Memorandum

To: The Water Supply Advisory Committee

From: Rosemary Menard, Nicholas Dewar, Karen Raucher

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Subject: Scenario Analysis Process Outline

This memorandum provides the Water Supply Advisory Committee (WSAC) with an overview of the scenario process that we will use in the Real Deal.

Our objective in writing this memorandum is to ensure that we all have a common understanding of the scenario process, including:

- Why scenario analysis is a good analytic tool for the WSAC
- How multi-criteria decision support (MCDS), criteria, and simple scenarios already used by WSAC fit into the next steps of the scenario analysis process
- How to use risk assessments to build scenarios
- How Committee members can use information developed by the Technical Team as they work with scenarios and portfolios.

The definitions in Box 1 and in the working glossary (also in the February materials packet) are provided to ensure that all readers have a shared understanding of the terms we use in this memorandum and this context. Please let Nicholas know if you want to discuss the definitions or how we are using them.

Box 1. Definitions

Decision support tools – Techniques used to help groups reach agreements (e.g., MCDS, Interest Based Bargaining).

Analytic tool – A technique for organizing and sharing information that increases its usability for decision-making (e.g., scenario analysis, triple bottom line, risk assessment, MCDS).

System – The components of the water system, from source to tap (simulated in the Confluence model).

Risk Assessment – Identification of the factors that make a system vulnerable; risk equals probability of an event occurring multiplied by its consequences (e.g., seismic and drought events).

System Plan – The set of management actions selected to meet future needs.

Portfolio – The set of future management actions to be recommended by WSAC as part of the system plan.

1. Background

Scenario analysis is a relatively new tool in the water utility planning toolkit. Water agencies are increasingly turning to scenario analysis as a means of identifying how well their water system plan can handle a variety of potential futures. Scenario planning

explicitly asks the question, "If my future looks like x, then what plan do I need to have in place to ensure my system provides adequate, reliable supplies of water for the best value with the smallest set of unwanted side effects?"

In the past, water utilities planned for one future. This worked well in a world where demand changes were linear; climate was expected to operate within bounds seen within recorded history; and technological, regulatory, and other potentially significant influences on water systems were sufficiently handled with the phrase, "all else considered equal."

Today, estimating demand is increasingly complex and no longer has a direct linear relationship to changes in population. At the same time, climate variability and climate change require agencies to plan for events that may occur outside of historical temperature and precipitation records. To make planning for the future even more difficult, it is largely unknown how future regulatory requirements, economic issues, and technological changes will influence community water systems. These large uncertainties and unknowns create significant planning challenges for water agencies that often, as part of their planning process, need to make expensive, long-term, and often irreversible decisions about investments in the community's infrastructure and water resource portfolio. Accordingly, water agencies now need to develop plans that meet the needs of more than one potential future, but they often struggle with how to do this. It is important for the WSAC to understand that most water agencies around the world are grappling with challenges that are similar to those facing the WSAC.

Scenario analysis is an analytic tool used to support the decision-making process by illuminating the kinds of events that may cause the system plan to fail. Decision-makers use the information developed as part of scenario analysis to identify the range of plausible future events, understand risks to the community, and evaluate the management actions that will ensure that the system performs as needed if these events occur in the future.

2. Overview of Next Steps in Scenario Development

Scenario analysis involves a number of discreet steps. It begins by identifying the set of community values that represent important community planning objectives. WSAC tackled this step by developing criteria that represent community interests as part of MCDS and scenario work in Recon. Insights from the *Attitudinal* survey and other city reports can also be used to ensure that the WSAC decisions reflect the full range of community values and interests.

The next step is to identify the set of external risks to the system that WSAC also needs to consider as it develops Portfolios. Finally, individual risks and community interests are combined to develop multi-variable scenarios.

A summary of the scenario process steps that will occur in the Real Deal are outlined in the following list and then described in more detail in the next sections. Scenario process steps include:

1. ***Identifying future risks to the system by developing single-variable scenarios***. Single-variable scenarios are used to identify the severity, frequency, and consequences of external, uncontrollable future events that the Portfolio needs to handle.

2. ***Developing multi-variable scenarios***. The future will likely present more than one event that presents challenges. The WSAC will bundle single-variable scenarios to develop a set of risks that it wants to ensure the community water system can handle. As part of developing multi-variable scenarios, the WSAC may also want to add future community interests that have the potential to affect water supply planning.

3. ***Building draft Portfolios (i.e., plans)***. WSAC will combine individual Alts into Portfolios designed to meet the future needs expressed in each multi-variable scenarios.

4. ***Analyzing how well each Portfolio performs***. The Technical Team will analyze each Portfolio with the objective of providing WSAC with an evaluation of how well the Portfolios perform in regards to meeting: (1) community needs for insurance against external events, and (2) community interests as expressed in MCDS. As part of the analytic findings, the Technical Team will provide information that informs MCDS criteria and scales, as well as risk reduction.

5. ***Iterate Steps 2 through 4***. Based on the findings from Step 4, the WSAC can decide if and how it wants to modify the scenarios (e.g., combining them) and the Portfolios. Iteration allows the WSAC to improve measures of community interest (criteria and scales); understand the severity, frequency, and consequences of risks; improve Portfolio performance; and reduce Portfolio side effects.

Step 1: Identifying future risks to the system by developing single-variable scenarios

Typically, once community interests are identified and a simple scenario exercise has been run (as WSAC did in Recon), the next step is to develop single-variable, risk-based scenarios. A single-variable scenario explicitly asks, "What happens if we change one planning variable and hold all else constant?" Single-variable scenarios provide an elegant frame for identifying how the water system responds to uncontrollable external events (e.g., long-term droughts, earthquakes). It is important to note that single-variable scenarios are designed to examine external threats to a system. This is done to support a decision-maker's need to ensure their plan operates successfully regardless of future conditions, so that he or she understands what kinds of events a plan needs to be resilient against. Risk management is a form of insurance against future uncontrollable, external events.

The first step in developing single-variable scenarios is risk identification. The WSAC needs to identify the events that create risks to the system and that may have large, and perhaps unpredictable, future consequences on the system's reliability (i.e., its ability to provide water when needed, and in the amounts needed). For example, the Santa Cruz Water Department (SCWD) system, which is largely supplied by winter rains that are stored for summer use, is vulnerable to regulatory requirements that decrease the availability of stored water for summer use or to climate changes that decrease the reliability of winter rains. An analysis of plausible single-variable futures allows decision-makers to identify and focus on the risk factors that drive planning requirements.

The objective of developing single-variable scenarios is to identify the set of uncontrollable, external events that can cause the system to not perform as desired (e.g., supply water at the level needed). Identifying individual risks allows planners to understand the specific alternatives that, when combined in a portfolio, are necessary and sufficient to reduce risks.

Typically, single-variable scenarios are developed using a risk-assessment tool. Risk assessments are also sometimes referred to as a vulnerability analysis. The Technical Team will share a simplified risk assessment of the SCWD with the WSAC at the February meeting.

Risk assessment

A risk assessment identifies the probability and consequence of an event occurring. The information from a risk assessment is often presented in a risk matrix. An example of a single-variable risk matrix is provided in Figure 1. It shows that the starred event, perhaps an eight-year drought, has a probability x of occurring and will result in a y level of consequences.

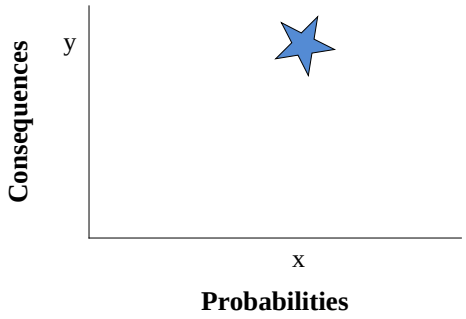

Figure 1. Risk profile matrix.

However, the likelihood of many future events is impossible to predict, making the use of probabilities difficult. Instead of using one specific probability in their risk assessment, many agencies are now developing plausible ranges that an event will occur. A plausible range means that the likelihood of an event occurring is equally likely for any quasi probability in this range. For example, we understand the climate is changing and that future drought events are likely to be more frequent and severe, but we don't know exactly how likely – how probable – their occurrence will be. So instead of selecting one probability and planning for that event, the lowest plausible probability and the highest plausible probability are selected and everything in this range is considered equally likely to occur. This is referred to as the "plausible range" of quasi probabilities that an event will occur.

Planning groups use risk assessments and risk matrices as they identify and build plans that will perform well (i.e., meet the community's needs) under future conditions. Plans can be developed that either reduce the probability that an event will occur or mitigate the consequences to the system if the event does occur.

The technical team is working closely with SCWD to develop a simple risk assessment of the SCWD system as the next step in scenario development.

At the February meeting, the Technical Team will provide WSAC with a simplified Risk Assessment that presents the plausible range and level of consequence for the following events:

- Droughts
- Seismic events
- Regulatory requirements (including fish flows)
- Economic events
- Sea level rise
- Wildfire in the watershed.

The WSAC needs to inform the Technical Team if there are other uncontrollable external events it would like to see examined as part of the risk assessment.

Step 2: Developing multi-variable scenarios

Once WSAC has reviewed the risk assessment findings in the February meeting, it can determine which single-variable scenarios – which building blocks – it wants to either examine in more detail or combine to create multi-variable scenarios that represent sets of future risks. As suggested above, this is done iteratively to allow the WSAC to see what happens to system risks and needs under a range of plausible futures. The WSAC will have the opportunity, during the February meeting, to identify two or three single- or multi-variable scenarios that it would like to see the Technical Team explore in more detail for the March meeting.

Step 3: Building draft Portfolios (i.e., plans)

Once WSAC has developed a first set of single- and multi-variable scenarios, it will begin the process of identifying Portfolios that meet the community's water needs and other criteria under a range of plausible futures. Developing Portfolios that meet future needs as represented by the scenarios is also done iteratively to allow the WSAC to identify how well different sets of Alts work together to reduce risks and meet community interests under a range of plausible futures. This process will begin in earnest in March.

Step 4: Analyzing how well each Portfolio performs

The Technical Team will take the Portfolios developed by the WSAC and analyze them to illuminate their ability to meet future needs, reduce risks, and meet interests as articulated in each scenario. Information provided by the Technical Team will include:

- Analysis of the consequences to the system of the combined risks in the multi-variable scenario (combining risks is not a linear process)
- Analytic insights into how well the Portfolio reduces the risks and satisfies other interests, as expressed in the criteria.

Step 5: Iterate Steps 2 through 4

When planning under large future uncertainty, it is important to identify the future events and community needs that drive plan performance. For example, if SCWD needs to plan for large drought events, and planning for large drought events meets all other risk- and interest-based needs, then it is not necessary to focus on any other risks and interests when developing a plan: the water manager has identified the scenario that needs to be planned for. However, it is unlikely that a Portfolio designed to meet a single future event will also meet all other identified risks and interests. Iterating the combination of external events and community needs, and the Portfolios needed to meet each plausible future, allows WSAC to identifying the drivers – the events that override other planning needs.

3. Conclusion

This memorandum provides a great deal of technical information. We look forward to clarifying this information in February and working with the Committee to ensure the scenario analysis process meets your decision-making needs.