RECLAMATION
Managing Water in the West

Development of Methodologies to Evaluate the Environmental, Financial and Social Benefits of Water Reuse Projects

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Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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This scoping study provides an assessment of how water reuse projects are currently valued as part of a traditional economic or financial analysis and the potential for applying a Triple Bottom Line (TBL) accounting framework to water reuse projects. A traditional financial analysis of reuse is based on cash flows of expenses and revenues to a utility for investing in a reuse facility. The TBL accounting framework expands the area of consideration to include social, environmental, and economic/financial effects. Examples of existing TBL tools and analyses are discussed and potential problems associated with the TBL approach are identified. Despite potential problems with using TBL, three possible approaches are identified which should be considered as part of a case study in follow-up research. The first approach places the effects into three categories of quantitative or qualitative measurement and ranks each alternative by category. The rankings are then weighted according to importance and results compared. The second approach is based on a portfolio approach, where different water supply scenarios or alternatives are considered and evaluated using economic/financial, environmental, and social criteria. The results for the different scenarios are then compared in economic terms to the extent possible and qualitative comparisons are also made. A third possible approach is to measure benefits and costs to the extent possible for each of the three bottom lines, identify uncertainties associated with potential benefits and costs, and apply the principles to assure that the worst possible outcome under different alternatives is acceptable to all stakeholders.

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Executive Summary

This scoping study provides an assessment of how water reuse projects are currently valued as part of a traditional economic or financial analysis and the potential for applying a Triple Bottom Line (TBL) accounting framework to water reuse projects. A traditional financial analysis of reuse is based on cash flows of expenses and revenues to a utility from investing in a reuse facility, where a negative net cash flow indicates poor financial performance. A traditional economic analysis provides a broader perspective of the benefits from water reuse, where the benefits and costs to a larger region such as a state or the nation are evaluated. An economic analysis is from more of a social perspective with the goal of generating positive net benefits to a larger group. The TBL accounting framework expands the area of consideration to include social, environmental, and economic/financial effects. The TBL approach theoretically provides a much more complete assessment of all the effects associated with various water supply alternatives, including reuse. As a result, the conclusion of water reuse viability from a TBL based analysis may be different than the conclusion from a traditional economic and financial analysis. The appeal of using a TBL approach to evaluate water reuse projects is the potential to account for impacts beyond the traditional financial and economic effects. This scoping study identifies differences between the traditional and TBL approaches, identifies how TBL fits in with current requirements and guidance for evaluating water supply alternatives, discusses data inputs and calculations that can be used with TBL, and provides recommendations for a basic TBL framework that can be used to evaluate reuse projects.

The TBL approach is based on the concept of combining three measures of performance into one analysis. This is a useful characteristic because the importance of different measures will vary across different stakeholder groups and each perspective should be included in a project analysis. Social measures are variables that reflect the social characteristics of a community, region, or state. Examples of social measures include education, environmental justice, health and well-being, and quality of life. Environmental measures are variables that reflect the type and quality of environmental and natural resources that would be potentially influenced by an action. Environmental measures would include air and water quality, energy consumption, waste generation, and land use. Given that these measures have different units of measurement, for example dollars in an economic analysis and tons of reduced solid waste in an environmental analysis, a unit-less numbering system is desirable so different categories of impacts can conceptually be added up and compared for different water supply alternatives. It is noted in the report that the updated Principles and Requirements for Federal Investments in Water Resources indicate the need to include environmental, economic, and social goals as part of the decision to invest in water projects and that both quantified and unquantified measures should be considered.

Examples of existing TBL tools and analyses discussed in this scoping report include a TBL Tool and guidance developed by Hammer, et al. (2014) and a TBL analysis of water reuse and desalination in El Paso, Texas (Stratus Consulting, 2011). The TBL Tool and guidance provides an example using multi-criteria decision analysis and scoring criteria to help identify and measure variables that reflect TBL impact categories and compare projects. The approach used by Stratus Consulting is based on a comparison of the costs and benefits associated with different water supply portfolios that meet future demands. The costs and benefits include economic, social, and environmental effects.

Potential problems associated with the TBL approach identified in this report include: measurement complexity resulting from intangible assets such as loyalty or reputation, difficulty in defining social measurement and performance, difficulty in assessing the goodness or badness of a problem, difficulty in comparing quantitative and qualitative effects, and an inability to aggregate results across the three TBL categories. Data availability can also be a limitation to completing a TBL analysis.

Despite the potential problems with the TBL approach, three possible approaches are identified which should be considered as part of a case study in follow-up research to evaluate the practical use of TBL in evaluating water reuse projects. The first approach is to measure the effects that can be quantified and monetized and place those impacts into an economic/financial category, measure the effects that can be quantified but not monetized and place those impacts into a second category, and identify those effects that cannot be quantified and place into a third category. Each possible alternative is then be ranked within each category and those rankings are weighted according to importance as determined by stakeholders, decision makers, the public, or some other person or group. This approach is essentially the approach used for the TBL Tool developed by Hammer, et al. (2014). The second approach is to use a portfolio approach, where different water supply scenarios or alternatives are considered and evaluated using economic/financial, environmental, and social criteria. The results for the different scenarios are then compared in economic terms to the extent possible and qualitative comparisons are also made. A third possible approach is to measure benefits and costs to the extent possible for each of the three bottom lines, identify uncertainties associated with potential benefits and costs, and apply the principles to assure that the worst possible outcome under different alternatives is acceptable to all stakeholders.

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Focus of this Scoping Study

The purpose of this scoping study is to provide an assessment of how water reuse projects are currently valued as part of a traditional economic or financial analysis and to evaluate the potential for applying a Triple Bottom Line (TBL) accounting framework to water reuse projects. A traditional financial analysis of reuse is based on the cash flows of expenses and revenues to a utility from investing in a reuse facility. The bottom line is incoming cash flows from revenues minus outgoing cash flows to costs. Negative net cash flows indicate poor financial performance. A traditional economic analysis provides a broader perspective of the benefits from water reuse than a financial analysis. The perspective of an economic analysis is from a larger region such as a state or the nation rather than the water utility. As a result, an economic analysis is from more of a social perspective with the goal of generating positive net benefits to the larger group.

The TBL accounting framework expands the area of consideration to include three dimensions or measures: social, environmental, and economic/financial. The TBL approach theoretically provides a much more complete assessment of all the effects associated with various water supply alternatives, including reuse. As a result, the conclusion of water reuse viability from a TBL based analysis may be different than the conclusion from a traditional economic and financial analysis. This scoping study identifies differences between the traditional and TBL approaches, discusses the strengths and weaknesses of the TBL approach, identifies how TBL fits in with current requirements and guidance for evaluating water supply alternatives, discusses data inputs and calculations that can be used with TBL, and provides recommendations for a basic TBL framework that can be used to evaluate reuse projects.

A Traditional Financial Approach to Evaluate Water Reuse

A traditional financial analysis for a water reuse project is from the perspective of the water supplier, where the cash flows in terms of revenues from providing the water reuse service to water users are compared to the cash flows in terms of the costs of providing the service. Given the relatively high cost of installing infrastructure and the annual operation and maintenance costs necessary for water reuse facilities, the direct financial cost of reuse is high from a financial cash flow perspective. Therefore, a financial analysis of reuse would tend to indicate very high water supply costs relative to other water supply options. This is especially true for comparisons that are made with existing water supply systems since previous water supply decisions would have chosen the lowest cost supply sources that were the easiest to obtain.

The financial costs of water reuse include the capital costs of reuse facilities, storage and distribution costs, costs of retrofitting existing water users with recycled water supply lines and associated devices, treatment costs, annual maintenance and periodic replacement costs, and the costs associated with financing the up-front capital costs of providing recycled water service and any future large expenditures for replacement and expansion that may be expected. The financial costs of reuse can then be compared to the financial costs of other supply alternatives

on a cost per unit basis. A water reuse project would be chosen in a financial analysis if the cost per unit of water provided is lower than the costs of other supply alternatives.
The financial costs may also be translated into water service rates that would be necessary to cover expected costs, given projected demand, and the resulting cost of water service per user. The representative cost can then be evaluated for affordability, which becomes a part of the project financing evaluation, and has a direct effect on bonding capability and borrowing rates.
A financial analysis of water reuse is complicated by the need to make assumptions regarding future demands, project costs, costs of project financing, changes in technology, and the availability and cost of other water supply sources which can be compared to reuse as an alternative. However, the basic approach and basis for choosing to implement or not implement water reuse is straight-forward.

A Traditional Economic Approach to Evaluate Water Reuse

An economic analysis of the costs and benefits of water reuse is more complex due to the need to identify and measure the benefits associated with reuse in addition to costs and the need to present value all benefits and costs in constant dollars. The economic decision to undertake a water reuse project depends on the benefits and costs of other water supply alternatives, where a project is economically justified if the economic benefits are greater than the costs.

The economic costs of a water reuse project are based on an analysis similar to the financial costs, except all costs must be expressed as a present value on a constant real dollar basis. Benefits must also be expressed in terms of a constant dollar present value. Present value can be defined as the worth of a future payment in terms of their current value. The equation for present value in terms of discreet time is shown below.

$$PV = \frac{A}{(1+r)^n}$$

where:
PV = present value,
A = amount of money paid or received in the future,
r = discount rate, and
n = year in which the future amount is paid or received.

The present value of a future amount is always worth less than the future amount, assuming a positive discount rate, because money has earning potential. Funds that are available now could be invested and the result would be a greater amount of money in the future.

A real dollar value is adjusted to remove the effects of general price level changes over time (inflation or deflation). Constant dollars are measured in terms of the general price level in some base year. A constant real dollar means that values are measured in terms of the same base year regardless of when the costs or benefit was incurred. For example, all values may be presented in constant 2000 dollars to represent the general price level in the year 2000. This adjustment allows costs and benefits to be compared on an equal basis and summed across the time period over which costs and benefits accrue.

An economic analysis is fundamentally different from a financial analysis because an economic analysis can account for different types of benefits and costs that could result from different water supply options, while a financial analysis is simply comparing the project cost per unit of water supplied. For example, a traditional surface water diversion project may include the cost of a diversion structure, pipelines, storage, water treatment, and environmental costs from reduced stream flows and ecosystem disruption. A reuse alternative may have costs associated with a reuse facility, pipelines, water treatment, and limited suitable uses. The financial analysis will not include the costs associated with reduced stream flows and ecosystem disruption, unless there are fines and penalties that are imposed on the water supplier, and will not include the reduced value of limited water use supplies. However, an economic analysis will consider these costs and reduced benefits to the extent that they can be quantified and monetized. An economic analysis can be used to determine if investment in a water reuse project generates more benefits to society than the costs imposed by the project on society.

Estimating the present value costs of building and operating water reuse facilities is a relatively straight-forward exercise based on engineering estimates of costs, construction period, timing of costs, and project life. However, estimation of other costs such as adverse environmental effects from construction and diversion of water and benefits such as increased wetland acreage or avoided adverse environmental effects are much more difficult. It is critical that these potentially difficult to quantify costs and benefits are identified and estimated to the extent possible to provide a useful economic analysis that can help determine whether a water reuse project should be built. Without a complete accounting of benefits and costs for all water supply alternatives, including reuse, an economic analysis may provide unreliable results and recommendations.

Numerous potential benefit categories have been identified in previous research studies and water reuse literature (Stratus Consulting, 2011; U.S. EPA, 2012; Schroeder, et al., 2012; U.S. EPA, undated). Some of the more common water reuse benefit categories include the following.

- Increased available water supply as a result of freeing up more valuable freshwater supplies for the types of use that require higher levels of water quality and allowing recycled water to be used for purposes that do not require high levels of water quality, such as landscape irrigation.
- Reduced diversion of freshwater from sensitive ecosystems.
- Reduced susceptibility of the water supply to drought conditions, resulting in improved water supply reliability.
- Decreased nutrient loading to sensitive water bodies and prevented or reduced pollution.
- Created or enhanced wetlands and riparian habitats.
- Reduced need for fertilizers/nutrients in water used for agricultural or urban irrigation.
- Reduced energy consumption associated with supply, treatment, and distribution of water.
- Reduced carbon emissions associated with reduced energy consumption.
- Avoided advanced water treatment costs for supplies that do not require higher levels of water quality.
- Reduced, delayed, or eliminated need/cost of water supply expansions.
- Reduced cost of proving water supplies.
- Increased opportunity for recreation and increased aesthetic values.

It should be noted that this is not an exhaustive list and these benefits are relative to other more traditional water supply alternatives, such as surface water diversion and groundwater pumping. There are two basic sources of difficulty in measuring water reuse benefits such as those listed above. First, the relationship between the reuse project and the magnitude of the resulting effects that generate benefits must be quantified. For example, if a water reuse project results in an increase of wetlands acreage, then the area and type of wetland created needs to be quantified. Second, the value per unit of effect must be estimated. For the wetland example, this means that the economic value associated with an acre of wetlands must be estimated. If these two pieces of information can be estimated, then the economic value of that component of the reuse project can be estimated.

Estimating the potential benefit of a reuse project is not a trivial undertaking. Information is required from engineers, hydrologists, biologists, and others to quantify the physical effects of a reuse project. Extensive data sets and complex models may be needed as part of the process of estimating effects.

Assuming the physical effects can be estimated, the economic value of these effects can be estimated using a variety of different techniques. The complexity of these techniques range from simply looking at the results of previously completed studies for similar types of effects, to elaborate studies that use survey data to estimate non-market resource values. Some of these techniques include the following.

- Stated preference approach – Relies on the use of survey techniques to ask individuals hypothetical questions from which benefits can be estimated for the resource or activity of interest. A common complaint regarding the use of stated preference is the hypothetical nature of the approach, which may present unfamiliar market choices and does not reflect an actual monetary commitment.
- Revealed preference approach - Based on actual observed behavior in market or market-like situations. Behavior reveals individual preferences, either through prices paid as part of a market interaction or spending time and money to access and participate in a desired activity. Availability of market price and quantity data may be a limiting factor in estimating willingness to pay functions from which benefits can be estimated.
- Benefits transfer approach – Uses the results from previously completed studies to estimate benefits at a different study site or the same study site at a different point in time. The use of this approach requires the availability of completed studies that are applicable to the study site. This approach is based on the assumption that the relationship between the value of a resource or activity and characteristics that influence those values is similar for the study site and the site where the previous analysis was completed.
- Cost of the most likely alternative – Based on use of the resource cost of the water supply alternative that would be implemented in the absence of the project under consideration as an estimate of benefits. The assumption of this approach is that if the most likely alternative without a project would actually be built, then the benefits of the likely alternative must be at least equal to the cost. The basic problem with this approach is that there is no theoretical reason to assume that the costs of a likely alternative are equal to the benefits of a project that under consideration because the project outputs, including environmental effects, are likely to be different.

The advantages and disadvantages of these benefit valuation techniques are described in terms of the complexity in applying the method and accuracy of the estimates in a municipal and industrial water supply valuation guidance document by Piper (2009). The advantages and disadvantages described in the guidance document are summarized in Table 1.

Table 1 – Advantages and disadvantages of water related valuation methods

Valuation Method	Complexity	Accuracy
Stated Preference – Survey based methods	5	4
Revealed Preference – Demand Curve Estimation	4	4
Benefits Transfer	2-3	2-3
Cost of Most Likely Alternative Without Project	1	1

Complexity in Table 1 is based on the following scale:

1. Requires only cost data, assumes project goal is met, rigorous economic analysis not required, simple to apply.
2. Requires only very basic secondary data (including at least a valuation estimate from a previously completed study) and basic socio-economic data depicting conditions in the study area.
3. Requires secondary data (including results from previously completed studies relevant to the study area), understanding of basic economic principles, and general socio-economic information for the study area.
4. Requires secondary economic data, rigorous modeling and economic analysis, and site specific information.
5. Requires potentially time consuming and complicated primary data collection, rigorous modeling and economic analysis, and site specific information.

Accuracy in Table 1 is based on the following scale:

1. Not a consistently reliable or accurate measure of benefits.
2. Estimates are based on general economic theory, but accuracy is reduced by limited data and/or by many potential sources of measurement error.
3. Estimates are representative and accurate within a range of values. Estimates tend to apply to regional characteristics and are not necessarily site specific.
4. A greater level of precision than for 3, but still uncertainty due to data errors, errors in data gathering, and errors in modeling. Sources of error can be identified but are not fully accounted for. Results are site specific.
5. Very accurate and site specific results.

A traditional economic evaluation of a water reuse project compares the present value of all project costs with the present value of quantified and monetized benefits. Since the common basis for comparison in an economic analysis is dollars, the accuracy of an economic analysis is dependent on the ability to quantify and accurately estimate all benefits and costs. Frequently some categories of benefits and costs cannot be quantified due to unavailable data, uncertain effects, or an inability to obtain reliable economic values. As a result, a traditional economic analysis of water reuse projects is likely to miss some important categories of benefits and avoided costs which may misrepresent the desirability of water reuse projects.

Triple Bottom Line Framework

The appeal of using a TBL approach to evaluate water reuse projects is the potential to measure impacts beyond the traditional financial and economic effects. The TBL incorporates three categories of impacts into an overall evaluation of a project, policy, or program. These categories include social, environmental, and financial and economic measures. Although there is no universal standard list of measures used to compute the TBL, there are some general measures that are typically considered when completing a TBL analysis. These measures are listed and described below.

Social Measures

Social measures are variables that reflect the social characteristics of a community, region, or state. Common measures include education, fairness/equity, environmental justice, health and well-being, quality of life, and social capital. Some of these measures could be considered economic, but many economic characteristics contribute toward the well-being of a population.

Education can be measured in terms of educational attainment, such as the percentage of adult population with a bachelors' degree or higher. Fairness/equity can be reflected through the distribution of income, wealth, home ownership, unemployment, and poverty rate for different groups of people. Groups can be defined by race, nationality, age, or some other characteristic.

Environmental justice is defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (EPA, 2014). An analysis of environmental justice requires overlaying patterns of project or policy impacts on top of the location of minority, low income, and other groups to determine if a disproportionate percentage of impacts are imposed on specific groups.

Health can be measured using several measures available from the U.S. Census Bureau. Examples include the percentage of the population with health insurance coverage, the incidence of various health issues within the population under consideration, and average age of the population. As mentioned previously, well-being can be reflected though economic measures such as median household income, unemployment rate, labor force participation rate, and poverty rates. Other measures of well-being could include crime rates and environmental conditions such as air quality and water quality.

Many of the variables discussed above would fit into the general measure of quality of life. Clearly economic, environmental, and health and well-being measures would all affect the general quality of life. Additional variables that affect quality of life but may not clearly fit into other measures of impact could include average commuting time to work, accessibility to recreation and entertainment opportunities, climatic conditions, and the existence of natural hazards.

Social capital refers to the connections between individuals and entities that can be valuable in economic terms and in terms of well-being and the quality of life. Social networks which include people who trust and assist each other can be useful in building a community that has a sustainable high quality of life.

Environmental Measures

Environmental measures are variables that reflect the type and quality of environmental and natural resources that would be potentially influenced by a project, policy, or program and would affect the viability of a project, policy, or program. These measures typically incorporate air and water quality, energy consumption, natural and environmental resources located in the study area, solid and toxic waste generation, and land use/land cover. Some specific variables that could be considered as part of environmental measures include sulfur dioxide and/or nitrogen oxide concentrations, identified priority pollutants that are of concern to a specific site, excessive nutrients, level of electricity consumption, consumption of fossil fuels, quantity of solid waste generated and disposal of that waste, hazardous waste generation and management, and changes in land use/land cover.

Environmental measures are described in terms such as the quantity of emissions or waste generated over a specified period of time, changes in ambient quality of air and water, the quantity of energy and other natural resources consumed over a period of time, the number of acres affected, and changes in land use.

These environmental measures are likely to be included as part of the social effects discussed above as well as the economic and financial effects listed below. For example, increasing concentrations of air pollutants could have health effects that affect social well-being and impact health related expenditures. However, it is also possible to have environmental affects that do not translate into identifiable social or economic impacts. Therefore, it is important to account for all three measures separately.

Economic Measures

Economic measures are variables that evaluate the value of affected resources and the flow of money that results from a project, policy, or program. Some of these economic values were discussed in the traditional economic analysis discussed above. Traditional measures that are used to evaluate economic and financial effects include per capita and household income, value of output produced, value of resources used, household and business expenditures and input requirements, taxes and unemployment, and the types of businesses and activities located in the area of interest.

Specific economic and financial variables that can be used to reflect these economic measures include per capita income, median household income, total labor force, unemployment rates, total number of firms in each sector, average size of an establishment in terms of total value of output produced and/or the number of people employed, the number of firms in each sector as a percentage of the total number of firms, total payroll by sector, total revenues by sector, value of output produced, number of employees by sector, unemployment compensation expenditures, taxes paid by businesses and households, government transfer payments received, growth in the number of jobs, business establishment churn, and pull factors. Most of these variables are commonly used in economic and financial analyses and are fairly well understood.

Employment, income, value of goods and services produced, value of available land and other resources, and economic growth are generally viewed as positive economic effects indicating an improvement in economic and financial conditions. Increasing unemployment, government transfer payments, unemployment compensation, and losses in the value of resources and goods and services can be viewed as a cost. Some of the economic variables listed above are described in more detail below.

Per capita income is equal to the total income of all people 15 years old and over in a geographic area divided by the total population in that area. Although income data is collected for only those 15 years of age and older, the entire population is included in the denominator of per capita income. Money income includes wage or salary income, net self-employment income, interest, dividends, net rental or royalty income, income from estates and trusts, Social Security, Railroad Retirement income, Supplemental Security Income, public assistance or welfare payments, retirement, survivor or disability pensions, and all other income. Capital gains, money received from the sale of property that is not part of a business, the value of income from food stamps, public housing subsidies, tax refunds, gifts and lump-sum inheritances, insurance payments, and other types of lump-sum receipts are not included as income.

Household income is the income of the householder and all other individuals 15 years old and over in the household, whether they are related to the householder or not. The median divides the upper half of the income distribution from the lower half of the income distribution. For households, the median income is based on the distribution of the total number of households including those with no income. The median is frequently used as a measure of central tendency rather than the mean because the mean is pulled upward by households with extremely high incomes, distorting the mean as a representation of typical household income.

The total labor force includes all persons classified as employed or unemployed. Employed persons are defined as persons 16 years of age and over in the civilian, non-institutional population who did any work as paid employees, worked in their own business/profession or farm, worked 15 hours or more as unpaid workers in an enterprise operated by a member of the family, or were not working but who had jobs or businesses from which they were temporarily absent. Unemployed persons are defined as persons aged 16 years of age and over who had no employment, were available for work (except for temporary illness), and had made specific efforts to find employment. Persons waiting to be recalled to a job from which they had been laid off do not need to be looking for work to be classified as unemployed. The unemployment rate represents the number unemployed as a percent of the labor force.

Unemployment compensation expenditures are payments made to beneficiaries under basic provisions of unemployment compensation programs and special program payments, such as for extended benefits triggered by economic conditions.

Government transfer payments represent a redistribution of income within a market. Examples of transfer payments include retirement and disability insurance benefit payments, medical payments such as Medicare, income maintenance benefit payments such as Supplemental Security Income and Supplemental Nutrition Assistance Program, unemployment insurance benefit payments, veterans benefit payments, federal education and training assistance, and other payments to individuals such as Bureau of Indian Affairs payments and disaster relief payments.

Churn rates may be calculated by a business to evaluate customer attrition or may be calculated at an aggregate level to compare the number of new businesses that have opened relative to the number that have closed. The churn rate regarding customer attrition is defined as the percentage of customers who stopped doing business with a company over a given period of time divided by the average number of customers existing during that time period. Business establishment churn measures how fast businesses open and close relative to the total number of businesses in a region.

According to the U.S. Small Business Administration, business churn tends to follow the change in Gross Domestic Product (GDP) with a six to eight quarter lag. GDP represents the value of all finished goods and services produced within a country's borders over a specific time period, which is usually a year. GDP includes all private and public consumption, government expenditures, all investments, and net exports. Growth in the churn rate is generally the result of increased economic activity. A six to eight quarter lag means that a change in the churn rate follows a change in GDP by about 1 ½ to 2 years. Establishment churn tends to increase with an increase in overall sales and business activity. Innovative and efficient companies tend to replace outdated firms or firms unable to modernize techniques and processes. Business churn is defined as the sum of the number of new establishments gained and the loss of failed establishments divided by the total number of establishments in the region. Typically a high churn rate is an indicator of a healthy and growing economy.

A pull factor (PF) is a measure of the relative strength of retail business in a community. A PF can be calculated for a city, county, or group of counties. A PF is calculated by dividing the local sales tax per capita of the population of a local entity by the statewide sales tax per capita of the local population. A PF of 1.0 indicates purchases of local residents who shop outside of the region are exactly offset by the purchases of customers living outside the region who shop within the region. A PF of less than 1.0 indicates more trade is lost outside the region than is pulled into the region. A PF greater than 1.0 indicates more purchases are pulled into the region than is lost outside.

Applications of the TBL Approach

The TBL approach is based on combining three measures of performance into one analysis. This is a useful characteristic because the importance of different measures will vary across different stakeholder groups and each perspective should be included in a project analysis. For example, the bottom line for businesses may be measured in terms of earnings, the bottom line for a local government agency may be measured in terms of the quantity of service provided, and the bottom line for an environmental advocacy group may be sustainability and reduced waste disposal. The TBL approach can account for these different bottom lines and can theoretically measure effects in a consistent and transparent way. Given that these measures result in different units of measurement, for example dollars in an economic analysis and tons of reduced solid waste in an environmental analysis, a unit-less numbering system is needed that can conceptually be added up across all measures for a project and can then be compared across projects. The issue is how to derive the numerical values that are comparable across all measures. An example is presented below.

An Example TBL Analysis Tool

A Triple Bottom Line Tool for Economic Development (TBL Tool) has been developed by Hammer, et al. (2014) through funding provided by the U.S. Economic Development Administration. The TBL Tool applies multi-criteria decision analysis to allow factors with different units of measurement to be considered together. The tool includes a set of well-defined goals, performance areas, and measures to derive numerical values that can be compared across various projects. The score for each goal is calculated by taking the average of the goal's performance area scores and each performance area score is calculated by taking the average of its measure scores. Results are reported for each goal, performance area, and measure so the analyst can evaluate the results to the appropriate level for a specific analysis. The TBL Tool documentation is careful to point out that the scores provide a general indication of how well a project supports TBL goals and that two projects with the same score may be very different in terms of the magnitude and types of impacts. As a result, when using the TBL Tool the analyst needs to look at each goal and performance area individually, rather than just the bottom line score, to properly evaluate the TBL effect of a project. The TBL Tool user's guide specifically states:

"We caution against directly comparing project scores for a number of reasons. First, the TBL Tool relies on user input and national data sets that require due diligence follow-up. This follow-up needs to be conducted before determining whether one project is indeed stronger than another. Second, as noted above, because a measure is scored NA when data is not available, one project might have a lower overall score than another simply because the first received a low score for a measure while the second received an NA. Third, for a number of measures, the TBL Tool identifies the presence of an impact without attempting to arbitrate the magnitude of significance of the impact to the community."

The TBL Tool acts as a decision and communication aid which can help determine how an investment supports economic vitality, natural resource stewardship, and community vitality goals. The TBL Tool includes 3 goals and 8 measures which are described by over 50 measures of performance. The TBL Tool goals, performance areas, and measures are summarized in Table 2. Each of the goals, performance areas, and measures are discussed in more detail in the following sections.

Economic Vitality

The economic vitality goal consists of two performance areas: quality jobs and sound investments. The quality jobs performance area includes overall employment impacts, direct jobs, construction related jobs, and good wages and training. The number of direct jobs and construction jobs are not included in a project's TBL score because there is no standard for defining a good or bad number of jobs created and retained. The quality jobs performance area score is based on good wages. The estimated number of direct jobs is provided for informational purposes in the model. Direct jobs are created directly as a result of the project and are measured as full time equivalent jobs. Total jobs created, which includes spin-off employment from direct jobs created, was originally considered by the TBL Tool authors as an appropriate employment measure, but these secondary effects were considered too imprecise to include as a measure of employment impact.

Good wages and benefits in the quality jobs performance area is defined as an average wage and percentage of employees with benefits that are than the average for the direct employment jobs created. Additional bonus points are given if the average wage and percentage with benefits is 120% or higher than the average. There is no penalty if wages are not above average. Measures are generally 0, 50 or 100 points. Training and advancement opportunities are included as part of benefits. Examples include apprentice or training programs, apprentice and non-apprentice hiring goals, and use of under-represented businesses. The same points are provided for direct jobs and construction related jobs.

The second performance area is sound investment, which is essentially an evaluation of financial feasibility and economic effects. Completion of pro forma is the first measure, where a project earns 100 points if pro forma completed and zero points otherwise. The pro forma is a document or analysis that meets certain requirements to demonstrate financial viability. Completion of a fiscal impact analysis, which evaluates the effect of a project on government finances, is worth 100 points if completed and shows positive fiscal impact, 0 points if not completed or the analysis indicates a negative fiscal impact. Consistency with an existing regional economic development strategy scores 100 points if supportive and 0 if not. An NA score, which has no effect on the overall score, is assessed if there is no regional development strategy. If the project supports local business, which is defined as purchasing inputs from within the region, a bonus of 100 points is given and 0 points is given if not supportive. A ratio of private to public investment is calculated for information purposes, but is not included in the TBL score. Finally, the proportion of investment that is leveraged from other funding sources is also calculated but not included in the score.

Natural Resource Stewardship

The natural resource stewardship goal reflects resource use, pollution generation, construction using recycled materials, conservation of energy and other natural resources, sustainability, and avoiding environmental disruption and degradation. The first of the three natural resource stewardship performance areas is industry eco-efficiency of production, which can generally be characterized as resources consumed and emissions produced per job. As shown in Table 2, there are 9 different categories of resource use and emissions that are evaluated. Each of these categories are assigned North American Industry Classification System (NAICS) codes which are identified with higher than average impacts. NAICS codes are the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. businesses. Each NAICS code is assigned a score of 0 to 100 to represent sectors that have relatively higher or lower impacts per job.

Table 2 – Goals, performance areas, and measures used in the U.S. Economic Development Administration TBL Tool.

Goal	**Economic Vitality**		**Natural Resource Stewardship**			**Community Well-Being**		
Performance Area	Quality Jobs	Sound investment	Industry Eco-Efficiency	Green Design and construction	Green Operations	Place-making and accessibility	Environmental Health	Governance
Measures	• Relative impact on employment • Direct jobs o Number o Good wages and benefits o Career access and advancement • Construction jobs o Number o Good wages and benefits o Career access and advancement	• Pro forma completed • Fiscal impact analysis • Pro forma • Consistent with regional economic development strategy • Support for local business • Ratio of private to public investment • Leveraged investment	• Fossil fuel energy use • Water use • Solid waste generation • Ozone depletion • Acidification • Photochemical smog • Eutrophication • Eco-toxicity • Greenhouse gasses	• Green building • Adaptive reuse • Sustainable site design • Remediation, restoration, conservation • Avoidance of of sensitive natural resources	• Energy from renewable resources • Energy management • Automobile trip reduction strategies • Tenant environmental incentives • Water use lower than industry norms • Emission lower than industry norms • Industry best practices • Green products and services	• Cultural and historic resources • Public spaces • Walkability of project location • Transit accessibility of project location • Project increases walking, biking, or transit options • Location in high need areas • No net loss of affordable housing • Housing affordability	• Toxic exposure o Cancer related toxins o Non-cancer toxins o Criteria pollutants	• Stakeholder engagement • Key infrastructure capacity • Accountability • Relocation planning and collaboration • Prevention and mitigation of displacement

The second performance area is green design and construction. Implementation of green standards, certifications, and practices earned 100, 75, 50, or 0 points depending on the level green building. The levels are 3rd party certification, green but without certification, employing some green building, no green building. A bonus for reuse of structures is provided. Bonus points are not reflected in the project score but are provided as additional project impact information. Implementation of sustainable site standards, certifications, and practices earned 100, 75, 50, or 0 points depending on the level of sustainable design. The same type of certification is used as described for green building. A bonus of 100 points is given to projects that remediate, restore, or conserve resources. A bonus is also given to a project that avoids flood zones, critical habitat, steep slopes, wetlands, water bodies, protected areas, prime farmland, and forestland. A total of 100 points is given if no sensitive area is affected, 75 points are given for nearly full avoidance or mitigation, 50 points are given for partial avoidance or mitigation, and 0 points for no avoidance or mitigation.

The third performance area for natural resource stewardship is green operations, which is the average score of eight project measures. The energy from renewable sources measure is the percentage of project energy from renewables, where 100 points is given if a portion of energy is renewable and an additional 100 or 75 points are given if businesses that provide services to the project are provided incentive to use renewable energy. Another measure is energy management, which is monitored through participation in the Energy Star program. A total of 100 points is given if there is Energy Star participation and 0 points otherwise. The automobile trip reduction measure provides 100 points if a telecommuting or public transport pass program exists. An additional 100 points are given to the project if there are incentives for businesses that support the project to participate in tenant green practices and meet best practices. A bonus of 100 points is given for each of water use lower than industry norms and emissions that are lower than industry norms. A 100 point bonus is also given for industry best practices, products, and/or services for each specific industry. Last, a bonus was given for green products and services supported by the project. Projects earn bonus points if some or all jobs created pertain to one or more of the five green product and service categories defined by the U.S. Bureau of Labor Statistics. A total of 100 points are given if 76% to 100% of jobs created are green jobs, 75 points for 1% to 75%, and no points if no green jobs are created.

Community Well-Being

The community well-being goal includes a combination of project aspects related to preservation of cultural and historic resources, availability of public spaces, accessibility, job creation in low income areas, impact on affordable housing, impacts on environmental health, and openness of the planning process and mitigation of potential displacement and relocation.

The first performance area is place-making and accessibility. The first measure within place-making and accessibility considers preservation, enhancement, or diminishment of cultural and historic resources. Three sub-measures are identified within the measure. The first sub-measure is culturally or historically significant structures, facilities, or districts; where 100 points are given for preservation investment that meet criteria for national, state, or local registry and have letter of support and 80 points are given if the project will preserve or enhance resources but will not meet the criteria for historical registry. The second sub-measure is culturally significant practices, where a positive impact is worth 100 points. The third is publicly accessible programming, where 100 points is given if there is a component specifically designed to serve the community.

A total of 100 points may be given for the second measure, which is preservation, enhancement, or diminishment of public spaces. The third measure, walkability, is given a score of 0 to 100 based on the walkscore.com website. A score of 90-100 means daily errands do not require a car, 70-89 points are awarded if most errands can be done on foot, 50-69 points means some amenities are within walking distance, a score of 25-49 points means a few amenities are within walking distance, and 0-24 points are given if almost all errands require a car. The walkscore.com website is also used for transit accessibility of project location scoring. A total of 90 to 100 points are awarded for world class public transportation, 70 to 89 points if transit is convenient for most trips, 50 to 69 points if there are many nearby public transportation options, 25 to 49 points if there are a few nearby public transportation options, are 0 to 24 points are given if it is possible to get a bus. A closely related measure of increased walking, biking, or transit options with the project in place provides an additional 100 points for a project designed to improve walkability.

Another measure related to project location in high need areas provides a bonus to projects located in an area defined as distressed or severely distressed. The U.S. Department of Housing and Urban Development calculates income limits for eligibility in a variety of programs. These limits are based on area median income (AMI), which is the median family income (MFI) for a defined area in the current year and adjusts that amount for different family sizes. The MFI is the income level that separates the top one-half of family incomes from the bottom-half. A total of 100 bonus points are given if the project area is defined by: 1) either MFI is at or below 80% of AMI from 2006 to 2010 or poverty rate 20% or greater over 2006 to 2010 period, and 2) must have one of the following factors: MFI at or below 60% of AMI over 2006 to 2010, poverty rate at or below 30% over 2006 to 2010, unemployment rate of at least 1.5 times 2006 to 2010 national unemployment rate, are in a county that is not part of a metropolitan statistical area.

The final two measures are related to affordable housing. The first measure is the existence of a binding agreement that provides for a one-for-one replacement of affordable housing units. A 100 point bonus is given to the project if such an agreement exists. The second affordable housing measure awards a 100 point bonus if there is replacement of housing units that ensures 10% or more of housing units are affordable to households at or below 120% of AMI.

The second performance area is environmental health, where scoring is based on whether a project's industry produces relatively more or less health impacting pollution per job created over the life of the project. Sectors are defined using NAICS codes. Scores are built around the Comprehensive Environmental Database Archive which uses input-output to evaluate environmental impact per dollar of final demand. Possible scores range from 0 to 100 and are a weighted average of environmental impact. The impacts are based on whether the sector is a higher or lower than average producer of emissions for chemicals associated with various health effect effects.

The third performance area is governance. This performance area includes measures that consider stakeholder involvement, evaluation of existing infrastructure and the need to improve infrastructure with a project in place, transparency of project funding and performance, and impact on residents including relocation and mitigation of displacement. A total of 100 points is given if there is a policy or program to work with diverse stakeholders that may be affected by the project. A score of 100 is given if existing infrastructure capacity has been evaluated and is or will be sufficient to accommodate the proposed project and 0 points are given if capacity is not confirmed. There are four accountability sub-measures. If legally binding provisions for performance exist, a project gets 100 points. If information regarding project subsidies and performance is easily obtainable by the public, then 100 points are awarded. Responsible contracting is awarded 100 points and if the entities responsible for building and operating the project use triple bottom line accounting, then 100 points is awarded.

Three sub-categories with specific point values are included in the relocation and displacement related measures. If businesses and/or residents would be relocated as a result of the project and an appropriate relocation strategy is in place, the project would receive 100 points for having a relocation plan. If a strategy to prevent or mitigate displacement of residents and businesses is in place, a project would receive 100 points. Finally, if a project does not encourage relocation of existing jobs away from other communities to the project area, they would receive 100 points. The project would receive 0 points if they encourage relocation and provide no plan to mitigate relocation impacts.

Summary of U.S. Economic Development Administration TBL Tool

The intended purpose of the TBL Tool developed by Hammer, et al. is to help identify and measure variables that reflect TBL impact categories, which can then be used to achieve investment and TBL goals. The TBL Tool can be used to configure investments for strong TBL performance, to compare projects, and to describe investments that align with TBL goals and community priorities. The grade or score criteria are not the same for each category (e.g. one may be -3 to +3 and another 0 to 100). However, when aggregating a total score, the TBL Tool normalizes all measures on a 0 to 100 scale. The TBL Tool does not attempt to determine the scale, quality, or value of an investment's contribution to account for the unique context of a project o community. Therefore, weights have not been assigned to any performance area or measures. However, implicit weighting occurs when the number of measures in a performance area varies. Measures that belong to a performance area with few other measures carry more weight when the average for the performance area is calculated. Project reports generated by the TBL Tool provide a general indication of how well a project aligns with TBL goals. When interpreting the TBL Tool output results, it needs to be recognized that two projects with the same score may differ in the type or magnitude of impact.

The details of the TBL tool are provided in this scoping report to demonstrate the detail involved in applying the TBL approach. Several different categories of impacts, definitions of performance areas and measures, sources of information, and assumptions for point totals are necessary.

A Triple Bottom Line Application to Water Reuse and Desalination – El Paso Water Utilities

A site specific TBL application is described in a report by Stratus Consulting (2011). The Stratus analysis provides a TBL analysis of desalination and water reuse programs in El Paso, Texas. The assessment included an evaluation of three bottom lines. The first was financial, defined by expenses incurred by the utility and avoided costs associated with options not taken. The second was social, which included improved reliability of supplies, energy savings, and health effects compared to other options. The third was environmental outcomes, such as changes in air pollution emissions and water quality impacts compared to other options. The El Paso TBL analysis quantifies and monetizes outcomes to the extent possible in a “reasonably credible manner” and effects that cannot be monetized are described qualitatively.

Four alternatives were considered. Scenario A is the baseline which includes the current El Paso Water Utilities (EPWU) water supply sources portfolio and the existing water plan. This scenario includes reuse and desalination and is compared to other scenarios that do not include desalination and/or reuse. Scenario B represents no desalination, or EPWU’s supply portfolio without the current desalination plant or future desalination options. Scenario C represents no reuse, or EPWU’s supply portfolio without past, current, or future reclaimed water supplies. Last, Scenario D represents no desalination and no reuse. Scenario D represents EPWU without either desalination or reclaimed water as a supply option either currently, in the past, or in the future. It should be noted that the progression of potential water supply options ranges the existing water management plan which has the most supply options (Scenario A), to a plan with the fewest options (Scenario D). The number of options available in each scenario could be reversed (Scenario A could have the fewest options), but the order of alternatives would not have any effect on the evaluation of reclaimed water and desalination as water supply options.

The approach used by Stratus Consulting is interesting because the baseline includes the water supply options that would typically be considered as alternative supply options. So, rather than asking the question if desalination and reuse is economically and financially feasible; the question is asked in terms of costs of providing the current level of service under four different water supply options. The results are all presented in dollars where social and environmental effects associated with available water supply constraints are translated into economic values to the extent possible. The financial bottom line represented cost savings from allowing reuse and desalination options. The social bottom line represents air quality health related risk reduction, increased supply reliability, the use of water supply sources that are not sensitive to climatic variability, and sustaining agricultural communities. The environmental bottom line includes carbon footprint reduction, energy savings, air quality improvement, groundwater quality improvement, and surface water diversions. Not all of the effects were monetized, but all were described. Based on the Stratus Consulting analysis, allowing water reuse and desalination options leads to an estimated 74% financial savings, 296% environmental savings, and 321% social savings over the next least-cost alternative.

The approach used in the Stratus study is promising because it takes essentially an optimization/linear programming type of approach to the triple bottom line. There is an objective function that is dependent on financial, social, and environmental factors (additive in this case and at least some converted to dollars) and a range of possible options/alternatives. Some options include reuse and/or desalination while others do not. The constraints are the possible options for meeting water demands. The results are compared in terms of each of the three bottom lines. Using this approach, reuse/desalination represents a relaxing of constraints and therefore TBL analysis properly accounts for the benefits of including water reuse and desalination that would not be accounted for in a traditional financial analysis.

Criticism of the TBL Approach

A study by Sridhar and Jones (2012) listed three basic criticisms of the TBL approach. The first criticism is that TBL measurement is complex because intangible assets such as loyalty or reputation can be vague and linking these areas to identifiable activities can be difficult and the appropriate measures may not be consistent. Attention needs to be given to not only how to measure TBL effects but how reliable the values are. An important limitation of TBL centers on social measurement and performance. It is difficult to quantitatively assess the goodness or badness of a problem, and in dealing with social impacts both quantitative and qualitative distinctions need to be made. Social measures are by necessity more qualitative.

Another complexity of TBL analysis is the lack of ability to aggregate the results across the three principles of TBL. This is a problem because the premise of TBL is to be able to provide a social profit and loss number. The social metric includes goals, costs of achieving them, and the availability of resources to meet the costs. A single objective of profit is replaced by three objectives in TBL, but not all can be measured comparatively. Effort towards social good, which may be measured in terms of spending for social programs or donations, is made to achieve social goals but is not necessarily proportional to realized social impacts.

The second basic criticism in the Sridhar and Jones study is that the TBL has a lack of integration as a systematic approach to evaluating projects. In systems theory it is proposed that the whole is more than the sum of the individual parts. In TBL the three dimensions involve separate data collection and analysis, failing to recognize interdependence of factors.

The third criticism by Sridhar and Jones is the use of TBL as a compliance mechanism. TBL could push corporations into compliance or beyond compliance. Implementation of TBL could be seen as a type of coercion that forces a corporation to undertake actions that are not beneficial due to shortcomings in the TBL approach. The difference between effort to attain social goals and actual results that justify actions is relevant here.

A study by Norman and MacDonald (2004) discusses some potential issues with the use of TBL accounting. First, they argue that the TBL approach is similar to the traditional view that the corporate world has a variety of obligations to many stakeholders. The difference is the belief that the overall fulfillment of obligations to communities, employees, customers, and suppliers should be measured, calculated, audited and reported in the same way as financial performance. Norman and MacDonald acknowledge that this is a desirable goal, but question that there is a common basis for adding up the three bottom lines in a useful fashion.

According to Norman and MacDonald, proponents of TBL are making two basic claims about the additional bottom lines. First, there is a measurement claim that the components of social performance or social impact can be measured in relatively objective ways on the basis of standard indicators, which can then be reported and audited. Second, there is an aggregation claim that a social bottom line can be calculated using data from these indicators and an understandable and defensible formula could be used by a business or for a project to account for these impacts. The authors also indicate that TBL supporters believe that measuring social performance will improve social performance and that firms with better social performance tend to be more profitable in the long run. Finally, Norman and MacDonald believe firms should have a responsibility to disclose information regarding performance to all stakeholders irrespective of the type of analysis used to evaluate a project.

In financial analysis, money provides a common unit of measure that permits expenses to be subtracted from revenues. However, social and environmental effects do not have similar common units of measure. Therefore, there is no real social bottom line because there is no uncontroversial way to add up social advantages and disadvantages and these effects are not reducible to a common unit that can be used for social bookkeeping. The TBL approach implies one of two things, social and environmental values are assigned dollar values or that the social and environmental impacts are considered and given a level of importance similar to financial effects. The conclusion of Norman and MacDonald is that there is no social bottom line that is directly comparable to a financial bottom line. Therefore, at best the use of TBL analysis requires reporting a number of data points that are potentially relevant to different stakeholder groups. Presentation of results may improve the knowledge of social and environmental impacts, but the comparability problem will continue.

In a response to the criticisms by Norman and MacDonald, Pava (2007) indicated that there are several different financial and economic measures of impact which cannot be directly added up (income, resource value, and employment for example). Therefore, why should the comparability constraint be imposed upon the social bottom line? Although TBL is not perfect, Pava sees it as a move in the right direction for project analysis. TBL can be seen as a method for organizing impacts into categories that can be systematically compared between different projects.

Data Availability as a TBL Limitation

The TBL approach can be used to evaluate a specific project that would affect a relatively small region such as a town or county or a more general policy or program that would have broad impacts across a large geographic area at the state or national level. An example of a specific project that TBL could be applied to would be a wastewater reuse project that is part of a city water management plan. An example of a more general policy based TBL analysis would be a federal mandate requiring specific types of treatment as part of wastewater reuse.

The set of measures used in a TBL analysis is ultimately determined by the analyst, stakeholders, subject matter experts, and the availability of data necessary to analyze a specific measure. The size of the geographic impact area and the type of project evaluated is important in determining what measures and variables should be included in a TBL analysis. Similar to a traditional economic analysis, in many cases the availability of data is the limiting factor.

In order to understand data as a limiting factor, the difference between primary and secondary data and the resulting difference in the cost of obtaining data must be understood. Primary data are original data collected for the first time by an investigator while secondary data have already been collected by a researcher or agency and are available for use by other researchers. Primary data are typically collected using survey questionnaires and are collected for specific factors needed by the investigator which are not already available from another source. Secondary data may not have been originally collected for the specific factors needed as part of the TBL analysis, but they may be applicable and sufficient for the area under investigation in the analysis. The cost of collecting primary data includes the cost of questionnaires, resources needed for the field visits, and the cost of additional collection time. The costs of collecting primary data can be prohibitively high in some cases. Using secondary data can eliminate many of these costs. Considering the cost of obtaining primary data, it is always advisable to determine the availability of secondary data that would meet the needs of the analysis.

Typically, more secondary data are available at the state and national level than at the local level. Secondary data for many of the measures listed above are readily available at the national, state, and in some cases the county level from the U.S. Census Bureau, Bureau of Labor Statistics, the U.S. Small Business Administration, the U.S. Environmental Protection Agency, and the U.S. Department of Agriculture. However, secondary data becomes more difficult to find as the geographic area decreases. Therefore, the same level of TBL analysis at a site specific level may be much more costly than at the national level due to primary data collection costs.

Reclamation and Federal Guidance Related to the Evaluation of Water Reuse Projects

There is Reclamation guidance on evaluating the economic and financial feasibility of water reuse and Federal guidance on the evaluation of investments in water resources which provide some additional insight into the use of TBL for evaluating water reuse projects. Bureau of Reclamation guidance on water reclamation and reuse and Federal guidance on water resource investments are summarized below.

Bureau of Reclamation Title XVI Water Reclamation and Reuse Program

An interesting example of the type of analysis typically completed to evaluate water reuse is the requirements for feasibility level analysis for the Bureau of Reclamation Title XVI Water Reclamation and Reuse Program (Title XVI). The Bureau of Reclamation Directives and Standards (D&S) for Water and Related Resources Feasibility Studies (CMP 09-02) outlines detailed requirements for evaluating feasibility, including economic analyses completed in accordance with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G’s) that were published in 1983 (U.S. Water Resources Council, 1983), cost allocation, and financial analysis to consider each project beneficiary's capability to pay for its share of costs. However, D&S CMP 09-02 specifically excludes analysis of Title XVI studies. The requirements for a Title XVI Feasibility Study are discussed in D&S WTR 11-01. The Title XVI feasibility study requirements are much less rigorous than for feasibility studies in general. A Title XVI feasibility study must include discussion of water reclamation and reuse opportunities, including a market assessment and discussion of potential sources of water; a description of alternatives, including at least two alternative measures; an economic analysis, which includes a cost effectiveness analysis and a qualitative discussion of benefits; and a financial analysis that indicates if the non-federal sponsor can pay their share of costs. The Bureau of Reclamation Title XVI feasibility level analysis essentially represents a comparison of the costs of alternative measures designed to meet water demands and the ability to finance the reuse project, which is a traditional financial type of analysis. An analysis based on the P&G's would be considered a traditional financial and economic analysis.

Principles and Requirements for Federal Investments in Water Resources

The Principles and Requirements for Federal Investments in Water Resources (P&R's) were approved in March 2013 with an effective date 180 days after the publication of the final Interagency Guidelines. The P&R's are an update of the 1983 P&G's mentioned above. The P&R's indicate that Federal water resource investment should try to maximize public benefits, with appropriate consideration of costs. Public benefits include environmental, economic, and social goals. In addition, public benefits include monetary and non-monetary effects and allow for the consideration of both quantified and unquantified measures. The P&R's also indicate there is no order of importance among these three goals and as a result, tradeoffs among potential solutions need to be assessed.

It is important to note that public benefits as defined in the P&R's are the same categories of benefits described in TBL analysis. In addition, the P&R's include a list of guiding principles which can be interpreted as non-traditional categories of benefits that need to be considered when evaluating projects and policies. These guiding principles include the following.

- Healthy and Resilient Ecosystems - Enhancement of the essential services and processes performed by the natural environment and contribution to the economic vitality of the Nation.
- Sustainable Economic Development – The creation and maintenance of conditions under which humans and nature can coexist in the present and into future. Federal investment in sustainable economic development activities contribute to the Nation's resiliency.
- Floodplains - Federal actions should seek to reduce the Nation's vulnerability to floods and storms and any potential adverse effects on floodplain functions need to be identified.
- Public Safety - Threats to people, including loss of life and injury, from natural events should be assessed as part of the decision making process.
- Environmental Justice – An evaluation of environmental justice includes identification of potential effects and actions that would be taken to mitigate adverse effects on specific groups and communities, including improving the access to information. Evaluation

methods should eliminate any biases and fully display the effects of alternative actions on minority, Tribal, and low-income communities.
- Watershed Approach – Consideration of the benefits of water resources for a wide range of stakeholders within and around the watershed, allowing for consideration of upstream and downstream conditions, needs, and potential impacts of proposed actions.

The similarity between the updated P&R's and the TBL approach is an important consideration in assessing the potential for using TBL to evaluate water reuse projects. The potential weaknesses identified in this scoping document regarding the use of TBL in evaluating water reuse projects would also apply to the P&R's.

A Framework For Applying TBL to Water Reuse Projects

Water reuse is integral to sustainable water management because it allows freshwater supplies to remain in the environment where they provide important ecosystem benefits and allows water sources to be preserved for future uses. These secondary benefits occur in addition to the primary benefit of meeting water requirements in the present. Non-monetary costs and benefits of reuse projects, such as increased water supply reliability in times of drought, reduced greenhouse gas emissions, and ecological impacts should be considered to determine the most socially, environmentally, and economically feasible water supply option.

The ability to reuse water, regardless of whether the intent is to augment water supplies or manage nutrients in treated effluent, has positive benefits that are also the key motivators for implementing reuse programs. As a result, reuse is particularly suitable for TBL analysis because it can accommodate supply constraints, environmental constraints, demand requirements, and reliability issues that may be intensifying in the future as a result of climate change.

Identifying the different categories of values associated with a reuse project and defining standard measurements for each category is necessary before a "standardized" TBL tool can be developed to evaluate the environmental, financial, and social benefits of water reuse projects. As shown in the discussion of the TBL Tool and the TBL applications, identifying categories and defining measures is a complicated process. However, developing such a tool would provide water resource managers with information to aid in making important funding decisions, such as those made as part of a capital improvement program, and to help educate the public and rate payers on the monetary and non-monetary benefits of reuse.

Categories of Water Reuse Benefits

As discussed previously in the section examining the traditional approach to evaluating water reuse, there are several potential categories of benefits from reuse. Additional categories of potential water reuse benefits related to potential cost savings as well as benefits related to environmental benefits (Stratus, 2009) include the following.
- Reduced cost relative to developing new supply sources.
- Reduced purchases from wholesalers.

- Reduced, deferred, or eliminated need for capacity expansions and capital facilities projects.
- Recreational use.
- Enhance aesthetics (reflected through property values – hedonic approach).
- Heat stress-related premature fatalities avoided – Greenery lowering the outside temperature.
- Wetland enhancement and creation.
- Poverty reduction benefits of local green creation infrastructure jobs.
- Air quality pollutant removal from added vegetation.
- Construction and maintenance related disruption impacts.

Water and energy are interconnected, and sustainable management of either resource requires consideration of the other. Water reuse may result in reduced energy use by eliminating the need to pump and convey water from alternative ground water or distant surface water sources. Non-potable reuse may avoid the need for potable water treatment. For example, about 20 percent of California's electricity is consumed by water-related energy use, including potable water conveyance, storage, treatment, and distribution and wastewater collection, treatment, and discharge (California Energy Commission, 2005). A summary of potential water reuse benefit categories and measures that should be considered in a TBL analysis of reuse is shown in Table 3. It should be noted that some measures appear in more than one category.

Potential TBL Frameworks for Water Reuse

The review of literature and analysis of TBL approaches that have been used in the past indicate there are a number of potential TBL frameworks which can be used to evaluate water reuse. Three possible approaches are summarized below.

1. Measure the effects that can be quantified and monetized and place those impacts into an economic/financial category, measure the effects that can be quantified but not monetized and place those impacts into a second category that may be environmental or social, and identify those effects that cannot be quantified and place into a third category. Each possible alternative can then be ranked within each category and those rankings are weighted according to importance as determined by stakeholders, decision makers, the public, or some other person or group. This approach is essentially the approach used for the TBL Tool developed by Hammer, et al. (2014).

2. Use a portfolio approach, where different water supply scenarios or alternatives are considered and evaluated using economic/financial, environmental, and social criteria. The results for the different scenarios are then compared in economic terms to the extent possible and qualitative comparisons are also made. This approach differs from the first approach in that the cost of achieving a water supply goal, where the goal can be defined in terms of the water supply needed to meet demand in combination with environmental and social constraints, is compared for alternatives of which one includes some type of reuse. The approach is more cost-based than the first approach, where the benefits (quantified and unquantified) are directly compared to the costs (quantified and unquantified). This approach was used by the Stratus Consulting in the El Paso, Texas analysis (2011).

Table 3 – Potential water reuse benefit categories and measures.

Economic	Environmental	Social

• Revenues to water suppliers
• Cost of service to customers
• Avoided construction costs
• Avoided O&M costs
• Reduced energy costs
• Improved debt coverage ratio of water suppliers
• Impacts on water rates
• Cost of carbon emissions
• Disposal cost of waste products
• Economic losses to agriculture
• Recreation benefits
• Impacts on health costs
• Property values
• Impacts on the regional economy
	• Reduced energy use
	• Impact on wetlands
	• Wastewater treatment flows
	• Water quality
	    o Aquatic toxicity
	    o Eutrophication
	    o Habitat changes
	    o Reduction in wastewater effluent discharges to the environment
	• Carbon emissions
	• Climate change effects
	• Disposal of bine
	• Reduced freshwater supply diversions
	• Water system sustainability
	• Resilience
	• Agricultural impacts
		• Impacts on employment and income
		• Recreation impacts
		• Aesthetic effects
		• Public health
		• Water supply affordability
		• Safety
		• Fiscal impacts
		• Climate change impacts
		• Income and employment effects
		• Impacts on business/industry revenues
		• Effects on waste generation and disposal
		• Land use effects
		• Public health
		• Community attractiveness
		• Increased M&I supply reliability
		• Freeing up freshwater for other uses
		• Improved water quality

3. A third possible approach is to measure benefits and costs to the extent possible for each of the three bottom lines, identify uncertainties associated with potential benefits and costs, and apply the minimax principle to the results. The minimax principle is a decision rule in a two-person zero-sum game where the possible loss from a worst case scenario is minimized.

   A zero-sum game represents a situation where a participant's gain (or loss) in income or utility is exactly balanced by the losses (or gains) of the other participant(s). The sum of total participant gains and losses in a zero sum game will add up to zero. The minimax solution in zero-sum games is the same as a Nash equilibrium. In game theory, a Nash equilibrium is a solution in which each player is assumed to know the equilibrium strategies of the other players, and no player has anything to gain by changing their own strategy unilaterally. Since there is no incentive to change positions by any player, a Nash equilibrium is stable and can be considered a "safe" strategy to avoid the worst possible outcome. However, in avoiding the worst possible outcome, a player may also fail to attain the best possible outcome.

   The minimax principle should not be confused with the maximin principle. Maximin is a strategy used to maximize one's own minimum payoff. John Rawls defined this principle as the rule that social and economic inequalities should be arranged so that "they are to be of the greatest benefit to the least-advantaged members of society" (Rawls, 1971).

   The idea behind the use of the minimax principle in a TBL water reuse evaluation is to choose an alternative that meets minimum levels of social measures (such as health and safety or community attractiveness), environmental measures (such as water quality and carbon emissions), and economic measures (such as unemployment and income) but meets these goals while maximizing the quantifiable benefits or minimizing the quantifiable costs. This approach is somewhat of a hybrid approach combining concepts of an objective TBL Tool that measures and ranks different performance areas as well as comparing the costs of alternatives that meet minimum requirements.

Integrating Reclaimed Water into a Water Resource Portfolio

Water reuse is recognized as an important component of integrated water resources planning. Therefore, the same principles that are used for funding water supply expansion and improvements should apply to recycled water systems. The underlying principles for a reclaimed water system's funding strategy should reflect the following:

1. Revenues from rates and charges should be sufficient to provide annual operating maintenance and repair expenses, capital improvements costs, adequate working capital, and required reserves.
2. Accounting practices should separate reclaimed water accounts from other governmental or entity operations for transparency and to prevent diversion of funds to uses unrelated to water services; this concept is typically reflected by use of an enterprise fund, which

may be stand alone for the reclaimed water system, or combined with the utility's potable water and wastewater systems.

3. Accounting practices should adhere to generally accepted accounting principles and comply with applicable regulatory requirements.
4. Rates and fees should equitably distribute the cost of water service based on cost-of-service principles, compliance with legal requirements, and transparency of communication regarding non-quantifiable benefits to rate payers.
5. Budgeting should be adequate to support asset management, including planned and preventive maintenance, as well as infrastructure re-investment.

It should be noted that utilities frequently set reclaimed water rates lower than potable water rates to promote the conversion to reclaimed water use. Charging a lower rate for reclaimed water allows users to pay the costs required to retrofit and design systems for reclaimed water use. However, it should also be noted that there are characteristics of a reclaimed water supply that may actually result in a higher value than a more traditional supply source. For example, recycled water may contain nutrients that are valuable in irrigation applications (both landscape and agricultural). Recycled water supplies may also be less susceptible to drought, resulting in reliability benefits. Recycled water supplies may also result in less environmental degradation. If water users recognize reduced environmental degradation as a benefit and are willing to pay for that environmental benefit, then recycled water supplies may have a higher value than traditional supplies. Sustainable water utility funding strategies are based on a combination of capital, operations and maintenance considerations, and revenue tools that provide the greatest value for the system and its customers.

Potential Impact of Different Types of Reuse on Triple Bottom Line Categories

Although there is not universal agreement on the definition of different categories of reuse, the following highlights the general differences in the types of reuse. Sources of information include California Senate Bill No. 918 (2010), Florida Administrative Code 62-610 (2012), and Tchobanoglous, et al. (2011).

1) Non potable reuse (NPR) – Treated water that is used to meet commercial or industrial demands.
2) Indirect potable reuse (IPR) – Augmentation of a drinking water source (surface or groundwater) with recycled water followed by separation of the water from the treatment process for drinking water and distribution as drinking water. This separation can be in terms of time (e.g. retention basin) or geography (e.g. natural environmental buffers).
3) Direct potable reuse (DPR) – Introduction of highly treated recycled water directly into a drinking water facility or into a drinking water distribution system. DPR does not include separation between the introduction of recycled water and its distribution as drinking water. DPR eliminates the passage of the treated water through an environmental buffer. The direct passage of treated water to the drinking water system is the main characteristic distinguishing it from the indirect path of IPR.

Although there is some variation in the definitions of direct potable reuse, they all exclude the existence of an environmental buffer. An environmental buffer allows time for mixing, dilution, and natural physical, chemical, and biological processes to improve the quality of the recycled water. The difference in IPR and DPR may lead to important differences in the impact of reuse on social, environmental, and economic/financial goals/measures. For example, IPR may have fish and wildlife and other ecosystem service benefits that do not occur with DPR and will therefore result in a more complicated and difficult analysis of TBL effects. Although IPR is more accepted than DPR, it is still controversial. According to the EPA Guidelines for Water Reuse, the primary opposition to IPR is related to the perceived health risks and the perception of the quality of the natural water source being degraded by the addition of reclaimed water.

Potable reuse systems can be more or less expensive than NPR systems. NPR may require less treatment, depending on the intended use of the reclaimed water, and can also reduce the peak demand on a potable system, which can be a big factor on water use in arid locations. However, non-potable reuse also typically requires a separate piping system, which can be a significant expense depending on where and how far the –non-potable water must be distributed. Along with the economic/financial stresses from separate piping systems required for NPR, the larger footprint and land disturbance required could impact potential environmental benefits for NPR projects.

Categories of social benefit and cost may vary considerably when comparing potable reuse and NPR. Using NPR for irrigation and industrial purposes tends to receive relatively high public acceptance while some communities have rejected potable reuse projects based on negative perceptions and health concerns (Conway, et al., 2008). However, potable reuse has been better accepted by the public when accompanied by information and education programs that explain water quality standards and public health requirements involved with reuse (Conway, et al., 2008).

Summary and Next Steps

This scoping report has characterized categories of costs and benefits, both quantifiable and non-quantifiable, associated with water reuse. Examples of existing TBL tools and analyses of water supply alternatives have also been presented as potential frameworks for evaluating water reuse alternatives. Potential frameworks for evaluating water reuse must account for benefits associated with beneficial uses of reclaimed water, the avoided costs of non-water reuse options such as reservoir development and water importation, improved environmental and recreational resources, and social factors. Finally, three possible TBL frameworks are presented for evaluating water reuse projects which could be developed into a standardized approach to account for monetary, non-monetary, quantifiable, and non-quantifiable benefits and costs of water reuse projects.

In order to test the applicability of these possible frameworks, a select but diverse set of regional water planning case studies need to be selected to develop a user-friendly TBL Tool that can help water resource managers measure the benefits of water reuse and predict future water reuse benefits. The TBL framework and tool could also potentially help Reclamation evaluate water reuse under the recently completed P&Rs.

Currently 53 projects have been authorized under Reclamation's Title XVI Program and several other projects have completed Title XVI feasibility studies and are awaiting new construction authorizations. A rigorous TBL approach could help simplify the ranking criteria Reclamation currently uses to allocate Title XVI funding for authorized construction projects. Water resource managers at all levels could use this tool to make important funding decisions, such as those made under a capital improvement program, and to help educate the public/rate payers on the numerous benefits of reuse. The tool and application could help promotes a fair and unbiased comparison of the true TBL costs and benefits of water reuse options with other alternative supply options that are under consideration.

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