AN ECONOMIC FRAMEWORK FOR EVALUATING WATER REUSE AND DESAL PROJECTS: WHAT ARE THE BENEFITS AND DO THEY EXCEED THE COST?

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Introduction

This paper provides an overview of an economic framework being completed for WRF project 03-006. The economic framework is, in essence, a tool to help water agencies and other water sector professionals conduct a benefit-cost analysis (BCA) of reuse or desal investments. The economic framework is thus designed to help water managers (1) identify, (2) estimate (to the degree feasible and meaningful), and (3) effectively communicate the full range of benefits associated with water reuse projects or related activities.

Having a reasonably complete recognition and accounting of the full range of benefits of a reuse or desal project is extremely important. This is because the financial costs of building and operating a reuse or desal facility are often relatively high (compared to the cost using more traditional sources of water). Given the high relative costs, water agencies and water resource planning bodies may wonder whether the expense is justified – i.e., whether the benefits may outweigh the costs. They may also face difficulties obtaining support from local governing officials or customers, or need economic justification for seeking funding support (e.g., cost sharing with neighboring entities in the region, or state and federal grants or loans).

One of the key challenges in assessing whether or where the benefits of reuse or desal outweigh the costs is that the benefits are often hard to estimate in full. Among the key reasons that benefits are hard to identify or estimate is:

1. The benefits often are very diverse in type (i.e., many types of benefits may be generated, and several may not be immediately obvious to some parties)
2. Many of the benefit types are hard to explain, and/or difficult to estimate in monetary terms (e.g., many benefits involve "nonmarket" values for ecological or recreational services)
3. Those who receive or enjoy the benefits (i.e., the beneficiaries) often are dispersed across water agency and political jurisdictional boundaries (meaning that there often are large externalities, and these are often positive externalities rather than negative ones).

These factors make it very difficult to justify or build public/political support for reuse or desal projects that, in reality, often have many important *net social benefits* to offer.

This short paper describes the intent of the economic framework and describes its key elements. In our Symposium presentation, we plan to (1) show attendees the key portions of the framework and associated report/guidance, (2) reveal how it was applied in one or more case studies, (3) present and discuss findings for those case studies, and (4) discuss how the benefit-cost perspectives can be usefully applied to issues like justifying cost-sharing and/or other forms of external funding, based on the size and distribution of benefits relative to costs (i.e., by using insights on who benefits – and by how much – as a fair and justifiable basis for distributing costs or obtaining grants).

Differences between Financial and Economic Analysis

The use of membranes and other advanced technologies now provides utilities with feasible ways to provide potable or otherwise useable waters (e.g., for safe irrigation) from what had previously been considered low quality sources, including wastewater effluent and high TDS waters (e.g., coastal waters or saline groundwaters). While technological advances and increased demands for water have combined to make water reclamation and reuse increasingly feasible and more cost-effective, there are still several economic roadblocks to broader implementation of water recycling.

One of the key challenges for reuse applications is that the financial assessment of such projects may often appear unfavorable, even though there may be total project benefits that outweigh the project's costs. Therefore, at the outset, it is important to make a clear distinction between:

1. A financial analysis of reuse (which is based solely on the cash flows of expenses and revenues in and out of the utility)
2. An economic analysis that provides a more suitable and broader perspective of the value of the reuse-generated waters (i.e., provides a suitable benefit-cost perspective for considering if a reuse or desal investment is worth the expense, to the broader region and community as a whole).

In brief, water reuse and desal are often considered relatively expensive in terms of the direct financial cost of installing and operating the required treatment processes and related infrastructure. At the same time, the anticipated revenue stream may appear relative low.

Revenue potential may appear low because reuse water often is priced at less than the average cost-based rates for traditional potable supplies (which raises an important but separate economic issue of how traditional water supplies, and reclaimed water, should be priced). Revenue projections also may be low relative to cash costs to the utility because, in some locations, there is a limited market of potential applications and customers (e.g., there may be a limited number of large-scale outdoor irrigation users in proximity to available or anticipated reuse infrastructure).

Thus, on a cash flow basis, reuse may appear to be a financial loser: A water district will typically see a relatively high estimate for a total annualized cost per acre-foot ($/AF) of water produced, while at the same time, a utility anticipates limited revenues from its reuse program (e.g., because it often feels constrained to price reuse water below the rates charged for traditional potable supplies). Thus, it is difficult (and perhaps impossible) to make a "business case" for reuse projects based solely on the utility's assessment of its internal financial outcomes.

While financial analyses are very important and useful in many ways, they typically provide too limited a context with which to evaluate the real social worth of a reuse project. This is because a financial analyses focuses strictly on revenue and cost streams internal to the water agency, and these cash flows are not the same as the true worth or value of most water reuse or desal projects to the community and society as a whole.

The problem is not that the value of reuse is too low. Rather, the problem is that a financial analysis provides too narrow a perspective of the "value" of the waters provided. For example, a financial analysis does not include benefits such as the environmental and social costs avoided when reuse enables a community to forgo developing alternative water supply options (e.g., when reuse avoids the need to extract more raw water from flow-limited streams). The WRF economic framework report and

associated tools provide a suitable economic framework within which the benefits ("value") of water reuse projects can be more fully identified and evaluated, and then properly compared to the full costs of reuse.

In economic parlance, we are developing an analytical tool for conducting a *full social cost accounting-based assessment* of the benefits and costs of reuse projects (as defined and discussed in greater detail below). We also provide case study illustrations of the benefit-cost framework to (1) help refine and guide the tool's development, (2) demonstrate how the tool can be used to estimate and portray environmental and other costs and benefits of reuse (relative to other source water alternatives) in an objective and comprehensive manner, and (3) reveal how the benefits of specific reuse projects compare to their costs.

A Full Accounting of Social Costs and Benefits

When communities, water agencies, governing officials, environmental advocates, and state agencies look at potential reuse or desal projects, several key issues and concerns tend to surface. These include questions such as:

1. What are the potential benefits of using reuse options to replace or reduce freshwater diversions from rivers, streams, and groundwater and thereby protect and enhance instream flows and restore aquatic ecosystems (especially in relatively dry years)?
2. Is there a potential for harm to ecological resources (e.g., by reducing wastewater discharge contributions to instream flows) associated with reuse projects, and if so, what are the benefits and costs of options for effectively mitigating or restoring any such losses?
3. What positive (or negative) consequences may arise for a community if a reuse project is developed (i.e., increased reliability of water supply, reduced likelihood of water shortages and use restrictions, impacts on growth management), and to what extent is increased supply reliability essential to maintaining the economic vitality of the community (or essential to policies for managing growth)?
4. For reuse options that reduce demands on groundwaters (and/or provide localized recharge), what benefits and costs may arise in terms of water supply reliability, conjunctive use opportunities, managing potential subsidence or salt water intrusion, and alleviating pressures on alternative surface or groundwater sources?

Local communities, water planning agencies, and water providers need a planning tool that can help them organize and conduct a comprehensive and objective assessment of these and related issues. In other words, what is needed is a framework that provides a *comprehensive, full social cost accounting-based assessment of the benefits and costs of reuse (or desal) relative to alternative water supply options.* This is what this research project helps address.

Key Issues and Approaches for Benefit-Cost Analysis

How does an agency demonstrate that a reuse project is "economically and environmentally appropriate," or that a project has "equitable access to benefits" and provides "the greatest public benefits?" Today, many wastewater agencies are individually developing their own "templates" for comparing alternatives and selecting water reuse management plans. These individual approaches vary in their quality and extent, and are likely to include widely differing approaches with widely differing effectiveness. And, as the public grows increasingly aware of and interested in water reuse and supply

planning for their communities, the necessity for thorough, acceptable analyses of alternatives continues to grow. A uniform and well-founded approach is needed to ensure quality, reduce utility effort, and promote broader acceptance and usefulness.

To address this need, we provide an analytical tool for conducting a "full social cost accounting"-based assessment of the benefits and costs of reuse projects. BCA is a technique that enables program evaluators to undertake structured comparative analyses of alternative approaches to achieve the same general outcome. It is widely used, and in some cases federally mandated, in evaluating complex projects that have substantial environmental and social impacts.

Including Internal and External Impacts; and Market and Nonmarket Impacts

The term "full social cost accounting" refers to the economics perspective of trying to identify and account for *all* the benefits and costs of a potential action or policy, regardless of who bears the impact, or whether the impact can be valued using observed market prices. In other words, our framework is intended to help utilities include benefits, costs, and risks borne "internally" by the wastewater (and/or water supply) agency as well as those impacts borne "externally" by other parties (e.g., households, businesses, special interest groups). The approach is also intended to help utilities include, to the greatest degree feasible, "nonmarket" goods and services – meaning impacts that are not typically traded in markets and therefore do not have market-observable values (instead, these values need to be estimated using nonmarket valuation techniques – revealed or stated preference methods such as hedonic pricing or conjoint survey analysis, respectively, and/or using results of studies applied elsewhere, an approach referred to as "benefits transfer").

The "Triple Bottom Line" Approach: A Variant of Benefit-Cost Analysis

The full social cost accounting-based application of BCA can also be portrayed within a "triple bottom line" (TBL) framework. The TBL is a planning tool developed to help agencies track their progress toward promoting sustainability, and in essence is a streamlined and often qualitative version of a social BCA. The TBL has been popularized through widespread application in Australian utilities, and consists of:

1. A financial bottom line that reflects the cash flow accounting stance of the agency (i.e., internal costs and revenues); then adds
2. A second bottom line to reflect social impacts of an agency action (e.g., "helps promote environmental justice by creating employment opportunities for economically disadvantaged members of the community"); and
3. A third environmental bottom line (e.g., "improves instream flows enhances and protects habitat for important special status fish and other aquatic species").

This report does not explicitly provide additional detail or methods for implementing a TBL approach. Nonetheless, the TBL is in effect a simplified version of the first steps of a more full-scale, social benefit-cost assessment (i.e., it essentially is a simplified representation of what is accomplished by the first steps of our economic framework). The TBL approach, and the first steps of our framework, provide an intuitive way to promote better communication with stakeholders, governing officials, etc., by explicitly identifying a range of outcomes beyond the traditional internal utility financials.

Engaging Customers, Governing Officials, and Other Stakeholders

In addition to developing a tool to encompass the environmental and economic implications of reuse projects, another key function of the economic framework project is to provide a basis that agencies can use to help communicate their key assumptions, inputs, and findings with impacted communities and stakeholders. The tool developed can (and should) be used to facilitate a process wherein input is invited from relevant individuals and organizations, and through which utilities systematically reveal the key assumptions, input values, sensitivities, and other factors embodied in the analysis.

The framework tools are *not* intended to be used as a "black box" that develops fixed empirical outputs (e.g., dollar values) for all benefits and costs. Instead, the materials provided here are intended as a tool to help organize, document, and communicate benefit-cost information in a transparent manner, so that it can help guide public discourse and policy making.

There are several important reasons for engaging stakeholders throughout the application and interpretation of the economic framework. First, it is important to ensure that the key benefits of a potential reuse project are well recognized. Water reuse can generate many important types of benefits, but often the full range of benefits are not well recognized because:

- Some benefits are disbursed across political or district jurisdictional boundaries
- Some beneficiaries may not be engaged in the deliberations
- Many benefits are not realized until many years in future
- Projects often are viewed from narrow financial perspective (revenues versus costs) rather than broader context of social benefits and costs.

In addition, it is important that analysts applying the framework avoid technical jargon, and instead try to find and apply lay terms (especially to describe the types of benefits to be derived) that communicate with the key stakeholders. This can be a challenge, because many reuse benefits are hard to describe in ways that resonate with stakeholders and public officials.

- Economic terminology is not always user friendly, intuitive, or communicative
- The traditional economics labels for key benefit categories (e.g., "passive use" to describe values associated with the motive to preserve endangered species) can foster the impression with some stakeholders that their core issues have not been fully recognized or included in the analysis
- Benefit measurement and estimation methods developed and used by economists may be seen as smoke and mirrors, and lead stakeholders to question the overall credibility of the economic analysis
- There may be a mistrust of BCA, especially where the approach is seen as incomplete (e.g., missing benefits or costs), biased (e.g., generating predetermined outcomes), or part of a broader political agenda (e.g., to undermine the fabric of environmental and health regulations).

Also, it is important to consider stakeholders within the context of equity – what is often referred to as environmental justice. The economic framework encourages utility analysts to identify the key beneficiaries of reuse projects. This is intended to help all parties recognize (and consider the implications of) who will realize benefits, and who will bear the costs of a reuse project. This is important for reuse project evaluations because:

- Real or perceived equity issues (e.g., who gets reclaim versus who gets source water) can serve to derail a project
- Disconnects may arise between who pays and who benefits (e.g., utility customers pay, but large benefits may be generated for many other people and locations, typically downstream).

There are several additional important advantages from applying the broad BCA of the water reuse economic framework. Identifying and describing the full range of benefits, including those that accrue beyond the utility and its customers, will help the water agency:

- Recognize the full range of benefits of each reuse option, and portray all these benefits to governing/oversight bodies
- Facilitate buy-in and support from utility customers, and help diffuse or offset possible opposition (e.g., by describing green values attributable to reuse, such as instream flow enhancement, and highlighting the local control benefits of reliance on a local water source)
- Identify beneficiaries beyond the agency's customer base, thereby providing a basis for pursuing broader cost-recovery (i.e., by showing who benefits and how they benefit, there is a more logical and equitable basis for cost allocations that better reflect the distribution of benefits)
- Provide a basis for seeking external funding support, by recognizing and systematically characterizing the external benefits (e.g., for seeking state or federal grants to recognize how the water district reuse choices generate benefits to downstream users and/or for the environment in general).

Therefore, the economic framework provided here is designed to help utility analysts think about the distribution of all lifecycle benefits and costs, and also to provide a forum around which stakeholder interactions can be structured.

Key Environmental and Economic Benefits and Costs to Include in the Assessment

For some, a major concern regarding the development of reuse projects is the potential for adverse environmental or public health impacts, or both. These issues and concerns certainly need to be given due consideration.

At the same time, comparatively little attention has focused on reuse as a mechanism for reducing adverse environmental impacts. The environmental and other benefits of reuse may include:

1. Increased ability to meet critical instream flow conditions for fish and other aquatic species and ecosystem services of concern, by reducing demands on existing freshwater surface and/or groundwater supplies
2. Reduced energy consumption and air pollution where imported waters would be the alternative to reuse, by reducing the need for pumping large volumes of source water across great distances and gradients
3. Increased protection of groundwater systems – from subsidence, reduced storage capacity, and salt water intrusion – by reducing pumping demands on aquifer
4. Increased reliability and drought relief (i.e., reducing the variability and uncertainty about the volume of water available to the community, in the event of droughts or other source water-impacting events)

5. Increased local control (i.e., reuse water can be viewed as a local resource, in contrast to waters imported to a community from regions and/or by agencies beyond the jurisdiction and control of the local community)
6. Sustaining agricultural communities, by reducing municipal demands on waters currently applied to irrigation
7. Any cost savings associated with using reuse relative to other water supply and wastewater management options (e.g., costs avoided because new waters and/or related infrastructure expansion will not need to be incurred by the community, or because wastewater treatment and discharges may be reduced or postponed).

Other potential social, economic, and institutional benefits and costs to be considered (most of which could be considered as specific subcategories under the items listed above) include:

1. Local and regional economic impacts under alternative water supply constraints (i.e., changes in local economic income and tax revenues, with and without reuse or alternative water supplies)
2. The risk-reducing value associated with developing alternative mixes of water supply options within a portfolio approach to water supply management (i.e., diversifying the types and sources of variability in water yields and/or costs, across the supply options in a community's water portfolio)
3. The pros and cons of changing the level of inter-dependencies between the water supply and power sectors
4. Comparative risks associated with different levels of dependence on technology for water supply.

In the WRF materials, we describe empirical evidence and a framework to enable water agencies with the means to identify and (in many instances) estimate types and likely level of all relevant benefits and costs associated with desal or reuse, using a regional and community-wide perspective to better capture the full range of potential societal returns and costs from reuse investments.

A Comparative Context, with Careful Attention to Defining the Baseline

One important key to conducting a proper economic evaluation is to place reuse in a comparative context, evaluating these options in terms of both a default scenario of no new water supplies, as well as comparing reuse to other water supply alternatives specific to given regions (e.g., additional surface water extractions, agricultural-urban water transfers, water conservation). The key is to set up the economic analysis in a "with versus without" reuse context.

Another key aspect of the comparative framework is that it is important to establish and then carefully maintain the suitable accounting stance. For example, if a water reuse projects enables a community to forgo (or postpone) capital and/or operating expenditures for alternative water supplies (and/or for wastewater management), then these cost savings need to be included in the economic analysis. However, how this is done depends on the baseline scenario and what other water supply alternatives are included in the assessment. For example:

- If the comparative analysis includes the relevant options to supply water, in addition to the reuse option, then the costs of the alternatives to reuse should be reflected in the estimates for those non-reuse options, and should not be double-counted as benefits of reuse (i.e., the cost of option A should not also be shown as a cost savings benefit for its alternative, option B)

- If the baseline is to develop or obtain water from a source other than reuse, then any cost savings from forgoing the baseline supply option can and should be counted as a benefit of the reuse option (i.e., if option A is the baseline, then if option B provides cost savings relative to option A, then those cost savings should be shown as benefits for option B).

Another challenge to defining the baseline is that the "with" and "without" context can become a place where stakeholder and utility hidden agendas or disagreement over core assumptions often arise. For example, setting the baseline may set off a debate between the utility and stakeholders, over future demand projections (e.g., where some members of the community hold alternative views about the size and pace of future population growth, or about the effectiveness of additional conservation opportunities). Therefore, it is important to carefully define the baseline, be transparent about underlying assumptions, and engage relevant stakeholders at this critical stage of the economic analysis.

What the Economic Framework Tool and Guidance Offer

The framework and its associated tools have been developed with the objective of providing water agency professions with a way to:

- Provide a technically sound, objective basis for identifying, quantifying, and monetizing benefits and costs (and net benefits)
  - Include and describe all the relevant benefits and costs of reuse
  - Adhere to principles of economics for professional integrity and rigor
  - Reveal how to address benefits that cannot be readily quantified or valued
- Work with stakeholders and public officials – and water agency professionals – to develop a "common parlance" for benefits (and costs)
  - Ensure that technicians (economists and engineers) do not talk past public officials, customers, constituencies, and stakeholders
  - Embrace and integrate stakeholder perceptions and value systems
  - Ensure broader recognition of all the applicable benefits of reuse (and costs).

The economic framework is intended to be generic, since each water reuse project and location has its unique properties. Thus, the framework tool should not be seen as a "plug and play" or "one size fits all" model. Rather, it is a practical framework or tool to organize, develop, and communicate credible analyses of benefits and costs. The framework tool and associated user guidance are provided in the WRF report, which should be completed by the fall of 2005.