Improving Analytical Procedures Used to Describe Future Water Conditions for the California Water Plan

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A major change in California Water Plan, Bulletin 160-05, is the departure from the analytical procedures used in previous water plans to describe future water conditions for California. Because of the limitations discussed below, the continued application of prior analytical procedures to describe future water conditions was commonly seen by Water Plan Advisory Committee members to have limited conceptual and practical value for planning and policy, and at worst had the potential to lead decision makers in the wrong direction in their water planning and policy-making. While the new plan has departed from this traditional analysis, it has not yet been replaced with a more comprehensive approach backed by stakeholder consensus. Here, we review the analytical procedures used in the previous Water Plan, Bulletin 160-98, and discuss where improvements need to occur. This paper builds on a related, unpublished opinion paper by Dr. Jay Lund of UC Davis and Dr. Robert Wilkinson of UC Santa Barbara entitled, "Mind the Gap: Traditional versus Modern Supply and Demand Analysis for California Water", dated June 14, 2005.

What was Done in Previous Water Plans?

Previous California Water Plans compared projected average year water uses to projected average year water supplies to estimate a shortage or surplus, so-called "gaps", statewide and by region. This general approach has appeared in State water plans of 1930 and 1957 through 1998, with the addition of "drought" years appearing in the 1993 and 1998 plans.

In Bulletin 160-98, estimates were made of current level and future level water uses and supplies, with the difference shown as a gap. Then, possible future water management options were compared to initial screening criteria to identify those water management options suitable for further evaluation. This analysis was performed for two water supply scenarios – typical average year and drought year, for both current conditions and future conditions. Water budgets were presented as a statewide summary and a summary for each of the state's 10 hydrologic regions. By necessity these summaries simplified what was happening at the local scale. However, the actual analysis was performed at a much smaller geographic scale. The major steps in the Bulletin 160-98 planning process are summarized in the box.

Summary of the Bulletin 160-98 Water Management Options Evaluation Process

- Identify water demands and existing water supplies on a regional basis.
- Compile lists of regional and statewide water management options.
- Use initial evaluation criteria to either retain or defer options from further evaluation. For options retained for further evaluation, group some by categories and evaluate others individually.
- Identify characteristics of options or option categories, including costs, potential demand reduction or supply augmentation, environmental considerations, and significant institutional issues.
- Evaluate each regional option or category of options in light of identified regional characteristics using criteria established for this Bulletin. If local agencies have performed their own evaluation, review and compare their evaluation criteria with those used for the Bulletin.
- Evaluate statewide water management options.
- Develop tabulation of likely regional water management options.
- Develop a statewide options evaluation by integrating the regional results.

Areas Where Current Analytical Capabilities Need to be Improved

Several factors have caused DWR to rethink how it evaluates California's future water conditions. First, there is a need to provide policy-makers and the public with more detailed quantitative information about the costs, benefits, and broad social, environmental, and economic tradeoffs associated with different water management strategies. Second, data, analytical tool development, and data management have not kept pace with growing public awareness of the complex interactions among water-related resources. Finally, California lacks a consistent framework and standards for collecting, managing, and providing access to data and information on water and environmental resources essential for integrated resource planning. More accurate data and analytical tools and better information management can reduce many uncertainties about the state's current and future water resources: how water supplies, demands, and quality change in response to different resource management strategies; how ecosystem health and restoration can succeed; and how we can adapt our water system to reduce controversy and conflicts.

Any evaluation of future water supply and demand conditions requires more robust data, estimation methods, and analytical tools. The use of estimation methods and analytical tools is unavoidable because data for the future is largely unavailable. Stakeholders have raised concerns about estimates, estimation methods, transparency, and documentation procedures used for past Water Plan Updates. However, these concerns are not unique to the Water Plan. In fact, there are no existing tools that address these problems sufficiently to be used for the Water Plan without significant modification. The following are some of the specific limitations identified by the Water Plan Advisory Committee and Water Plan staff related to analysis performed in Bulletin 160-98.

Data. The Water Plan is statewide in scope. Much of the basic water supply and demand data are limited in availability, quality, transparency, and documentation. An example is groundwater data, where there is insufficient data available statewide and insufficient staff resources to conduct a comprehensive assessment of future groundwater conditions. Bulletin 160-98 responded to this by estimating groundwater use based on land use, unit water use and supply source. However, this approach prevents a full description of future groundwater storage conditions, groundwater recharge, and the connection to surface water.

Water Flow and Operations Models. Commonly, computer models are needed to estimate how water will be stored and allocated to produce water deliveries or supplies to various areas over a range of projected conditions. However, currently available operations models do not capture the complexity of the water management system to study questions raised by decision makers and stakeholders. For example the CALSIM II model underwent a significant stakeholder review in 2003 through the California Bay-Delta Authority Science Program. The review affirmed CALSIM's use of an optimization engine for hydrology simulation and allocation decisions, the model's numerous recent improvements, and successes addressing many of the complexities of the SWP and CVP systems and water management decisions. The review also identified many areas of needed improvement including determination of local water supplies, description of the groundwater system, and the geographic scope. Stakeholder uncertainty about

the operations models used to generate information for the Water Plan added to the uncertainty and controversy of Bulletin 160-98 water supply and water use projections.

Forecasts of Future Water Uses. Future water use can be estimated by employing computer models. While Bulletin 160-98 used a state of the art water use forecasting model (Water Savings Simulation Program), the Bulletin failed to adequately communicate the details of the model and how it was applied. More sophisticated models of water demand like IWR-MAIN have yet to be applied on a statewide scale and must be proven to provide the kind of transparent, documented, and tested methods desirable for a more open planning analysis of water in California.

Scenarios. Different assumptions about the future can significantly affect the nature and outcome of various mixes of management strategies. Some management strategies may be effective and economical for a wide range of scenarios. Other strategies may be more suited if specific conditions develop in the future. Bulletin 160-98 examined a single "likely" future for two supply scenarios (average and drought conditions). Multiple scenarios of baseline conditions offer water planners, decision makers, and stakeholder's new insight into the key assumptions related to water supply and demand and reveal opportunities to make critical management changes.

Consumptive and Non Consumptive Water Uses. The concepts of consumptive water use and non consumptive water use are critical to understanding the movement of water in the system. Consumptive demands include activities that deplete water from the water management system by evaporation, evapotranspiration, or flows to saline water bodies. Non-consumptive demands include activities that require a specific quantity of water at a particular location and time, but do not deplete water from the water management system. This includes releasing water for hydropower production, instream flows, or the portion of municipal water use that flows to a wastewater treatment facility and is later released to a stream or recharged to groundwater. While the Bulletin 160-98 analysis did explicitly account for both consumptive and non-consumptive water uses, this information was not presented in a way that was easy to understand.

Economic Efficiency. The role of economics in forecasting water use and evaluating management options is becoming a larger part of water planning. A gap between a supply and forecasted use does not mean that more water is "required" to fill the entire gap because economic efficiency should still be considered. Considering economic efficiency means that the economic benefits received by reducing the scarcity of water should be compared to the costs before implementing new water management strategies. Improved methods for implementing a more strategic view of water management planning now exist and should be used. These new methods improve the determination of the effects of economic factors on water use, the evaluation of the scarcity value of water, and the evaluation of the economic justification of specific water management options. Bulletin 160-98 did use some economic concepts related to agricultural markets and population and urban income growth in water use forecasts, but the economic assumptions were not transparent, the economic efficiency criterion was not specifically applied, and the economic analysis was not done as comprehensively as some stakeholders wanted.

Hydrologic Variability. California's size, ocean influence, and varied geography result in a varied climate, which adds to the difficulties of predicting future hydrologic conditions. Water availability and use varies significantly over a wide range of wet to dry years, including persistent series of wet and dry years. The presentation of a water balance for single "average" and "drought" years in Bulletin 160-98 did not provide enough details on many important water management activities that store water in wet years (or wet seasons) for use in dry years (or dry seasons), and the frequencies of surplus or shortage quantities. A wide range of wet and dry events is important for planning and policy, helping us identify particularly worrisome conditions and promising opportunities.

Water Quality. Bulletin 160-98 had limited representation of problems and opportunities regarding water quality. Many water operations today are driven by water quality objectives. Improvements are needed in procedures to integrate water quality with water quantity. Limited availability of water quality data is a significant obstacle to implementing this goal.

Single-objective. Bulletin 160-98 summarized the performance of the water system with respect to only an average year and drought year water supply objective. While this might have once been sufficient, California's water management objectives are now much more diverse, complex, and inter-twined. Many objectives were considered in the Bulletin 160-98 planning process when screening potential water management options. These included potential negative effects or barriers associated with engineering limitations, economic factors, the environment, institutional or legal factors, social and third party considerations, and human health. However, these objectives were evaluated outside of the analytical procedures used to estimate future water use and supply. A major challenge is to integrate water management objectives with the water use and supply analysis in a transparent and robust way to better evaluate the costs, benefits, and tradeoffs associated with competing water management options.

Groundwater Management. Some parts of California have persistent overdraft of groundwater. In the short-term, such overdraft is used as a supply. In the long-run, such overdraft can lead to water quality degradation, land subsidence, increased pumping costs on water suppliers, and other problems. The analytical procedures applied in Bulletin 160-98 did not lend itself to adequately evaluate and describe groundwater management in California including the effects of groundwater overdraft and the ability to integrate groundwater and surface water management for multiple objectives. The limited availability of groundwater information is a major barrier to implementing a more integrated analysis.

Transparency and Level of Detail. As stated earlier, Bulletin 160-98 presented water balances as a statewide summary and a summary for each of the state's 10 hydrologic regions. By necessity these summaries simplify what is happening at the local scale. Unfortunately these simplified summaries of average year supplies and demands has led to the perception that there are straightforward solutions to California's water problems. The lack of regional details about water uses, supplies, and water management strategies also tend to mask the reality, complexity, problems, and opportunities for water planning and policy in California, particularly from the perspective of a local water agency.

What should come next?

There is considerable agreement that California needs some sort of quantitative analysis of future water use and supply conditions. However, there is little consensus as to the precise form this

analysis should take. DWR is working to reach consensus with the Water Plan Advisory Committee on an improved analytical approach in forthcoming water plans. Several efforts to improve analytical capabilities for statewide water planning are being undertaken, notably by the California Water Plan, the CALFED Surface Storage program, and the California Water and Environmental Modeling Forum (cwemf.org). And several major water suppliers in California already employ sophisticated and insightful forms of water supply and demand analysis, notably Metropolitan Water District of Southern California and San Diego Water Authority. This is a difficult transition in Water Plan analysis, from projected, average year water uses and projected average year water supplies, to an approach showing robust, diversified, and cost-effective portfolios of local, regional, and statewide water management activities for multiple objectives over a range of hydrologic and future conditions.

DWR outlined some initial directions for improving analytical procedures in Chapter 4, Volume 1 of Bulletin 160-05. This included a partial application of an approach to implement multiple scenarios of future baseline conditions in the Water Plan. The information in Chapter 4 is further elaborated on in several Bulletin 160-05 Reference Guide articles (Volume 4) in the section, “Data and Analytical Tools”. DWR is also collaborating with others to investigate new, cutting edge approaches to water planning. Some immediate next steps for DWR are described in a concept paper, “Recommended Next Steps for Improving Quantitative Information for the California Water Plan”. This concept paper (also in Volume 4) will be used to start discussions with other planning entities, decision makers, and stakeholders to develop a long-term approach for improving analytical procedures used for statewide water planning.