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October 8, 2021

To: Members of the Delta Independent Science Board

From: Richard B. Norgaard

Richard B. Norgaard

Re: Addendum to my comments of 211001

I would like to clarify my concern about the lack of a conceptual model that I expressed in my earlier comments on the public draft Water Supply Reliability Estimation (WSRE) Report dated October 1. I am placing these additional comments and their implications as a preface to and in front of my earlier comments.

As I understand the water system simulation models of this report, California is modeled as an isolated unit, simulating historic data to foresee the consequences of alternative storage and release decisions in a probabilistic format derived from historic variations. There is surely more to the simulation models than this, but this is my basic understanding. My understanding would be deeper if this report provided a constructive, critical description of the simulation models and their strengths and weaknesses. The key point to my understanding is that the simulation models and probabilities are rooted in the past and modeled as if California were an isolated relatively stable system with variation around a mean (even though the distribution of precipitation is bimodal).

I would suggest starting with a conceptual model of California as a terrestrial portion of a warming planet on the eastern edge of the Pacific Ocean. With warmer ocean and air temperatures, storms off the Pacific can bring more rain. Yet we also know that this is highly variable. We now know more about how warming is changing ocean dynamics and resulting in extreme floods and droughts. At the same time, also very important, warmer land surface and air temperatures increase evapotranspiration rates that affect the quantities of water from precipitation that is delivered to reservoirs, the ability of reservoirs to store water from year to year, and the effectiveness of water delivery. We also know more about how the atmosphere and oceans are behaving under warming and producing extreme floods and droughts in California. The WSRE ought to be starting with the fact that California is a part of a larger hydrological system in transition and exploring what kind of water modeling might work best under these conditions.

Instead, the WSRE strikes me as anchored to the historic models with three things pulling in different directions on the anchor line: 1) the unmentioned consequences of poor decisions made over past decades without climate change in the models, 2) the mostly unmentioned advances in climate science, and 3) our vastly superior computer modeling capabilities that are little mentioned in the report.

The WSRE Report mentions climate change repeatedly with some detail of the challenges on page 15. On page 33 we learn that water supply reliability estimators have been addressing the challenges of climate change, but we learn nothing about how this is being done, how well these efforts have worked, and what has been learned from them. The section specifically addressing climate change starting on page 34 starts with a quote dated 1991: "Another area that remains to be addressed is the management response to long-term climate change." But 30 years later, this report does not actually address the modeling challenges and how they are being met, or how the model results are complemented by climate related information in the process of making water reliability estimates. If there has been effort with only modest results, the Delta ISB should be informed of this and what has been learned. If there has not been significant effort, then there is an institutional problem that needs to be addressed. Either way, the WSRE Report misses the mark.

I hope this helps clarify my comments of a week ago and helps further explain why I do not find this report scientific in nature and do not recommend approval of this draft. My apologies for being more judgmental than clear a week ago.

October 1, 2021

To: Members of the Delta Independent Science Board

From: Richard B. Norgaard

Re: 2021.09.01 public draft of the *Water Supply Reliability Estimation Report*

I do not recommend approval of the 2021.09.01 public draft of the *Water Supply Reliability Estimation Report* (hereafter WSRE or current draft). Even within its defined narrow scope, this draft does not address the science behind the water models and estimators and how that science is changing. The WSRE has been presented to the board as addressing a highly technical issue on which the primary author is an expert, but techniques must be scientifically based. The current report does not assess how the models and estimators have worked with respect to key hydrological events and proposed projects in California. It does not compare the models and estimators used and being proposed in California with those used and proposed in similar regions, particularly the Colorado River Basin, to determine whether California is using the best available science. The independence of the primary author is an issue. The WSRE is not a scientific product and should not be approved by a board charged with assessing the science in support of adaptive management.

On the Science. The 2021.09.01 public draft of the *Water Supply Reliability Estimation Report* centers on existing water simulation models and estimators developed over past decades but the review lacks scientific framing and analysis.

- In my judgment, a proper assessment of water simulation models and reliability estimators would lay out the conceptual models behind the scientific framework and assumptions that went into their design. This report, however, does not discuss what the conceptual models, whether explicit or implicit, were at the time the simulation models and estimators currently being used were constructed.
- The current challenges are mentioned in the WSRE, but they are not tied into the underlying scientific framing and assumptions of the current water simulation models and estimators.
- A proper assessment would try to match the current challenges of providing water reliability with a conceptual model based on the best available science that helps organize and explain why these challenges have arisen. Clearly, the most important current challenges to WSRE have arisen through climate change.

- Over the past half century, the sciences of how global warming is affecting the climate of California have improved dramatically. We also now know more about how climate change is affecting watersheds through vegetation change, fire, and new patterns of erosion. The challenge is to incorporate this new knowledge into water models and reliability estimation.
- The review incorporates interview responses largely from water managers and modelers rather than largely from climate and water scientists. Similarly, the questions asked do not dig into the science.
- While the report notes that California has extremely wet and extremely dry periods, it does not elaborate on how current water simulation models and techniques for estimating water supply reliability address the marked bimodal nature of precipitation in California. Knowing when a switch from one mode to the other will occur is a fundamental issue for making water management decisions.
- We have known for many decades that wet years in California are associated with El Nino conditions, and dry years with La Nina conditions tied to the location of large areas of warm surface water in the Pacific Ocean. Climate scientists are learning more about the El Nino – Southern Oscillation and how it is changing. Yet the WSRE does not even mention the basic terms known to many Californians, indeed to many people around the world because of their great importance.
- Climate scientists have been arguing for decades that climate extremes would become greater, and this has been corroborated over the past decade in California and around the world. Again, the WSRE does not incorporate this fundamental scientific understanding.

Without discussion of the new developments in global change science and their implications for the conceptual framings of water models and reliability estimation, the WSRE cannot assess the quality of the existing models and estimators and make meaningful proposals for new models and estimators for use adaptive in management for water reliability. Climate change is mentioned in the report, but the specific scientific developments of climate science and global change science are not. Similarly, while the report mentions that important topics are addressed in numerous articles in the scientific literature, it does not note the specific findings of these articles and how they provide insights into past models and estimators and inform the possibilities for new improved ones.

On the Empiricism. The WSRE fails to address how well current water simulation models and reliability estimators that inform adaptive management decisions have been working in practice. Real issues in the past are sometimes mentioned, but the report does not adequately address what has been learned from them and how the models and estimators have been adapted.

- The current report does not investigate whether and how challenges of the recent floods and droughts, including the near disaster at Oroville Dam, may have occurred in part because of existing models and estimators. How are these experiences

providing lessons that are, or at least could be, instigating adaptive responses in the design and use of models and estimators?

- The WSRE does not investigate how well current models and estimators are working in the analysis of the proposed Sites Reservoir, let alone the much greater challenge of the proposed Delta tunnel.
- The current report notes that a new model has been in development for some time, but it does not use this experience to help us understand what challenges are being addressed and why it is difficult to do so.

Comparative Assessment. The WSRE does not investigate how water models and reliability estimates are designed in other regions. The Colorado River Basin has been experiencing major droughts as well as unusual wet periods and the region is undergoing a major reassessment of its water reliability. On a smaller scale, though still entailing very size-able populations, the eastern front of the Rockies and the western front of the Wasatch are learning with and adapting to how climate is affecting their water reliability. Surely something can be learned by investigating how other areas deal with their water reliability challenges. This is one of the best ways to determine whether what is being done in California is the best available. One of the reasons the Delta Independent Science Board has sought a mix of in-state and out-of-state members is to avoid intellectual insularity.

Independence of the Primary Author. Lastly, I am concerned with the conflicts of interest of the primary author of the WSRE. The independence of reviewers is essential to the scientific process. The legislature was concerned about this possibility and inserted a provision into the Delta Reform Act of 2009 to help avoid this possibility. The California Water Code [§ 85280 (through 2012 Leg Sess) a2] states that: *The members shall not be directly affiliated with a program or agency subject to the review activities of the Delta Independent Science Board*. The WSRE has been led by such a board member with respect to this topic. Much of the material reviewed is authored or coauthored by this member or directly affiliated with this member's institution in which he has played a leading role in water research. In this respect, I am concerned that the scope, focus, and framing have been constrained by this board member's expertise with additional material then added on without being integrated. No doubt this problem has been exacerbated by the pandemic, change in board members, and difficulties in retaining appropriate compensation for board members, but this should not excuse correcting the problem.

A Full Assessment of Water Reliability. A review of the science in support of adaptive management for water reliability in California is still very much needed. California needs to transition effectively in how it manages and uses water in response to emerging climate change realities. The energy transition that has taken place over nearly half a century in California provides a very important model of adapting the production, distribution, and use of energy to new knowledge and conditions.

Global change science should provide the conceptual model from which new practical models for water reliability policy and management are assessed. It is global warming that is driving the intensity with which heat is being redistributed from the equator toward the poles and into the ocean deep and changing terrestrial temperatures, precipitation, and evapotransporation. California's place in the global hydrologic system constrains how Californians can live. That hydrological system is different than it was when the water simulation models were built. Furthermore, climate change is not simply a new stage. It is ongoing change requiring an ongoing, future-looking water models and decision rules that adapt to changing times.

Like the assessment of monitoring being undertaken by the Board and Delta Science Program, substantial funding will be needed to bring in additional scientific expertise to undertake a full assessment of water reliability science and its incorporation in policy and adaptive management. The Board will need the assistance of dedicated Delta Science Program staff. The Board could play an important role in the design of such an assessment. The Board could effectively query experts specifically tasked to undertake a review, query other regional climate and water scientists, and play a key role in interpreting the findings and making recommendations.

To repeat, because of the considerable shortcomings in the WSRE, I do not recommend approval of the current draft, even as a step toward a full assessment of water reliability in California. I acknowledge that the past reviews undertaken by the Delta ISB have varied in their approach and that none have been ideal for a variety of reasons. Nevertheless, in my judgment, the multiple departures from the ideal in this case cast a deep shadow on the current report's findings and recommendations and threaten the integrity of the Delta ISB. I am especially concerned because the WSRE avoids discussion of the underlying science of past models and estimators and does not incorporate new scientific understanding from climate and global change science. The scientific shortcomings of this report are too important to stand as a document of the Delta Independent Science Board.