February 12, 2004

To: **Members, Water Use Efficiency Subcommittee**
From: **Bennett Brooks and Eric Poncelet, CONCUR**
Re: **Appropriate Measurement – Background Materials**

Attached please find background materials intended to support the Water Use Efficiency's February 18, 2004, discussion of the Staff Proposal on Agricultural and Urban Water Use Measurement. Specifically, please find attached:

- ***Final Report of the Independent Review Panel on Appropriate Measurement of Agricultural Water Use.*** This document, finalized in October 2003, provides the foundation for many of the agricultural-focused recommendations included in the Staff Proposal. {Attached is the main section of the Final Report. Detailed technical appendices are available on the Authority's web page. Also, please note that the attached version includes blank pages; these are intentional and are a result of pagination done for the printed version.)

- ***Staff Definition of Appropriate Urban Water Use Measurement.*** This document, developed in discussion with the Staff Work Group and numerous urban water experts, provides the foundation for many of the urban-focused recommendations included in the Staff Proposal.

These documents are not intended to serve as the focus for the WUE Subcommittee's deliberations. Rather, they are provided as background information..

Independent Panel on Appropriate Measurement of Agricultural Water Use

Convened by the California Bay-Delta Authority

FINAL REPORT

SEPTEMBER, 2003

September 2003

Mr. Tom Gohring
Assistant Deputy Director, Water Management
California Bay-Delta Authority

Dear Mr. Gohring:

Attached please find our Final Report on the Definition of Appropriate Agricultural Water Use Measurement. We believe appropriate measurement is essential for the well being of California and its natural resources.

The Report, representing the consensus view of all six panelists, puts forward the Panel's definition of appropriate agricultural water use measurement. The Report represents more than two years of work.

As readers will see, a definition of appropriate agricultural water use measurement defies a simplistic answer. Nonetheless, the Panel believes it is putting forward a perspective that is grounded in a thorough analysis, is meaningful given today's agricultural water use measurement practices and needs in California, and is useful for future deliberations by affected stakeholder communities and state decision-makers.

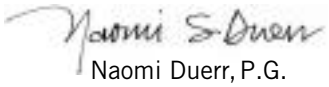
The recommended definition of appropriate agricultural water use measurement builds upon the extensive technical analysis conducted by Authority staff and consultants. The Panel believes the analysis is both consistent with past Panel guidance and sufficient to support the Panel's deliberations.

The recommendation also is shaped by the important and ongoing involvement of stakeholder and agency representatives. These representatives, many participating in an unpaid capacity, provided essential information on local conditions and perspectives throughout the process. The Panel wishes to thank these many individuals for their remarkable commitment to this effort.

Finally, while the Panel recognizes that concepts included in this report may be controversial to some, the Panel believes it has honored its commitment to—in a neutral manner—put forward a consensus definition rooted in well-informed and well-reasoned deliberations.

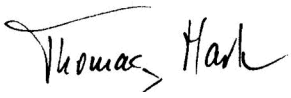
The Panel hopes this Report will be useful to the stakeholder and agency representatives who must now craft a strategy for implementing this consensus definition. We are available to answer questions or concerns that may arise as this process moves forward.

We thank the Authority for the opportunity to be involved in this effort and compliment it on its efforts to further California's understanding of this important topic.

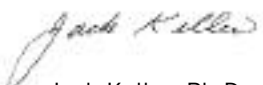


Naomi Duerr, P.G.
South Florida Water Management District

Chris Kapheim
Alta Irrigation District

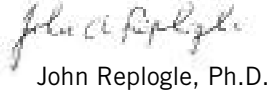


Thomas Harter, Ph.D.
University of California, Davis



Jack Keller, Ph.D.
Keller-Bliesner Engineering, LLC

Steve Hatchett, Ph.D.
Western Resource Economics



John Replogle, Ph.D.
U.S. Water Conservation Laboratory

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EXECUTIVE SUMMARY

BACKGROUND

The August 2000 CALFED Record of Decision (ROD) called for legislation requiring the appropriate measurement of all water uses in California. As a first step towards that goal, the ROD directed that a panel of independent experts be convened to help define appropriate agricultural water use measurement.

APPROACH

Based on this and related ROD commitments, the California Bay-Delta Authority (Authority)—formerly referred to as the CALFED Bay-Delta Program—convened six nationally recognized experts who collectively provided understanding in the areas of measurement technology/hardware; resource economics; groundwater hydrology; technical water policy; water district operations; and, irrigation engineering.

The Panel, first convened in June 2001, deliberated over a two-year period. The Panel's deliberations were informed throughout by the ongoing involvement of stakeholder and agency representatives with both policy and technical perspectives. Additionally, the Panel's deliberations were grounded in an extensive technical analysis shaped by the panelists and conducted by Authority staff and consultants.

FINDINGS

The attached Panel Report, representing the consensus view of all six panelists, puts forward the Panel's definition of appropriate agricultural water use measurement.

Building off the regionally based technical analysis, the Panel's recommended definition focuses on those measurement practices panelists identified as likely to—in a cost-effective manner—support state and federal planning and water rights objectives, allow water users to undertake and demonstrate the effects of efficiency measures, and facilitate valid water transfers. Key elements of the Panel's definition include:

Farm-Gate Measurement: Require districts to report delivery data to the State. State and federal planners are currently unable to adequately assess the potential of on-farm water use efficiency improvements due to gaps in how farm-gate delivery data is presently collected and reported to the State. Accordingly, the Panel recommends that districts be required to report aggregated farm-gate delivery data to the State. Changes in methodology are not recommended at this time, since current practices—whether estimated or directly measured—are considered sufficient to support both water transfers and efficient on-farm water management practices. Moreover, roughly 90% of all farm-gate deliveries are already measured at an accuracy of ± 6% by volume. This recommendation is not intended to preclude state and federal entities from linking approval of site- or condition-specific grant-funding applications or water contracts to higher levels of farm-gate measurement.

Groundwater Use Measurement: Employ more precise methods to compute and report net usage to the State. Current state and federal characterizations of groundwater resources are not conducted using consistent methods and are not done frequently enough to adequately characterize groundwater usage. This hampers the State's efforts to determine the amount of groundwater used in various regions and to characterize the extent of overdraft. Accordingly, the Panel recommends that the State employ more precise methods—specifically, continuous regional characterization of groundwater—to compute net usage. This approach, expected to cost the State an additional $2 million per year, represents a substantial change from current practices. This recom-

mendation is not intended to preclude the most precise measurement standards, which are needed to support water transfers or are required by various authorities to meet site- or condition-specific needs.

Crop Water Consumption Measurement: Measure using satellite-generated remote-sensing. Current approaches to measuring crop water consumption rely on indirect methods applied infrequently, a practice that means state estimates of crop consumption—a significant portion of California's total water use—are not validated and could include significant error. The Panel's recommended approach—using satellite-generated remote sensing to measure crop consumption—is expected to yield significantly better estimates than current practices. It represents a minimum of $500,000 additional annual cost to state or federal water agencies, and would have no direct impact on water users.

Surface Water Diversion Measurement: Measure all major surface water diversions using the best available technologies and report data to the State. Accurate data on surface water diversions is essential if state and federal water agencies are to adequately manage and plan for current and future needs. The completeness, consistency and accuracy of current reports do not allow these managers to quantify the amount of water diverted. Accordingly, the Panel recommends that all major surface diversions employ the best-available technologies—such as flow-totaling devices and data loggers—and report the data to the State. As most diversions are already using best-available technologies, the impact to districts is expected to be minimal.

Undertake comprehensive reviews to determine measurement needs for return flows, water quality and in-stream flows. The Panel recognizes that measurement of return flows, water quality and in-stream flows is

Agricultural vs. Urban Water Use: Measuring Water Delivery to End Users

PREPARED BY PANELIST JACK KELLER, ON BEHALF OF THE PANEL

Different approaches are required to measure water deliveries to agricultural and urban water users because of inherent differences in agricultural and urban demand patterns, delivery systems, water quality, and costs (see Table Below).

Perhaps the most fundamental difference between agricultural and urban water systems is their patterns of use which dictate important characteristics of their delivery systems. Urban water is available to all customers on demand—although the range of flow is typically low, when an urban water user turns on the tap, water comes out. This level of service is expected by residential and industrial customers throughout the United States. To provide this level of service, urban water systems—storage, pumps, and pipes - must be sized to provide peak water demand to many customers at once while meeting fire hydrant flow and pressure standards. Because urban water users can take water many times a day at different flow rates, only a recording measurement device—such as a totalizing meter—can give accurate delivery data.

On the other hand, agricultural distribution systems are sized to deliver water to only a few customers at a time on delivery schedules that provide water to farms once every two to six weeks. Typical agricultural delivery systems are designed to provide water for traditional surface irrigation methods that periodically apply relatively large quantities of water to a field and then use the on-farm water storage properties of the soil root zone to provide water to the crops between irrigations. These systems must use either fixed rotational or arranged delivery schedules to match deliveries to system inflow. Over-delivery results in some customers not getting their optimal flow rate; under-delivery results in canal spills (most agricultural water suppliers use open-channel gravity-flow delivery systems). Either of these conditions leads to low water use efficiency. Water district operators usually measure water delivery flows during these delivery events to make sure that their canal system does not get out of balance. As a result of these operational requirements, agricultural water suppliers typically have a record of the farm delivery flow rate and duration for each water use event. This data can be used to estimate the volume of water delivered even without a recording water measurement device.

Agricultural water quality and the variability of agricultural deliveries also affect end user water measurement. Farm size, crops, and irrigation methods are different from field to field. Water delivery rates can even vary on a given field from one irrigation event to another because of plant maturity or cultural practices such as rice paddy flood-up. Flow rate changes are even possible during an irrigation event due to irrigation management actions. Unlike urban water systems that deliv-

needed to support a variety of state and federal water management objectives. However, given the lack of information regarding the location, distribution and type of existing measurement for these locations, the Panel was unable to develop a more specific recommendation at this time. The comprehensive reviews are recommended as a state follow-on responsibility.

Additionally, the Panel stressed that its definition is not static and is likely to defy a one-size-fits-all prescription. Any implementation approach must be adaptive, include appropriate exemptions, and allow for local flexibility and creativity.

NEXT STEPS

Following review of this material with the Authority's public advisory bodies, the Authority intends to move forward with its next step: developing an implementation strategy capable of being broadly supported by affected stakeholder communities. This phase, expected to take no more than six months, will incorporate the following tasks:

Program Manager Work Group: Convene a diverse stakeholder group to give guidance to Authority staff in developing an implementation proposal.

Public Reviews: The proposed approach will be discussed with CALFED advisory and decision-making bodies, and the public. (This step might also incorporate an urban water use measurement approach, which is being developed separately.)

Legislative/Agency Discussions: Finally, the Authority will work with state policymakers, as necessary, to put forward an implementation approach. This approach could necessitate legislative changes, administrative changes or both.

Though the issuance of this Report represents the Panel's final task, the Panel remains available to answer questions that may arise as this process moves forward.

er potable water, agricultural systems contain debris such as plant matter or algae. Consequently, agricultural water measurement devices must handle a variety of flow rates under very difficult conditions. For example, while a water meter may work adequately at the beginning of the irrigation season when flow rates are high and debris is low, later in the season they may not work at all because flow rates have been reduced below the operating range of the device or because aquatic weeds foul the impeller. Because agricultural delivery flow rates, system configurations, and water quality varies so much, agricultural water end user measurement defies a "one size fits all" solution.

Finally, the relative costs of measurement are very different in agricultural and urban settings. For residential customers, the cost of implementing measurement (hardware, meter-reading, etc.) represents an increase in water rates of $5 to $20 per month ($60 to $240 per year). On the other hand, agricultural farm-gate measurement represents an increase in farm costs for a single field of $30 to $200 per month. For most crops, this is a significant fraction of farm income—in some cases eliminating the ability of the farm to make a profit. This high sensitivity to the cost of end use water measurement makes decisions about farm-gate measurement particularly significant.

COMPARISON OF AGRICULTURAL & URBAN RESIDENTIAL WATER DELIVERY SYSTEMS

Characteristics	Agricultural	Urban Residential
Demand Patterns	Ability to serve peak crop ET and typical losses; only deliver to 5% to 15% of customers at a time	Ability to serve peak demand and meet fire hydrant flow/ pressure standards; could serve virtually all customers at once
System Hardware	Mostly open channel, gravity flow; unexpected changes in deliveries can result in canal spills	Piped and pressureized systems; pipes flow full
Delivery Frequency	Deliveries arranged in advance or on fixed schedule (rotation) - two to six weeks between deliveries	Deliveries available on demand
Delivery Rate	0.5 to 20 cfs (225 to 9,000 gpm)	0.5 gpm to 20 gpm
Delivery Duration	2 to 72 hours	5 minutes to 2 hours
Water Quality	Untreated, contains debris	Treated to potable standards
On-Site Storage	Root zone stores crop demand for 2 to 6 weeks	None

INTRODUCTION

OVERVIEW

Measurement of water usage in the agricultural landscape is nearly as varied as the crops themselves. Some regions or districts rely on precise and frequent measurement to track how water moves through and within their systems. Others depend more heavily on estimates. The current approach to measurement grows out of unique, place-specific histories, economics and needs.

Water users and suppliers rely on the information generated for a variety of purposes. Measurement data can help local water districts distribute water to users, make operational decisions and improvements, and charge for water according to the amount used.

More recently, as California's water resources have become increasingly scarce, diverse stakeholder groups also have recognized the importance of measurement to state and federal agencies trying to manage a much-in-demand resource. Measurement can, among other things, provide better information on statewide and regional water use to support planning and water rights objectives, allow water users to undertake and demonstrate the effects of efficiency measures, and facilitate valid water transfers.

IMPETUS FOR THE PANEL

The California Bay-Delta Authority (formerly referred to as the CALFED Bay-Delta Program) is a cooperative effort among state and federal agencies and the public to ensure a healthy ecosystem, reliable water supplies, good quality water, and stable levees in California's Bay-Delta system.

Recognizing the potential impact of water use measurement on these overarching goals and the intense stakeholder interest in this topic, the August 2000 Record of Decision (ROD) called on the Authority's Water Use Efficiency (WUE) Program to take a closer look at measurement and determine what is needed and, as appropriate, put forward legislative or other strategies to bolster the current approach:

> "Diverse stakeholder groups have recognized the importance of, and need for, appropriate measurement of water deliveries. Measurement will provide better information on statewide and regional water use, enable water purveyors to charge for water according to the amount used, allow water users to demonstrate the effects of efficiency measures, and facilitate a water transfers market. CALFED Agencies have initiated a public process to add greater definition to 'appropriate measurement':
>
> - An independent review panel on appropriate measurement will be convened. This panel will provide guidance that will help define appropriate measurement as it relates to surface and groundwater usage. The panel will prepare a consensus definition of appropriate measurement by the end of 2001.
>
> - At the completion of this stakeholder/technical process, CALFED Agencies will work with the California State Legislature 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."

Based on this ROD commitment, the Authority convened an Independent Review Panel on Appropriate Agricultural Water Use Measurement to: (1) assist it in defining appropriate measurement as it relates to agricultural water use efficiency; and (2) outline possible steps for moving forward. [The

ROD-stipulated deadlines noted above have shifted to satisfy the Panel's subsequent call for a more detailed and time-consuming analysis than initially anticipated.]

The intent of the Panel's deliberations were neither to chart nor preclude any particular implementation path. That task is to be handled in subsequent stakeholder discussions and will, like other facets of the Authority's Water Use Efficiency Program, be underpinned by the Program's commitment to regionally sensitive, incentive-driven and cost-effective approaches. (A separate process is being used to address urban water use.)

PANEL PARTICIPANTS

In designing the Panel, the Authority sought to bring together a cross-disciplinary mix of independent experts capable of credibly tackling the potentially controversial question of defining appropriate agricultural water use measurement for both surface and ground water. The Authority further strove to craft a set of deliberations that would be objective-driven, involve the input of affected and informed stakeholder communities, be outcome-focused, and be perceived as credible.

To recruit panelists, the Authority worked with stakeholder and agency representatives to identify and select nationally recognized technical experts who collectively were able to provide understanding of the following areas:

Measurement technology/hardware: This panelist is to bring an understanding of existing and emerging measurement technologies and hardware. He/she should also be familiar with the technological limitations.

Resource economics: This panelist is to bring expertise related to the costs and benefits associated with measurement. He/she should also be familiar with issues related to financing measurement improvements.

Groundwater hydrology: This panelist is to bring an understanding of the purposes, benefits, limitations and costs associated with groundwater measurement.

The Value of Information

PREPARED BY PANELIST NAOMI DUERR, ON BEHALF OF THE PANEL

Water measurement plays an important role in managing California's water resources.

PLANNING AND MANAGEMENT

In order to manage California's water, the State must first know something about its characteristics, such as its quantity, quality, depth, location, ease of access, current use, and source and rate of replenishment. These characteristics must all be measured (or estimated). Once we have knowledge about a water system, we can assess how changes in weather, water withdrawal patterns, water uses, or restoration efforts might affect it. Measurement is key to understanding dynamic systems and assessing impacts to them over time.

BASELINE TO MEASURE EFFECTIVENESS OF CONSERVATION MEASURES

Water resources are increasingly valuable as demands rise over time. Conservation can be a cost-effective way to stretch water supplies. Conservation can delay the need to construct larger wellfields or to expand a community's water treatment facilities. Yet without measuring current water use, we can only guess at which conservation techniques might be most cost-effective. Should a farmer line a canal or invest in a drip irrigation system? Should a district build a new reservoir or store water underground? Only by measuring water use and understanding the nature of that use can we predict which conservation measures are likely to be most cost-effective. Once appropriate conservation tools are implemented, measurement is again key to quantifying actual gains and determining whether we are reaching our targets.

FINALLY, THE ACT OF MEASURING IMPLIES INTRINSIC VALUE

The accuracy with which we measure the use of a resource generally reflects its unit value—the cost of measuring more accurately needs to be justified by the benefit achieved. Resources which are perceived to have very high economic value per unit are measured precisely (diamonds are measured in hundredths of a carat), while resources with low unit value are measured imprecisely (fill dirt is measured to the nearest cubic yard). In the past, water supply for irrigation has been relatively abundant in some regions of California, due to firm and abundant water rights. Although water is extremely valuable to these areas (essential in fact), its marginal value has been relatively low. As a result, the cost of precise measurement has not seemed worth it. However, these days, good, clean plentiful water is not as available as it once was, and treatment costs have increased over time as concerns about purity have grown. If we appropriately measure water extraction, end use, return flows, and quality, we recognize water's inherent value. Valuing water is a cornerstone of sound resource management.

Ideally, he/she would have experience working in and out of adjudicated basins.

Technical water policy advisor: This panelist is to bring an in-depth understanding of how the integration and interpretation of large data sets can be used to inform public-sector policy making. This includes understanding: 1) what's required to collect and use data, and, 2) what are the relative costs and benefits of maintaining centralized data.

Water district operator: This panelist will contribute an on-the-ground perspective of a water district operator intimately familiar with agricultural irrigation in California.

Senior integrator/irrigation engineering: This panelist is to contribute expertise related to irrigation engineering. As well, this panelist will bring practical experience in recommending measurement programs for water agencies.

Potential panelists also were considered for their ability to meet the following criteria: 1) objectivity, as reflected in the perceived willingness/ability to integrate diverse viewpoints; 2) ability to work collaboratively; 3) understanding of the various objectives related to measurement; 4) practical experience with on-the-ground use of measurement; 5) competent and comfortable with analysis, storage, dissemination and use of measurement data; and, 6) availability. A list of the panelists, along with their expertise and affiliation, is provided in the chart below. (More detailed biographies are included in Appendix 1.)

To foster a process informed by local stakeholder views and perspectives, the Panel process also incorporated the continued input of diverse and informed stakeholders and state and federal agency representatives. These individuals participated in two different ways.

Technical Advisors: Each major stakeholder group—agricultural, environmental and agency—was asked to name three technical representatives to support the Panel's deliberations by helping the panelists and the Authority to better understand local issues and information sources. These Technical Advisors were invited to participate in Panel deliberations and provided interim guidance as well. A listing of these individuals is included in Appendix 1.

Ad Hoc Work Group: Each major stakeholder group—agricultural, environmental and agency—also was asked to name representatives able to provide more policy-focused guidance to the Authority and Panel. These participants—also invited to contribute to Panel deliberations and provide between-meeting guidance—served as a sounding board regarding Panel design, panelist selection and ongoing Panel process. A listing of these individuals is included in Appendix 1.

Finally, the Panel's deliberations were supported by a Technical Team consisting of Authority staff and consultants with expertise in hydrology, irrigation technologies and practices, resource economics, water law and stakeholder involvement/ facilitation. At times, panelists Jack Keller and Steve Hatchett also participated in a liaison role to ensure the Technical Team's work was consistent with previous Panel guidance. A listing of Technical Team members is included in Appendix 1.

PANELISTS WITH AFFILIATION AND AREA OF EXPERTISE

Panelist	Affiliation	Expertise
Naomi Smith Duerr	Director, Environmental Monitoring and Assessment Department, South Florida Water Management District	Technical Water Policy Advisor
Thomas Harter	Associate Cooperative Extension Specialist, Department of Land, Air and Water Resources, University of California, Davis	Groundwater Hydrology
Steve Hatchett	Economist, Western Resource Economics	Resource Economics
Chris Kapheim	General Manager, Alta Irrigation District	Water District Operator
Jack Keller	Professor Emeritus of Agricultural and Irrigation Engineering, Utah State; Founder and CEO, Keller-Bliesner Engineering	Irrigation Engineering
John Replogle	Research Hydraulic Engineer and Chief Scientist, U.S. Water Conservation Laboratory	Measurement Technology

PANEL MEETING SCHEDULE

Initially, the Authority anticipated the Panel process would require two meetings and last six to nine months. Given the complexity of the topic and early-on Panel guidance that directed the Technical Team to undertake an extensive, rigorous and region-specific analysis, the Panel's deliberations spanned two years and involved numerous in-person and teleconference meetings.

The Panel met in three face-to-face sessions. The first session, held in June 2001, focused on scoping questions and information needs related to the Panel's deliberations. The second session, held in October 2001, centered on an interim review of a preliminary technical analysis. The third and final session, held in June 2003, focused on developing a consensus definition of appropriate agricultural water use measurement.

The Panel also held numerous teleconferences to review the evolving technical analysis and provide continued input to the Technical Team. Panelists also reviewed and commented on interim staff technical analyses via e-mail.

Throughout the process, the deliberations were structured to incorporate and encourage the participation of affected stakeholder communities. As noted above, stakeholder and agency representatives were invited to participate in Panel deliberations. The public also was invited to attend Panel meetings. Finally, CALFED held a series of public workshops throughout the state to provide updates and information to interested members of the public.

TECHNICAL APPROACH

In its earliest deliberations, Panel members stepped out a series of topics essential to better understand prior to answering the primary question: What is the definition of appropriate measurement?

Most generally, the Panel called on the Technical Team to undertake a region-by-region analysis of the following:

- What are the purposes of agricultural water use measurement?
- What are the current baseline conditions, including an overview of measurement locations and intensities and regional snapshots?
- What are the benefits and limitations of the current approach?
- What would be the costs and benefits associated with altering the current measurement approach?

To develop comprehensive and credible answers to these questions, the Technical Team worked with the Panel and local consultants and stakeholders to undertake a rigorous analysis that relied on the following overarching methodology:

Implication of Irrigation Measurement Accuracy

PREPARED BY PANELIST JOHN REPLOGLE, ON BEHALF OF THE PANEL

Water measurement, as referred to in this document, is usually worded, for example, "…accurate to within ± 6% *by volume*." Water measuring devices may display either *flow rate* or *flow volume*, or both. Suppose a weir, which is basically a flow-rate device—that is, a depth reading used in an equation or table to indicate, say, 4000 gallons per minute—is fitted with a depth gauge on the canal sidewall that has been accurately referenced to the weir lip. However, waves make reading of the wall gage difficult to within 20% of the depth. The basic flume or weir may have a proven accuracy better than 2% to 5 %, but expensive stilling wells or sonic level detection and time-rate accumulation may not be practical at the site. Can this location produce a "*by volume*" measurement to meet accuracies to within ± 6% for system management and billing purposes?

The answer is that it is possible to meet the requirement. This is true because, if enough manual readings are accumulated over the delivery time of interest, some of the wave-hampered readings will be high and some will be low, so that by applying statistical methods, the sloppy readings (if enough are available) will give a volume delivery to the customer that approaches the basic 2% to 5 % accuracy of the weir. This would be well within the ± 6% target. The number of readings needed can be determined by statistics. However, the wide margin on individual readings does not bode well for the farmer who is trying to determine when to return to his canal gate to change the water to the next field. Ultimately, it is hoped that more precise instantaneous measurements can be implemented to improve the farmer's on-farm management. Meanwhile, for canal system operations, measurements of ± 15% by volume, is tolerated as being acceptable at individual customer levels, again because the random "overages" and "underages" of many customers will compensate and produce a volumetric accuracy suitable for the delivery authority who uses the information to assure that the main canal is adequately operated and for billing purposes.

The above explanation illustrates the desires of the Panel to incorporate and make use of flow measurements for one or more of at least two purposes. The limits recommended for a flow measurement that is accurate enough depends on the

Step One: Articulate objectives of measurement. The Panel called for the analysis to be structured to explore objectives of measurement (surface and groundwater) that support both specific Authority goals and broader statewide needs. In doing so, panelists strongly recommended that the analysis focus primarily on state and federal objectives related to water planning, water availability, water transfers and water use efficiency. At the same time, the Panel recommended that the analysis also identify important linkages between measurement and local objectives. The results of this analysis are presented in Section 1.

Step Two: Identify measurement components. In order to undertake a regional analysis, it was necessary for the Technical Team to develop a strategy for characterizing and considering changes to existing measurement practices. To accomplish this task, the Technical Team articulated three critical aspects of measurement: (1) the general location of where measurement is made (in other words, how the data is derived); (2) the intensity of the measurement; and, (3) the fate of the data associated with a measurement (how the data is used). The results of this analysis also are presented in Section 1.

Step Three: Track baseline conditions. In order to characterize the capabilities of existing measurement practices and estimate the incremental costs and benefits associated with different measurement strategies, it was first necessary to articulate the existing baseline conditions. This step necessitated working with regional experts to develop region-by-region estimates of existing measurement infrastructure and practices. It also required characterizing the State's current legislative and regulatory approach to measurement. These assessments are included in Section 2 (Baseline Conditions) and Appendix 2 (California Legal Authorities).

Step Four: Characterize benefits, limitations and potential changes to existing practices. Once baseline conditions were understood, the Technical Team undertook a regional analysis to: (1) characterize the ability of current measurement practices to meet the critical state and federal objectives identified in Step One; and, (2) identify possible and realistic changes to existing practices. In doing so, the analysis sought to identify—in a qualitative manner—the potential benefits to state and federal objectives if water suppliers and users altered their current measurement practices. The results of this analysis are presented in Section 3.

intended use of the measurement. One use of measurement information is for *flow volume* accounting over a day, a month or season. Water districts need information on volume of water delivered if they are going to equitably allocate water supplies to growers or bill growers by volume of water delivered. Growers need information on volume of water delivered if they are going to use a field water budget to schedule their irrigations. Here, as illustrated above, the measuring accuracy need not produce an instant reading that is highly precise at any moment. An example of "precise" is the ability to distinguish the markings on, say, a wall gage. "Accuracy" refers to the ability to determine a flow rate, or flow volume, in relation to some otherwise determined correct flow rate or flow volume. It is not always possible to have a correct value for comparison outside of a laboratory setting. On the other hand a "precise" reading may not necessarily equate to an "accurate" reading because the zero-setting on a weir may have shifted, or the rating equation or table may not be well matched to the structure, causing a bias error.

A more stringent and rarely needed form of measurement is for immediate *flow-rate* management applications. This situation could arise if that same farmer, mentioned above, needs to know instantaneously when he has applied the correct amount of water. For precision-leveled basin irrigation of upland crops at a steady, known flow rate, the irrigator can calculate a shutoff time. For example, irrigating 10 acres at 10 acre-inches per hour (10 cfs) will apply 4 inches in 4 hours. This measurement reading would need to be as precise and accurate as practical, because a 20% error in his single reading of the flow metering system could cause his shut-off time to be wrong by over three-quarters of an hour. However, this is less important for most other irrigation methods such as furrow and sloping border irrigation as the timing of irrigations is based on the relatively unpredictable time it takes for the water to reach the ends of the furrows or border strips. And for flooding rice basins, differences in flow rates merely alters the depth of the water stored in the basins.

For these reasons, the Panel believes the accuracy levels incorporated into its recommendations are both appropriate and achievable.

Step Five: Develop cost projections associated with different measurement practices. Relying on baseline conditions developed in Step Three and potential changes to measurement practices first outlined in Step Two and further considered in Step Four, the analysis looked at the quantitative costs associated with altering current measurement practices (both hardware and data management). These costs were developed at both regional and statewide levels. The results of this analysis are presented in Section 4.

Step Six: Analyze costs and benefits. As directed by the Panel, the last step in the analysis was to put forward a draft staff analysis of the potential quantitative costs and qualitative benefits associated with changes to current measurement practices and develop draft recommendations based on that analysis. This analysis also included any general recommendations related to future implementation considerations. The results of this regionally based analysis were presented to the Panel during its final set of deliberations and served as the foundation for their discussions. This analysis is included in Section 5.

The Technical Team relied on a variety of strategies and information sources to develop and confirm the analytic steps outlined above. It surveyed water suppliers and water users throughout the state, catalogued measurement practices and costs, talked with state and federal water managers and interviewed environmental stakeholders. Team members reviewed the State's regulatory and statutory framework, as well as talked with water managers in six other states to better understand their experiences. Additionally, the Technical Team met with local experts throughout the state to gather relevant data, present the results of its analysis and solicit feedback. Finally, public workshops were held to solicit feedback and comment on the analysis. (A summary of the public comment on the draft analysis is included in Appendix 4.)

More specific descriptions of the analytic techniques and information sources are outlined within each section of this report.

NEXT STEPS

As noted earlier, CALFED is committed to working through a two-step process to ensure it puts forward an approach to agricultural water use measurement that is both technically sound and capable of being broadly supported.

The first step—the Panel's determination of a definition of appropriate measurement—is summarized in this report, which will be distributed to and discussed with CALFED advisory- and decision-making bodies and the public. A summary of all public comments received on this Panel report will be attached as part of the permanent record.

Following these discussions, the Authority intends to move forward with the second step: developing an implementa-

Project Specific Costs and Benefits

PREPARED BY PANELIST STEVE HATCHETT, ON BEHALF OF THE PANEL

A comment received from water users concerned the need to evaluate the costs and benefits of measurement (especially farm-gate measurement) in the context of future water use efficiency and water management projects that might require or be enabled by better measurement. The comment suggested using a comprehensive benefit-cost evaluation of both the measurement approach itself and any linked future projects.

The Panel considered this comment seriously. The Panel's approach throughout the process has been that measurement needs to serve one or more defined objectives, and it has not recommended measurement levels simply because there may be future uses of the information. However, the Panel also felt that the Technical Team's ability to make reasonable and quantitative estimates of future benefits is limited. Therefore, the Panel came to two general conclusions regarding the comment:

1. It would not be reasonable to attempt to estimate the costs and benefits of future water use efficiency and management projects requiring or enabled by better measurement. Such an analysis would be virtually unlimited in scope and too speculative to be meaningful.

2. The state should be cautious in supporting measurement approaches that significantly increase costs when the benefits are uncertain. Rather, a tiered recommendation is preferred which sets a lower, but acceptable baseline level of measurement and then identifies conditions under which higher (more precise) measurement would be appropriate. These conditions could include: state grant funding of water use efficiency projects that require better measurement; and/or, local agency decisions to implement volumetric water pricing.

tion strategy capable of being broadly supported by the many affected stakeholder communities. This phase, expected to take no more than six months, will have several steps:

Program Manager Work Group: The WUE Program will convene a diverse stakeholder group to serve as a sounding board as it develops a proposed implementation approach. As discussed earlier, the Program's proposed approach will draw on the Panel's report and be shaped by the Program's commitment to regionally sensitive, incentive-driven and cost-effective approaches.

CALFED and Public Reviews: Once drafted, the WUE Program proposed approach will be drafted for review, discussion with and final revision by CALFED advisory- and decision-making bodies and the public. It is possible that this step will incorporate an approach to urban water use measurement that is being developed through a separate process.

Legislative/Agency Discussions: Finally, the WUE Program will work with state policymakers, as necessary, to put forward an implementation approach. It is uncertain at this point whether a final recommended implementation package will necessitate legislative change, administrative changes or both. Again, it is possible that this step will incorporate an approach to urban water use measurement that is being developed through a separate process.

Interested stakeholders are invited to review the accompanying materials and submit any comments to the California Bay-Delta Authority for its consideration as it continues discussions related to this important topic.

CVPIA Water Measurement Requirements

PREPARED BY USBR AGENCY REPRESENTATIVE TRACY SLAVIN, ON BEHALF OF THE PANEL

The United States Bureau of Reclamation requires all Central Valley Project water service or repayment contracts for agricultural, municipal, or industrial purposes that are entered into, renewed, or amended under any provision of Federal Reclamation law after enactment of the Central Valley Project Improvement Act (CVPIA), shall provide that the contracting district or agency:

- Ensure that all surface water delivery systems within its boundaries are equipped with water measuring devices or water measuring methods of comparable effectiveness acceptable to the Secretary within five years of the date of contract execution, amendment, or renewal;
- Ensure that any new surface water delivery systems installed within its boundaries or on or after the date of contract renewal, are so equipped; and
- Inform the Secretary and the State of California annually as to the monthly volume of surface water delivered within its boundaries.

This requirement is also incorporated into the Criteria for Evaluating Water Management (Conservation) Plans (Plans) prepared under the CVPIA. The Plan is required of each contractor which receives more that 2,000 irrigable acres or receives more that 2,000 acre feet in their service area, or receives more than 2,000 acre feet for M&I purposes. For these contractors, the Plan can be used to ensure that they are meeting the water measurement requirements under CVPIA.

The Water Conservation Criteria were first developed in 1993 through an extensive public scoping process. Water Measurement to each farmer was determined to be a Best Management Practice (BMP) that, when tied with volumetric pricing, provided farmers with a strong price signal resulting in agricultural water conservation. Based on this input, Reclamation identified measurement as a critical BMP and incorporated this requirement into the Standard Criteria.

Both Reclamation and the CALFED's Agricultural Water Management Panel address requirements for farm-gate measurement, but the purposes of the measurement differ. The Panel's recommendations focus on the need to aggregate estimates of farm-gate measurement in the context of providing information that will assist state and federal water planning and water balance estimates. The Panel recommendations reflect its conclusion that the hardware currently in place is appropriate for such planning purposes if data are collected and reported.

Independent Panel on Appropriate Measurement of Agricultural Water Use

Convened by the California Bay-Delta Authority

PANEL REPORT

SEPTEMBER, 2003

PANEL REPORT

As directed by the August 2000 CALFED Record of Decision, the California Bay-Delta Authority (Authority) convened the Independent Review Panel on Appropriate Agricultural Water Use Measurement (Panel) in June 2001 to develop a consensus definition of appropriate agricultural water use measurement.

The Panel represents a cross-disciplinary mix of six nationally recognized experts who collectively provide understanding in the areas of measurement technology/hardware; resource economics; groundwater hydrology; technical water policy; water district operations; and, irrigation engineering. A complete listing of Panel members is included in Appendix 1.

This final Panel Report, representing the consensus view of all six panelists, puts forward the Panel's definition of appropriate agricultural water use measurement. The Report represents more than two years of work by the Panel, involving three in-person meetings and numerous teleconferences, frequent communications with staff and consultants to the Authority, and the ongoing involvement of and input from stakeholder representatives. The Panel's final set of deliberations was held June 9, 2003, in Sacramento, California.

The recommended definition builds off the extensive technical analysis conducted by Authority staff and consultants (referred to as the Technical Team). That analysis, shaped by the Panel and presented in Part Two of this document, identified—on a region-by-region basis—the quantitative costs and qualitative benefits likely associated with changes to current agricultural water use measurement practices.

As guided by the Panel, the analysis centered on the potential for measurement improvements at seven specified locations to meet state and federal water management objectives. The seven locations are: 1) surface water diversions, 2) groundwater use, 3) crop consumption, 4) return flow sites, 5) water quality monitoring sites, 6) in-stream flows and 7) farm-gate deliveries. The Panel further directed the Technical Team to use state and federal objectives related to water allocation, water planning, water transfers, and water use efficiency to guide their analyses. The Panel also instructed the Technical Team to note the potential for measurement improvements to contribute to local objectives—such as on-farm water management—but not to use these local objectives as the basis for justifying the definition of appropriate measurement.

Following the general recommendations presented below, a set of "Location-Specific Definitions" summarize the Panel's consensus view on the definition of appropriate measurement at the seven locations under discussion. Each location-specific discussion is summarized into four parts:

ISSUE: This provides a brief description of the rationale for improved measurement.

RECOMMENDATION: This provides a summary of the Panel's recommendation related to what measurement it considers appropriate. The recommendations are characterized as either "basic," "high" or "highest technically practical," to be consistent with terminology used in the detailed technical analysis. (Although the Panel recognizes there are more than just three measurement options for each location, the analysis focused on the three discrete levels introduced above to provide a consistent basis for analysis of costs and benefits.) Taken together, these recommendations constitute the Panel's definition of appropriate measurement.

EXPECTED IMPACT: This outlines the expected impact—both in terms of cost and burden—to local water users. It also identifies where the State is likely to bear the cost.

FOLLOW-ON NEEDS: This lists out key follow-on needs raised during the Panel discussion.

The Panel hopes this Report will be useful to the stakeholder and agency representatives who will now work with the Authority to craft a strategy for implementing this consensus definition.

GENERAL RECOMMENDATIONS

The Panel believes that its consensus recommendations articulate a definition of appropriate agricultural water use measurement that is both grounded in a sound technical analysis and responsive to California's current and near-term needs. Moreover, the Panel believes the definition can serve as a solid foundation for follow-on discussions, to be convened by the Authority, centered on crafting an implementation approach.

Still, as the Authority moves forward with this initiative, the Panel wishes to put forward some important general recommendations related to the Authority's development of an implementation approach.

1. The Panel's final definition of appropriate measurement needs to be summarized in a manner that is straightforward, accessible and supported by the underlying detailed technical analysis.

2. The intent of these recommendations is neither to chart nor preclude any particular implementation path. The Panel recognizes that the implementation task is to be handled in connection with subsequent stakeholder discussions and will be underpinned by the Authority's commitment to regionally sensitive, incentive-driven and cost-effective approaches.

3. Any new approach to measurement must be adaptive and structured in a manner that enables an evolving definition of "appropriateness." This adaptive structure would, over time, account for changes in pertinent factors such as technology and economics. Accordingly, any legislative or regulatory implementation strategy must be carefully crafted to account for, among other things: (1) technological advancements over time; and (2) statewide growth, development, and increases in relative scarcity of water for various beneficial uses over time.

4. As the Authority drafts its implementation approach, the Panel recommends it consider the following: (1) the need to accompany any measurement requirements with an appropriate set of available exemptions, variances and "second-best" approaches; (2) the importance of focusing on how measurement "data" will be turned into "information" useful to governmental and private entities; and, (3) the necessity to provide staffing adequate to carry out certain labor-intensive measurement requirements or to implement approaches that allow requirements to be satisfied in a way that minimizes the labor involved.

5. The Panel has some concern that certain measurement costs included in the analysis (particularly those for groundwater and crop consumption) may have been underestimated by the Technical Team. The Panel urges the Technical Team to either re-review their cost estimates or indicate that further refinement may be required. The Panel does not believe its definition of appropriate agricultural water use measurement is contingent on the precision of cost information provided. In other words, the Panel would have made the same recommendations even if the actual costs are considerably higher than indicated.

Measurement and On-farm Efficiency

PREPARED BY PANELIST JACK KELLER, ON BEHALF OF THE PANEL

Many factors influence a farmer's decision to invest in on-farm water conservation. Aside from the obvious issue of how much the conservation improvement will cost, the farmer will consider: the amount and reliability of the farmer's water right or allocation; the price paid for water delivery, assuming the cost varies with volume received and the price is large enough to provide a meaningful cost signal; the availability of other water sources; the cost of other farm inputs; the relative financial health of the farm; and the potential impact on other water users. In many situations, factors such as the availability of other water sources, the perceived scarcity of water, the cost of other farm inputs, and the relative economic health of the farm overshadow the water delivery and water cost factors.

In California, surface water rights and the resulting supply are treated much the same as property rights and are typically collectively held by water suppliers for their water users. The agricultural water suppliers (irrigation districts) are non-profit public agencies with Boards of Directors that are elected by their water-users. The charges for supplying irrigation water for the lands the district was formed to serve cannot be greater than the cost of operating the district, and water-users favor having low water service costs. Approaches such as tiered pricing can be used to maintain a district's revenue equal to its cost, but these are often resisted by growers for various reasons.

All districts already have some means for diverting their legal share of surface water and distributing it to the farms they serve in a reasonably equitable manner. The delivery efficiency and accuracy of allocations generally depends on the size of the district's dependable water supply relative to irrigation demand during the dry periods, especially in drought years. (For purposes of this discussion, demand is the sum of applied water requirements for comfortably irrigating all the farmland in the district's service area.) The delivery efficiency, measurement and allocation accuracy is typically directly related to the district's relative water supply. The lower the surface water supply is relative to the demand, the higher

Farm-Gate Deliveries

ISSUE

State and federal agencies need accurate information on the sources and destinations of agricultural water to allow them to adequately manage and plan for current and future needs. To this end, the State needs improved estimates of water balance components, including improved information on farm-gate deliveries. This information is required so the State can adequately update the State Water Plan, make decisions about future storage and conveyance investments, and determine whether to direct water use efficiency grant funds and technical assistance toward farm or district improvements.

Farm-gate deliveries are measured using a variety of methods. Approximately 11% of all farm-gate deliveries statewide—primarily in the Sacramento Valley and Eastside of the San Joaquin Valley—are currently at the basic (estimated) level*. These estimated measurements are typically accurate to within ± 15% by volume. (Due to a lack of a comprehensive data reporting system for agricultural water deliveries, the exact volume of water delivered to the 11% is not known at this time.) The remaining 89% of turnouts are directly measured using rated flow structures coupled with duration of use or with continuous or totalizing measurement devices. These are typically accurate to within 6% of volume. However, regardless of the measurement method used, virtually none of this data is currently reported to the State. This information gap hampers state and federal water managers' ability to assess the potential of on-farm water use efficiency improvements.

RECOMMENDATION

It is appropriate to measure the volume of water delivered to farms. Also, it is appropriate for aggregated farm-gate delivery data, whether currently estimated or directly measured, to be collected, managed locally and reported to the State.

Regarding farm-gate measurement methodologies, the Panel believes the current approaches are sufficient to support efficient on-farm water management practices at this time. Although more accurate farm-gate delivery measurement can be an important component of local water management strategies, changes in farm-gate measurement alone will not likely result in significant water management improvements. This is due to the fact that there are many factors that motivate improved on-farm water use efficiency, including knowledge of the volume of water delivered, water price and pricing structure, water availability (or scarcity), the availability of other water sources, the costs of other farm inputs and the financial stability of the farm enter-

* The Panel recognizes that there are many different strategies for measuring farm-gate deliveries. The analysis defined three discrete levels—basic, high and highest technically practical—to provide a consistent basis for the analysis of costs and benefits.

the corresponding efficiency and measurement accuracy. However, where groundwater is available and inexpensive this may not be the case.

Some districts measure, allocate, and deliver the required or available amount of surface water to each farm-turnout; additional deliveries are made only if the grower has arranged for a transfer from within the district. This is done where a limited supply of water is being taken from a dedicated amount of surface storage. However, it is not really an issue where the surface water rights are ample for the area served or there is easy and cheap access to groundwater.

The water requirements during peak growth periods are similar for most crops within a region. However, due to different crop planting dates, crop cycles and irrigation practices, water requirements for different fields can vary considerably during non-peak periods. Consider, for example, the beginning of the season in a rice growing area. The first field planted and flooded in a given area may actually end up recharging the perched water table in the surrounding fields. Thus much more water may be required for it compared to its neighboring fields. In such cases, it may be more equitable or effective to meter the water delivered to the whole area rather than to individual fields.

Districts with sufficient relative water supplies can simplify operations to keep costs low by choosing not to measure and charge according to the volume of water delivered. To cover the costs of operation, they divide the district's total operating cost by the total number of irrigated acres served to arrive at a per acre delivery charge. Then districts would charge each customer according to the number of irrigated acres they have. However, some districts adjust the per acre charge to account for the different irrigation delivery requirements of various crops, soil, and application system types and/or the value of various crops.

In conclusion, water delivery data and water cost signals can be contributing factors in motivating growers to conserve water. However, their efficacy in inducing water conservation is frequently overshadowed by other factors including farm economics, district operations, and overall water availability.

prises. Therefore, given current physical and institutional conditions, it is not necessary to require flows at farm-gates to be more rigorously or accurately measured at this time.

The Panel acknowledges that there would be increased benefits to state goals if all measurements were at the high level. However, the Panel believes that the costs associated with changing those farm gates still at the basic level outweigh the benefits. Panel members also note the following:

- The basic level of farm-gate measurement (which relies on estimated flow rates) is typically accurate to within ± 15% by volume.
- The high level of farm-gate measurement (which relies on collecting flow measurements on rated structures and duration of use data) is typically accurate to within ± 6%by volume.
- The highest technically practical level of farm-gate measurement (which relies on continuous or totalizing measurement devices) is typically accurate to within ± 3% by volume.

Additionally, the Panel notes that incentive-pricing methods (such as tiered pricing) can be used with all current farm-gate measurement methods.

Finally, the Panel acknowledges that state and federal entities may wish to link approval of site or condition-specific grant-funding applications or water contracts to higher levels of measurement. Accordingly, this general statewide recommendation should in no way be considered to preclude or limit higher standards of farm-gate delivery measurement that may be deemed necessary by appropriate entities, including local agencies or authorities, to meet site- or condition-specific needs.

EXPECTED IMPACT

The definition does not represent an upgrade of farm-gate hardware or changes in measurement methodologies, but it does imply an increase in data collection and reporting activities for water suppliers. Water suppliers not currently collecting this information may need to add a half- to full-time staff position for data management.

Note: If and where grant applications are conditioned on applicants' demonstration of higher levels of measurement, some costs may be borne by water users.

FOLLOW-ON NEEDS

None at this time.

Who Pays for Measurement?

PREPARED BY TECHNICAL TEAM MEMBER DAVID MITCHELL, ON BEHALF OF THE PANEL

The Panel's recommendations of appropriate measurement of agricultural water uses is expected to lead to higher costs for measurement compared to existing practices, at least for some locations. The anticipated changes in costs are discussed in detail in Section 4 of this report. This sidebar discusses briefly the question of who would likely incur these costs.

Costs Likely to be Borne by State or Federal Agencies

The Panel's definitions of appropriate measurement for groundwater and crop water consumption entail improvements in the way state and federal water management agencies currently characterize groundwater and crop water uses. This primarily involves improvements in state-sponsored surveying and modeling practices. These are functions that CALFED agencies such as DWR or USBR would perform and pay for. It is not anticipated at this time that agricultural water districts or their customers would be allocated costs for these activities. Similarly, it is anticipated that installation, operation, and maintenance of stream gauging stations would remain within the purview of state and federal agencies and costs associated with these activities—either for flow or quality measurements—would continue to be borne by these agencies.

Costs Likely to be Partially or Completely Borne by Local Water Districts

The Panel's definition of appropriate measurement for major surface water diversions would require surface water diversion points with "basic" or "high" measurement capability to be upgraded to "highest technically practical." This would entail changes to approximately 16% of current major surface water diversion points. Local water districts would likely have primary responsibility for associated costs for the upgrades. However, loan and grant programs administered through the Water Use Efficiency Program may allow some state and federal cost sharing. While the Panel was unable to provide a definition of appropriate measurement of agricultural surface water return flows because of data limitations, it is expected that cost allocation would be similar to major surface water diversions. Water districts would have primary responsibility for necessary infrastructure improvements. However, loan and grant programs administered through either the Water Use Efficiency Program, Ecosystem Restoration Program, or Water Quality Program may allow some state and federal cost sharing.

The Panel's definition of appropriate measurement of farm-gate deliveries does not entail changes to existing delivery hardware, but would require more extensive data collection, management, and reporting. It is anticipated that water districts would pay for district-level data management and administrative costs. Costs associated with state or federal data repositories would be paid for with state or federal funds.

Groundwater Use

ISSUE

State and federal agencies need accurate information on the sources and destinations of agricultural water to allow them to adequately manage and plan for current and future needs. To this end, the State needs improved estimates of water balance components, including improved measurement of net groundwater use. This information is required so the State can adequately update the State Water Plan, make decisions about future storage and conveyance investments, and characterize and assess the sustainable yield of groundwater basins.

State and federal water management agencies currently conduct periodic assessments of groundwater resources for selected basins. However, these analyses are not conducted using consistent methods and are not done frequently enough to adequately characterize groundwater usage. More rigorous and consistent methods are required to determine the amount of groundwater used in various regions of the state and to characterize the extent of overdraft.

RECOMMENDATION

It is appropriate to measure net groundwater use at the high level*—in other words, continuous regional characterization of groundwater volume using two methods simultaneously: (1) development of detailed sub-basin hydrologic balances; and, (2) the water table/specific yield method. Initial cost analyses indicate these methods can be implemented statewide at reasonable cost. However, should the cost of these methods exceed available state resources, the State should focus its effort on those sub-basins with the greatest need for improved groundwater use data.

Additionally, when water transfers involve groundwater substitution, the groundwater wells directly involved in the transfer require the highest technically practical level of measurement (i.e., some form of continuous measurement, monitoring and frequent reporting).

This definition should in no way be considered to preclude or limit higher standards of groundwater measurement that may be deemed necessary by entities with legal jurisdiction over groundwater management, including local agencies or authorities, to meet site- or condition-specific needs.

EXPECTED IMPACT

The expected impacts to water users are likely to be minimal. The proposed method of continuous regional characterizations will mean higher state planning costs: roughly $2 million extra per year. Note: Where continuous measurement of well discharge is required due to water transfers, opportunities may exist for costs to be internalized into the transaction costs borne by the participants to the transfer.

FOLLOW-ON NEEDS

In moving forward with this definition, the Panel recommends that that the Authority reconfirm the incremental costs associated with measurement at the high level (including the costs of data collection and quality control) and amend its costs analysis, as necessary.

As was the case for surface water measurement, the Panel notes that benefits from the proposed improvements in groundwater measurement will be fully realized only if they are coupled with improved measurement of surface water diversions and crop water consumption. Finally, the Panel suggests highlighting the initial groundwater system characterization—i.e., soil types, hydrology—inherent in this definition.

* The Panel recognizes that there are many different strategies for measuring net groundwater usage. The analysis defined three discrete levels—basic, high and highest technically practical—to provide a consistent basis for the analysis of costs and benefits.

Crop Water Consumption

ISSUE

State and federal agencies need accurate information on the sources and destinations of agricultural water to allow them to adequately manage and plan for current and future needs. To accomplish this activity, the State needs improved estimates of water balance components, including improved measurement of crop consumption. This information is required so the State can adequately update the State Water Plan, make decisions about future storage and conveyance investments, determine whether basins are over-allocated, verify water transfers, and adjudicate water rights disputes.

The Department of Water Resources currently estimates crop consumption using indirect methods on a rotating frequency of approximately once every five years for each county. These estimates do not provide information on crop consumption during alternate years. They also are not validated on a large scale and could include error due to lack of information on localized crop consumption variability (such as crop stress, microclimates or other site-specific factors). These uncertainties are of particular concern, given that crop consumption accounts for a significant portion of California's total water use.

RECOMMENDATION

It is appropriate to implement crop water consumption measurement at the high level*—in other words, to incorporate into the State's current estimation procedure the use of satellite-generated remote-sensing of evaporative water consumption, with a monthly time-step, during the full growing season. It is also appropriate for the data to be housed in a state repository.

EXPECTED IMPACT

This measurement approach is not expected to have a direct impact on water users. It does, however, represent a major change in how crop consumption is measured in California. Annual cost of measurement, beyond current state outlays, would be a minimum of $500,000 and would likely be borne by state and federal water agencies.

FOLLOW-ON NEEDS

The Panel believes the additional cost for this level of measurement may prove substantially higher than has so far been projected in the technical analysis to date. Accordingly, in moving forward with this definition, the Panel recommends that the Authority reconfirm the incremental costs associated with measurement at the high level and amend its costs analysis, as necessary.

Additionally, the Panel notes that—to maximize benefits—changes to the measurement of crop consumption need to be coupled with improved accuracy of surface water diversions and groundwater use.

Finally, the Panel believes measurement at the high level may serve other local or regulatory purposes and recommends that the Authority more fully explore and articulate these potential benefits.

* The Panel recognizes that there are many different strategies for measuring crop water consumption. The analysis defined three discrete levels—basic, high and highest technically practical—to provide a consistent basis for the analysis of costs and benefits.

Surface Water Diversions

ISSUE

State and federal agencies need accurate information on the sources and destinations of agricultural water to allow them to adequately manage and plan for current and future needs. To this end, the State needs improved estimates of water balance components, including improved measurement of surface water diversions. This information is required so the State can adequately update the State Water Plan, make decisions about future storage and conveyance investments, determine whether basins are over-allocated and adjudicate water rights disputes.

The State—through the State Water Resources Control Board—receives limited diversion data from water rights permitees. However, the completeness, consistency and accuracy of these reports does not now allow state or federal water management agencies to quantify the amount of water diverted. Quantification of diversions would greatly improve the credibility of and confidence in ongoing water resource initiatives, such as the Bay-Delta Program's integrated storage investigation.

RECOMMENDATION

It is appropriate to measure all major surface water diversions at the highest technically practical level*—in other words, using flow-totaling devices and, if necessary, data loggers and telemetry. It is also appropriate for data to be managed locally and reported to the State.

EXPECTED IMPACT

The impact to water users is expected to be minimal since more than 80% of major surface water diversions are already at the highest technically practical level. Local agencies and the State will have expanded data management requirements. Where upgrades are needed, incremental costs on an annual basis are expected to range between $1,000 and $8,000 per diversion point. The total statewide incremental cost is expected to range from $75,000 to $125,000 per year.

FOLLOW-ON NEEDS

In moving forward with this definition, the Panel recommends that the Authority more clearly define what it means by "major diversions." It further recommends that the Authority confirm the data management costs, if any, associated with those diversions already at the highest technically practical level and amend its costs analysis, as necessary.

Additionally, the Panel notes that although these measurements are necessary, the State would derive even more benefit if groundwater use and crop water consumption measurements are also improved.

* The Panel recognizes that there are many different strategies for measuring surface water diversions. The analysis defined three discrete levels—basic, high and highest technically practical—to provide a consistent basis for the analysis of costs and benefits.

Return Flow

ISSUE

State and federal agencies need accurate information on the sources and destinations of agricultural water to allow them to adequately manage and plan for current and future needs. To this end, the State needs improved estimates of water balance components, including improved information on return flows. This information is required so the State can adequately update the State Water Plan, make decisions about future storage and conveyance investments, verify water transfers and determine the potential for agricultural water conservation to contribute to water quality and in-stream flow and timing objectives.

However, the technical analysis suggests there is a lack of information regarding the location, distribution and type of existing return flow measurement points. There is also a lack of information on the number and type of return flow sites required to adequately collect the needed information. Given these constraints, the Panel concludes there is insufficient information to articulate credible statewide measurement requirements.

RECOMMENDATION

It is appropriate to measure return flow. However, given the lack of information, it is not yet possible to develop a statewide or even region-by-region definition of appropriate measurement for return flow.

EXPECTED IMPACT

There is no expected direct impact to water users at this time, as the State would be responsible for this comprehensive review.

FOLLOW-ON NEEDS

The Panel recommends that the State undertake a comprehensive review to determine existing return flow measurement needs focusing on location specific return flow information requirements. Wherever possible, the analysis should build on existing data sets.

Water Quality

ISSUE

State and federal agencies need accurate information on the existing and desired water quality of agricultural surface and subsurface return flows. This information is required so the State can adequately update the State Water Plan and determine the potential for agricultural water conservation to contribute to water quality objectives.

However, the technical analysis suggests there is a lack of centralized information regarding the location, distribution and type of existing water quality measurement sites. There is also a lack of information on the number and type of water quality measurement sites required to adequately collect the needed information. Given these constraints, the Panel concludes there is insufficient information to articulate credible statewide agricultural water quality measurement requirements.

RECOMMENDATION

It is appropriate to measure water quality. However, given the lack of information, it is not yet possible to develop a statewide or even region-by-region definition of appropriate measurement for water quality.

EXPECTED IMPACT

There is no expected direct impact to water users at this time, as the State would be responsible for this comprehensive review.

FOLLOW-ON NEEDS

The Panel recommends that the State undertake a comprehensive review to determine existing water quality measurement needs focusing on location specific return flow information requirements. Wherever possible, the analysis should utilize existing information sources such as the U.S. EPA's 303(d) list, the State Water Resources Control Board's watershed initiative and the Regional Water Quality Control Boards' Basin Plans.

In-Stream Flows

ISSUE

State and federal agencies need accurate information on the sources and destinations of agricultural water to allow them to adequately manage and plan for current and future needs. To this end, the State needs improved estimates of water balance components, including improved information on in-stream flows. This information is required so the State can adequately update the State Water Plan, make decisions about future storage and conveyance investments and determine the potential for agricultural water conservation to contribute to in-stream flow and timing objectives.

However, the analysis suggests there is a lack of information regarding the number and location of in-stream flow measurement sites required to adequately collect the needed information. Given these constraints, the Panel concludes there is insufficient information to articulate credible statewide in-stream flow measurement requirements.

RECOMMENDATION

It is appropriate to measure in-stream flow. However, given the lack of information, it is not yet possible to develop a statewide or even region-by-region definition of appropriate measurement for in-stream flow measurement.

EXPECTED IMPACT

There is no expected direct impact to water users at this time, as the State would be responsible for this comprehensive review.

FOLLOW-ON NEEDS

The Panel recommends that the State undertake a comprehensive review to better determine its needs for the number and location of additional in-stream flow measurement sites. Wherever possible, the analysis should build on existing information from U. S. Geologic Survey, California Data Exchange Center and local and regional agencies. In addition, the Panel recommends that this analysis begin with an assessment of the costs and benefits of restoring recently discontinued USGS stream gauging stations.

THE TECHNICAL REPORT AND APPENDICES ASSOCIATED WITH THIS REPORT MAY BE FOUND ON THE CALIFORNIA BAY-DELTA PROGRAM'S WEB SITE:

WWW.CALWATER.CA.GOV

California Bay-Delta Authority

Staff Definition of Appropriate Urban Water Use Measurement

For Discussion at the February 18, 2004 Meeting of the Water Use Efficiency Subcommittee

Definition
Appropriate Urban Water Use Measurement
California Bay-Delta Authority

Contents

The outline for the Draft Definition of Appropriate Urban Water Use Measurement is as follows:

Introduction

Background

This document constitutes the California Bay-Delta Authority's (Authority or CBDA) proposed definition of appropriate urban water use measurement.

The impetus for addressing this topic stems from longstanding stakeholder concerns over the increasing scarcity of California's water resources and recognition of the need for more complete and accurate measurement of urban and agricultural water deliveries. Improved measurement along these lines can assist state and federal agencies in their efforts to achieve the following four key *water management objectives*:

- Provide better information on statewide and regional water use to support planning;
- Allow users to undertake and demonstrate the effects of water use efficiency measures;
- Facilitate valid water transfers; and
- Help the State more effectively administer the existing water rights system.

Recognizing the potential impact of water use measurement on these overarching objectives and the intense stakeholder interest in this topic, the August 2000 CALFED Record of Decision (ROD) called for the CBDA to produce a definition of what it termed "appropriate" measurement of urban water use. The ROD also called for CBDA staff to recommend legislative and/or other strategies, as appropriate, to bolster the current approach.

Structure and organization of document

The proposed definition of appropriate urban water use measurement is structured into four main sections as follows:

I. State standards and protocols for recording and reporting urban water use

II. Measurement of urban water uses
   - Urban water purveyor water sources and production
   - Urban water purveyor customer water uses
   - Urban wastewater discharger wastewater collection and discharge
   - Urban groundwater use

III. Reporting of urban water uses
   - Urban water purveyor reporting to State of California
   - Urban wastewater discharger reporting to State of California

IV. Urban water use research program

Each of these sections and sub-sections begins by defining the Authority's current thinking on what constitutes an appropriate level, amount, or reporting of urban water use measurement. This is followed by discussion of: 1) the justifications for the

proposed definition, 2) expected impacts (mostly cost-related), and 3) follow-on considerations. The follow-on considerations will be addressed in the development of an implementation approach (see companion Draft Implementation Approach document).

Guiding perspective and considerations

The perspective by which Authority staff and consultants have approached the task of defining "appropriate" urban water use measurement has been guided in large part by the following question: What level, form, and/or process of urban water use measurement is necessary to better achieve state and federal water management objectives related to planning, allocation, transfer, and water use efficiency?

Authority staff and consultants also based their proposed definition of appropriate measurement of urban water use on the following additional key considerations:

- Declared policy of state of California
- Industry practice and standards
- Empirical evidence demonstrating the efficacy of the proposed measurement definition
- Assessment of need (based upon meetings and interviews with experts in the field as well as background research)
- Prioritization of flow information over water quality information[1]
- Practical and achievable steps capable of yielding meaningful benefits to state water management objectives
- Need for an adaptive management approach

Process approach

To inform this proposed definition, Authority staff and consultants have drawn upon the expertise and advice of broad stakeholder and technical expert communities as follows:

- In the summer and fall of 2002, the Authority conducted stakeholder interviews with 25 individuals representing a cross-section of water suppliers, environmental organizations, CALFED agencies and partners, business groups, citizen groups, and consultants.

- In the spring of 2003, Authority staff convened a multistakeholder Staff Work Group on Urban Water Use Measurement to begin providing individual feedback on Authority staff's proposed definition of appropriate urban water use measurement (see Appendix 1 for a list of the Staff Work Group members).

- In the summer of 2003, Authority staff convened a meeting among urban water use technical and policy experts to better establish the specific information needs driving considerations of urban water use measurement. Authority consultants

[1] The decision to prioritize flow information over water quality information arose out of consultations with representatives of DWR, DHS, and SWRCB. It is assumed that water quality measurement and reporting are currently adequately handled.

also conducted a series of targeted follow-up interviews to provide additional clarity from the perspective of state urban water managers and planners (see Appendix 2 for a list of the meeting attendees and the individuals interviewed).

- In the fall of 2003, Authority staff reconvened the Work Group on Urban Water Use Measurement to further assist Authority staff efforts to define appropriate measurement and develop an associated implementation approach.

Anticipated next steps

Authority staff have drawn upon this Definition of Appropriate Urban Water Use Measurement and the definition of appropriate agricultural water use measurement produced by the Independent Panel on Appropriate Measurement of Agricultural Water Use to develop a proposed implementation approach for all water use measurement in the state of California. This document is entitled Staff Proposed Implementation Approach for Agricultural and Urban Water Use Measurement. This process has been informed by the Urban Water Use Measurement Work Group mentioned above as well as a corresponding ad hoc stakeholder work group focused on agricultural water use measurement.

Authority staff intends to take the additional next steps toward implementation of a broadly supportable approach to water use measurement:

- *Conduct broader Authority and public reviews.* Authority staff to submit the Staff Proposed Implementation Approach for Agricultural and Urban Water Use Measurement for review by and discussion with Authority advisory and decision-making bodies as well as the public. Final revisions will be made at that time.

- *Initiate legislative discussions.* CBDA staff to work with implementing agencies and state policymakers, as necessary, to put forward an implementation approach.

Definition of Terms

Water Meter - includes any suitable water measuring device or facility that measures or determines the volumetric flow of water.[2]

Water Service - means the sale, lease, rental, furnishing, or delivery of water for beneficial use, and includes, but is not limited to, contracting for the sale, lease, rental, furnishing, or delivery of water, except bottled water.[3]

Water Purveyor - means any person who furnishes water service to another person.[4]

Urban Water Purveyor – means a water purveyor that provides water service for domestic, municipal, or industrial uses.[5]

Urban Wastewater Discharger – means any discharger subject to an NPDES permit or Waste Discharge Requirement.

NPDES Permit – is a federal permit governing discharge of wastewater to surface waters authorized by the federal Clean Water Act. (In California, authority to issue NPDES permits has been delegated to the State Water Resources Control Board.)

Waste Discharge Requirements – is the state "permit" governing the discharge of wastewater to surface or groundwater in California authorized by the state Porter-Cologne Water Quality Control Act [6] (For surface water discharges, the State Water Resources Control Board / Regional Water Quality Control Boards issues a combined NPDES permit and WDR; for ground water, only a WDR is issued.)

Water Reclamation Requirements – is the state "permit" governing wastewater reclamation activities in California issued by the Regional Water Quality Control Boards in lieu of a WDR.[7]

[2] Cal. Water Code, § 516.
[3] Cal. Water Code, § 515.
[4] Cal. Water Code, § 512. "Person" means any individual, firm, association, partnership, corporation, or public entity of any kind." Cal. Water Code, § 513. "Public entity" includes a city, county, city and county, whether general law or chartered, a district, board, commission, bureau, authority, agency, department, division, section, any other political subdivision of the state of any kind, or the state." Cal. Water Code, § 514.
[5] As such, "Urban Water Purveyors" are not confined to urban areas.
[6] Cal. Water Code, § 13374.
[7] Cal. Water Code, § 13523.

Definition of Appropriate Measurement for Urban Water Systems

I. State Standards and Protocols for Recording and Reporting Urban Water Use

Appropriate measurement of urban water uses requires the state to develop the following:

a) Data collection guidelines and protocols for urban water purveyors and wastewater dischargers. At a minimum, the guidelines and protocols need to address (1) estimation of service area population; (2) classification of water supply source measurement data; (3) classification of customer water use measurement data; (4) classification of wastewater source and disposal measurement data; (5) classification of water service rates and charges; and (6) estimation of service area economic (including income) data.

b) Systems for water purveyors and wastewater dischargers to report urban water use data annually to the state.

c) Systems to disseminate urban water use data to local, regional, state, and federal water planning and management agencies and authorities; water purveyors and customers; research institutions and universities; and the general public.

d) Guidelines for ensuring the accuracy of the measurement data.

Justification of Definition:

1. Most urban water and wastewater purveyors in California currently collect vast amounts of data to manage their own systems. These purveyors also report some of these data to a variety of state and federal water management agencies. These data are not always readily obtainable, comparable, or understandable by water managers outside of these utilities. Nor can state/federal agencies readily share the data that they each collect. There is a generally recognized need to develop data collection standards and protocols—i.e., determine what kinds of data need to be collected, how this will be done and how this information will be transmitted to others, and measures for QA/QC. Standardizing to some degree how urban water purveyors compile and provide data to state and federal water planners is an essential step in achieving the state's overarching policy objective of determining and communicating the quantities of water in use throughout the state to the maximum extent reasonable.[8] The absence of standards for urban water use data collection and reporting greatly diminishes the value of this data for regional and statewide planning and water resource management.

2. The adoption of standards and protocols would likely lead to reporting efficiencies and may well diminish the reporting burden on local purveyors.

[8] Cal. Water Code, § 520. The California State Legislature has declared that, "pursuant to the primary interest of the people of the state to put the limited available supplies of water in this state to beneficial use to the fullest extent of which they are capable, and to prevent waste, unreasonable use, or unreasonable method of use, it is necessary to determine the quantities of water in use throughout the state to the maximum extent that is reasonable to do so."

Expected Impacts:

1. The state would incur costs to develop state water data collection guidelines and protocols; provide technical assistance to water and wastewater purveyors implementing the guidelines and protocols; administering data collection processes; and enforcing adoption of any standards. Federal funds for developing a statewide reporting system for wastewater discharges subject to NPDES permitting requirements have already been committed. A statewide system for NPDES reporting is projected to be operational in 2005.[9]

2. Some, possibly most, urban water purveyors and wastewater dischargers would incur costs to conform their data collection and reporting systems to the guidelines and protocols.

3. The State as well as urban water purveyors might incur potential cost benefits if the standards and protocols developed enable combination of the multiple existing planning and reporting processes (e.g., DWR, DHS, USBR, CUWCC).

[9] Personal Communication with State Water Resources Control Board; Personal Communication with Environmental Protection Agency, Region 9.

II. Measurement of Urban Water Uses

A. Urban water purveyor water sources and production

*Appropriate measurement of urban water purveyor water sources and production requires the following:**

a) *Use of suitable water meters at all water source and production points, including source water intakes, treatment works, and storage reservoir outlets. Source water includes surface water, groundwater, and recycled water. A suitable water meter is one that is in compliance with relevant standards of the American Water Works Association and any relevant state standards and legal requirements.*
b) *Source and production meters to be read at least once each month.*
c) *Source and production meters to be sized appropriately, well maintained, and periodically calibrated to ensure reasonable accuracy.*
d) *Source and production measurement data to be recorded using standard measurement units and stored by the urban water purveyor using a suitable database management system. Data structures and classification schemes should conform to relevant state water data collection guidelines and protocols (see Section I).*

** Nothing in this definition should be construed to supercede existing state and federal authority and requirements embodied in or through the federal Safe Drinking Water Act and the California Safe Drinking Water Act to impose measurement, monitoring, and reporting requirements on water quality subject to regulation under these acts.*

Justification of Definition:

1. The California State Legislature has declared that, "pursuant to the primary interest of the people of the state to put the limited available supplies of water in this state to beneficial use to the fullest extent of which they are capable, and to prevent waste, unreasonable use, or unreasonable method of use, it is necessary to determine the quantities of water in use throughout the state to the maximum extent that is reasonable to do so."[10] Volumetric measurement of urban water purveyor water sources and production is a necessary and reasonable action to determine the quantities of water in use by urban areas in California.

2. The California Public Utilities Commission (CPUC or Commission), pursuant to General Order 103, requires water systems within its jurisdiction to install a suitable measuring device, or otherwise determine production, at each source of supply in order that a record may be maintained of the quantity of water produced by each source. It further requires that at least once each month, the quantity produced from each source of supply be determined. Twelve-month totals by sources are to be recorded and transmitted to the Commission in the utility's annual report to the Commission.[11]

3. The California Department of Health Services (DHS) issues permits to public water systems. Among the conditions which must be demonstrated for issuance of a permit is that the water system "assure a reliable and adequate supply of

[10] Cal. Water Code, § 520.
[11] California Public Utilities Commission, General Order 103, Rules Governing Water Service Including Minimum Standards for Design and Construction (as amended March 9, 1994), § I.1.a.

water at all times that is pure, wholesome, potable and does not endanger the health of consumers."[12] During DHS preparation of a technical report in support of the permit, the DHS engineer reviews each water source. A water system cannot add a water source without applying for and receiving a permit amendment. As a result of the strong linkage of water source with permit issuance, the water systems are required to correlate their production capacity with the existing demand. DHS requires water systems to report annually on the aggregate quantity of water produced and/or delivered.

4. As a matter of policy, the American Water Works Association (AWWA) recommends "that every water utility meter all water taken into its system and all water distributed from its system to its users." AWWA policy further states that "[m]etering of all water services is an effective means of improving and maintaining the close control of water system operations necessitated by the increasing difficulty in maintaining and providing adequate water supplies and the increasing costs of providing water service to consumers.... Metering provides a database for system performance studies, facility planning, and the evaluation of conservation measures. It also improves accountability for water delivered through the system and, therefore, facilitates management decisions. Periodic performance testing, repair, and maintenance of meters are essential parts of an effective metering program."[13]

5. Preparing urban water system water balances, assessing and pinpointing system water losses, and characterizing and managing system water demands require accurate measurement of source water intake, production, and distribution. Empirical evidence conclusively demonstrates the necessity of frequent flow measurement of source water intake, production, and distribution to undertake these management activities.[14]

6. Meter accuracy is a function of correct sizing and proper maintenance. Incorrectly sized and/or poorly maintained source and production meters will result in inaccurate water measurement data.[15]

Expected Impacts:

1. Minimal. The above definition is consistent with standard water industry practice in California. Urban water purveyors may incur some cost to conform their data collection and storage systems to relevant state water data collection guidelines and protocols.

[12] Reference Health and Safety Code 116540.
[13] Adopted by the Board of Directors of the AWWA on Jan. 26, 1969, and revised on June 15, 1980, reaffirmed June 22, 2986, revised June 6,1993, and June 21, 1998.
[14] Farley, Malcom and Stuart Trow, Losses in Water Distribution Networks, IWA Publishing, 2003.
[15] Ibid.

B. Urban water purveyor customer water deliveries

Appropriate measurement of urban water purveyor customer water deliveries requires the following:

a) *Use of suitable water meters at all customer connections to the water delivery system. A suitable water meter is one that is in compliance with relevant standards of the American Water Works Association and any relevant state standards and legal requirements.*
b) *Customer meters to be read at least monthly if possible, and under no circumstances less frequently than bi-monthly.*
c) *Customer meters to be sized appropriately, well maintained, and periodically calibrated to ensure reasonable accuracy.*
d) *Customer measurement data to be recorded using standard measurement units and stored by the urban water purveyor using a suitable database management system. Data structures and customer classification schemes should conform to relevant state water data collection guidelines and protocols (see Section I).*
e) *Measurement data on water consumed to be forwarded to the customer for the customer's information. This should include previous year data for the same period.*

** Nothing in this definition should be construed to supercede existing state and federal authority and requirements embodied in or through the federal Safe Drinking Water Act and the California Safe Drinking Water Act to impose measurement, monitoring, and reporting requirements on water quality subject to regulation under these acts.*

Justification of Definition:

1. The California State Legislature has declared that, "pursuant to the primary interest of the people of the state to put the limited available supplies of water in this state to beneficial use to the fullest extent of which they are capable, and to prevent waste, unreasonable use, or unreasonable method of use, it is necessary to determine the quantities of water in use throughout the state to the maximum extent that is reasonable to do so."[16] Volumetric measurement of urban water purveyor customer water uses is a necessary action to determine the quantities of water used for domestic, municipal, and industrial purposes.

2. The California State Legislature has declared that "water furnished or used without any method of determination of the quantities of water used by the person to whom the water is furnished has caused, and will continue to cause, waste and unreasonable use of water, and that this waste and unreasonable use should be identified, isolated, and eliminated."[17] It has also declared that "waste or unreasonable use of water imposes unnecessary and wasteful consumption of energy to deliver or furnish the water, and it is necessary, therefore, to determine the quantities of water in use throughout the state to the maximum extent that it is reasonable to do so in order to reduce that energy consumption."[18]

[16] Cal. Water Code, § 520.
[17] Cal. Water Code, § 521.
[18] Cal. Water Code, § 522.

3. Since 1991, California law has required meters on all new potable water connections.[19] The 1991 law does not include provisions that the meters be read, just installed. By limiting the metering requirement only to new connections, implementation of the law has resulted in dual measurement systems within some water systems. It has been suggested that this has at best complicated and at worst discouraged a unified measurement and pricing policy to isolate and eliminate waste and unreasonable use of water within these water systems, thereby thwarting the original intent of the legislation.

4. As a matter of policy, the American Water Works Association (AWWA) recommends "that every water utility meter all water taken into its system and all water distributed from its system to its users." AWWA policy further states that "[m]etering of all water services is an effective means of improving and maintaining the close control of water system operations necessitated by the increasing difficulty in maintaining and providing adequate water supplies and the increasing costs of providing water service to consumers…. Metering provides a database for system performance studies, facility planning, and the evaluation of conservation measures. It also improves accountability for water delivered through the system and, therefore, facilitates management decisions. Periodic testing, repair, and maintenance of meters are essential parts of an effective metering program."[20]

5. Federal law enacted under the Central Valley Project Improvement Act (CVPIA) makes universal metering of urban CVP contractors a condition of CVP contract renewal. The United State Bureau of Reclamation (Bureau or USBR) deems metering of customer deliveries coupled with volumetric pricing an essential demand management practice for CVP M&I contractors. Metering coupled with volumetric pricing is the only non-exemptible Best Management Practice (BMP) required under Bureau Conservation Plan Requirements. Based on review of demands between metered and unmetered service areas, the Bureau has concluded that metering can reduce M&I demands by 20% to 25%. This level of demand reduction is consistent with findings from other empirical studies.[21]

6. The California Public Utilities Commission, pursuant to General Order 103, recommends all water sold by a utility be on the basis of metered volume sales.[22]

7. Retrofitting unmetered customer connections with meters coupled with volumetric pricing is a BMP under the Memorandum of Understanding Regarding Urban Water Conservation in California (MOU). Urban water purveyors providing water service to more than 70% of the state's populace have

[19] This law became effective January 1, 1992.
[20] Adopted by the Board of Directors of the AWWA on Jan. 26, 1969, and revised on June 15, 1980, reaffirmed June 22, 2986, revised June 6,1993, and June 21, 1998.
[21] CALFED Water Use Efficiency Program Staff Work Group on Urban Water Use Measurement -- Compilation of Background Information on Current Urban Water Use Measurement Practices, Costs, and Benefits. March 31, 2003.
[22] California Public Utilities Commission, General Order 103, Rules Governing Water Service Including Minimum Standards for Design and Construction (as amended March 9, 1994), § I.1.a. It should be noted that under General Order 103 the Commission has discretion to waive metering requirements for a water utility under its jurisdiction.

signed the MOU. Retrofitting unmetered customer connections with meters coupled with volumetric pricing is also a BMP under the Water Forum Agreement.

8. Empirical evidence conclusively demonstrates that metered water service coupled with volumetric pricing can reduce water demand by 20% to 25% or more.[23] These studies strongly indicate that metering customer uses discourages very low value water uses and wasteful practices.

9. Meter accuracy is a function of correct sizing and proper maintenance. Incorrectly sized and/or poorly maintained customer meters will under-read water flow and result in inaccurate water measurement data.[24] Because meters tend to under-read as they age, meter maintenance programs often can pay for themselves through recovered water sales revenue.

Expected Impacts:

1. Urban water purveyors with a large number of unmetered customer connections would incur capital costs to retrofit unmetered connections. It has been estimated that statewide retrofitting of unmetered connections would cost in the neighborhood of $250 million.[25] Some of this cost would be recouped by water purveyor customers through avoided operation and water system expansion costs due to slower growth in demand. Most urban water purveyor service areas in California, particularly in coastal areas, are already universally metered. Large pockets of unmetered customer connections, however, remain in the Central Valley and Foothill regions. Thus, impacts of the definition would not be uniformly distributed across the state's urban water purveyors, but rather concentrated within a subset of urban water purveyors located mostly in the Central Valley.

2. Urban water purveyors with a large number of unmetered customer connections would incur O&M costs to operate and maintain the new meters. For some purveyors, the O&M costs may be significant.

3. Water purveyors could incur costs to conform to state water data collection guidelines and protocols. Water purveyor data collection and storage systems are designed primarily for customer billing, financial accounting and water system management purposes. These systems are quite heterogeneous across

[23] CALFED Water Use Efficiency Program Staff Work Group on Urban Water Use Measurement -- Compilation of Background Information on Current Urban Water Use Measurement Practices, Costs, and Benefits. March 31, 2003.
[24] Ibid.
[25] CALFED Water Use Efficiency Program Staff Work Group on Urban Water Use Measurement -- Compilation of Background Information on Current Urban Water Use Measurement Practices, Costs, and Benefits. March 31, 2003.. This estimate assumed an average retrofit cost of $600 per meter and did not account for any upgrades to the delivery network. The average cost per AF of water saved through meter retrofitting has been estimated at about $350/AF. This estimate assumed an average retrofit cost of $600 per meter, a 20% average reduction in demand, and a 15-year average useful life for a meter. Compared to recycling and desalination, with costs ranging from $600 to $1500 per AF, meter retrofitting would appear to be a cost-competitive alternative.

urban water purveyors. Many may need to be modified to some degree to conform to state water data collection guidelines and protocols.

4. Most urban water purveyors, especially those already metering customer connections, already deliver customer water use data to their customers via their billing systems. Those urban water purveyors with large numbers of unmetered customer connections would incur a cost to retrofit their billing systems to include customer water use data.

C. Urban wastewater discharger wastewater collection and discharge

*Appropriate measurement of urban wastewater requires the following:**

a) Use of suitable measurement devices at all effluent discharge points (including wastewater reclamation) capable of measuring and recording continuous flow. Use of monitoring equipment or methods, including, where appropriate, biological monitoring and effluent sampling methods as prescribed by NPDES permits, Waste Discharge Requirements, or Water Reclamation Requirements.

b) Effluent and wastewater reclamation measurement data should be recorded and stored by the urban wastewater discharger using a suitable database management system. Data structures and classification schemes should conform to relevant permit/WDR requirements as well as state water data collection guidelines and protocols.

** Nothing in this definition should be construed to supercede existing state and federal authority and requirements embodied in or through the federal Clean Water Act and state Porter-Cologne Water Quality Control Act to impose measurement, monitoring, and reporting requirements on wastewater discharges subject to regulation under these acts.*

Justification of Definition:

1. Measurement of discharges consistent with the above definition is necessary to implement, monitor, and enforce compliance with various provisions of the federal Clean Water Act (CWA) and state Porter-Cologne Water Quality Control Act.

    a. The California Porter-Cologne Water Quality Control Act applies to both surface and groundwater and to both point and nonpoint sources. More narrowly, the federal CWA establishes a program to regulate point source discharges to surface waters under the National Pollutant Discharge Elimination System (NPDES). Discharges that are not subject to the CWA but that nonetheless have the potential to affect the quality of the waters of the state remain subject to regulation under the state's Porter-Cologne Water Quality Control Act, which was enacted earlier and is broader in scope than the federal CWA.

    b. Under the Porter-Cologne Water Quality Control Act, the state regulates, in part, by requiring that persons proposing to discharge or reclaim wastewater first obtain Waste Discharge Requirements (WDRs), or Water Reclamation Requirements (as the case may be), from the state. U.S. EPA has delegated the NPDES program to the State of California to implement based on findings that the Porter-Cologne Water Quality Control Act is sufficiently equivalent to the federal Clean Water Act. Accordingly, state-issued WDRs also serve as federal NPDES permits for surface water discharges. [The terms "waste discharge requirements" and "NPDES permits" are often used interchangeably when they cover surface point sources.[26]] WDRs and NPDES permits are issued and enforced by the Regional Water Quality Control Boards and, when necessary, are further enforced by the State Water Resources Control Board.

[26] Cal. Water Code, § 13374.

c. Issued for varying durations, WDRs and NPDES permits contain monitoring and reporting provisions necessary to evaluate discharger compliance. Monitoring requirements generally include daily effluent flow measurement from the permitted facility along with a variety of water quality monitoring requirements specific to the effluent discharge of the facility and the water quality status of the receiving water body. Permitted dischargers generally submit monthly reports to their Regional Board on daily flow and various water quality parameters.

2. Quantification of discharges will facilitate estimation of urban water uses for statewide and regional planning.

3. Quantification of discharges and water quality assessments will also facilitate estimation of urban water recycling potential for statewide and regional planning.

4. Currently, state water planners do not have a good understanding of water withdrawal and consumption by self-supplied large industrial water users. Quantification of wastewater discharges from self-supplied industrial water users (where they have a separate discharge permit), coupled with information about facility water uses and processes, should facilitate estimation of urban uses for statewide and regional planning.

5. Measurement of effluent flow can by and large serve as a surrogate for influent flow into wastewater discharger facilities, given that the approximate volume of materials being extracted during the treatment process is known.

Expected Impacts:

1. Negligible. The above definition is consistent with standard wastewater industry practice in California. Urban wastewater dischargers may incur some cost to conform their data collection and storage systems to relevant state water data collection guidelines and protocols. However, the state and federal governments are already proceeding with development of a statewide NPDES reporting system and will start transitioning NPDES permit holders to this system in 2004 or 2005. Use of this system for non-NPDES WDRs will follow. Thus, the proposed definition does not represent a change in current or planned measurement and reporting of urban wastewater discharges.

D. Urban Groundwater Use

Appropriate measurement of urban groundwater use requires the following:[27]

a) Continuous regional characterization of groundwater net usage using two methods simultaneously: (1) development of detailed sub-basin hydrologic balances; and (2) the water table/specific yield method. [This is consistent with findings from the Agricultural Water Use Measurement Panel.]

b) In cases of groundwater substitution transfers[28] *where water is being transferred from urban users, continuous measurement (via totalizing flow or power meters*[29]*) and monitoring of the groundwater wells involved. Measurement is to be focused on the transferring entity. [This is consistent with findings from the Agricultural Water Use Measurement Panel.]*

c) Measurement (and associated reporting) of individual groundwater extraction as required in adjudicated and managed basins.

Justification of Definition:

1. The California State Legislature has declared that, "pursuant to the primary interest of the people of the state to put the limited available supplies of water in this state to beneficial use to the fullest extent of which they are capable, and to prevent waste, unreasonable use, or unreasonable method of use, it is necessary to determine the quantities of water in use throughout the state to the maximum extent that is reasonable to do so."[30] Quantification of groundwater use is a necessary and reasonable action to help facilitate local, state and federal agency water management and planning.

2. State water planners currently have an incomplete understanding of water withdrawal and consumption by groundwater users, including self-supplied users. Complete information is only being collected for adjudicated and managed basins—i.e., basins already determined to be at risk for overdraft. Improved measurement of net groundwater use in all sub-basins statewide will facilitate estimation of groundwater uses for non-adjudicated basins. This recommended approach represents an improvement in the consistency of the analytic rigor with which the groundwater resources of the state are assessed, and will serve to improve understanding of amounts used and the extent of overdraft. Additionally, where there is a proposal for a water transfer or a project converting land from an agricultural to an urban use (e.g., to a residential development exceeding 500 units), regions that have been measured consistent with the above definition will have improved data available in order to evaluate whether a factual basis exists to support legally required agency findings of fact.

[27] Measurement associated with groundwater banking project can be treated as a composite or hybrid of some of the disparate measurement challenges entailed in each of the numerous elements that make up the banking program.
[28] A groundwater substitution transfer is a water transfer involving the substitution of groundwater in lieu of surface water diversions. As such, it entails a reduction in surface water use which is offset with additional groundwater pumping.
[29] Measurement via totalizing flow meters is preferred over power meters, as power meters provide only an estimate of groundwater pumped.
[30] Cal. Water Code, § 520.

3. There is not currently sufficient evidence to support mandated measurement of all self-supplied urban groundwater uses. Before requiring such direct measurement, further research is needed to better characterize the scope of self-supplied groundwater users (number, impact on overall groundwater use, geographic distribution, etc.) and refine the costs and benefits associated with such measurement. This research is called out in Section IV of this definition. [This is consistent with the CBDA-convened Agricultural Water Use Measurement Panel's finding regarding direct measurement of agricultural groundwater use.]

4. Current practice requires direct measurement of groundwater extraction in managed or adjudicated basins. In any suit brought in any civil action in a federal or state court for determination of the rights to water, the court can order that the matter be referred to the State Water Resources Control Board, for resolution of any issue, including investigation and report on the physical facts involved. (Cal. Water Code, §§ 2000, 2001, 2075.) The SWRCB produces a report containing opinions, findings, and conclusions on the applicable law and facts. (Cal. Water Code, §§ 2011, 2012.) The report becomes evidence, before the reviewing court, of the issues referred and reported on. (Cal. Water Code, § 2019.) The SWRCB can also file an action in state court to restrict pumping, or to impose physical solutions, or both, pursuant to statutory procedures. (Cal. Water Code, § 2100.) In addition, individual right holders can turn to the courts to settle disputes. In any of these instances, the courts may appoint a watermaster to oversee implementation of the court's eventual judgment, including measurement and reporting of quantity of water used.

5. In connection with water transfers, California law typically requires that there be no injury to other legal users of the water. DWR has pointed to two steps that help ensure that this "no injury" standard will be satisfied. First, participants should determine the water available for transfer based on conditions that would exist absent the transfer. Second, participants should include real-time monitoring programs to trigger rapid response corrective actions to help avoid possible impacts as they may develop. The first set of measurements help establish a baseline for identifying the quantity available, but also can help ensure that the groundwater to be pumped is not hydrologically connected to the surface supply to be foregone. Thus, measurement, along with other factors such as distance between a well and surface supplies, can help ensure that it is a true transfer. Real-time monitoring is important not only to avoid injury, but also to avoid wrongly attributing adverse impacts to a transfer. That is, after a transfer has started, an adequate monitoring/measurement program can help participants shut off the wells involved in the transfer when they are causing adverse impacts and better know when neighbors' adverse impacts on their own wells are likely due to some other cause (e.g., ordinary seasonal or annual variation in water levels). In addition, the purchaser of water transferred will typically be purchasing it with a price based on volume delivered at a particular time of year when it is most needed. Thus, the purchaser will have it in their own self interest to insist on measurement by the transferor.

Given considerations such as these, DWR has developed nonregulatory guidance to shape its involvement in groundwater substitution transfers. Along with Reclamation where appropriate, DWR has instituted a program to require that adequate measurement and other steps be taken whenever one or more of the following situations exists in a proposed groundwater substitution transfer: (1) DWR is purchasing water; (2) DWR is an operator of facilities through which the transferred water is to be conveyed; or (3) DWR is a downstream user potentially injured by a proposed transfer.

Expected Impacts:

1. The expected impact on water users of measuring groundwater extraction in adjudicated basin is minimal, as this practice is already required by law and largely implemented.

2. The expected impact of net groundwater use measurement to water users are likely to be minimal. The proposed method of continuous regional characterization will mean higher state planning costs: roughly $2 million additional per year. Where continuous measurement of well discharge is required in the case of a water transfer, opportunities may exist for costs to be internalized into the transaction costs borne by the participants to the transfer.

3. As water basins become at risk for overdraft and are recategorized as adjudicated or managed, the expected impact on water users becomes large, as this requires all water users to measure groundwater extraction.

III. Reporting of Urban Water Uses

A/B. Urban water purveyor reporting to State of California

*Appropriate measurement of urban water uses requires urban water purveyors to report annually the following to the State of California:**

a) An estimate of service area population that conforms to state water data collection guidelines and protocols
b) The number of metered and unmetered customer connections subtotaled by customer class definitions conforming to state water data collection guidelines and protocols.
c) Water production by month subtotaled by water source definitions conforming to state water data collection guidelines and protocols.
d) Annual water deliveries subtotaled by customer class definitions conforming to state water data collection guidelines and protocols.
e) Monthly or bi-monthly water deliveries, according to meter read frequency, subtotaled by customer class definitions conforming to state water data collection guidelines and protocols.
f) Water service rates, rate design (i.e., inclining block rates, declining block rates, or uniform rates), and charges (fixed and commodity) in effect for report year.

** Nothing in this definition should be construed to supercede existing state and federal authority and requirements embodied in or through the federal Safe Drinking Water Act and the California Safe Drinking Water Act to impose measurement, monitoring, and reporting requirements on water quality subject to regulation under these acts.*

Justification of Definition:

1. The California State Legislature has declared that, "pursuant to the primary interest of the people of the state to put the limited available supplies of water in this state to beneficial use to the fullest extent of which they are capable, and to prevent waste, unreasonable use, or unreasonable method of use, it is necessary to determine the quantities of water in use throughout the state to the maximum extent that is reasonable to do so."[31]

2. The California State Legislature has declared that "the people of the state have a primary interest in the orderly and coordinated control, protection, conservation, development, and utilization of the water resources of the state by all individuals and entities and that it is the policy of the state that The California Water Plan, with any necessary amendments, supplements, and additions to the plan, is accepted as the master plan which guides the orderly and coordinated control, protection, conservation, development, management and efficient utilization of the water resources of the state."[32]

3. It is the responsibility of the Department of Water Resources to "plan for the orderly and coordinated control, protection, conservation, development, and utilization of the water resources of the state … " and to update this plan – The

[31] Cal. Water Code, § 520.
[32] Cal. Water Code, § 10005.

California Water Plan -- "on or before December 31, 2003, and every five years thereafter."[33] The Department of Water Resource is required by law to release assumptions and other estimates used for the California Water Plan, including, but not limited to, the following:

a. Current and projected population

b. Current and projected water use for all of the following:
   - Interior uses in a single-family dwelling.
   - Exterior uses in a single-family dwelling.
   - All uses in a multifamily dwelling.
   - Commercial uses.
   - Industrial uses.
   - Parks and open spaces.[34]

4. As part of its 2003 California Water Plan Update, the Department of Water Resources is now instituting a Water Portfolio approach to state water planning and management. While past California Water Plan water uses and supply data have been based on long-term averages, the Water Portfolio approach is based instead on actual water uses and supplies. This approach is founded on the development of annual water portfolios, and these are best supported by annual reporting of water use data.

5. The Department of Water Resources administers annually a survey of about 700 urban water purveyors to collect the kinds of data listed in the proposed definition.[35] The Department has indicated that the present approach suffers from the following shortcomings:

   a. Individual surveys are frequently incomplete or improperly filled out. Unmetered service areas in particular are unable to provide data on deliveries to different customer classes or must estimate these deliveries.

   b. About 50% of responses don't report water deliveries by customer class either because they don't maintain records on water use by customer class or because their customer classes don't match the survey's categories. As an example, many systems classify multi-family residential water use as commercial whereas the production survey provides a separate category for this use. Guidelines and protocols for classifying urban water users are needed to provide state planners with consistent and comparable data on urban water uses.

   c. DWR considers the population estimates provided by survey respondents to be unreliable. Experience suggests that many (perhaps most) urban water suppliers do not provide reliable estimates of the total population served by

[33] Cal. Water Code, § 10004.
[34] Ibid.
[35] One exception is information about water rates and charges, which is currently not part of the survey. Department staff has indicated that information about water rates and charges is needed to make projections of future water demands by customer class for the California Water Plan.

their system. Thus per capita use estimates derived from the data can be inaccurate. Guidelines and protocols for estimating service area population are needed to provide state planners with reliable population estimates.

d. The survey does not always provide good geographic representation of urban water uses. In particular, the survey frequently under-samples less densely populated areas. More comprehensive data collection is required to provide adequate representation statewide.

e. The survey does not collect water use information for self-supplied residential, commercial, or industrial water users. Because many of these users are in rural areas this compounds the problems associated with under-sampling discussed previously.

f. The survey currently does not collect information about water rates or costs. The Department requires information about rates and cost trends to forecast how costs are changing and how this might affect water demand.

The proposed definition will provide the Department of Water Resources with more comprehensive and accurate data on urban water uses needed for statewide water planning.

6. Data to be collected and reported under this definition is needed by urban water purveyors subject to regional and urban water management planning requirements under state water code sections 10530 – 10546 and 10610 – 10657. The Urban Water Management Planning Act calls for urban source and delivery data to be submitted with monthly specificity. However, as purveyors are only required to submit Urban Water Management Plans every five years, this leaves significant gaps in the availability of this data.

7. The Department of Health Services (DHS) currently requires water sources and deliveries data annually from virtually all urban water suppliers. However, the DHS system only collects this data with annual specificity. Monthly (or bi-monthly, in the case of deliveries) data is needed to show seasonal variation and allow computation of both indoor and outdoor water use.

Expected Impacts:

1. Reporting requirements for some urban water purveyors will increase. Not all urban water purveyors participate in DWR's current survey.

2. Urban water purveyors may incur costs to conform their data collection and reporting system to state water data collection guidelines and protocols.

C. Urban wastewater discharger reporting to State of California

*Appropriate measurement of urban water uses requires urban wastewater dischargers report at least annually the following to the State of California:**

a) *Conditions and limits of discharge (including wastewater reclamation) specified in relevant NPDES permits, waste discharge requirements, or water reclamation requirements.*
b) *Volume of effluent from each discharge location.*
c) *Effluent discharge and receiving water body quality measurements as specified by the relevant NPDES permit or WDRs.*

**Nothing in this definition should be construed to supercede existing state and federal authority or requirements embodied in or through the federal Clean Water Act and state Porter-Cologne Water Quality Control Act to impose measurement, monitoring, and reporting requirements on wastewater discharges subject to regulation under these acts.*

Justification of Definition:

1. Water Code section 13166 requires the State Water Resources Control Board, with the assistance of the Regional Boards, "to prepare and implement a statewide water quality information storage and retrieval program. Such program shall be coordinated and integrated to the maximum extent practicable with data storage and retrieval programs of other agencies."

2. State compilation of NPDES permit information is needed to fulfill the state's NPDES permit reporting obligations under Title 33, Chapter 26, Subchapter IV of the US Federal Code.

3. Compilation of wastewater discharge data will facilitate estimation of urban water uses for statewide and regional planning. Currently the Regional Boards in a variety of ways house data on permitted discharges. Mostly this data is collected and filed using paper-based reporting systems. Little of this information is currently stored in electronic format, rendering much of it inaccessible from a practical standpoint. State data warehousing would enable currently collected data on wastewater discharges to be used for a variety of regional, state, and federal water management purposes, including, but not limited to: (1) monitoring, reporting, and enforcement responsibilities specified by CWA and Porter-Cologne Act; (2) State Water Plan updates; and (3) regional and state recycled water planning.

4. Currently, state water planners do not have good understanding of water withdrawal and consumption by privately- or self-supplied large industrial water users, especially when the source is groundwater. Quantification of wastewater discharges from self-supplied industrial water users (where they have a separate discharge permit), coupled with information about facility water uses and processes, should facilitate estimation of urban uses for statewide and regional planning. While discharge data from these permitted facilities is collected by the Regional Boards it is not centrally stored or accessible. State data warehousing would allow access to this data.

Expected Impacts:

1. Minimal. The state and federal governments are already proceeding with development of a statewide NPDES reporting system and will start transitioning NPDES permit holders to this system in 2004 or 2005. Use of this system for non-NPDES WDRs will follow. Thus the proposed definition does not represent a change in planned measurement and reporting of urban point source discharges.

IV. Urban water use research program

Appropriate measurement of urban water uses requires the state to implement and sustain an urban water use research program.
***Highest priority**: The following research areas have been identified as having significant potential impacts on state/federal water management and planning efforts and should be given the highest priority: The state will establish a budget and timeline for accomplishing each of these:*

a. Measurement of irrigated landscape water use. These studies should address, at a minimum, the following questions:
- *What are the benefits of more precise measurement of irrigated landscape use?*
- *Do dedicated landscape meters (or other technologies such as ET controllers or remote sensing) have a measurable impact on landscape water use when compared to landscapes served by mixed-use meters, after controlling for climate, price, and policy variables?*
- *Are dedicated landscape meters (or other technologies such as ET controllers or remote sensing) necessary to the effective implementation of landscape budget and pricing programs, or can such programs be implemented in the presence of mixed-use meters?*
- *Are the planning, management, and water supply benefits that may be realized by dedicated landscape meters (or other technologies such as ET controllers or remote sensing) sufficient to justify the costs of the policy?*

***Other priorities**: Other research topics that have been defined as important include (but are not limited to):*

b. Submetering in multi-family dwellings.
c. Contributions of self-supplied urban groundwater use (including industrial, commercial, and residential users) to net groundwater usage. These studies should address, at a minimum, the following questions:
- *What is the scope of self supplied groundwater use with respect to: number of self-supplied users, type of use, impact on overall groundwater use, geographic distribution, etc.?*
- *With respect to groundwater extractions in adjudicated and managed basins, what data is being collected by watermasters? To what degree is this data being collected in a consistent fashion? And to what extent does this data help the state meet its water management and planning objectives?*

d. Residential, commercial, and industrial water end use studies
e. Urban land use changes and associated changes in water uses
f. Efficacy of alternative urban water use forecasting methods
g. Economic studies addressing:
- *Value of water in alternative urban uses*
- *Household water use decision-making*
- *Commercial and industrial water use decision-making*
- *Water demand reduction potential of emerging conservation technologies and programs*

h. Evaluation of the methodologies (and the consistency among these methodologies) by which urban water suppliers and local agencies (cities and counties) develop actual versus projected water use for projects covered by SB 610 water supply assessments and

SB 221 written verifications of water supply (verifications and assessments may be prepared by local agencies if there is no water supplier).

***Research results and adaptive management**: The state should take into consideration the results of the research program to re-evaluate annually its definition of appropriate measurement of urban water uses as defined previously in Section II.*

Justification of Definition:

1. Improving the state's ability to forecast and plan for future urban water demands requires a fuller understanding of how water is used in urban areas and how this use is changing over time due to changes in land use patterns, demographics, technology, and economics.

2. A frequent criticism of previous State Water Plan Updates is the use of very general and simplified assumptions to predict future urban water demand. A robust and sustained research program could provide the Department of Water Resources with tools (e.g. a statewide urban GIS of urban land and water uses) and information (e.g. value of water in alternative urban uses) that would substantially improve its ability to make regional urban water use forecasts.

3. A fuller understanding of how water is used in urban areas would support regional water management planning activities authorized under California Water Code sections 10530 through 10546 (Integrated Regional Water Management Plans) and 10610 through 10657 (Urban Water Management Plans).

Expected Impacts:

1. State and / or urban water purveyors and wastewater dischargers would incur cost to fund research program.

APPENDIX 1

Participants – Staff Work Group on Urban Water Use Measurement

Water Suppliers

Angela Anderson – Water Conservation Administrator, City of Sacramento
Dick Bennett – Water Conservation Administrator, East Bay Municipal Utility District
Mary Lou Cotton – Water Resources Manager, Castaic Lake Water Agency
Luis Generoso – Water Resources Manager, City of San Diego Water Department
Mike Hollis – Director, Conservation, Metropolitan Water District of So. CA
Joe Lima – Water Use Manager, Modesto Irrigation District
Steve Macaulay – Executive Director, California Urban Water Agencies
Bill Miller – General Manager, North of the River Municipal Water District
Rich Plecker – General Manager, Fair Oaks Water District
Tim Treloar – Asst. District Manager, Bakersfield District , California Water Service Co.

Environmental Groups:

Roberta Borgonovo - Water Director, League of Women Voters—CA
Dana Haasz - Research Associate, Pacific Institute
Ed Osann - Consultant, Natural Resources Defense Council
Betsy Reifsnider - Executive Director, Friends of the River
Fran Spivy-Weber - Executive Director, Policy, Mono Lake Committee
Eric Wesselman - Regional Representative, Sierra Club (CA-NV-HI Field Office)

Environmental Justice Organizations:

Michael Stanley-Jones - State Director, California Clean Water Action

Business Organizations:

Darin Gale - Governmental Relations Mgr, Sacramento Metropolitan Chamber of Commerce
Brian White - Legislative Advocate, CA Building Industry Association

CBDA Implementing Agencies and Partners

Jeff Barnickol - Statewide Assistance Section, Chief, State Water Resources Control Board
Lucille Billingsley - Water Conservation Specialist, Bureau of Reclamation
Nadine Feletto - Safe Drinking Water State Revolving Fund, Department of Health Services
David Todd - Supervising Land and Water Use Analyst, Department of Water Resources
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California Bay-Delta Authority Staff/Consultants

Tom Gohring - Assistant Deputy Director, Water Management
David Mitchell - M.Cubed
Lee Axelrad - Resources Law Group
Bennett Brooks - CONCUR, Inc.
Eric Poncelet - CONCUR, Inc.

APPENDIX 2

Participants – June 3, 2002 Urban Water Measurement "Brainstorming" Session

Scott Matyac (DWR)
David Todd (DWR)
Monique Wilbur (DWR)
Scott Hayse (DWR)
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Lucille Billingsley (USBR)
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Mike Hollis (Metropolitan Water District)
Warren Teitz (Metropolitan Water District) – *by phone*
Dana Haasz (Pacific Institute)
Eric Wesselman (Sierra Club)
Peter Vorster (Bay Institute) – *by phone*
Tom Chestnut (A & N Technical Services, Inc.) – *by phone*
Bill Madaus (Maddaus Water Management)
Julio Sanchez (Conservision)
Anil Bamezai (Western Policy Research) – *by phone*
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Mark Roberson (Independent consultant)
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Bennett Brooks (CONCUR, Inc.)
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Follow up interviews – Urban Water Use Measurement Experts

Scott Matyac (DWR)
Tracy Slavin (USBR)
Jay Lund (University of California – Davis)
Jacque De Bra (City of Davis)