ACHIEVING RELIABILITY AND SUSTAINABILITY IN WATER SUPPLY PLANNING

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Traditionally, those responsible for delivering water to urban areas strive to make their systems reliable. They seek consistent dependability of performance by bolstering those systems against foreseeable threats: mechanical breakdowns; natural disasters; sudden contamination; or protracted droughts. Achieving this goal requires attention during design (e.g., providing sufficient storage, redundant transmission lines, etc.), construction (e.g., quality of materials and workmanship), maintenance, as well as planning for disaster response. Over the past 20 years, analytic models have evolved to assist decision-makers in choosing how much reliability is economically rational.

More recently, new terminology has appeared in the vocabulary of water system planning: "sustainability." Unlike reliability, the new term is amorphous. It could be understood to refer, as it does in Jared Diamond's recent book Collapse: How Societies Choose to Fail or Succeed to the very physical existence of a particular society. Alternatively, it could have a more narrow meaning: the ability to continue to make use of a particular natural resource (oil, wood, water, etc.) indefinitely. Or it could mean almost anything in between.

James Boyd and H. Spencer Barzhaf recently observed, "Ten years ago environmental policy discussions became flooded with the term 'sustainability'. . . No doubt the word took off because it evoked environment-friendly concepts like balance and stewardship. Its success may also have been due to the fact that it could mean almost anything." ("Ecosystem Services and Government Accounting," RFF, Resources, (Summer 2005)) Whatever the reason, sustainability is in fashion in California water planning circles. In January, for example, the State Water Resources Control Board adopted a resolution declaring that sustainability is a "core value" for all SWRCB and Regional Water Quality Control Board activities and programs and directing staff of both the State and regional boards to include consideration of sustainability in all future policies and regulatory actions. SWRCB Resolution 2005-0006 (January 20, 2005)

Shortly thereafter, in February 2005, the San Francisco Public Utilities Commission (SFPUC) forwarded to the San Francisco Planning Department a report summarizing its recommended water system infrastructure improvements to meet level of service goals for water quality and water delivery reliability. The document, titled "Water System Improvement Program: Prepared for the Programmatic Environmental Impact Report" (WSIP), employs both of these concepts: reliability and sustainability.

The WSIP provides an opportunity to address the distinction between reliability and sustainability in the context of water supply planning.

This article will attempt to show that "reliability" is a measurable criterion of water supply planning and will review an economic model designed to identify the most cost-effective level of reliability. The article also will argue that "sustainability" is a multi-discipline, evolving construct but not yet a rigorous decision tool. The article will suggest, however, that the California Environmental Quality Act already requires that policy makers give explicit attention to the long-term, inter-generational considerations inherent in the concept of "sustainability".

Least Cost Planning is an established method of quantitatively evaluating resource reliability.

The starting point for water supply planning is a clear process to find the appropriate level of supply reliability given the costs of alternatives.

So, what is supply reliability? And what does planning for it entail? Water supply reliability is an expected part of modern urban living. Perceptions of reliability are common to other utilities' demand/supply contexts and engineers have formalized its measurement as follows:

> Reliability is the probability that a system does not fail, or conversely, it is the probability of system failure subtracted from one.[1]

More generally stated, reliability is a measure of a utility's ability to deliver uninterrupted service. Reliability planning is well understood, defined and concretely

[1] This definition is taken from the CalFed Bay Delta Program, "Water Supply Reliability," Draft August 12, 2003.

measured.[2] Criteria for measuring the success of achieving the objective begin with the probability, magnitude and duration of supply shortages over time for various supply and demand options. Water supply reliability is a stand-alone determination based on economic efficiency. Economic efficiency implies delivery of water service at the lowest average cost, where cost is a holistic concept.

The objective of water supply reliability planning is to determine the most effective way of achieving an additional increment of reliability at the least cost. The approach includes information about the costs and losses associated with shortages of varying severity and duration as well as the costs of long-term and contingency water management options. The primary objective of least cost planning is to develop an economically efficient regional water management plan.

The costs to be minimized are the sum of two costs: the cost of reliability augmentation and the cost of unreliability. This can be restated as the cost of water -- alternative water supplies, or programs that reduce the need for alternative water supplies; and the cost of shortages -- drought management program costs including conservation and reclamation, lost water sales revenues, costs imposed on customers by water shortages; and regional economic losses. The reliability evaluation process explicitly allows for the inclusion of environmental externalities, which internalizes sustainable environmental effects.

Foregone use is the direct consequence of shortages. Foregone use occurs when residential users, businesses, or industries have established a lifestyle or a level of economic production based on an expected level of water supply available for use and that expectation is not realized in a particular year or sequence of years; i.e., a "shortage event" occurs. The costs and losses associated with shortages, both economic and environmental, tend to increase at an increasing rate as shortages increase in duration and severity.

Reliability planning requires sequential information about:

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[2] This section of the paper is designed only to provide an overview of the tenets of reliability planning. An abundant literature can be found on the subject.

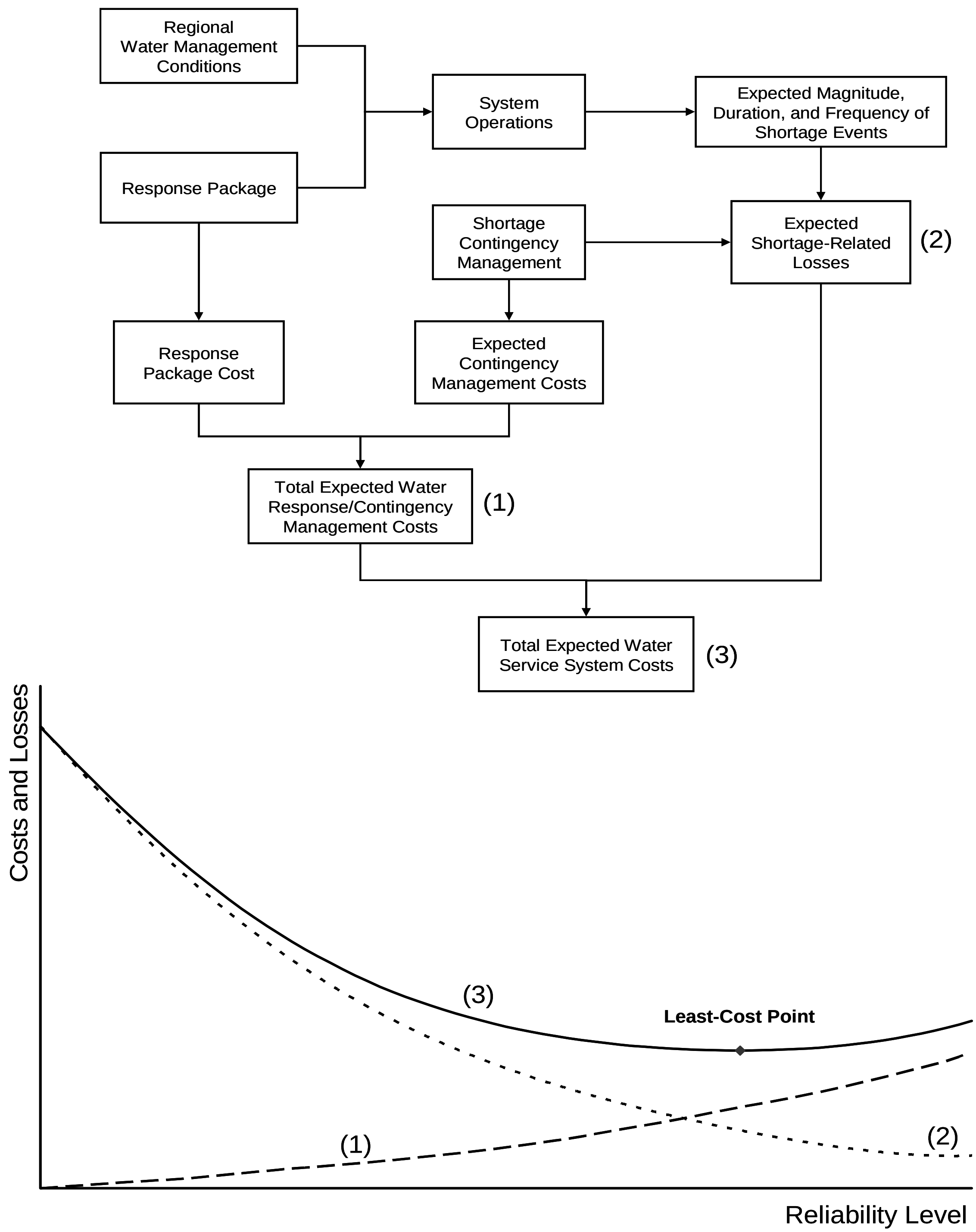
1. the costs of construction, operation, and maintenance for alternative water management plans;
2. the expected frequency and severity of shortages matched to alternative plans;
3. how additional water management options are likely to affect that frequency and severity of shortages;
4. how available contingency measures can reduce the impact of shortages when they occur;
5. how large are the shortage-related costs and losses for alternative water management plans;
6. what nonmonetary social and environmental costs need to be incorporated.

With this information, the least cost alternative can be calculated as the point of minimum average cost including expected costs and losses from shortages plus expected costs of water management.

Reliability planning based on the Least Cost Planning (LCP) process offers the best opportunity to identify how to integrate demand management and supply augmentation options into their planning process in the most productive and justifiable manner. Figure 1, taken from a 2002 CDWR discussion[3] emphasizes that the water supply reliability goal is established as the least cost point of the two curves, which represents the economic efficient mix of resource costs and remaining shortage costs. Both the expected water management and contingency management costs (Curve 1) and the expected shortage-related losses (Curve 2) are a function of the level of demand reduction or supply enhancement response options implemented. Both curves are affected by the availability, cost, and effectiveness of contingency management (e.g., transfers, rationing programs, etc.) While the total cost of the management and response options increases as reliability increases, the expected shortage-related losses decrease as a consequence of the increased reliability. The total expected water service system cost (Curve 3) is the sum of these costs and losses. The lowest point on this curve represents the level of reliability provided by the economically efficient resource and response mix.

[3] CDWR, “LCPSIM Background,” 2002.

Figure 1. LCPSIM Conceptual Diagram



The SFPUC adopted a reliability goal of 80 percent of normal deliveries during an extended drought. It selected the 80 percent reliability goal with limited information about the costs of achieving three levels of reliability and no information about the costs of providing less than 100 percent reliability.

The SFPUC was provided by its staff with a summary chart that showed the following:

	Option A	Option B	Option C
Level of Reliability	100%	90%	80%
Cost (in millions)	$1,222	$603	$422

Thus, the difference between achieving an 80% level of reliability and a 90% level was estimated at $181 million.

The SFPUC did not, however, attempt to quantify the economic costs and losses of a 20% systemwide shortage.[4]

Without both the costs of enhancing reliability and the costs that shortages impose on society, the SFPUC was not able to make even the most rough-cut approximation of the balance between the costs of improved reliability and its benefits. Without this information, no economic basis exists to find the lowest cost point among the three options considered.

Sustainability embeds differing perspectives and eludes quantification.

The term "sustainable development" is associated with the 1992 UN Conference on Environment and Development held in Rio de Janeiro. A report issued by one of the commissions preceding the Conference contained this passage:

> "Humanity has the ability to make development sustainable - to ensure that it meets the needs of the present without

[4] Energy and Water Economics was commissioned by the Bay Area Water Supply & Conservation Agency, which is comprised of and represents the 28 wholesale customers of the SFPUC in Alameda, San Mateo and Santa Clara counties, to estimate those omitted costs. That report suggests that the impact of a 20% water supply deficiency on firms in those industrial categories for which water is a critical component in the production process would far exceed the SFPUC's estimate of the incremental costs to improve system reliability to 90% or, for that matter, to 100%.

compromising the ability of future generations to meet their own needs."

A perceptive 1995 article, "Sustainable Development - A Slogan or a Strategy", observed:

> "In the few years since the Rio Conference, sustainable development has become a centerpiece of, and the lingua franca for, scores of international meetings of government officials, think-tank analysts, advocacy groups and private-sector representatives. But despite its occasional elevation to the lofty status of such concepts as peace, democracy and justice, there is considerable uncertainty, indeed confusion, as to just what sustainable development means or entails."[5]

The subsequent literature on sustainability reveals a range of criteria to consider, which to some degree are dependent on political perspectives. Differing interpretations have impeded sustainability from becoming a useful analytic tool. The American Society of Civil Engineers defines a sustainable water resource system as one "designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining ecological, environmental, and hydrological integrity."[6] This definition, like other definitions of sustainability, is too vague to implement.

Measuring and accounting for sustainability remains a challenge for agencies as they try to advance sustainable resource management. The primary tenet of the sustainability bible – the President's Council on Sustainable Development report[7] -- is that social, economic and environmental problems are intertwined and must be considered together. Institutions and individuals must adopt a process that inextricably links these three elements. Exactly how this is to be accomplished

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5 Chester Cooper, "Sustainable Development - A Slogan or a Strategy." COSMOS Journal 1995 (http:www.cosmos-club.org/journals/1995/cooper.html)

6 ASCE, Task Committee on Sustainability Criteria and Working Group UNESCO/IHP IV Project M-4.3 (1998). Sustainability Criteria for Water Resources Systems, Water Resources Planning and Management Division. Washington, D.C.

7 President's Council on Sustainable Development (PCSD), Sustainable America: A New Consensus for Prosperity, Opportunity, and a Healthy Environment for the Future, February 1996. This document emphasizes analytic approaches and challenges to measuring and evaluating sustainable resource development alternatives.

remains unclear. Neither the PCSD report nor subsequent Clinton Administration reports[8] achieved a consensus on how to measure and balance the three elements of sustainability, or how to achieve sustainable development.

<u>San Francisco's WSIP invokes lofty sustainability goals but overlooks intergenerational reliability objectives</u>.

In light of the inherent complexities in sustainability, it is not surprising that the WSIP's treatment of the topic is unsteady.

At the outset, the WSIP states that the mission of the SFPUC "is to deliver high quality, affordable water . . . in a reliable and sustainable manner. To that end, the current system furnishes affordable water in a highly sustainable manner by minimizing the need for filtration and the use of power." (WSIP, p.2) But neither filtration nor power use relate to sustainability *per se*. They relate to costs. Many other elements of cost must be tallied besides those of power and filtration in selecting water supply reliability goals. And costs are only one criterion to measure and balance in the search for a sustainable resource plan. Societal welfare is related to a reliable supply of high quality water rather than the degree of filtration or pumping power.

A sustainable water supply plan must address infrastructure needs firmly rooted in multi-generational considerations. A reliability goal that achieves only 80 percent reliability for the next generation fails to consider whether the activities undertaken to ensure only that level of reliability will cause water supply for subsequent generations to fall below 80 percent. The link between the investment in long-term water management options and the size and frequency of shortages and their costs and losses associated with foregone use is the critical element missing from the WSIP.[9]

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[8] President's Council on Sustainable Development, "Natural Resources Management and Protection: Task Force Report," 1999.

[9] The SFPUC has recently indicated that it will investigate the economic impacts of different levels of shortage.

The WSIP quotes at length from the SFPUC's "Stewardship Policy" which is described as "providing the framework for managing environmental and natural resource issues system-wide." A component of the Stewardship Policy is, apparently, a promise to develop and implement a "Sustainability Plan." This Plan, in turn, is described as "a strategic management tool to integrate and achieve a continuing balance of social, environmental and economic objectives" -- the "triple bottom line of sustainability." (WSIP, p.21, 23)

Developing the Sustainability Plan will not be a simple matter. Instead,

> "the SFPUC will use a multi-criteria assessment, business case, or other approved model/method to assess and design integration of the triple bottom line into organizational and system management, policy, and practices. This will include managing natural resources and capital; decision-making and public outreach; facilities design and construction; maintenance and options. To assist its staff, SFPUC will use a contractor with proven experience and expertise in sustainable development assessment, design, planning, monitoring and reporting." (WSIP, p.23)

What the Plan will actually contain remains vague, but its potential scope is extremely broad. According to the WSIP, the components may include

> "vision, goals, and criteria; inventories of natural resources and lands, facilities, assets, and operations; facility and materials lifecycle assessments; performance criteria and indicators; performance measurement and reporting; developing and prioritizing initiatives; strategic design and implementation; identifying benefits and costs; evaluating return on investment; sensitivity analysis; risk assessment; and benchmarking." (WSIP, p.23)

It is not evident how all this activity relates to the basic challenge facing the SFPUC: rehabilitating an aging water system that serves over 2.4 million people and that is at great risk of catastrophic failure in the event of a major earthquake on any of the three active faults that lie beneath it. Postponing urgently needed seismic rehabilitation until the elaborate Sustainability Plan has been created would not foster either reliability or sustainability, however defined. With Hurricane Katrina as the new paradigm for needed planning urgency, infrastructure needs must be sorted out with available tools.

CEQA compels attention to sustainability and provides a structured and public process for balancing competing social and economic goals.

Instead of adopting cryptic pronouncements of sustainability as a "core value" on the one hand, or embarking on development of grand but ambiguous plans, on the other, California water planners might consider a third approach.

This approach is rooted in California's basic environmental law - the California Environmental Quality Act (CEQA). The legislative policies enshrined in CEQA include several that explicitly direct decision-makers to consider, and protect, the welfare of future generations. Public Resources Code Section 21001(d), for example, declares that it is the policy of the State to "ensure that the long term protection of the environment, consistent with the provision of a decent home and suitable living environment for every Californian, shall be the guiding criterion in public decisions." (Emphasis added.) Section 21001(e) directs decision-makers to "create and maintain conditions under which man and nature can exist in productive harmony to fulfill the social and economic requirements of present and future generations." (Emphasis added.) And Section 21001(g) announces that governmental agencies are to consider "long term benefits and costs, in addition to short term benefits and costs." These policy declarations are hortatory rather than prescriptive. But the regulations implementing CEQA, issued by the Secretary of Resources, give them operative effect and require attention to the long-term environmental consequences of government action. (14 California Code of Regulations, Section 15065.) Whenever a proposed project has "the potential to achieve short-term environmental goals to the disadvantage of long-term environmental goals," Section 15065(b) provides that the agency proposing the project must prepare an Environmental Impact Report (EIR), rather than a negative declaration. The EIR process, in effect, compels the balancing of economic, social and environmental goals that lies at the heart of the "sustainable development" concept.

Utilizing CEQA to structure the consideration of the multi-generational implications of resource decisions has several advantages:

- EIRs must describe the potential adverse environmental impacts of a project with specificity.
- EIRs must identify feasible ways to lessen those harmful impacts, either through mitigation measures or alternatives to the project.
- If significant environmental adverse effects are unavoidable, then the project proponent must explicitly engage in balancing those harms against the social/economic benefits and must publicly acknowledge its ultimate choice of values.

The recommendation for water supply planners, therefore, is twofold:

- Determine the economically efficient level of supply reliability as the first order of business. Least Cost Planning, outlined above, provides a rigorous tool to evaluate complex mixes of infrastructure and policy options to increase water supply or reduce demands. This is a sufficiently challenging task that it must be accomplished before introducing other "sustainability" criteria that may be important to stakeholders.
- Utilize the EIR process as an established analytic framework within which the balancing to achieve the ideal "triple bottom line" of sustainability can occur in an intellectually rigorous manner, and in a public forum.

"Sustainability" remains an elusive concept. Nevertheless, resources and infrastructure improvements can be planned and managed to assure that future generations' welfare in relation to water supplies is enhanced, or at least not reduced, by linking the LCP process together with CEQA.