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OVERVIEW OF WATER USE MEASUREMENT STAFF PROPOSAL

Agenda Item: 9
Meeting Date: February 11, 2004

Summary: The CALFED Record of Decision (2000) called for staff to: 1) develop a definition of appropriate water use measurement; and 2) work with the Legislature to prepare legislation that requires appropriate measurement of all water use in California. The definition of appropriate agricultural water use measurement was completed by an independent panel of experts in September 2003. Staff has also prepared a draft definition of appropriate urban measurement. Staff is currently crafting a proposal (for consideration at the Authority's April meeting) that will present suggested legislative, budgetary, and administrative actions for implementing appropriate measurement.

Recommended Action: This is an informational item only. No action will be taken.

Attached please find an Overview of the Agricultural Water Use Measurement (Attachment 1) and an Overview of the Urban Water Use Measurement (Attachment 2) that together provide an overview on the status of the Authority staff efforts to develop implementation approaches for both agricultural and urban water use measurement.

As you will see, staff has made significant progress in moving forward with discussions on these two topics. Over the past few months, the Program has convened multiple stakeholder-agency workgroups to provide informal, technically focused feedback on the evolving drafts. As well, staff has conducted outreach meetings to broaden stakeholder awareness of these activities and seek comment on the emerging approach. Prior to these ad hoc stakeholder meetings, an independent panel completed its definition of appropriate agricultural measurement (Attachment 3).

Given the interim nature of this briefing, it is possible that the final Staff Proposal approach may differ somewhat from the broad outline presented in the attached materials. Still, these materials provide an accurate picture of the current thinking related to this topic.

Fiscal Information

Not applicable

List of Attachments

Attachment 1 – Overview Agricultural Water Use Measurement
Attachment 2 – Overview Urban Water Use Measurement
Attachment 3 – Independent Panel on Appropriate Measurement of Agricultural Water Use

Contact

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Water Management
and Regional Coordination

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Attachment 1
Overview
California Bay-Delta Authority
Agricultural Water Use Measurement
Working Draft Implementation Approach

Section I: Background

Purpose
As California's water resources have become increasingly scarce, diverse stakeholder groups have recognized the importance of measurement to state and federal agencies trying to manage a much-in-demand resource[1]. Measurement can assist state and federal agencies in their efforts to achieve the following four key *water management objectives*:

1. Provide better information on statewide and regional water use to support planning;
2. Allow users to undertake and demonstrate the effects of water use efficiency measures;
3. Facilitate valid water transfers; and
4. Prevent over-allocation of water within the state.

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 called for the Authority to take a closer look at measurement, determine what is needed, and, as appropriate, put forward legislative or other strategies to bolster the current approach.

Authority efforts to date
To move forward with this task, the Program initially convened an Independent Review Panel to prepare a definition of appropriate measurement of agricultural water use. The Independent Panel on Appropriate Measurement of Agricultural Water Use met for nearly two years and held its final session in June 2003. Based on its deliberations, the Panel prepared a consensus definition of appropriate measurement for agricultural water use. (The definition, included in the Final Report, is available on the Authority's website.)

Following the Panel's deliberations, the Authority convened an informal ad hoc stakeholder work group – the Staff Work Group on Agricultural Water Use Measurement – to serve as a sounding board for the Program as it drafts an implementation approach based on the Panel's definition[2]. The Staff Work Group, consisting of a technically focused, staff-level group of agricultural, environmental and agency representatives, is currently ongoing. Authority staff intends to present a draft implementation approach to Authority advisory and decision-making bodies in the March/April 2004 timeframe (see section III below for a description of this process).

[1] CA Water Code calls for water to be put to beneficial use and for measures to be taken to prevent waste.
[2] A parallel process is moving forward on the subject of appropriate urban water use measurement.

Guiding considerations and principles
In the interest of creating a practical and durable measurement approach, Authority staff's development of an implementation strategy has been guided by the following *overarching principles* as well:

- Adhere to the Authority's overarching principles such as beneficiary pays and no redirected impacts;
- Streamline and rationalize state and federal reporting requirements to minimize redundancies and improve value of information;
- Use legislative remedies only when existing statutes and regulations are deemed insufficient to ensure implementation;
- Acknowledge and account for smaller water suppliers' resource limitations;
- Foster meaningful progress within both the agricultural and urban sectors;
- Stress incentives over penalties.

Section II: Key Elements

As noted earlier, Authority staff discussions related to an implementation approach are still ongoing. However, based on the Panel's report and the Authority's discussions to-date with the Staff Work Group, staff currently anticipates putting forward a proposed implementation package likely to focus on a handful of key actions. These critical needs – detailed below – apply most directly to the overarching State water management objectives mentioned earlier.

Critical Needs

1. ***State standards/protocols for recording/reporting agricultural water use***

   Description of need: Current state regulations require water suppliers to provide data in multiple formats and to multiple agencies. These requirements can place an unnecessary burden on water purveyors. Moreover, as there are no overarching standards and protocols to guide the way purveyors compile this data, the value of the information to the State is greatly diminished due to inconsistencies across water supplier data.

   Actions under consideration: Authority staff proposes to standardize how agricultural water purveyors compile and provide data to the State. Working closely with local water purveyors and other concerned stakeholders, the Department of Water Resources (DWR) and State Water Resources Control Board (SWRCB) would establish standards and protocols for collecting, recording, and reporting agricultural water measurement data and develop an electronic system for receiving, compiling, storing, managing, quality-checking, and making available this data. Efforts would be made to eliminate data recording and reporting redundancies. The timeframe for implementing these standards/protocols – still to be determined – would take purveyor constraints into account. Authority for this action would come from existing agency authorities.

2. ***Farm-Gate Deliveries***

Description of need: 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.

Actions under consideration: Authority staff proposes requiring agricultural water districts to report aggregated farm-gate delivery data to the state (DWR); the frequency and time-step of reporting is still under consideration. (Current farm-gate measurement practices – whether estimated or directly measured – are considered sufficient at this time 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.) Funding is needed to support state costs associated with reviewing and confirming data; it may also be needed to support water districts where actions are not locally cost-effective. Periodic reassessments are necessary to gauge the adequacy and validity of measurement and reporting practices and methodologies. Authority staff believes legislation will be necessary to implement such reporting requirements, as they represent a significant departure from current practice and legal authorities.

3. ***Surface Water Diversions***

Description of need: 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.

Actions under consideration: Authority staff proposes requiring direct diverters of surface water to measure all major surface water diversions using best available technologies such as flow-totaling devices, data loggers and telemetry. (Approximately 80% of all major diversions are already measured using such devices.) Additionally, staff proposes that direct diverters report this data to the State (State Board); the frequency and time-step of reporting is still under discussion. Diverters below a certain threshold (staff's current thinking is somewhere between 10 and 50 cubic feet per second) would be exempt from such requirements. Funding is needed to support state costs associated with reviewing and confirming data; it may also be needed to support water districts' initial implementation. Authority staff believes legislation will be necessary to implement such reporting requirements, as they represent a significant departure from current practice and existing authorizations.

4. ***Groundwater Use Assessment***

Description of need: 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.

Actions under consideration: Authority staff proposes that the State (DWR) perform continuous regional characterization of groundwater net usage in all sub-basins statewide. This approach – expected to cost the State an additional $2 million per year – would enable the State to better monitor the overall status of groundwater in the state. It would not entail any additional measurement of individual self-supplied groundwater use outside of what is already required in adjudicated and managed basins. Implementation of this action would be coordinated with ongoing revisions to the California Water Plan. Performing this assessment is seen as falling under DWR's existing responsibilities; no new legislation or regulation is anticipated.

5. ***Crop Water Consumption***

Description of need: 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.

Actions under consideration: Authority staff proposes that the State (DWR) incorporate into its ongoing estimate procedures the use of satellite-generated remote sensing of evaporative crop water consumption, with a monthly time step, during the growing season. This approach – expected to cost the State an additional $500,000 per year – would have no direct impact on growers or districts. Implementation of this action would be coordinated with ongoing revisions to the California Water Plan. Performing this assessment is seen as falling under DWR's existing responsibilities; no new legislation or regulation is anticipated.

6. ***Research and adaptive management programs***

Description of need: Improving the state's ability to forecast and plan for future agricultural water demands requires a fuller understanding of how water is used by the agricultural sector and how this is changing over time due to evolving land use patterns, demographics, technology, and economics. Previous State Water Plan Updates have been characterized by the use of very general and simplified assumptions to predict future agricultural water demand.

Actions under consideration: Authority staff proposes a two-pronged strategy to address this concern:

a. *Research Program:* State agencies would work with water purveyors and universities/research organizations to develop and sustain an agricultural water use research program. The Authority Science Board would establish a priority list for research to be performed. Among the current research items designated as having the highest priority is to define appropriate water use measurement as it relates to return flow, water quality and in-stream flow.

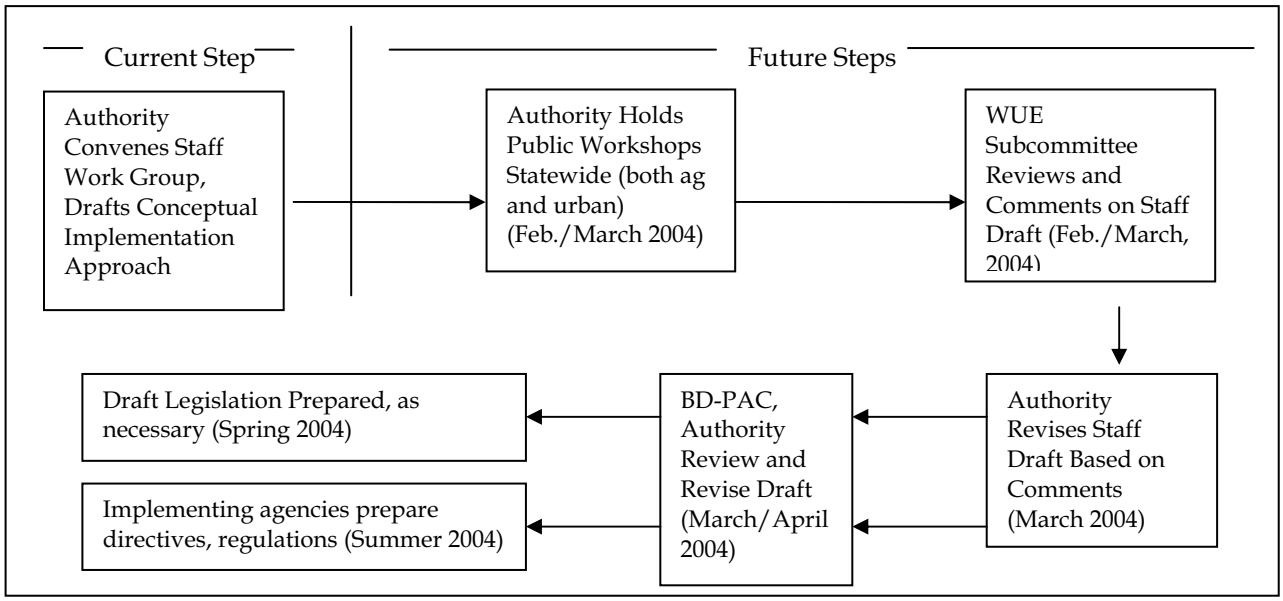
b. *Adaptive management:* State agencies (Authority Science Board working in conjunction with DWR and other State Water Plan actors) would identify and pursue adaptive management needs for measurement as appropriate over time. This adaptive management program would serve to evaluate the adequacy of agricultural water use information available and the effectiveness of the measurement actions adopted.

Other Elements. Additionally, staff anticipates that a final implementation approach will reiterate the importance of ongoing measurement activities, such as the requirement that groundwater substitution transfer permittees measure and report groundwater use per existing state agency guidance. As well, staff is still refining critical components of its approach, such as assurances, cost estimates and implementation timelines.

Section III: Anticipated Process and Timeline

The approach outlined in this document is a staff-driven proposal informed by numerous discussions with Authority agencies and with a diverse subset of agricultural water supplier and environmental stakeholders. The approach will be further reviewed and refined through a public process that will include informal briefings with affected communities, as well as formal review and discussion with Authority public advisory bodies and Authority. (See Figure 1 below.)

Figure 1: Expected Process to Develop an Ag Water Use Measurement Implementation Approach



Expected steps in the process include the following:

- **Public Outreach Meetings.** Authority will initiate a series of discussions with affected stakeholder communities to elicit wider reactions to and feedback on the proposed implementation approach. This review, which may coincide with public review of a parallel

proposed implementation approach for urban water use measurement, is expected to include regional rollout sessions throughout the state.

- **Authority Policy-Level Review.** WUE staff will discuss its recommended approach with various Authority advisory and decision-making bodies, including the WUE Subcommittee, the Bay-Delta Public Advisory Committee and the Authority.

Following these discussions, Authority staff will work with state policymakers, as necessary, to put forward an implementation approach. This approach will likely necessitate state legislative changes, administrative changes or both.

Attachment 2
Overview
Urban Water Use Measurement
Working Draft Implementation Approach

Section I: Background

Purpose
As California's water resources have become increasingly scarce, diverse stakeholder groups have recognized the importance of measurement to state and federal agencies trying to manage a much-in-demand resource.[1] Measurement can assist state and federal agencies in their efforts to achieve the following four key *water management objectives*:

1. Provide better information on statewide and regional water use to support planning;
2. Allow users to undertake and demonstrate the effects of water use efficiency measures;
3. Facilitate valid water transfers; and
4. 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 called for the Authority to take a closer look at measurement, determine what is needed, and, as appropriate, put forward legislative or other strategies to bolster the current approach.

Authority efforts to date
Based on this ROD commitment, Authority staff undertook a series of interviews with stakeholders and technical experts in the urban water arena and convened an informal ad hoc stakeholder work group (the Urban Water Use Measurement Staff Work Group). The Work Group has served as a sounding board for Authority staff in their efforts to: 1) define "appropriate" urban water use measurement,[2] and 2) develop an implementation approach based on this definition. This technically focused, staff-level work is ongoing.[3] Authority staff intends to present a draft implementation approach to Authority advisory and decision-making bodies in March and April 2004 (see section III below).

Guiding considerations and principles
The Authority has based its efforts to craft a new strategy for measuring urban water use on an assessment of the need for improved measurement, declared water measurement policy of the state of California, industry practice and standards, the practicality and feasibility of the steps involved, and anticipated long-term state water management benefits. Staff has also been guided by the following *overarching principles*:

- Use legislative remedies only when necessary;
- Streamline and rationalize state and federal reporting requirements;
- Acknowledge and account for smaller water suppliers' resource limitations;
- Seek parity – not symmetry – across agricultural and urban sectors; and

[1] CA Water Code calls for water to be put to beneficial use and for measures to be taken to prevent waste.
[2] The most current draft definition may be found on the CBDA website (http://calwater.ca.gov/Programs/WaterUseEfficiency/WaterUseEfficiencyUrbanWaterMeasurementAdHocWorkgroup.shtml).
[3] A parallel process is moving forward on the subject of appropriate *agricultural* water use measurement.

- Stress incentives over penalties.

Section II: Key Elements

Authority staff has taken a comprehensive look at urban water use measurement needs in the areas of urban water purveyor supplies (both surface water and groundwater) and deliveries and urban wastewater discharger collection and discharge. Current thinking suggests five critical areas where change is needed most to help the State meeting its overarching water management objectives.

Key Elements -- Requiring Changes in Urban Water Measurement

1. ***State standards/protocols for recording/reporting urban water use***

   Description of need: Current state regulations require water suppliers to provide data in multiple formats and to multiple agencies. These requirements can place an unnecessary burden on water purveyors. Moreover, as there are no overarching standards and protocols to guide the way purveyors compile these data or centralized system to store and retrieve the data, the value of the information to the State is greatly diminished due to inconsistencies across water supplier data.

   Actions under consideration: Authority staff proposes to standardize how urban water purveyors compile and provide data to the State. Working closely with local water purveyors, pertinent state agencies (e.g., the State Water Resources Control Board and the Department of Health Services), and other concerned stakeholders, the Department of Water Resources (DWR) would establish standards and protocols for collecting, recording, and reporting urban water measurement data and develop an electronic system for receiving, compiling, storing, managing, quality-checking, and making available this data. This computer-based data system would allow local purveyors to report data in a convenient format and data users to access targeted data. A priority would be placed on eliminating data recording and reporting redundancies. The timeframe for implementing these standards/protocols – still to be determined – would take purveyor constraints into account. State agencies currently have statutory authority to implement this action.

2. ***Metering of urban customer deliveries***

   Description of need: For decades, many of California's diverse regions have pursued a policy of metering urban water purveyor customer water deliveries. Empirical research conclusively demonstrates that metered water service coupled with volumetric pricing can reduce water demand by 20-25% or more.[4] Currently, approximately 7% of urban water deliveries in the state have no requirement to meter.

   Actions under consideration: Authority staff proposes requiring the use of suitable water meters at all customer connections to the water delivery system. This proposal is consistent with the Authority's proposed Urban Water Use Efficiency (WUE) Certification Program (BMP 4). In cases where retrofitting is not locally cost effective, purveyors would

[4] 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.

be eligible for grant funding or could defer timeline for implementation. Legislative action is expected to be required to implement this action.

3. ***Reporting of urban water source and delivery data***

Description of need: As part of its responsibilities to "plan for the orderly and coordinated control, protection, conservation, development, and utilization of the water resources of the state,"[5] DWR is required by law to release assumptions and other estimates used for the California Water Plan (e.g., current and projected population, current and projected water uses for various user categories). To determine this information, DWR administers annually a survey of about 700 urban water purveyors. This current approach suffers from several shortcomings. Individual surveys are frequently incomplete or improperly filled out, the data is at times unreliable, and the survey does not always provide good geographic representation.

Actions under consideration: Authority staff proposes that urban water purveyors report water sources and customer deliveries data *annually* to the State (for most water purveyors, this constitutes an increase in the frequency of reporting from every five years to every year). These reports should include monthly production data and monthly or bi-monthly (every two months) customer delivery data. They should also conform to the state water data collection, recording, and reporting protocols. Legislation is expected to be required to assure compliance with existing requirements or as part of defining a specific authority to impose detailed reporting requirements. A size threshold for exempting smaller purveyors from the reporting requirement will be established to account for cost-benefit considerations. The timeframe for implementing this action will take into account the water management benefits of improved information and the economic and logistical constraints that increased reporting requirements pose for urban water purveyors.

4. ***Groundwater Assessment***

Description of need: State water planners currently have an incomplete understanding of water withdrawal and consumption by groundwater users. This pertains in particular to non-adjudicated basins, which constitute the majority of groundwater basins in the state. This impedes the State's (and regional/local government's) ability to plan for growth and more effectively manage groundwater resources in times of drought.

Actions under consideration: Authority staff proposes that the State (DWR) perform continuous regional characterization of groundwater net usage in all sub-basins statewide. This would enable the State to better monitor the overall status of groundwater in the state. It would not entail any additional measurement of individual self-supplied groundwater use outside of what is already required in adjudicated and managed basins. Implementation of this action would be coordinated with ongoing revisions to the California Water Plan. Performing this assessment falls under DWR's existing responsibilities; no new legislation or regulation is anticipated.

5. ***Research and adaptive management programs***

[5] Cal. Water Code, § 10004.

Description of need: 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 is changing due to evolving land use patterns, demographics, technology, and economics. Previous State Water Plan Updates have been characterized by the use of very general and simplified assumptions to predict future urban water demand.

Actions under consideration: Authority staff proposes a two-pronged strategy:

a. *Research Program:* State agencies would work with water purveyors and universities/research organizations to develop and sustain an urban water use research program. The Authority Science Board would establish a priority list for research to be performed.

b. *Adaptive management:* State agencies (Authority Science Board working in conjunction with DWR and other State Water Plan actors) would identify and pursue adaptive management needs for measurement as appropriate over time. This adaptive management program would serve to evaluate the adequacy of urban water use information available and the effectiveness of the measurement actions adopted.

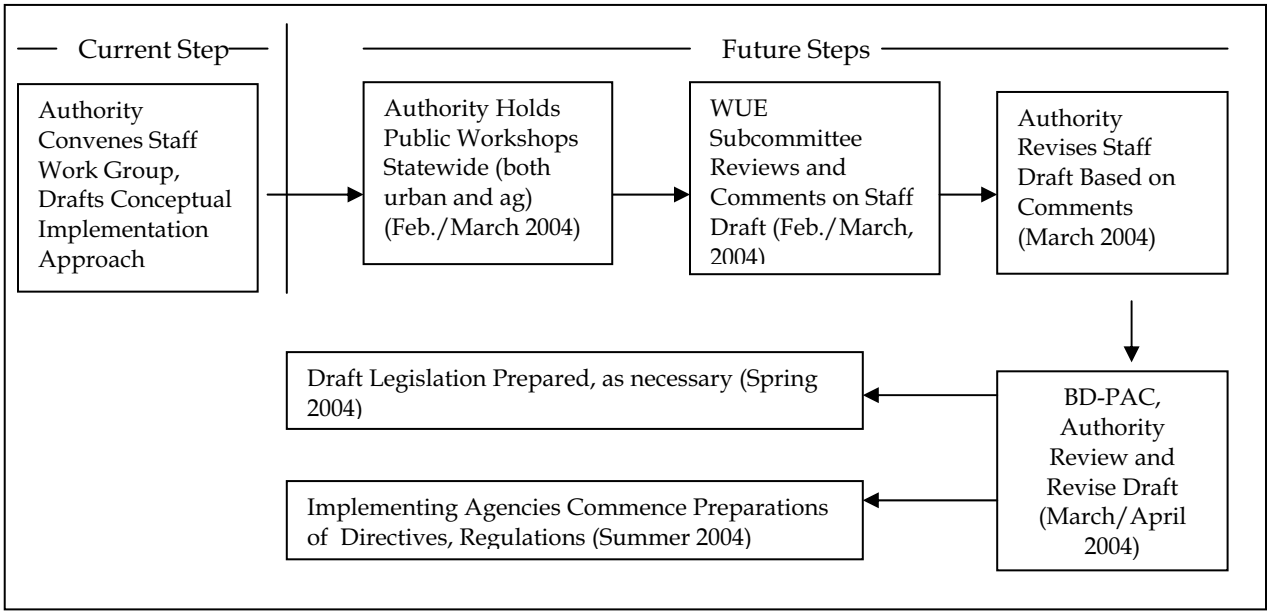
Other Elements -- Not Requiring Changes in Urban Water Measurement

Additionally, staff anticipates that a final implementation approach will reiterate the importance of ongoing measurement activities, such as the requirements that urban water purveyors measure water sources and production, wastewater dischargers measure and report wastewater discharges, self-supplied groundwater users in adjudicated basins measure and report per existing judicial rulings, and groundwater substitution transfer permittees measure and report groundwater use per existing state agency guidance. As well, staff is still refining critical components of its approach, such as assurances, cost estimates, and implementation timelines.

Section III: Anticipated Process and Timeline

The approach outlined in this document is a staff-driven proposal informed by numerous discussions with Authority agencies and with a diverse subset of urban water supplier and environmental stakeholders. The approach will be further reviewed and refined through a public process that will include informal briefings with affected communities as well as formal review and discussion with Authority public advisory bodies and Authority. (See Figure 1 below.)

Figure 1: Expected Process to Develop an Urban Water Use Measurement Implementation Approach



Key steps in the process include the following:

- **Public Outreach Meetings.** Authority staff will initiate a series of discussions with affected stakeholder communities to elicit wider reactions to and feedback on the proposed implementation approach. This review, which may coincide with public review of a parallel proposed implementation approach for agricultural water use measurement, is expected to include regional rollout sessions throughout the state.

- **Authority Policy-Level Review.** Authority staff will discuss its recommended approach with various Authority advisory and decision-making bodies, including the WUE Subcommittee, the Bay-Delta Public Advisory Committee, and the Authority.

Following these discussions, Authority staff will work with state policymakers, as necessary, to put forward an implementation approach. This approach will likely necessitate state legislative changes, administrative changes, or both.

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.

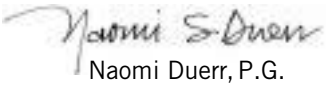
The recommended definition of appropriate agricultural water use measurement builds upon the extensive technical analysis conducted by Authority staff and consultants. The Panel believes the analysis is both consistent with past Panel guidance and sufficient to support the Panel's deliberations.

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.



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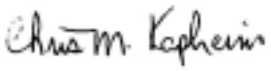

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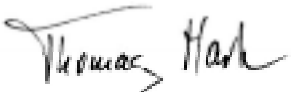

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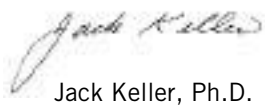

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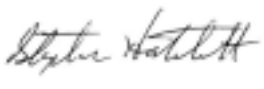

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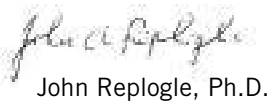

John Replogle, Ph.D.
U.S. Water Conservation Laboratory

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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 associated appendices can be found on the California Bay-Delta Authority's website (under the Water Use Efficiency section) at: http://calwater.ca.gov