implementation Plan budgeted $350 million for state and federal financial assistance programs for urban WUE implementation through Stage 1. These were to consist of low-interest loan programs for implementation of locally cost-effective conservation measures and grant programs for measures that were not locally cost-effective but did provide statewide benefits.

The WUE program developed a competitive PSP process for urban grants that has operated over the first four years of the program. An analogous program for low-interest loans to support implementation of locally cost-effective conservation measures has yet to be implemented.[34] Funds from Proposition 13 initially set aside for urban loans were reprogrammed for urban grants following a challenge to the bond language by urban water agencies.[35] As a result, no funding has been available for an urban low-interest loan program. One consequence of this reprogramming was the use of grants in 2002 and 2003 to fund locally cost-effective conservation measures. This decision was inconsistent with ROD direction, which stated that financial assistance for implementation of locally cost-effective conservation measures should be limited to "capitalization loans, not grants."[36]

SUMMARY OF URBAN GRANT FUNDING

Table 3.1 summarizes grant funding for urban water conservation capital outlay projects for the first four years of Stage 1. Over this period a total of $50.5 million was authorized by the State Legislature for urban water conservation grants. This funding came from three sources: SB 23, Proposition 13, and Proposition 50.

During the first four years of Stage 1, WUE received 357 applications for grant funding to implement urban water conservation projects, feasibility studies, and research, evaluation, and education projects. Funding requests exceeded available grant funds by a ratio of about eight-to-one. WUE funded 122 urban projects, awarding all available funding. The grant cost share varied by project, ranging from a low of 6% to a high of 100%. On average, grant funding accounted for 46% of project costs. Table 3.2 shows the number of projects funded and amount of funding going to urban conservation implementation versus research/demonstration/education projects. The distributions of funding by type of project and geography are shown in Figures 3.14 and 3.15, respectively.

GRANT FUNDED URBAN WATER SAVINGS AND COSTS

Projected water savings from these grants are shown in Table 3.3. These projections are based on applicant estimates of water savings and have not been independently verified. Through 2004, grant funded urban conservation projects have projected annual water savings of more than 37,000 acre-feet.[37] On average, the WUE grant program added about

33. Past grant allocation processes have been mindful of maintaining an equitable distribution of grant funds by geography and size of applicant. Additionally, disadvantaged communities are given a handicap in the application scoring process to increase the likelihood that projects in these communities are funded. The modeling done for the look-forward analysis, in contrast, only utilized benefit-cost metrics to allocate grant funds. Consequently, the modeling favored efficiency for equity to a degree that is unlikely to be replicated in the real world.

34. The ROD identified capitalization loans rather than grants as the preferred method for providing state/federal financial assistance for implementation of locally cost-effective conservation measures. ROD, pg. 60.

35. Chapter 8 of Proposition 13 provided up to $155 million of funding for water conservation capital outlay projects and feasibility studies. Article 6 of Chapter 8 dedicated $30 million of this funding for urban conservation projects and feasibility studies. Initially the Department of Water Resources interpreted the language in Article 6 as authorizing low-interest loans of up to $5 million per project for urban conservation capital outlay projects and grants of up to $100,000 for feasibility studies of urban conservation projects potentially eligible for loans. These terms paralleled those in Article 3 for agricultural conservation projects and feasibility studies. However, there were small differences in wording between Article 3 and Article 6 of Chapter 8. While Article 3 was very specific that only loans should be used for agricultural conservation projects, Article 6 was somewhat more vague. This vagueness caused urban water agencies to request a legal review of the language to determine whether Article 6 prohibited funding urban conservation capital outlay projects with grants rather than loans. This legal review concluded that Article 6 did not imply such a prohibition. Consequently the DWR reprogrammed the funds for grants rather than loans.

36. ROD, pg. 60.

TABLE 3.2 URBAN CONSERVATION GRANT FUNDED PROJECTS BY TYPE

	Number of Projects Funded			Grant Funding Allocation		
Year	Implemented Projects	Research, Demonstration, Education	Total	Implemented Projects	Research, Demonstration, Education	Total
2001	18	12	30	$4,000,000	$2,000,000	$6,000,000
2002	21	0	21	$9,000,000	$0	$9,000,000
2003	25	0	25	$18,000,000	$0	$18,000,000
2004	23	23	46	$13,500,000	$4,000,000	$17,500,000
Totals	**87**	**35**	**122**	**$44,500,000**	**$6,000,000**	**$50,500,000**

FIGURE 3.14 ALLOCATION OF URBAN CONSERVATION GRANT FUNDS: 2001–04

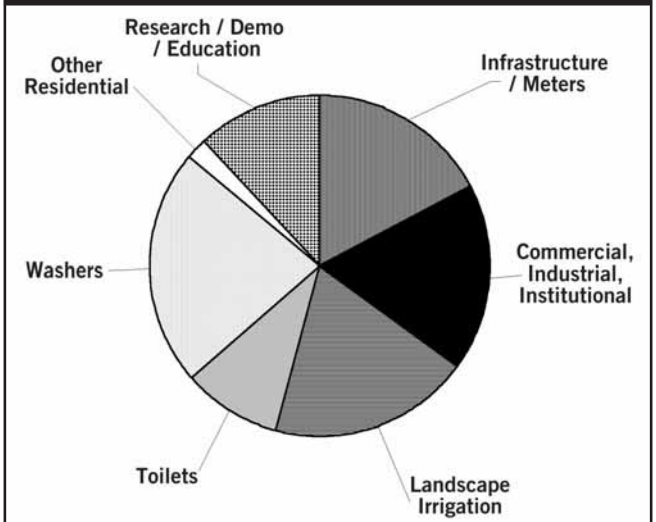


FIGURE 3.15 DISTRIBUTION OF URBAN CONSERVATION GRANT FUNDS: 2001–04

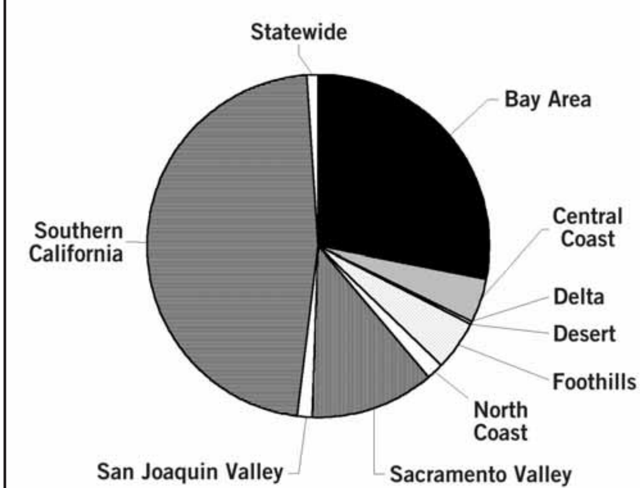


TABLE 3.3 EXPECTED WATER SAVINGS FROM GRANT FUNDED URBAN CONSERVATION

Year	Incremental Yield (AFY)	Cumulative Yield (AFY)
2001	5,664	5,664
2002	7,125	12,790
2003	13,188	25,978
2004	11,375	37,353

9,338 acre-feet of new urban water savings each year.

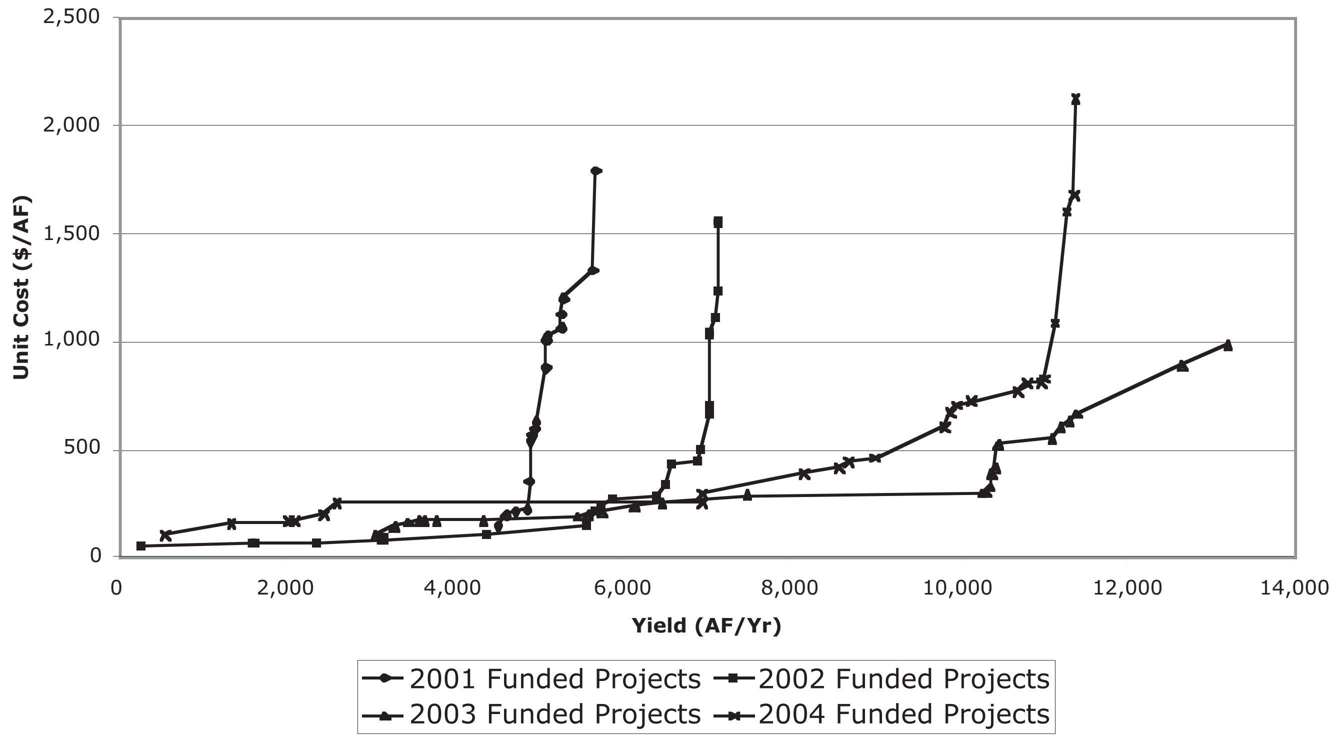
The ROD assumed that unit costs of urban conservation measures would range between $150 and $450 per acre-foot of water savings. Table 3.4 shows the average unit cost of water savings in each grant year, as well as other summary cost statistics. These cost statistics are based on estimated total project costs and the expected useful life and quantity of water savings. Average unit costs in all four funding years fall within the range predicted by the ROD.[38]

Data on unit costs, however, also suggest some tendency of the urban PSP process to fund projects with unit costs significantly exceeding the cost range expected by the ROD. This tendency is illustrated by Figure 3.16, which shows the conservation "supply curves" resulting from grant funded urban conservation measures for each funding year. In 2001 the unit cost for 47% of the funded projects was greater than $1,000 per acre-foot. In 2002 and 2004 close to 20% of the funded projects had unit costs greater than $1,000/AF. Only in 2003 was this threshold not exceeded. These results coupled with the fact that in the following year many projects with much lower unit costs were funded suggests the proposal solicitation process as operated over the first four years did not always direct grant dollars to the lowest-cost projects.

37. The reader should note that Table 3.4 shows the expected annual savings from projects funded in the year shown. However, savings would not begin in that year because of the lag between the time funds are awarded and the time the project is completed. As discussed in a previous section, we have assumed a two-year lag, on average, for our analyses of Stage 1 savings.

38. It is important to remember that the PSP process used different cost-benefit criteria in 2002 and 2003 than in 2001 and 2004. When Proposition 13 funds for urban loans were reprogrammed for grants the requirement that projects be locally cost-effective to implement was retained. Thus in 2002 and 2003 grant applicants could only request funding for projects that were locally cost-effective while in 2001 and 2004 they could only request funding for projects that were not locally cost-effective. As a result, a larger proportion of lower-cost projects were funded in 2002 and 2003 than in 2001 and 2004.

FIGURE 3.16 **GRANT FUNDED URBAN CONSERVATION SUPPLY CURVES: 2001–04**



It suggests that considerations of fairness, geographic distribution or project benefits more difficult to quantify than water supply significantly influenced funding decisions.[39]

The data also indicate a tendency to fund many small to medium scale projects rather than a smaller number of large projects. Indeed, the amount of funding any one project could receive was limited to $5 million by the application process, but funding awards never exceeded half this amount. Three-fourths of the projects funded between 2001 and 2004 had total costs of one million or less. The average grant amount was just under $500,000 and three-quarters of all grants were for less than $630,000. To the extent that lower unit costs could be realized through economies of scale, the urban grant PSP process during the first four years was not set up to capture them.[40]

TABLE 3.4 **UNIT COST SUMMARY STATISTICS: 2001–04**

Year	Incremental Annual Yield AF/Year	Mean Cost $/AF	Median Project Cost $/AF	Min. $/AF	Max. $/AF
2001	5,664	$290	$879	$149	$1,792
2002	7,125	$161	$286	$53	$1,549
2003	13,188	$333	$288	$108	$987
2004	11,375	$338	$533	$105	$2,125

LINKAGE OF GRANT FUNDING TO URBAN MOU COMPLIANCE

The ROD intended access to urban grants to be "conditioned on agency implementation of the applicable water management plans."[41] For urban water suppliers Urban MOU compliance was meant to be a prerequisite to receiving CALFED grant funding assistance. The ROD recognized it would not be possible to make this linkage during the first few years of implementation because the certification process was not expected to be ready until the end of 2002.[42] In the interim, it called on CALFED Agencies to develop a plan for awarding grant funds in the absence of information about Urban MOU compliance.[43]

To date PSP funding awards have not been conditioned on Urban MOU compliance. Eligibility does require that water supplier applicants have filed urban water management plans in accordance with the UWMPA, but this, in itself, does not ensure Urban MOU compliance. CALFED agencies

39. For example, in the most recent funding round, the economic analysis of the project contributed 35 out of 100 possible points. Considerations other than the benefit-cost analysis included project relevance, technical/scientific merit, monitoring plan, applicant qualifications, community involvement, and innovation. Additionally, projects located in disadvantaged communities were given a handicap in the scoring process to increase the likelihood that these projects would receive funding.

40. Reversing this tendancy potentially could increase the efficiency of the program, but might impact the ability of smaller communities to effectively compete for grant funds. Currently the program is structured to increase the likelihoold of funding projects in small economically disadvantaged communities.

41. ROD, pg. 60.

42. ROD, pg. 62.

43. Ibid.

have not established a timetable for linking grant eligibility to Urban MOU compliance, though the ROD expected such a linkage by the beginning of 2003.

IMPLEMENTATION OF A PROCESS TO CERTIFY URBAN MOU COMPLIANCE

WUE finished a framework for certifying water supplier compliance with the Urban MOU in June 2002.[44] The framework report was the culmination of more than two years of work by CALFED Agencies, the CUWCC, and WUE stakeholders. The framework was guided by the following imperatives:

- Build upon CUWCC experience and expertise, while preserving the impartiality and collegiality of the CUWCC MOU process.
- Rely on an independent entity with enforcement capabilities—not the CUWCC—to take on the formal certification and appeals responsibilities.
- Identify, refine and resolve critical technical and analytic issues prior to formally implementing an Urban MOU certification program.
- Develop a certification framework in a balanced manner that furthers urban water conservation efforts, supports CALFED objectives and preserves the flexibility embodied in the MOU.
- Build capacity and awareness, via technical assistance and financial incentives, among smaller and disadvantaged water suppliers, thereby recognizing and accounting for the resource and technical expertise limits constraining their participation. This includes water suppliers that currently are small enough to be exempted from the proposed Urban MOU certification requirements, but may meet the participation criteria in the near future.
- Focus certification, at least initially, on a limited number of water suppliers in a balanced manner that takes into consideration, among other things: percentage of population served; mix of CUWCC MOU signatory and non-signatory water suppliers; workload/resource constraints of the certifying entity; and potential water savings.
- Structure an urban certification framework in a manner that minimizes redundancies and inconsistencies with existing regulatory and planning processes, such as the CPUC, CVPIA, and Urban Water Management Plans.
- Recognize the value of and need for an adaptive management approach that ensures ongoing assessments and appropriate revisions to an Urban MOU certification process.

44. A copy of the framework can be found at http://calwater.ca.gov/Programs/WaterUseEfficiency/WaterUseEfficiencyUrbanWaterConservationAdHocWorkgroup.shtml.

Following the release of the report, statewide workshops were held to explain the proposed framework and receive public comment. The framework was put before the Bay-Delta Public Advisory Committee (BDPAC) for action in August of 2002. BDPAC engaged the topic, but took no action at that time for three reasons. First, it wanted resolution of key outstanding technical issues. Second, it wanted WUE to address water supplier proposals for linkage of certification to progress on other CALFED program elements. And third, it questioned the necessity of a regulatory approach to Urban MOU compliance. While the outstanding technical issues have been largely addressed, substantive progress on the other issues has not been made. Currently, there is no timetable for implementing an Urban MOU certification process as part of the CALFED WUE program.

IMPLEMENTATION OF SUPPORTING WUE ELEMENTS

The strategy for urban WUE articulated by the ROD depended on implementation of several supporting activities. These included providing technical assistance to water agencies implementing BMPs, defining appropriate measurement of urban water use, initiating research and evaluation projects to support urban WUE programs and evaluate program results, and providing coordination and oversight of program implementation. Implementation of these supporting functions over the first four years of Stage 1 is discussed in this section.

TECHNICAL ASSISTANCE

During the first four years of Stage 1, WUE initiated several technical assistance efforts related to urban water use efficiency. These efforts included:

- Assisting urban water suppliers with UWMPA compliance.
- Producing brochures, articles and newsletters pertaining to urban water conservation, including publication of Guidebook for Implementation of Senate Bill 610 and Senate Bill 221 of 2001, and conducting SB 610/SB 221 workshops.
- Providing technical assistance to water suppliers and water users through USBR's field services program.
- Providing assistance to water suppliers implementing urban BMPs.
- Addressing several technical issues relating to the proposed framework for Urban MOU Certification, including:
    - — Clarification of BMP language.
    - — Development of BMP exemption review procedures.
    - — Development of financing options for an Urban MOU certification program.
    - — Creation of guidelines for calculating avoidable

water supply costs associated with BMP implementation.
- — Creation of guidelines for calculating environmental benefits associated with BMP implementation.
- — Developing analytical tools to evaluate the cost-effectiveness of BMPs from local agency and statewide perspectives.
- — Compiling data on BMP water savings and costs.
- — Evaluating new conservation technologies and practices as possible new BMPs.

These efforts were lead by DWR and USBR. Much of the work listed above was accomplished in cooperation with the CUWCC through two technical assistance cooperative agreements. The first agreement, signed in 2000 between the CUWCC and USBR, provided $410,000 of funding to the CUWCC to complete 17 tasks related to planning for Urban MOU certification, BMP implementation support and guidance, and research of conservation savings and costs. The second agreement, signed in 2002 between the CUWCC, DWR, USBR, and California Bay-Delta Authority (CBDA), provided $1.7 million to the CUWCC to carryout another 17 technical assistance tasks over a three-year period. As with the first agreement, the tasks revolve around planning for Urban MOU certification, BMP implementation support, and urban conservation research. CUWCC was to have completed most of the second agreement tasks by the end of 2005. The deadline for tasks funded by the USBR, however, has been extended to April 2007.

Funding for urban technical assistance through Year 4 has totaled $10 million.[45] Funding agreements with the CUWCC accounted for about $2.1 million of this total. The remaining $7.9 million was expenditure for DWR and USBR staff and technical assistance programs. Combined funding for technical assistance for urban, agriculture, and recycling WUE has totaled $19.3 million over the first four years.[46] This is 56% of the funding level for technical assistance called for by the ROD over the first four years of Stage 1.[47] The ROD did not provide guidance on how this funding should be allocated among urban, agriculture, and recycling WUE programs.

APPROPRIATE MEASUREMENT

Recommendations for urban water use measurement were part of the overall definition of appropriate water use measurement adopted by CBDA in April 2004.[48] CBDA staff worked throughout 2003 with technical experts, CALFED Agency staff and stakeholder representatives to take a comprehensive look at urban water use measurement needs in the areas of urban water purveyor supplies (surface water and groundwater) and deliveries and urban wastewater discharger collection and discharge. Based on these efforts, CBDA staff put forward a proposed implementation package focusing on a handful of key actions related to urban water use measurement. These critical needs—detailed below—primarily concerned state water management objectives identified during the process. The urban definition addressed four critical urban water use measurement needs:

- State standards/protocols for recording/reporting urban water use.
- Metering of urban customer deliveries.
- Reporting of urban water source and delivery data.
- Urban groundwater use.

The resulting CBDA staff proposal described each of these needs and put forward specific recommendations to address them. With the exception of metering of urban customer deliveries, the CBDA staff recommendations have been incorporated into legislation (SB 866) proposed by Senator Kehoe in February 2005, which was sent to the Natural Resources and Water Committee in March 2005. The bill expired without ever being heard by committee. The metering recommendations were not incorporated into SB 866 because they were addressed by two earlier pieces of metering legislation that have subsequently become law.[49] The work done by CBDA and CALFED Agency staff and stakeholder representatives to characterize the need for comprehensive metering of urban customer deliveries contributed to the passage of this earlier legislation.

RESEARCH AND EVALUATION

WUE undertook several urban research and evaluation initiatives during the program's first four years. These efforts were funded through the PSP grant process, through the two cooperative agreements with the CUWCC, or directly by CALFED Agencies.

Ten urban research grants were awarded through the PSP grant programs; two in the 2001 funding cycle (SB 23) and eight in the 2004 funding cycle (Proposition 50). Proposition 13 funds were restricted to project feasibility studies and implementation projects and therefore no urban research grants were awarded in 2002 and 2003. The PSP grant programs funded urban research projects with costs totaling approximately $4 million. Grant funds covered approximately 60% of this cost while local cost-sharing paid for the remainder. These projects addressed a number of different issues relevant to urban water conservation planning and implementation, including:

45. CBDA, Water Use Efficiency Multi-Year Program Plan, July 2004.
46. Ibid.
47. ROD, pg. 62.
48. A copy of this report can be found at http://calwater.ca.gov/Programs/WaterUseEfficiency/WaterUseEfficiencyAgriculturalWaterMeasurement.shtml.
49. Volume 2: Urban Water Use Efficiency.

- Water savings potential within the urban residential, commercial and industrial water use sectors.
- Feasibility and cost-effectiveness of submetering multi-family housing.
- Evaluation of evapotranspiration (ET)-based landscape irrigation control technology.
- Development of analytic tools to evaluate benefits and costs of urban conservation measures.
- Quantification of energy and water of alternative residential hot water systems.
- Benchmark studies of residential water use.

Additional research on urban WUE was conducted through the two cooperative agreements with the CUWCC, including:

- Evaluation of eight water use efficiency devices/practices as possible new BMPs.
- Evaluation of alternative program designs for distributing ultra-low flush (ULF) toilets in the presence of freeridership.
- Two updates to the CUWCC's BMP Costs and Savings Study, which provides guidance and data for conducting cost-effectiveness analysis of BMPs.
- Analysis of BMP implementation data to determine BMP implementation and exemption rates; MOU compliance rates; and BMP water savings, results of which have been used extensively by the Comprehensive Evaluation.

While much of the need for scientific review is often focused on habitat restoration efforts, the CALFED Science Program will cover all of the program components. For Stage 1 the emphasis for the Science Program will be on ecosystem restoration activities. The lead scientist will work with CALFED program managers and CALFED Agencies to develop priorities for these program areas.

Performance Measures

One of the ROD identified research priorities is performance measures. Performance measures are used to translate program goals and objectives into measurable benchmarks of program progress that present information on program implementation, conditions, trends, outcomes, and the significance of program activities in meeting the objectives and goals. Performance measures are used to:

- Evaluate progress in obtaining program objectives and goals.
- Inform future decisions via adaptive management
- Provide information designed to facilitate management decisions.
- Inform the public and policy makers on program progress.

The 2005 program plan identifies the existing information on performance measures. The plan specifies that in year 6 (2005/06), the implementing agencies will develop an initial set of indicators and conceptual models, that a more complete set of metrics will then be developed, and that information from this report will be used to revise targets and inform program assessment.

Oversight and Coordination

Oversight and coordination for urban WUE during the first four years of Stage 1 focused on three areas of program implementation: (1) design and implementation of the PSP grant process; (2) development of the framework to certify water supplier compliance with the Urban MOU; and (3) definition of appropriate measurement of urban water uses. Total expended on oversight and coordination over years 1–5 was $2.07 million for all water use efficiency efforts.

LOOK-FORWARD: PROJECTIONS OF WATER SAVINGS

The purpose of the Comprehensive Evaluation's "look-forward" analysis is to answer the question: What is the potential of water use efficiency actions statewide and regionally given different levels of state/federal investment and policies? This chapter summarizes the results of analyses undertaken to answer this question. It presents a range of projections that reasonably bracket potential water use efficiency savings over the next 25 years or so.

The projections presented in this chapter cover urban water conservation. Economic models of local and state/federal investment in water use efficiency were used to project urban water conservation potential. The methods, data, and core assumptions underlying these models are discussed in subsequent sections of this chapter.

The projections of water savings potential for different policies and levels of urban conservation investment are defined in Table 3.5. There are six projections that are common to both the agricultural and urban sectors. A seventh projection —Regulated Deficit Irrigation—applies only to the agricultural sector and is not discussed in the chapter. Projections 1-5 are functions of both technology and economics. Projection 6, Technical Potential, is a function of only technology and provides an upper limit to urban savings potential for the conservation measures evaluated by the Comprehensive Evaluation.

The projections of water savings presented in this chapter will be used to: (1) inform assumptions used for surface water storage investigation modeling (Common Assumptions); (2) assist state and federal decision-makers in assessing the ramifications of various WUE implementation levels; and (3) update water demand projections for the California Water Plan Update.

This chapter first describes the scope of analysis, data, and methods used to develop the urban conservation projections. Next it presents estimates of urban water conservation by source of savings. It then combines these source estimates into the savings projections presented in Table 3.5. The chapter concludes with an analysis of the total investment and average unit costs associated with each projection level.

SCOPE OF ANALYSIS

The analysis of urban water conservation potential covers a period of 30 years (2001–30); results are summarized for the years 2005, 2010, 2020, and 2030. The geographic unit of analysis is the hydrologic region as defined by DWR. The Comprehensive Evaluation presents results statewide and for each hydrologic region. The analysis projects water savings potential for existing Urban BMPs as well as other technologically and economically feasible conservation measures for the six projection levels shown in Table 3.5.

Table 3.6 lists the conservation measures used to project urban water savings potential. To avoid having an open-ended set of possible conservation measures, non-BMP measures were restricted to those having a history of implementation by urban water suppliers. Additionally, only BMPs with quantifiable coverage requirements and water savings were included in the analysis. Several BMPs therefore were not modeled. These included BMPs 7 and 8 (public information and school education), BMP 10 (wholesale water supplier assis-

TABLE 3.5 URBAN CONSERVATION PROJECTIONS

Projection	State/Federal Funding Assumption
1. Reasonably Foreseeable: Regulatory code-induced conservation plus continuation of historic rate of investment in Urban BMPs; continuation of investment trend in locally cost-effective ag. conservation; state/federal investment in projects that are not locally cost-effective but do have statewide positive net benefits.	Limited to remaining Proposition 50 funds. Analysis assumes funds fully awarded by 2006.
2. Locally Cost-Effective Practices: Regulatory code-induced conservation plus full implementation of locally cost-effective practices; state/federal investment in projects that are not locally cost-effective but do have statewide positive net benefits.	Limited to remaining Proposition 50 funds. Analysis assumes funds fully awarded by 2006.
3. Moderate CALFED Investment: Same as Reasonably Foreseeable but state/federal funding increased and extended to 2030.	$15 million/yr through 2030.
4. Locally Cost-Effective Practices w/ Moderate CALFED Investment: Same as Locally Cost-Effective but state/federal funding increased and extended to 2030.	$15 million/yr through 2030.
5. Locally Cost-Effective Practices w/ ROD Funding Levels: Same as Locally Cost-Effective but state/federal funding increased and extended to 2030.	$40 million/yr for first 10 years; $10 million/yr thereafter.
6. Technical Potential: 100% adoption of urban conservation measures included in analysis. Funding is not a constraint to implementation. This projection provides the upper limit of water savings for modeled conservation measures and serves as a point of reference for the other projections.	Not Applicable

tance), BMP 11 (conservation pricing), BMP 12 (conservation coordinator) and BMP 13 (water waste prohibition).

The Comprehensive Evaluation also did not directly model water-pricing policies as a source of potential urban water savings. This decision was made not because of any belief or evidence that price is not a factor affecting urban water uses; evidence to the contrary is overwhelming. Rather, the decision was made for two reasons unrelated to the efficacy of water-pricing policies as a conservation tool. First, because every decision a consumer makes about water use is partly a function of the price for water, it is not possible to treat decisions to invest in conservation and decisions to use less water because it costs more independently. If the Comprehensive Evaluation added together water savings from conservation investments and from price responses, it would double count water savings to an unknown extent. Second, the Comprehensive Evaluation lacked clear guidance regarding water-pricing policies. BMP 11 (conservation pricing) does not include specific requirements about either the form or level of water rates. Local water agencies are generally left to their own devices when setting rates. The Comprehensive Evaluation's approach therefore was to forecast the average avoided cost of water supply for each hydrologic region and to use these avoided cost forecasts when evaluating the benefits of each conservation measure included in the analysis. If water supply costs were forecast to increase with time, this would increase the expected benefits of each conservation measure, and therefore increase the likelihood it would be cost-effective to implement either locally or with CALFED financial assistance. In this way, changes in the cost of water were transmitted into the urban water conservation projections.

The analysis of urban conservation potential occurs on four levels:

- Water savings driven by plumbing and energy code requirements, primarily affecting water savings from toilets, showers, clothes washers, and meters, often referred to as natural replacement water savings;
- Water savings from measures local water suppliers would be expected to implement independent of CALFED financial assistance programs;
- Additional measures that would be implemented due to CALFED financial assistance; and
- Total water savings assuming 100% saturation of the urban water conservation devices and activities included in the analysis.

The Comprehensive Evaluation treats the first three levels of analysis additively. That is, urban conservation potential is the sum of savings from (1) plumbing and energy code requirements, (2) locally funded measures that accelerate or go beyond natural replacement, and (3) state/federal funded measures that go beyond locally funded conservation. Because these levels of analysis are layered upon one another to project urban conservation water saving potential, special care was required to avoid double counting water savings that could be realized by more than one analysis level. For example, if the analysis assumed a toilet was replaced because of energy code requirements, that toilet could not also be replaced through local or state/federal investment because this would double count water savings. Likewise, a measure funded locally could not also be implemented with CALFED funding. The deconstruction of water savings into (1) savings primarily due to code requirements, (2) savings primarily due to local investment, and (3) savings primarily due to state/federal investment allows a comparative assessment of the efficacy of different urban conservation policies that would otherwise not be possible.

The fourth level of analysis, total water savings assuming 100% saturation, is not additive to the first three. Whereas the first three levels of analysis were constrained by assumptions about technology, regulatory requirements, costs, and benefits, the fourth level of analysis was constrained only by assumptions about technology. It answers the question: "How much would urban water use decrease if all of the measures listed in Table 3.6 were implemented to achieve 100% saturation?" The answer provides a point of reference from which to judge the extent to which savings potential is captured when regulatory requirements, costs, and benefits are factored into the analysis.

While the Comprehensive Evaluation's scope of analysis of urban water conservation potential is broad, it is also constrained in important ways that affect the level of projected water savings. The following are key among these constraints:

- The level and rate of BMP implementation is limited to coverage requirements specified by the Urban MOU. In many cases it may be possible to increase the rate or level of implementation beyond that required by the MOU. Water savings from this additional potential was not modeled.
- As a Wall Street pundit once commented, "Forecasts are difficult, particularly if they involve the future." Rather than put the analysis on too speculative a footing, the decision was made to limit conservation measures to already proven technologies and existing or highly likely regulatory requirements. Non-BMP conservation measures were therefore limited to known technologies with good implementation track records. Likewise, water savings primarily due to code requirements were limited to existing or reasonably foreseeable regulatory codes. While this provides a

TABLE 3.6 MEASURES USED TO PROJECT URBAN WATER CONSERVATION POTENTIAL

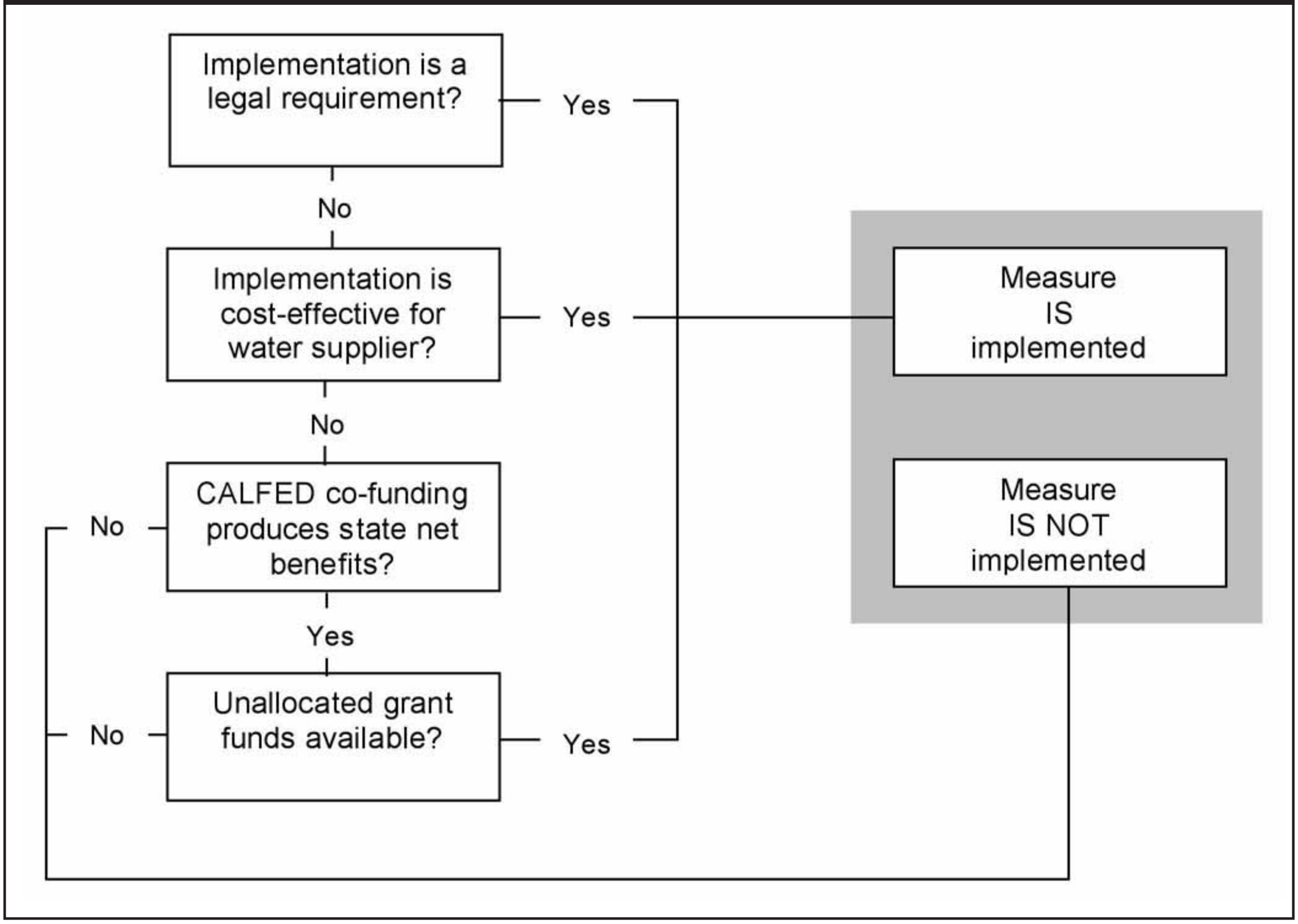
Measure Name	Description	Affected Water Use
State/Federal Code Requirements for Toilets	Prohibits sale and installation of toilets with rated flush volumes exceeding 1.6 gallons per flush.	Single- and multi-family residential uses; non-residential indoor uses
State Code Requirements for Residential Clothes Washers	Prohibits sale of clothes washers with water factors exceeding 8.5 after 2007 and 6.0 after 2010.	Single- and multi-family residential indoor uses
State/Federal Code Requirements for Showerheads	Prohibits sale and installation of showerheads with flow rates exceeding 2.0 gallons per minute.	Single- and multi-family residential indoor uses
State Code Requirements for Metering	Requires metering of unmetered urban water connections served by CVP by 2015 and other unmetered connections by 2025.	Primarily single-family residential indoor and outdoor uses
BMP 1	Residential water surveys done by water supplier staff or consultants.	Single- and multi-family residential uses
BMP 2	Showerhead distribution programs to accelerate replacement of inefficient showerheads.	Single- and multi-family residential indoor uses
BMP 3	Supply system audits and leak detection programs.	Unaccounted for water system losses
BMP 4	Meter retrofits.	Primarily single-family residential indoor and outdoor uses
BMP 5 – Landscape Surveys	Large landscape surveys.	Commercial, industrial, and institutional outdoor water uses
BMP 5 – Landscape Budgets	ET-based water use budgets for large landscapes with dedicated meters.	Commercial, industrial, and institutional outdoor water uses
BMP 9 – CII Surveys	Commercial, industrial, and institutional surveys other than landscape.	Commercial, industrial, and institutional water uses other than landscape
BMP 14	Replacement of residential toilets with ULF toilets.	Single- and multi-family residential indoor uses
Residential ET-Controllers	Financial incentive programs for installation of ET landscape irrigation controllers.	Single-family residential outdoor uses
CII ULF Toilets	Toilet distribution programs to accelerate replacement of non-ULF toilets.	Commercial, industrial, and institutional indoor water uses
Dishwashing Pre-Rinse Spray Valves	Pre-rinse spray valve distribution programs to replace inefficiency spray valves with low-flow spray valves.	Commercial, industrial, and institutional indoor water uses; primarily commercial restaurant uses
Commercial Dishwashers	Financial incentive programs for installation of high-efficiency commercial dishwashers.	Commercial, industrial, and institutional indoor water uses; primarily commercial restaurant uses
Medical Sterilizers	Financial incentive programs for retrofit of medical sterilizers used by hospitals and labs.	Commercial and institutional indoor uses
Industrial Process	Financial incentive programs to improve water use efficiency of various industrial processes, including cooling.	Commercial and industrial water uses
Large Landscape Beyond BMP 5	Financial incentive programs to reduce large landscape water uses beyond savings that can be achieved through BMP 5.	Commercial, industrial, and institutional outdoor water uses

prudent basis for projecting conservation savings, it is also necessarily a conservative one given the length of the forecast period.

- State/federal investment in urban conservation is constrained to the amounts shown in Table 3.5. These amounts spanned the range of possible investment levels considered feasible by the Comprehensive Evaluation given the CALFED Record of Decision and current state and federal budget realities. There is always the possibility, however, for these funding constraints to result in a less than optimal level of state/federal investment.[1]
- A conservation measure is assumed to be implemented only if it meets at least one of the following criteria: (1) it is a regulatory requirement (e.g. metering unmetered connections); (2) it is locally cost-effective from the water supplier perspective; or (3) it can be made locally cost-effective with state grant funds and doing so would produce net benefits for the state as a

1. Investment would be less than optimal if additional investments with positive net benefits from a statewide perspective were possible. An optimal level of investment would result in the benefits equaling the costs of the last increment of investment.

FIGURE 3.17 DECISION CRITERIA FOR URBAN CONSERVATION MEASURE IMPLEMENTATION



whole and there are unallocated state/federal funds to implement the measure. The decision criteria just described are shown schematically in Figure 3.17. Note that implementation criterion not met in one period of the analysis may be met in later periods depending on how costs and benefits change over time.

It is important to view the scope of analysis and resulting conservation projections within the context of the policies they are attempting to address. It was not the intent of the analysis to estimate the maximum possible amount of urban conservation that could be realized through implementation of all possible current and future conservation measures. Nor was it the intent to find a socially optimal level of urban conservation. Rather, the intent was to bracket the expected range of water savings given existing and reasonably foreseeable regulatory requirements affecting urban water use efficiency, the set of existing BMPs as governed by the Urban MOU, other proven water saving technologies, and alternative levels of state/federal investment deemed consistent with the CALFED Record of Decision and state/federal fiscal constraints.

APPLIED WATER USE PROJECTIONS

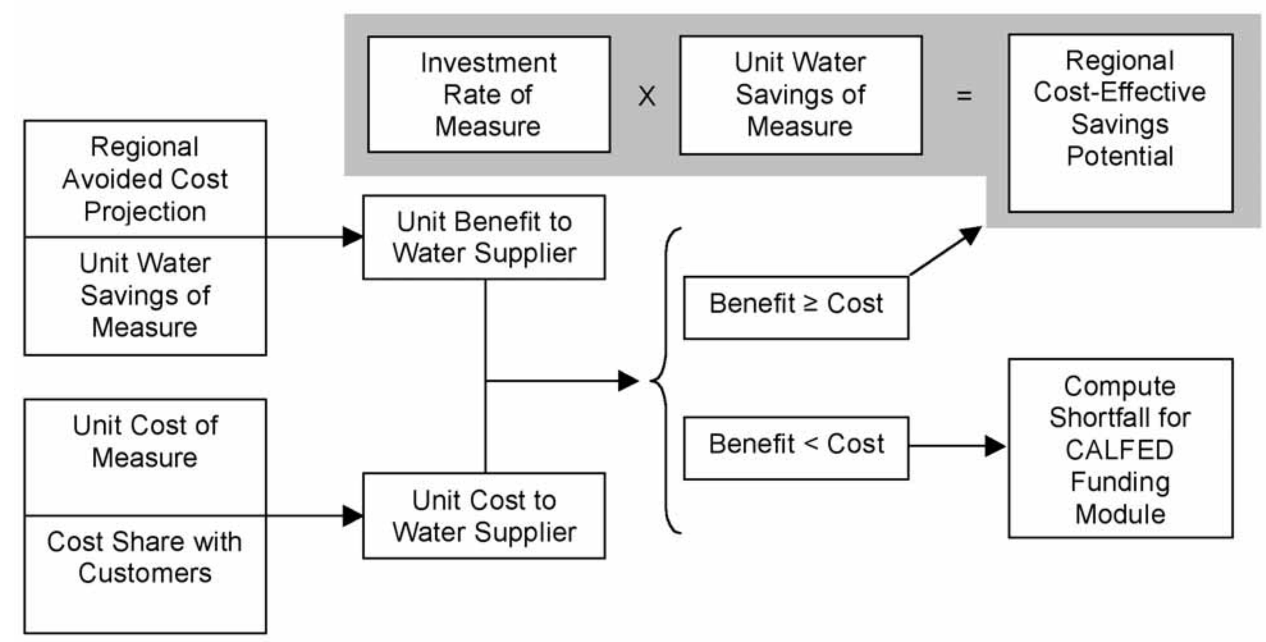
In addition to estimating urban water conservation potential, the Comprehensive Evaluation estimated applied water use by hydrologic region for each projection level over the forecast period. Applied water use projections were constructed by first creating a baseline applied water use projection that freezes per capita water use at Year 2000 efficiency. Baseline applied water use was then increased in proportion to population growth over the forecast period. Applied water use by projection level was then estimated by deducting from the baseline applied water use the calculated water savings potential for each projection level.

METHODS, DATA, ASSUMPTIONS

MODELING APPROACH

Modeling urban water savings potential for Projections 1–5 occurred in three stages. The first stage estimated code-driven water savings, sometimes referred to as natural replacement savings. The second stage estimated additional savings from local water supplier investment. The third stage estimat-

FIGURE 3.18 MODEL TO CALCULATE REGIONAL COST-EFFECTIVE URBAN WATER SAVINGS POTENTIAL



ed additional savings from state/federal grant programs.

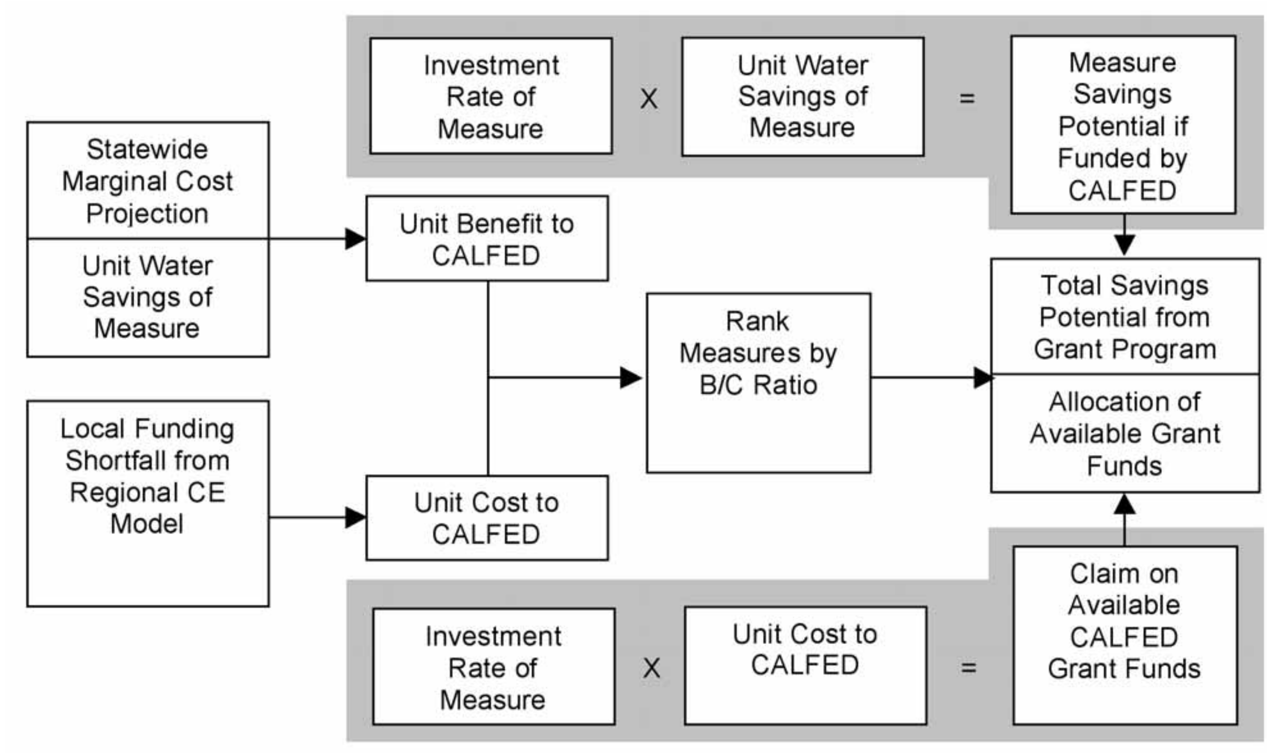
Code-driven water savings, which are included in projections 1-5, were estimated for toilets, showerheads, clothes washers, and meters using the following steps:

- First, the stock of low-efficiency devices (e.g. number of non-ULF residential toilets) as of the effective date of the code requirement was estimated using data from the American Housing Survey, California Department of Finance population projections, CUWCC, CALFED WUE Program, and other sources.
- Second, the proportion of devices at the start of the forecast period that had already been converted to comply with code requirements was estimated. Turnover rates were adopted for each device subject to code requirements. These rates were used to estimate the number of devices converted to higher efficiency between the effective date of the regulatory requirement and the start of the forecast period. Added to this was any additional replacement from BMP implementation occurring between the effective date of the regulatory requirement and the start of the forecast period. In the case of washers and meters, the effective date of the code requirement occurs after the start of the forecast period. Turnover of meters was assumed to start in 2010 and conclude by 2025. Turnover of washers prior to the effective date of the code requirement (2007) was modeled as a function of past BMP 6 implementation and current market share for high-efficiency washers.
- Third, the turnover rates were applied to the remaining stock of low-efficiency devices subject to code requirements. This resulted in a schedule of device conversions over the forecast period.
- Finally, device unit water savings were multiplied with the schedule of device conversions to produce the schedule of code-driven water savings over the forecast period.

Water savings from local water supplier investment were modeled using two different approaches. The first approach is based on the historic rate of BMP implementation. The second approach calculates regional cost-effectiveness to determine which measures are implemented. The first approach is used for Projections 1 and 3 while the second approach is used for Projections 2, 4, and 5.

The first approach estimated the average annual rate of BMP implementation for each hydrologic region using data for the period 1992–2002 from the CUWCC. These rates of implementation were assumed to continue over the forecast period. This first approach only considers potential savings from BMP implementation because data on past implementation of non-BMP conservation was not available. This results in a very conservative estimate of potential local water supplier conservation investment. This first approach is used for Projections 1 and 3 only.

FIGURE 3.19 MODEL TO CALCULATE CALFED GRANT FUNDED URBAN WATER SAVINGS POTENTIAL



The second approach used a model to identify locally cost-effective conservation measures. The model evaluates all of the measures listed in Table 3.6 for each hydrologic region. A schematic of the model is shown in Figure 3.18. The model estimates the benefits and costs of a conservation measure from the perspective of a representative water supplier. Benefits are the present value of avoided water supply costs over the forecast period that would be realized by implementing the measure. Costs are the present value of costs to implement the measure net of customer cost-sharing. If benefits are less than costs the measure is not locally cost-effective. In this case the model calculates the shortfall in benefits and passes this information to the CALFED funding model. If benefits are greater than or equal to costs the measure is locally cost-effective. In this case the model calculates the potential savings for the measure. A measure's potential savings depends on its investment rate and unit savings. The annual investment rate for a BMP measure is the rate of implementation needed to achieve the remaining Urban MOU Coverage Requirement after accounting for past implementation reported to the CUWCC. The annual investment rate for a non-BMP measure was set to one-tenth of the total economic potential of the measure. Unit savings for a measure may or may not be constant through time. If a measure is subject to code-driven natural replacement (e.g. toilets) unit savings are adjusted over time to account for this. Likewise, if a measure's savings degrade over time (e.g. residential and landscape surveys) unit savings are adjusted to account for this degradation. These investment rate and unit savings assumptions are discussed in more detail in the following sections.

In the third stage, another model was used by the Comprehensive Evaluation to estimate urban water savings that CALFED could leverage with grant funding. This model, depicted in Figure 3.19, is used for Projections 1–5. It allocates grant funds available under each projection level using the following steps:

- First, the model gets funding shortfall information from the regional cost-effectiveness model for each conservation measure that is not locally cost-effective in a particular region in a particular year. These shortfalls represent the unit costs to CALFED to implement the various measures.
- The model then estimates the unit benefit of each measure to CALFED as the present value of avoided statewide marginal supply costs assuming the measure was implemented. The projections of statewide marginal costs are discussed in the next section.
- From these two pieces of information, the model computes statewide benefit-cost ratios for each measure

in each year in each region, and, for each year, ranks measure/region pairs in decreasing order of these statewide benefit-cost ratios.

- At the same time, the model determines the implementation cost and savings potential of each measure/region pair. In most instances, the model uses the same unit savings and investment rate assumptions used by the regional cost-effectiveness model along with the funding shortfall information to do this.[2]
- The model then allocates grant funds to measure/region pairs based on the ranking of benefit-cost ratios until either all available grant funding is allocated or it runs out of measure/region pairs with benefit-cost ratios greater than or equal to one.

PRIMARY DATA

The modeling approach described in the previous section is data intensive. This section describes the primary sources of data used by the models. These data can be organized into seven categories:

Demographic Data—Includes population, employment, and housing by hydrologic region. Population projections for each hydrologic region were constructed using the most current county population forecasts from the Department of Finance. The county data were allocated to each hydrologic region using an estimate of the distribution of county populations within hydrologic regions from DWR. DWR also provided employment forecasts by hydrologic region. Housing forecasts were constructed using housing count data from the 2000 Census and the county population projections. Housing units were then allocated to each hydrologic region in the same manner as population. The population and employment forecasts used by the Comprehensive Evaluation are presented in Appendix 2A.

Device/Fixture Count Data—Include counts of residential and non-residential water-using fixtures such as toilets, showerheads, and clothes washers, as well as an array of CII fixtures and devices. Device/fixture count data came from a variety of sources, including American Housing Survey, American Water Works Association Research Foundation (AWWARF) *Residential End Use Study*, Pacific Institute's *Waste Not, Want Not*, and CUWCC. Device counts used by the Comprehensive Evaluation are discussed in more detail in Appendix 2B.

2. Metering is an exception. The unit water savings for CALFED and a local water supplier differ because of law that requires local water suppliers fully meter their service areas by 2025. This issue is discussed in more detail in a later section.

Conservation Measure Unit Water Savings Data—Includes data on expected water savings, device/fixture life spans, and device/fixture savings performance over time. These data came from a number of sources and are discussed in more detail in Appendix 2C.

Conservation Measure Unit Cost Data—Includes data on expected up-front capital and on-going annual costs for each measure. As with unit savings data, information on unit costs came from a variety of sources and are discussed in more detail in Appendix 2D.

BMP Implementation to Date—BMP implementation data covering the period 1991–2002 are from the CUWCC. These data are self-reported by Urban MOU signatories and are not independently verified, though obvious data entry errors were identified and either corrected or dropped from the data set.

Conservation Measure Savings Potential—Savings potential for BMPs is defined as remaining coverage requirement, which was derived for each hydrologic region using the demographic and BMP implementation data. Savings potential for non-BMPs came from various information sources, which are discussed in Appendix 2E.

Regional/Statewide Marginal Water Supply Costs—The schedule of average marginal water supply costs for each hydrologic region over the forecast period were updated from California Urban Water Agencies' 2001 report *California Urban Water Conservation Potential*. This updating was coordinated with California Urban Water Agencies, which used the resulting estimates in *Urban Water Conservation Potential: 2003 Technical Update*. For the San Francisco Bay and South Coast hydrologic regions, statewide marginal costs were based on updates of the Economic Evaluation of Water Management Alternatives report published by CALFED in 1999. For other hydrologic regions, the statewide marginal cost was set to the median price paid for water conservation savings by CALFED for the period 2001–03 and then annually escalated by the average rate of increase for Bay Area and south Coast statewide marginal costs. Appendix 2F contains the regional and statewide marginal water supply cost data used for the urban analysis.

CORE MODELING ASSUMPTIONS

A number of core modeling assumptions were used that have significant influence on the results of the analysis. These assumptions were as follows:

Discounting—Future costs and benefits are discounted to present value using a 3% real discount rate. This rate is lower than the 6% rate used by Department of Water Resources for most of its economic analyses. It was selected using Office of Management and Budgets Circular A-94 Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses, which is recommended for use by CUWCC when evaluating the cost-effectiveness of BMPs. The effect of using a 3% rather than a 6% real discount rate is to increase (decrease) the present value of future benefits (costs) of a conservation measure.

Water Supplier Benefits—Water supplier benefits are the present value of avoided costs to acquire, transport, treat, store and distribute water. Water supplier benefits do not include avoided wastewater treatment costs. This assumption was adopted to mimic how the majority of water suppliers evaluate BMPs and other conservation investments. Most of these suppliers do not have integrated wastewater operations and therefore do not treat avoided wastewater costs as benefits they can capture directly.[3] The practical effect of this assumption is to slightly reduce the benefits of non-landscape conservation measures. The reduction in benefit is small because the conservation measures evaluated would only avoid wastewater energy and chemical costs, not capital expenditures, since wastewater treatment plants are sized to accommodate storm water flows.

Conservation Measure Cost Escalation—Costs of conservation measures are assumed to increase at a real rate of 2% per year. Annual cost escalation was used as a proxy for diminishing returns to investment as more and more of the technical potential of a measure was realized. The practical effect of this assumption is to increase the unit costs of conservation measures over time. In regions where this causes costs to grow at a faster rate than avoided supply costs, measures become less cost-effective with time. In regions where the opposite is true, measures become more cost-effective with time.

The 2% cost escalation assumption was adopted after consultation with a panel of water utility representatives with extensive experience implementing water conservation programs. According to these representatives, program costs escalate as saturation levels rise and the lowest cost opportunities get exploited. The water agency representatives originally suggested a 4% cost escalation, which was the assumption used by CUWA (2001) in its analysis of conservation potential. After additional discussion, 2% was deemed reasonable for the Comprehensive Evaluation analysis. Because of the uncertainty of this estimate the Comprehensive Evaluation tested its influence on water savings estimates. The model was run with cost escalators ranging from 0–4%. At 0–1% cost escalation estimated water savings would be less than 1% higher than reported water savings for projections 1 and 2; about 10% higher for projections 3 and 4; and about 4% higher for projection 5. At 3–4% cost escalation, estimated water savings would be up to 4% lower for projections 1 and 2; up to 3% lower for projections 3 and 5; and about 6% lower for projection 4.

Customer Cost Sharing—The default modeling assumption for customer cost-sharing was 50%. However, if a different level of cost-sharing for a conservation measure was known to be typical, then this known level was used in place of the default assumption. For example, dishwashing spray valve replacement programs typically have operated without a customer cost share. The customer cost share was used as a proxy of customer benefits other than avoided water supply cost (e.g. avoided energy costs) derived from the measure. The practical effect of the customer cost-sharing assumption was to lower the unit cost of the measure for the water supplier and therefore increase the likelihood it would be cost-effective to implement.

Device Turnover Rates—Device turnover rates were assumed for devices already or about to be subject to replacement efficiency standards specified by law. This included toilets, showerheads, and clothes washers. Residential toilets were assumed to turnover at the rate of 4% per year. This assumption was taken from Exhibit 6 (Assumptions and Methodology for Determining Estimates of Reliable Water Savings From the Installation of ULF Toilets) of the Urban MOU. CII toilets were assumed to turnover at the rate of 5% per year. This higher rate of turnover relative to residential toilets was adopted to reflect harsher operating environments that a significant proportion of CII toilets are subjected to (e.g. restaurants, airports, public gathering places, retail outlets, etc.). Residential showerheads were assumed to turnover at the rate of 10% per year. This assumption is from California Urban Water Agencies' 2001 report *California Urban Water Conservation Potential*. Clothes

3. While this is true for the majority of urban water suppliers it is not true for all of them and therefore it is a conservative assumption. The State Water Resources Control Board Wastewater Treatment Facilities (WWTF) Database lists 222 city operated WWTFs. Of these cities, 106 are also listed as urban water suppliers. Some of these have integrated wastewater operations and some, like the City of Fresno, do count avoided wastewater costs as benefits they can capture directly, while others do not.

washers were assumed to turnover at the rate of 7% per year. This rate was based on industry estimates of the average useful life for residential clothes washers. These turnover rate assumptions determine the level of code-driven water savings realized over the forecast period. They also influence the local cost-effectiveness of accelerating natural replacement of these devices. If turnover rates turn out to be higher (lower) than assumed by the Comprehensive Evaluation then the amount of code-driven water savings will be higher (lower) than forecast and the amount of locally cost-effective savings may be lower (higher) than forecast. Available empirical estimates of replacement rates suggest the chosen assumptions are reasonable.[4]

Metering—California law now requires metering of all residential water customers served by the federal Central Valley Project (CVP) by 2015 and all other unmetered residential service connections by 2025. The Comprehensive Evaluation assumed that water suppliers taking supply from the CVP would take ten years to meter their unmetered customers, starting in 2005 while other water suppliers would take an average of 15 years to meter their service areas, starting in 2010. Metering would occur regardless of local cost-effectiveness because California law now mandates it. CALFED could invest to help water suppliers meter their service areas. Doing so would make meter programs more cost-effective for suppliers and could cause water suppliers to start replacement programs sooner. However, CALFED investment was not assumed to increase the rate of annual replacement since doing so could result in logistical and service problems water suppliers would want to avoid. Taken together, these assumptions determined the amount of additional water savings CALFED investments in metering could yield —about five years additional savings per meter. These assumptions therefore determine the cost-effectiveness of metering from the perspective of CALFED and have significant influence on grant model results.

BMP Coverage Requirements—Under the Urban MOU, BMP coverage requirements are determined separately for each signatory water supplier according to their service area characteristics. Data limitations made it impractical to attempt to determine coverage requirements for each water supplier within a given hydrologic region. Therefore the Comprehensive Evaluation approximated the total coverage requirement for each hydrologic region based on the demographic and water account data for the region as a whole. Progress towards regional coverage requirements was measured by deducting from the total requirements the amount of BMP activity reported to the CUWCC by water suppliers within the region and any additional BMP activity determined by the regional cost-effectiveness and grant-funding models. This approach may understate to an unknown, but probably small, extent the actual BMP activity required for coverage under the Urban MOU. The potential for understatement occurs because aggregating coverage for the region as a whole ignores questions of who is undertaking the BMP activity. Under the Urban MOU, if one water supplier exceeds its coverage requirement for, say, toilets, this in no way alleviates other water suppliers in the region from their coverage requirements for toilets. The approach taken by the Comprehensive Evaluation to model coverage requirements, however, implicitly does alleviate other water suppliers in the region from their coverage requirements, since any BMP implementation counts towards the regional coverage requirement, regardless of who does it. Data from CUWCC show that some water suppliers have exceeded their coverage requirements for some BMPs, though usually by only small amounts.

Conservation Measure Investment Rates—Annual investment rates for BMPs are governed by BMP coverage requirements specified in the Urban MOU. The Comprehensive Evaluation assumes total investment in a BMP is capped by its coverage requirement. Annual investment rates for non-BMP conservation measures are set to 10% of the total water savings potential. These assumptions control the rate at which conservation measures are implemented over the forecast period.

Demographics and Housing—The Comprehensive Evaluation implicitly assumes that the proportion of the state's population in single- and multi-family housing remains the same as it was at the time of the 2000 Census. It also assumes that housing densities and average fixtures per dwelling unit stay at their 2000 levels. In short, the Comprehensive Evaluation's baseline future water use forecast is driven by population growth alone and not fundamental changes in patterns of living.

Year 2000 Baseline Applied Water Use—Estimates of applied water use by hydrologic region in 2000 are from DWR. The Comprehensive Evaluation used these estimates of applied water use to generate the baseline

4. See, for example, M.Cubed (2004), "Santa Clara County Residential Water Use Baseline Survey, Final Report." Santa Clara Valley Water District; or Water Resources Engineering, Inc. (2002) "Water Conservation Market Penetration Study, Final Report." East Bay Municipal Utility District.

TABLE 3.7 BASELINE APPLIED URBAN WATER USE PROJECTION (1,000 AF)

Hydrologic Region	2000	2005	2010	2020	2030
Central Coast	277	291	306	332	353
Colorado River	502	586	670	816	963
North Coast	143	150	156	174	196
North Lahontan	41	45	48	56	62
Sacramento River	856	957	1,059	1,292	1,500
San Francisco Bay	1,043	1,097	1,151	1,270	1,378
San Joaquin River	566	638	710	882	1,049
South Coast	4,081	4,371	4,661	5,054	5,396
South Lahontan	234	254	274	304	333
Tulare Lake	638	702	766	905	1,066
State	**8,382**	**9,092**	**9,801**	**11,086**	**12,295**

applied water use projection. All other applied water use projections stem from this baseline projection, as discussed in a previous section. Appendix 2G contains the applied water use estimates for 2000 supplied by DWR.

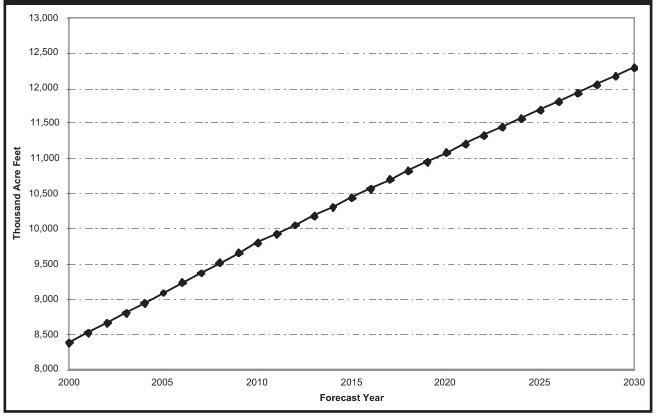
BASELINE APPLIED URBAN WATER USE

The Comprehensive Evaluation developed a baseline applied water use projection using water use data from the DWR and population forecasts from the Department of Finance. First, county population forecasts were aggregated to hydrologic regions using population distribution data from DWR. This provided a projection of population by hydrologic region for the period 2000–30. Second, DWR Year 2000 per capita applied water use estimates for each hydrologic region were multiplied by the population projection. This provided a projection of baseline applied water use for the period 2000–30. The baseline applied water use projection implicitly assumes the following:

- Per capita water use efficiency is frozen at the Year 2000 level. Whatever mix of appliance and device efficiencies that were in place in 2000 are assumed to stay the same. In other words, regions make no additional gains in water use efficiency.
- Household and business uses of water do not change over the forecast period. Preferences are static. Only increases (decreases) in population result in increases (decreases) in water use.
- Water suppliers make no further investments in water use efficiency.
- Plumbing and energy codes compelling changes in appliance efficiency cease to operate.

These implicit assumptions obviously result in a highly

FIGURE 3.20 STATEWIDE BASELINE URBAN APPLIED WATER USE PROJECTION



stylized and unrealistic projection of future applied water use. However, this baseline projection enabled the Comprehensive Evaluation to add increasing levels of conservation activity, such as operation of plumbing and energy codes, investment in locally cost-effective conservation by water suppliers, and grant-funded conservation, to determine the relative contribution of each type of conservation policy. In other words, the baseline projection provided the reference point from which to measure various water use efficiency improvements. The baseline applied water use projections by hydrologic region for 2000, 2005, 2010, 2020, and 2030 are shown in Table 3.7.[5] The same data for the state as a whole is shown graphically in Figure 3.20.

TECHNICAL WATER SAVINGS POTENTIAL

The baseline projection of applied water use provides an extreme view of future urban water use in California. Essentially, it shows what water use would look like if the state made no further improvements in water use efficiency. Another extreme view is provided by looking at future water use assuming all measures listed in Table 3.6 are immediately and fully implemented. Under this view, there are no economic, policy, or temporal constraints that limit the adoption of the listed conservation measures. This view quantifies the maximum amount of water savings potential embodied in the measures under evaluation. This too is a highly stylized and unrealistic projection of future water use. But like the baseline projection, it serves an important purpose. It provides another reference point from which to measure gains in water use efficiency realized by the different policies evaluated by the Comprehensive Evaluation. By quantifying the technical potential of the measures listed in Table 3.6, the Comprehensive Evaluation is able to measure how much of this potential the state is

5. The 2000 baseline applied water use estimates in Table 3.7 exclude water uses for energy production and conveyance losses. This causes the estimates to be less than estimates in the 2005 State Water Plan Update.

FIGURE 3.21 TECHNICAL WATER SAVINGS POTENTIAL ASSUMING 100% ADOPTION OF CONSERVATION MEASURES LISTED IN TABLE 3.6

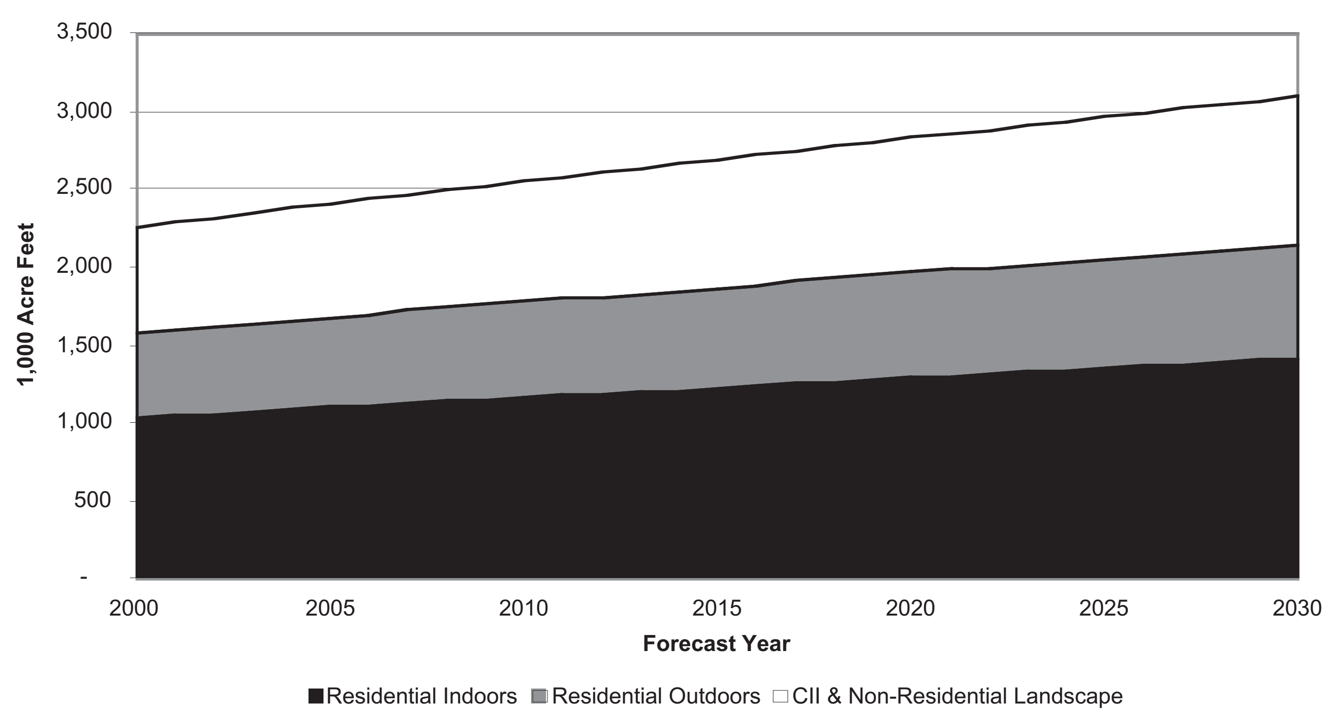
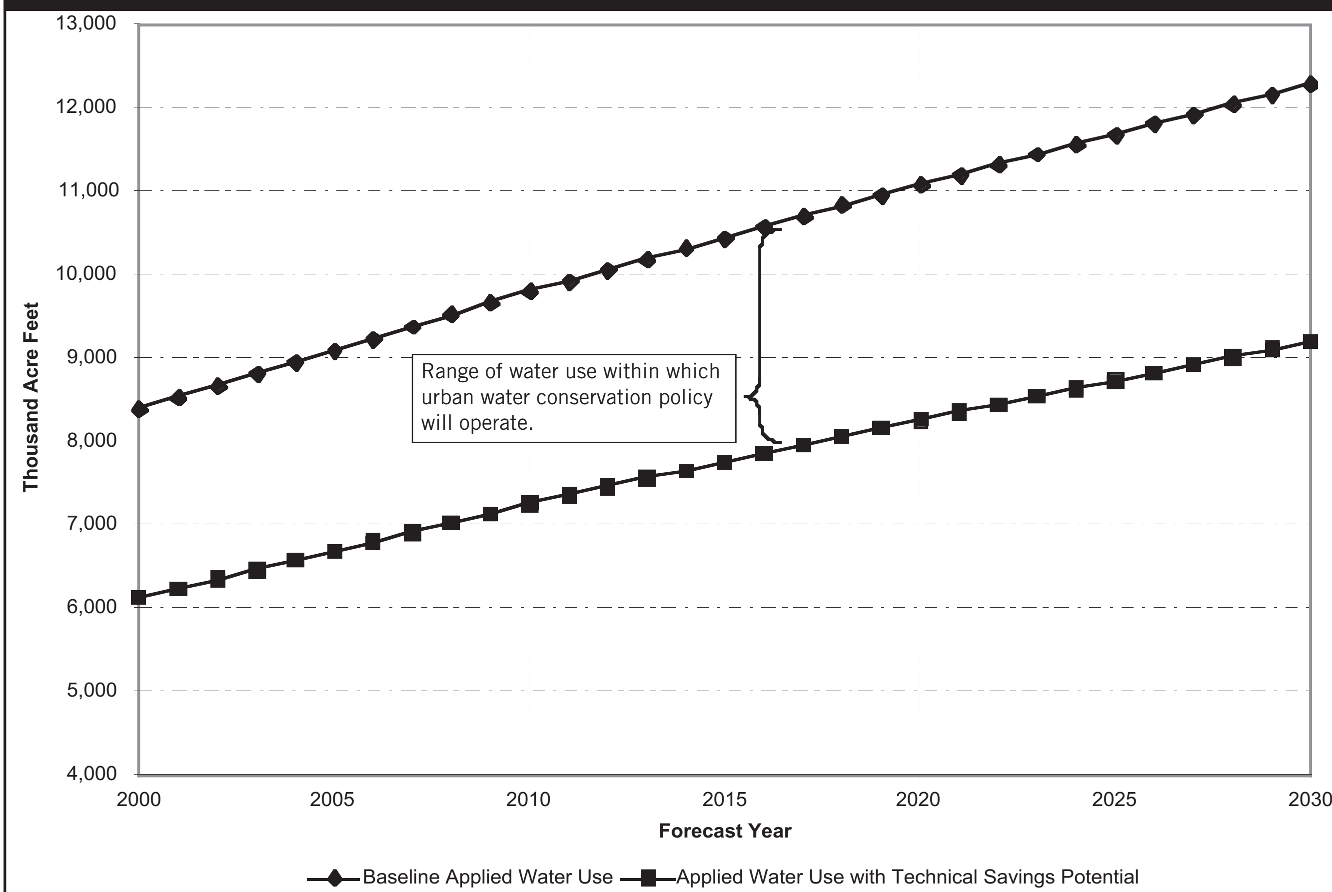


FIGURE 3.22 STATEWIDE APPLIED WATER USE UNDER BASELINE AND TECHNICAL POTENTIAL ASSUMPTIONS



able to realize and over what time period through different policies. The projection of technical water savings potential is predicated on the following assumptions:

- All existing and future residential toilets, washers, showerheads, and dishwashers are high-efficiency. Toilets are all ULF toilets, showerheads have flow ratings of 2.5 gpm, washers have water use factors of 6.0, and water use by dishwashers is reduced 46% (per estimates from Pacific Institute's *Waste Not, Want Not* report).[6]
- Per capita residential leak rates (as measured by AWWARF's *Residential End Uses of Water*) are reduced by half.
- All urban water connections are metered and billed by volume of use.
- All residential landscape irrigation systems use ET-controllers.
- All toilets in the CII sectors are ULF toilets.
- CII water using appliances listed in Table 3.6 are fully adopted.
- The total water savings potential for non-residential landscape, CII process water uses, and water supplier system losses discussed in the Technical Appendices is fully realized.

Figure 3.21 shows the statewide technical water savings potential implied by these assumptions. This potential is disaggregated into indoor and outdoor residential uses and non-residential uses of water. The figure indicates that full adoption of the measures listed in Table 3.6 has the potential to reduce current applied water use by approximately 2.3 million acre-feet. By 2030, technical savings potential of the measures listed in Table 3.6 increases to about 3.1 million acre-feet. Figure 3.22 compares the baseline applied water use projection with applied water use assuming full realization of technical water savings potential. This figure shows the range within which urban water conservation policies are likely to operate.

CODE-DRIVEN WATER SAVINGS POTENTIAL

The water savings potential of efficiency codes is significant. Efficiency standards for toilets, clothes washers, and showerheads as well as recent legislation requiring metering of all unmetered connections are helping to transform the efficiency of urban water use in California.

6. Some urban water agencies are now offering rebates for high-efficiency toilets (HETs), which use even less water than ULF toilets. These programs are in a nascent stage of development and did not meet the Comprehensive Evaluation's conservation technology modeling criteria.

Residential Toilets—In the early 1990s, state and federal legislation was passed requiring installation of ULF toilets in new residential construction and prohibiting the sale of non-ULF toilets. This effectively requires substitution of a ULF toilet for a non-ULF toilet whenever an existing non-ULF toilet is replaced. The Comprehensive Evaluation estimates there were approximately 18.8 million non-ULF residential toilets in 1991. By 2004, this number was estimated to be approximately 9.7 million non-ULF residential toilets. Over the coming decades the number of non-ULF toilets will continue to shrink as they are replaced due to failure or remodeling. By 2030, the Comprehensive Evaluation estimates efficiency code requirements alone will reduce the stock of non-ULF toilets in residential buildings to approximately 3.4 million.

Commercial Toilets—Starting around 1994, state and federal legislation prohibited the installation and sale of non-ULF toilets in non-residential buildings. The Comprehensive Evaluation estimates there were approximately 4 million non-ULF toilets in commercial buildings in 1991. By 2004, the number of non-ULF toilets had decreased by almost half, to 2.2 million toilets. By 2030, the Comprehensive Evaluation estimates efficiency code requirements alone will reduce the stock of non-ULF toilets in non-residential buildings to approximately 600,000.

Residential Showerheads—Similar to toilets, state and federal legislation was passed in the early 1990s requiring installation of low-flow showerheads in new construction and prohibiting the sale of non-low-flow showerheads. The Comprehensive Evaluation estimates there were approximately 15.8 million non-low-flow residential showerheads in 1991. By 2004, the number of non-low-flow residential showerheads had decreased to approximately 4 million. By 2030, the Comprehensive Evaluation estimates efficiency code requirements alone will effectively eliminate the remaining stock of non-low-flow residential showerheads.[7]

Residential Clothes Washers—On February 4, 2004, by a Commission Vote of 5-0, the California Energy Commission adopted water efficiency standards for clothes washers. It is a tiered standard based on the

7. A countervailing trend in recent years has been to install several showerheads per shower stall in new and remodeled residences. If this becomes a commonplace practice it has the potential to eliminate the water savings gained by replacing non-low-flow showerheads with low-flow showerheads. A lack of data prevented the Comprehensive Evaluation from addressing this possibility in its estimate of showerhead savings potential.

FIGURE 3.23 WATER CONSERVATION POTENTIAL OF EFFICIENCY CODES (2000–2030)

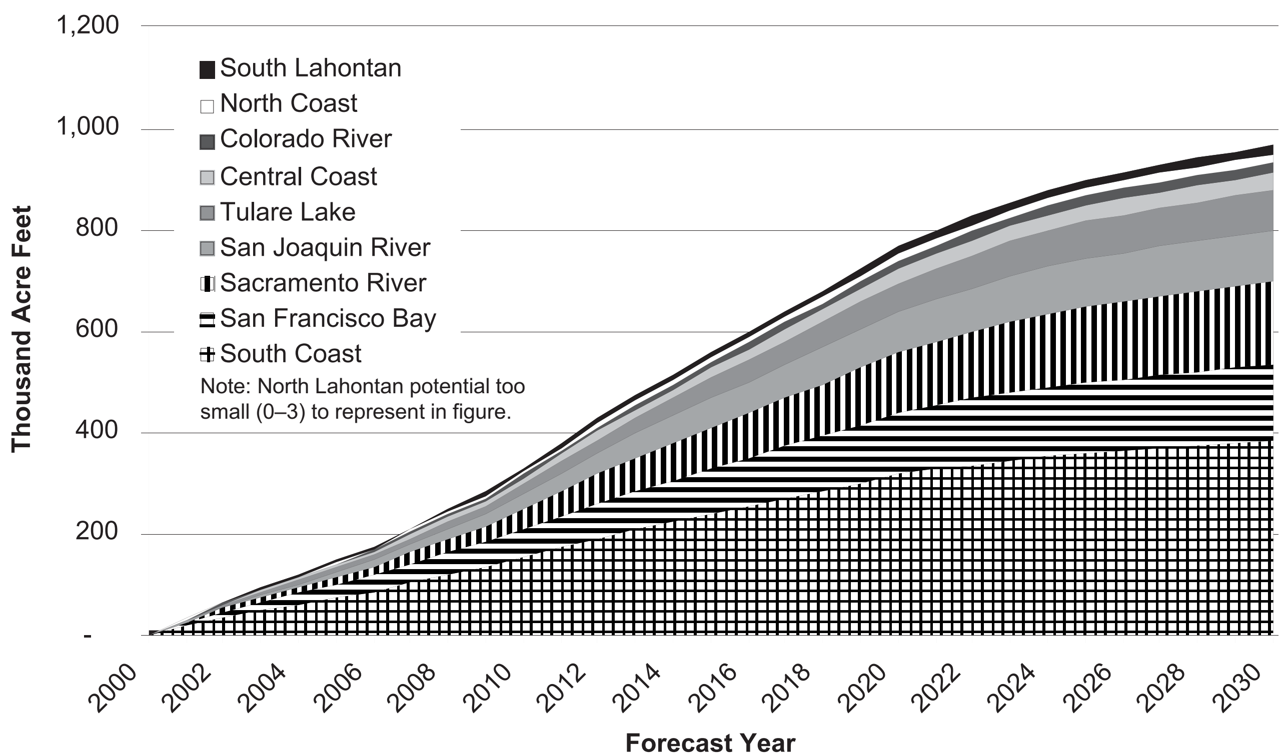


TABLE 3.8 WATER SAVINGS POTENTIAL OF EFFICIENCY CODES (1,000 AF)

Hydrologic Region	2005	2010	2020	2030
Central Coast	6	13	28	34
Colorado River	3	7	16	21
North Coast	3	6	13	17
North Lahontan	0	1	2	3
Sacramento River	14	38	120	160
San Francisco Bay	26	56	121	152
San Joaquin River	10	30	79	102
South Coast	75	155	317	384
South Lahontan	3	7	14	18
Tulare Lake	8	19	58	80
State	**148**	**331**	**769**	**970**

"water factor" of the clothes washer, which is the number of gallons per cubic foot of wash load. In 2007, the maximum water factor that will be allowed is 8.5 per machine. By 2010 the standard will be further reduced to 6.0. Conventional washers have a water factor of about 13.3, thus the standards would reduce per wash load water use 36% by 2007 and 55% by 2010. Federal approval will still be required, as the Federal Energy Policy Act of 1992 allows only the federal government to regulate residential clothes washers unless a state exemption is approved. California has already been instructed by the Legislature to apply for that exemption. It was part of AB 1561, which was passed in 2003. The Comprehensive Evaluation assumed the standards would take effect as scheduled. Washers have an average useful life of about 14 years. Given normal turnover of the stock of washers, the standards have the potential to convert all existing conventional washers to washers with water factors not greater than 8.5 by 2030.

Metering—Legislation was passed in 2003 requiring all residential water customers served by the federal CVP to have water meters by 2013. A similar bill was signed into law in 2004 requiring installation and use of water meters by 2025 on all unmetered residential water connections. The Comprehensive Evaluation estimated that the federal CVP currently serves 145,429 unmetered residential customers and that these connections will become metered over the period 2005–14. Additionally, the Comprehensive Evaluation estimated there are an additional 692,000 unmetered

FIGURE 3.24 STATEWIDE BASELINE APPLIED WATER USE ADJUSTED FOR EFFICIENCY CODE EFFECTS

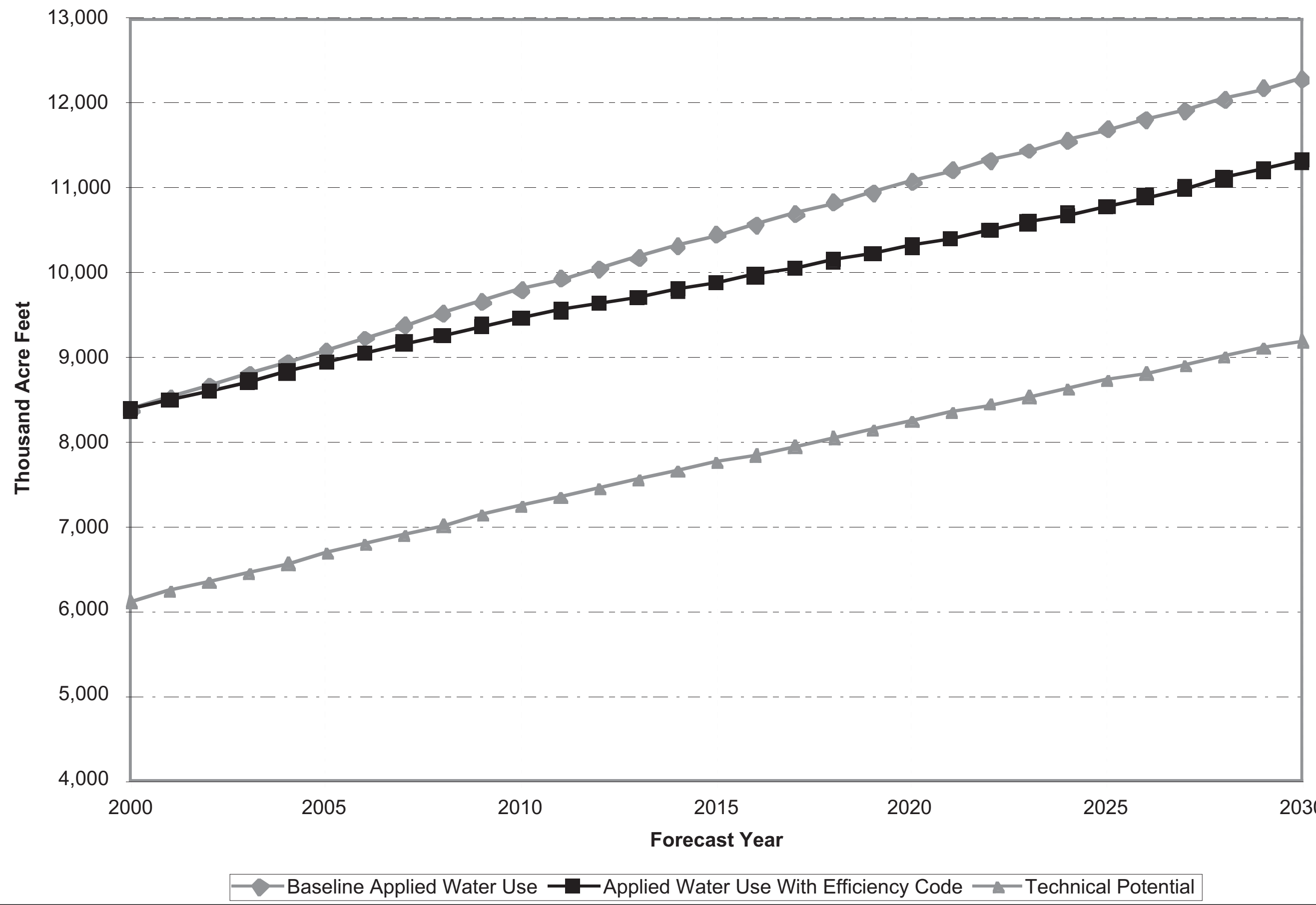


TABLE 3.9 2030 APPLIED WATER USE BY HYDROLOGIC REGIONS: BASELINE & EFFICIENCY CODE ADJUSTED (1,000 AF)

Hydrologic Region	Baseline	Efficiency Code Adjusted	Volume Diff.	% Diff
Central Coast	353	319	34	-10%
Colorado River	963	942	21	-2%
North Coast	196	179	17	-9%
North Lahontan	62	59	3	-5%
Sacramento River	1,500	1,340	160	-11%
San Francisco Bay	1,378	1,226	152	-11%
San Joaquin River	1,049	947	102	-10%
South Coast	5,396	5,012	384	-7%
South Lahontan	333	315	18	-5%
Tulare Lake	1,066	986	80	-7%
State	**12,295**	**11,324**	**970**	**-8%**

residences not served by the federal CVP, and that these connections will become metered over the period 2010–24.

Table 3.8 shows the savings potential of these code requirements by hydrologic region for the years 2005, 2010, 2020, and 2030. Figure 3.23 shows the same information graphically for the full forecast period. It is important to note that the water savings potential shown in Table 3.8 is above and beyond and water savings realized by code requirements prior to the start of the forecast period. For toilets and showerheads, the water savings that already have been realized over the period 1992–2000 are substantial.

Efficiency codes are projected to save an additional 970,000 acre-feet statewide by 2030. This is a volume of water capable of supporting the residential water demands of approximately five and a half million people.[8]

8. The AWWARF report *Residential End Uses of Water* estimated residential water use averaged 172 gallons per day per capita for a sample of 1,188 homes, or 0.193 AF/Year. This study was completed in 1999. Assuming that per capita residential water use decreases by 8% by 2030 as a result of code requirements, then the estimated statewide water savings from existing efficiency codes would be capable of meeting the residential water demands of 5.46 million people.

FIGURE 3.25 REDUCTION IN STATEWIDE BASELINE APPLIED WATER USE DUE TO EFFICIENCY CODES BY TYPE OF USE

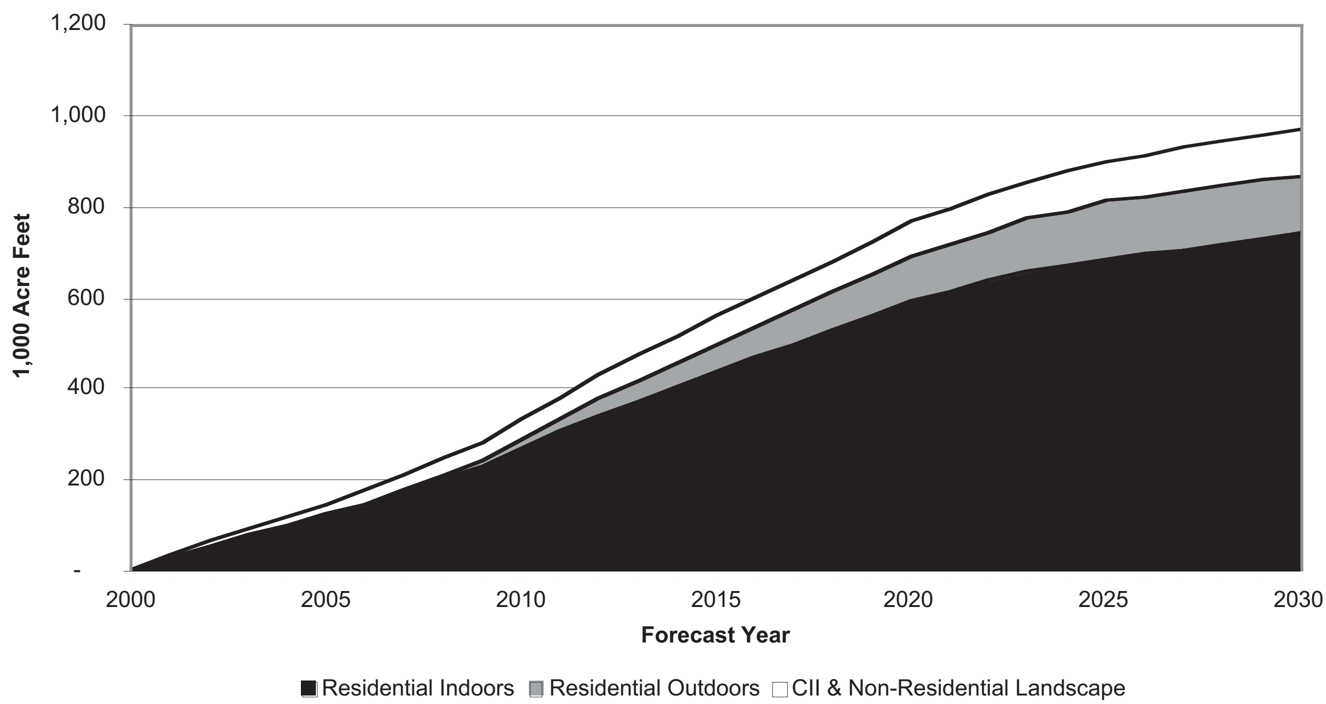


TABLE 3.10 AVERAGE ANNUAL BMP IMPLEMENTATION RATES BY REGION: 1998–2002 (Activity Counts from CUWCC)

	BMP 1 (Residential Surveys)		BMP 2 (Residential Fixtures)		BMP 5 (Landscape)		BMP 6 (Washers)	BMP 9 (CII)	BMP 14 (Residential Toilets)	
Hydrologic Region	Single Family	Multi-Family	Single Family	Multi-Family	Budgets	Surveys		Surveys	Single Family	Multi-Family
Central Coast	2,152	277	6,207	338	172	28	402	179	2,172	670
Colorado River	—	—	225	—	—	—	—	—	—	—
North Coast	2,096	204	4,164	91	182	14	394	32	4,614	1,619
North Lahontan	—	—	—	—	—	—	—	—	—	—
Sacramento River	798	69	3,339	124	95	262	55	150	311	26
San Francisco Bay	9,425	11,149	13,980	1,076	667	871	8,405	702	9,365	11,128
San Joaquin River	434	42	1,089	12	—	7	1	115	374	103
South Coast	29,358	23,107	190,002	19,681	1,564	650	6,986	987	85,285	47,896
South Lahontan	—	—	20	—	2	—	—	—	—	—
Tulare Lake	4,905	36	1,057	722	—	—	20	5	49	36

APPLIED WATER USE

Table 3.9 shows 2030 applied water use by hydrologic region for the baseline and efficiency code adjusted projections. Figure 3.24 shows the statewide baseline and adjusted applied water use projection over the forecast period. The efficiency code projection adjusts per capita water use to account for the effects of code requirements on toilet, shower, and washer water uses, as well as metering requirements. Applied water use after adjusting for efficiency code effects is 8% lower than baseline applied water use. Percentage reductions vary by hydrologic region and are driven by the mix of residential and non-residential water uses and the extent of unmetered water deliveries at the start of the forecast period. Figure 3.24 also shows applied water use assuming full realization of technical water savings potential. By 2030, changes in water use due to efficiency codes capture approximately 31% of technical savings potential.

Figure 3.25 shows the reduction in applied water use due to efficiency codes by type of end use. Residential uses account for 90% of total savings potential while CII and non-

TABLE 3.11 WATER SAVINGS POTENTIAL AT HISTORIC RATES OF BMP IMPLEMENTATION (1,000 AF)

Hydrologic Region	2005	2010	2020	2030
Central Coast	5	5	5	4
Colorado River	0	0	0	0
North Coast	2	3	4	4
North Lahontan	0	0	0	0
Sacramento River	3	4	6	8
San Francisco Bay	20	27	33	31
San Joaquin River	1	1	2	2
South Coast	58	75	102	123
South Lahontan	0	0	0	0
Tulare Lake	1	1	0	0
State	**88**	**115**	**151**	**172**

TABLE 3.12 2030 APPLIED WATER USE BY HYDROLOGIC REGIONS: BASELINE & EFFICIENCY COST AND HISTORIC RATE OF BMP IMPLEMENTATION (1,000 AF)

Hydrologic Region	Baseline	Efficiency Code + Historic Rate BMP Implementation	Volume Diff.	% Diff
Central Coast	353	314	39	-11%
Colorado River	963	942	21	-2%
North Coast	196	174	22	-11%
North Lahontan	62	59	3	-5%
Sacramento River	1,500	1,332	168	-11%
San Francisco Bay	1,378	1,195	183	-13%
San Joaquin River	1,049	944	104	-10%
South Coast	5,396	4,889	507	-9%
South Lahontan	333	315	18	-5%
Tulare Lake	1,066	986	80	-7%
State	**12,295**	**11,150**	**1,144**	**-9%**

residential landscape uses account for the other 10%. Within residential uses, approximately 85% of the savings potential comes from indoor water uses and 15% from outdoor landscape water uses. The reduction in outdoor residential water use is due entirely to metering codes.

BMP WATER SAVINGS POTENTIAL AT HISTORIC IMPLEMENTATION RATES

Comprehensive Evaluation Projections 1 and 3 assume that implementation of BMPs will continue at their historic rates. The Comprehensive Evaluation calculated these rates using BMP implementation data from the California Urban Water Conservation Council for the period 1998–2002. BMP implementation data were aggregated to the hydrologic region and then average rates of implementation for each region were calculated. BMP implementation was assumed to persist at this average rate over the forecast period until either the regional coverage requirement was satisfied or the end of the forecast period was reached.

Table 3.10 shows the average annual rates of BMP implementation by hydrologic region. The reader will note that BMP 4 (meters) does not appear in Table 3.10 because average annual rates of implementation were very close to zero over the period 1998–2002. The resulting water savings potential by region from continuing this level of BMP implementation is shown for the years 2005, 2010, 2020, and 2030 in Table 3.11. It must be emphasized that this presents an extremely conservative projection of savings potential from future BMP implementation for the following reasons:

1) The projection only reflects implementation activity reported to the CUWCC. Reporting rates are below 100% and some activity that has occurred has not been reported.
2) The projection only reflects water savings from a subset of BMPs with quantifiable activity and water savings. It does not account for synergistic effects of information and education programs, nor does it account for savings from conservation investments outside of the BMPs.
3) The projection ignores questions of relative scarcity and increasing water supply cost, which would be expected to increase the rate of BMP implementation over time. It also ignores the likelihood of BMP implementation by water agencies not currently implementing BMPs or currently implementing BMPs at very low levels.

For these reasons, this projection should be viewed as the lower bound of savings potential from BMPs absent any state/federal financial assistance. The next section of this report will present regionally cost-effective savings potential of BMPs and other conservation measures, which could be viewed as an upper bound of savings potential absent any state/federal financial assistance.

The South Coast and San Francisco Bay regions account for approximately 90% of 2030 projected water savings from BMPs assuming implementation continues at the historic rate of implementation. The overwhelming preponderance of water savings in these two regions simply reflects past patterns of BMP implementation. During the first ten years of the Urban MOU, the vast majority of BMP implementation occurred in these two regions.

FIGURE 3.26 STATEWIDE BASELINE APPLIED WATER USE ADJUSTED FOR EFFICIENCY CODE & BMP IMPLEMENTATION AT HISTORIC RATE

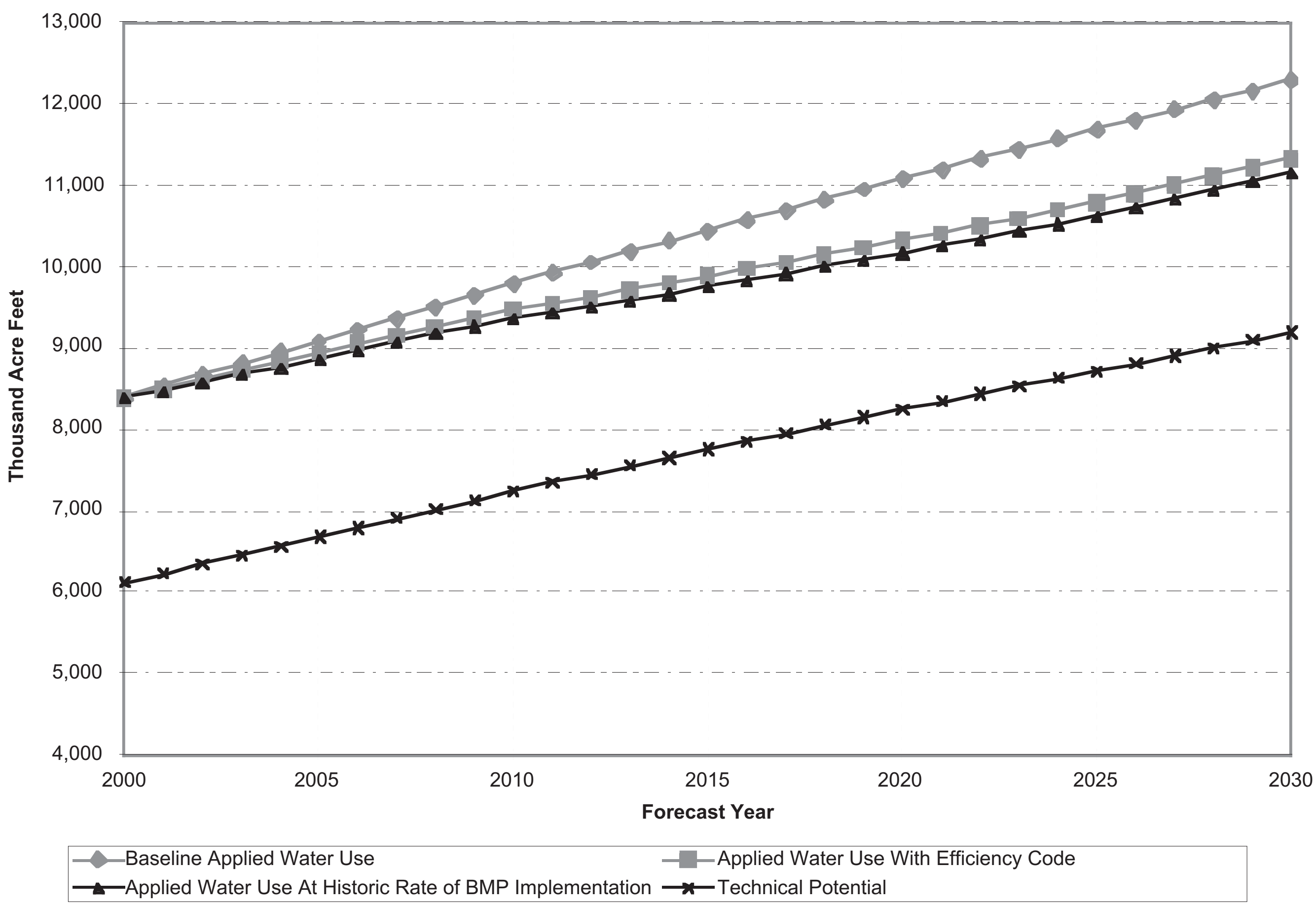


FIGURE 3.27 REDUCTION IN STATEWIDE BASELINE APPLIED WATER USE DUE TO EFFICIENCY CODES & BMP IMPLEMENTATION AT HISTORIC RATE BY TYPE OF USE

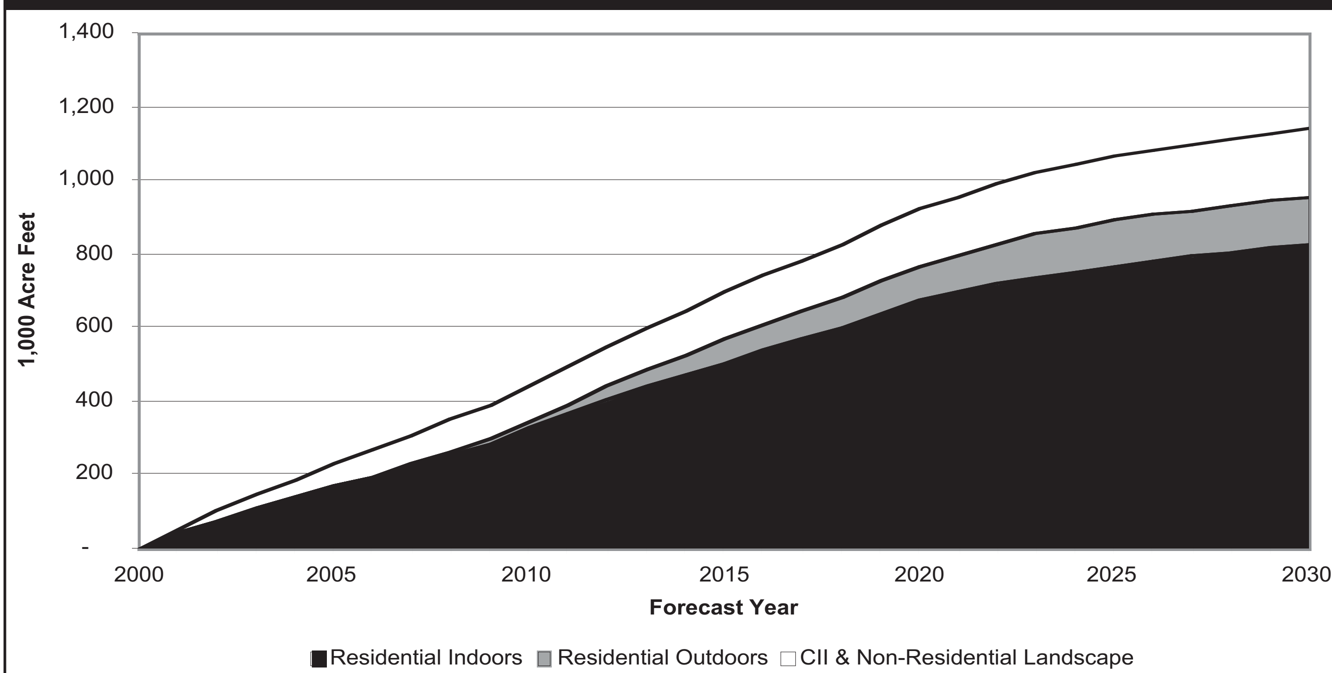
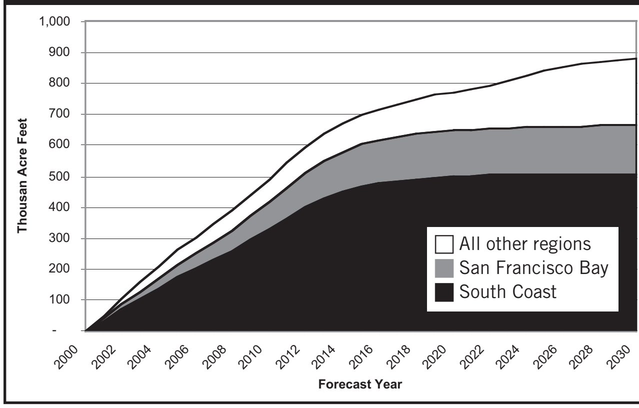


TABLE 3.13 WATER SAVINGS POTENTIAL OF REGIONALLY COST-EFFECTIVE CONSERVATION MEASURES (1,000 AF)

Hydrologic Region	2005	2010	2020	2030
Central Coast	4	8	30	47
Colorado River	28	38	52	70
North Coast	2	5	9	13
North Lahontan	0	1	2	15
Sacramento River	1	1	2	33
San Francisco Bay	41	89	148	156
San Joaquin River	6	8	11	15
South Coast	174	330	501	509
South Lahontan	4	8	13	14
Tulare Lake	2	4	6	8
State	**262**	**492**	**773**	**881**

FIGURE 3.28 WATER SAVINGS POTENTIAL OF REGIONALLY COST-EFFECTIVE CONSERVATION MEASURES



APPLIED WATER USE

Table 3.12 shows 2030 applied water use by hydrologic region for the baseline and baseline adjusted for efficiency code effects and BMP water savings at the historic rate of implementation. Figure 3.26 shows the same information for all of California over the full forecast period. Applied water use in 2030, after adjusting for efficiency code effects and BMP implementation, is 9% lower than baseline applied water use. As seen in Figure 3.26, most of the reduction in applied water use is associated with efficiency code effects.

Figure 3.26 also shows applied water use assuming full realization of technical water savings potential. By 2030, changes in water use due to efficiency codes and BMP water savings at the historic rate of implementation capture approximately 37% of technical savings potential, a 6% improvement over reliance on efficiency codes alone.

Figure 3.27 shows the reduction in applied water use due to efficiency codes and BMPs at the historic rate of implementation by type of end use. Compared to efficiency codes alone, water savings for CII and landscape uses account for a larger share of overall water savings when BMPs are taken into account.

REGIONALLY COST-EFFECTIVE CONSERVATION POTENTIAL

Comprehensive Evaluation Projections 2, 4, and 5 assume local water suppliers would implement BMPs and other conservation measures listed in Table 3.6 if they are regionally cost-effective from the water supplier perspective. In effect, the Comprehensive Evaluation is assuming in Projections 2, 4, and 5 that the Urban MOU is fully implemented by all water suppliers and that water suppliers also invest in other conservation measures whenever it is in the financial interest of their ratepayers to do so.

The modeling of cost-effective implementation of conservation measures followed the schematic in Figure 3.18. The core modeling assumptions underpinning the analysis were discussed in a previous section. The Technical Appendices for the Comprehensive Evaluation present more detailed information on conservation measure water savings, costs, and benefits that were integral to the analysis of cost-effectiveness and rates of investment. This section focuses on the results of the modeling.

Table 3.13 shows conservation potential for the years 2005, 2010, 2020, and 2030 resulting from implementation of regionally cost-effective conservation measures. Figure 3.28 shows the same information graphically. Total savings potential from implementation of regionally cost-effective conservation measures reaches 881,000 acre-feet by 2030. The South Coast region accounts for 58% of projected savings, while the San Francisco Bay Area accounts for approximately 18%. Together, these two regions account for 75% of projected statewide water savings from implementation of regionally cost-effective conservation measures.

Potential water savings as a percentage of baseline applied water use varies significantly by hydrologic region. Implementation of regionally cost-effective conservation reduced baseline applied water use by 9% or more for four out of ten regions—North Lahontan, Central Coast, San Francisco Bay, and South Coast Regions.[9] For the other six regions – Colorado River, South Lahontan, Tulare Lake, San Joaquin River, Sacramento River, and North Coast—baseline applied water use was reduced by 7% or less, and in three of these regions the reduction was 2% or less. The smallest percentage reductions corresponded to regions with the lowest regional marginal supply costs, as would be expected.

As seen in Figure 3.28, projected water savings from regionally cost-effective conservation grow at a decreasing rate starting around 2015 for most regions. This is primarily caused by the Comprehensive Evaluation's assumptions about BMP

9. These percentages do not account for the effects of efficiency codes on applied water use—just the net affect of regionally cost-effective conservation investments.

FIGURE 3.29 REGIONALLY COST-EFFECTIVE CONSERVATION POTENTIAL: BMPS VERSUS NON-BMPS (1,000 AF)

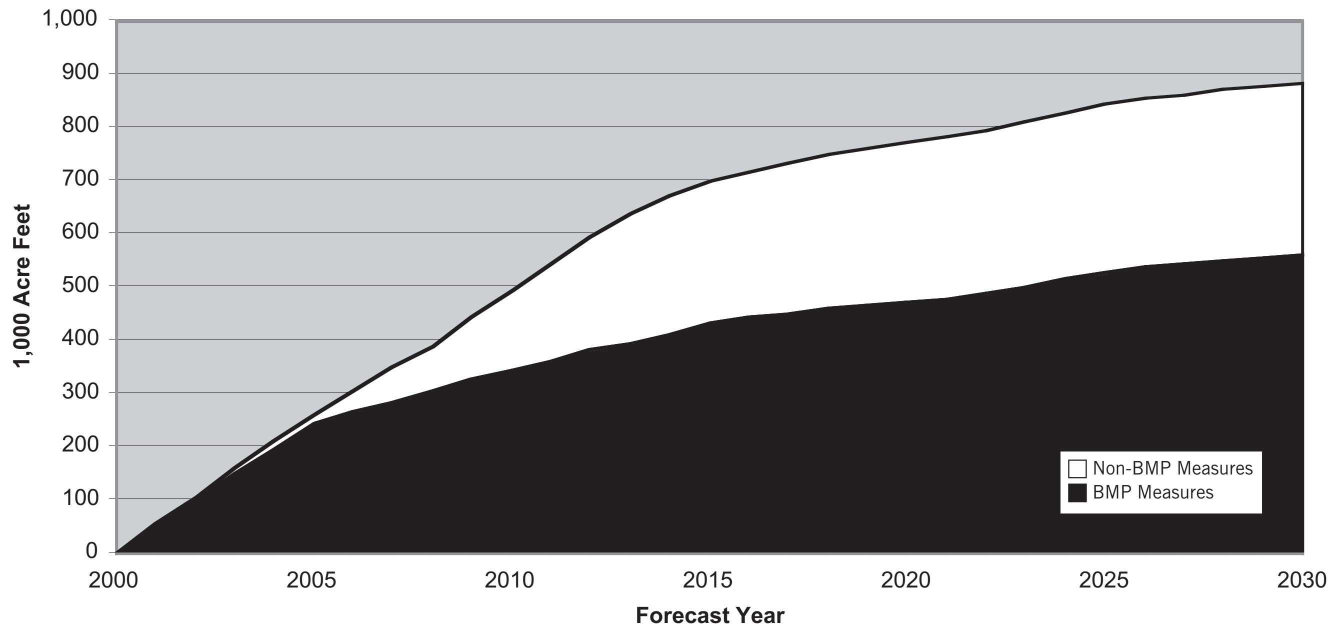


TABLE 3.14 2030 APPLIED WATER USE BY HYDROLOGIC REGIONS: BASELINE & ADJUSTED FOR EFFICIENCY COST AND REGIONALLY COST-EFFECTIVE CONSERVATION (1,000 AF)

Hydrologic Region	Baseline	Efficiency Code + Cost-Effective Conservation	Volume Diff.	% Diff
Central Coast	353	273	80	-23%
Colorado River	963	872	91	-9%
North Coast	196	165	30	-16%
North Lahontan	62	43	18	-30%
Sacramento River	1,500	1,307	194	-13%
San Francisco Bay	1,378	1,069	308	-22%
San Joaquin River	1,049	933	117	-11%
South Coast	5,396	4,503	893	-17%
South Lahontan	333	301	32	-10%
Tulare Lake	1,066	977	88	-8%
State	**12,295**	**10,443**	**1,852**	**-15%**

and non-BMP investment rates. As noted earlier, the Comprehensive Evaluation assumed that annual investment in non-BMP conservation measures is equal to one-tenth of the overall savings potential. Thus, after ten years of investment much of the potential is realized for measures identified as cost-effective at the start of the forecast period, and subsequent investment is largely replacing earlier savings. Likewise, coverage schedules for BMPs span ten years, so coverage requirements will be satisfied by 2015 for BMPs identified as cost-effective at the start of the forecast period. Because many of the conservation measures were cost-effective at the beginning of the forecast period for the South Coast and San Francisco Bay regions, the flattening in the growth of regionally cost-effective conservation savings around 2015 is most pronounced for these two regions.

Figure 3.29 shows the division of savings potential between BMP and non-BMP conservation measures. BMP measures accounted for the majority of projected water savings, especially for the first fifteen years of the forecast. By the end of the forecast period, BMPs accounted for 63% of savings potential while non-BMP conservation measures accounted for 37%.

APPLIED WATER USE

Table 3.14 shows 2030 applied water use by hydrologic region for the baseline and baseline adjusted for efficiency code effects and implementation of regionally cost-effective conservation measures. Figure 3.30 shows the same information for all of California over the full forecast period. Implementation of regionally cost-effective conservation measures when combined with efficiency code requirements has the potential to reduce 2030 baseline applied water use by 15%, or 1.85 million acre-feet, statewide. This is a volume of water capable of meeting the residential demands of 10.4 million people. Figure 3.30 also shows applied water use assuming full realization of technical water savings potential. By 2030, changes in water use due to efficiency codes and cost-effective BMP implementation capture approximately 60% of technical savings potential.

Figure 3.31 shows the reduction in applied water use due to efficiency codes and regionally cost-effective conserva-

FIGURE 3.30 STATEWIDE BASELINE APPLIED WATER USE ADJUSTED FOR EFFICIENCY CODE & REGIONALLY COST-EFFECTIVE CONSERVATION IMPLEMENTATION

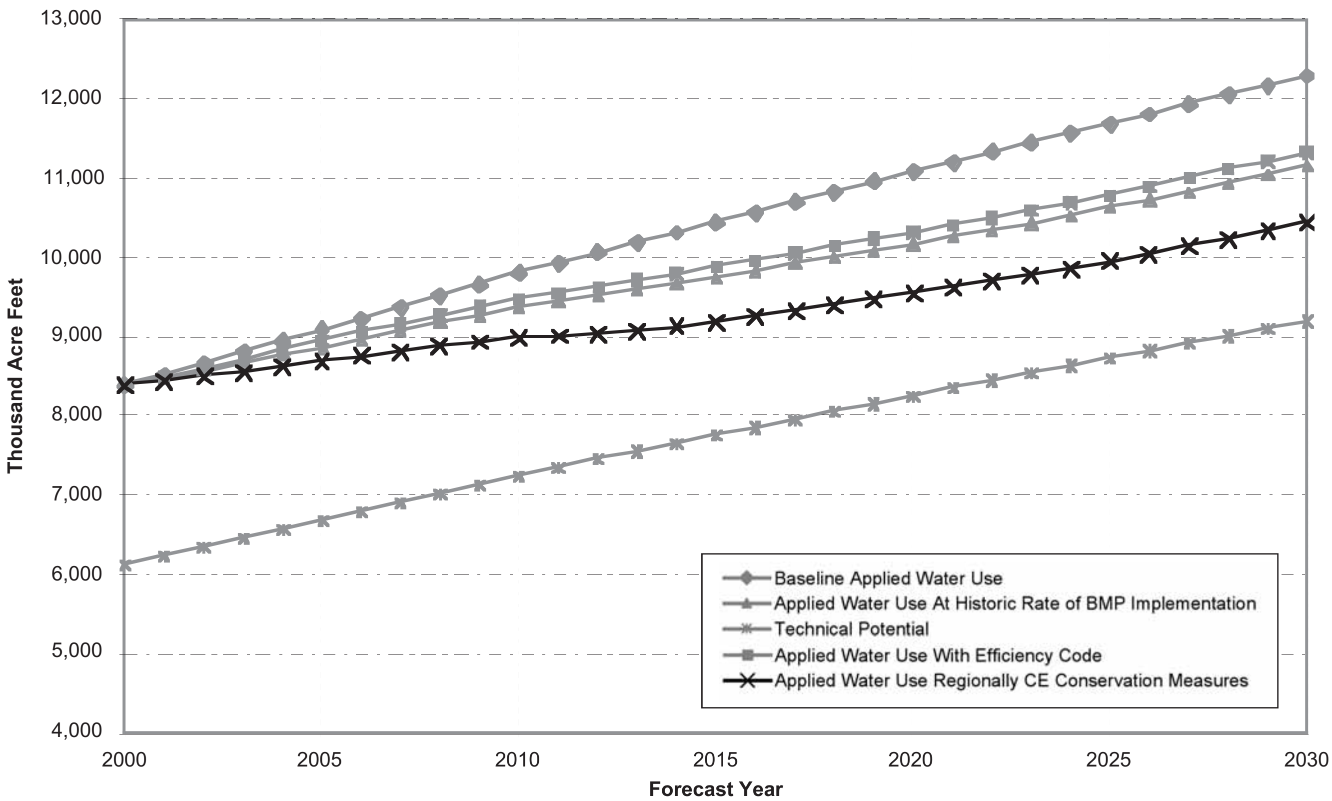


FIGURE 3.31 REDUCTION IN STATEWIDE BASELINE APPLIED WATER USE DUE TO EFFICIENCY CODES & REGIONALLY COST-EFFECTIVE CONSERVATION BY TYPE OF USE

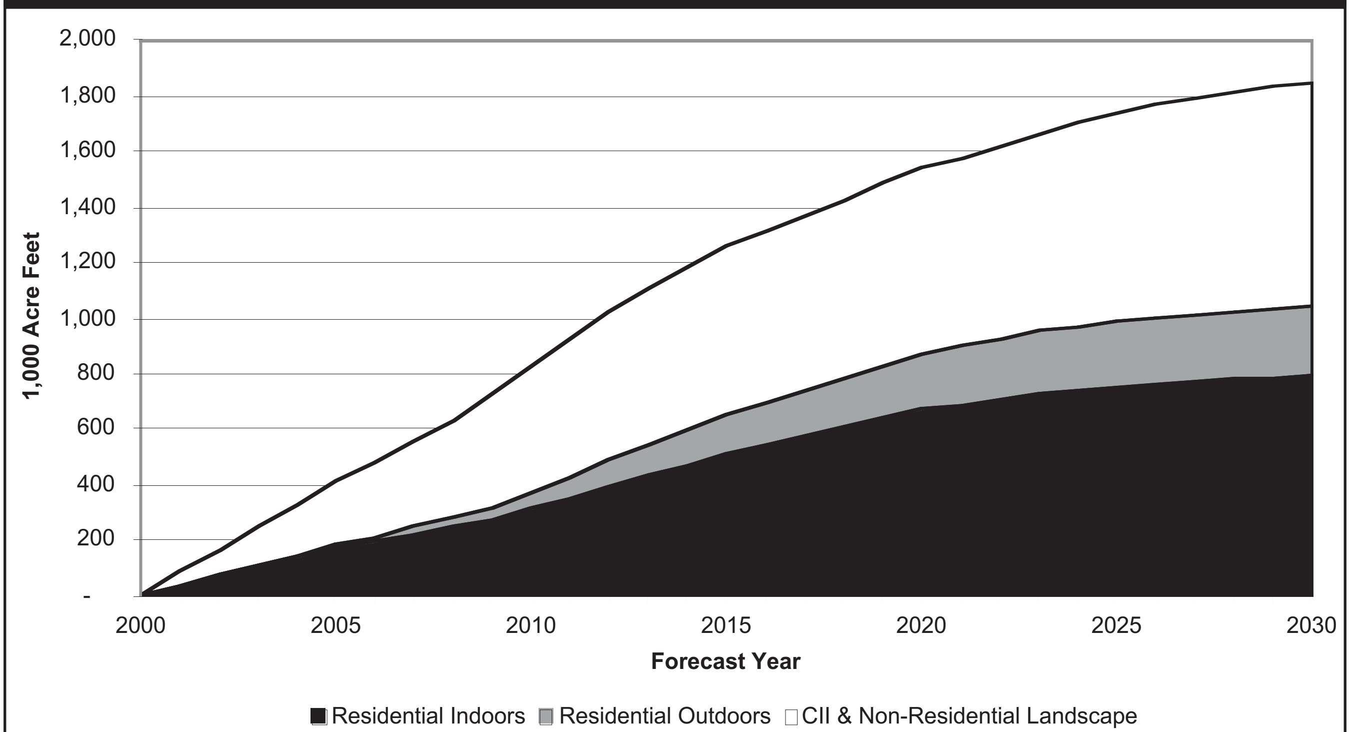


TABLE 3.15 GRANT FUNDING ASSUMED AVAILABLE FOR URBAN CONSERVATION IMPLEMENTATION BY COMPREHENSIVE EVALUATION

Funding Level	Amount	Notes
1. Remaining Proposition 50 Funds	$15 million/year 2005 thru 2006	75% for implementation, 25% for RD&D, monitoring, and evaluation
2. Moderate CALFED Investment	$15 million/year 2005 thru 2030	75% for implementation, 25% for RD&D, monitoring, and evaluation
3. ROD Funding	$40 million/year thru 2005 thru 2014 $10 million/year 2015 thru 2030	75% for implementation, 25% for RD&D, monitoring, and evaluation

tion investments by type of end use. Residential uses account for 57% of total savings potential while CII and non-residential landscape uses account for the other 43%. Within residential uses, approximately three-fourths of the savings potential comes from indoor water uses and one-fourth from outdoor landscape water uses. Most of the indoor residential water savings are efficiency code-driven savings.

STATE/FEDERAL GRANT WATER SAVINGS POTENTIAL

GRANT FUNDING LEVELS

The Comprehensive Evaluation evaluated three different levels of state/federal grant funding for implementation of urban conservation. These funding levels are shown in Table 3.15. The first level assumed future state/federal grant funding would be limited to remaining Proposition 50 funds set aside for urban conservation grants. This level assumed a total of $30 million allocated in 2005 and 2006.

The second level assumed a moderate level of CALFED investment would persist through 2030. The moderate level was set to correspond to CALFED grant funding levels for urban conservation during the first four years of the program, about $15 million per year.

The third level was set to correspond to the amount of urban conservation grant funding discussed in the ROD for Stage 1 implementation. However, rather than assume all of this funding would be allocated in Stage 1 (the first seven years of the CALFED Program), the Comprehensive Evaluation assumed funding would be spread through 2030. And, as with the ROD funding discussion, the Comprehensive Evaluation assumed funding would be front-loaded in the early years of the program. Consequently, the analysis assumed funding of $40 million per year through 2014, and then $10 million per year between 2015 and 2030. The present value of this funding stream is approximately equal to the total amount of funding for urban conservation discussed in the ROD for Stage 1.

For each funding level, the Comprehensive Evaluation assumed that 75% of available funds would be set aside for implementation grants and 25% would be set aside for research, design, and development, education, monitoring, and evaluation grants. This division of funds approximately corresponds to current WUE Program grant policy, though it is important to note there is no ROD requirement to allocate grants in this way.

GRANT ALLOCATION ASSUMPTIONS

The modeling assumptions used by the Comprehensive Evaluation to project water savings of state/federal grants were discussed previously. This section briefly reviews the key assumptions before presenting model results.

- Grant funds are available only for projects that are not regionally cost-effective and produce statewide net benefits.
- Regional cost shares are set equal to the regional benefit of the conservation measure from the perspective of the water supplier. In other words, grant funding is used to cover any shortfall in regional benefit in order to make the measure regionally cost-effective.
- Grants are awarded to projects using a ranking of benefit/cost ratios from the perspective of the state. In other words, the state seeks to maximize its return on its investment. The model does not impose regional share or other constraints on the allocation of available grant funds. Rather it mimics a competitive award process intended to maximize returns to investment of state/federal funds.
- If funds remain after funding all projects with benefit/cost ratios equal to or greater than one, the model stops allocating grant funds. In other words, the model only funds projects producing statewide net benefits, even if this means not allocating all available grant funds.

WATER SAVINGS POTENTIAL

Model results of water savings potential for grant funding levels 1, 2 and 3 are shown in Table 3.16.

Grant Funding Level 1

Points to note about this projection include the following:

- Potential water savings reach a maximum of 27,000 acre-feet in 2010. After 2010, water savings start to decrease as the useful lives of the investments are real-

TABLE 3.16 WATER SAVINGS POTENTIAL, GRANT FUNDING LEVELS 1–3 (1,000 AF)

	2005			2010			2020			2030		
Hydrologic Region	**Level 1**	**Level 2**	**Level 3**	**Level 1**	**Level 2**	**Level 3**	**Level 1**	**Level 2**	**Level 3**	**Level 1**	**Level 2**	**Level 3**
Central Coast	2	2	3	3	10	17	1	17	24	1	11	17
Colorado River	1	1	1	2	7	7	0	14	14	0	9	7
North Coast	1	1	1	2	5	6	1	11	11	1	10	9
North Lahontan	0	0	0	0	1	1	0	3	3	0	2	2
Sacramento River	1	1	2	3	8	12	2	23	21	1	28	24
San Francisco Bay	2	2	2	4	11	12	3	20	17	2	20	18
San Joaquin River	2	2	5	3	9	30	2	23	52	1	40	52
South Coast	1	1	1	3	8	8	3	20	13	2	28	22
South Lahontan	2	2	2	4	12	12	2	27	26	2	35	33
Tulare Lake	3	3	4	4	15	23	2	36	39	1	73	39
State	**15**	**15**	**22**	**27**	**87**	**128**	**16**	**194**	**220**	**11**	**257**	**224**

ized. Under this scenario, grant funds are not available beyond 2006 to spur reinvestment and so the water savings do not persist. By 2030, water savings from grant funding level 1 diminish to 11,000 acre-feet.

- Grant funds are fully appropriated. That is, there are sufficient urban conservation investment opportunities yielding statewide net benefits at this funding level.
- Meter retrofit projects are not funded at this grant funding level. This occurs because funds are fully appropriated by other types of conservation measures providing greater net benefits to the state.
- Grant funds leverage considerable local investment. Leveraged regional investment in conservation is approximately $3.4 million per $1 million of grant funding. The regional cost share is approximately 77%.

Grant Funding Level 2

Points to note about this projection include the following:

- Potential water savings increase yearly, reaching a maximum of 257,000 acre-feet by 2030.
- As with funding level 1, grant funds are fully appropriated. That is, there are sufficient urban conservation investment opportunities yielding statewide net benefits at this funding level.
- Similar to funding level 1, meter retrofit projects are not funded at this funding level. Other conservation measures providing greater statewide net benefits fully appropriate available grant funds.
- This funding level leverages, on average over the full forecast period, approximately $3.25 million of regional investment per $1 million of state/federal investment. Regional cost shares average 76%, slightly lower than under grant funding level 1.

Grant Funding Level 3

Points to note about this projection include the following:

- Potential water savings increase yearly, reaching a maximum of 224,000 acre-feet by 2030.
- Potential water savings grow more rapidly between 2005 and 2020 compared to grant funding level 2. This occurs because of the greater amount of up-front grant funding. For example, in 2010 potential water savings are almost 50% greater compared to grant funding level 2 and in 2020 they are approximately 13% greater. However, lower back-end funding offsets the higher up-front funding. As a result, by 2030, potential water savings are actually less than the water savings realized under funding level 2.
- As with funding levels 1 and 2, grant funds are fully appropriated. That is, there are sufficient urban conservation investment opportunities yielding statewide net benefits at this funding level.
- Unlike funding levels 1 and 2, meter retrofit projects that produce statewide net benefits are funded under funding level 3. If meter retrofit projects were excluded from grant funding, approximately 46% of available grant funds would go unallocated during the period 2005–14. Funding metering projects allows the state to realize sooner the potential water savings associated with recently passed metering legislation and fully allocate available grant funds at this funding level.
- This funding level leverages a lower amount of regional investment per dollar of grant funding. On average, grants leverage $2.2 million of regional investment per $1 million of grant. Regional cost shares also are lower compared to grant funding levels 1 and 2, averaging about 69%. The lower amounts of investment lever-

TABLE 3.17 URBAN CONSERVATION PROJECTIONS

Projection	State/Federal Funding Assumption
1. Reasonably Foreseeable: Regulatory code-induced conservation plus continuation of historic rate of investment in Urban BMPs plus investment of remaining Proposition 50 funds.	Limited to remaining Proposition 50 funds (grant funding level 1). Analysis assumes funds fully awarded by 2006.
2. Locally Cost-Effective Practices: Regulatory code-induced conservation plus full implementation of locally cost-effective practices; state/federal investment in projects that are not locally cost-effective but do have statewide positive net benefits.	Limited to remaining Proposition 50 funds (grant funding level 1). Analysis assumes funds fully awarded by 2006.
3. Moderate CALFED Investment: Same as Reasonably Foreseeable but state/federal funding increased and extended to 2030	$15 million/year through 2030 (grant funding level 2).
4. Locally Cost-Effective Practices w/ Moderate CALFED Investment: Same as Locally Cost-Effective but state/federal funding increased and extended to 2030.	$15 million/year through 2030 (grant funding level 2).
5. Locally Cost-Effective Practices w/ ROD Funding Levels: Same as Locally Cost-Effective but state/federal funding increased and extended to 2030.	$40 million/year for first 10 years; $10 million/year thereafter (grant funding level 3).
6. Technical Potential: 100% adoption of urban conservation measures included in analysis. Funding is not a constraint to implementation. This projection provides the upper limit of water savings for modeled conservation measures and serves as a point of reference for the other projections.	Not Applicable

TABLE 3.18 2030 URBAN WATER CONSERVATION SAVINGS POTENTIAL BY COMPREHENSIVE EVALUATION PROJECTION (1,000 AF)

	— Projection 1 —		— Projection 2 —		— Projection 3 —		— Projection 4 —		— Projection 5 —		— Projection 6 —	
Hydrologic Region	**Total AF**	**Reduction**	**Total AF**	**Reduction**	**Total AF**	**Reduction**	**Total AF**	**Reduction**	**Total AF**	**Reduction**	**Total AF**	**Reduction**
Central Coast	39	11%	81	23%	49	14%	91	26%	97	28%	120	34%
Colorado River	21	2%	91	9%	30	3%	100	10%	98	10%	98	10%
North Coast	23	12%	32	16%	32	16%	41	21%	40	20%	55	28%
North Lahontan	3	5%	19	30%	5	9%	21	34%	21	33%	25	41%
Sacramento River	169	11%	194	13%	193	13%	219	15%	215	14%	358	24%
San Francisco Bay	185	13%	310	23%	203	15%	329	24%	326	24%	474	34%
San Joaquin River	105	10%	117	11%	144	14%	157	15%	168	16%	249	24%
South Coast	510	9%	896	17%	536	10%	921	17%	915	17%	1,363	25%
South Lahontan	20	6%	34	10%	53	16%	67	20%	65	20%	82	25%
Tulare Lake	81	8%	89	8%	153	14%	161	15%	127	12%	271	25%
State	**1,155**	**9%**	**1,863**	**15%**	**1,398**	**11%**	**2,105**	**17%**	**2,073**	**17%**	**3,096**	**25%**

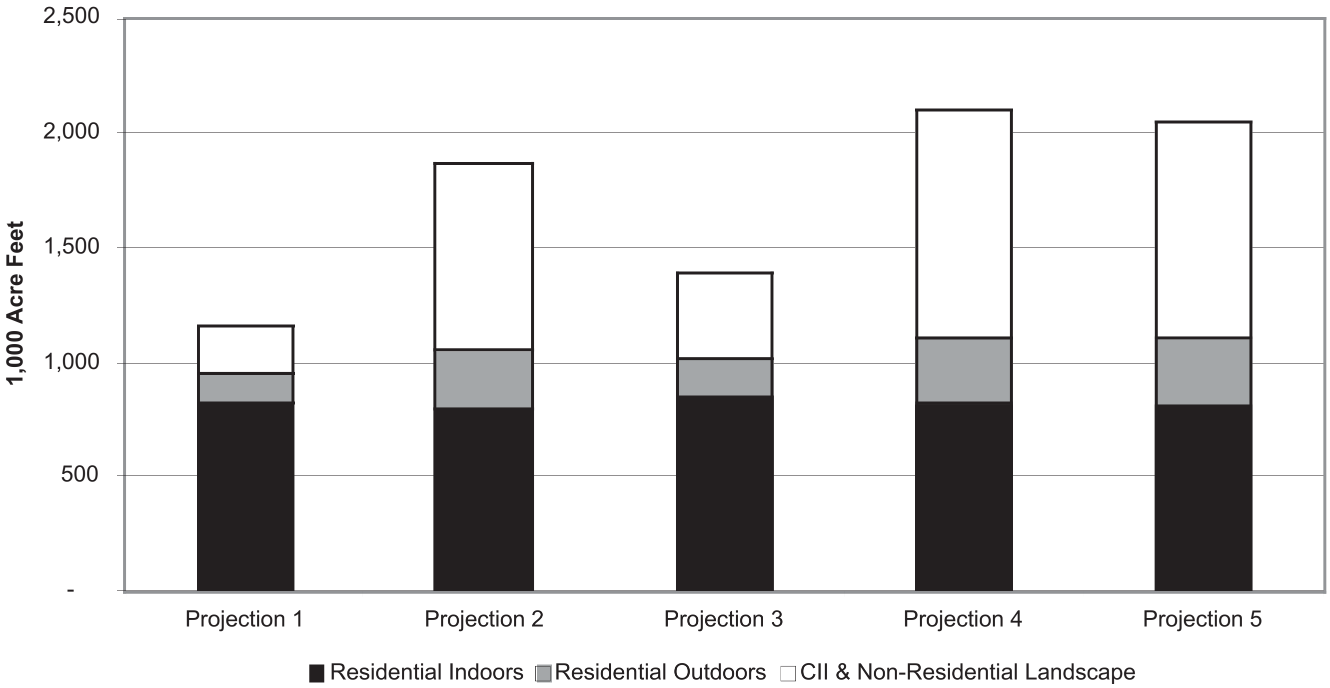
aging and cost-sharing primarily occur during the first ten years of the forecast when available grant funding is at its highest level. This is an expected result, since the higher level of grant funding causes the model to fund a greater proportion of conservation projects with cost-benefit ratios approaching 1.0. Nonetheless, it is important to emphasize that all of the funded projects produce positive statewide net benefits.

SUMMARY OF PROJECTIONS OF URBAN CONSERVATION SAVINGS POTENTIAL

The foregoing analyses of urban water savings potential can be combined and summarized to produce the Comprehensive Evaluation's six urban water conservation projections. Five of these projections consist of different combinations of efficiency code policies, local investment levels, and state/federal grant funding. The sixth, Technical Potential, provides the upper limit of water savings for the urban conservation measures evaluated for the Comprehensive Evaluation. Table 3.17 summarizes again for the reader the Comprehensive Evaluation's six urban conservation projections.

Table 3.18 shows 2030 water savings potential by hydrologic region for each projection. The table also shows the percentage reduction from the baseline applied water use projection. Some conclusions that can be drawn from Table 3.18 include the following:

FIGURE 3.32 2030 WATER SAVINGS POTENTIAL BY TYPE OF USE



- The technical potential of the conservation measures evaluated by the Comprehensive Evaluation (Projection 6) is approximately 3.1 million acre-feet in 2030. Full realization of this potential would reduce the baseline applied water use projection by 25%.
- Water savings potential for Projections 1-5 ranges between 1.2 and 2.1 million acre-feet in 2030. This corresponds to a reduction in the baseline applied water use projection of between 9% and 17%. Different combinations of urban water conservation policies clearly result in significantly different levels of water savings potential.
- 2030 water savings potential for Projection 4 is slightly higher than for Projection 5, even though the total amount of state/federal grant funding under Projection 5 is higher than under Projection 4 and the two projections are the same in all other respects. This occurs because grant funding under Projection 5 is front-loaded in the first ten years of the forecast period. It is then ratcheted down significantly for the remaining twenty years. Water savings potential under Projection 5 is greater than Projection 4 over the first ten to fifteen years of the forecast, but this gain is not maintained over the long-term.
- The combination of efficiency codes and implementation of regionally cost-effective conservation measures account for most of the water savings potential. Comparing savings potential for Projection 2, which limits grants to remaining Proposition 50 funds, to savings potential for Projections 4 or 5, which assume state/federal grant funding over the entire forecast, shows this. While grant funding can augment the water savings from these two primary sources, it does not supplant it.

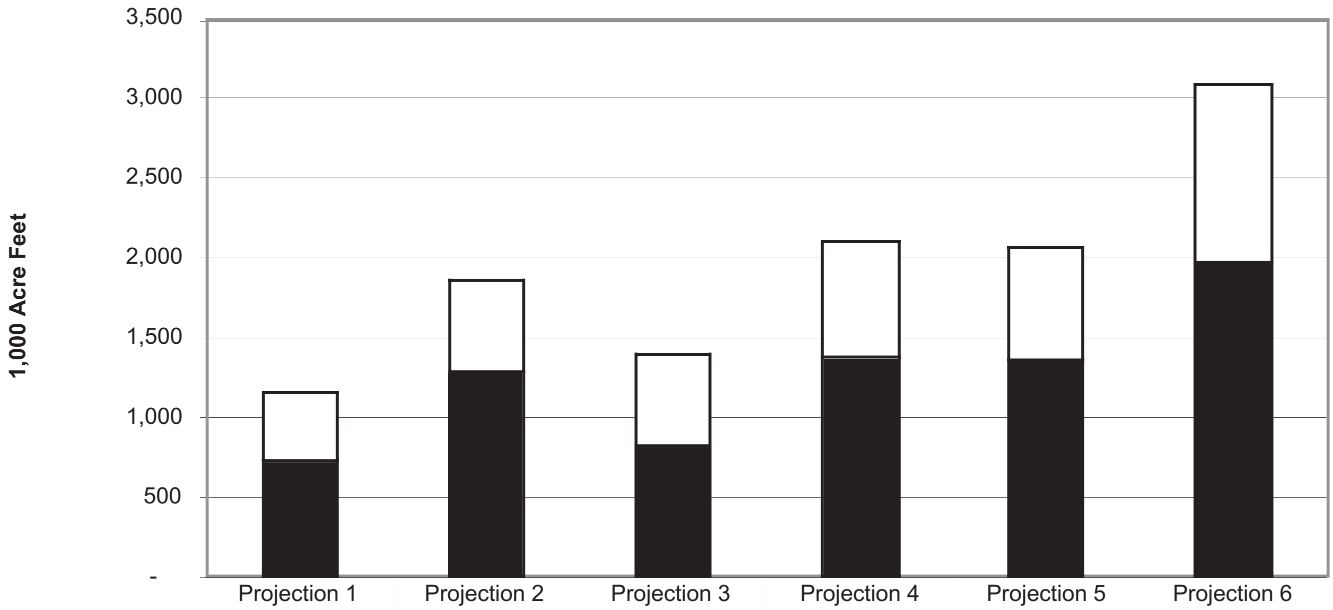
TABLE 3.19 PROPORTION OF WATER USE GOING TO IRRECOVERABLE SINKS BY REGION

Hydrologic Region	% Loss Irrecoverable
Central Coast	90%
Colorado River	50%
North Coast	50%
North Lahontan	50%
Sacramento River	10%
San Francisco Bay	90%
San Joaquin River	10%
South Coast	90%
South Lahontan	50%
Tulare Lake	10%

Figure 3.32 breaks down 2030 savings potential for Projections 1–5 by type of use. The following conclusions can be drawn from this figure:

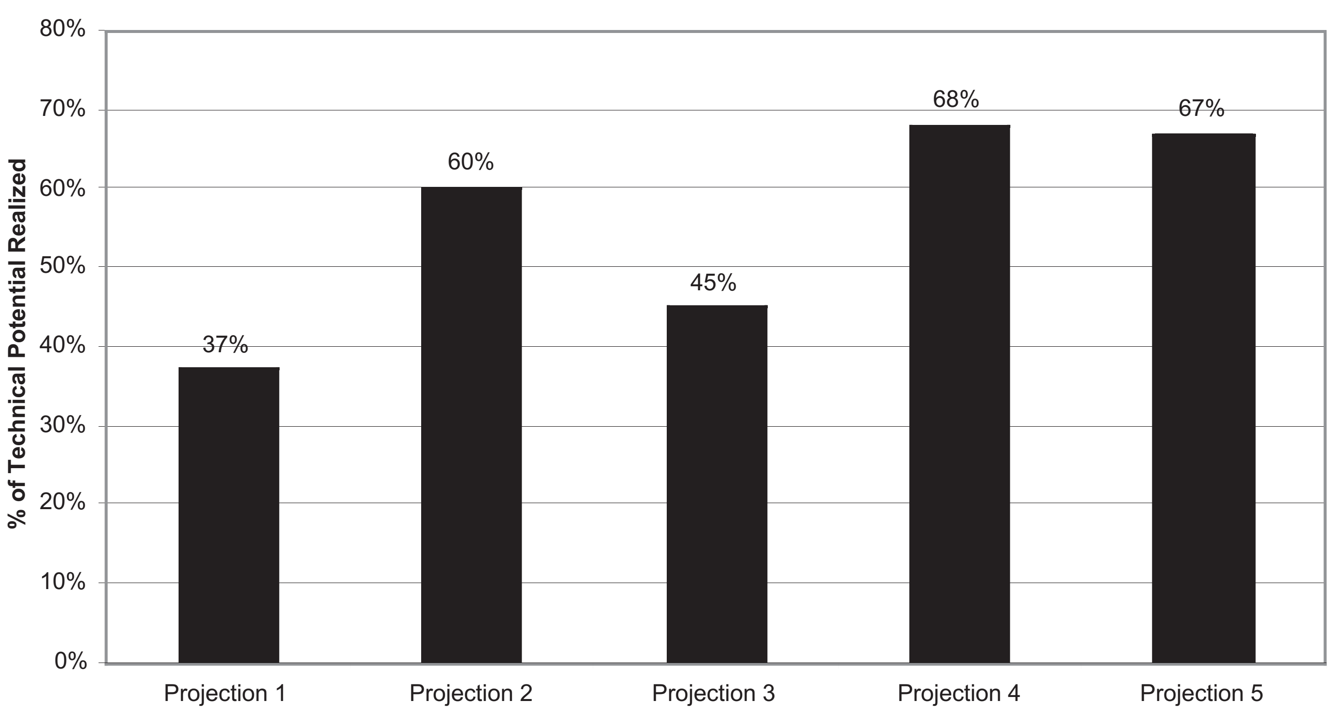
- Residential indoor water savings does not vary sig-

FIGURE 3.33 2030 WATER SAVINGS POTENTIAL—RECOVERABLE VERSUS IRRECOVERABLE SAVINGS



	Projection 1	Projection 2	Projection 3	Projection 4	Projection 5	Projection 6
□ Recoverable	426	577	579	731	705	1,117
■ Irrecoverable	729	1,285	818	1,375	1,368	1,980

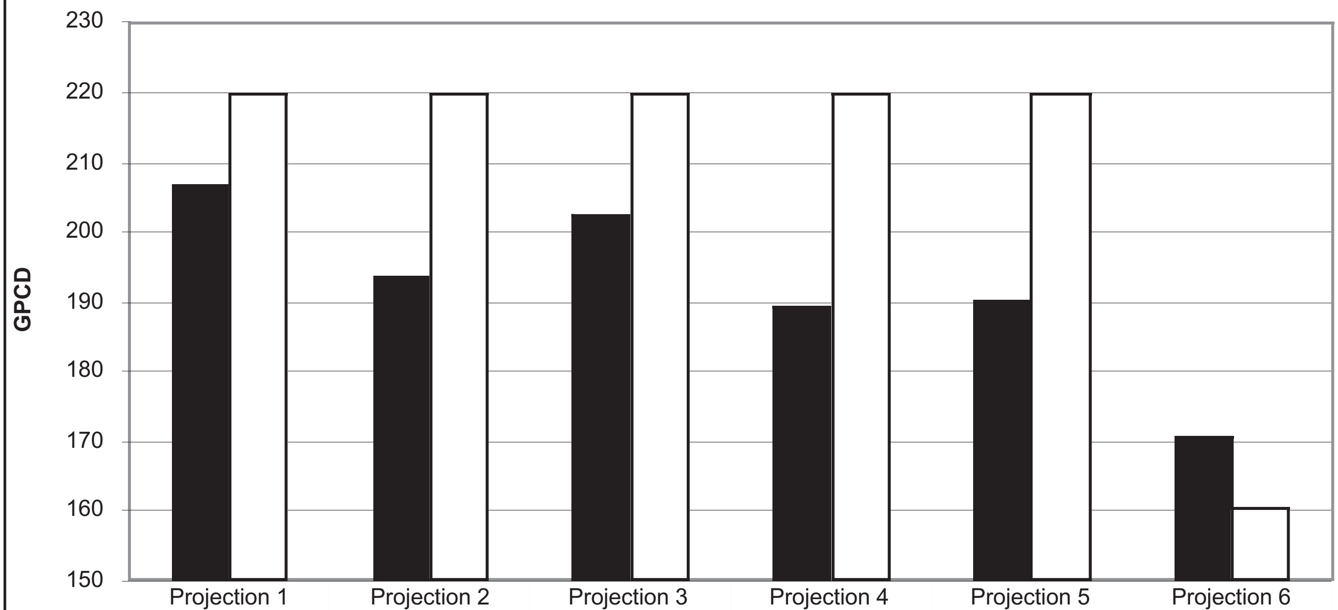
FIGURE 3.34 2030 TECHNICAL WATER SAVINGS POTENTIAL (PROJECTION 6) REALIZED BY OTHER PROJECTIONS



nificantly across projections. Efficiency codes produce most of these savings and the influence of these codes is the same for each projection.

- The greatest difference in savings potential occurs within CII and non-residential landscape uses. Projections 2, 4 and 5 capture a large fraction of total savings potential while Projections 1 and 3 lag well behind.
- Likewise, residential outdoor water savings lags for Projections 1 and 3 relative to Projections 2, 4, and 5. This occurs because the conservation measures in

FIGURE 3.35 2000 AND 2030 PER CAPITA URBAN APPLIED WATER USE



	Projection 1	Projection 2	Projection 3	Projection 4	Projection 5	Projection 6
■ 2030	207	194	202	189	190	171
□ 2000	220	220	220	220	220	160

Projections 1 and 2 are limited to existing BMPs, which do not aggressively pursue residential outdoor water savings, other than through BMP 4 (metering), which operates over a limited geography.[10] Investment in ET-controllers under Projections 2, 4, and 5, on the other hand, increases the amount of residential outdoor water savings.

RECOVERABLE AND IRRECOVERABLE WATER SAVINGS

Water savings for each projection can be divided into recoverable and irrecoverable savings. Recoverable water savings refer to water flows that return to useable groundwater or surface water systems. Irrecoverable water savings refer to flows that return to saline or other unusable sinks or are lost to the atmosphere. The Comprehensive Evaluation did not have much information with which to classify recoverable and irrecoverable urban water savings. It relied on rough approximations of the split between recoverable and irrecoverable water losses for each hydrologic region. These proportions are shown in Table 3.19.

Figure 3.33 shows the amount of recoverable versus irrecoverable savings potential for each Comprehensive Evaluation projection. Water savings that would otherwise flow or evaporate to irrecoverable sinks account for between 59% and 66% of total savings potential. Projection 5 has the highest proportion of irrecoverable savings while Projection 3 has the lowest.

10. BMP 1 (residential surveys) also includes some outdoor elements. However, this BMP is not cost-effective for many water suppliers.

REALIZATION OF TECHNICAL SAVINGS POTENTIAL

Figure 3.34 shows the percent of 2030 technical savings potential (Projection 6) realized by Projections 1-5. Conclusions that can be drawn from this figure include the following:

- Projection 1 results in the smallest realization (37%) of 2030 technical potential. Projection 1, which limits its grants to remaining Proposition 50 funding and assumes BMPs will be implemented at the historic rate can be viewed as a "no action" state policy regarding urban water conservation.
- Projection 3 captures approximately 45% of 2030 technical potential, the second lowest level of the five projections. Projection 3, like Projection 1, assumes BMPs will be implemented at the historic rate. Unlike Projection 1, however, it assumes that moderate amounts of state/federal financial assistance will be available over the entire forecast period. Thus it mimics a policy that emphasizes state/federal financial assistance over programs to promote adoption of regionally cost-effective conservation measures.
- Projection 2 captures approximately 60% of 2030 technical potential, fully a third more than Projection 3. Unlike Projections 1 or 3, Projection 2 assumes the implementation of all regionally cost-effective conservation measures. Like Projection 1, it does not assume grant funding beyond Proposition 50. In this regard, it mimics a policy that empha-

FIGURE 3.36 **STATEWIDE URBAN APPLIED WATER USE BY COMPREHENSIVE EVALUATION PROJECTION**

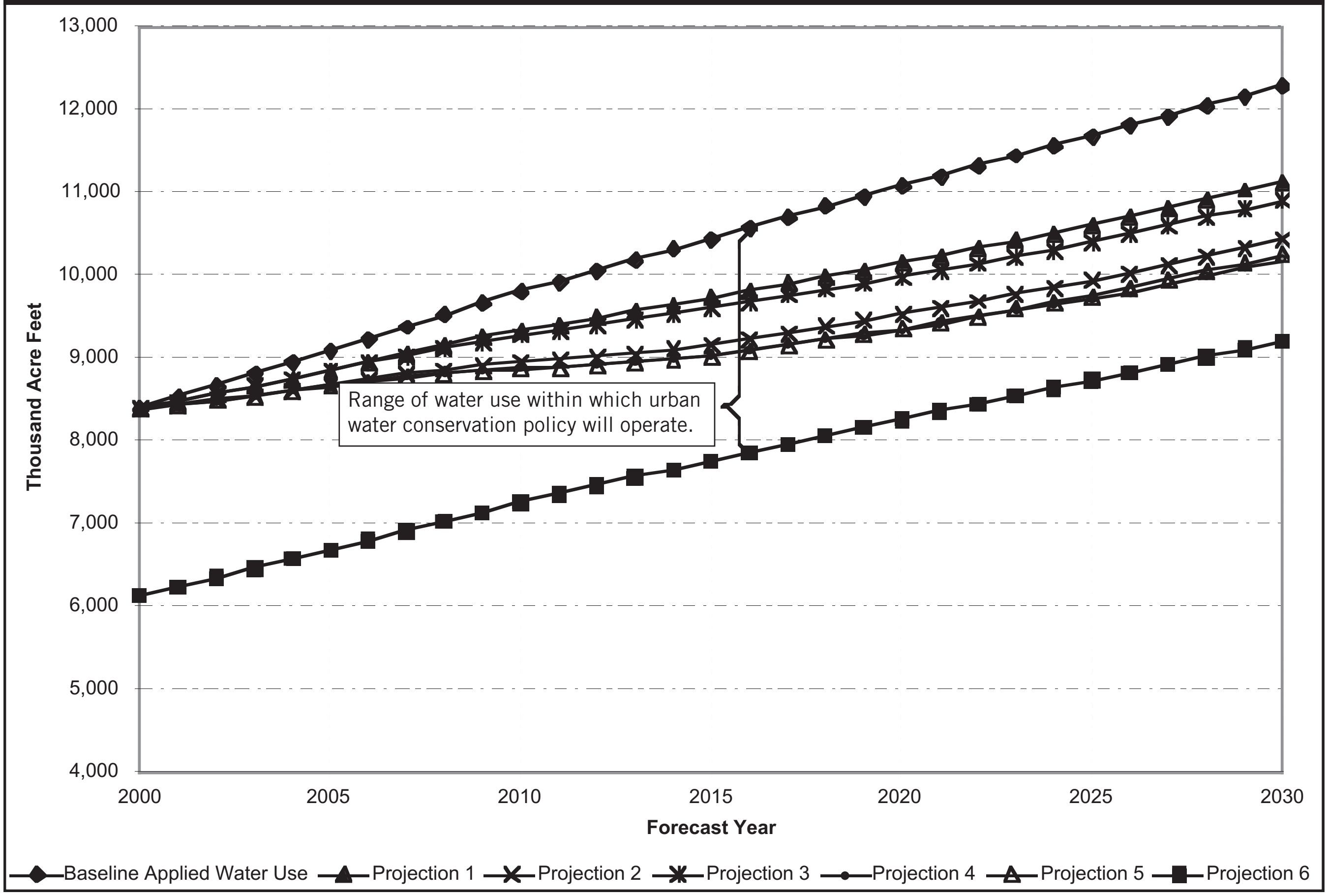


TABLE 3.20 **STATEWIDE URBAN APPLIED WATER USE BY COMPREHENSIVE EVALUATION PROJECTION** (1,000 Acre-Feet)

Projection	2005	2010	2020	2030
Baseline	9,092	9,801	11,086	12,295
Projection 1	8,844	9,333	10,148	11,140
Projection 2	8,666	8,952	9,528	10,432
Projection 3	8,844	9,274	9,973	10,897
Projection 4	8,666	8,893	9,353	10,189
Projection 5	8,659	8,851	9,327	10,222
Projection 6	6,681	7,245	8,255	9,198

sizes programs to promote adoption of regionally cost-effective conservation measures (e.g. Urban MOU certification) over state/federal financial assistance.

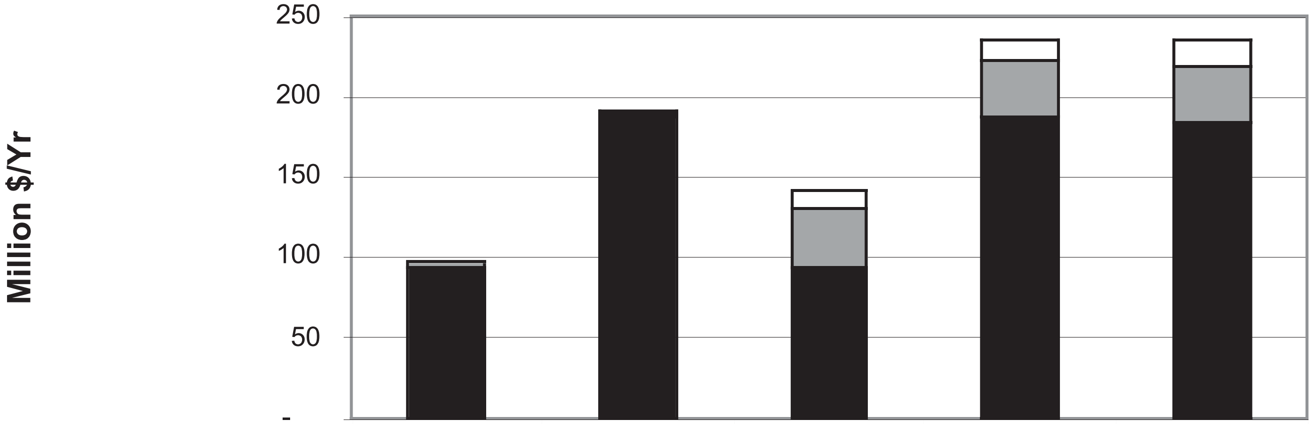
- Projections 4 and 5 capture 68% and 67% of 2030 technical potential, respectively. These two projections combine sustained levels of state/federal financial assistance with aggressive implementation of regionally cost-effective conservation measures. In this regard, they mimic a more proactive urban conservation policy that gives dual emphasis to programs to promote local investment and state/federal financial assistance.

PER CAPITA URBAN APPLIED WATER USE BY PROJECTION

Figure 3.35 shows the implications of the different Comprehensive Evaluation projections for per capita water use (gallons per person per day). When reviewing the data in this figure it is important to keep in mind the following:

- Figure 3.35 shows per capita water use for all urban applied water uses, not just residential water uses.
- The figure shows statewide average per capita use, which tends to mask to some extent the magnitude of change in per capita water use for some hydrologic regions. This

FIGURE 3.37 AVERAGE ANNUAL LEVELS OF INVESTMENT BY SOURCE OF FUNDS (2000–30)



	Projection 1	Projection 2	Projection 3	Projection 4	Projection 5
State/Federal Grants	1	1	11	11	16
Regional Grant Match	3	3	37	37	35
Direct Investment	95	188	95	188	185

occurs because over the forecast period the state's population distribution changes. In 2030 a greater proportion of the state's population will reside in the Central Valley and other dryer inland areas, which has the tendency to increase per capita water use, all else equal. Projection 6 in Figure 3.35 clearly shows this.

URBAN APPLIED WATER USE BY PROJECTION

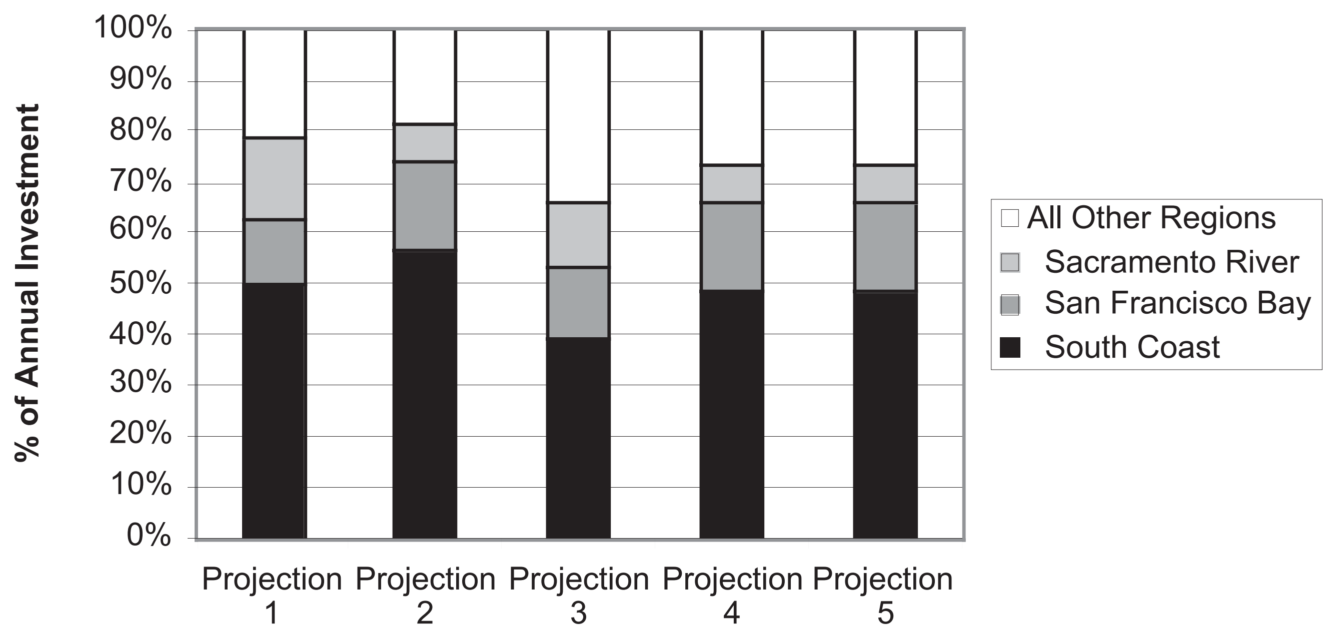
Figure 3.36 shows statewide urban applied water use over the forecast period for the six Comprehensive Evaluation projections. Table 3.20 shows the same information for 2005, 2010, 2020, and 2030. These data suggest the following:

- Given a policy that relies on existing and reasonably foreseeable efficiency codes and minimal to moderate local investment in BMPs (Projection 1), urban applied water use is projected to increase 33%, or 2.8 million acre-feet, over the period 2000–30.
- Policies promoting aggressive local investment in cost-effective BMP and non-BMP conservation measures (Projection 2) can help to reduce further the growth in applied water use. Under such a policy, urban applied water use is projected to increase 24%, or 2.0 million acre-feet, over the period 2000–30, a gain of 800 thousand acre-feet relative to Projection 1.
- Policies that solely emphasize state/federal financial assistance to implement non-locally cost-effective conservation measures (Projection 3) are less effective in reducing the rate of growth in applied water use than are policies that emphasize aggressive local investment in cost-effective BMP and non-BMP conservation measures. Under the former approach, urban applied water use is projected to increase 30%, or 2.5 million acre-feet, over the period 2000 to 2030, half a million acre-feet more than under Projection 2.
- Policies that combine aggressive local investment in cost-effective BMP and non-BMP conservation measures with state/federal grant programs to leverage additional local investment in conservation measures that individual water suppliers do not consider cost-effective (Projections 4 and 5) produce the greatest reduction in the rate of growth in applied water use. Under this approach, urban applied water use is projected to increase by about 22%, or 1.8 million acre-feet, over the period 2000 to 2030.
- The increase in applied urban water use under Projections 4 and 5 is roughly 1 million acre-feet less than the increase under Projection 1, which can be viewed as a "no action" policy. Clearly, different state conservation policies can have considerable impact on California's future urban water demands.

COSTS OF ALTERNATIVE PROJECTIONS OF URBAN CONSERVATION

Projections 1 through 5 imply different levels of investment in urban water conservation by local water supply agencies and state and federal governments. This section summarizes average annual costs by projection and discusses the distribution of investment cost across hydrologic regions. Lastly, it discusses the average unit cost of conservation water savings for each projection.

FIGURE 3.38 DISTRIBUTION OF ANNUAL INVESTMENT BY HYDROLOGIC REGION



AVERAGE ANNUAL COSTS BY PROJECTION

The previous sections evaluated costs for Projections 1 through 5 from the perspective of the state and federal governments and local water suppliers. This approach matches the benefits accounting used by the Comprehensive Evaluation and reflects the costs to water supply agency ratepayers and state/federal taxpayers to actively invest in urban water conservation. This accounting stance does not include costs incurred by end users of water through cost-sharing with local water suppliers or in response to efficiency code requirements. Thus the average annual costs discussed in this section cannot be viewed as full social costs of investment. By the same token, however, the benefit accounting does not reflect the full social benefits of the investments. Rather, benefit accounting is limited to benefits directly captured by water supply agency ratepayers and state/federal taxpayers. It excludes end user co-benefits, such as energy savings, and other types of social benefit, such as reduced water pollution. This provides a consistent accounting stance that mimics the way most water supply agencies evaluate water conservation investments.

Figure 3.37 shows the average annual level of investment for Projections 1 through 5 by funding source.[11] These averages were computed over the full forecast period and it is important to emphasize that costs in any given year may significantly differ from the average. The average costs, however, show the relative contributions by funding source over the forecast period. Three funding sources are identified: direct investment, state/federal grants, and regional matching funds for state/federal grants. Direct investment includes investments made by local water suppliers for cost-effective or reasonably foreseeable conservation activity. State/federal grant investment is based on the assumed grant funding levels for each projection. Regional matching of state/federal grants is the amount of additional investment by local water suppliers leveraged by grant funds.

Average annual statewide expenditure for urban conservation under the five projections ranges between $98 million (Projection 1) and $236 million (Projection 5). Direct investment by local water supply agencies is the primary source of funding, accounting for between 66% (Projection 3) and 98% (Projection 2) of average annual expenditures. Adding regional grant matching to direct investment, and local spending accounts for between 92% (Projection 3) to nearly 100% (Projection 2) of average annual investment. Grant funding provides less than 10% of total funding for all projections. Its contribution is greatest for Projections 3 and 5, providing 8% and 7%, respectively. For Projections 1 and 2, on the other hand, it accounts for less than 1% of total investment.

DISTRIBUTION OF URBAN CONSERVATION INVESTMENT BY REGION

Figure 3.38 shows the distribution of statewide investment by hydrologic region for the five projections. This figure combines funding from the three funding sources and averages it

11. The Comprehensive Evaluation did not attempt to estimate the cost of Projection 6. Projection 6, while providing a useful point of reference for gauging the effectiveness of different polices implied by Projections 1-5, does not itself provide a plausible investment path. It assumes conservation potential is realized fully and instantaneously, something that is beyond the technical and economic capacity of the state. It is reasonable to assume that costs of Projection 6 would be deemed prohibitive under any reasonable set of assumptions.

FIGURE 3.39 **DISTRIBUTION OF GRANT FUNDING BY HYDROLOGIC REGION**

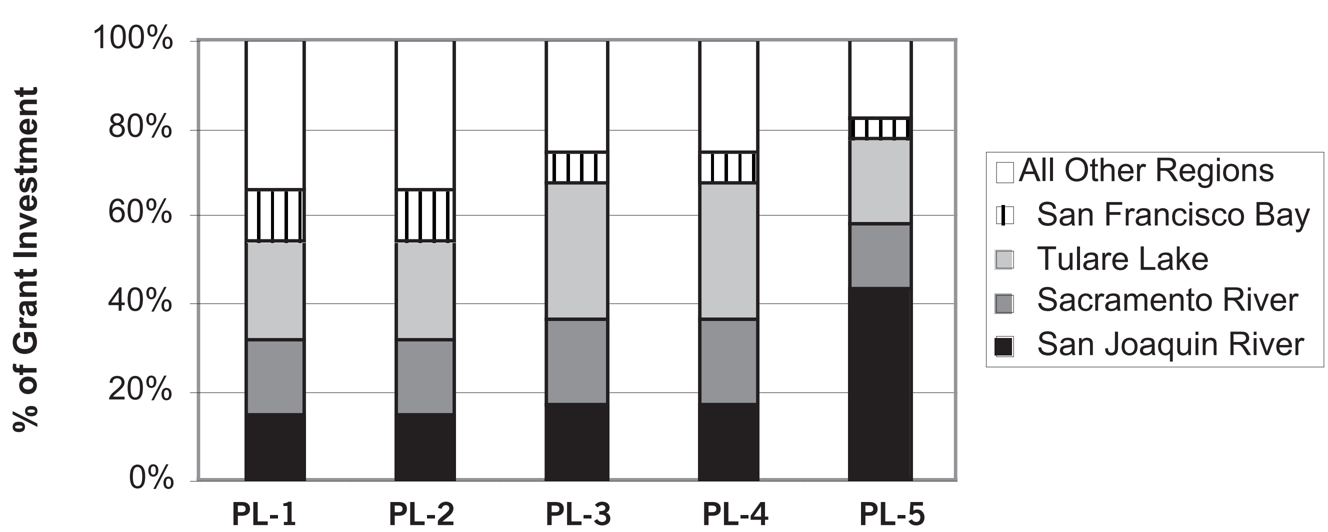
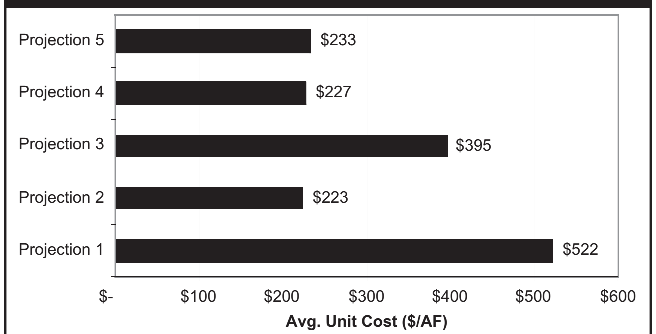


FIGURE 3.40 **AVERAGE UNIT COST BY COMPREHENSIVE EVALUATION PROJECTION**



over the entire forecast period. Investment in the South Coast region accounts for between 40% and 50% of statewide investment. Just three regions, South Coast, San Francisco Bay, and Sacramento River, account for between 66% (Projection 3) and 82% (Projection 2) of statewide investment. The other seven regions each account for the remainder.

While the South Coast accounts for half or nearly half of total investment in all but one projection, its share of state/federal grant funding is not proportional. Most of the grant funds are allocated to regions other than the South Coast, as shown in Figure 3.39. The South Coast region receives less than 5% of available grant funds under all projections. The majority of grant dollars are distributed to the three hydrologic regions in the Central Valley. This occurs because these regions have the lowest regional marginal costs for water and therefore a greater proportion of conservation measures in these regions are not locally cost-effective. By contrast, the South Coast has the highest marginal water costs and therefore a correspondingly greater proportion of conservation measures that are locally cost-effective. Thus, a policy that prohibits co-funding locally cost-effective projects with grant dollars without also imposing some type of regional grant distribution requirement will direct more investment towards the Central Valley and less towards coastal population centers.

AVERAGE UNIT COST OF URBAN CONSERVATION MEASURES

Average unit costs were calculated for Projections 1 through 5, as shown in Figure 3.40. The method for calculating the unit costs shown in the figure is discussed in Appendix 2D.[12] Average unit costs range between $223 (Projection 2) and $522 (Projection 1) per acre-foot. Recall that these unit costs do not reflect end user costs associated with cost sharing or efficiency code compliance, other than metering, which is a water supplier cost.[13]

The costs shown in Figure 3.40 are average costs. Many of the conservation measures have unit costs that exceed these amounts, and several have costs that are less than these amounts. The marginal cost of investment varies by region and time period, and therefore cannot be easily summarized. Figure 3.40 suggests that policies only emphasizing state/federal grant funding (Projections 1 and 3) result in higher average unit costs compared to policies that also promote aggressive investment in locally cost-effective conservation measures (Projections 2, 4, and 5).

12. Calculating the unit costs entailed a terminal value problem. Water savings from investments made towards the end of the forecast period would persist beyond 2030. Unless these water savings are in some way counted, unit costs will be overstated. To address this terminal value problem, the Comprehensive Evaluation adopted the assumption that 2030 water savings would persist for another 10 years without reinvestment.

13. To ensure consistency, the unit costs also do not account for the water savings from efficiency codes other than metering either. Thus, the unit costs reflect only the costs and water savings resulting from direct water supplier and state/federal investment.

APPENDIX 2A:
REGIONAL POPULATION AND EMPLOYMENT FORECASTS

TABLE 2A1 REGIONAL POPULATION FORECASTS

Hydrologic Region	2000	2010	2020	2030
Central Coast	1,459,902	1,610,039	1,748,701	1,857,368
Colorado River	603,831	805,892	980,937	1,158,234
North Coast	644,662	702,676	784,039	880,090
North Lahontan	97,462	114,744	132,352	145,769
Sacramento River	2,595,546	3,209,149	3,918,146	4,548,231
San Francisco Bay	6,091,443	6,717,563	7,416,319	8,044,650
San Joaquin River	1,754,275	2,202,092	2,735,163	3,254,333
South Coast	18,195,041	20,783,311	22,531,522	24,057,882
South Lahontan	722,012	845,697	936,744	1,024,520
Tulare Lake	1,879,025	2,255,604	2,667,819	3,139,596
State Total	**34,043,198**	**39,246,767**	**43,851,741**	**48,110,671**

Source: Department of Finance and Department of Water Resources

Table 2A1 shows the regional population forecasts for 2000, 2010, 2020, and 2030 used by the Comprehensive Evaluation. These forecasts are based on the Department of Finance County Population Forecasts for the same years. Population estimates for intervening years were based on linear extrapolation. County population was distributed to hydrologic regions using population shares provided by Department of Water Resources shown in Table 2A2.

TABLE 2A2 HYDROLOGIC REGION SHARES OF COUNTY POPULATION

County	Central Coast	Colorado River	North Coast	North Lahontan	Sacramento River	S.F. Bay	S.J. River	South Coast	South Lahontan	Tulare Lake
Alameda	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
Alpine	0%	0%	0%	78%	11%	0%	11%	0%	0%	0%
Amador	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
Butte	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Calaveras	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
Colusa	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Contra Costa	0%	0%	0%	0%	0%	84%	16%	0%	0%	0%
Del Norte	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
El Dorado	0%	0%	0%	21%	49%	0%	29%	0%	0%	0%
Fresno	0%	0%	0%	0%	0%	0%	2%	0%	0%	98%
Glenn	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Humboldt	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
Imperial	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%
Inyo	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Kern	0%	0%	0%	0%	0%	0%	0%	0%	11%	89%
Kings	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Lake	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Lassen	0%	0%	0%	89%	11%	0%	0%	0%	0%	0%
Los Angeles	0%	0%	0%	0%	0%	0%	0%	97%	3%	0%
Madera	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
Marin	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
Mariposa	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
Mendocino	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
Merced	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
Modoc	0%	0%	14%	14%	73%	0%	0%	0%	0%	0%
Mono	0%	0%	0%	17%	0%	0%	0%	0%	83%	0%
Monterey	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Napa	0%	0%	0%	0%	2%	98%	0%	0%	0%	0%
Nevada	0%	0%	0%	16%	84%	0%	0%	0%	0%	0%
Orange	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
Placer	0%	0%	0%	6%	94%	0%	0%	0%	0%	0%
Plumas	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Riverside	0%	24%	0%	0%	0%	0%	0%	76%	0%	0%
Sacramento	0%	0%	0%	0%	97%	0%	3%	0%	0%	0%
San Benito	99%	0%	0%	0%	0%	0%	0%	0%	0%	1%
San Bernadino	0%	5%	0%	0%	0%	0%	0%	76%	19%	0%
San Diego	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
San Francisco	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
San Joaquin	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
San Luis Obispo	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
San Mateo	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
Santa Barbara	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Santa Clara	6%	0%	0%	0%	0%	94%	0%	0%	0%	0%
Santa Cruz	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Shasta	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Sierra	0%	0%	0%	6%	94%	0%	0%	0%	0%	0%
Siskiyou	0%	0%	74%	0%	26%	0%	0%	0%	0%	0%
Solano	0%	0%	0%	0%	31%	69%	0%	0%	0%	0%
Sonoma	0%	0%	77%	0%	0%	23%	0%	0%	0%	0%
Stanislaus	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
Sutter	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Tehama	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Trinity	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
Tulare	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Tuolumne	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
Ventura	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
Yolo	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Yuba	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%

Source: Department of Water Resources

APPENDIX 2B:

DEVICE FIXTURE COUNTS

TABLE 2B1 AVERAGE RESIDENTIAL WATER USING FIXTURES PER DWELLING UNIT

Dwelling Type	Toilet	Shower	Dishwasher	Clothes Washer
Single, Detached	2.08	1.78	0.72	0.87
Single, Attached	1.74	1.42	0.66	0.60
2 or More Units	1.26	1.15	0.43	0.24
Other	1.54	1.43	0.48	0.54

Source: 1998 American Housing Survey

RESIDENTIAL INDOOR FIXTURES

Residential indoor fixture counts were derived using data from the 1998 American Housing Survey. This survey reports the average number of bathrooms, half bathrooms, dishwashers, and clothes washers per dwelling unit for various types of housing. The average number of full and half bathrooms were added together to estimate the average number of toilets per dwelling unit. The average number of full baths was used as a proxy for the average number of showerheads per dwelling unit. Fixture counts are based on a nationwide sample of households within standard metropolitan statistical areas. Average fixtures per dwelling unit used to estimate total fixtures for each hydrologic region are shown in Table 2B1. Multiplying the average fixtures per dwelling unit by the estimate of dwelling units over the forecast period produced the Comprehensive Evaluation's estimate of total fixtures for each hydrologic region.

RESIDENTIAL OUTDOOR FIXTURES

ET-controllers constitute the only residential outdoor fixture directly modeled by the Comprehensive Evaluation. (The other avenues to achieve residential outdoor water savings evaluated by the Comprehensive Evaluation were meters and residential surveys.) The Comprehensive Evaluation assumed the top 25% of detached single-family homes were potential candidates for ET-controllers. It assumed an average turf-equivalent landscape area for these sites of 0.046 acres and an average of 1.42 feet per year of excessive irrigation. These estimates were used to derive average water savings per retrofitted site. The estimates are from CUWCC (2004), *A Report on Potential Best Management Practices*.

TABLE 2B2 COUNT OF UNMETERED SINGLE FAMILY RESIDENCES AS OF 2000

Region	Unmetered SF Residences Subject to CVPIA	Unmetered SF Residences Not Subject to CVPIA
Central Coast	0	1,674
Colorado River	0	5,734
North Coast	0	2,164
North Lahontan	0	0
Sacramento River	47,940	407,616
San Francisco Bay	0	28,251
San Joaquin River	97,489	196,264
South Coast	0	4,635
South Lahontan	0	0
Tulare Lake	0	190,928
TOTAL	**145,429**	**837,278**

Source: Derived from Department of Water Resources 2000 Production Survey Data; CALFED Water Use Efficiency Program.

RESIDENTIAL METERS

Table 2B2 shows the count of unmetered single-family residences as of 2000 used by the Comprehensive Evaluation to calculate water savings from metering. Unmetered residences are divided into two categories: those subject to metering requirements under CVPIA and those not subject to CVPIA. The distinction is important because the dates when each category must be metered differ. The counts were derived using data from Department of Water Resources 2000 Production Survey. This survey collects information from water suppliers on the number of metered and unmetered connections. Housing count data from the 2000 Census then was used to scale up the counts from the Department of Water Resources survey. The number of households subject to CVPIA metering requirements came from the CALFED Water Use Efficiency Program.

TABLE 2B3 COUNTS OF CII NON-ULF TOILETS AS OF 1992

Hydrologic Region	Hotels	Restau-rants	Health Care	Offices	Retail/ Wholesale	Industrial	Churches	Govern-ment	K:12 Schools	Other
Central Coast	36,065	5,777	19,491	33,379	48,541	8,873	3,333	4,724	7,421	11,688
Colorado River	18,533	2,156	6,485	7,508	18,349	1,310	1,136	1,610	4,180	4,432
North Coast	16,868	2,372	11,098	12,135	22,519	4,900	1,596	2,262	3,158	6,107
North Lahontan	8,203	649	1,075	1,426	4,008	372	462	654	685	1,992
Sacramento River	29,576	8,844	33,527	57,130	73,873	12,469	4,386	6,216	14,733	19,072
San Francisco Bay	114,497	23,543	90,530	257,912	193,320	61,312	13,700	19,416	30,471	53,830
San Joaquin River	16,210	4,174	19,203	18,786	40,834	9,602	2,223	3,151	9,923	9,424
South Coast	260,135	58,609	275,896	552,656	495,903	174,298	34,395	48,746	100,663	178,276
South Lahontan	13,230	2,276	6,456	8,230	18,987	2,105	1,077	1,527	5,368	3,820
Tulare Lake	18,938	5,041	23,292	28,038	47,322	7,914	2,496	3,537	12,301	8,899
Total	**532,254**	**113,447**	**487,058**	**977,454**	**963,734**	**284,282**	**64,830**	**91,880**	**188,902**	**297,540**

Source: CUWCC (2001) The CII ULFT Savings Study.

TABLE 2B4 COUNTS OF RESTAURANT/BAR DISHWASHERS AND PRE-RINSE SPRAY VALVES

Region	Commercial Dishwashers	Pre-Rinse Spray Valve
Central Coast	3,607	4,725
Colorado River	1,105	1,447
North Coast	1,653	2,165
North Lahontan	227	298
Sacramento River	5,910	7,742
San Francisco Bay	16,272	21,316
San Joaquin River	3,521	4,613
South Coast	40,536	53,102
South Lahontan	1,516	1,985
Tulare Lake	3,570	4,677
TOTAL	**77,916**	**102,070**

Source: Derived from State Board of Equalization and CUWCC data.

TABLE 2B5 STARTING COUNTS OF MEDICAL STERILIZERS

Region	Medical Sterilizers as of 2000
Central Coast	333
Colorado River	138
North Coast	147
North Lahontan	22
Sacramento River	591
San Francisco Bay	1,388
San Joaquin River	400
South Coast	4,146
South Lahontan	165
Tulare Lake	428
TOTAL	**7,758**

Source: CUWCC

CII NON-ULF TOILETS

The estimated stock of non-ULF toilets is from CUWCC. These estimates were derived using the methodology laid out in CUWCC (2001) *The CII ULFT Savings Study*. Table 2B3 shows the estimates number of non-ULF toilets by CII sector as of 1992. Applying the CII toilet replacement rate assumption to the 1992 stock plus replacements reported to the CUWCC derived the stock of non-ULF toilets as of 2000.

COMMERCIAL DISHWASHERS AND SPRAY VALVES

The number of restaurants/bars in California was estimated from 2002 State Board of Equalization records. Restaurant/ bars were allocated to hydrologic regions in proportion to population. The Comprehensive Evaluation assumed 1 dishwasher and 1.31 spray valves per restaurant/bar. The latter estimate was based on the experience of the CUWCC Pre-rinse Spray Valve Replacement Program. Table 2B4 shows the counts of dishwashers and spray valves used for the Comprehensive Evaluation.

MEDICAL STERILIZERS

Two types of medical sterilizer water efficiency improvements were evaluated by the Comprehensive Evaluation: Jacket and Chamber Condensate Modification, and Ejector Water Modification. The estimate of the number of medical sterilizers that could be retrofitted with these modifications came from CUWCC (2004) *A Report on Potential Best Management Practices*. The statewide estimate was distributed to hydrologic regions in proportion to population. The total number of sterilizers was increased each year by the rate of population growth for each hydrologic region. Table 2B5 shows the starting counts of medical sterilizers used for the Comprehensive Evaluation.

APPENDIX 2C:

UNIT WATER SAVINGS DATA AND ASSUMPTIONS

TABLE 2C1 RESIDENTIAL ULF TOILETS UNIT WATER SAVINGS (GALLONS/TOILET/DAY)

Region	Single Family	Multi Family
Central Coast	19.4	34.7
Colorado River	18.6	33.4
North Coast	18.8	30.9
North Lahontan	18.9	29.7
Sacramento River	19.5	30.5
San Francisco Bay	18.9	30.9
San Joaquin River	18.8	33.5
South Coast	18.8	30.9
South Lahontan	18.8	34.3
Tulare Lake	18.8	35.3

Source: Urban MOU Exhibit 6

TABLE 2C2 RESIDENTIAL LF SHOWERHEAD UNIT WATER SAVINGS (GALLONS/SHOWERHEAD/DAY)

Region	Single Family	Multi Family
Central Coast	8.0	9.9
Colorado River	9.0	10.2
North Coast	7.1	8.5
North Lahontan	7.2	8.4
Sacramento River	7.6	8.5
San Francisco Bay	8.2	8.5
San Joaquin River	8.3	9.7
South Coast	8.8	9.9
South Lahontan	8.8	10.0
Tulare Lake	8.8	10.5

American Water Works Association Research Foundation *Residential End Uses of Water*.

TABLE 2C3 SINGLE-FAMILY RESIDENTIAL CLOTHES WASHER WATER USE (GALLONS/WASHER/DAY)

Region	Conventional Washer	8.5 Water Factor	6.0 Water Factor
Central Coast	44.2	28.1	24.4
Colorado River	47.8	30.4	26.4
North Coast	40.6	25.8	22.4
North Lahontan	41.0	26.1	22.6
Sacramento River	42.5	27.0	23.4
San Francisco Bay	44.7	28.4	24.6
San Joaquin River	45.1	28.7	24.9
South Coast	47.2	30.0	26.0
South Lahontan	47.3	30.0	26.1
Tulare Lake	47.1	30.0	23.9

Source: American Water Works Association Research Foundation *Residential End Uses of Water*; Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California.*

TABLE 2C4 MULTI-FAMILY RESIDENTIAL CLOTHES WASHER WATER USE (GALLONS/WASHER/DAY)

Region	Conventional Washer	8.5 Water Factor	6.0 Water Factor
Central Coast	39.2	24.9	21.6
Colorado River	40.1	25.5	22.1
North Coast	35.2	22.4	19.4
North Lahontan	35.0	22.2	19.3
Sacramento River	35.2	22.4	19.4
San Francisco Bay	35.3	22.4	19.4
San Joaquin River	38.7	24.6	21.4
South Coast	39.1	24.9	21.6
South Lahontan	39.5	25.1	21.8
Tulare Lake	40.7	25.9	22.4

Source: American Water Works Association Research Foundation *Residential End Uses of Water*; Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California.*

RESIDENTIAL TOILETS

Unit water savings for residential ULF toilets are from Exhibit 6 of the Urban MOU. Savings estimates are a function of average number of toilets and persons per dwelling unit and therefore vary somewhat by hydrologic region. The unit water savings are shown in Table 2C1.

RESIDENTIAL SHOWERHEADS

Average water use for low-flow and non-low-flow showerheads was taken from the American Water Works Association Research Foundation *Residential End Uses of Water*. Per capita-day water use estimates from this study were combined with estimates of housing density and shower counts to estimate average water savings from low-flow showerheads. The unit water savings are shown in Table 2C2.

RESIDENTIAL CLOTHES WASHERS

Water use of conventional clothes washers was taken from American Water Works Association Research Foundation *Residential End Uses of Water*. Water use of high-efficiency washers with water factors of 8.5 and 6.0 was taken from Pacific Institute *Waste Not, Want Not: The Potential for Urban Water*

TABLE 2C5 SINGLE-FAMILY RESIDENTIAL DISHWASHER WATER USE (GALLONS/DISHWASHER/DAY)

Region	Conventional Dishwasher	High Efficiency
Central Coast	3.0	1.6
Colorado River	3.3	1.8
North Coast	2.7	1.4
North Lahontan	2.7	1.4
Sacramento River	2.8	1.5
San Francisco Bay	3.1	1.6
San Joaquin River	3.1	1.6
South Coast	3.3	1.7
South Lahontan	3.3	1.7
Tulare Lake	3.3	1.7

Source: American Water Works Association Research Foundation *Residential End Uses of Water*; Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California*.

TABLE 2C6 MULTI-FAMILY RESIDENTIAL DISHWASHER WATER USE (GALLONS/DISHWASHER/DAY)

Region	Conventional Dishwasher	High Efficiency
Central Coast	2.5	1.3
Colorado River	2.6	1.4
North Coast	2.2	1.2
North Lahontan	2.2	1.1
Sacramento River	2.2	1.2
San Francisco Bay	2.2	1.2
San Joaquin River	2.5	1.3
South Coast	2.5	1.3
South Lahontan	2.6	1.4
Tulare Lake	2.7	1.4

Source: American Water Works Association Research Foundation *Residential End Uses of Water*; Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California*.

Conservation in California. These water use estimates were per load of laundry. The Comprehensive Evaluation converted per load water use to average daily use per washer using load frequency and person per household information in *Residential End Uses of Water*. Water use per washer per day for conventional, 8.5 water factor, and 6.0 water factor washers are shown in Tables 2C3 and 2C4. Implied water savings is the difference between use for the conventional washer and the higher efficiency washers. Water use estimates for multi family housing are for owned washers only. Lower daily use for washers in multi-family settings compared to single-family settings occurs because of fewer people per washer and lower use intensities.

RESIDENTIAL DISHWASHERS

Estimated loads per capita-day and gallons per load for conventional dishwashers are from American Water Works Association Research Foundation *Residential End Uses of Water*. Gallons per load for high-efficiency dishwashers is from Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California*. Loads per capita-day were assumed to be the same for the two types of washers. Estimated water uses in single- and multi-family settings are shown in Tables 2C5 and 2C6.

RESIDENTIAL ET-CONTROLLERS

The Comprehensive Evaluation assumed the top 25% of detached single-family homes were potential candidates for ET-controllers. It assumed an average turf-equivalent landscape area for these sites of 0.046 acres and an average of 1.42 feet per year of excessive irrigation. Average annual savings per site under these assumptions are 58.3 gallons per day. The estimates are from CUWCC (2004), *A Report on Potential Best Management Practices*.

RESIDENTIAL METERS

Installing meters on unmetered connections was assumed to reduce applied water use by 20%. This estimate is from Exhibit 1 of the Urban MOU. The percentage reduction in water use was converted to daily savings per meter using data from Department of Water Resources on water use of unmetered connections. Average water use for unmetered households was 806 gallons per day. Daily savings from metering was about 160 gallons. Reduction in outdoor use was assumed to account for 85% of this water savings. The estimate of outdoor savings was taken from data compiled by the CALFED Water Use Efficiency Program during its work on appropriate water measurement.

BMP 1—RESIDENTIAL SURVEYS

Residential surveys of single-family housing were assumed to produce first year water savings of 15 gallons/day. Survey savings were assumed to decay by 15% per year. The estimate is from CUWA (2001) *California Urban Water Conservation Potential*. That study derived its estimate of unit saving from CUWCC (2000) *BMP Costs & Savings Study: A Guide to the Data and Methods for Cost Effectiveness of Urban Water Conservation Best Management Practices*. Savings from single-family surveys exclude potential water savings from low-flow showerhead and toilet dam installation to avoid possible double counting of savings with BMPs 2 and 14.

Residential surveys of multi-family housing were assumed to produce first year water savings of 6.6 gallons/day. Survey savings were assumed to decay by 15% per year. The information sources are the same as for single-family surveys. Savings from multi-family surveys exclude potential water savings from turf audits and other outdoor measures to avoid potential double counting of savings with BMP 5.

TABLE 2C7 BMP 5 LANDSCAPE BUDGET UNIT WATER SAVINGS	
Region	Acre-feet/Year
Central Coast	0.29
Colorado River	2.97
North Coast	0.23
North Lahontan	0.61
Sacramento River	1.04
San Francisco Bay	0.51
San Joaquin River	1.93
South Coast	0.66
South Lahontan	0.61
Tulare Lake	2.23

Source: Metropolitan Water District of Southern California (1997), DWR

TABLE 2C8 BMP 5 LANDSCAPE SURVEY UNIT WATER SAVINGS	
Region	First Year Savings (Acre-feet/Year)
Central Coast	0.53
Colorado River	1.13
North Coast	0.62
North Lahontan	0.62
Sacramento River	0.79
San Francisco Bay	0.62
San Joaquin River	0.81
South Coast	0.75
South Lahontan	1.13
Tulare Lake	0.81

Source: CUWA (2001), CALFED Bay-Delta Program

NON-RESIDENTIAL TOILETS

The Comprehensive Evaluation evaluated non-residential toilet water savings for five aggregate CII sectors. Water savings are gallons/toilet/day: Office (20), Restaurant (47), Hotel (16), Retail (40), and Other (21). Unit water savings were drawn from data in CUWCC *CII ULFT Savings Study, 2nd Edition*.

DISHWASHER PRE-RINSE SPRAY VALVES

High-efficiency dishwasher pre-rinse spray valves were assumed to save 137 gallons of water per day. This estimate is from CUWCC *Evaluation, Measurement & Verification Report for CUWCC Pre-Rinse Spray Head Distribution Program*, SBW Consulting, Inc. Report No. 0401, May 2004.

HIGH-EFFICIENCY COMMERCIAL DISHWASHERS

High-efficiency commercial dishwashers were assumed to save 100 gallons of water per day. This estimate came from technical memoranda prepared for the CUWCC by Koeller and Company.

MEDICAL STERILIZER RETROFITS

The Comprehensive Evaluation evaluated water savings for two medical sterilizer retrofits: jacket and chamber condensate modification, and ejector water modification. Mid-point water savings per device retrofit are from CUWCC (2004) *A Report on Potential Best Management Practices*. The unit savings for jacket and chamber condensate modification is 1,243 gallons/day, and for ejector water modification is 1,723 gallons/day.

BMP 5—LANDSCAPE BUDGETS

Unit water savings for BMP 5 landscape budgets were derived using data from Metropolitan Water District of Southern California (1997) *Landscape Water Conservation Programs: Evaluation of Water Budget Based Rate Structures*. This study reported average water savings as a percent of pre-budget water use. Estimated water savings included the combined effects of the budget and rate structure. The Comprehensive Evaluation reduced the percentage savings by 25% because linking budgets to rate structures is not a strict requirement of BMP 5. With this adjustment, the Comprehensive Evaluation assumed that landscape budgets would reduce pre-budget use by an average of 15%. The percentage reduction in water use was combined with estimates of the average pre-budget water use for large landscapes by hydrologic region. Applied water use by landscape accounts was estimated using data from the Department of Water Resources Production Survey. The unit savings per landscape budget for each hydrologic region are shown in Table 2C7.

BMP 5—LANDSCAPE SURVEYS

Unit water savings for BMP 5 landscape surveys are from CUWA (2001) *California Urban Water Conservation Potential*. Landscape surveys are assumed to result in an initial reduction in water use of 15%. These savings are assumed to decay by 10% per year. Average acres per survey were based on information gathered from water agency conservation coordinators in different hydrologic regions. Average water uses per acre of landscape are from CALFED and are based on urban landscape ETo requirements by hydrologic region. The first year unit water savings are shown in Table 2C8.

OTHER LANDSCAPE SAVINGS

The Comprehensive Evaluation used estimated large landscape savings potential from Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California* to estimate total landscape savings potential. Estimated water savings from BMP 5 budget and surveys were then deducted from this total potential. A unit cost to achieve any remaining potential was developed using cost information from the Pacific Institute report. The Comprehensive

Evaluation constrained annual investment in remaining potential to one-tenth of remaining potential.

BMP 9—CII SURVEYS

Unit water savings for BMP 9 CII surveys are from CUWA (2001) *California Urban Water Conservation Potential*. The unit water savings reported in that study came from Hagler Bailly Services, Inc. *Evaluation of the MWD CII Survey Database*. CUWA (2001) combined data on measure savings and useful life from the Hagler Bailly report to calculate a weighted-average water savings of 1.27 acre-feet per year. Water savings are assumed to persist for an average of 12 years. This average useful life was also based on data in the Hagler Bailly report.

CII PROCESS WATER

A single unit savings estimate for CII process water was not developed because process water uses are too heterogeneous. Rather, the process water savings potential is based on a cost curve for industrial water conservation measures derived from a variety of industrial process conservation unit cost estimates developed by the Pacific Institute. Based on these costs, the statewide volumes of locally cost-effective conservation in each year were calculated from the cost curve. These volumes were then allocated to regions in proportion to CII accounts and divided by 10 to reflect an assumed 10-year implementation period.

Thus, unlike the other activities, there is no range of cost-effective years for industrial processes. Instead, in each year and in each region, there is some volume of process savings that is cost-effective. Once an investment is made in a water-efficient process technology, the customer is assumed to reinvest on its own at the end of that technology's useful life.

BMP 3 WATER SYSTEM AUDITS AND LEAK DETECTION

A single unit savings estimate for water system audits and leak detection was not developed because outcomes from this BMP are too heterogeneous. Rather, the average cost to achieve an acre-foot of water savings was taken from CUWA (2001) *California Urban Water Conservation Potential*. The regional economic model then determined for each hydrologic region when implementation of BMP 3 was cost-effective. Total savings potential by hydrologic region also came from CUWA (2001). BMP 3 annual investment was constrained to one-tenth of total savings potential.

APPENDIX 2D:

UNIT COST DATA AND ASSUMPTIONS

Levelized unit costs were calculated for each conservation measure included in the forecast model. The levelized costs are from the perspective of the water supplier and do not account for co-benefits such as avoided end-user energy or waste disposal costs. Unit costs that include co-benefits are discussed in this appendix.

White and Howe (1998) define the levelized unit cost as shown in equation (1):

$$(1)\quad LC = \frac{PV(\text{Cost})}{PV(\text{Water Saved})}$$

The levelized unit cost is similar to the annualized unit cost, which is defined as the annualized cost of a project divided by its annual yield, but has the added advantage that it does not require constant annual yield and operating cost. The levelized unit cost accounts for the time value of money and captures all capital and operating expenditures for the project, regardless of how they vary over time. By definition, multiplying the levelized cost by the amount of water saved in each period and then discounting these expenditures back to the present will yield the present value of all capital and operating expenditures. In other words, the levelized unit cost fully recovers the capital and operating cost of a project, unlike some other approaches to calculating unit cost.

The cost-effectiveness and grant allocation models compute water savings for a measure as either a decay process or as constant with a finite useful life. The approach used by the models depends on the conservation measure being considered. For example, water savings for ULF toilets are modeled as a decay process whereas water savings for residential ET controllers are modeled as constant with a finite useful life. Water savings for ULF toilets are modeled as a decay process to avoid double counting ULF savings due to plumbing and energy code requirements. If a water utility replaces a residential high-flow toilet with a ULF toilet it is only accelerating the date this toilet would have otherwise been converted to a ULF under energy and plumbing code requirements. Over large populations of residential toilets, data suggest that toilets turnover at a rate of about 4% per year. If this is so, then savings attributed to active replacement of toilets would decay at a rate of about 4%. This decay reduces the present value of savings attributable to active replacement and thus increases the levelized unit cost. Currently there are no code requirements for residential ET-controllers. These devices are therefore assumed to produce constant annual water savings over their useful lives.

When savings were modeled as a decay process the levelized unit cost was computed as follows. Let s_0 be the unit savings in the initial year and assume that each year thereafter this unit savings decays by d. If r is the real discount rate, then the present value of savings, S, is shown in equation (2).

$$(2)\quad S = \sum_{t=0}^{t=N} s_0 \left[\frac{(1-d)}{(1+r)}\right]^t = s_0 \frac{\left(1-\left[\frac{(1-d)}{(1+r)}\right]^{N+1}\right)}{\left(1-\left[\frac{(1-d)}{(1+r)}\right]\right)}$$

When $N \to \infty$, then S is given by equation (3).

$$(3)\quad S = \frac{s_0}{\left(1-\left[\frac{(1-d)}{(1+r)}\right]\right)}$$

If C is the present value of costs, then the levelized cost was computed using equation (4).

$$(4)\quad LC = \frac{C\left(1-\left[\frac{(1-d)}{(1+r)}\right]\right)}{s_0}$$

When savings were modeled as constant with a finite useful life, N, the present value of savings, S, was computed using equation 5.

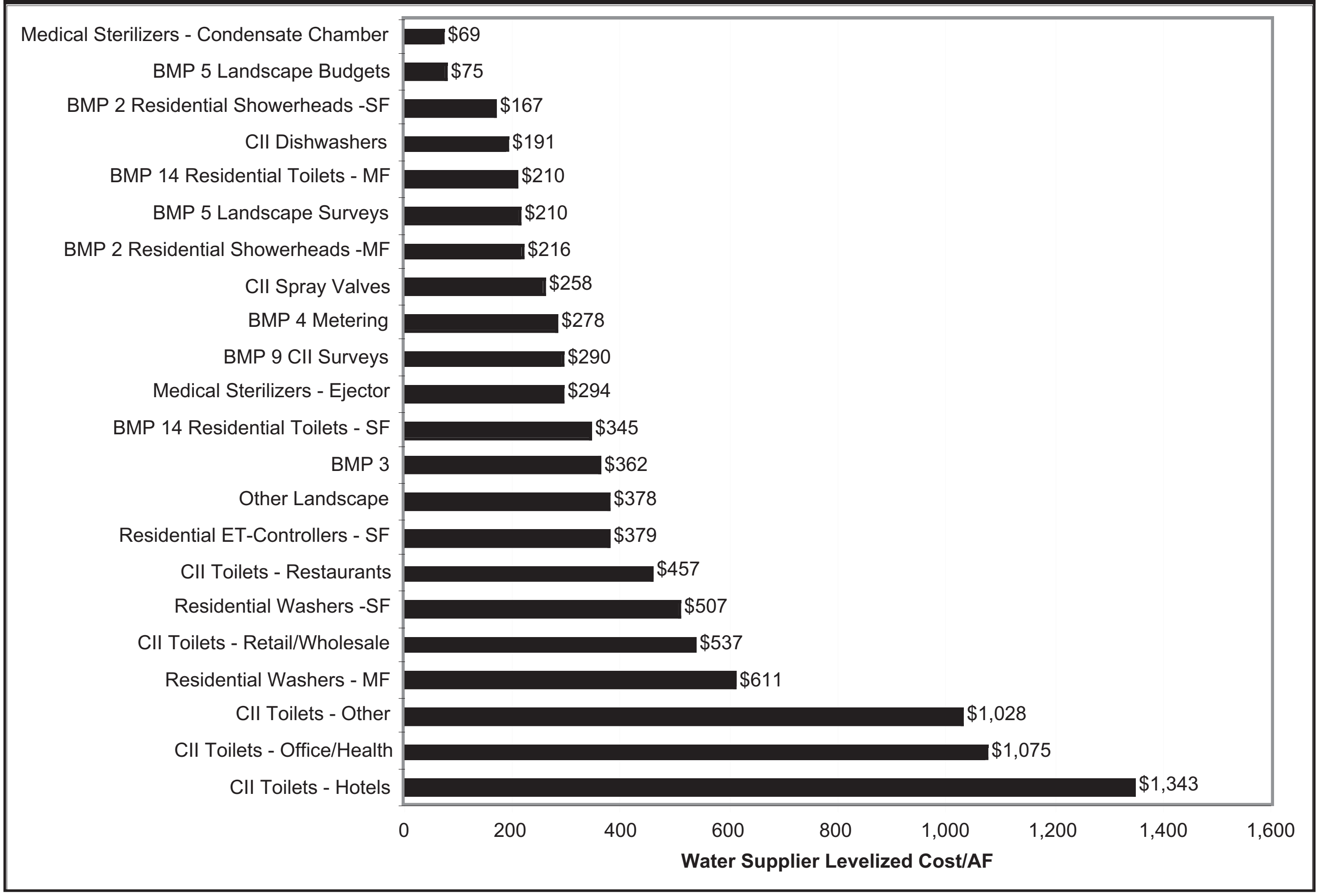
$$(5)\quad S = \sum_{t=0}^{t=N} s_0 \frac{1}{(1+r)^t} = s_0 \frac{(1+r)^{N+1}-1}{\left(r(1+r)^N\right)}$$

If C is the present value of costs, the levelized unit cost was computed using equation (6).

$$(6)\quad LC = \frac{C}{s_0} \frac{\left[r(1+r)^N\right]}{\left[(1+r)^{N+1}-1\right]}$$

Levelized costs for the water supplier vary slightly by region because unit savings vary by region. They also vary by year because the Comprehensive Evaluation assumed costs escalated by 2% per year. Figure 2D1 shows levelized costs for the South Coast region in 2000 to provide a sense of relative magnitudes for the different measures evaluated by

FIGURE 2D1 WATER SUPPLIER LEVELIZED COST/AF OF WATER SAVINGS BY CONSERVATION MEASURE



the Comprehensive Evaluation.

To implement this methodology, the Comprehensive Evaluation compiled data on representative capital, financial incentive, and annual administrative and operational costs for each conservation measure included in the models. These data are summarized in this appendix.

BMP 1—RESIDENTIAL SURVEYS

The Comprehensive Evaluation assumed an average cost to the utility of $125 per single-family residential survey. This total cost includes costs for field labor, equipment, and program administration. Multi-family surveys were assumed to have an average cost to the utility of $330 per survey. This is the average cost to survey a multi-family complex with six units. The source for the estimates was CUWA (2001) *California Urban Water Conservation Potential*.

BMP 2—RESIDENTIAL PLUMBING DEVICES OTHER THAN TOILETS

The Comprehensive Evaluation assumed an average cost to the utility of $12 per installed plumbing device retrofit kit. This cost covers the cost of equipment, distribution, and administration. It assumes that 55% of kits are actually installed by homeowners. The source for the estimates was CUWA (2001) *California Urban Water Conservation Potential*.

BMP 3—WATER SYSTEM LEAK DETECTION AND SYSTEM AUDITS

The Comprehensive Evaluation assumed an average cost to the utility of $1,656 per acre-foot of system water loss reduction. The estimate is based on information contained in CUWA (2001) *California Urban Water Conservation Potential*.

BMP 4—METERING

The Comprehensive Evaluation assumed an average meter installation cost of $600/meter. Annual meter reading costs were assumed to be $4/year. Meters were assumed to have a useful life of 10 years. The Comprehensive Evaluation based its cost estimates on information compiled by the CALFED Water Use Efficiency Program's work on appropriate water measurement.

BMP 5—LANDSCAPE SURVEYS

The Comprehensive Evaluation assumed an average cost per large landscape survey of $500, which includes both field labor and program administration. Additionally, it assumed the water supplier offered a financial incentive of $750 per survey for equipment upgrades. This resulted in a total cost of $1,250/survey. The estimate is based on information contained in CUWA (2001) *California Urban Water Conservation Potential*.

BMP 5—LANDSCAPE BUDGETS

The Comprehensive Evaluation assumed an average cost of $431 per landscape budget. This includes the upfront cost to establish the budget and the present value cost to administer it over time. The estimate is based on information contained in CUWA (2001) *California Urban Water Conservation Potential*.

BMP 9—CII SURVEYS

The Comprehensive Evaluation assumed an average cost of $1,200 per survey. It also assumed the water supplier offered a financial incentive of $2,500 per survey for equipment upgrades. This resulted in a total cost of $3,700 per survey.

BMP 14—RESIDENTIAL TOILET RETROFITS

The Comprehensive Evaluation modeled two different toilet replacement programs: direct installation and financial rebates. For the direct installation program, the Comprehensive Evaluation assumed an average cost of $107 per toilet. It also assumed that 20% of installed toilets went to program freeriders. For the financial rebate program it assumed an average rebate of $75 per toilet and administrative cost of $25 per toilet for a total cost of $100 per toilet. It assumed that 50% of toilets replaced with rebates went to freeriders. The unit cost assumptions are from CUWA (2001) *California Urban Water Conservation Potential*. The freeridership assumptions are based on data from CUWCC (2002) *Freeriders in ULFT Programs*.

RESIDENTIAL CLOTHES WASHERS

The Comprehensive Evaluation assumed an average cost of $150 per washer for financial rebates to customers. Washers were assumed to have an average useful life of 14 years. The unit cost assumptions are from CUWA (2001) *California Urban Water Conservation Potential*.

RESIDENTIAL ET-CONTROLLERS

ET-controllers were assumed to have an equipment and installation cost of $175/controller. In addition, controllers incurred annual signal fees of $48/year. Controllers were assumed to have an average useful life of 15 years. The Comprehensive Evaluation assumed the water supplier paid for the equipment and installation while the customer paid the annual signal fee. The source for these estimates was CUWCC (2004) *A Report on Potential Best Management Practices*.

CII TOILET RETROFITS

CII toilet retrofits were assumed to have an average cost of $310 per toilet. The estimate is from Pacific Institute *Waste Not, Want Not*. It was also assumed that customer and the water supplier shared the cost 50/50. Therefore the cost to the water supplier was $155 per toilet.

MEDICAL STERILIZERS

Jacket and chamber condensate modification equipment costs were assumed to average $2,500 per retrofit. The water supplier was assumed to incur administrative cost of $375 (15% of capital cost) per retrofit. Devices were assumed to have a useful life of 20 years. Ejector water modification equipment costs were assumed to average $14,700 per retrofit. The water supplier was assumed to incur administrative cost of $2,205 (15% of capital cost) per retrofit. Devices were assumed to have a useful life of 20 years. The Comprehensive Evaluation assumed retrofit costs were split 50/50 between the water supplier and customer. The source for both estimates was CUWCC (2004) A Report on Potential Best Management Practices.

DISHWASHER PRE-RINSE SPRAY VALVES

The Comprehensive Evaluation assumed pre-rinse spray valves were distributed through a direct installation program at an average cost of $181 per valve. Pre-rinse valves were assumed to have a useful life of five years. The for the estimates was CUWCC (2004) *A Report on Potential Best Management Practices*.

HIGH-EFFICIENCY COMMERCIAL DISHWASHERS

The Comprehensive Evaluation assumed an average retrofit cost of $300 per dishwasher. Dishwashers were assumed to have a useful life of eight years. Costs were assumed to be split 50/50 between the water supplier and the customer. The estimate is from Pacific Institute *Waste Not, Want Not*.

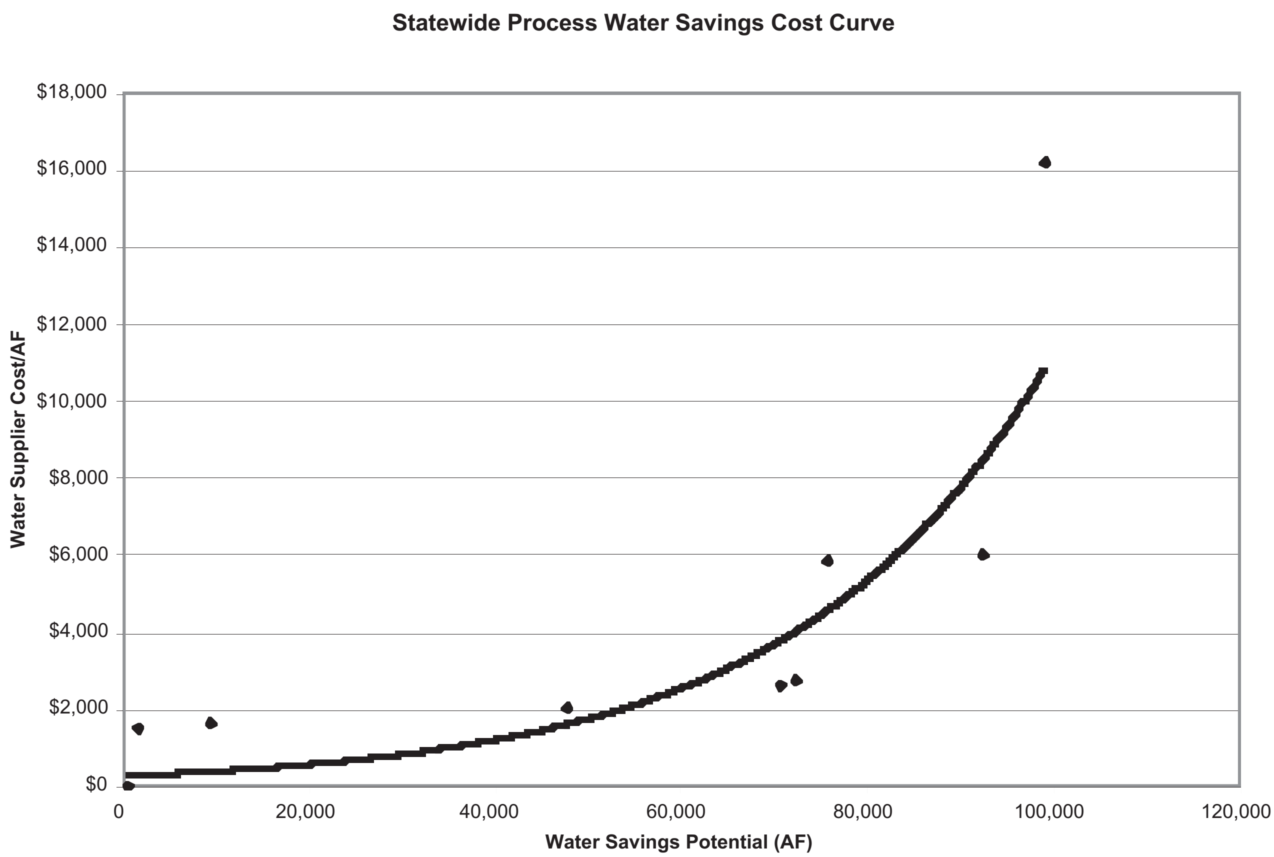
LANDSCAPE WATER SAVINGS OTHER THAN FROM BMP 5

The Comprehensive Evaluation assumed an average cost of $711 per acre-foot of landscape water savings above and beyond water savings from BMP 5. It further assumed costs were split 50/50 between the water supplier and customer. The estimate is based on Pacific Institute estimates in Figure 5-4 and Tables 5-8 and 5-9 of *Waste Not, Want Not*. It is an average across the size, climatic, and vegetation categories used in the Pacific Institute analysis.

CII PROCESS WATER SAVINGS

Process savings were handled differently than other conservation measures because of their heterogeneity. For process water savings the Comprehensive Evaluation used cost and

FIGURE 2D2 STATEWIDE PROCESS WATER SAVINGS AND COSTS



water savings data from Pacific Institute *Waste Not, Want Not* to construct a statewide process water savings cost curve. Total savings potential for each process was allocated to hydrologic regions in proportion to its share of statewide CII accounts. This resulted in process water savings cost curves for each region. These cost curves were then combined with regional marginal water supply costs to determine the amount of locally cost-effective process water savings. The Comprehensive Evaluation assumed process water savings were shared 50/50 between the water supplier and the customer. Hence, the water supplier cost was half the total cost reported by Pacific Institute.

A range of process water uses are embedded in the process water savings cost curves. These include dairy plant water filtration, textile dye-bath reuse, refinery cooling towers, refinery low-pressure boilers, x-ray processors, meat processing, commercial laundries, and produce processing and packing. Figure 2D2 shows the utility cost per acre-foot for different levels of statewide process water savings.

APPENDIX 2E:

CONSERVATION MEASURE SAVINGS POTENTIAL

Water savings potential for non-BMP devices and BMPs with quantifiable coverage requirements is controlled by the device count data and regional coverage requirements. Water savings cannot exceed these implied limits in the models. Some measures, however, are not controlled by device counts or coverage requirements. These measures are CII process water savings, landscape savings other than BMP 5, and BMP 3 system water audits and leak detection. This appendix discusses the derivation of savings potential for these measures.

CII PROCESS WATER SAVINGS POTENTIAL

The Comprehensive Evaluation used statewide estimates of savings potential for various CII water processes from Pacific Institute *Waste Not, Want Not*. This report identified just under 100,000 acre-feet of potential process water savings. This total was distributed to hydrologic regions in proportion to their share of CII accounts.

LANDSCAPE OTHER THAN BMP 5

Total landscape savings potential was taken from Pacific Institute *Waste Not, Want Not* report. This report estimated a total of 478,000 acre-feet of savings potential in 2000 from landscape measures, of which 291,000 acre-feet was attributable to irrigation system upgrades and better scheduling and 187,000 was due to changes in landscape design and end user preferences. The Comprehensive Evaluation evaluated only the savings potential associated with irrigation system upgrades and better scheduling. Total savings potential from equipment and scheduling improvements was distributed to hydrologic regions in proportion to their share of CII accounts and then increased over the forecast period by the population growth rate for each region. Estimated water savings from BMP 5 implementation was then deducted from the total to estimate the remaining potential after accounting for BMP 5 activity.

BMP 3—SYSTEM WATER AUDITS AND LEAK DETECTION

Savings potential is based on the BMP 3 coverage requirement that agencies undertake a full-scale audit whenever unaccounted losses exceed 10% of water into the system. The Comprehensive Evaluation relied on water system data from Department of Water Resources Production Survey to estimate the percent of water production coming from water systems with losses exceeding 10%. This data was also used to estimate the amount of water that would be saved if losses from these systems did not exceed 10%. These losses were estimated to be 166,000 acre-feet in 2000. This total was distributed to hydrologic regions in proportion to population and then increased over the forecast period by the population growth rate for each region. An obvious limitation to the regional allocation approach is the implicit assumption that average system losses do not vary by region.

APPENDIX 2F:
REGIONAL AND STATEWIDE MARGINAL COSTS

TABLE 2F1 REGIONAL MARGINAL WATER SUPPLY COSTS

Hydrologic Region	2005	2010	2020	2030
Central Coast	$148	$156	$511	$634
Colorado River	$232	$269	$361	$485
North Coast	$232	$269	$361	$485
North Lahontan	$232	$269	$361	$485
Sacramento River	$41	$42	$44	$189
San Francisco Bay	$308	$439	$583	$671
San Joaquin River	$137	$141	$151	$161
South Coast	$643	$697	$696	$743
South Lahontan	$276	$282	$296	$311
Tulare Lake	$130	$134	$140	$147

Source: Based on Sample of Water Agencies from Each Region

TABLE 2F2 STATEWIDE MARGINAL WATER SUPPLY COSTS

Hydrologic Region	2005	2010	2020	2030
San Francisco Bay	$427	$427	$511	$634
South Coast	$445	$510	$617	$963
All Other Regions	$213	$286	$385	$517

Source: Based on Sample of Water Agencies from Each Region

Regional marginal water supply costs are based on a representative sample of water agencies from each hydrologic region. Marginal water supply costs include avoided costs of transport, treatment, and distribution and are from the perspective of a retail water supplier. Marginal supply costs used by the Comprehensive Evaluation are averages for large regions and therefore may mask important intraregional cost differences.

Projections of regional marginal supply costs were made for each year of the forecast. Table 2F1 shows regional marginal supply costs for the years 2005, 2010, 2020, and 2030 for each hydrologic region. This table shows the relative magnitudes and rates of growth in water supply cost across regions.

For each measure in each region, the present value of the CALFED benefit was computed based on the statewide marginal water supply costs. Data was not available to estimate these costs for each region, but data was available for South Coast and San Francisco Bay, the two most populous regions. For the San Francisco Bay and South Coast regions, these marginal costs were based on updates of the *Economic Evaluation of Water Management Alternatives* (EEWMA) report published by CALFED in 1999. The EEWMA analysis identified the sources of water supply available to each region, along with their magnitudes and costs. The points of intersection between these supply curves and projected demand curves for each region at 5-year intervals determine the marginal costs of supply. Table 2F2 shows the statewide marginal costs for South Coast and San Francisco Bay. For other hydrologic regions, the statewide marginal cost was set to the median price paid for water conservation savings by CALFED for the period 2001-2003 and then annually escalated by the average rate of increase for Bay Area and south Coast statewide marginal costs.

APPENDIX 2G:
YEAR 2000 APPLIED WATER USE

TABLE 2G1 YEAR 2000 TOTAL URBAN APPLIED WATER USE BY REGION AND SECTOR (1,000 AF)

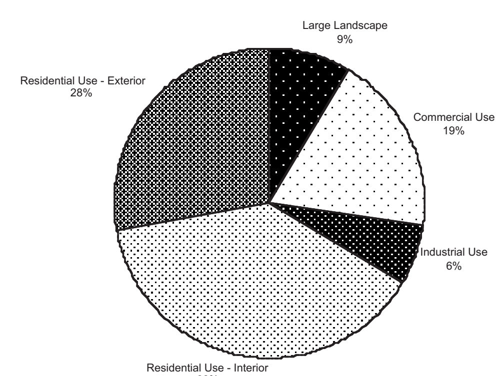
Region	Large Landscape	Commercial	Industrial	Residential Interior	Residential Exterior	Total
Central Coast	12	53	21	121	70	277
Colorado River	185	79	5	146	87	502
North Coast	13	16	28	44	43	143
North Lahontan	3	10	13	9	6	41
Sacramento River	114	147	79	217	300	856
San Francisco Bay	92	224	56	317	354	1,043
San Joaquin River	35	38	63	193	237	566
South Coast	236	928	211	1,812	894	4,081
South Lahontan	6	18	5	121	85	234
Tulare Lake	19	45	64	249	261	638
State	713	1,558	544	3,230	2,337	8,382

TABLE 2G2 YEAR 2000 PER CAPITA URBAN APPLIED WATER USE BY REGION AND SECTOR (GPCD)

Region	Large Landscape	Commercial	Industrial	Residential Interior	Residential Exterior	Total
Central Coast	7	32	13	74	43	170
Colorado River	271	116	7	215	128	738
North Coast	18	22	38	61	60	199
North Lahontan	25	91	114	84	58	371
Sacramento River	39	50	27	75	103	295
San Francisco Bay	13	33	8	46	52	153
San Joaquin River	18	19	32	99	121	288
South Coast	12	45	10	89	44	200
South Lahontan	7	22	6	150	105	290
Tulare Lake	9	21	30	118	124	302
State	19	41	14	85	61	220

DWR supplied Year 2000 applied water use by hydrologic region data to construct the baseline applied water use projection. Table 2G1 shows Year 2000 total applied water use by sector while Table 2G2 shows per capita applied water use by sector. Figure 2F1 shows statewide the proportion of applied water use by major water use sector. The reader should note that some of the per capita applied water use estimates are outside the expected range, which may indicate errors in the data. This is especially true with respect to per capita residential water use for the Colorado River hydrologic region. At the time this report was written, DWR was still finalizing its applied water use estimates and the final estimates may differ from the ones presented here.

FIGURE 2F1 STATEWIDE URBAN APPLIED WATER BY MAJOR WATER USE CATEGORY (2000)



VOLUME 3: RECYCLING & DESALINATION

LOOK-BACK: IMPLEMENTATION RESULTS

PURPOSE OF URBAN WATER RECYCLING & DESALINATION

The CALFED Record of Decision (ROD) intended the Water Use Efficiency Program (WUE) to accelerate implementation of cost-effective actions to conserve and recycle water throughout the state. The ROD cited two primary reasons for giving near-term emphasis to WUE investments. The first was WUE's potential to "yield real water supply benefits to urban and agricultural users in the short term."[1] The second was WUE's ability to "generate significant benefits in water quality and timing of in-stream flows."[2] While the ROD was careful not to establish specific targets for WUE with respect to water supply benefits, it did identify the range of water savings that WUE could potentially achieve by the end of Stage 1.[3] These estimates were divided between urban water savings, agricultural water savings, and recycled water, as follows:

- 520–680,000 acre-feet in the Urban Sector
- 260–350,000 acre-feet in the Agricultural Sector
- 225–310,000 acre-feet in water reclamation (urban water recycling) projects

The ROD did not subdivide these estimates into water supply and in-stream flow potential, but it did note the "substantial contribution that water use efficiency investments can make to other CALFED program goals."[4] Moreover, the ROD called for the implementation of several WUE initiatives, such as agricultural quantifiable objectives and state and federal financial assistance programs, intended to generate both water supply and in-stream flow benefits statewide.

The ROD proposed an unprecedented level of state, federal, and local funding of WUE through Stage 1. The ROD estimated that achieving the water savings potentials cited above "would require an investment by State and Federal governments in the range of $1.5–2 billion over the seven years of Stage 1."[5] During the first four years of the program, the ROD proposed state and federal expenditures of $500 million, for agricultural and urban conservation and recycling grants and loans, and an additional $500 million coming from local matching funds.[6] It labeled the proposed program scope and level of investment as "aggressive and unprecedented nationally."[7]

The ROD did not call for a desalination component of the WUE program. No funding or performance ranges were specified. In addition to the institutional connections between recycling and desalination, the latter was added to the effort due to the fact that both use similar technologies to produce new water from unusable sources (wastewater, brackish groundwater, seawater, agricultural drainage, and other impaired waters). Furthermore, both efforts require considerable infrastructure for operation and distribution.

1. ROD, pg. 59.
2. Ibid.
3. The ROD estimates include only water that would have otherwise been lost to evaporation or an unusable sink, such as the ocean.
4. ROD, pg. 59.
5. ROD, pg. 63-64.
6. Ibid.
7. ROD, pg. 64.

TABLE 4.1 EXISTING USES AND VOLUMES OF RECYCLED WATER AS REPORTED IN THE 2002 STATE WATER RESOURCES CONTROL BOARD SURVEY

Type of Reuse	Volume acre-feet/year
Agricultural Irrigation	240,951
Landscape Irrigation	111,100
Industrial Use	27,857
Groundwater Recharge	49,033
Seawater Barrier	25,651
Recreational Impoundment	33,103
Wildlife Habitat	20,200
Geysers and Energy Production	2,198
Other and Mixed Use	35,664
Total	**544,979**

THE ROLE OF RECYCLING IN THE ROD

Recycling actions in the ROD are primarily intended to help address the growing mismatch between water supply and demand caused by rapidly growing urban populations and static supplies. The ROD viewed WUE investment in recycling as a cost-effective way to better balance supply and demand in the near-term, especially compared to surface storage and major conveyance improvements that the ROD estimated would take at least 5–10 years to complete.[8] Recycling is seen as a way to address growing urban water demands and simultaneously reduce pressure on Delta resources caused, in part, by these demands.

Using recycling to relieve pressure on Delta resources is not new or unique to the ROD. Much of what the ROD proposed with regard to recycling built upon earlier initiatives. The State Water Resources Control Board (SWRCB) is the state agency with primary responsibility for implementing recycling. Since 1977 the SWRCB has had several grant and loan programs for water reclamation projects that meet the following conditions:

- Beneficial use of wastewaters that otherwise discharge to marine or brackish receiving waters or

8. ROD, pg. 59.

evaporation ponds.
- Reclaimed water to replace or supplement the use of fresh water or better quality water.
- Reclaimed water that will be used to preserve, restore, or enhance in-stream beneficial uses which include, but are not limited to, fish, wildlife, recreation and esthetics associated with any surface water or wetlands.

A 2002 survey of recycling efforts in the State indicates that nearly 550,000 acre-feet of urban wastewater is recycled each year for beneficial uses. Table 4.1 gives the categories of recycled water uses and the statewide volumes.

In 2001 AB 331 was passed requiring the formation of a recycling task force by the Department of Water Resources. This task force was in response to Governor Davis' Advisory Drought Planning Panel Critical Water Shortage Contingency Plan that recommended that, in the interest of implementing the CALFED WUE program as quickly as possible, DWR maximize use of grants rather than capitalization loans, to bring local agencies up to the base level of efficiency contemplated in the ROD. The base level efficiency refers to the implementation of locally cost-effective WUE actions.

THE ROLE OF DESALINATION

Although not a component of the ROD, desalination operates much like recycling in that investments in desalination are seen as a cost-effective way to better balance supply and demand in the near-term, especially compared to surface storage and major conveyance improvements that the ROD estimated would take at least 5–10 years to complete.[9] Desalination is seen as a way to quickly address growing urban water demands and simultaneously reduce pressure on Delta resources caused, in part, by these demands.

In September 2002, AB 2717 was signed into law, directing the DWR to convene a Desalination Task Force to "make recommendations related to potential opportunities for the use of seawater and brackish water desalination." The panel found that the potential for the increased use of desalination in California is significant. The opportunities are great for providing water supply from seawater and brackish water desalination as well as recovering contaminated groundwater. Although most Task Force members estimate that desalination will contribute less than 10% of the total water supply needs in California, this still represents a significant portion of the State's water supply portfolio. Potentially, desalination can provide significant value and numerous benefits including:

- Providing additional water supply to meet existing and projected demands.
- Replacing water lost from other sources and relieving drought conditions.
- Enhancing water reliability and supplying high quality potable water.
- Reducing groundwater overdraft and restoring use of polluted groundwater.
- Replacing water that can be used for river and stream ecosystem restoration.

9. Ibid.

APPROACH

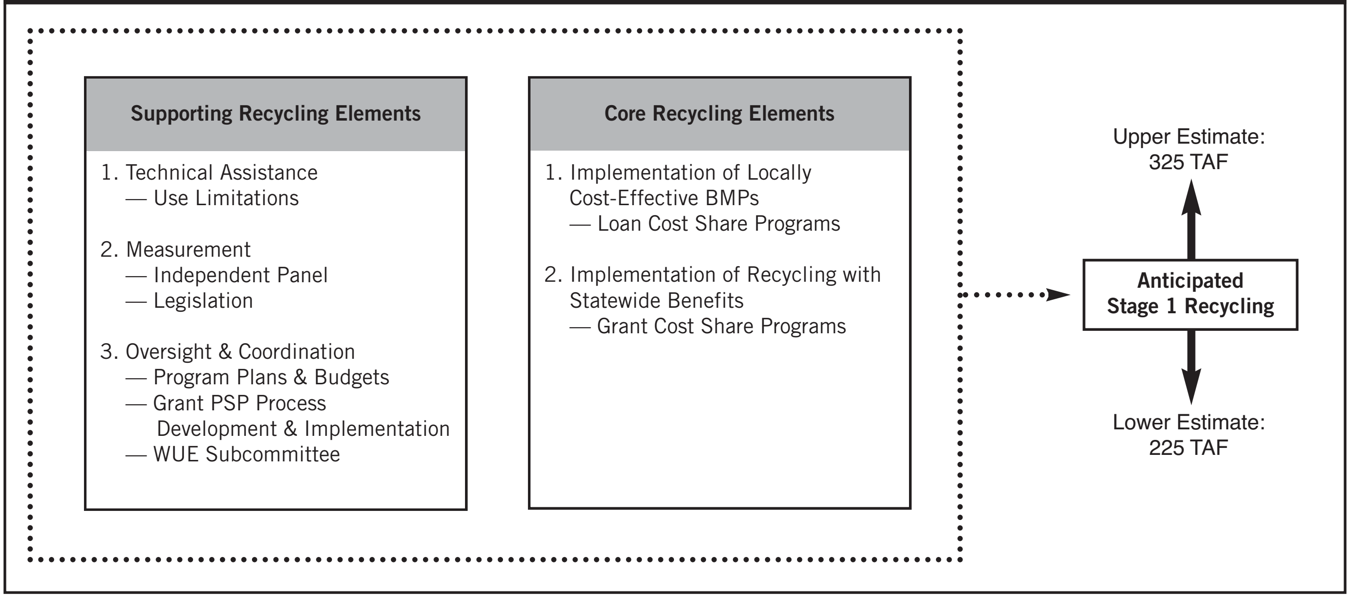
The ROD proposed a two-pronged approach to realize the water savings from recycling for Stage 1.[10] The first was implementation of locally cost-effective practices for urban wastewater suppliers. This base level of implementation is supported by CALFED agencies through low-interest loan programs and technical assistance. The second prong is the use of grants to leverage further local investment in recycling. These grants are to go towards measures that, while not locally cost-effective from the perspective of an individual water supply agency, provided statewide water supply, water quality, and ecosystem restoration benefits. The idea stated in the ROD was that "some water use efficiency measures may not be cost-efficient when viewed solely from a local perspective, but may be cost-effective when viewed from a statewide perspective, compared to other water supply reliability options. In this case, CALFED Agencies anticipate a larger State and Federal assistance share in the form of grants."[11] Access to this grant money, however, was to be made conditional on "agency implementation of the applicable water management plans". In some cases this requirement applies because the local agency preparing the water management plan has authority over water recycling. In other cases this requirement does not apply due to a lack of authority.

In addition to the two core program elements—implementation of locally cost-effective actions supported with loans and implementation of supplemental recycling efforts providing statewide net benefits supported with grants—the ROD identified the need for technical assistance to local water suppliers, the definition of appropriate measurement of water use, and program oversight and coordination.

Technical Assistance—The ROD called for technical assistance to local agencies in part to resolve the limitations of agricultural and urban wastewater. The ROD did not provide guidance on the level of funding; however, the Program Implementation Plan indicated a need of $3.9 million in technical assistance.

10. ROD, pg. 60.
11. Ibid.

FIGURE 4.1 WATER RECYCLING PROGRAM STRUCTURE AS DESCRIBED IN THE ROD



Oversight and Coordination—Oversight and coordination functions for recycling revolve around designing and implementing processes for recycling and desalination loan and grant programs, and coordinating technical assistance efforts between CALFED Agencies and developing program priorities, plans, and budgets. Most of this work is guided in part by input from the WUE Subcommittee. Per the ROD, the Department of the Interior was to establish this committee as part of the Federal Advisory Committee Act (FACA)-chartered public advisory committee overseeing all of CALFED. The role of the WUE subcommittee is to "advise State and Federal agencies on structure and implementation of assistance programs, and to coordinate Federal, State, regional and local efforts for maximum effectiveness."[12]

All of these related efforts were intended to help the State achieve the Stage 1 recycling potential put forward by the ROD. Figure 4.1 summarizes the structure of the urban WUE program envisioned by the ROD.

SUMMARY OF KEY FINDINGS FOR RECYCLING

A primary aim of the Comprehensive Evaluation is to assess the potential of recycling by reviewing progress over the past four years and projecting potential contributions over the next 20–30 years. Below is a brief synopsis of findings based on the available data:

- Incentive program funding exceeded the ROD estimates (see Figure 4.2).
- Grant-funded project performance information is not readily available for all funding sources. This lack of data prevents any meaningful analysis of the benefits derived from all projects.
- Lack of readily available economic data prevents the establishment of cost information for program development and adaptive management.
- The extent of implementation of locally cost-effective implementation is not known.
- Findings from research activities are not available to improve the assumptions used for adaptive management of the program.
- A lack of performance measures prevents an assessment of technical assistance.
- No formalized oversight is used to track the ROD or Program Implementation Plan.

12. ROD, pg. 62.

LOOK-BACK: STAGE 1 RESULTS

RECYCLING INCENTIVES PROGRAM—LOANS

During the first four years of the CALFED Program the SWRCB continued with the State Revolving Fund. However, this activity is not considered part of the CALFED program and there is no reporting to CALFED on funding or benefits. In addition to the Revolving Fund the SWRCB has an ongoing Water Recycling Fund that began in 1984.

RECYCLING INCENTIVES PROGRAM—GRANTS

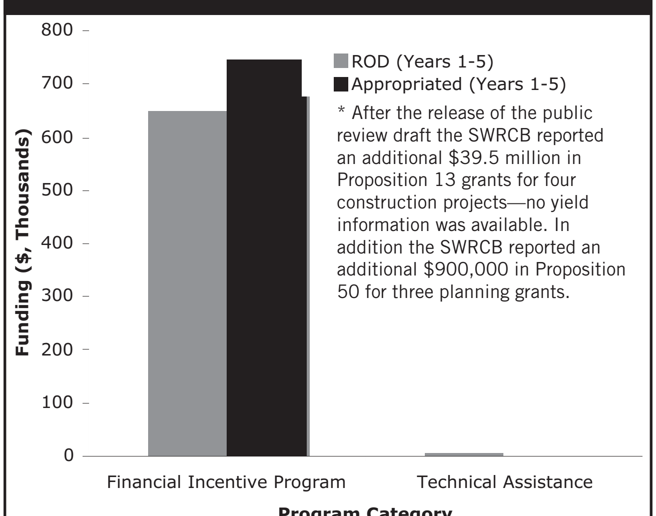
Two recycling grant programs were operated during the first four years of CALFED—one administered by the SWRCB using Propositions 13 and 50 bond funds, and the Federal Title XVI funds administered by the USBR (Table 4.2). It is possible that projects received funding from more than one source. Figure 4.3 shows the anticipated recycling benefits from Proposition 13 grant funds.

RECYCLING ASSISTANCE PROGRAM PERFORMANCE

LOAN AND GRANT PROGRAM

Proposition 13 funds amounted to $61.5 million for 19 projects and Title XVI obligations totaled $97.63 million for 10 projects. Because of the potential overlap between the Proposition 13 and Title XVI projects, the yields are not totaled to avoid double counting. In addition, since 2003 the SWRCB processed $52.9 million of Proposition 50 to fund Category I projects on their competitive project list. There is no information on the potential yield from the Proposition 50 funding. Projects represented in Figure 4.3 represent $58.5 million of Prop 13 funding. There is no benefit information for the remaining $2.99 million of Proposition 13 grants.

FIGURE 4.2 ROD AND APPROPRIATED FUNDING FOR THE RECYCLING PROGRAM ACTIVITIES*



DESALINATION GRANTS

There was one desalination grant funding cycle. This grant program was administered by DWR in 2005 using a competitive proposal solicitation package process. This grant cycle was based on the Desalination Task Force findings, which highlighted the need for applied research and development, feasibility studies, pilot and demonstration projects for brackish water, and seawater desalination.

In March 2005, DWR used Proposition 50 funding to award a total of $25 million in grants to 25 desalination projects (Table 4.3). Projects included construction, feasibility studies, pilot and demonstration studies, and research and development studies. 54% of the funding was for brackish water desalination efforts and 46% for ocean desalination efforts. Yields are estimated at 20,000 acre-feet annually for the three construction grants awarded. No build-out date for the desalination grants is available.

TECHNICAL ASSISTANCE

The SWRCB and DWR provide technical assistance to local and state agencies for recycling and desalination. Assistance is also provided for development of guidelines for regulation, permitting and water quality. The SWRCB and DWR implement the Recycled Water Task Force's and the Desalination Task Force's recommendations and increase public awareness about the safe use of recycling and desalination. In addition both agencies help identify potential recycling and desalination projects.

At the state and federal levels, funding for technical assistance is through ongoing programs and specific bond funds. DWR funds technical assistance for recycling and desalination activities and administers the Proposition 50 desalina-

FIGURE 4.3 DISTRIBUTION OF ANNUAL YIELD FROM THE 19 REPORTED RECYCLING PROJECTS FUNDED THROUGH PROPOSITION 13 GRANTS

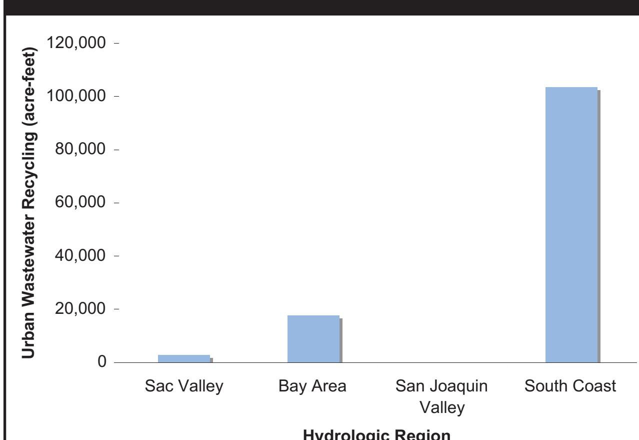


TABLE 4.2 SUMMARY OF RECYCLING PROJECTS WITH COMMITTED PUBLIC FUNDING

Category	Count	Yield in acre-feet[1]	Public Funding	Local	Total
Proposition 13 (Other)[2]	19	123,665	$58,871,000		
Proposition 13 (Implementation projects)	NA		$2,997,000		
Federal Title XVI (Obligations)	10	387,963	$97,635,000	$539,650,000	$637,285,000
Proposition 50[3]	NA	NA	$52,871,000		
Total	**NA**	**NA**	**$212,374,000**	**$539,650,000**	

1. Yield values are all estimated, nothing is verified.
2. Since the public review draft was released the SWRCB has reported an additional $39.5 million in Proposition 13 grants for four construction projects—no yield information was available..
3. Since the public review draft was released the SWRCB has reported an additional $0.9 million in Proposition 50 for three planning grants.

TABLE 4.3 DESALINATION PROJECTS REQUESTED AND FUNDED BY DWR THROUGH PROPOSITION 50 IN 2005

Project Category	Total Applications	Total Cost	Total Requested	Projects Funded	Award Amount	Annual Yield acre-feet/year
Construction	8	$104,359,000	15,000	3	$8,931,000	20,000
Pilot and Demonstration	14	$26,438,000	10,474	6	$7,975,000	
Research and Development	11	$13,804,000	6,005	7	$6,005,000	
Feasibility	9	$4,437,000	2,090	9	$2,090,000	
Total	**42**	**$149,039,000**	**33,569**	**25**	**$25,000,000**	**20,000**

tion grants program. There is no reported technical assistance funding by the SWRCB or Reclamation. The ROD required finance plan called for $3.9 million to provide technical assistance for recycling to date. About $570,000 has been spent on recycling technical assistance and desalination administration. In addition, after the release of the public review draft the SWRCB reported that $2 million was spent on research grants.

LOOK-FORWARD: PROJECTIONS OF WATER SAVINGS

APPROACH AND METHODOLOGY

The approach to the analysis of urban wastewater recycling (recycling) and desalination potential differs from the methods used for agricultural and urban water use efficiency. The general approach is to review existing information, establish a pre-CALFED baseline of recycling and desalination projects and develop a list of future projects. This approach is taken because, unlike the agricultural and urban water use efficiency review efforts, data and information for desalination and urban wastewater is limited.

A baseline of recycling was developed based on the SWRCB's 2001 recycling inventory. This inventory provides a geographic distribution of projects along with the quantities and uses of the recycled water. This analysis does not distinguish between CALFED and non-CALFED. There is little readily available information about the current amount and uses of desalination in California.

Future desalination and recycling potential is determined based on analyzing project inventory obtained from local state and federal agencies. The goal of data collection was to obtain information regarding recently constructed, proposed, and to the extent possible, projected projects. The following steps were taken to prepare desalination and recycling project listings.

1. Collection of existing information from various sources including the SWRCB, the DWR, the Water Reuse Association, the Statewide Recycling and Desalination Task Force and the Statewide Desalination Task Force.
2. Information collected from the various sources was organized in spreadsheets based on geographic location and presented based on source of information.
3. Information "clean up" was done by recycling and desalination stakeholders. This process required stakeholders to review projects in their areas and make appropriate data entry corrections. A workshop was held on August 3, 2004 in Sacramento to explain the review request to recycling and desalination stakeholders.

Below is an overview of each of the steps outlined above.

RECYCLING PROJECT LISTING

The following data sources were used to compile the recycling project listing.

- BARWRP Recycled Water Master Plan 1999
- SCCWRRS Phase II Executive Summary 2002
- SWRCB Revolving Fund Priority List (01/2001)
- Bond Law 2000
- WateReuse Association (WRA) 02-03-2003
- Proposition 13 (2001-2002)
- Federal Title XVI
- Bond Law (DWR APP B)

Project data gathered through the various sources was compiled into a spreadsheet that organized information by geographic location, type and location of project, cost and yield. In addition, there are columns that request further refinement about cost and expected completion date. Using the above information, a list of projects with the following attributes was developed.

Project Agency—Agency or entity proposing the project.

Project Description—Title or name given to the specific proposed project.

County—The county in which the project is located.

Hydrologic Region—Indicates the hydrologic region in which the project is located. The hydrologic regions, as defined by the California DWR, are as follows: North Coast, San Francisco Bay (SF Bay), Central Coast, South Coast, Sacramento River (Sacramento), San Joaquin River (San Joaquin), Tulare Lake, North Lahontan, South Lahontan, and the Colorado River.

Total Capital Cost—Indicates the total capital cost. This includes costs from all funding sources (i.e. grants, local or regional share and loans). Preliminary review of the data indicates that some projects are listed as total project and do not have cost breakdown for capital and operation and maintenance.

Annual O&M Cost—Annual operation and maintenance costs.

Funding Sources—Amount of funding by source: State, Federal, Regional or Local Agency or other.

Build Out Yield—Total project yield in acre-feet per year.

Build Out Year—Year of project completion.

RECYCLING INFORMATION REQUEST

Using the above information, stakeholders were asked to review familiar projects and complete or update the information. In particular stakeholders were asked—to the extent possible—to update any information on yield, cost or implementation timeline. The initial project listing and the review request were presented at a stakeholder workshop on August 3, 2004. Reviewer comments were compiled to develop a final project listing.

DESALINATION PROJECT LISTING

The process used for desalination parallels what was done for recycling. The initial task of data collection and compilation—archived in a spreadsheet—relied on the following sources:

- California Coastal Commission July 2002
- California Coastal Commission August 2003
- California Coastal Commission March 2004
- Metropolitan Water District 2002
- Metropolitan Water District May 2004
- West Basin Municipal Water District
- Western Groundwater Jan/Feb 2003
- California Energy Commission May 2004
- Monterey Bay National Marine Sanctuary May 2004
- Civil Engineering February 2004

Project data gathered through the various sources was compiled into a spreadsheet that organized information by geographic location, type and location of project, cost and yield. In addition, there are columns that request further refinement about cost and expected completion date. Using the above information, a list of projects with the same attributes as those used for the recycling projects was developed.

DESALINATION INFORMATION REQUEST

Using the above information, stakeholders were asked to review familiar projects and complete or update the information. In particular stakeholders were asked—to the extent possible—to update any information on yield, cost or implementation timeline. The initial project listing and the review request were presented at a stakeholder workshop on August 3, 2004. Reviewer comments were compiled to develop a final project listing.

RESULTS

RECYCLING AND DESALINATION PROJECT LISTING

After the August 3, 2004 workshop, copies of the Recycle and Desalination Projects spreadsheets were sent to 26 individuals for updating. Seven responses were received. Responses varied from lists containing four projects for one specific water district to region-wide responses (Bay Area and Southern California) where a single respondent contacted multiple agencies and compiled all the individual comments into one spreadsheet. In some instances agencies forwarded reports from which pertinent project information was extracted. DWR provided a detailed spreadsheet on desalination projects compiled to assist in preparing the California Water Plan Volume 2 (Bul 160-03). The responses received thus far reduced duplications, provided detail to existing project descriptions and provided new project listings for both the recycling and desalination efforts.

The updated recycling list contains 730 potential projects of which 565 projects total yield is more than 3 million acre-feet of yield (Table 4.4). Capital cost estimates are available for 100 projects and total $2.1 billion (year basis not known). The reader is strongly advised to note that this listing represents any project that provided a minimum level of detail. Not all projects were reviewed by stakeholders; therefore, duplication of entries probably still exists. In addition, projects may represent expansion of existing facilities or distribution systems to move the supply to new customers. Another aspect of the list is that recycling projects include wellhead treatment of contaminated groundwater and desalination of brackish groundwater. Because the SWRCB considers desalination and wellhead treatment of polluted groundwater as recycling, no effort was made to reclassify those listings.

Based on the project listing, it is clear that there is substantial recycling potential. However, this potential is a bookend and applies only to the total volume of wastewater that is potentially available for recycling. A simple analysis comparing the Water Plan's 2001 applied urban water estimate (approximately 9.1 million acre-feet) to the listed projects indicates that between existing and proposed projects about 40% (3.62 million acre-feet) of the effluent of applied water is reflected (assuming no duplications, etc.) in the listing. Furthermore, the DWR Water Plan estimates about 54% of urban water is used indoor (4.9 million acre-feet); thus the listed recycling projects approach the applied water volume that can potentially move through wastewater treatment plants.

The Recycled Water Task Force estimates that there is potential for an additional 1.4–1.7 million acre-feet of recycled water use by 2030 beyond what was known in 2002. They estimate that total capital cost will range between $9.2–$11 billion, or $6,400–$6,800 per acre-foot of project capacity (2002). In the finance plan prepared for the CALFED Bay-Delta Program, recycling was projected to add 300,000 acre-feet of capacity by 2014 at a capital cost of $5,000 per acre-foot of project capacity (2004).[12]

12. Comment by SWRCB: "The units for data in this paragraph should be: $6,400 to $6,800 per acre-foot per year, 300,000 acre-feet per year, and $5,000 per acre-foot per year. Capacity of projects is expressed in terms of quantity of water produced per unit of time and the initial capital costs are expressed in terms of dollars per unit of capacity."

TABLE 4.4 RECYCLING PROJECT LISTING, YIELD AND COST INFORMATION

Hydrologic Region	# of Projects	# of Projects with Yield	Yield count (acre-feet/yr)	# of Projects with Cost	Capital Cost
Central Coast	26	22	52,291	3	$65,545,500
Colorado River	1	1	1,000	0	NA
North Coast	19	13	33,028	2	$35,847,084
Sacramento	23	20	90,955	1	$6,300,000
San Joaquin	20	18	101,372	2	$6,700,000
SF Bay	191	137	371,976	21	$555,525,040
South Coast	423	339	2,356,316	65	$1,343,981,410
South Lahontan	17	6	14,850	6	$107,200,000
Tulare Lake	10	9	57,512	0	NA
Total	**730**	**565**	**3,079,300**	**100**	**$2,121,099,034**

A potential funding source for recycling and desalination projects is Chapter 8 of Proposition 50, which contains $380 million in funding capacity for integrated regional water management. It is assumed that these funds are available for both demand management and supply augmentation; however, at this time there is no basis for allocating the funding and therefore no projections of future projects are made.

TABLE 4.5 SUMMARY OF POTENTIAL DESALINATION PROJECTS BY FEED WATER SOURCE

Project Category	Count	Yield (acre-feet)
Seawater	74	468,305
Brackish (surface or groundwater)	63	637,543
Wastewater	19	173,096
Total	**172**	**1,278,738**

DESALINATION

The desalination list contains 172 projects with a proposed yield of 1.27 million acre-feet, as shown in Table 4.5. The reader is strongly advised to note that this listing represents any project that provided a minimum level of detail. Not all projects were reviewed by stakeholders therefore, duplication of entries may still exist. In addition, projects may appear on both the recycling and desalination project listing. The listing includes multiple high-capacity ocean water plants that are capable of fifty to one hundred fifty thousand acre-feet per year. Brackish water plants are typically around 10,000 acre-feet; however, there is one listed for over 100,000 acre-feet with the intended use of replenishing groundwater.

The Water Desalination Task Force identified approximately 170,000 acre-feet of brackish groundwater desalinated annually and that, over the next decade, additional facilities could generate another 290,000 acre-feet annually. For seawater and estuarine desalination, the Task Force identified 4,600 acre-feet of capacity and that additional facilities currently being planned could generate an additional 240,000 acre-feet annually. The Coastal Commission reports that there are 11 desalination facilities along the Coast with an annual yield of 3,300 acre-feet. These facilities are operated by local agencies, private industry and the federal government.

A potential funding source for recycling and desalination projects is Chapter 8 of Proposition 50, which contains $380 million in funding capacity for integrated regional water man-

STAKEHOLDER COMMENT SUMMARY

BACKGROUND

The materials included in this final Comprehensive Evaluation were developed with the ongoing involvement of and comment by diverse stakeholder groups.

The Comprehensive Evaluation, begun in the summer of 2003, was conducted primarily by California Bay-Delta Authority (Authority) staff and consultants. However, recognizing the sensitivity and complexity of the Comprehensive Evaluation and the need for extensive input, the team coordinated with staff from the Department of Water Resources (DWR), the US Bureau of Reclamation (USBR), the State Water Resources Control Board (SWRCB) and the Natural Resources Conservation Service (NRCS). The team also coordinated with CALFED Agency staff to ensure data generated through the Comprehensive Evaluation was in a format beneficial to ongoing studies such as the California Water Plan Update and the Common Assumptions modeling.

Additionally, from the outset, the effort has elicited the input of both implementing agencies and affected stakeholder communities. Among the specific public outreach efforts undertaken to explain and seek feedback on the proposed approach includes:

WATER USE EFFICIENCY SUBCOMMITTEE MEETINGS

Staff and consultants meet with the WUE Subcommittee on several different occasions to lay out their proposed methodology, seek feedback on critical assumptions and present preliminary look-forward results.

PUBLIC WORKSHOPS

In coordination with the WUE Subcommittee, staff and consultants held general workshops to present and seek feedback on their analytic approach to generating projections for agricultural water use efficiency, urban water use efficiency, recycling, desalination and reduced deficit irrigation (RDI).

Most recently, a public review draft of this document was made available in spring 2006 for stakeholders to review and provide comment. The Program received several written comments in response to the public review draft. Some comments have been incorporated into this final report. Others were considered, but not included. Below is a synopsis of the comments received and the Program's responses. Complete copies of each comment received are attached.

COMMENT SUMMARY

The Program received a total of three written comments: one from the Natural Resources Defense Council (NRDC), one from the California Urban Water Agencies (CUWA) and one from the Pacific Institute. Two of the commentors focused exclusively on the urban elements of the report; the third provided feedback on the agricultural and urban aspects. Several parts of the Comprehensive Evaluation were revised based on the stakeholder comments. These included:

COST ESCALATION FACTOR

The Technical team received comments on the cost-escalation factor both while conducting the analysis and in response to the Public Review Draft. During the development of the report, urban water agencies suggested the cost-escalation factor was too low. In response to the Public Review Draft, Pacific Institute suggested in its comments that the 2% cost escalation factor used in the analysis is too high and results in making conservation seem more expensive as time goes on. In response to this comment, the Technical Team undertook a sensitivity analysis to determine the impact of cost escalation factors varying from 0% to 4%. The results of this analysis are presented in the final report.

INSTITUTIONAL BARRIERS

CUWA requested that the final report emphasize the

State Landscape Task Force's conclusion that State leadership is needed to overcome the significant barriers to realizing the potential for urban landscape water savings. Language has been added regarding the Task Force's conclusion.

Other comments were considered, but no changes were made. Below is a summary of these comments and the Team's rationale for not making further revisions.

FROM CUWA AND NRDC:

BMP IMPLEMENTATION PROGRESS
CUWA suggests that simply looking at BMP reports is not adequate to evaluate the impact of statewide urban water conservation programs and likely misses significant water savings. Moreover, it suggests that the flat water demand in growing urban areas is evidence of effective water conservation. The Technical Team does not recommend revising the report since (1) the report already calls out the potential for savings not being reported to the BMP database; and (2) there is no empirical evidence linking flat water demand in growing urban areas to the results of water conservation (as opposed to other causes such as hydrology, changes in industry, etc.)

MOU CERTIFICATION/RECOMMENDATIONS
CUWA suggests it is necessary to consider an urban water conservation certification process as part of a more comprehensive discussion that explores the full range of barriers that keep the State from achieving a higher level of water savings. The Technical Team believes this comment is beyond the purview of this report and is more appropriately engaged at the policy level.

OVERALL RECOMMENDATIONS
In addition to stating its support for the recommendations, NRDC suggests specific strategies for moving forward. CUWA suggests the recommendations presented in the report be pursued as a package and not singly. The Technical Team believes these comments are beyond the purview of this report and are more appropriately engaged at the policy level.

FROM PACIFIC INSTITUTE:

METHODS AND ASSUMPTIONS UNDERLYING THE COST-EFFECTIVENESS ESTIMATES
Pacific Institute took exception to a number of the methods and assumptions underlying the Technical Team's cost-effectiveness analyses, suggesting these approaches underestimate the potential of water conservation actions and are likely to lead to poor public policy decisions. While the Technical Team appreciates the comments, it does not believe additional revisions to the report are necessary at this time. Below is a fairly detailed explanation of the Team's perspective on Pacific Institute's concerns, as the Team believes a more thorough response is helpful in giving interested readers a deeper understanding of the issues under discussion.

ASSESSMENT OF COST-EFFECTIVENESS FROM A WATER SUPPLIER OR STATEWIDE PERSPECTIVE
Pacific Institute suggests that the analysis does not fully reflect proper measurements of cost-effectiveness as it excludes end-user benefits and other types of social benefits. As they wrote in their comments: "One of the most glaring inadequacies of the draft report is the perspective from which the cost-effectiveness analysis is evaluated. The fundamental CALFED ROD states: "some water use efficiency measures may not be cost-efficient when viewed solely from a local perspective, but may be cost-effective when viewed from a statewide perspective, compared to other water supply reliability options." However, both of these "perspectives"—the local utility or statewide—do not fully reflect proper measurements of cost-effectiveness, as noted in detail below." It also claims the report fails to acknowledge their importance or relevance to cost-effectiveness.

TECHNICAL TEAM RESPONSE
The urban analysis evaluated the cost-effectiveness of conservation measures implemented by water utilities from two perspectives: the local utility perspective and the statewide water supply benefit perspective. The former perspective was used to identify measures that would be locally cost-effective to implement per the terms of the Urban MOU. The latter perspective was used to identify measures that would be eligible for state financial assistance. In addition, the analysis examined water conservation driven by codes and regulations. This modeling approach is consistent with the expected structure of the WUE Program as set forth in the ROD and CALFED Program documents. In order to answer the question: "Is this the correct basis from which to evaluate water savings potential?" it is necessary to recall the purpose of the Comprehensive Review. The purpose was to evaluate the future potential water savings from the CALFED Water Use Efficiency Program, which, as it currently stands, is structured around the MOU, certification, and state financial assistance programs. Underlying these programs were existing and expected efficiency regulations. The urban analysis was set up to simulate the operation of these programs and institutional structures under alternative policy and

financial conditions. The Public Review Draft states this very clearly. At the heart of Pacific Institute's comment is the difference between "positive" and "normative" economic analysis. Positive economic analysis can be described as "what is, what was, and what probably will be" economics. Normative economic analysis, by contrast, focuses on "what ought to be". Both approaches can yield important insights. The Comprehensive Review is much more positive than normative in its approach.

ACCELERATED REPLACEMENT COSTS
FOR SOME EFFICIENCY MEASURES

Pacific Institute claims the urban analysis assumes full accelerated replacement costs for all water efficiency measures, assigns these costs entirely to the act of saving water, and does not account for costs that would have occurred otherwise through new construction, remodeling, or replacement of broken fixtures. This, Pacific Institute says, is conceptually incorrect – "the only cost of conservation is the incremental cost incurred to achieve conservation, not the total capital cost if some of this amount was going to be spent anyway." Its comment goes on to say: "Accelerated replacement is the least desirable and least intelligent way to design a water conservation program. Smarter programs and policies implement measures incrementally so that the economics of the measures will be as attractive as possible…This point should be included explicitly…"

TECHNICAL TEAM RESPONSE

The Technical Team does not agree with this comment. The analysis does, indeed, differentiate between water savings realized through active conservation programs operated by water utilities and water savings realized through the operation of efficiency codes. In the latter case, the analysis captures water savings realized through new construction, remodeling, and replacement and does not count the cost of these savings as an implementation cost. The report makes this clear on page 104. Additionally, based on recent discussions with and communications from stakeholder groups that have reviewed the public review draft, it seems clear to the Team that the report succeeded in communicating the use of efficiency codes to drive natural replacement and lower implementation costs.

MARGINAL COST ASSUMPTIONS

Pacific Institute suggests that the urban analysis relies on an unreasonably low short-run marginal cost of supply to calculate avoided supply cost benefits of conservation. "It is important to recognize that marginal costs are higher over longer time periods, since utilities can avoid or defer other costs if demand reductions are permanent (e.g., labor or capital facilities). Economists refer to marginal costs over long time periods as long-run marginal costs (LRMC). SRMC and LRMC are opposite ends of a spectrum of marginal costs that depend on the time duration of the cost comparison." Relying on short-run marginal costs, Pacific Institute says, results in under-valuing the benefits of conservation.

TECHNICAL TEAM RESPONSE

The Technical Team does not agree with this comment. The regional marginal cost estimates are based on avoidable capital and operating costs for a sample of water agencies from each region. Marginal costs include avoided cost of supply, transport, treatment, and distribution from the perspective of a retail water supplier. Moreover, the estimates of marginal cost are not time-invariant. They increase in real terms over time and are incorporated into the benefit estimates for water savings. Finally, it is not correct to associate retail water service rates with marginal supply costs. Retail water service rates are almost universally based on average system costs and embed within them huge amounts of sunk capital expenditure that is irrelevant to marginal supply cost calculations. The analysis used the best available information to construct reasonable estimates of average regional marginal supply cost. These estimates were developed in consultation with CALFED economists and regional water supply agencies. It is true that marginal costs used in the analysis will be lower than the actual marginal costs for some agencies and higher for others. That is the nature of an average and cannot be avoided.

The CALFED Program invites interested stakeholders to submit additional comments based on this final report.

CALIFORNIA URBAN WATER AGENCIES

June 29, 2006

Mark Roberson
California Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

SUBJECT: Comments on "Public Review Draft, Water Use Efficiency Comprehensive Evaluation, April 2006"

Dear Mr. Roberson:

These are comments on the "Public Review Draft, Water Use Efficiency Comprehensive Evaluation", distributed and discussed at a May 16, 2006 DWR meeting with interested water use efficiency stakeholders. California Urban Water Agencies (CUWA) has been engaged actively in water conservation since the organization was formed 16 years ago. We and our member agencies helped to negotiate the Urban Water Conservation Memorandum of Understanding, and remain solid supporters of this essential water management tool. We understand the delays in getting this draft report out for review, which had initially been planned to be completed by late 2004.

We participated in the dialogue at the May 16 meeting, and these comments supplement the comments we offered at that meeting. Our comments on the draft report are limited to urban water conservation, and do not address the other components of the Water Use Efficiency (WUE) Program. Our detailed comments are organized below by subject. The draft report brings up very important issues of interest to CUWA:

1. Inadequacy of State and Federal funding

2. Inadequate progress by urban water agencies in implementing BMPs

3. The prospect of implementing a BMP certification program

4. Water conservation implementation challenges – CALFED evaluation and support

5. Overall draft recommendations

<u>Inadequacy of State and Federal funding</u>. Although the CALFED Record of Decision (ROD) did not include a specific breakdown among the WUE components (urban and

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Santa Clara Valley Water District
Zone 7 Water Agency
Contra Costa Water District
East Bay Municipal Utility District
Los Angeles Department of Water & Power

agricultural conservation, water reclamation), it did state: "…CALFED Agencies have estimated that achieving the potential water savings above would require an investment by the State and Federal governments in the range of $1.5 to $2 billion over the seven years of Stage 1" (page 63). More detailed guidance is found in the June 2000 "Framework for Action" which formed the policy and program basis for what later ended up in the ROD. That document set forth a total water use efficiency budget for Stage 1 (Appendix A, Page 1) of almost $3 billion, half of which would come from the State and Federal governments and the remainder from "other" – presumably water users funding locally cost-effective measures. The ROD numbers cited above were based on savings resulting from both grant funding and implementation of "…all locally cost-effective conservation measures…."

It is clear by any measure that State and Federal funding for urban water conservation has been far less than assumed by the ROD. We believe this level of support needs to be highlighted even more in the final version of the comprehensive review.

Inadequate progress implementing best management practices. We are disappointed in the performance of the urban water conservation programs reflected in the draft report. This information originated with data and analyses collected and evaluated by the California Urban Water Conservation Council (CUWCC), in which many of our members are active participants. CUWCC staff indicate that performance on the whole regarding compliance with the MOU has not been what was expected. Poor performance in some geographic areas, and with some of the individual BMPs, is documented in both the draft report as well as the most recent annual report from the CUWCC.

However, the complete picture is not presented. As reflected in the draft recommendations (page 4), far more work needs to go into improving data collection for locally funded actions, and to develop and track performance measures. In promoting the greater use of urban water conservation, Bay-Delta Authority (BDA) officials and many others comment about how urban southern California has been able to meet its water needs with little increase in net water use over the past 20 years. For example, Chapter 22, Volume 2 of the 2005 California Water Plan Update includes the following (page 22-1):

> *As has been demonstrated in various regions of the state, an increase in population does not necessarily result in a proportionate increase in urban water use. For example, the Los Angeles Department of Water and Power reports in their Urban Water Management Plan Update 2002 2003 that "water conservation continues to play an important part in keeping the city's water use equivalent to levels seen 20 years ago."*

In addition, the 2003 Bay Area Water Agency Coalition report, *Advancements in Water Conservation*, indicates that "…current water use levels are below pre-drought (mid 1980's) levels, despite a 16.8% population increase." These are remarkable statements indicating the success of conservation programs.

We believe that measuring progress toward meeting the BMPs is a complex subject, and one that requires additional attention and action by the State. There is also significant water savings from conservation programs that are not captured by the BMPs or by agencies that have not signed the MOU. Simply looking at the BMP reports is not nearly adequate to evaluate statewide urban water conservation progress.

Implementing a BMP Certification Program. Certification is addressed in the ROD as a means of gaining access to grant funds: a *quid pro quo*. Certification was pursued several times since the ROD was adopted in 2000 but gained no legislative traction. BDA Executive Director Joe Grindstaff indicated at the June 15 Bay-Delta Authority meeting that the Schwarzenegger Administration may pursue legislation in this area – perhaps certification as originally discussed, or some other performance requirements related to existing BMPs that are linked to access to future State bond funds.

As we address later in our comments, we believe that certification alone is not an answer to achieving higher levels of urban water conservation. This is a complex area that requires a more comprehensive look – both research and dialogue – at the full range of barriers that keep us from achieving a higher level of water savings.

Water conservation implementation challenges – CALFED evaluation and support. At the May 16 stakeholder meeting I stated that one of the ROD commitments was to "…include recommendations on removing any impediments to aggressive program implementation." (ROD, page 64) There are likely many reasons why performance has not been what is expected, and urban water utilities understand that there are implementation challenges. We believe that this is an area that requires a higher policy focus than has occurred up to now. DWR's *2005 Water Plan Update* identifies a range of numbers for the technical potential for future urban water conservation savings. Although the technical potential is high, it is clear *(DWR, 2005 Water Plan Update)* that additional research is needed to examine funding problems and detailed implementation challenges.

CUWA has done initial research in this area and shared our results with the CUWCC, DWR and Bay-Delta Authority. In addition, the State Landscape Task Force's recommendations *(AB 2717 Landscape Task Force Findings, Recommendations & Actions, December 2005)* indicated that there are significant barriers to overcome to realize the potential for urban landscape water savings. Since the technical analyses for the draft report were done before the State Landscape Task Force was convened and developed recommendations, it is clear that something on that subject needs to be added including the Task Force's recommendations for State leadership on key issues. The draft report includes a variety of future scenarios regarding conservation savings -- the same scenarios discussed at a BDPAC Water Use Efficiency Subcommittee meeting in late 2004. We believe these scenarios should reflect issues ranging from assumed local investments to impediments to implementation.

Finally, as I mentioned at the May 16 meeting, page 64 of the CALFED Record of Decision indicates that annual reports on water use efficiency program progress will include: (1) evaluation of availability of local cost-share financing, and (2) recommendations on removing any impediments to aggressive program implementation. The draft WUE program plan that was also presented at the May 16 meeting did not address either of these two subjects, but we appreciate your willingness to showcase this problem in the final program plan.

Draft Recommendations. The draft report makes specific recommendations in each of four areas: (1) program structure / assurances, (2) monitoring performance, (3) financial assistance program, and (4) technical assistance and research. Each of these proposed recommendations is good, although how they will be pursued depends on important details. For example, the recommendation to "…determine whether to implement a process to certify compliance with the urban MOU…" (page 4) invites a full discussion of what would be accomplished – particularly since one of the other recommendations is to do a much better job of monitoring performance. All of the recommendations are interrelated, and it does not make sense for the BDA to pursue single actions – such as certification -- without first having the technical tools in place to evaluate success.

Thank you for the opportunity to provide comments on the draft report. CUWA and our member agencies remain strong supporters of urban water conservation as a key water management tool, and we look forward to activities of the Bay Delta Authority, the California Urban Water Conservation Council, and others that are aimed at getting even greater value from conservation.

Sincerely,

Steve Macaulay
Executive Director

cc:

Mr. Tom Gohring
California Bay-Delta Authority
Water Use Efficiency Program
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

Mr. William J. Bennett, Chief
Office of Water Use Efficiency
Department of Water Resources
P.O. Box 942836
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NATURAL RESOURCES DEFENSE COUNCIL

June 29, 2006

Mr. Mark Roberson
CALFED Bay-Delta Program
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

Dear Mr. Roberson:

On behalf of the Natural Resources Defense Council (NRDC), I would like to commend you on the thorough and illuminating, albeit distressing, Water Use Efficiency Comprehensive Evaluation. The Comprehensive Evaluation presents the most thorough analysis to date of recent water use efficiency (WUE) efforts in California and the likely outcome of our current efforts. The news is dismal. The Comprehensive Evaluation highlights glaring program failures in both the urban and agricultural WUE programs, and clarifies that significant policy changes are critical if we are to achieve even a fraction of the potential benefits from WUE.

Below we discuss what we believe to be the most important of the reports findings and recommendations. While we support every recommendation contained in the Comprehensive Evaluation, we believe that the findings particularly underscore the need to:

- Improve Water Measurement
- Implement Urban Certification
- Adopt Agricultural Assurances
- Establish Performance Measures
- Institute Reporting Requirements
- Conduct Monitoring and Verification

The Comprehensive Evaluation offers compelling evidence that while water use efficiency has tremendous potential to help California meet the water supply needs of a growing population, existing efforts are failing to reach that potential, and key policy changes are needed.

Water Use Efficiency Has Tremendous Potential

The good news, which should not be lost in the dismal performance review, is that the Comprehensive Evaluation confirms that WUE offers extensive untapped resources. The report notes that:

> *Projections strongly support the position that aggressive investment in water use*

efficiency actions can result in significant reductions in applied water use over the next 25 years. Depending on the level of investment and other policies, the analysis projects savings of 1.4 to 3.2 million acre-feet by 2030. (p.1)

The report's review of water recycling activities also represents good news, with near term yield ranging from 387,000 to 513,000 acre-feet, nearly double the low end of Stage 1 estimates. Funding at higher than expected levels greatly contributed to this water recycling success and further illustrates that investments in water efficiency and recycling can yield tremendous benefits. The report notes that projections indicate future water recycling potential of more than 3 million acre-feet.

Existing Efforts are Failing to Reach That Potential

Unfortunately, the Comprehensive Evaluation clearly illustrates that we have not achieved the Stage 1 CALFED goals for WUE, nor are we on track to achieve anywhere near the potential water savings forecast by CALFED and the ROD. The report notes that:

Urban WUE

- Stage 1 urban sector annual savings are expected to range between 101,000 and 150,000 acre-feet. This represents only 20% of the ROD projected savings.
- Had local water suppliers pursued all locally cost effective conservation measures per the ROD, total urban sector savings by the end of Stage 1 could have ranged between 267,000 to 356,000 acre-feet—about two and a half times what is likely to be realized.
- BMP data strongly suggests the MOU process is not working as intended and its impact on urban water use remains well below its full potential.
- For 9 out of the 14 best management practices, more than 50% of water agencies are out of compliance.
- For 4 of the remaining 5 BMPs, more than 30% of water agencies are out of compliance.
- Non-compliance rates are highest for BMPs that are expected to produce the most water savings.

Agricultural WUE

- Only 3% of the in-stream flow and timing (ecosystem restoration) benefits identified in the agricultural WUE program are expected through grant funded activities.
- Only 3% of the water quantity (water supply reliability) benefits identified in the agricultural WUE program are expected though grant funded activity.
- Even these minimal benefits have not been verified.

Existing Policies are Inadequate

Inadequate funding, lack of programmatic assurances, and insufficient local efforts have all contributed to the failure to reach the WUE goals. Additionally, lack of program monitoring and verification, local reporting and inadequate baseline data makes it difficult to assess progress.

The Comprehensive Evaluation identifies the following key shortcomings:

- Overall, the data show that most Urban MOU signatories do not voluntarily comply with the Urban MOU process. Few submit exemptions for the Best Management Practices (BMPs) they are not implementing and few are complying with most of the BMPs.

- Although agencies and stakeholders proposed a consensus approach to urban certification, to date these ROD provisions have not been implemented.

- Realization of agricultural WUE potential depends on locals implementing cost-effective actions. However there is no comprehensive reporting of water conservation benefits available from state or federal water management plans and, therefore, the extent of non-CALFED-funded WUE is not known.

- There are no centralized data repositories to assess progress at the farm level.

- There is no mechanism within the grant process to verify that applicant-claimed benefits are realized.

- There is insufficient linkage between grant funding decisions and water suppliers' implementation of locally cost-effective actions.

Recommendations

NRDC supports every recommendation described in the Comprehensive Evaluation report. We believe all of the recommendations are necessary to assure implementation of cost-effective water use efficiency measures. We wish to offer comments and suggestions on six of the recommendations to which we would give highest priority.

<u>1. Improve Water Measurement</u>
Water resource management in California is handicapped by inadequate, incomplete and potentially inaccurate information about water use. Particularly in agriculture, the State doesn't know to any accurate degree how much water is being used and where.
Draft legislation crafted by CALFED would help address those shortcomings by creating a water use database and a system for reporting water deliveries and diversions. The state should support introduction and passage of this legislation. Additionally, DWR should

begin immediately to implement administrative actions identified by CALFED, including measuring crop water use consumption via remote sensing and better assessment of net groundwater usage.

2. Implement Urban Certification

It has been almost 15 years since the development of the Urban Memorandum of Understanding Regarding Urban Water Conservation in California (MOU) laying out urban water conservation Best Management Practices (BMPs). As discussed above, the Comprehensive Evaluation clearly finds that the current voluntary process is not working. The report recommendation is to "decide whether to implement a process to certify compliance with the MOU." NRDC strongly believes that a certification program is necessary.

The establishment of a certification program was specified in the federal Record of Decision (ROD) on the CALFED Bay-Delta Program, yet some urban agencies have resisted the implementation of a certification program until they receive a water supply quid pro quo. While we believe that water users have, in fact, achieved water supply benefits from the CALFED program, compliance with the BMPs, which can only be verified through a certification program, should not be contingent upon any particular CALFED result. The major urban water agencies in California agreed, as an outgrowth of the State Water Board hearings in1992, to implement water conservation BMPs as a means to forestall more stringent requirements that the State Board was considering. Fifteen years later, it is time to assure that they will live up those commitments: an urban certification program, which has been under development for almost 10 years, is long overdue.

3. Adopt Agricultural Assurances

Paralleling the need for an urban certification program is the need for an assurances package for the Agricultural Water Use Efficiency program. NRDC participated extensively in the development of the Quantified Objective (QO) approach, a two-year process that included unprecedented stakeholder commitment and participation on this issue. We continue to believe that the QO approach offers the best prospect for creating clear performance standards and determination of compliance, and thus the best opportunity to a) achieve real environmental benefits b) reduce conflicts between agricultural water users and the environmental community over what comprises adequate conservation efforts by the agricultural community, and c) craft a transparent assurances package.

Our willingness to support a departure from the QO approach was contingent upon development and adoption of an acceptable assurances package tied to DWR's proposed alternative approach focusing on the more general targeted benefits. While several meetings were held on this subject, we do not believe that an appropriate assurances package has been developed. The targeted benefits approach may offer DWR some guidance in directing grant funding; however, it does not provide any performance standard, or consequences for non-compliance. We urge DWR to establish performance standards for the agricultural water use efficiency program, including consequences for

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failure to meet those standards. If this cannot be done with a targeted benefits approach, then we urge DWR to return to the carefully crafted Quantified Objective approach.

4. Establish Performance Measures

The Comprehensive Evaluation notes that "The WUE program has yet to articulate a comprehensive set of performance measures that it will use to evaluate program performance and determine whether the program is meeting stated objectives…. These measures should address water savings, cost-effectiveness, and supply reliability, water quality, and ecosystem benefits derived from WUE investments." (p.21) We concur.

5. Institute Reporting Requirements

We offer two suggestions to improve baseline data as well as data on locally funded actions. First, we believe that the agricultural planning requirements contained in SB 1640 (Kuehl), currently pending in the California Senate, should be applied to all agricultural districts above 2,000 acres, consistent with CVP planning requirements. SB 1640 establishes agricultural water management planning requirements and asks DWR to establish the appropriate size threshold to at which to apply these planning requirements. The gross inadequacy of existing information about water use and conservation suggests that these plans would be a tremendous asset.

Second, we believe that future public funding for the Agricultural Water Management Council (AWMC), which is supposed to play a role similar to the CUWCC, should be contingent upon the AWMC maintaining an accessible reporting database comparable to the CUWCC BMP reporting database.

6. Conduct Monitoring and Verification

We strongly agree with the report's finding that data gaps and limited program assessment greatly handicap effective program implementation. The WUE grant program must be revised to more closely monitor and verify results. This will allow quantification of water savings and better evaluation of water use efficiency program performance. We are pleased to see an increased commitment to monitoring and assessment in DWR's recent program plan and hope to see that reflected in the next Proposal Solicitation Package for Prop. 50 funds.

Data Gaps

We recognize that there are many gaps in the available data, and that some stakeholders may therefore criticize some of the numbers in the Comprehensive Evaluation. However, the Evaluation does an excellent job in pointing out that the failure to collect baseline data, or to monitor and verify project savings, are among the key shortcomings of the WUE program and related efforts. Indeed the report notes that the Comprehensive Evaluation was greatly hampered by the lack of data related to locally cost-effective agricultural water use efficiency actions."(p.21) Hopefully, those who criticize any weakness in the Evaluation's numbers will strongly support passage of the draft CALFED water measurement legislation, as well as meaningful agricultural water management planning and reporting requirements.

Conclusion

It is difficult to give an honest self-appraisal. The Comprehensive Evaluation takes an unflinching look at the WUE program record and presents reasonable recommendations to improve the situation. It should be required reading for everyone interested in promoting efficient use of California's water resources.

Thank you for considering our comments. We look forward to working with you and the implementing agencies to address the shortcomings in the WUE program and to help achieve the great potential for water use efficiency in California.

Sincerely,

Ronnie Cohen
Senior Policy Analyst

PACIFIC INSTITUTE

Research for People and the Planet

Pacific Institute Comments on the

PUBLIC REVIEW DRAFT of the Water Use Efficiency Element of the Comprehensive Evaluation CALFED Bay-Delta Program Dated April 2006

June 27, 2006

We appreciate the opportunity to provide comments on the CALFED Water Use Efficiency Element of the Comprehensive Evaluation draft report (dated April 2006). We can see that a tremendous amount of effort has gone into this analysis and it adds important and vital information on the critical issue of water conservation and efficiency.

Unfortunately, there are some important unresolved problems associated with the methods and assumptions used to evaluate the cost-effectiveness of water conservation and efficiency programs that lead to grossly inflated estimates of the costs of efficiency improvements. These inflated estimates are likely to lead to two bad outcomes: a misunderstanding on the part of policy makers and the public about the benefits and costs of reducing water waste, and inadequate efforts to capture wasted water by agencies, governments, corporations, and individuals.

One of the most glaring inadequacies of the draft report is the perspective from which the cost-effectiveness analysis is evaluated. The fundamental CalFed ROD states: "some water use efficiency measures may not be cost-efficient when viewed solely from a local perspective, but may be cost-effective when viewed from a statewide perspective, compared to other water supply reliability options." However, both of these "perspectives" – the local utility or statewide – do not fully reflect proper measurements of cost-effectiveness, as noted in detail below. All perspectives are not equally valid, as is assumed in the draft report.

This flaw can be seen on page 105 of the draft report, when conservation measures are "assumed to be implemented only if" they are determined to be (among other things) "locally cost-effective from ***the water supplier perspective***." (Italics added.) Using this perspective leads to a logically consistent but fundamentally flawed analysis, in large part because (as CalFed notes on page 130) it "excludes end user co-benefits, such as energy savings, and other types of social benefit, such as reduced water pollution." These are real and large benefits of water efficiency improvements and excluding them artificially inflates net costs, and reduces their apparent cost-effectiveness. The argument supporting the use of this inappropriate perspective is that it "provides a consistent accounting stance that mimics the way most water supply agencies evaluate water conservation investments" (page 130). While this may be true, it is wrong to adopt this approach. In addition, other problems with the draft report are associated with assumptions made in the calculation of the water conservation potential and the cost of efficiency improvements.

Below we address some specific problems with the draft report:

CalFed Inappropriately Includes a Cost "Escalation" Factor of 2% per Year.

On page 110 of the draft report, a "cost escalation" factor assumption is described: "Costs of conservation measures are assumed to increase at a real rate of 2% per year. Annual cost escalation was used as a proxy for diminishing returns to investment as more and more of the technical potential of a measure was realized." The effect of this assumption is to make conservation more expensive as time goes on, when in fact, for many efficiency technologies, costs drop dramatically over time. Figure 1 shows how the price of refrigerators has dropped as energy efficiency standards and improvements have been implemented. Over the past 25 years, the real price of refrigerators has dropped more than 50%, while average energy use has dropped 75% -- a huge improvement in energy efficiency. Not only has the cost of refrigerators not increased 2% per year, but these costs have plummeted, making energy efficiency a better and better investment. The same curves can be expected for almost all water-efficient appliances.

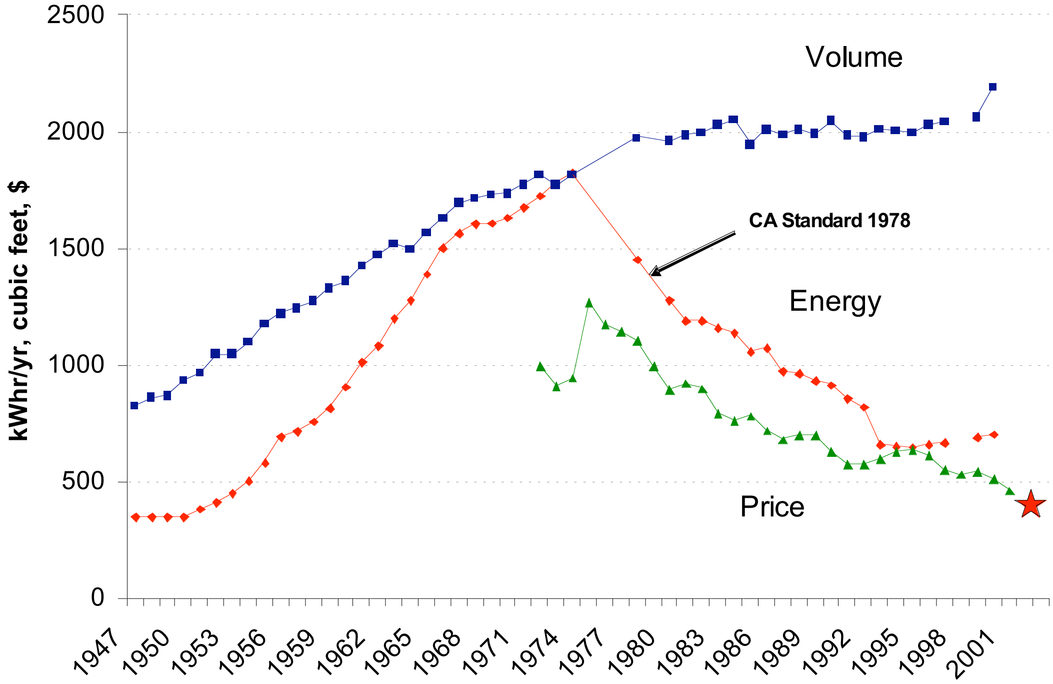

Figure 1. The volume (blue), energy use (red) and real price (green) of refrigerators available in California. As this shows, real prices have plummeted along with total energy use. This is the complete opposite of the assumptions made by CalFed for cost escalations of water efficiency appliances and investments. Data from Rosenfeld (2006).

CalFed Incorrectly Assumes Accelerated Replacement Costs for Some Efficiency Measures

The CalFed water efficiency estimates incorrectly assume full accelerated replacement costs for all water efficiency measures. That is, all measures are assumed to be installed only to save water, with no credit for expenses that would have occurred otherwise, e.g., in new construction or retrofits motivated by remodeling. This is conceptually incorrect -- the only cost of conservation is the incremental cost incurred to achieve conservation, not the total capital cost if some of this amount was going to be spent anyway. [Of course if action was not going to take place anyway, the entire capital cost is the incremental cost, as assumed.]

Accelerated replacement is the least desirable and least intelligent way to design a water conservation program. Smarter programs and policies implement measures incrementally so that the economics of the measures will be as attractive as possible. Examples of such programs or policies include appliance standards and code requirements for new construction or remodeling building permits. This point should be included explicitly, and costs recomputed to reflect the intelligent, low-cost implementation approaches that conservation managers adopt most of the time, rather than unintelligent, high-cost implementation approaches that are rarely adopted.

Problems with the Margin Cost Assumptions[1]

The marginal costs cited from the CalFed report reflect costs that can be avoided by water utilities in the very short term: what economists call short-run marginal costs (SRMC). For example, delivering one less unit of water will reduce raw water purchase needs and electric and chemical use that same day or within a few weeks. It is important to recognize that marginal costs are higher over longer time periods, since utilities can avoid or defer other costs if demand reductions are permanent (e.g., labor or capital facilities). Economists refer to marginal costs over long time periods as long-run marginal costs (LRMC). SRMC and LRMC are opposite ends of a spectrum of marginal costs that depend on the time duration of the cost comparison. And more than one marginal cost may be relevant for specific time durations (e.g., 10 years); for example, 10-year marginal operating costs and 10-year marginal capital costs may both be relevant for decision making.

Longer-run marginal costs can be much higher than $200-$300 per AF. Although costs and rates need not be aligned, suppose for discussion purposes that volumetric rates paid by customers reflect marginal costs of supply. Many commercial, industrial, institutional (CII) and residential customers pay volumetric rates of $600 per AF or more.[2] If these rates represent the appropriate LRMC of additional supplies, all CII conservation measures with costs less than $600 per AF would be cost effective.

Further, because volumetric prices are often based on average costs calculated by blending the cost of more expensive new supplies with the less-expensive cost of older supplies, the appropriate cost-effectiveness threshold may be far higher than $600 per AF. For example, long-run marginal costs in areas where new projects like seawater desalination are being considered can range from $1,000 per acre-foot to over $1,300 per acre-foot.

CalFed Uses an Inappropriate Cost-Effectiveness "Perspective"

CalFed chooses to do the cost-effectiveness analysis from the perspective of the water utility alone, and remarks on this only in passing, as though the choice is unimportant. In fact, it is critical to the conclusions. When the cost of conserved water is computed from the perspective of utility customers as a group, assuming the utility must be kept whole financially, a completely different conclusion results. This involves including the investment required of the customer and any changes in operations and maintenance costs they would experience from the investment (excluding water bill payments), and then

[1] Much of this discussion comes from Gleick et al. 2003 (Waste Not, Want Not: The Potential for Urban Water Conservation. Pacific Institute, Oakland), where a far more comprehensive discussion and analysis of the cost-effectiveness of urban conservation measures are available. The approach taken in Chapter 5 of that analysis is a more appropriate way of evaluating water-use efficiency economics.

[2] Unfortunately, most survey data for water rates in California do not separately identify volumetric and fixed charges. But the data suggest that many urban water systems in California currently have volumetric charges ranging from $1.50 to $2.00 per ccf, equivalent to $650 to $870 per acre-foot. ($1 per ccf equals $435/AF.)

comparing the cost of conserved water with the appropriate economic criteria, such as the short-run or long-run marginal costs described above.

This approach addresses both costs and benefits to the water supplier – which are eventually passed on to customers – as well as costs and benefits customers experience apart from what they pay for water service. Costs and benefits to the water supplier can and should be accounted for in program evaluation and design because the supplier needs to be kept whole financially. But a program that is not cost-effective from the supplier perspective may be desirable for utility customers as a group. In that case, the lack of cost-effectiveness from the supplier perspective is merely an implementation obstacle. Assessing benefits and costs for customers as a group, including energy and other "co-benefits" shows that the real cost of water-conservation measures is often much lower than it appears to be when evaluated using the narrow approach taken by CalFed.

The use of the customer perspective in cost-effectiveness analysis, with the caveat that the utility must be kept whole financially, is based on methods developed in the field of energy economics. The energy approach determines the cost of conserving energy without a change in level of service experienced by the user of energy (see, for example, the work of Koomey (LBL) and the CPUC).[3] Gleick et al. (2003) found that this approach produces significant cost-effective savings, even excluding difficult-to-quantify cost factors, which would make estimates of the cost of conserved water even more favorable. These include the following:

- The niche market status for many water-efficient products leads to mark-ups, limited product selection, slow product innovation, and unrealized economies of scale. While the current premium market prices for most water-efficient products may disappear over time through normal market transformations (standardization of products, larger-scale production, etc.), an analysis using current retail prices taken from major national retailers and consumer evaluations still shows large savings. Los Angeles' experience with toilet retrofits demonstrates that additional savings can be achieved though high-volume, wholesale purchases of water-saving devices by water suppliers. CalFed ignores these factors.

- Significant savings result just by including avoided water-heating costs for indoor conservation and avoided labor, fertilizer, and green-waste disposal costs for outdoor conservation. Other co-benefits, such as lower soap and detergent costs for clothes- and dishwashers and lower gasoline or electric costs for mowing and trimming, were excluded from Gleick et al. (2003), but would have increased the cost-effectiveness of options that produce these benefits. Note that energy costs have increased

[3] Koomey et al. 1995, "The effect of efficiency standards on water use and water heating energy use in the U.S.: A detailed end-use treatment." Energy, Vol. 20, No. 7, pp. 627, and California Public Utilities Commission, 2001, "California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects."

dramatically[4] since Gleick et al. (2003) was released, greatly increasing the amount of water conservation that is cost-effective.

- There are significant differences regionally in the cost of energy, and energy costs are rising, making energy savings even more important. Some homeowners (especially those in the Sierra Nevada or other remote terrain) use more-expensive electricity for water heating. Their “co-benefits” are especially large.

- Indoor residential water conservation will reduce wastewater treatment costs. These savings will accrue directly to the local wastewater treatment and sewer system agencies that are responsible for building and operating sanitation infrastructure, and might be passed on to ratepayers who use the infrastructure. These savings can be in the range of $15 to $150 per acre-foot or even higher.

- The avoided costs from reduced or deferred water, wastewater, or energy infrastructure investments are not included in this CalFed analysis.[5] Utility rebate programs are often used to “communicate” these costs to customers.

- Unlike new water from surface sources, the cost of the conserved water will stay the same for the life of the conservation device. This provides a cost-of-service reliability benefit whose value can be estimated, and is often quite significant. This is neglected in the CalFed study. We comment above on the inappropriate use of a 2% per year cost escalation factor for the conservation investment.

- Conserved water will cost less per acre-foot if the device actually lasts longer than the estimated lifetimes used here, and we believe some of the lifetimes used are conservative.

Table 1 shows our estimates, from Gleick et al. (2003) of the costs per acre-foot of a few commercial water-efficiency improvements, including appropriate co-benefits. As shown here, these costs are far below the costs in the CalFed report, and often negative, which means that even if the cost of water to consumers was zero, there would be substantial economic benefits to consumers from implementing these savings.

Lower “external” environmental costs, which can offset some of the financial costs of water conservation, have also been excluded from the analysis. These include environmental damages arising from freshwater withdrawals from natural systems and damages from sewage discharges to rivers, lakes, or bays, among other possible effects. The net result of accounting for these non-financial, but economically relevant, costs would be to further decrease the cost of conserved water.

[4] For example, natural gas for residential customers was assumed to cost about $0.70 per therm in Gleick et al. (2003), but now costs more than $1.10 per therm.
[5] It is possible that some avoided water infrastructure costs are included in the CalFed analysis. But if so, they and the method, sources of data, and date should be presented.

When the cost of conserved water from a specific measure is less than the cost of water supply displaced by conservation, the customer and the water utility (collectively) will "make money" via the measure. If volumetric water rates and utility rebates do not reflect the appropriate marginal costs of supply, however, this benefit may be obscured. For example, if volumetric water rates are higher than variable costs associated with delivering water, the water utility will lose more revenue than the costs it can avoid. When these losses are less than the gains by customers, a measure is collectively beneficial, yet such measures are **incorrectly** deemed to be not cost effective by CalFed.

Commercial Conservation Measures
Potential Savings and the Cost of Conserved Water Using Consumer Perspective

	AF/yr	$/AF
Commercial Dishwashers	9,000	-4,739
Restaurant Dishware Sensing	6,500	-3,575
Fruit/Veg RO Wastewater Recovery	6,700	-1,548
Restaurant Pre-Rinse Nozzles	5,400	-808
CII Toilets: Hotel Showers	10,400	-803
Coin Laundry H-Axis	1,500	-632
Meat Processing: Good Housekeeping	3,500	-595
Dairy Cow Water Resale	460	1
Hospital Sterilizers	1,200	26
CII Toilets (30 flushes/day)	102,700	103
Landscaping	407,000	106
Hospitals X-Ray	1,600	249
Textile Dye Bath Reuse	7,700	322
Textile Prep Water Reuse	1,300	322
Commercial Laundry VSEP	16,554	325
Refinery Boilers	22,900	388
Refinery Cooling	38,400	483
CII Toilets (15 flushes/day)	6,160	598
Total Cost Effective (Minimum) AF/yr	**650,000**	

Source: Gleick et al. 2003. "Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute, Oakland, California.

CalFed Inappropriately Excludes Co-Benefits of Water Efficiency Improvements

The cost estimates in the CalFed study are inaccurate because they inappropriately exclude many favorable factors, and many co-benefits of efficiency that save substantial amounts of money; for example, avoided wastewater treatment costs, avoided energy costs, and avoided landscape maintenance costs. Omitting these factors biases the costs of efficiency upward. By including reasonably quantifiable and financially tangible "co-benefits" of water conservation as economic benefits, completely different conclusions about the volume of cost-effective conservation are reached. (Co-benefits are benefits that automatically come along with the intended objective. For example, low-flow showerheads reduce water-heating bills and improved irrigation scheduling reduces fertilizer use.) CalFed fails not only to evaluate co-benefits but even to acknowledge their importance, stating only in passing that the approach used excludes them. A study that includes only conservative co-benefits found much more extensive and favorable water conservation potential (Gleick et al. 2003). Thus, including co-benefits dramatically affects the results of any conservation assessment. **Excluding them is methodologically erroneous and leads to incorrect and misleading results.**

-- end --

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